Environmental Impact Statement (EIS) assessment report under the *Environmental Protection Act 1994*

Ensham Life of Mine Extension

Proposed by Ensham Joint Venture

November 2021

Queensland Government

Prepared by: Environmental Impact Assessment, Department of Environment and Science

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ACH Act	*Aboriginal and Cultural Heritage Act 2003*
AEIS	Amended environmental impact statement
ALA	Atlas of Living Australia
ALC	Agricultural land classifications
BOM	Bureau of Meteorology
BPA	Biodiversity planning assessment
BRB	Brigalow Belt Bioregion
Brigalow TEC	Brigalow (Acacia harpophylla dominated and co-dominated) TEC
CBA	Cost-benefit analysis
CG	Coordinator General
CHDC	Central Highland Development Cooperation
CHMA	Cultural heritage management agreement
CHMP	Cultural heritage management plan
CHPP	Coal handling preparation plant
CHRC	Central Highland Regional Council
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
DAF	Department of Agriculture and Fisheries
DSDSATSIP	Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships
DAWE	Department of Agriculture, Water and Environment
DES	Department of Environment and Science
DIDO	Drive-in drive-out
DTMR	Department of Transport and Main Roads
DRDMW	Department of Regional Development, Manufacturing and Water
DSDILGP	Department of State Development, Infrastructure, Local Government and Planning
EA	Environmental authority
EC	Electrical conductivity
EIS	Environmental impact statement
EO Act	*Environmental Offsets Act 2014*
EO Regulation	Environmental Offsets Regulation 2014
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP (Air)	Environmental Protection (Air) Policy 2019
EPP (Noise)	Environmental Protection (Noise) Policy 2019
EPP (Water and Wetland Biodiversity)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019

EP Regulation	Environmental Protection Regulation 2008
ERA	Environmentally relevant activity
ESA	Environmentally sensitive area
EV	Environmental value
FIFO	Fly-in fly-out
FoS	Factors of safety
FTE	Full time equivalent
GDEs	Groundwater dependent ecosystems
GHG	Greenhouse gas
HES	High ecological significance
HVR	High value regrowth
IESC	Independent expert scientific committee on coal seam gas and large coal mining development
LGA	Local government area
LiDAR	Light detection and ranging
MAW	Mine affected water
MDL	Mining development lease
ML	Mining lease
MLA	Mining lease application
MNES	Matters of National Environmental Significance
MOU	Memorandum of understanding
MR Act	*Mineral Resources Act 1989*
MSES	Matters of State Environmental Significance
MSQ	Maritime Safety Queensland
Mtpa	Million tonnes per annum
MWMS	Mine water management system
NC Act	*Nature Conservation Act 1992*
NGER	*National Greenhouse and Energy Reporting Act 2007*
NNTT	National Native Title Tribunal
NPI	National pollutant inventory
NPV	Net present value
NT Act	*Native Title Act (Cwth) 1993*
OCG	Office of Coordinator General
PAA	Priority agricultural area
PFA	Prefeasibility assessment
PM_{10}	Particular matter 10µm or less in diameter
$PM_{2.5}$	Particular matter 2.5µm or less in diameter
PMF	Probable maximum flood
PMLU	Post mine land use

PMST	Protected matters search tool
PRC Plan	Progressive rehabilitation and closure plan
QAS	Queensland Ambulance Service
QFES	Queensland Fire and Emergency Services
QWQG	Queensland water quality guidelines
RE	Regional ecosystems
REDD	Regional Ecosystems Description Database
REMP	Receiving environment monitoring program
Resources	Department of Resources
RIDA	Regional interests development approval
ROM	Run-of-mine
RPI Act	*Regional Planning Interests Act 2014*
RTK-GPS	Real time kinematics-global positioning system
SCL	Strategic cropping land
SDPWO Act	*State Development and Public Works Organisation Act 1971*
SIA	Social impact assessment
SIMP	Social impact management plan
SIMR	Social impact management report
SMP	Subsidence management plan
SPRAT	Species Profile and Threats Database
SRI	Significant residual impact
SSRC Act	*Strong and Sustainable Resource Communities Act 2017*
STP	Sewage treatment plant
TARP	Trigger action response plan
TAP	Threat abatement plan
TDS	Total dissolved solids
TEC	Threatened Ecological Community
TOR	Terms of reference
TSP	Total suspended particles
TSS	Total suspended solids
TSSC	Threatened Species Scientific Committee
UWIR	Underground water impact report
VM Act	*Vegetation Management Act 1999*
WaTERS	Water tracking electronic reporting system
Water Act	*Water Act 2000*
WAV	Worker accommodation village
WMP	Water management plan
WQO	Water Quality Objectives
WSBM	Water and salt balance model

WTP	Water treatment plant

1 Introduction

This Environmental Impact Statement (EIS) assessment report ('assessment report' hereafter) for the proposed Ensham Life of Mine Extension Project (the project) was prepared by the Department of Environment and Science (the department) pursuant to Chapter 3 of the *Environmental Protection Act 1994* (EP Act). It provides an evaluation of the EIS prepared by Ensham Joint Venture, comprised of Idemitsu Australia Resources Pty Ltd, Bligh Coal Limited and Bowen Investment (Australia) Pty Ltd. ('the proponent' hereafter). The scope of the matters dealt with in the EIS were defined in the terms of reference (TOR) published by the department in November 2020.

This report is an assessment of the proponent's EIS. It outlines the findings of the EIS and information provided through public and agency consultation. This assessment report:

- summarises the proposed project, the EIS process and the regulatory approvals that would be necessary for the project to proceed (section 3)
- evaluates the potential environmental, economic and social impacts of the proposed project
- assesses the potential impact on prescribed environmental matters under State legislation
- outlines avoidance, planning, management, monitoring and other measures proposed to minimise adverse environmental impacts
- assesses the suitability of the project and identifies matters required to be dealt with for the proposed project to proceed
- identifies issues that were not resolved or that require specific conditions or recommendations for the proposed project to proceed
- recommends conditions relevant to the siting, operation, monitoring, management, offset and other requirements
- completes the EIS assessment process for the project under the EP Act.

This assessment report has been prepared and completed in accordance with the requirements of the EP Act and will assist the department in making decisions under Chapter 5 of the EP Act and other departments in making decisions under their respective legislation. The EP Act EIS process is accredited for the assessment of matters of national environmental significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland (2014). A copy of this assessment report will be given to the Commonwealth Minister for the Environment, who will decide with respect to the controlled action under Part 9 of the EPBC Act.

2 Project description

A detailed description of the proposed project is provided in Chapter 1 Introduction and Chapter 4 Project Description and alternatives of the amended EIS (AEIS) dated 13 August 2021. Additionally, a summary of the key project elements is provided below.

The existing Ensham Mine operation is an open-cut and underground bord and pillar coal mine located approximately 35km of Emerald in Queensland. The proponent is proposing to extend the life of the existing Ensham Mine underground operations by up to nine years beyond the existing Ensham Mine, with sufficient coal reserves to approximately 2037. Ensham Mine operates under EA EPML00732813 and the proponent is not proposing to change the EA which authorises the mining of 12 million tonnes of run of mine (ROM) coal per annum.

The EIS is not consistent in its terminology to describe the project, using ‘project area’, ‘project site’ and ‘project footprint’ interchangeably, despite clarifying that the project site consists of zones 1, 2 and 3 which are areas of proposed underground mining (Figure 1). This assessment report uses ‘project area’ to describe the area within these zones.

The project area would be within mining lease (ML) 7459, ML 70326, ML 70365, and ML 70366 to an area west of ML 70365 within part of Mining Lease Application (MLA) 700061. The proposed project would be comprised of three zones: zone 1 is a portion of MLA 700061 which the Nogoa River and minor tributaries traverse; and zones 2 and 3 located within the existing Ensham Mine mining leases. Land use in zone 1 includes dry land cropping, cattle grazing and irrigation cropping. The project area has a surface area of approximately 2,737ha comprised of: zone 1 (2,134ha); zone 2 (394ha); and zone 3 (209ha).

Capital costs associated with the project are $314.9 million, of which $10.9 million are one-off sustaining costs and $304 million are ongoing costs. The estimated benefits ranged between $217.9 million and $244.1 million and the cost -benefit ratio ranging between 1.17 and 1.19.

The proposed project is expected to have minimal surface impact as existing surface infrastructure on the current MLs would be utilised. Existing associated infrastructure includes ventilation, compressed air, electricity supply, communications, raw water supply, mine dewatering flood protection and surface buildings. The only upgrade would be for the gas drainage where two flares would be installed in zone 2 and another two in zone 3 where fenced exclusion zones would be put in place.

During operation, there would be minor temporary exploration activities including drilling and seismic vibration in all three zones. All environmental harm associated with these activities have been assessed and authorised under the current environmental authority (EA) (EPML00732813).

Underground mining would occur at a depth of 120–210 metres below the surface and the mine design has been completed with a factor of safety (FoS) of 2.11 for bord and pillar working beneath the Nogoa River channel, and an FoS of 1.6 for bord and pillar below the Nogoa River floodplain. Zone 2 is planned to be the first underground mining area within ML 70365. Zone 1 mining would extend in a south-west direction from approximately 2027, and mining in zone 3 in ML 70365 would commence from approximately 2028.

Extracted coal is currently transported from the underground production panels to the ROM storage area using underground conveyors. Existing ROM stockpile/s, loaders and road trains would be utilised during the proposed project. Minor upgrade of the coal handing preparation plant (CHPP) is currently being trialled with a small dry processing module.

The proposed project is not predicted to increase traffic volumes from current approved levels and the access on Duckponds Road was assessed by the proponent as being suitable.

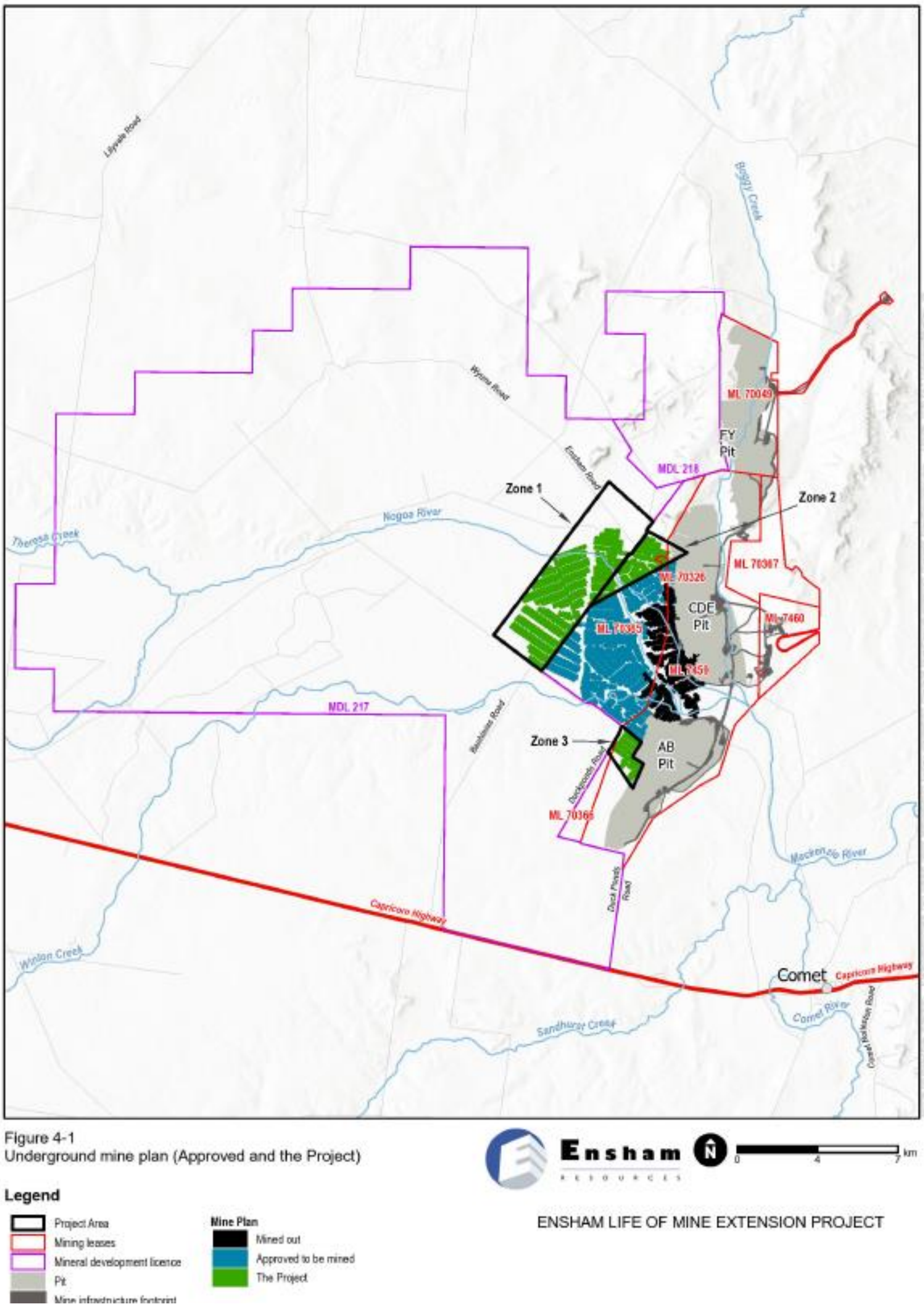


Figure 1 Proposed project area (from EIS Figure 4-1 Underground mine plan)

2.1 Project location

The proposed project would be located adjacent to the existing Ensham Mine, in the western central Bowen Basin, along the Nogoa River, a tributary of the Fitzroy River. The terrain in the area is generally flat, with the area to the west of Ensham Mine a floodplain of the Nogoa River. It is located approximately 200km west of Rockhampton, 25km east of Emerald and 18km north-west of Comet.

Existing land use in zone 1 of the proposed mine site includes cattle grazing, dry land cropping, and irrigation cropping. The Nogoa River and minor tributaries run through this zone, with ephemeral Terresa Creek and releases from Fairbairn Dam feeding into the Nogoa River, providing a year-round flow. Zones 2 and 3 are located within the existing Ensham Mine mining leases. The southern portion of zone 2 includes mapped Strategic Cropping Land (SCL) and Priority Agricultural Area (PAA) while to the north, there is largely cleared land with seismic lines and tracks. Zone 3 comprises of disturbed land with borrow pits, dragline spoil, levees, topsoil stockpiles, pre-strip areas, tracks, and seismic lines associated with the existing open-cut operations at Ensham Mine.

2.2 Tenure

The proposed project comprises of nine registered land parcels, native title values and waterways. The tenure of the proposed project land includes freehold, reserve and leased land. Part of the land is subject to a secondary interest, being a strata easement for a stock route. There is one registered native title claim over the project area by the Western Kangoulu People.

Ensham Joint Venture holds seven MLs and two MDLs within Ensham Mine. Production permits have been identified in zones 2 and 3 of the proposed project area, including ML 7459, ML 80326, ML 70365 and ML 70366. Zone 1 of the proposed project area is located within MLA 700061, a new ML application reference lodged 25 March 2020.

Predominant land uses within the proposed project area include resource activities, cropping, grazing land and waterways. Two homesteads are located within the proposed project area on freehold land, and there are ten homesteads located within the vicinity.

2.3 Project alternatives

Alternative project strategies, mine plans and methodologies were compared by the proponent to determine the optimal concept design. A prefeasibility assessment was undertaken to consider the following strategic alternatives:

- ‘do nothing’ scenario
- development of greenfield mine separate to the existing Ensham Mine
- development of brownfield mine expansion.

The ‘do nothing’ scenario predicated a reduction in community and economic benefits and mine closure in 2028 and was not considered by the proponent to be a preferred outcome. The development of greenfield underground mine would result in additional surface area disturbance and investment to replicate existing onsite coal handling and railing infrastructure.

The brownfield mine expansion was considered as the best scenario due to:

- Ensham Mine existing mining infrastructure allowing the proponent to avoid impacts on surface agricultural land and strategic cropping areas as well as reducing additional infrastructure costs

- existing access to Capricornia Coal Chain including the Blackwater and Moura Rail corridors
- availability of coal resource and positive technical and economic feasibility.

Following the selection of the brownfield scenario, the proponent analysed potential mine plans and mining methodology. There were six underground mine development cases which the prefeasibility assessment (PFA) valuated based on:

- seam thickness and structure
- access to personnel and materials
- conveyor access to the surface
- ventilation requirements.

The mine plan selected by the PFA is based on the design principles used at the Ensham Mine.

2.4 Sensitive receptors

The EIS identified 31 sensitive receptor locations for the purposes of air, noise and visual amenity impacts assessment (Table 1)

Table 1 Sensitive receptors for the project

Sensitive receptor	Distance from proposed project
Resident R01	6.6km
Resident R02	12.6km
Resident R03	8.0km
Resident R04	4.0km
Resident R05	10.5km
Resident R06	9.0km
Resident R07	6.3km
Resident R08	6.4km
Resident R09	6.3km
Resident R10	6.7km
Resident R11	7.2km
Resident R12	6.9km
Resident R13	6.5km
Resident R14	3.1km
Resident R15	3.1km
Resident R16	3.1km
Resident R17	3.1km

Resident R18	3.5km
Resident R19	3.6km
Resident R20	5.1km
Resident R21	11.0km
Resident R22	4.6km
Resident R23	6.4km
Resident R24	12.1km
Resident R25	11.5km
Resident R26	8.7km
Resident R27	17.0km
Resident R28	10.3km
Resident R29	9.8km
Resident R30	13.6km
Resident R31	4.4km
Resident R32	14.4km
Resident R33	12.2km

2.5 Workforce

The Ensham Mine currently employs approximately 687 full-time equivalent (FTE) personnel, who are a mixture of local Emerald and surrounding community-based persons, and drive in/drive out and fly in/fly out persons. Approximately 78% of the workforce are either Emerald based, or drive in/drive out based. The current workforce would remain until approximately 2024 when the current open-cut operations are scheduled to be completed. From that time, the workforce would be approximately 603 FTE personnel until around 2037, inclusive of the proposed project. A further reduction in the mine workforce would occur in approximately 2037 with the remaining workforce undertaking decommissioning and rehabilitation activities.

2.6 Current mine operations

The existing underground mining is accessed through three portals located in Pits C and D (Figure 1) which are also used for ventilating the mine. The coal is transported by road trains on private roads to the coal handing plant (CHPP). The product coal is then transported via rail to Gladstone Power Station and Gladstone Coal Terminal for export overseas.

Methane gas is drained from the target coal seam through in-seam drainage holes that are connected by an underground piping system to a borehole where gas is flared on the surface. This in-seam gas drainage would drain in situ gas in advance of mining to maintain a safe working environment. Flaring would be required to reduce greenhouse gas emissions as required by the Clean Energy regulation and section 318CO *Mineral Resource Act 1989* (MR Act).

The EIS states that existing underground equipment such as continuous underground miners, shuttle cars, mobile bolters, feeder breakers and ancillary underground equipment would continue to be used for the proposed project. The ROM stockpile area is expected to remain approximately the same size and similar loaders and road trains would continue to manage the ROM stockpiles.

The existing CHPP comprises a truck dump station, crushing and screening plant, product conveyors, stackers, reclaim and loadout system. There would be an upgrade of the CHPP, within the footprint of the current CHPP disturbance area. This upgrade includes a dry processing module which removes rock from coal and complies with existing EA.

2.7 Associated infrastructure

The existing underground ventilation system would be extended into the proposed project area and would be developed in line with current practices and procedures. To provide a safe working environment in the underground works, coal seam drainage gas would be vented in zones 2 and 3 via flaring infrastructure. A total of four flares would operate continuously on existing mining leases: two flares in zone 2 (ML 70326, ML 70365 and ML 7459), and two flares in zone 3 (ML 7459 and ML 70366). There would be an exclusion area around the flaring infrastructure of 80m by 20m. Flaring stacks would be approximately 8m tall with a flare height of up to 3m above the stack.

Existing infrastructure would be used for: compressed air in Pit C; regulated structures for flood protection; and electricity supply of 66 kilovolts. The existing underground fibre optic communication network would be extended for the proposed project. There would be no other new surface buildings required for the proposed project.

For water supply, the EIS proposed no changes to water licencing. Additional piping and booster pumps would need to be installed underground to supply the required water pressure. The EIS also proposes extension of the current dewatering system of mine affected water with additional underground piping and booster pump installation.

2.8 Transport infrastructure

The EIS predicts no increase in traffic volume with existing access facilities for Ensham Mine on Duckponds Road predicted to be suitable to cater for the proposed project. Additionally, the proposed project would utilise the Rockhampton to Longreach Queensland Rail network system for delivery to both Gladstone Coal Terminal and Gladstone Power Station. No changes to the rail transport or port operations are proposed.

2.9 Waste

The proposed project would utilise the existing waste management systems onsite for the mining and non-mining wastes as well as waste water and air emissions.

Waste rock produced from the coal handling plant is approximated at 18,000m^3 per annum which would be placed into Pit C and Pit D. The total estimated waste rock over the life of proposed mine expansion is 225,000m^3.

Non-mine waste includes the following and will be dealt with as per the existing Ensham Mine:

- general domestic waste

- plant and equipment waste such as tyres, batteries, oil filters and hydrocarbon contaminated waste
- electrical and electronic wastes
- solvents, paints, drums and packaging
- sewage
- minor amounts of medical and clinical wastes.

3 Environmental impact assessment process

The EIS for the proposed project was jointly assessed under Queensland's EP Act and the Commonwealth EPBC Act. The EIS process under the EP Act was used in accordance with the assessment bilateral agreement between the Commonwealth of Australia and the State of Queensland. Further information on the EIS process under the EP Act is described in the department Guideline titled *'The EIS process for resource projects under EP Act'* which is available on the department's website at www.des.qld.gov.au (DES 2019d).

3.1 Environmental Protection Act 1994

Key steps undertaken in the project's EIS assessment process were as follows. This is also listed in Table 2.

- On 24 April 2020, the proponent applied to the department for approval to voluntarily prepare an EIS. The application included an initial advice statement, and a list of interested and affected persons. On 4 June 2020, the department approved the application. Between 3 August and 15 September 2020, the draft TOR document was publicly notified inviting comment on the draft TOR. The proponent responded to all comments received by the department during the comment period. After consideration of the responses and all comments received, the department issued the final TOR for the EIS on 12 November 2020.
- On 12 March 2021, the proponent submitted their EIS to the department.
- The department determined that the EIS sufficiently addressed the TOR and the project was able to progress to public notification. Public notification was contingent on the proponent providing additional information required by the Independent Expert Scientific Committee on coal seam gas and large coal mining development (IESC). A 30-day public submission period was nationally advertised, commencing 27 April 2021 and closing 8 June 2021.
- On 13 August 2021, the proponent provided to the department an AEIS addressing submissions on the EIS, including the additional information requested by the IESC. The proponent's response to critical issues raised in submissions were assessed by the department and other State and Commonwealth departments.
- On 10 September 2021, the department decided the response to submissions and the amended EIS were adequate for the EIS process to proceed.
- On 24 September 2021, a notice of decision to allow the EIS to proceed was provided to the proponent.

Table 2 Key steps undertaken during the EIS process for the project

Step in the EIS process	Date completed
A mining lease granted (ML 70365)	4 November 2010
A mining lease applied (ML 700061)	25 March 2020

Step in the EIS process	Date completed
The proponent prepared and submitted a voluntary EIS application to the department	24 April 2020
The department approved the voluntary EIS application	4 June 2020
Proponent referred the project to the Commonwealth Environment Minister for the Department of Agriculture, Water and the Environment former Department of Environment and Energy	11 May 2020
Commonwealth Minister for the Environment decided the project is a ‘controlled action’	29 June 2020
The proponent prepared and submitted a draft TOR to the department	13 July 2020
Comment period for the draft TOR	3 August to 15 September 2020
The department finalised the TOR	12 November 2020
Proponent submitted the EIS	12 March 2021
The EIS submission period	27 April to 8 June 2021
Submissions were provided to the proponent	22 June 2021
The period within which the proponent had to prepare a response to submissions was changed by agreement	20 July 2021
The proponent responded to the submissions, provided an amended EIS and submitted an EIS amendment notice to the department	13 August 2021
The department decided the response to submissions and amended EIS were adequate for the EIS process to proceed	10 September 2021
Notice of decision for EIS to proceed	24 September 2021
The department prepared the EIS assessment report	9 November 2021
EIS assessment report finalised and issued to the proponent completing the EIS process	9 November 2021

3.2 Environment Protection and Biodiversity Conservation Act 1999

The proposed project was referred on 6 May 2020 to the Commonwealth Department of Agriculture Water and Environment (DAWE) to determine whether the action should be controlled. On 29 June 2020, the Minister for the Environment determined the proposed project to be a controlled action (EPBC 2020/8669) to be assessed by EIS in accordance with the bilateral agreement with the State of Queensland. The Minister determined that the proposed action was likely to have a significant impact on two controlling provisions:

- listed threatened species and communities (sections 18 and 18A)
- a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

The potential impacts of the proposed project on the controlling provisions were assessed under Queensland’s EIS process which has been accredited for the assessment under the EPBC Act in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland (2014).

On 12 November 2020, the department finalised the TOR for the project which included a specific MNES appendix.

On 12 March 2021, the proponent submitted a draft EIS to the department. The EIS was released for public notification between 27 April 2021 and 8 June 2021. The department, as the assessing agency, reviewed the proposed project's EIS against Appendix 3 of the TOR, EPBC Act guidelines and other relevant conservation advice and technical information.

As per the bilateral agreement, DAWE carried out its own review of the EIS assessment documentation. DAWE provided a submission during the public EIS notification period and subsequent comments on the amended EIS on 13 August 2021.

DAWE and the department sought advice on the water resource controlling provision from the IESC. This is a statutory body under the EPBC Act that independently advises government regulators on the impacts that large coal mining development may have on Australia's waters resources. The IESC provided advice on the proposed project on 29 June 2021.

DAWE provided comments to the department on the draft of this EIS assessment report as required by the administrative arrangements under the bilateral agreement. Section 4.15 MNES of this assessment report explains the extent to which the Queensland Government EIS process addresses the actual or likely impacts of the proposed project on the controlling provisions under the EPBC Act and provides a conclusion about the acceptability of the impacts considering the commitments to undertake mitigation and management measures.

A copy of the final EIS assessment report will be provided to DAWE. The Minister for the Environment (or a delegate of the Minister) will decide whether to approve or refuse the controlled action under Part 9 of the EPBC Act and if relevant, apply conditions to the approval necessary to protect MNES.

3.3 Consultation

3.3.1 Commonwealth Department of Agriculture, Water and the Environment

DAWE was consulted throughout the assessment and attended various meetings with the department and the proponent. DAWE, in its capacity as an advisory agency to the department, provided adequacy reviews of the TOR and EIS prior to public notification. Section 3.2 details DAWE submissions and comments during the EIS process.

3.3.2 Public consultation

Chapter 2 of the EIS outlined the public consultation program carried out by the proponent. The proponent completed the statutory requirements for advertising the TOR and EIS notices and mailing those notices to interested and affected persons. In addition, the proponent undertook community consultation with members of the public and other stakeholders before, during and after the public submission period of the EIS in accordance with the Coordinator-General's Social Impact Assessment guideline (required in the TOR).

The proponent reported that community and stakeholder consultation activities included:

- one-on-one meetings with landholders and local community groups
- government agency meetings and briefings
- elected representative briefings
- establishment of key project contact points
- factsheets/ newsletters and letters
- media releases
- statutory consultation and public notice advertisements published in local and national newspapers

- information provided on the proponent’s website; including making the EIS available online.

3.3.3 Advisory body

The department consulted the following organisations to assist in the assessment of the draft TOR and EIS for the proposed project:

- Department of Agriculture and Fisheries (DAF)
- Department of Agriculture, Water and Environment (DAWE)
- Department of Children, Youth Justice and Multicultural Affairs
- Department of Communities, Child Safety and Disability Services
- Department of Communities, Housing and Digital Economy
- Department of Education
- Department of Employment, Small Business and Training
- Department of Energy and Water Supply
- Queensland Fire and Emergency Services
- Department of Health
- Department of Housing and Public Works
- Department of Local Government, Racing and Multicultural Affairs
- Department of Regional Development, Manufacturing and Water (DRDMW)
- Department of Resources (Resources)
- Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships (DSDSATSIP)
- Department of State Development, Infrastructure, Local Government and Planning
- Department of Transport and Main Roads (DTMR)
- Department of Tourism, Innovation and Sport
- Fitzroy Basin Association
- Government Employee Housing, Department of Energy and Public Works
- Mackay Conservation Group
- Mackay Regional Council
- Office of the Coordinator–General (under DSDMLGP) (OCG)
- Office of Industrial Relations Workplace Health and Safety
- Queensland Ambulance Service
- Queensland Government Accommodation Office
- Queensland Health—Mackay Public Health Unit
- Queensland Police Service
- Queensland Treasury (Workplace Health and Safety Queensland)
- Capricornia Catchments Inc.

- Central Highlands Regional Council
- Energy Queensland
- Ergon Energy
- Queensland Farmers' Federation
- Road Accident Action Group Inc.
- Sunwater Ltd.

The department further consulted with Resources, DRDMW, DAF, DSDSATSIP, DTMR, OCG and DAWE on the amended EIS.

3.3.4 Public notification

In accordance with statutory requirements, public notices were placed in *The Australian* and *Buy search sell.com.au* to notify the availability of the draft TOR and EIS for review and public comment.

The draft TOR and EIS were placed on public display at the following locations during their respective public comment and submission periods:

- the Queensland Government website: https://www.qld.gov.au/environment/pollution/management/eis-process/projects/current-projects/ensham-life-of-mine-extension-project
- the proponent's website: https://www.idemitsu.com.au/mining/projects/ensham-life-of-mine-extension-project/

3.3.5 Key matters raised in submissions

The department finalised the TOR after considering comments from the proponent, advisory bodies and the public.

The published EIS for the proposed project attracted 25 submissions within the submission period, including one from the department, one from DAWE, 14 from other State government organisations, and 10 non-government submissions. Nine of these submissions had nil comments on the proposed project. There were two additional submissions outside of the submission period, which the department accepted as a submission.

All government agencies that made submissions raising matters were given the opportunity to review and provide comments on the amended EIS. The department also sought comments and recommendations on conditions that should apply to the proposed project and on the adequacy or otherwise of the amended EIS chapters in addressing concerns raised in submissions.

Key matters raised in submissions on the draft EIS are summarised in Table 3. These matters, as well as other comments and recommendations made in submissions were addressed by the proponent in their response to submissions and in changes made to the EIS. These matters raised and any other comments and recommendations made by the advisory body on the EIS documents were considered by the department in undertaking the assessment of the EIS and in reporting the findings and recommendations in this assessment report.

Table 3 Key matters raised in public and agency submissions on the EIS

Topic	Issue summary
Project description	• Mining lease ML 70049 expires in 2028 • cumulative impacts, avoidance and mitigation measures not adequately addressed

Topic	Issue summary
	• Impact assessment based on anecdotal information • Mine closure and rehabilitation not addressed adequately. Proposed project should be included in the Ensham Mine Progressive Rehabilitation and Closure Plan (PRC Plan) which should consider cumulative impacts • Demonstrate how the proposed project would comply with Environmental Protection (Air) Policy 2019 (EPP (Air)) annual average objective
Surface Water / Groundwater	Surface water • Provide details of the trends in water quality by presenting long-term data for all available bores, surface monitoring points and gauging stations, referenced to climatic events • Provide a receiving environment monitoring program (REMP) that includes the proposed project footprint and that meets the content requirements of the Department of Environment and Science guideline Receiving Environment Monitoring Program (ESR/2016/2399) • Investigate the recent increasing electrical conductivity (EC) trend at this monitoring point and identify the possible source • Drainage flares should be constructed and operated a minimum 100m distance away from waterways providing for fish passage • Ensure the bord and pillar mining under waterways providing for fish passage does not alter surface water flows • The Biosecurity Plan should assess and mitigate the risk of introduction or spread of identified priority species to the project area or adjacent areas • Fish passage would need to be counterbalanced should the project result in significant residual impact to waterways • Ensure surface disturbance and impacts to waterways providing for fish passage are avoided • No spoil to be disposed of within waterways Groundwater • Obtain baseline data for the proposed new monitoring bores before construction modelling • Explain and justify why a 2m drawdown threshold has been proposed • Conduct more recent field bore census than 2014 • Demonstrate and justify in the EIS that the alluvial water quality and water level is not influenced by the Nogoa River, and that alluvial water is primarily influenced by irrigation and rainfall • Install additional bores for the monitoring and compliance program. Upgradient alluvial monitoring points must be incorporated into the monitoring program design • Elucidate and justify the hydrogeological conceptual models, particularly the nature of the groundwater–surface water interactions • Improve confidence in the groundwater modelling by expanding the sensitivity analysis for key hydrogeologic parameters • Amend to reflect that groundwater is regulated in the Highlands Ground Water Management Area under the Water Plan (Fitzroy Basin) 2011
Land/ ecology	Ecology • Provide details of how the National Recovery Plan for white throated snapping turtle applies • Expand study area beyond the 50km radius for potential impacts to groundwater springs • Assess Groundwater Dependent Ecosystems (GDEs) of riparian vegetation and Brigalow on alluvial sediments by using direct techniques as described in Doody et al. (2019) and Jones et al. (2019)

Topic	Issue summary
	Subsidence • Recalculation and minor adjustment of the pillar FoS design curves • Adoption of a lower probability of failure/higher FoS criteria for the pillar panels that lie beneath the Nogoa River and an adjacent angle of drawdown corridor on either side • Addition of a small depth loading supplement (6m) to all design figures to provide for the potential maximum weight of floodwater above the project area which lies under the flood plain • Consider wider barrier pillars between sub-panels, designed to a higher FoS value • Provide clarity and guidance to the mine operator to enable a simple but reliable and effective means of managing mining heights (and bell-out geometries) in each panel to avoid any exceedances • Clarify the known geological structures across the Project area and how these have been taken account of within the design • Subsidence assessment is based on anecdotal information • Assess long term impacts of flooding the underground mined void; provide rehabilitation methodology on groundwater, GDEs and impacts on surface water • Provide an alternative to flooding of the underground void • Assess subsidence effects on irrigated cropping • Assess nature and severity of impacts on soil composition during and after mining • Identify a width to height ratio that will ensure the pillars have permanent stability, which means that the design would ensure that the likelihood of failure of the pillar system leading to non-compliance is no more than 1 in 1 million, using pillar design methodology for multi-seam mining stress environments (e.g. experts have suggested 7–8) • Identify any required mitigation measures to prevent permanent impacts on the strategic cropping land status of the land due to changes in the direction or concentration of surface water flows (i.e. runoff) and potential ponding of water, or required soil erosion mitigation structures (contour banks or laser levelling) on the basis of subsidence induced from pillar collapse in the long term (e.g. 20 years, 50 years and 200 years post mining) • Provide the subsidence management plan (SMP) Land suitability assessment • Provide geochemical assessment and characterisation of the project area • Appendix B of the EIS contradicts Chapter 8 in regard to methodology of land suitability assessment • Land suitability assessment should be completed in accordance with Guidelines for Agricultural Land Evaluation in Queensland 2015 • Provide evidence that supports the validity of the rules used to determine the land suitability conclusions • Demonstrate whether the proposed activity will require an application for a Regional Interests Development Approval (RIDA) • Secure all appropriate tenures • Engage with Resources to assess likely implications of native title to the project area. State land tenure dealings, including native title, may take an extended period to negotiate • The supporting information for the PRC Plan provided in the EIS must meet the requirements of the EP Act and the prescribed guideline Progressive Rehabilitation and Closure Plans (ESR2019/4964) (DES 2019a) • Demonstrate in the EIS how the proposed post-mining land uses are consistent with the outcomes of consultation with the community
Social/ economic	• Air quality issues for neighbouring landholders • Include results of further consultation with affected landholders on potential subsidence impacts • Confirm details of the existing Aboriginal and Torres Strait Islander workforce profile and

Topic	Issue summary
	proposed workforce target • Clarify scope of additional business opportunities that may be available as part of mine closure • Encourage increasing employment opportunities for people with disability and seniors, either through the mine or in the region more broadly • Housing should be situated close to community facilities such as medical facilities and be accessible via public transport or on foot • There is no DSDSATSIP disability services in the local area. This is managed as part of NDIS
Transport	• Incorrect rail network • Commitment to ensuring ships contracted for the ongoing export of coal • Include Port operations in Chapter 23–Transport
GHG	• No mitigation measures provided for impacts from scope 1 and scope 2 emissions • Scope 3 GHG emission should be presented in the EIS, and avoidance and mitigation measures identified

3.4 Matters considered in the EIS assessment

This assessment report fulfils the requirements of the prescribed matters of the EP Regulation and the EP Act.

The following matters were considered by the department in the assessment of the EIS:

1. The final TOR for the EIS, issued in November 2020, set out the key information requirements to be considered in the EIS, including critical and routine matters. While they were not exhaustive, the TOR outlined the scope of critical matters that should be given detailed treatment in the EIS. The TOR stated that if significant matters arose during the course of preparation of the EIS that were not incorporated in the TOR (e.g. currently unforeseen issues that emerge as important or significant from environmental studies) then these issues should be fully addressed in the EIS.
2. The submitted EIS which refers to the combined submitted documents provided by the proponent. The submitted EIS comprised of:
    - the EIS submitted 12 March 2021 that was made available for public submissions from 27 April 2021 to 8 June 2021
    - the AEIS submitted 13 August 2021 consisting of:
        - the proponent’s summary of the submissions
        - a statement of the proponent’s response to the submissions EIS (referred to as the ‘Response to Submissions’ in this assessment report)
        - any amendments made to the submitted EIS because of the submissions (referred to as the ‘AEIS’ in this assessment report).
3. Other information provided to the department prior to the assessment report being completed are included in the appendices of this assessment report.
    - Appendix D – Amended table of commitments to include soil survey and social impact assessment commitments, received on 15 September 2021
    - Appendix E
        - URS 2005 Geotechnical Characterisation Overburden and Rejects, received on 6 September 2021

        - URS 2015 Geotechnical Characterisation Overburden and Potential Rejects, received on 6 September 2021

4. All properly made submissions and any other submissions accepted by the chief executive.
5. The standard criteria listed in schedule 4 of the EP Act.
6. Matter(s) prescribed under a regulation. For the purpose of assisting the decision stage of the EA assessment, the regulatory requirements, which the department is required to comply with for all environmental management decisions, are listed in Chapter 4 of the EP Regulation and include:
    - assessment against the environmental objectives and performance outcomes specified in schedule 8, part 3 of the EP Regulation for the operational assessments of air, water, wetlands, groundwater, noise, waste and land; and the land use assessment of site suitability, location on site and critical design requirements
    - environmental values declared under the EP Regulation
    - the attributes for the area under the *Regional Planning Interests Act 2014* (RPI Act)
    - environmental protection policies
    - MNES under the EPBC Act (listed threatened species and ecological communities).
7. Section 59 of the EP Act requires that an EIS assessment report must:
    - address the adequacy of the EIS in addressing the final TOR
    - make recommendations about the suitability of the project
    - recommend any conditions on which any approval required for the project may be given
    - contain another matter prescribed under a regulation.

4 Assessment of the EIS

This EIS assessment report fulfils the content requirements of section 56A of the EP Act and section 9 of the EP Regulation. The assessment also suitably addresses the requirements of Schedule 8 of the EP Regulation.

This section of the assessment report addresses the required content of the TOR and it discusses in more detail the adequacy of the EIS, taking into account key matters of concern identified in the EIS and particularly those of significant concern raised in submissions. The level of detail of the assessment considers the significance of the potential impacts of the project, particularly having regard to the impacted environmental values.

The critical and routine matter in sections 9.1–9.15 of the TOR are reproduced in the same order. Each matter provides a summary of the existing environmental values, potential impacts and avoidance, mitigation and management measures, commitments and any recommendations and regulatory requirements for the project to be suitable to proceed.

The assessment of the amended EIS by the department and advisory agencies has identified further work that would need to be completed prior to the EA application and prior to any environmental conditions being finalised for an EA approval. Recommendations for resolving these issues are detailed in relevant sections of this assessment report.

4.1 Project alternatives

The EIS described feasible alternatives to the proposed project. Several scenarios were considered to evaluate the relative social, economic and environmental advantages and disadvantages of different project alternatives. Results were used to select the final project proposal and scope.

The ‘no development scenario’ was not preferred given that the employment workforce will cease in 2028 and the project will miss out on $256 million State royalties which could be derived from the additional coal resources.

The brownfields scenario was identified to be economically beneficial compared to the greenfield scenario as there would be infrastructure and transport to be managed, while still extended the life of the project by nine years.

Mining method of bord and pillar was selected to be the best option for mining under the Nogoa River and its floodplain as decided for the existing Ensham Mine.

Ecological sustainable development was reviewed against the objectives of National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee, 1992).

4.2 Climate

Climate was addressed in the following EIS sections: Chapter 6 Climate; Appendix G-1 Air Quality Impact Assessment; Chapter 11 Flooding and geomorphology; and Chapter 19 Hazards and safety. The waste management section of this assessment report (section 4.10) also addresses climate impacts.

The TOR required the EIS to describe the proposed project area’s climate patterns regarding proposed discharges to water and air. The EIS was to assess the vulnerability of the mine site area to natural and induced hazards, and climate change, while considering the relative frequency and magnitude of these events, including describing possible adaptation strategies to minimise the risk of impacts from climate change.

4.2.1 Assessment

The EIS adequately described the regional climatic conditions and the potential impacts of climate, natural disasters, natural hazards (including, floods, bushfires and cyclones) and climate change. It also set out climate change adaptation strategies. Likely changes to observed mean temperatures, annual rainfall, and cyclone activity are anticipated to amplify over the next century (CSIRO 2015). However, the expected frequency and intensity of storms and cyclones are unlikely to change significantly in the project area during the life of the proposed project. A climate risk assessment identified potential impacts to the project from climate change and extreme climate events, including bushfire, flood hazards, and cyclones.

The EIS has assessed the proposed project area against impacts of natural hazards. The project area is within a drought declared area and a heightened bushfire risk area. The bushfire risk in the region extends from mid-late winter through to early summer. Bushfire risk increases because of reduced rainfall and increased temperature, leading to increase in amount of dry grass available. The proposed project is unlikely to alter the risk profile of the existing Ensham Mine.

The area is prone to thunderstorms and heavy rains with the proposed project located within the floodplain of the Nogoa River. The river catchment land use is predominantly rural with the Fairbairn Dam upstream of Emerald supplying water for industries, agricultural and residential users. Two major floods have been recorded for this area (2008 and 2010).

Ensham Mine has several flood protection measures and the proposed project will not alter the current profile of the risk of flooding. To mitigate the risk of flood impacts, the proposed project will have increased pillar dimensions as discussed in the land section (section 4.3) of this assessment report.

4.2.2 Conclusions

The EIS adequately addressed the requirements of section 9.1 of the TOR in relation to climate. The values and the potential risks have been adequately described. Climate factors have been also assessed in relation to the proposed project's discharges to water and air, and the propagation of noise.

The proposed project includes design controls and strategies to adequately mitigate risks to climate factors.

4.3 Land

EIS Chapter 7 Land use and tenure described the current tenure and land use of the proposed project area. EIS Chapter 8 Land resources, described and assessed topography, geology, soils, and visual amenity of the proposed project. Rehabilitation was addressed in EIS Chapter 9 Rehabilitation and closure. Additional information was also presented in EIS Appendix B-1 Land Resources, B-2 Subsidence, B-2a Ensham Subsidence Management Plan and B-2b Sinkhole and Subsidence Assessment.

Section 9.2 of the TOR required the EIS to adequately describe any changes to:

- landscape and visual amenity
- tenure arrangements
- temporary or permanent land use changes
- any conflicts in land use and suitable proposed mitigation measures
- impacts to the existing stock route
- whether there is contaminated land on the site
- existing or potential native title rights impacted by the proposed project.

4.3.1 Assessment

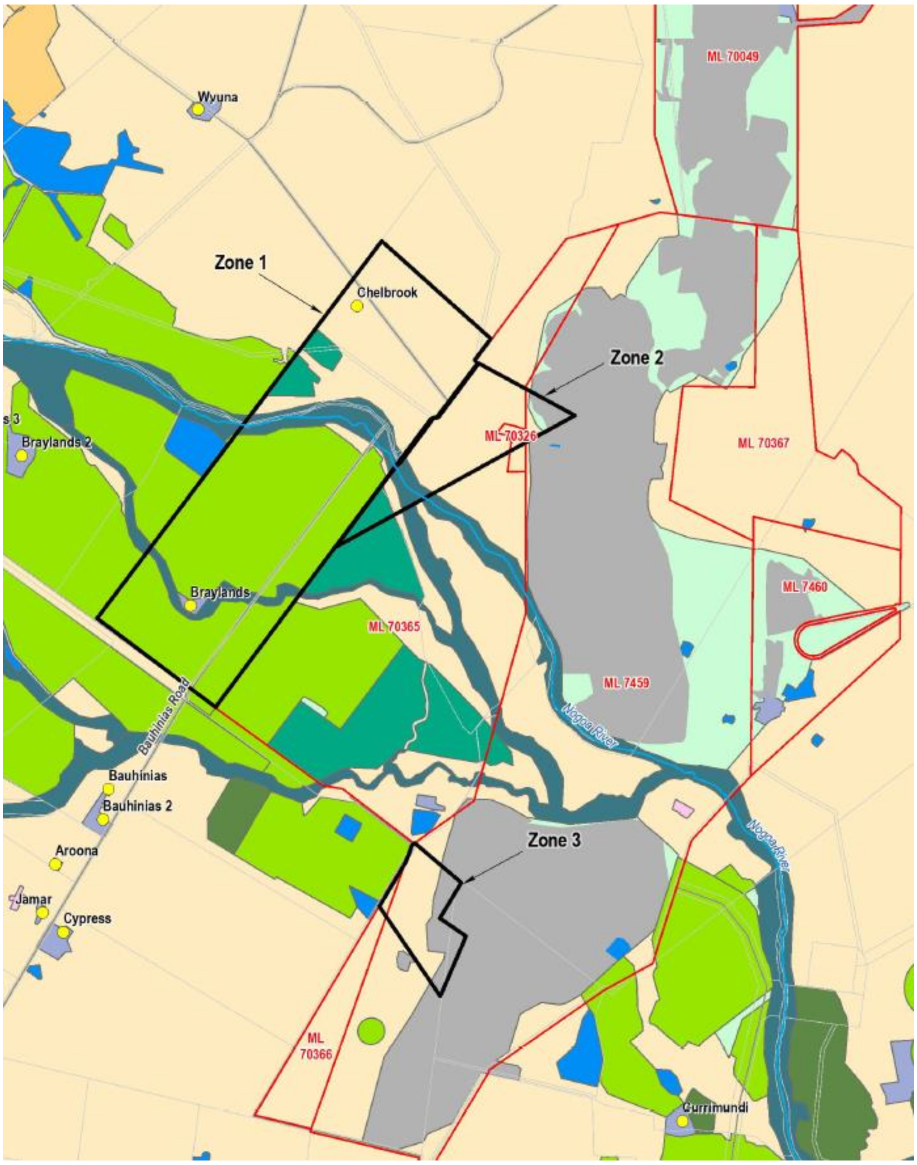
Tenures relevant to the proposed project are ML 7459, ML 70326, ML 70365, ML 70366 and MLA 700061 (MLA is marked by the borders of zone 1) (Figure 2). Land use at the project area includes cropping, grazing and resources activities. The project area is divided into zones 1, 2 and 3 and intersects with nine registered land parcels, including two homesteads on freehold land, being Braylands and Chelbrook (

Table 4). The land also has native title values (see below) and ecological values (assessment report sections 8 and 17).

4.3.1.1 Native Title

The TOR required the EIS to identify native title rights potentially impacted by the proposed project. The EIS identified one registered native title claim over the entire project area by the Western Kangoulu People (QC2013/002).

The EIS identified one native title claim within the project area - the Western Kangoulu People, Tribunal number QC2013/002. The EIS noted that the proponent will not carry out operations under ML 700061 in zone 1 until a native title agreement is in place. Resources highlighted that native title must be adequately addressed in accordance with the *Native Title Act (Cwth) 1993*, prior to the granting of any tenure over state lands. Resources recommended that the proponent engage with them as a native title agreement can take an extended amount of time. In response, the proponent advised that negotiation with the Western Kangoulu People had commenced in October 2019, but agreement was unable to reached by December 2020. The proponent therefore filed a future act determination application with the NNTT (National Native Title Tribunal). On 21 May 2021, the NNTT made a determination that the MLA may be granted.



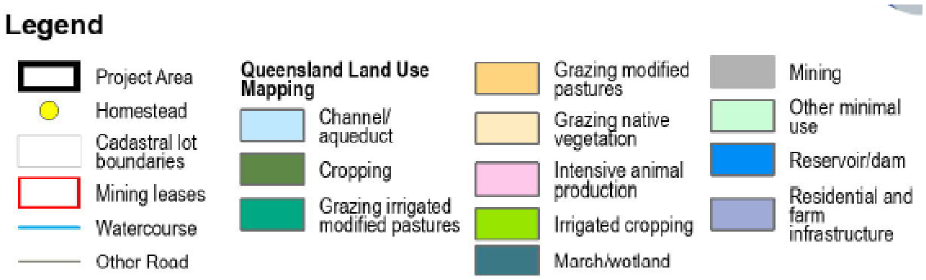


Figure 2 showing mining leases (ML) and land use of the project area. Zone 1 is within the MLA 700061 (from EIS Chapter 7 Figure 7-4)

Table 4. Tenure of land parcels within the project area (from EIS Chapter 8 Table 8-1)

Lot on plan	Current landowner	Tenure type
Lot 6 TT309	Central Highlands Regional Council (CHRC) (Reserve)	Reserve lands lease
Lot 7 TT309	CHRC (Reserve)	Reserve lands lease easement
Lot 8 TT345	Cowal Agriculture Holdings Pty Ltd	Freehold
2 CP911010	Privately Owned	Freehold
Lot A AP7202	CHRC (Reserve)	Reserve lands lease
Lot 32 RP908643	Idemitsu Australia Resources Pty Ltd, Bligh Coal Limited and Bowen Investment (Australia) Pty Ltd	Freehold
Lot 30 CP864574	Idemitsu Australia Resources Pty Ltd, Bligh Coal Limited and Bowen Investment (Australia) Pty Ltd	Freehold
Lot 31 CP864573	Idemitsu Australia Resources Pty Ltd, Bligh Coal Limited and Bowen Investment (Australia) Pty Ltd	Freehold

4.3.1.2 Agricultural and cropping area

The project area is covered by the Central Queensland Regional Plan, which identifies and provides direction on resolving competing matters of State Interests relating to agriculture and the resources sector. The project area is largely within an Important Agricultural Area (IAA) and includes SCL and PAA. These areas are matters of State Interest and the State Planning Policy seeks to ensure that agricultural development opportunities are promoted and enhanced in IAA areas. As the proposed project is within an area of regional interests, prior to commencement of any construction, a RIDA is required under the RPI Act. In further discussions, post-submission of the AEIS, the proponent has indicated that they consider themselves to be exempt from the requirement of RIDA for zone 1 under s22 of the RPI Act because they have a Compensation Agreement with the relevant landholder(s), and they believe that the activity is not likely to have a significant impact on PAA or SCL.

No vegetation clearing is proposed in relation to flare construction. Although a total of four flares will be placed within land mapped as PAA and/or SCL in zones 2 and 3, they are in locations already disturbed by grazing and mining activities.

The EIS failed to address several government guidelines relevant to land assessment. Resources noted that the EIS did not follow the contemporary principles of either land suitability or agricultural land assessment. Resources recommended that the proponent complete a land suitability assessment in accordance with the Guidelines for Agricultural Land Evaluation in Queensland 2015 (DSITI and DNRM 2015), and to follow the rules specified in the Regional Suitability Frameworks for Queensland (DNRM and DSITIA 2013). In response, the AEIS included commitments to update the land suitability assessment and conclusions in accordance with the Guidelines for Agricultural Land Evaluation in Queensland 2015.

Additionally, the EIS failed to comply with the TOR requirement to follow the departmental EIS guideline – Land, which specifies to undertake a soil survey assessment. Instead, the soil mapping in the EIS was based on a desk top survey and was not adequate to characterise soils within the project area. Resources, in their submissions, indicated that there is no evidence to support many of the EIS’s soil map unit boundaries nor the conclusions on land suitability, Agricultural Land Classifications (ALC) or topsoil stripping depths required for restoration. Resources recommended a property-scale soil and land resources survey to be conducted in accordance with recommended best practice soil surveying standards and this was reiterated in another (landholder) submission. In response, there is a commitment in the AEIS to undertake a land suitability assessment soil field survey, and to prepare a report to include site-based soil surveys. It is recommended that this is undertaken by 11 December 2021 as per discussions between the proponent and the department. The department expects the proponent follow through on their commitment to provide results of the soil survey, along with the land suitability assessment and any necessary amendments to the soil type tables and maps from the EIS. There is a potential that the conclusions from the soil survey will contradict those of the AEIS, depending on the findings.

4.3.1.3 Stock route

The EIS identified two stock routes within the project area. One is an open stock route reserve which follows the Bauhinias Road through zone 1. It is classified as minor and unused, although currently supports cropping. The second stock route is located adjacent to (but outside of) zone 1 along its southern boundary. There is no aboveground infrastructure shown in zone 1 and the EIS concludes that the integrity of the stock routes will be maintained.

4.3.1.4 Resource tenements

The EIS has identified several production and exploration permits within the project area. The proponent holds various resource tenements within the existing mine footprint, including seven MLs, and a new application for MLA 700061. A submission raised a concern that ML 70049, where the powerline for the existing mine lies, will expire in 2028, prior to the end of mining. The proponent, in their response to the submission, has made a commitment to enter into another agreement with the relevant landholder and apply for the mining lease.

4.3.1.5 Subsidence

The EIS assessed the stability of the mining operations using the design FoS, pillar dimensions (width to height ratio) and the stability of the overburden. The assessment was based on a project design FoS of 1.6. When making predictions on the degree of subsidence, the proposed project utilised industry accepted University of New South Wales Pillar Design procedure, which accounts for: short and long-term pillar stability; compression of the pillars over the maximum depth of cover; surface cracking and sub-surface cracking. This was then verified based on visual and Light Detection and Ranging (LiDAR) surveys across the existing bord and pillar mining area. The EIS predicted only low levels of subsidence (40mm) that are unlikely to result in formation of significant depressions in the surface topography. The EIS based the verification of the predicted 40mm subsidence on the existing bord and pillar LiDAR data, claiming a high degree of confidence due to the existing data. The department is concerned that the LiDAR data used for the verification of predicted subsidence value of 40mm is not valid as LiDAR has limited sensitivity. Further baseline, reference and ongoing monitoring data will be required to ensure that any minor subsidence is recorded, and mitigation measures put in place.

Subsidence was raised as a concern in multiple submissions on the EIS. Resources raised concerns related to potential subsidence induced permanent impacts and performance measures on the land surface post mining. The potential for the pillars to fail in their function 20, 50 and 200 years post mining was not addressed in the EIS. Furthermore, Resources noted that there was no discussion in the EIS around remediation methods that may be required if the pillars were to fail, nor a subsidence management plan. During the public notification stage, ten other subsidence related submissions were made, five from landholders who were concerned with the impacts on their land. Landowner concerns included subsidence impacting their agricultural land use and the overlying agricultural land values. In their response, the proponent has committed to compensate landowners under the MR Act and to have Compensation Agreements in place with affected landowners prior to granting of the ML (and hence commencing mining activities).

DAF, in their submission, was concerned that the EIS had not assessed the potential impacts to fish passage from subsidence or proposed subsequent mitigation measures, despite fish passage values being identified for the Nogoa River and its tributaries. The AEIS included an SMP and response to submission that incorporates monitoring of subsidence in relation to fish passage and, where impacts to fish passage are linked to mining activity, a commitment that rehabilitation and restoration works will be undertaken. DAF has recommended conditions to be added to the EA to manage and monitor impacts to fish passage from subsidence.

In response to the submissions made on the EIS about potential subsidence and associated impacts, the AEIS included additional LiDAR survey data from an un-mined area within the existing Ensham Mine, collected between 2016 and 2020. The AEIS concluded that there is natural annual variation in ground levels, with vertical movements of 200mm to 500mm. The proponent has therefore proposed that a 300mm or greater change in ground levels should be the trigger for investigation of potential subsidence due to the proposed project. The department sought advice from Resources on this new data. Resources have questioned the validity of the proponent’s methodology that shows such a large variation in the soil surface. They recommended that the SMP should include monitoring measures that are sufficiently accurate to establish the baseline ground levels of the project area and to detect even subtle impacts from subsidence, including to the surface levels of irrigated farmland. Resources also recommended that once the soil mapping has been completed, the SMP should include a map showing soil types overlaid with the locations of subsidence monitoring transects, including within laser levelled paddocks.

The AEIS included ground level survey data collected using Real-Time Kinematic (RTK) GPS from April 2021 at sites on the current underground mine, in both un-mined and recently commenced (May 2021) mining locations. From the limited data, there appears to be a slight increase in subsidence at the site where underground mining has commenced. However, the AEIS concluded that this was related to the rainfall pattern. The department requested LiDAR and RTK GPS survey data for the duration of underground mining and analysis from the proponent for mined and proposed mining areas, in order to better understand the natural subsidence. The data provided in response, showed a similar variation across time for both the mined and unmined areas.

As highlighted in the MNES section (section 4.15) of this report, the department and DAWE jointly requested advice from the IESC on the potential risks and impacts on water resources and related assets from the proposed project. The following advice was provided from IESC in relation to subsidence:

- For measuring subsidence, the accuracy of LiDAR monitoring is limited (given that the accuracy (+/-50mm) is higher than the predicted subsidence (40mm)). Use of a more accurate survey technique is recommended (Hebblewhite conclusion #7; s3.3(b) and s3.3e; IESC paragraphs 1 and 17).
- Addition of a depth loading supplement (6m) to all design figures to provide for the potential maximum weight of floodwater above the majority of the project area which lies under the floodplain (Hebblewhite conclusion #2; s3 of use ‘use of diagrams’ page 21-22).

- Adoption of a lower probability of failure/higher FoS (2.11) criteria for the pillar panels that lie beneath the Nogoa River and an adjacent angle of draw corridor on either side (Hebblewhite conclusion # 3; s3.4b and s2 of use 'use of diagrams' page 20-21).

- Consideration of wider barrier pillars between sub-panels, designed to a higher FoS value (Hebblewhite conclusion #4; s3.4d).

- Provision of clarity and guidance to the mine operator to enable a simple but reliable and effective means of managing mining heights (and bell-out geometries) in each panel to avoid any exceedances (Hebblewhite conclusion #5; s4 of use 'use of diagrams' page 22).

- Further clarity with respect to known geological structures across the project area and how these have been taken account of within the design (Hebblewhite conclusion #6).

In response to the IESC advice on subsidence, the proponent has: included the SMP; commenced measuring surface movement using RTK-GPS; adapted an FoS of 2.11 for pillars beneath the Nogoa River; implemented wider barrier pillars between sub-panels; and committed to managing the mining heights in each panel to ensure the FoS still applies as they mine. The outstanding issues are the lack of sufficient and accurate subsidence data to back up the predicted 40mm subsidence and lack of geological characterisation of the project area. DAWE has recommended that the SMP be peer-reviewed by a suitably qualified mining or geotechnical engineer.

4.3.1.6 Geology

The project area is located within the Bowen Basin, known to be the largest productive coal basin in Australia. The target coal seam layer is in the Rangal Coal Measures and includes Aries and Castor seams. The Rewan Group aquitard overlies the Rangal Coal Measures and separates the coal seam from the Nogoa River and the alluvium. The Rewan Group comprises low permeability siltstones, mudstones and lithic sandstones and can be up to 200m thick.

The EIS relies on previous geochemical studies of the existing mine (Appendix E – URS 2005 and URS 2015) during which a total of 64 samples (49 overburden sandstone, siltstone and mudstone samples and 17 coal reject samples) were profiled. These studies concluded that there was sufficient acid neutralising capacity to buffer any dissolved acidity. Additionally, it was concluded that there was no risk of waste rock materials that would generate readily mobilised metals nor sulfate.

The EIS notes that approximately 18,000m^3/ annum of waste rock will be generated from the CHPP. Over the proposed life of the mine, there will be 225,000m^3 of waste rock placed into Pits C and D, which is approximately 0.6 per cent of total waste rock volumes (36 million m^3) proposed in the waste management plan for the existing Ensham Mine.

Landholders, members of the public, DAWE and the department all submitted comments on the lack of geochemical analysis of the project area. Geochemical characteristics of the project area were not provided in the AEIS despite the department requesting the information on several occasions. The proposed disposal of waste rock has the potential to contaminate groundwater over time. In the AEIS, the proponent argued that the existing geological survey undertaken in 2015 can be applied to the proposed project due to uniformity of the geology. The results in the survey reports do not demonstrate sufficient uniformity in the geochemistry to justify the lack of the geochemical characterisation of the project area. I therefore recommend further geochemical analysis of the waste rock, and the development and implementation of management and mitigation measures if waste rock is found to have the potential to contaminate groundwater. In addition, the EA will ensure that monitoring of groundwater adjacent to the pits will be continued by the proponent. This is further addressed in the water section (section 4.5) of this assessment report.

4.3.1.7 Contamination

The EIS has identified three Environmental Management Registers within the project area: waste storage, treatment and disposal; mine waste and petroleum product or oil storage; and landfill and mine waste. These are all managed under the existing EA and are not subject to change.

4.3.2 Conclusions and recommendations

The EIS lacks a soil survey for the project area; the proponent has committed to completing it by 11 December 2021. The results of the soil survey analysis will inform the potential impacts from subsidence. If the soil types differ from those presented in the EIS, I recommend that the soil types be amended along with the amended SMP, where required, to ensure monitoring sites are spread across varying soil types. The results of the soil survey for zones 2 and 3 will also be submitted to Resources and DAF for the RIDA application, before the commencement of the operation in these zones.

Without additional data collected using adequate methodologies and statistical analysis, I cannot properly assess the conclusions on subsidence levels. The subsidence monitoring to date, lacks sensitivity in the methodology and hence further monitoring will be required. I recommend that further subsidence monitoring be conducted, and the results included in the SMP which is to be revised annually. The monitoring would include reference sites located outside of the mining footprint; control sites within the mining lease; sites where underground mining will be conducted in the future; and sites where underground mining has already commenced. As recommended by Resources, DAWE and the department, a sensitive method, such as RTK-GPS, is to be used for subsidence monitoring.

In the AEIS, the proponent suggested a 300mm subsidence trigger value for investigating the cause of subsidence. However, the EIS predicted up to 40mm of subsidence as a result of the proposed mining activity. In the absence of reliable site-specific data, I recommend subsidence trigger value of 40mm.

The soil types may impact the level of subsidence, and for this reason, the SMP should also include a map showing soil types (identified through a soil field survey) overlaid with the locations of subsidence monitoring transects, including within laser levelled paddocks.

The EIS does not fully address the monitoring requirements for fish passage, nor mitigation measures should fish passages be impacted. An additional subsidence monitoring location is recommended to detect surface level changes that may impact fish passage. Furthermore, sudden changes in water level or water quality could be used to detect subsidence under the waterway. As suggested in the AEIS, I recommend that causes to fish passage be included in the SMP, and in the event of changes to fish passage, further investigations be conducted to determine the cause. As recommended by DAF and committed to by the proponent in their response to submission, I further recommend that mitigation and restoration of the banks and waterways be put in place in case mining activities cause any alteration to fish passage.

The EIS has not included data on geochemical characteristics from the project footprint, instead extrapolating from surveys at the existing Ensham Mine site. As the waste rock from the proposed project is planned to be placed in the pits within the existing mine, I recommend analysis of waste rock as per the WMP for existing Ensham Mine and that these analyses are provided to the department upon request. I further recommend that the proponent has a contingency plan in place to manage any potential contaminants that are found in the waste rock.

Despite the department and Resources seeking further evidence that subsidence will not impact the laser levelled irrigation within the mine footprint, the AEIS did not provide compelling evidence to alleviate these concerns. The proponent’s response was to have the Compensation Agreement in place, I therefore support on-going consultation, as stated in the EIS, between the proponent and landholders in addition to the progress of a Compensation Agreement, highlighting the commitments by the proponent to notify entry onto their lands; assist the landowners with managing their daily routines; limit potential impacts; and compensate for the diminution of value to the property as a result of the grant of the Mining Lease.

Matters to be include the recommended conditions:

- A soil survey of the project area is to be completed and analysed by 11 December 2021. Any amendment to the soil type tables and maps for the proposed project must be included with the soil survey.
- The SMP must be developed by an appropriately qualified person and implemented by the EA holder. The SMP must:
    - reflect the results of the soil survey, with monitoring points representing each of the soil types present in the project area
    - include a map showing soil types overlaid with the locations of subsidence monitoring transects, including within laser levelled paddocks
    - include monitoring using sensitive methodology, such as the proposed RTK-GPS and update the subsidence survey data
    - include subsidence monitoring at reference sites, control sites, planned mining sites, existing mining sites and at least one site within 1 metre of a waterway
    - require investigation to be undertaken if subsidence above 40mm (trigger value) is detected. Where the investigation links the subsidence to mining activities, the EA holder must prepare a report and submitted to the department upon request.
- Include monitoring of fish passage within the SMP. Include an alert system when subsidence has been detected along the waterway which could impact the fish passage.
- Include monitoring of fish passage within the bank stability management of the REMP.
- Geochemical characteristics of the waste rock to be placed in the pits should be analysed as soon as practical and results provided to the department, as per the model mining condition for waste rock.
- Proactive management measures to be put in place in case contaminants are detected in the waste rock.

4.4 Rehabilitation

The EIS chapters used to assess rehabilitation include Chapter 9 Rehabilitation and closure. Future consultation in relation to rehabilitation are mentioned in Chapter 2 Consultation process, Chapter 21 Social and Appendix I-1 Social impact assessment.

Section 9.3 of the TOR required the EIS to address the requirements for PRC Plan for mined land. In the rehabilitation plan, it is a requirement to describe the condition to which the holder must rehabilitate the project land before the EA may be surrendered. The rehabilitation milestones must describe where and when the activities will be carried out and in a way that maximises the progressive rehabilitation of the project land to a stable condition.

The proponent submitted the PRC Plan to the department for the existing Ensham Mine in accordance with the transition notice on the 29 April 2021. On 12 July 2021, the department issued a notice requesting further information. The proponent has until the 17 January 2022 to respond to the information request. Once the PRC Plan and schedule has been approved, the proponent will seek for an amendment to include the additional disturbance area for this project.

4.4.1 Assessment

The EIS indicated that rehabilitation of zones 2 and 3 have been previously approved in the existing Ensham Mine EA (EPML00732813). The only new area is within zone 1.

The EIS predicted that the impacts from subsidence due to bord and pillar operations are negligible and therefore surface rehabilitation will not be required for the proposed underground mining area.

The EIS indicated that the pre-mining land use for zone 1 is cropping on the south of the Nogoa River and grazing on the north of the Nogoa River. The pre-mining land use for zones 2 and 3 is grazing. An additional map has been provided by the proponent post AEIS submission for clarification (Figure 3). The EIS claimed that the post mine land use (PMLU) for zone 1 will remain as cropping on the south side of the Nogoa River and grazing on the north side of the river during and post mining. Gas flaring infrastructure will be constructed within zones 2 and 3. The proponent is the underlying landholder of these zones and is committed to rehabilitate the area to grazing for the PMLU.

It is noted by the assessing officer that there is a discrepancy in the location of gas flares in zone 2, provided in Chapter 4 and Chapter 27 of the AEIS. The AEIS also indicates that the sites would be moved. However, no proposed relocation or discussion around alternatives was provided in the AEIS. It is recommended that the proponent provide further indicative location of flares and associated surface disturbance as any changes to the location may require an EA amendment.

Waste rocks from the CHPP are proposed to be placed into Pit C and Pit D. The EIS quantified that the waste rock will occupy 0.6% of the overall volume of overburden material approved for placement into the pits and will not impact the approved final landform. The geochemistry of the project area substrates has not been assessed and this omission has been addressed in the land section (section 4.3) of this assessment report.

The EIS has committed to providing updates on mine closure and rehabilitation plans to key stakeholders. These include Ensham personnel and suppliers, the Central Highland Regional Council (CHRC), the Central Highland Development Cooperation (CHDC) and the Department of Education ahead of the closure of the open cut and underground operations.

The underground void is proposed to be filled with groundwater post mining. During the public notification period, several submitters raised concerns related to the lack of rehabilitation of the underground void, which has the potential to impact on groundwater quality and levels and hence on GDEs. In response, the proponent indicated that the groundwater inflow in the project area is predicted to have similar quality as groundwater inflows in the existing underground operations. The flooding of the underground workings also may not be in the alluvial layer, hence would not impact on the stygofauna communities.

Figure 3. Pre-mining land use for zones 1, 2 and 3 (provided by the proponent post AEIS submission)

The submissions also raised concerns that there was no assessment of alternatives proposed in the EIS to the flooding of the underground mine. Submissions noted that the rehabilitation strategy should have included an assessment of the option of backfilling the underground workings with the waste rock. In their response, the proponent stated that the flooding of underground workings resulted in similar stability outcome to that achieved by backfilling and therefore, no further assessment of backfilling was undertaken.

A submission also noted that the rehabilitation planning in the EIS should not be assessed separately from the current Ensham Mine’s progressive rehabilitation and closure plan. The proponent clarified that there is no requirement to assess cumulative impacts of the proposed project in the PRC Plan, however, acknowledged the requirement to be consistent in the rehabilitation objectives in the EA and the PRC Plan.

Submissions also pointed to the lack of long-term assessment of subsidence post mining, the lack of a rehabilitation strategy for subsidence and the stability of pillars affecting subsidence. In their response, the proponent indicated that the pillar stability has been evaluated to withstand extreme events (Q1000) and will not pose any long-term impacts on the floodplain. In addition, the AEIS has included that the bord and pillar layout is an appropriate and a well-developed design. Assessment of subsidence is further discussed in the land and MNES sections of this assessment report (sections 5 and 17 respectively).

The TOR requires meaningful and ongoing consultation with stakeholders in the development and implementation of the rehabilitation plan. In its submission, the department considered that while the EIS stated that the PMLUs proposed in the EIS are consistent with consultation outcomes, no evidence was provided to support this. In response, the proponent included further details of the consultation process in the AEIS. The AEIS also included a commitment to amend the PRC Plan and schedule once the EA has been granted for this project.

Assessment of the EIS has raised concerns by the department that the PMLU of cropping may not be achievable or may result in a sustainable PMLU given the risks associated with subsidence. As mentioned in the land section (section 4.3) of the assessment report, despite the department and Resources seeking further evidence that subsidence will not impact the laser levelled irrigation within the mine footprint, the AEIS did not provide compelling evidence to alleviate these concerns. However, the proponent responded to the submission, and confirmed in an email post AEIS, that the landholders are well-consulted and land compensation agreements have been prepared.

4.4.2 Conclusions and recommendations

The PRC Plan information response for the existing Ensham Mine is due to the department on 17January 2022. Once the Ensham Mine PRC Plan has been transitioned, the proponent will be requested to amend the PRC Plan and schedule to include this extension project. The proposed re-location of flares will need to be undertaken with the EA amendment.

As in the land section of this assessment report, I recommended that further subsidence monitoring be conditioned and further rehabilitation to be considered for areas impacted by subsidence.

I also recommend further monitoring of GDEs is conditioned in the EA as discussed in the water and MNES sections (sections 7 and 17 respectively) of this assessment report.

I also support the ongoing consultation and updating of the stakeholders in relation to mine closure and rehabilitation.

4.5 Water

EIS documents used to assess potential impacts to water environmental values (EVs) include EIS chapters 10 Surface water resources, 11 Flooding and geomorphology, 12 Groundwater, EIS appendices B-2 Subsidence, E-1 Surface water quality, E-2 Water balance model development, E-3 Hydrology and flooding, F-1 Groundwater, and F-2 Underground water impact report.

The EIS was required to conduct an impact assessment in accordance with departmental guidelines for water quality, water resources, and flooding (TOR section 9.4).

4.5.1 Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity)

The project area is located within the Nogoa River Sub-basin and the receiving environment for the existing and proposed mine is in the Mackenzie River Sub-basin within the greater Fitzroy Basin. The Nogoa River meets Comet River, 9km downstream of existing Ensham Mine, to form the Mackenzie River, which in turn flows into the Fitzroy River. The project area is within the Nogoa River floodplain.

Winton Creek flows into an anabranch of the Nogoa River within the existing Ensham Mine mining lease (ML 7459) (Figure 4**Error! Reference source not found.**) and Mosquito Creek, a tributary of the Nogoa River, flows through the project area. Boggy Creek is the main tributary within the existing Ensham Mine project, flowing north to south and joining the Nogoa River downstream of Winton Creek confluence. Corkscrew Creek runs west to east at the southern end of existing Ensham Mine (Figure 5).

The Nogoa River is considered perennial due to the releases from Fairbairn Dam situated approximately 60km upstream of the project area. Local catchments, drainage lines and watercourses associated with existing and proposed extension project include (from north to south):

- Winton Creek

- Boggy Creek
- Mosquito Creek
- Nogoa River
- Corkscrew Creek.

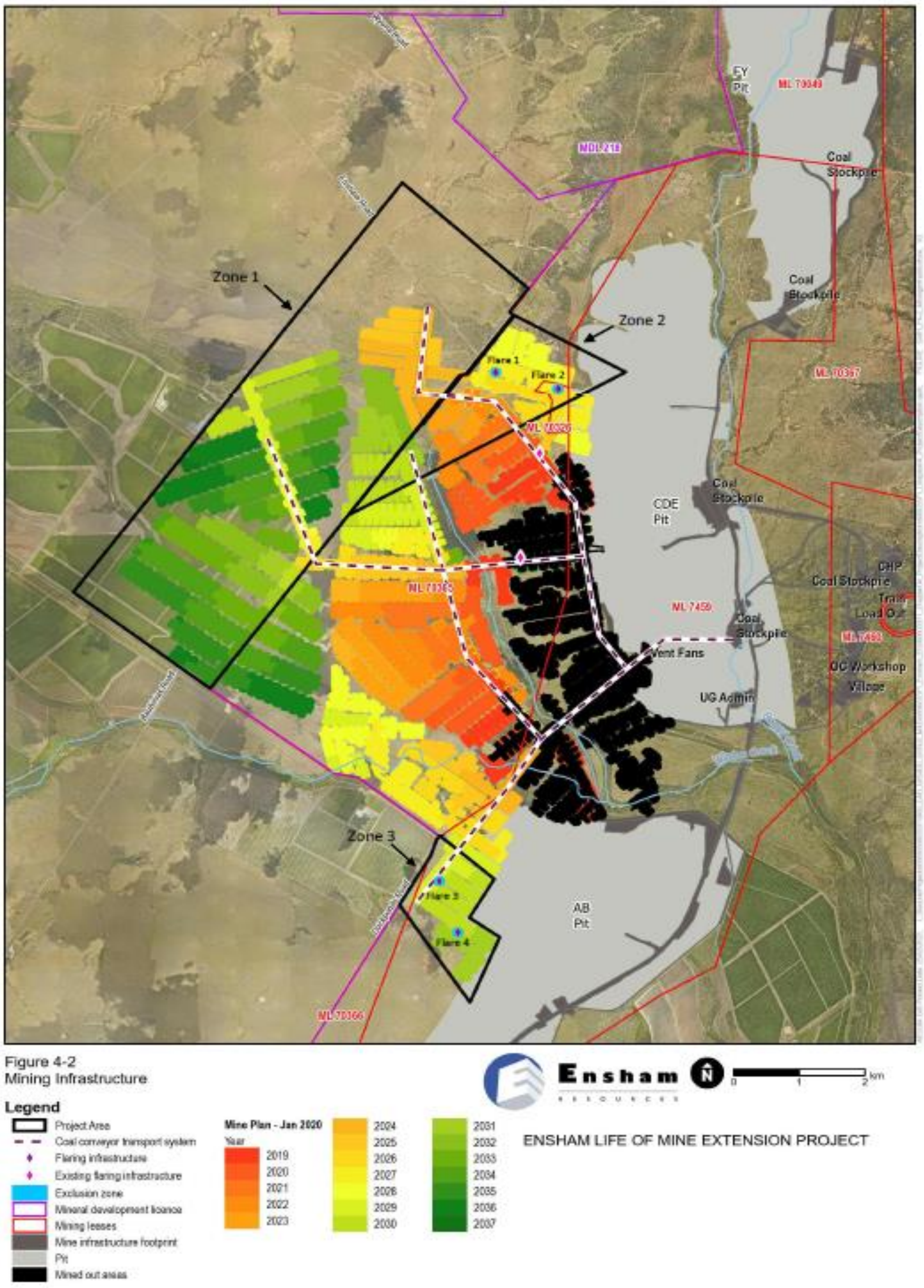


Figure 4 Map showing the existing Ensham Mine and proposed Ensham LOME mining area (from EIS Chapter 4 Figure 4-2)

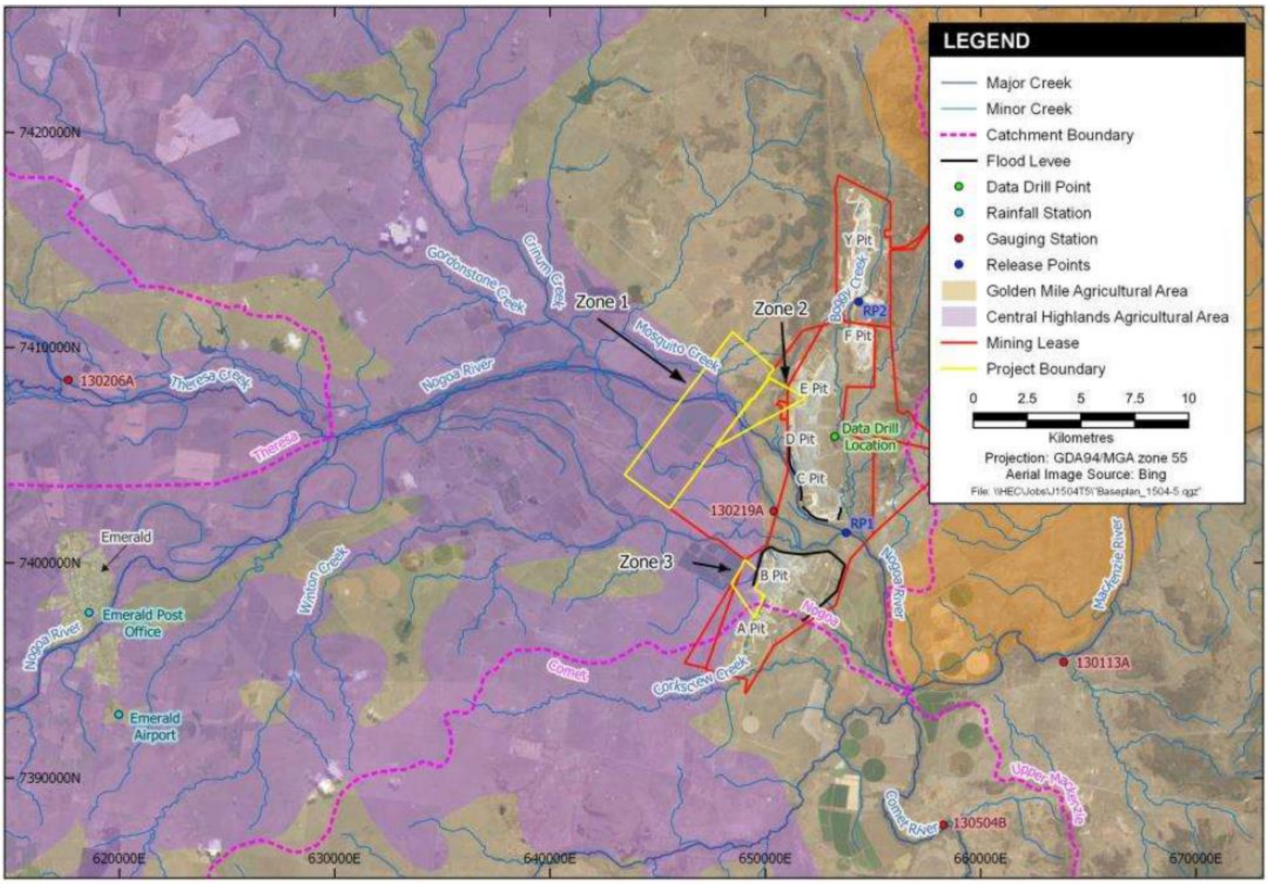


Figure 5. Map showing current Ensham Mine release points and gauging stations (from EIS Chapter 10 Figure 10-3)

The waterways that comprise the Lower Isaac River sub-basin are generally classified as slightly to moderately disturbed under the Queensland Water Quality Guidelines (QWQG) (DEHP 2009). The EVs and water quality objectives (WQOs) are provided in the regulatory document *Environmental Protection (Water and Wetland Biodiversity) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives (Basin NO. 130) (DEHP 2011)*.

4.5.2 Assessment

The EIS water chapters described the existing surface water and groundwater resources as well as identified the relevant site-specific EVs that have the potential to be impacted by the proposed project. The EIS discussed whether guideline values and WQOs would be met by the proposed project, and, where sufficient baseline data was available, proposed project-specific triggers and limits to be incorporated into the EA. The EVs within the project area include aquatic ecosystems, irrigation, farm supply stock water, aquaculture, recreation, visual recreation, drinking water, industrial use and cultural and spiritual values. The EIS assessed the potential risk to groundwater, downstream water resources and quality, flooding and geomorphology. As the proposed project is the expansion of a current underground mining operation, the EIS concluded that impacts to EVs are not expected to be significant.

The EIS proposes that water management for the proposed project will be interconnected with the existing Ensham Mine operations through transfer of mine affected water (MAW) and the supply of raw water using existing allocations. The proposed project's main water requirements will be for dust suppression and vehicle washdown as well treated raw water for onsite potable use.

Given the interconnected nature of water management, the EIS highlights that the proposed project will continue to use the existing water management plan which is required under Condition C31 of the existing Ensham EA. The current mine water management system at the existing Ensham Mine comprises several interlinked components, including open-cut pit storages, water storage dams, a water treatment plant (WTP) and pumping systems. There are three main open-cut pit storages located north and south of the Nogoa River, and west of Boggy Creek. All pits are subject to groundwater inflow. A system of water storage dams is located to the east of Boggy Creek and the Nogoa River which stores and transfers water to the CHPP, the WTP and the underground mine. The EIS noted that as the existing open cut mine comes to an end in 2023, Pit B (Figure 4) will be used as part of the mine water management system, increasing the surface water storage capacity up to 48,000ML.

The EIS noted that as sections of the underground mine are exhausted, the area can be used as water storage. The EIS estimated that the total volume of water storage available in the existing underground workings is 6,000ML. This is estimated to increase to approximately 48,000ML by the end of the life of the mine.

The water and salt balance model (WSBM) was developed for the existing mine and the proposed project. The WSBM simulates the volume of water and mass of salt stored in and pumped between all simulated water storages, sourced from and released to the Nogoa River. The water balance model described in the EIS predicts the following:

- Groundwater inflow is 4,112ML/yr for existing mine and 3,762ML/yr for the proposed project.
- Average annual release to the Nogoa River will be 2,766ML/yr compared to the existing 2,896ML/yr. For 50th percentile results, annual release volume to the Nogoa River is between 1,800ML/yr and 2,800ML/yr.
- The underground storage capacity will increase to approximately 48,000ML and the surface water storage capacity will increase to 48,000ML, which totals to 96,000ML by the end of the life of mine.
- Annual extraction volume between 600ML/yr and 700ML/yr is required to be supplied from the Nogoa River, which is less than the existing Ensham Mine EA allocation of 1,500ML/yr.

For numerical groundwater model, a study area was selected, which includes the project area and surrounds (Figure 6). The EIS was unable to predict the saltwater balance accurately as groundwater salinity values of 2,000µS/cm were initially used for the numerical model. However, when further sampling and analysis was undertaken, electrical conductivity (EC) was found to be variable, and a maximum EC of groundwater was measured as high as 10,200µS/cm in Ramp 24. The EIS noted that additional relevant EC and volume data is required to complete model calibration and will be collected as part of normal water monitoring activities with the view to confirming the modelling provided in the EIS.

4.5.3 Surface water quality

The EIS notes that data from the existing Ensham Mine water quality monitoring program exceeded some of the WQOs for sub-basin including EC, turbidity, and several metals. There are five upstream sites, five downstream sites, two mine undisturbed sites and 11 mine disturbed sites within the water quality monitoring plan (Figure 7). According to the EIS, data has been collected from some of the monitoring points since 2006. However, not all the monitoring points nor the data are submitted to the department's WaTERS database, hence, I recommend that future monitoring data be submitted to the departmental database.

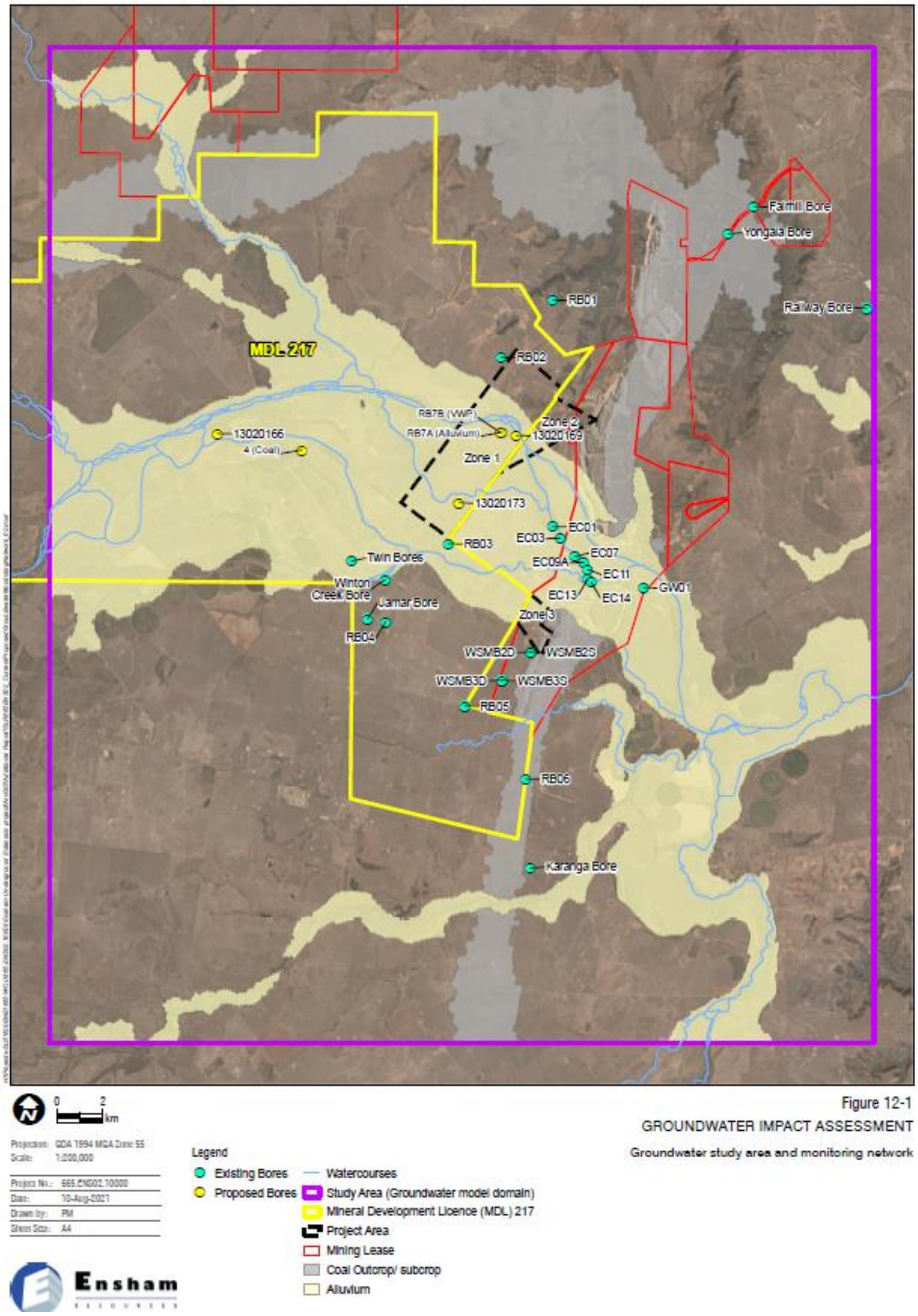


Figure 6. Groundwater study area and monitoring network (from Figure 12-1 of the EIS).

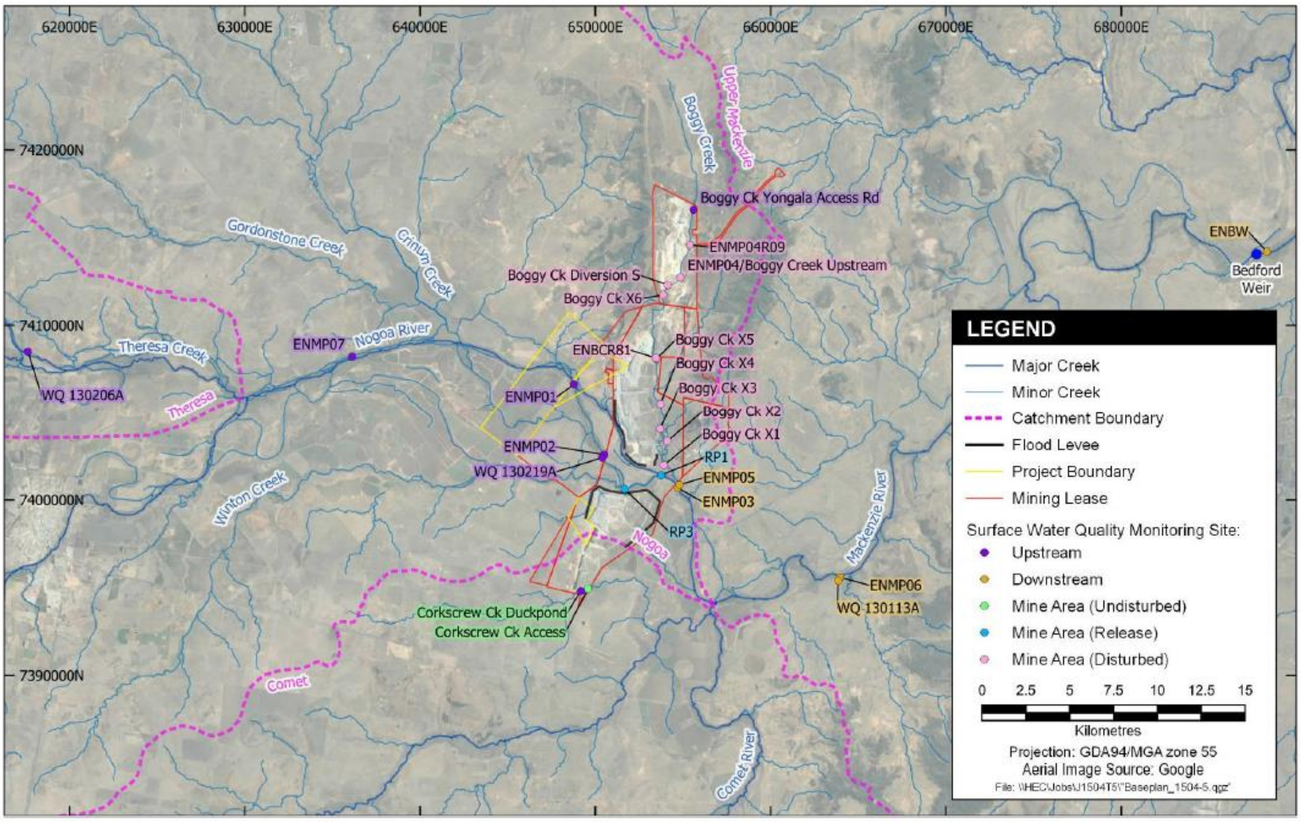


Figure 7. Map showing surface water quality monitoring points (from EIS Appendix E-1 Figure 2)

4.5.3.1 Surface water quality baseline data

The department’s submission on the 27 April 2021 EIS identified that there are insufficient upstream monitoring locations presented for the proposed project. The EIS proposed to use only the existing surface water monitoring sites which did not include a point upstream of the proposed underground mining footprint. The proponent responded to the department’s submission and the AEIS included an upstream monitoring point (ENMP07 at Bridges Flat) in the REMP and in the draft conditions.

Furthermore, there is an increase in the EC levels at Duckpond 130219A gauging station which is a current upstream monitoring point. The department’s submission on the 27 April 2021 EIS, recommended the proponent investigate the cause of this EC increase and justify the use of this upstream monitoring point.

Boggy Creek Yongala Access Road monitoring point is listed as an upstream monitoring point in the EIS. However, data presented to date is insufficient for this to be used as the only upstream monitoring point to determine the baseline water quality for the proposed project. To have a better understanding of the baseline water quality of the area, I recommend further water quality monitoring of the upstream monitoring point.

4.5.3.2 Surface water quality limits and triggers

The EIS indicated that except for the gas flares, no surface disturbance is proposed. Based on this information the EIS indicated that the only potential change to surface water release (quantity and quality) would be attributed to groundwater entering the underground mine.

Groundwater modelling was undertaken to assess the contribution of the proposed project to potential surface water impacts. The groundwater modelling predicted that the surface water quality of groundwater inflows will be same as that of the existing inflows. The inflows are predicted to increase in the short term but will trend downwards with time. For this reason, the EIS predicts that there will minimum changes to the groundwater inflow and it will continue to be managed within the existing Ensham Mine water management system with releases to surface water controlled under the provisions of the current EA (EPML00732813). There will, therefore, be no amendments to the surface water release limits and no uncontrolled releases as there should be sufficient storage capacity.

Based on the information presented above I recommend additional upstream monitoring points and that a sufficient number of samples be obtained to derive site-specific baseline water quality values for these monitoring points as per the departmental Queensland Water Quality Guideline (DEHP 2009). I recommend inclusion of new upstream monitoring points at ENMP07 and ENMP01 into the revised EA and continued data collection at the government gauging station 130219A.

4.5.4 Groundwater quality

The EIS described the existing hydrogeological environment and characterised the different aquifers at the project area. The groundwater study assessed the potential impacts of active mine dewatering which removes groundwater intersected by the underground mining within the permeable sediments in the target coal seams.

Underground mining for the proposed project will occur predominately at a depth of approximately 120m to 210m below the surface, however, mining under the Nogoa River would occur at a depth of 120m to 190m below the surface. The quaternary alluvium layer is approximately 20m thick and the EIS concluded that there is no connectivity between the Nogoa River and the alluvium due to the differences in the EC level.

The Rewan Group can be up to 200m thick in the study area (Figure 6) and acts as an aquitard between the alluvium and the Rangal Coal Measures which is the target layer consisting of economic coal seams. This layer may also be recharged by downward seepage where subcrop in localised zones occur beneath alluvium associated with the Nogoa River.

On average, iron concentration in 80th percentile of existing alluvium bores was above the ANZECC guidelines for aquatic ecosystem. Furthermore, silver, arsenic, selenium and aluminium were also elevated.

4.5.4.1 Groundwater quality and levels baseline data

The EIS has proposed five monitoring bores in addition to the existing groundwater monitoring scheme. The department’s submission considered additional monitoring bores upgradient of the project area, along the Nogoa River. The EIS committed to providing site-specific trigger levels for these new bores in accordance with ‘Using monitoring data to assess groundwater quality and potential environmental impacts’ (DES 2021). Although I agree with this approach, I do not support the proposed interim trigger values based on the existing EC trigger values. The existing EC bore trigger values were specifically calculated for those bores and therefore may not be appropriate for the new bore locations. Further monitoring will be required to obtain a site-specific baseline data as per the departmental guideline (DES 2021).

The AEIS has added further alluvium monitoring bores as shown in Figure 8 and Table 5 below. As RN13020172 appears to represent the local WQO, I recommend adding this bore to the monitoring program (Figure 9).

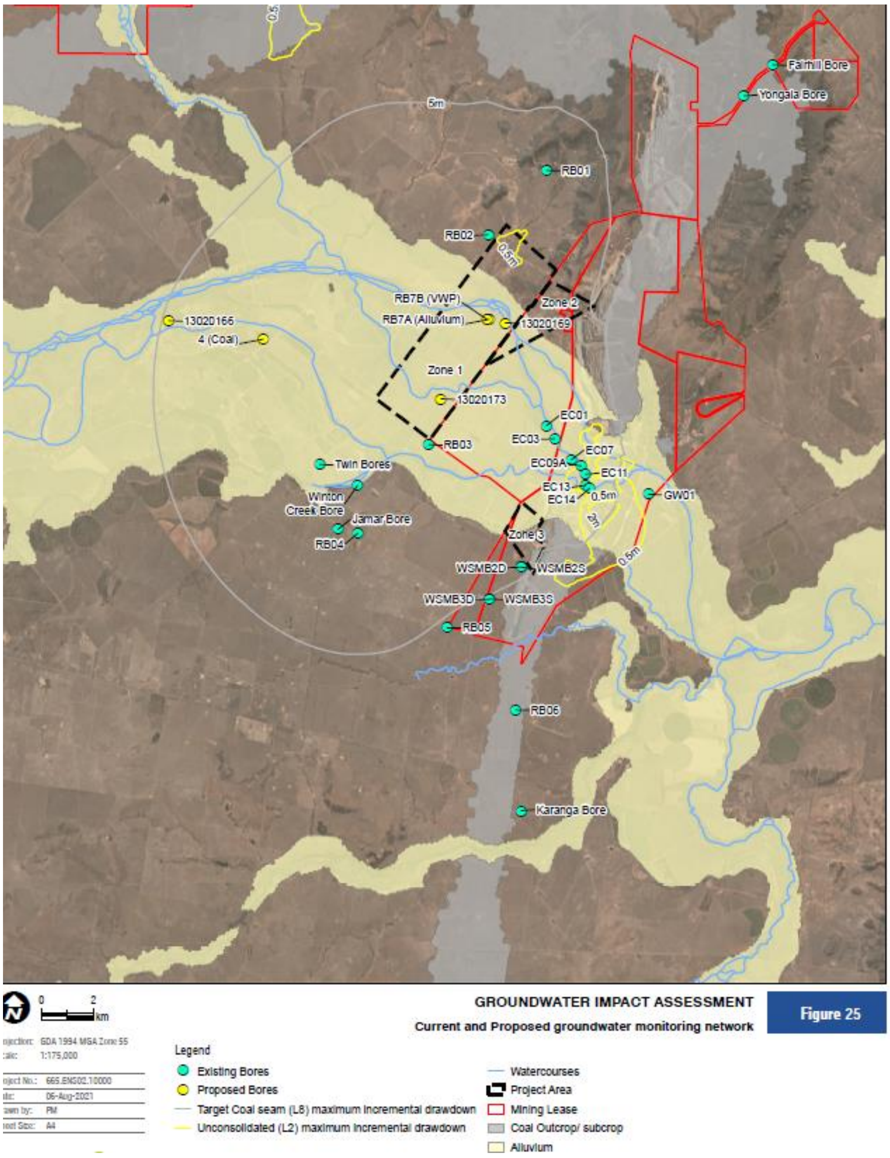
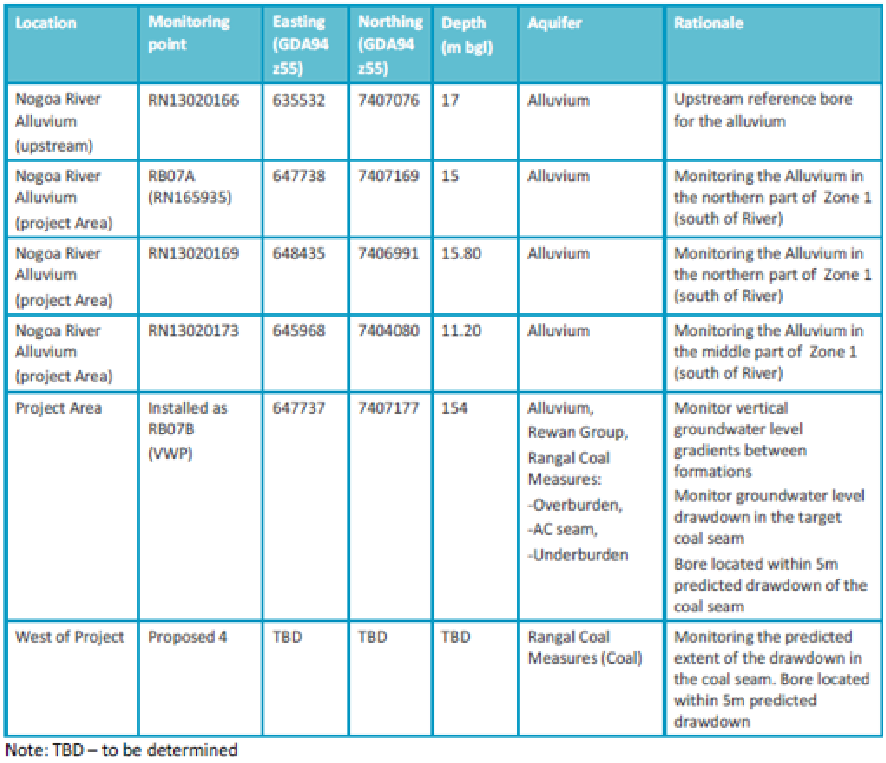


Figure 8. Current and proposed groundwater monitoring network (from AEIS Appendix F-1a Figure 5)

Table 5. Proposed additional groundwater monitoring network (from AEIS Appendix F-1a Table 5)



Location	Monitoring point	Easting (GDA94 z55)	Northing (GDA94 z55)	Depth (m bgl)	Aquifer	Rationale
Nogoa River Alluvium (upstream)	RN13020166	635532	7407076	17	Alluvium	Upstream reference bore for the alluvium
Nogoa River Alluvium (project Area)	RB07A (RN165935)	647738	7407169	15	Alluvium	Monitoring the Alluvium in the northern part of Zone 1 (south of River)
Nogoa River Alluvium (project Area)	RN13020169	648435	7406991	15.80	Alluvium	Monitoring the Alluvium in the northern part of Zone 1 (south of River)
Nogoa River Alluvium (project Area)	RN13020173	645968	7404080	11.20	Alluvium	Monitoring the Alluvium in the middle part of Zone 1 (south of River)
Project Area	Installed as RB07B (VWP)	647737	7407177	154	Alluvium, Rewan Group, Rangal Coal Measures: -Overburden, -AC seam, -Underburden	Monitor vertical groundwater level gradients between formations Monitor groundwater level drawdown in the target coal seam Bore located within 5m predicted drawdown of the coal seam
West of Project	Proposed 4	TBD	TBD	TBD	Rangal Coal Measures (Coal)	Monitoring the predicted extent of the drawdown in the coal seam. Bore located within 5m predicted drawdown

Note: TBD – to be determined

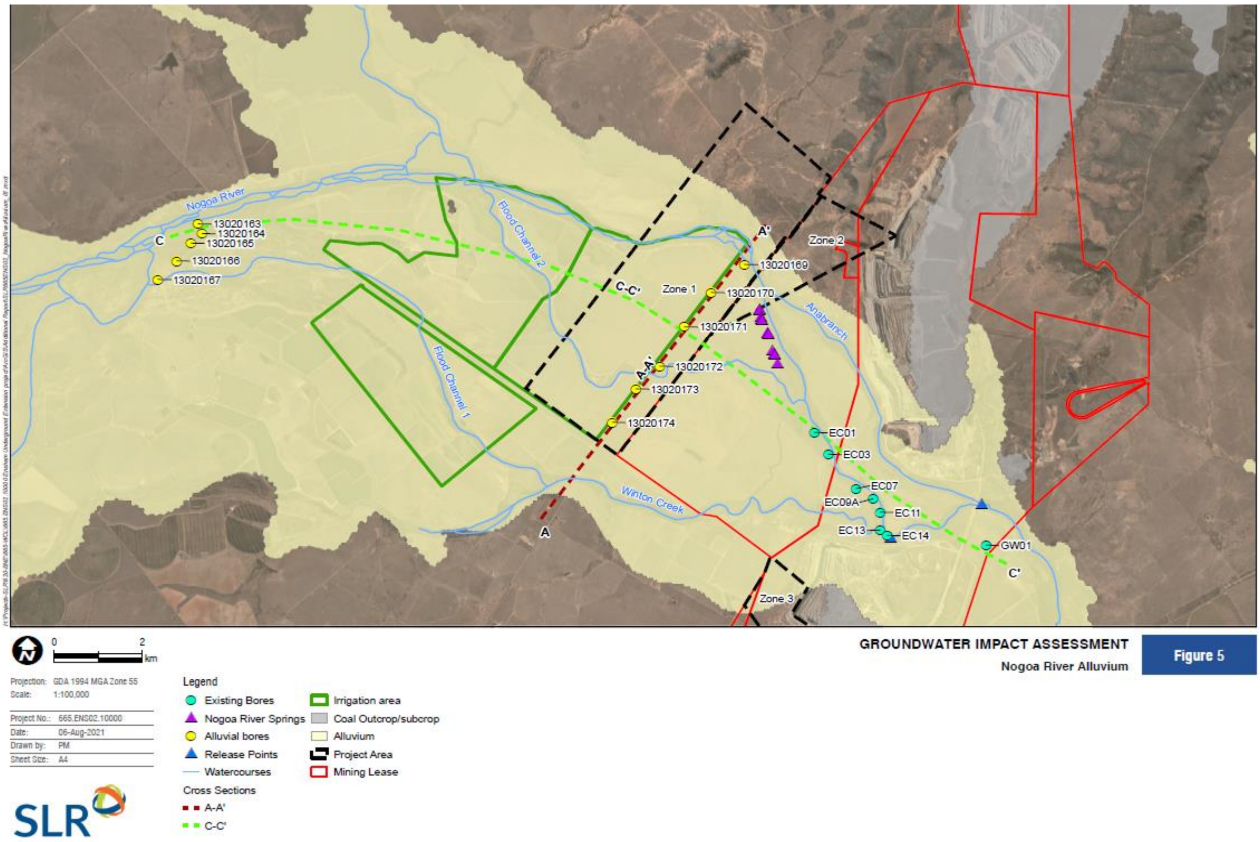


Figure 9. Alluvium bore location, including RN13020172 (from AEIS Appendix F-1a Figure 5)

In response to the department’s recommendation, the EIS was amended to include the water quality objectives (WQOs) for Fitzroy groundwater chemistry (Zones 13 and 43) to be used as interim trigger values for pH, EC and sulfate. For all remaining parameters in the proposed EA, the ANZG (2018) guideline values have been applied.

4.5.4.2 Storage capacity

The EIS did not predict impacts on groundwater quality. As the existing open cut mine comes to an end, Pit B will become available for water storage and the surface water storage capacity will increase to 48,000ML. Once underground mining is underway, groundwater storage capacity will increase from 6,000ML to approximately 48,000ML by the end of the proposed project. This will mean that the current mine affected water system and the existing Ensham Mine EA conditions related to release of mine water will be sufficient to manage the water storage and releases and no changes to EA release conditions will be required.

4.5.4.3 Groundwater contamination

The EIS did not predict any changes to groundwater quality resulting from the proposed project as there will be no new open voids or spoil emplacement. As mining proceeds, the underground voids will naturally recharge over time and the inflow water will have the same quality as previously stored in the coal.

The EIS did not assess the risk of seepage from the pits, where waste rock will be placed, into the groundwater. The EIS did not undertake geochemical analysis of the overburden material for the project area. As discussed in the land section (section 4.3) of this assessment report, the department will impose additional conditions to monitor the waste rock as it is being placed into the pits, for inclusion of a contingency plan for when contaminants are detected in the waste rock. Any seepage is expected be detected by groundwater monitoring in the bores adjacent to the pits as per the existing Ensham Mine EA conditions.

In response to concerns raised by the department regarding rising EC and groundwater levels in some of the alluvial bores, the AEIS included a substantial number of graphs with EC plotted against commencement of irrigation and underground mining, and the climatic index. The AEIS interpreted the increase in EC and groundwater because of the intensity of irrigation upgradient from the alluvial bores, and the climatic impacts, such as heavy rainfall. The figures inaccurately presented underground mining commencement and did not indicate when the open cut mine started. The data did not clearly demonstrate water quality trends associated with irrigation activities upstream.

4.5.5 Water resources

The EIS found no high confidence GDE in the project area. The EIS identified a Palustrine wetland 2.6km south of the existing Ensham Mine, however, no potential impacts were predicted from the estimated drawdown on aquifers at the mine site.

There are no registered springs within 50km radius of the project area.

Overall, groundwater usage is limited in the area as there is an existing reliable water source from the Fairburn Dam which releases into the Nogoa River. The EIS identified 12 active private bores during the 2014 census. DRDMW recommended undertaking a more recent field bore census and contacting the surrounding landholders to confirm that no additional bores are present. No new bore census has been conducted. However, the AEIS included a commitment to complete the bore census by 30 November 2021 and to conduct impact assessment for any new landholder bores.

As also addressed in the MNES chapter of this report, the proposed project is located in the western part of Bowen Basin. Stratigraphic sequence of the project area comprises of unconsolidated quaternary aged sediments overlying consolidated Permian Tertiary aged sequences. The quaternary alluvium layer comprises of clay, silt and sand, underlain by discontinuous basal sands and gravel. The groundwater water quality monitoring for the existing Ensham Mine shows variability in the EC levels, ranging from 1,000µS/cm to 30,000µS/cm.

The Rewan Group aquitard overlies the Rangal Coal Measures and separates the Nogoa River and the alluvium floodplain. The Rewan Group comprises of low permeability siltstones, mudstones and lithic sandstones. Groundwater monitoring data shows that this group is generally saline with median EC of 6,000µS/cm.

The uppermost Permian unit contains the Rangal Coal Measures, which is targeted by Ensham Mine. Groundwater monitoring indicates the salinity of this layer with a median of 7,700µS/cm

The Nogoa River floodplain comprises silt and clay underlain by a discontinuous basal unit of sand and gravel. The alluvium floodplain is overlain by a deep clay-rich black soil, which tends to be highly absorbent during rainfall events. The alluvial sequence varies in thickness, with a maximum observed depth of 25m.

4.5.5.1 Groundwater model

Modelling of groundwater flow and drawdown was undertaken for the EIS using the conceptual hydrogeological model. Further to the EIS, an additional hydrogeological conceptual model was provided at the request of the IESC. However, the IESC is concerned that these conceptual models are not broadly representative of the region and do not adequately capture the heterogeneity of the underlying geology. Furthermore, the spatial variability of the interactions of flows between the alluvium and the Nogoa River is poorly represented.

The EIS used the numerical groundwater model constructed by HydroSimulations in 2019 for the Ensham Mine Residual Void Project. The IESC also advised that the conceptual model should be reflected in the numerical model. Further discussion can be found in the IESC section below.

4.5.5.2 Drawdown

The groundwater model predicted no incremental groundwater level drawdown within the alluvium above the project area. In the wider study area however, drawdown of 0.5m is predicted in the regolith of zone 1; 1m to the northwest of the proposed project where Rangal Coal Measure subcrops below an ephemeral creek and to the east of the open cut pits.

The EIS notes that there will be minimal impacts to GDEs as the model predicted little hydraulic connectivity between the Nogoa River and the alluvium. The EIS also notes that due to limited drawdown and unfavourable habitat for GDEs, mitigation measures are not discussed. DAWE recommended further ground-truthing of GDEs. This is discussed further in the flora fauna and MNES sections of this assessment report (sections 8 and 17 respectively).

The EIS also predicted between 10cm and 20cm drawdown in landholder’s private bores. The proponent has committed to make good measures if the drawdown exceeds 2m in the alluvium layer and 5m in the consolidated hydrostratigraphic units.

The EIS used 0.5m for modelling the groundwater drawdown level, however, the interim trigger level of 2m drawdown is proposed. The department has advised that the trigger level should not be greater than what has been modelled, and to either re-run the model or amend the drawdown trigger level to 0.5m. In response to submission, the proponent noted that there are no drawdowns predicted in zone 1 bores, however, the interim water level triggers have taken out and instead suggested monitoring for 24 months to establish a natural variability of the groundwater. As the proponent will not have 24 months of monitoring to establish the baseline drawdown trigger value prior to commencement of the proposed project, an interim trigger level of 0.5m should be in place.

The cumulative drawdown impact assessment did not incorporate impacts from surrounding mines. I recommend that the proponent re-submit the cumulative drawdown impact assessment to DAWE for further assessment for the Commonwealth approval.

4.5.5.3 Subsidence

The EIS predicted minimum subsidence in the project area, typically less than 40mm, which the EIS notes is less than the 50mm seasonal variation in surface levels predicted by IESC (Commonwealth of Australia 2015). The EIS concluded that subsidence due to removal of groundwater from the target coal will be limited due to the overlaying geology and the nature of bord and pillar mining method.

The EIS has proposed that there will be no impacts to GDEs, Brigalow TEC, nor to threatened species from subsidence or associated surface cracking as there are no subsidence greater than 40mm. This is further discussed in the MNES section of this assessment report (section 4.15).

DAF raised concerns regarding the lack of monitoring and mitigation commitment in relation to subsidence impacts on fish passage. It was recommended that the proponent undertake monitoring for impacts to fish passage, and to consider how this can be restored. In response to the submission, the AEIS has consideration of fish passage impacts in the SMP. The department will be placing further conditions to monitor impacts associated with fish passage as part of REMP and SMP.

DAWE questioned the accuracy of LiDAR survey which is proposed for future monitoring by the proponent. The accuracy of LiDAR survey is +/-50mm which is higher than the predicted subsidence of 40mm. As a result, the AEIS included an SMP which includes using RTK-GPS, a more sensitive monitoring technique. The proponent has already commenced monitoring using this technique in three locations. I recommend further subsidence survey work to be included as part of the EA.

Due to the limited subsidence predicted to occur on site, the EIS predicted only minor above ground disturbance and impacts to agricultural land. Resources highlighted that further soil surveys and current soil mapping are required to improve the accuracy of statements and conclusions presented in the EIS Both Resources and the department have raised concerns about subsidence impacting flood irrigation and laser-levelled irrigation systems. The proponent was unable to complete a soil survey within the EIS timeframes but has committed to completing this work by 11 December 2021. This will inform the RIDA application under the RPI Act.

4.5.5.4 Underground water impact report

The underground water management framework is established under Chapter 3 of the *Water Act 2000* (Water Act). When a mine pit is dewatered or experiences evaporative loss, groundwater levels in the area can decline and this may have an affect active landholder bores. Under the Water Act, a resource holder is required to prepare an underground water impact report (UWIR) to identify groundwater impacts and set out monitoring and management strategies for the proposed project. Where potential impacts are predicted for landholder bores, a ‘make good’ process must be entered into between the resource holder and the landholder with a ‘make good’ agreement between parties also required. The resource holder is required to provide ‘make good’ measures to bores that are likely to be impaired. The EIS has prepared the UWIR and acknowledges the underground management requirements under Chapter 3 of the Water Act will apply to the proposed project. This includes requirements to enter make good agreements with bore users predicted to be affected by the mine dewatering.

4.5.5.5 IESC

Information requirements contained in the IESC’s Information guidelines for proposals relating to the development of coal seam gas and large coal mines where there is a significant impact on water resources (IESC 2015) were addressed in Appendix F of the EIS, with the checklist in Table 2. The EIS was referred to the IESC in accordance with the EPBC Act in a joint request from the department and DAWE. The IESC advice and the AEIS responses to that advice are set out in the MNES section (section 4.15) of this assessment report.

4.5.6 Flooding

The hydrological model, previously developed in 2013 by KBR (Ensham Flood Levees Model Upgrade Report), has been used to base inundation, flow depth and flow velocity of the Nogoa River. The modelling considered the 10% AEP, 5% AEP,1% AEP and 0.1% AEP maximum inundation areas. The model was used to characterise existing flooding and assess changes to flood flow characteristics (such as extent, depth, velocities and shear stress) and impacts on beds, banks and floodplains during operational and post-mining flood conditions.

The EIS noted that the proposed project will not have an impact on the flow regime of the Nogoa River. The existing surface infrastructure (flood levee) will be used to provide flood protection from a 1 in 1,000 year flood event, which is in accordance with the current Ensham Mine EA. Furthermore, the analysis indicates that there would be no additional flooding impacts at the project area because of the proposed project.

4.5.7 Conclusions and recommendations

The proponent has addressed many of the issues relating to water that were raised in submissions on the EIS and advice from the IESC. However, the following issues are still outstanding, and I recommend that they are addressed prior to commencement of the proposed activity or through the EA conditions.

The proponent has committed to undertake bore census by 30 November 2021. I recommend that if additional bores are identified that they be included in the model to predict drawdown at the additional locations. Furthermore, if impacts are identified to any new bores, make good measures, proposed as mitigation measures in the EIS, would apply. The proponent will also have the make good obligations under Chapter 3 of the Water Act.

The interim drawdown trigger levels for bores in zone 1 should be amended to 0.5m. The proponent is proposing to obtain a baseline drawdown level by monitoring for 24 months. Although I support the on-going monitoring, there should be interim trigger levels in place since the proponent will not have sufficient time to monitor prior to planned commencement of this proposed project. As recommended by DAWE, the cumulative drawdown study, incorporating the impacts from surrounding mines, would also need to be completed for the Commonwealth approval.

I recommend that the proponent continue to monitor the impacts of mining operations on both surface and groundwater. Further upstream surface water monitoring points (ENMP01 and ENMP07) and groundwater monitoring points, as per

Table 5, with an additional monitoring bore (RN1302072) are recommended to be included in conditions of an EA, should one be issued for the project. Data obtained from monitoring will be required to be entered into the WaTERS database.

The data on EC and groundwater level did not clearly demonstrate water quality trends associated with irrigation activities upstream and further investigation is warranted.

The following information is recommended to be included in EA conditions:

Surface water quality
- further baseline data for the two additional upstream monitoring points must be collected to provide sufficient local water quality data for deriving surface water quality triggers and limits
- collection of further EC and water quantity data for model calibration

REMP
- addition of two upstream monitoring points
- further monitoring of riverbanks to detect any impacts to fish passage

Groundwater quality
- incorporate the most up to date baseline data set to finalise groundwater triggers and limits for the EA conditions
- include a separate EA condition to collect adequate baseline data from the additional bores that have been proposed because of the modelled drawdown contours and incorporate the bores as monitoring points in the EA
- investigate the increasing EC and groundwater levels in the alluvium bores adjacent to the storage pits

Drawdown
- incorporate drawdown from surrounding mines into the cumulative drawdown impact assessment

4.6 Flora and fauna

Several EIS documents described flora and fauna of the project area, namely Chapter 13 Terrestrial Ecology, Chapter 14 Aquatic Ecology and Chapter 25 Matters of National Environmental Significance, Appendix C-1 Flora Technical Report, Appendix C-2 Fauna Technical Report, Appendix D-1 Aquatic Ecology Assessment and Appendix D-2 Stygofauna Assessment.

Section 9.6 of the TOR required the EIS to describe the biodiversity and existing environmental values of the project area, the effectiveness of any proposed avoidance, mitigation or management measures and propose suitable offsets for any significant residual impacts consistent with the Queensland Government and Commonwealth's environmental offsets framework. It also required the EIS to identify and adequately assess biosecurity matters, including detailing measures to effectively remove, control and limit the spread of pests and weeds on the project area.

This section of the assessment report assesses the EIS conclusions for terrestrial and aquatic ecology. It focuses on the Queensland regulatory requirements and MSES, including environmental offsets for MSES. The Commonwealth regulatory requirements and MNES are discussed separately in section 4.15 of this assessment report.

4.6.1 Assessment—existing environmental values

The project area is located within the Isaac – Comet Downs subregion of the northern section of the Brigalow Belt Bioregion (BRB). The project area is predominantly characterised by an undulating landscape with lower flats and alluvial areas. The project area has been largely cleared for grazing purposes and irrigated cropping but contains scattered remnant Brigalow and open woodland Eucalypt communities. The Nogoa River bisects the project area west to east and a tributary of the Nogoa River, Mosquito Creek, joins from the north.

To characterise the environmental values, the EIS undertook desktop assessments in 2019 and 2020 that included review of ecological assessments previously undertaken for the existing Ensham Mine.

Baseline flora field surveys were undertaken in the autumn and spring seasons of 2019 and summer of 2020. The extent, classification and condition of ground-truthed vegetation communities within the project area was in accordance with the Queensland herbarium's survey methodology (Neldner et al., 2020). This consisted of a total of 125 sites, including 10 tertiary transects and 115 quaternary sites. Additionally, 22 BioCondition assessment sites were surveyed to determine vegetation condition and biodiversity attributes within the project area.

Threatened ecological community (TEC) surveys were undertaken at 10 sites for the Brigalow (*Acacia harpophylla* dominated and co-dominated) TEC (Brigalow TEC).

The flora survey trigger map for protected plants surveys indicated that the project area was outside protected plant trigger areas. Targeted surveys for threatened flora were undertaken in areas identified as suitable habitat.

Baseline fauna field surveys were undertaken in accordance with Queensland and Commonwealth species-specific survey guidelines in the autumn and spring seasons of 2019 for zone 1 only. A rapid fauna survey was conducted within zone's 2 and 3 in January 2020 (summer), outside of the recommended survey seasons (Eyre, 2018). This survey only undertook habitat assessments and diurnal bird surveys and thus did not meet required guideline standards.

4.6.1.1 Environmentally sensitive areas

The only identified environmentally sensitive area (ESA) is the Brigalow endangered regional ecosystem (RE) that is listed as a Category B ESA. It is patchily scattered throughout the project area comprising an area of 16.91ha.

4.6.1.2 High Ecological Value waters/wetlands

No high ecological value waters or wetlands listed under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 are mapped or ground-truthed within the project area.

4.6.1.3 Vegetation communities

Most of the study area, approximately 2,263ha or 83%, is comprised of non-remnant vegetation. Approximately 403ha of remnant (category B regulated vegetation), 47ha of high value regrowth (HVR) (category C regulated vegetation) and 24ha of regrowth vegetation was also identified within the project area.

The EIS desktop assessment identified nine regional ecosystems (REs) within the project area based on Queensland Regional Ecosystem mapping (version 11). Field surveys undertaken in 2019 and 2020 only confirmed five remnant REs.

The endangered Brigalow vegetation community, RE 11.3.1, comprised remnant, high value regrowth and regrowth vegetation categories totalling 82.15ha.

Table 6 describes the vegetation, regulated vegetation category and RE classification and status for the project area.

Table 6. Regional ecosystems within the project area (from Chapter 13, Table 13-1 of the EIS)

Regional ecosystem	Description	VM Act status	Biodiversity status	Extent (ha)
RE 11.3.1	*Acacia harpophylla* open forest on alluvial plains	Endangered	Endangered	16.91
RE 11.3.1 HVR	*Acacia harpophylla* low open forest on alluvial plains	Endangered	Endangered	46.71
RE 11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Of concern	169.43
RE 11.3.25	*Eucalyptus camaldulensis* woodland fringing drainage lines	Of concern	Least concern	52.34
RE 11.7.1	*Eucalyptus thozetiana* with a mid-storey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust	Of concern	Least concern	127.67
RE 11.7.2	*Acacia shirleyi* woodland on Cainozoic lateritic duricrust and scarp retreat zones	No concern at present	Least concern	37.13
Regrowth	Brigalow regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust	Category X	Non remnant	18.53
Regrowth	*Acacia regrowth* on clay plains and lower scarp slopes on Cainozoic lateritic duricrust.	Category X	Non remnant	5.00
Total area				**473.72**

The ground-truthed REs (VM Act status) are depicted in Figure 10. Ground-truthed regional ecosystems.

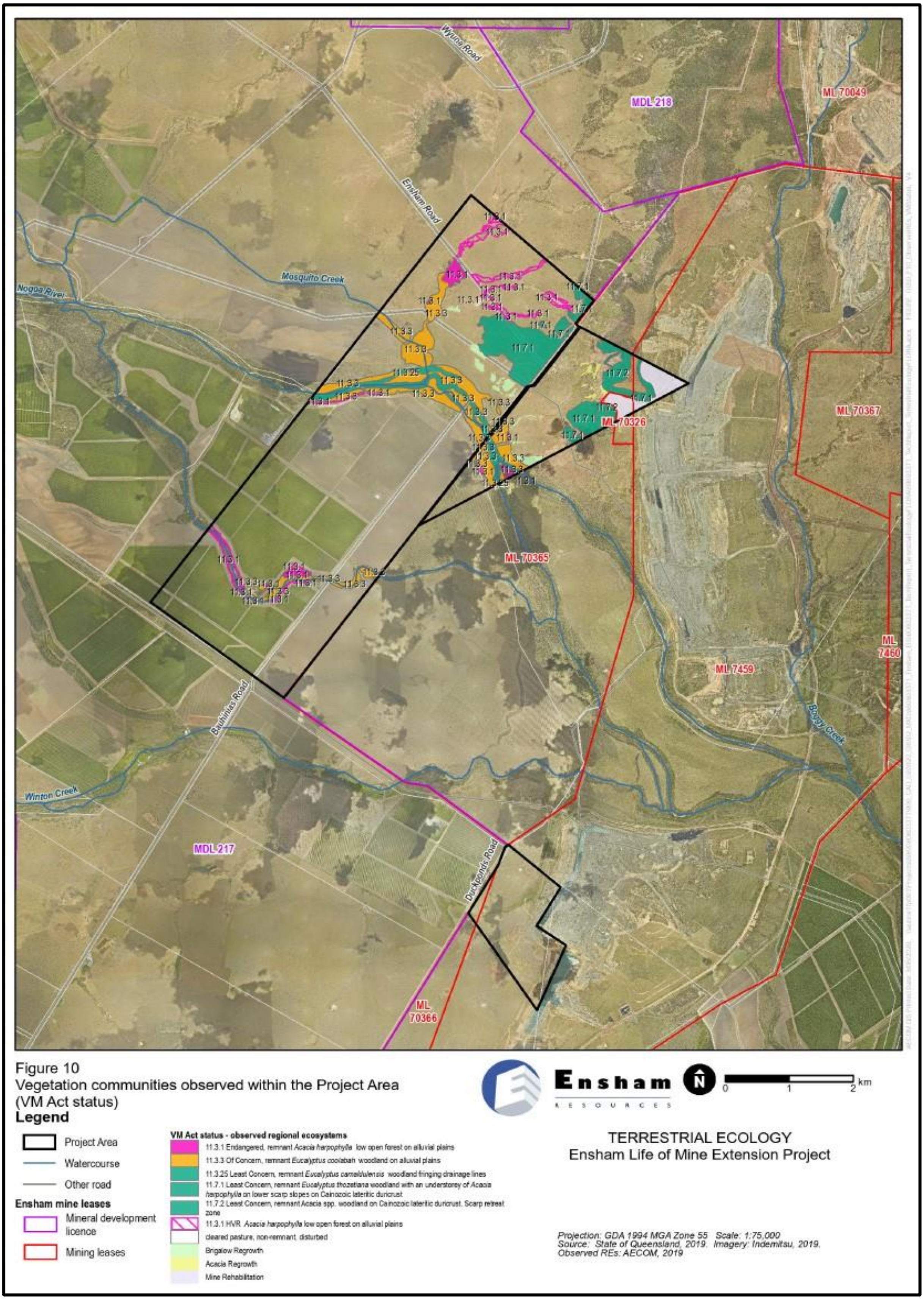


Figure 10. Ground-truthed regional ecosystems. Threatened ecological communities (from EIS Appendix C1, Figure 10)

One terrestrial threatened ecological community (TEC), Brigalow (*Acacia harpophylla* dominant and co-dominant), was confirmed within the project area. Brigalow that met the key diagnostic criteria and condition thresholds from the Conservation Advice criteria (TSSC, 2013) totalled 46.11ha and comprised 5.14ha of remnant and 40.97ha of HVR. Additional patches of Brigalow that did not meet the condition thresholds (either a patch was less than 0.5ha or weed species comprised more than 50 per cent of the groundcover) were not included in the TEC.

Further assessment of this TEC is provided in section 4.15 MNES of this assessment report.

4.6.1.4 Terrestrial flora

One threatened flora species, *Cerbera dumicola*, listed as near threatened under the *Nature Conservation Act 1992* (NC Act) was found within the project area during the 2020 field survey. A likelihood of occurrence assessment determined that one other species, *Acacia spania*, also listed as near threatened under the NC Act, was likely to be present.

4.6.1.5 Habitat values and connectivity

The project area is located on the Nogoa River floodplain. The Fairbairn Dam releases water into the Nogoa River so that it flows almost continuously. The aquatic ecological value of the Nogoa River was assessed as high due to the potential for two species of threatened turtles. Several tributary creeks are highly ephemeral but contain aquatic habitat largely in small, isolated pools. Larger pools found in artificial waterbodies provide refugial habitat for aquatic fauna. Surveyed riparian vegetation was stated to be in a moderate to highly disturbed condition.

Brigalow vegetation and riparian vegetation associated with the Nogoa River and tributaries in the project area is mapped as having state biodiversity significance under the BRB Biodiversity Planning Assessment (BPA) (DES, 2018). The BPA states that networks of major and minor riparian linkages are a significant element of habitat continuity and provide important migratory and dispersal pathways for a substantial number of species. Remnant vegetation containing endangered REs that are poorly conserved in the subregion are also assigned ‘State’ significance.

As there is no proposed clearing of vegetation for surface construction activities, an analysis of connectivity changes using the State’s Landscape Habitat Connectivity and Fragmentation Tool was not required. The EIS determined that there will be no significant residual impact under the State’s environmental offsets framework.

4.6.1.6 Terrestrial fauna

Terrestrial ecology field surveys undertaken for the EIS span the period 2019 to 2020. Zone 1 and a wider study area were surveyed in the autumn and spring seasons of 2019. Zones 2 and 3 were surveyed in January 2020. Ecological reports undertaken for the existing Ensham Mine in 2019 were also reviewed.

Desktop assessment identified 27 listed threatened fauna species potentially occurring within the project area, and 16 migratory bird species.

There were 205 fauna species recorded from the site surveys including 128 birds, 34 mammals (including 17 bat species), 31 reptiles and 12 amphibians.

Only two conservation significant fauna species were recorded in the project area, the greater glider, *Petauroides volans*, and the short-beaked echidna, *Tachyglossus aculeatus*. Two conservation significant fauna species were recorded just outside the project area, the golden-tailed gecko, *Strophurus taenicauda albiocularis*, and the grey falcon, *Falco hypoleucos*.

One conservation significant migratory species was recorded, the glossy ibis, *Plegadis falcinellus*.

A likelihood of occurrence assessment based on survey results also identified five NC Act listed fauna species and three migratory species with the potential to occur within the project area (Table 7).

Table 7. Likelihood of occurrence of threatened terrestrial fauna species (from EIS Appendix C-2; section's 7.4, 7.6 and 7.7)

Species	NC Act status[1]	EPBC status	Likelihood of occurrence[2]
Greater glider (*Petauroides volans*)	Vulnerable	Vulnerable	Known to occur
Short-beaked echidna (*Tachyglossus aculeatus*)	Special least concern	Not listed	Known to occur
Glossy Ibis (*Plegadis falcinellus*)	Special least concern	Migratory	Known to occur
Koala (*Phascolarctos cinereous*)	Vulnerable	Vulnerable	Likely
Golden-tailed gecko (*Strophurus taenicauda albiocularis*)	Near threatened	Not listed	Likely
Grey falcon (*Falco hypoleucos*)	Vulnerable	Not listed	Likely
Fork-tailed Swift (*Apus pacificus*)	Special least concern	Migratory	Likely
Rufous fantail (*Rhipidura rufifrons*)	Special least concern	Migratory	Likely
White-throated snapping turtle (*Elseya albagula*)	Critically endangered	Endangered	Likely
Fitzroy River turtle (*Rheodytes leukops*)	Vulnerable	Vulnerable	Likely
Ornamental snake (*Denisonia maculata*)	Vulnerable	Vulnerable	Potential
Squatter pigeon – (southern subspecies) (*Geophaps scripta scripta)*	Vulnerable	Vulnerable	Potential
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	Potential
White-throated needletail (*Hirundapus caudacutus*)	Special least concern	Migratory	Potential
Latham's Snipe (*Gallinago hardwickii*)	Special least concern	Migratory	Potential
Caspian Tern (*Hydroprogne caspia*)	Special least concern	Migratory	Potential
Satin flycatcher (*Myiagra cyanoleuca*)	Special least concern	Migratory	Potential

[1] conservation status under the NC Act.

[2] likelihood of occurrence. (Based on EIS conclusions that may differ from the department's assessment of likelihood of occurrence).

4.6.1.7 Aquatic ecology

Only one comprehensive freshwater field survey was undertaken for the EIS prior to the wet season in November 2019. Standard aquatic ecology survey methods were undertaken in accordance with relevant guidelines. No significant rainfall had occurred in the four months prior to the survey and results across the six survey sites reflected low or no flow in the Nogoa River tributaries – Boggy Creek, Corkscrew Creek and Mosquito Creek.

Five species of freshwater turtles are recorded from the region but only the Krefft's river turtle, *Emydura macquarii krefftii*, was identified at one survey site. The threatened white-throated snapping turtle, *Elseya albagula*, and Fitzroy River turtle, *Rheodytes leukops*, are expected to inhabit the main channels of the Nogoa River.

A total of 12 common native fish species and two exotic fish species were collected in the survey.

A total of 17 common aquatic plants were identified in the field survey.

4.6.1.8 Watercourses

The proposed project is located within the Nogoa River drainage sub-basin, an inland basin of approximately 27,000km^2 that ultimately discharges to the Great Barrier Reef via the Fitzroy River. The Nogoa River, stream order 8, is the major watercourse that traverses the site from west to east. It is a regulated watercourse flowing 99% of the time due to releases from Fairbairn Dam 60km upstream. The Winton and Mosquito Creeks and several minor unnamed watercourse features and tributaries of the Nogoa River are within the project area.

4.6.1.9 Fish passage

Waterway barrier works are not proposed on any watercourses.

4.6.1.10 Wetlands

There are no mapped high ecological significance (HES) wetlands within the project area. Watercourses within the project area are mapped as riverine wetlands by the Queensland Wetlands Program.

4.6.1.11 Groundwater dependent ecosystems

Desktop mapping only used national GDE mapping to identify the potential for GDEs to occur within the project area. The state GDE mapping available on the department's WetlandInfo website was not used.

A desktop study was undertaken to determine the suitability of the project area's groundwater ecosystems to provide habitat for stygofauna. The EIS identified geological units that are known to provide habitat for stygofauna.

A stygofauna pilot study conforming to the Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DSITIA 2016) was undertaken over two sampling periods – November 2019 and in July 2021 and included in the AEIS. Results identified stygofauna from four of the 26 bores in the Nogoa River alluvium.

No GDE field surveys were undertaken as part of the aquatic ecology survey.

4.6.2 Assessment—potential impacts and proposed mitigation measures

4.6.2.1 Impacts on terrestrial ecosystem values

The proposed project identified no clearing of the approximately 403ha of remnant vegetation that provides suitable habitat for terrestrial fauna. The EIS indicated that underground mining activities would not directly impact surface EVs. This includes gilgai habitat on regrowth and non-remnant vegetation identified as ornamental snake habitat totalling 487ha of regulated vegetation – essential habitat. Flaring infrastructure to be constructed in zones 2 and 3 would be located in areas of disturbed land.

Potential impacts from subsidence to terrestrial ecosystem values relate to soil movement, tension cracking or changes in drainage characteristics. This can lead to senescence and die-back of vegetation and change habitat characteristics for fauna.

The EIS noted that potential subsidence impacts were modelled to be relatively minor and no greater than existing seasonal surface variations. An SMP proposes subsidence trigger levels to be monitored. No remedial actions are proposed but any significant subsidence would trigger an investigation.

4.6.2.2 Impacts on aquatic ecosystem values

The EIS indicated that no works are proposed within the Nogoa River or any tributaries. The drainage flare proposed nearest to a watercourse would be more than one kilometre distant.

The EIS indicated that potential indirect impacts from subsidence may alter stream beds or lead to bank failure resulting in restrictions to fish passage. The EIS noted that the modelled level of subsidence (less than 40mm) was within natural seasonal surface variation and therefore would have no additional impact.

Proposed management measures for monitoring subsidence within waterways include real time GPS monitoring, surface inspections, LiDAR and groundwater monitoring. Where trigger levels are exceeded, an investigation would be undertaken by a fish biologist to identify and manage potential impacts to fish passage. Remedial actions may include rehabilitation and restoration works.

4.6.2.3 Impacts on groundwater dependent ecosystems

The EIS considered that the mapped GDEs were of moderate environmental value and that the risk to these values from the mine activities did not warrant specific field surveys. Groundwater assessments indicate that drawdown impacts on GDEs would be minor due to the Rewan Group aquitard separating the alluvium from the coal seams subject to underground mining.

Potential indirect impacts from groundwater drawdown to terrestrial ecosystem values and GDEs relate to potential alluvial drawdown. The EIS considered that potential groundwater drawdown impacts were modelled to be no greater than 0.5m in the north-west portion of zone 1 and outside of zone 3. Drawdown impacts in zone 1 were stated to be close to an area of mapped GDEs, but state mapping does not identify any derived terrestrial GDEs in this location.

The EIS concluded that impacts on any GDEs in the project area would be negligible. The EIS proposed new groundwater monitoring bores and the establishment of site-specific trigger levels to be specified within a groundwater management plan.

The EIS indicated that floristic observations alone were sufficient to determine that riparian vegetation communities were unlikely to be GDEs. However, GDE field surveys are commonly undertaken to ground-truth desktop values. Assessment methods include drill cores to provide evidence for tree rooting depth and to characterise local hydrogeological conditions; soil moisture potential measurement; leaf water potential measurement; and stable isotope analysis of xylem water, soil moisture, surface water and groundwater.

The IESC advice (IESC 2021-123) recognised groundwater drawdown impacts could potentially alter the community composition and viability of GDEs. The IESC recommended that field surveys using direct techniques are undertaken to determine the groundwater dependency of Brigalow, coolibah and red gums (wetland indicator species) on alluvial sediments and along watercourses.

The stygofauna survey undertaken in 2019 was augmented by an additional survey in 2021. Additional stygofauna taxa were recorded in the 2021 survey. The EIS expressed that the alluvium provided generally suitable hydrological characteristics for stygofauna. The Queensland guideline (DSITA, 2015) recommends that a comprehensive stygofauna survey is undertaken when a pilot survey detects the presence of stygofauna, however, this was not undertaken.

4.6.3 Biosecurity

The TOR required the EIS to propose measures to remove, control and limit the spread of pests, weeds disease, pathogens and contaminants on the project area with reference to Queensland's *Biosecurity Act 2014*.

Surveys undertaken for the EIS included invasive flora assessments. The EIS identified 30 introduced weed species within the project area, with six declared as restricted matters under the *Biosecurity Act 2014*.

The pest fauna species: feral cat, dog, fox, house mouse, rabbit, hare, cane toad and common mynah were recorded in the project area and are also declared as restricted matters under the *Biosecurity Act 2014*. Feral pigs are expected as they have been recorded within the existing Ensham Mine.

An updated version of the existing Ensham Mine's *Weed and feral animal management environmental operating procedure* was provided as part of the EIS. The update included species recorded in the project area. Treatment methods for the identified weed and feral animal species were provided and are in accordance with pest fact sheets published by DAF.

Suitable mitigation measures are proposed to reduce the introduction and/or spread of weeds, including vehicle wash-down protocols and coordinating with the local council on pest controls.

Weed and pest animal management measures were considered within the framework of the CHRC Biosecurity Plan 2017-2020. Implementation of the management measures should align with that of the CHRC Biosecurity Plan.

I consider the EIS has adequately addressed the TOR and support the proponent's management and control strategies for weed and feral animal species in relation to biosecurity.

4.6.4 Conclusions and recommendations

The EIS has adequately identified flora and fauna values of the project area that potentially would be directly and indirectly impacted by the proposed project. The EIS indicated that the proposed underground mining operations would minimise the direct disturbance area of the proposed project.

No surface disturbance to remnant vegetation or threatened species habitat is predicted from exploration activities and the proposed construction of gas flares. No threatened species under the NC Act (that are also listed as MNES) would be significantly impacted by indirect impacts to habitat and no MSES offsets are proposed.

Potential indirect impacts from both groundwater drawdown and subsidence on environmental values are considered unlikely in the EIS.

4.6.4.1 Terrestrial flora

Despite there being low risk to the threatened flora species in the project area, I recommend that pre-clearance surveys are undertaken. If protected plants are identified in areas to be cleared (i.e. for flares) during the pre-clearing survey, a Clearing Permit (Protected Plants) would be required. Protected plants found in the impact zone should be considered for translocation into adjacent suitable habitat away from direct and indirect impacts. Relevant approvals under the NC Act would be required for translocation.

4.6.4.2 Terrestrial fauna

The EIS concluded that significant residual impacts to MSES (protected wildlife habitat) were unlikely. However, the EIS did not identify the individual species comprising this category. It is assumed that the assessment includes those species identified in Table 7. However, I am concerned that potential indirect impacts to terrestrial GDEs that provide habitat for threatened fauna have not been clearly established. This is due to the lack of site-specific GDE field methods. Riparian trees adjacent to the Nogoa River and Mosquito Creek that are large, old and contain significant hollows are suitable habitat for greater glider. These trees also provide foraging and dispersal habitat for koalas. The degree of groundwater dependency of these key Eucalypt species has not been confirmed for the project area.

I recommend that any Commonwealth approval for the proposed project should contain suitable management conditions for the koala, greater glider, squatter pigeon (southern), and ornamental snake.

4.6.4.3 Aquatic ecosystems

The EIS concluded that significant residual impacts to MSES (such as regulated vegetation – watercourses, wetlands, and protected wildlife habitat) are unlikely. No direct or indirect impacts to the populations of the white-throated snapping turtle or Fitzroy River turtle (MSES protected wildlife habitat) are predicted. I support proposed recovery actions of these species relating to the control of turtle egg predation from wild dogs, feral pigs and foxes within the Weed and Feral Animal Management Plan in Appendix C-1b of the AEIS.

I support the proposed subsidence monitoring measures that include annual LiDAR and RTK-GPS surveys as detailed in the SMP. The implementation of subsidence trigger levels is also supported. A detailed investigation by a fish biologist is also supported such that potential impacts to fish passage are identified and managed. However, I believe that trigger levels require ongoing refinement, recognising that subsidence impacts from bord and pillar mining is gradual, may be localised and may be delayed for many years.

I do not agree with the assumption that remedial management measures are not required. I recommend that the SMP is amended to detail time-bound remedial management measures, and a monitoring program to determine the effectiveness of those measures. This is discussed further in the land and water sections of this assessment report (sections 5 and 7).

4.6.4.4 Groundwater dependent ecosystems

The EIS concluded that significant residual impacts to GDEs are unlikely due to the stated very low likelihood of subsidence.

I support the IESC recommendation that field surveys using direct techniques (such as leaf water potential and stable isotope analysis) are undertaken to determine the groundwater dependency of Brigalow, coolibah and red gums (wetland indicator species) on alluvial sediments and along watercourses. I consider that GDE field methods over seasonal timeframes are required to fully characterise plant/ water interactions and to determine seasonal vegetation dependence on groundwater. This would also inform terrestrial GDE trigger levels for monitoring and reporting.

I recommend undertaking appropriate seasonal surveys to inform the validity of assumed low impacts to stygofauna communities. Monitoring must be in accordance with the DSITIA

Guideline (2016).

4.6.5 Offsets

Under Schedule 1 of the Environmental Offsets Regulation 2014 (EO Regulation), a resource activity carried out under an Environmental Authority under the EP Act is a prescribed activity for the purposes of the *Environmental Offsets Act 2014* (EO Act). Any MSES values listed in Schedule 2 of the EO Regulation subject to mining activities are therefore required to be assessed.

The proponent identified and assessed the potential impacts of the proposed project on prescribed environmental matters defined as MSES. No residual significant impacts from proposed mining activities were identified for any MSES values. Consequently, no offsets have been proposed.

The EO Act requires offsets to compensate for significant residual impacts on MSES after all on-site avoidance and mitigation measures have been applied. The proponent has demonstrated reasonable on-site avoidance by not proposing to clear remnant vegetation and by siting proposed flare infrastructure within existing disturbed areas. Mitigation measures have been applied to most MSES.

Based on material provided in the EIS, I agree that MSES would not be significantly impacted by the proposed mining construction and operational activities and no MSES offset conditions are recommended for the resulting EA.

4.7 Air

The relevant sections of the EIS used to assess the air shed and management of likely air impacts were EIS Chapter 15 Air Quality, Chapter 16 Greenhouse Gas, and Appendix G-1 Air Quality and Appendix G-1a Air Quality Management Report.

TOR section 9.7 required that the EIS undertake a range of assessment measures to ensure that the activity will be operated in a way that protects the environmental values of air. The TOR also explicitly required an emissions inventory, assessment of impacts and minimisation measures for greenhouse gases (GHG).

4.7.1.1 Environmental Protection (Air) Policy 2019 (EPP Air)

The air quality objectives from the Environmental Protection (Air) Policy 2019 (EPP Air) were adopted by the EIS for the proposed project assessment. Dust deposition objectives for the site are not defined in the EPP Air, and therefore the model mining conditions were applied in the EIS. Objectives for dust deposition were proposed from the model mining conditions guidance levels for total insoluble solids.

4.7.2 Assessment

4.7.2.1 Air quality

The EIS reviewed the existing air quality monitoring data sourced from the existing Ensham Mine and predicted the potential impacts of operational emissions associated with the proposed project. The EIS listed 33 sensitive receptors (all rural dwellings) with varying distances of 6 to 23 km from the CHPP. Sensitive air quality receptors were identified from aerial images. The EIS used the CALMET (a diagnostic 3-dimensional meteorological model) meteorological processor and the CALPUFF (an air quality dispersion model) to predict the airborne transport and dispersion of project pollutants. The parameters used for the meteorological data were wind direction, wind speed and modelled atmospheric turbulence.

Background air quality data for the selected indicators (total suspended particle (TSP), particular matter 10µm or less in diameter (PM_{10}) and particular matter 2.5µm or less in diameter ($PM_{2.5}$) was sourced from the department's air quality monitoring station at Blackwater, about 41km south-east of the proposed project using data from April 2019 to March 2020. The background levels were compared with the objectives for the selected indicators under the EPP Air. The department noted that the annual average background concentration for PM_{10} of 23.5µg/m^3 was close to the 25ug/m^3 EPP Air PM_{10} objective and therefore that there was limited assimilative capacity for additional emissions. An addendum appendix in the AEIS reviewed the background data and identified that there were exceedances of PM_{10} and $PM_{2.5}$ objectives at the Blackwater air quality monitoring station during the second half of 2019. This was likely due to dust storms carried from inland as well as bushfires and hazard reduction burns, combined with drier than average conditions in this period. The AEIS concluded that the background levels presented are likely to be a very conservative overestimate of indicator levels, particularly for PM_{10}. Dust deposition data was sourced from an existing monitoring site south of Ensham Mine, near the Capricorn Highway.

The National Pollutant Inventory (NPI) search showed Kestrel Mine (24km north-east of the project), Blackwater Mine (35km south-east) and Curragh Mine (40km east) as other potential sources of emissions for the study area. Due to the prevailing wind direction, Kestrel Mine emissions from the north were not predicted to impact the study area. The emissions from Blackwater and Curragh mines were considered to have been captured in the baseline data from the Blackwater air quality monitoring data. Two proposed mines were identified to have potential impacts on the air quality of the study area in the future. These are the Wilton Coal Project, located 3km east of the Ensham Mine, and the Fairhill Coal Project, 20km north-west of the Ensham Mine. The potential for cumulative impacts on air quality was assessed but due to proposed mitigations for these projects and the separation distance of Fairhill Coal Project, the likelihood of cumulative impacts on proposed project air quality as a result of other mines is considered low.

Three emissions scenarios were modelled based on 2024, 2028 and 2031 throughputs including emissions from rehabilitation works. Emissions from construction works were not included as a scenario, given the limited above-ground infrastructure and disturbance as a result of the proposed project. For 2031, the open-cut throughputs were not included, as the open-cut operations would have ceased.

Modelling results for emissions from the project, which included Ensham Mine and a cumulative value for both the project, Ensham Mine and background levels, were presented in the original EIS. The results predicted exceedances of the annual average PM_{10} EPP Air objective in each modelled scenario and for two sensitive receptors. In response to the predicted exceedances, the department required the proponent to demonstrate how they would comply with the EPP Air. In their response, the proponent set out how the methodology used to derive these numbers was inappropriate, as the cumulative impacts were calculated based on the aggregate worst affected receptors rather than for each sensitive receptor. It is not clear, however, why the value was ascribed to a particular receptor in the results table. In the AEIS, the analysis was revised so that the cumulative impacts were calculated for each sensitive receptor. The revised model predicted that the proposed project would contribute minor amounts to pollutant concentrations at sensitive receptors for all scenarios and that cumulative pollutant concentrations would remain below relevant air quality criteria. While the EIS has presented evidence that background concentrations are conservative, the department considers that there is a risk that under worst case meteorological conditions, the EPP Air PM_{10} objective may be exceeded.

The department notes that dust deposition data presented in Appendix G-1 indicates that maximum monthly averages exceeded the 120mg/m^2/day objective at a sensitive receptor on three occasions with similar exceedances reported at other nearby receptors. A submission to the EIS also questioned whether the current placement of the dust monitoring station on the western boundary of the property, at furthest reach from the current Ensham mining operations would accurately represent dust levels experienced on the property. The proponent confirmed that placement of the monitoring apparatus was in the vicinity (approximately 700m north) of the place of residence on the property but removed from the site of local equipment movement and the main road.

Current air quality control measures implemented at the Ensham Mine will be continued for the project including:

- dust control on haul roads via watering
- dragline drop heights limited to 9m
- overburden dumping from trucks restricted to within pits
- dozer utilisation rates at 90% or less
- rehabilitation as per residual void rehabilitation plan
- monthly dust deposition monitoring (currently three locations)
- modification of operation during adverse meteorological conditions
- application of coal loading techniques to reduce overfilling and spillage during transport
- application of veneer suppressant to surface of loaded coal wagons.

The EIS committed to complying with the existing conditions of the Ensham Mine EA, which included air quality conditions to regulate dust deposition and concentrations of particulate matter and odour. The department noted that draft EA condition B3(b) in Chapter 27, which included allowance for five exceedances per year, did not reflect the current EPP Air. This condition was revised in the AEIS. The department also noted that there were no proposed conditions in the EIS (Chapter 27) to regulate the flaring of the gas and suggested appropriate conditions as part of the submission. The proponent response stated that these conditions were generally applicable to petroleum activities rather than mining and were also already addressed in the project design. However, the department considers that the regulation of flares would be usual practice for the proposed project and recommends additional conditions.

4.7.2.2 Greenhouse gas emission

As per the TOR requirements, the EIS confirmed that the amount of greenhouse gas emissions (GHG) produced by the proponent meets the threshold for annual reporting of emissions to the Australian government's Clean Energy Regulator under the *National Greenhouse and Energy Reporting Act 2007* (NGER). The EIS identified reporting requirements under the NGER for scope 1 (fugitive emissions, ventilation air and diesel) and scope 2 (electricity usage) emissions. Several submissions to the EIS raised the need to quantify scope 3 emissions (downstream emissions e.g. from the burning of product coal) and their potential impacts on national and global environments. However, assessment of scope 3 emissions was not included in the TOR and there are no requirements for scope 3 emissions reporting under the NGER legislation for the proposed project.

The key project GHGs were identified as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and the volumes of these GHGs were converted into carbon dioxide equivalent (CO_{2}-e) on the basis of their global warming potential. For example, a tonne of methane would have 25 times the global warming effect of a tonne of CO_2. An inventory of predicted annual emissions was provided for the proposed project in accordance with the NGER methods and criteria. Emissions factors (amount per unit) for fugitive emissions, diesel fuel combustion and purchased electricity (Qld) were taken from the most recent National Greenhouse Accounts Factors. The inputs were based on forecast ROM coal production, ventilated underground air discharge rates and CH_4 and CO_2 composition and diesel and electricity usage rates based on recent usage by the proponent at Ensham Mine

Estimated annual greenhouse gas emissions predicted for each year of the project from

2020 through to 2057 (at the completion of rehabilitation works) were presented for the "base case", without any mitigation, and the "mitigation scenario." Proposed mitigation consisted of gas drainage of the underground air from all three zones to a residual gas content of 2.0m^3/t, and release of the drained gas by flaring at zone 2 and zone 3, which is expected to convert 80% of the drained gas CH_4 to CO_2. This conversion of CH_4 to CO_2 reduces the total $CO_{2\text{-}}$e content by 25 times. The remaining underground mine gas will be released through existing ventilation infrastructure. Mitigation through gas drainage and flaring results in a predicted 6.6Mt of $CO_{2\text{-}}$e of GHG emissions for all inputs over the life of the Project, with an average annual GHG emission rate of 0.36Mt $CO_{2\text{-}}$e. This is a reduction of 2.0Mt $CO_{2\text{-}}$e compared with the unmitigated "base case".

The EIS did not provide justification for the proposed residual gas content underground (2.0 m^3/t) or whether this could be further reduced through more drainage and flaring, despite the release of this residual methane representing 82% of the total GHG emissions. The EIS discussed the alternative abatement measure of capture and reuse of the coal seam gas, however, it concluded that the low size of the gas reservoir and low average flow rates meant this was not commercially viable. Other GHG minimisation strategies currently implemented at Ensham Mine and proposed for the project were listed including prioritising a suite of energy efficiencies in operations, equipment and machinery, local procurement where possible to minimise transport of goods and limiting vegetation clearance. While these are labelled best practice there is no reference to an industry standard for comparison. Two submissions expressed little confidence in the mitigation scenario on the basis of historical failures to implement mitigation commitments by the mining industry. To improve confidence in the delivery of emissions mitigations it is recommended that the proponent prepares an emissions reduction management plan to capture and implement the emissions mitigations set out in the EIS and detail continuous improvement steps the proponent will take for emissions reduction.

The EIS compared projected emissions from the proposed project to state and national emissions. The average annual $CO_{2\text{-}}$e from the mitigated emissions scenario, with flaring of drained gas, represented 0.07% of Australia's emissions and 0.22% of Queensland's emissions from the 2017/2018 period. The contribution of the proposed project to the national emissions total and global carbon emissions was the subject of four submissions, which also raised concerns about the impacts on national and global emissions reductions targets. The proponent responded that while State and Commonwealth government climate policies include strategies for businesses to reduce net emissions, they do not currently preclude mining development. Submissions were also made on the human rights impacts of the project, due to contributions to GHG emissions, although these were not specific about which rights were impacted. The proponent's response referenced other sections of the EIS which dealt with climate change and hazards and safety, as well as social impacts relevant to the project. Two submissions specifically quoted the ruling on the recent Sharma case in NSW (FCA 2021) and suggested that the proposed project would contribute to personal injury of future generations. Both of the submissions called for the social and economic costs of GHG emissions to be assessed in the economic cost benefit analysis for the proposed project. The proponent indicated that decision making on the proposed project would need to take into account all costs and benefits of the proposed project including ongoing economic and social benefits as a result of the mine, at a national, state and regional levels. The proponent considered that the cost of $CO_{2\text{-}}$e emissions had been addressed in the economic cost benefit analysis in Chapter 22 of the EIS. These submissions also contended that GHG emissions, including scope 3 emissions are relevant to the statutory (sic) criteria considered in assessments and decision making under the MR Act and the EP Act.

4.7.3 Conclusions and recommendations

Background air quality monitoring was undertaken and cumulative impacts from other mining activities were discussed in the EIS. Modelling of impacts from the proposed project on air quality was undertaken and revised following submissions for the AEIS.

The revised modelling results for cumulative impacts from the proposed project emissions and background air quality found that the annual PM_{10} concentration would be very close to the EPP Air objective with little residual assimilative capacity. The department also noted exceedances of dust deposition in the EIS data. The department considers that under worst case meteorological conditions, there is a risk of exceedances and therefore recommends that EA conditions include limits and monitoring requirements for 24 hour and annual PM_{10} levels, more detailed exceedance reporting and complaint investigation procedures. In addition, the development and implementation of an ambient dust monitoring program should be conditioned together with weather monitoring. Any monitoring must be located and executed in accordance with the relevant Australian Standards. Monitoring results would inform a project dust management plan required for the project to manage impacts from the project on local air quality.

The model mining conditions are generic and conditions may also be specified for projects that involve particular risks or other activities, such as flaring of gas. I therefore recommend conditions for flaring infrastructure design and performance as well as flare operation and project odour. Such conditions are common regulatory practice where flaring is undertaken.

The EIS proposed greenhouse gas abatement measures through gas drainage and flaring of the underground air. Flaring would significantly reduce the global warming potential of the underground gas released from the project. Other mitigation measures such as energy efficiencies are also proposed in line with measures currently implemented at Ensham Mine. However, the EIS lacks detail on these measures, such as justification for the choice of the residual gas content of $2.0m^3/t$ or explanation why additional drainage and flaring could not be implemented. Submissions raised broad doubts over the capacity and commitment of the mining industry to implement GHG mitigations. To improve confidence in the mitigation of GHG emissions by this project, the department recommends inclusion of a condition in the EA that requires an emissions reduction management plan for the proposed project. The plan would capture the emissions mitigations set out in the EIS and detail and report on their implementation and on continuous improvement steps that the proponent would apply for emissions reductions. I recommend that the emissions reduction management plan include the following:

- details of the intended objectives, measures and performance standards to avoid, minimise and control emissions
- a process for regularly reviewing new technologies to identify opportunities to further reduce emissions and energy use, consistent with best practice environmental management
- any voluntary initiatives or research into reducing the lifecycle and embodied energy of the project’s processes or products
- annual energy audits with a view to progressively improving energy efficiency, including monitoring, auditing and reporting on GHG emissions from all relevant activities and the success of abatement and offsetting measures.

4.8 Noise and vibration

EIS Chapter 17 Noise and Vibration and Appendix H-1 Noise and Vibration Technical Report were used to assess the potential impacts of noise and vibration emissions by the project on sensitive receptors and the surrounding environment.

Section 9.8 of the TOR required the EIS to:

- describe and illustrate the locations of sensitive receptors defined in the Environmental Protection (Noise) Policy 2019 (EPP Noise)

- describe other environmental values that could be impacted by noise and vibration from the project
- describe sources and characteristics of noise and vibration that would be emitted during the construction, commissioning operation, upset conditions and closure of the project
- conduct noise and vibration impact assessment that address low frequency noise emissions and potential cumulative impacts from existing and known future developments
- demonstrate that the project can meet the environmental objectives and performance outcomes defined in the Environmental Protection Regulation 2019
- describe how the project would be managed to be consistent with best practice environmental management
- describe how the environmental management objectives for noise and vibration impacts would be achieved, monitored, audited and reported, and how corrective actions would be managed.

4.8.1 Environmental Protection (Noise) Policy 2019 (EPP noise)

The EPP (Noise) lists the environmental values and the acoustic quality objectives to enhance or protect the environmental values. As described in the EPP (Noise), environmental values of the acoustic environment have been developed to protect the health and biodiversity of ecosystems, human health and wellbeing, and community amenity.

The EPP Noise includes acoustic quality objectives to protect environmental values for sensitive receptors which include residential and other premises including protected areas.

Cumulative noise criteria proposed for the sensitive receptors identified for the project are taken from the EPP Noise acoustic quality objectives. As the project is an extension of the current underground operation of the Ensham Mine, and construction and blasting activities are not proposed, construction noise and vibration were not included in the assessment.

The model mining conditions include noise limits for sensitive places. Noise limits (criteria) for the project, including for low frequency noise, have been proposed for sensitive receptors based on modified model mining conditions and used by the EIS for impact assessment purposes. The criteria have been established to assess long tern noise impacts as the project progresses.

4.8.2 Assessment

The EIS followed the assessment framework outlined in the department’s EIS Noise and Vibration guideline (DES 2020). Eighteen sensitive receptors within a 10km radius of the project have been identified and mapped. Two of the sensitive receptors are identified as being within the project area. Background noise monitoring was conducted at six sensitive receptor locations over a two-week period in 2019. Survey data collected previously from other operational mine sites within the region was not considered in the assessment due to their distance from the project area (the nearest active mine site is Kestrel Mine, located between 12km and 16km from the nearest sensitive receptor).

Measured background noise levels have been presented across all sensitive receptors. However, as the levels were below 30dB(A) across all the monitoring locations, the 30dB(A) was substituted for the measured background level, reflective of the model mining conditions.

Predicted noise levels produced by the project were obtained using industry-recognised Environmental Noise Model software. The modelling was based on adverse meteorological conditions. The EIS states that the model was run for both project sources only and with sources from the existing Ensham Mine operations and considered the cumulative impacts of open-cut operations, underground operations and rehabilitation works being conducted concurrently.

Three operational phases considered in the noise assessment were:

- 2020–2024—open-cut operations and underground operations ongoing along with rehabilitation works
- 2024–2037—underground operations ongoing along with rehabilitation works
- 2037–2043—rehabilitation works only.

Noise sources include all equipment and plant associated with the proposed underground operations, including above-ground infrastructure and equipment. This includes the CHPP, rail loadout, road trains, conveyors, ventilation shafts and associated mobile equipment.

As the project will not require any additional infrastructure, noise levels for operational equipment incorporated into the model were obtained from data collected from fixed/mobile plant at Ensham Mine in 2019, and from a previous noise and vibration assessment conducted in 2006.

Model predicted noise levels were compared to the proponent’s proposed noise limits, which are based on Ensham Mine’s existing EA conditions. For project only and cumulative noise impacts, the predicted noise levels comply with the EPP Noise acoustic quality objective and model mining conditions at all sensitive receptors. Low frequency noise was not predicted to exceed the proposed noise criterion.

To reduce noise impacts at sensitive receptors for years 2024 and 2025, when the rehabilitation fleet will be near the southern extent of the mine, works will not commence until 7am, avoiding the night-time period.

As the project is an extension of the existing underground operations at Ensham Mine, the EIS lists the current noise mitigation measures that are employed and are considered appropriate for the project. Ensham Mine’s Noise and Blast Monitoring Environmental Operating Procedure outlines the noise management measures as follows:

- plant and equipment to be maintained and repairs to noisy equipment conducted
- ongoing consultation to monitor noise impacts from reversing alarms
- operational activities shall be modified as appropriate when acceptable noise impacts are identified
- drilling and blasting to occur during daylight hours only
- pumps and generators are noise damped.

The EIS assessed the noise impacts on fauna, however no increases of noise are predicted to occur above the current levels at Ensham Mine and the EIS has therefore concluded impacts will be minor.

4.8.3 Conclusions and recommendations

The project is considered to be low risk with respect to noise impacts. The requirements of the TOR in relation to noise and vibration potential impacts were adequately addressed in the amended EIS. The EIS has provided information on the baseline noise levels, predicted noise levels at sensitive receptors and proposed noise limit criteria. Based on the outcomes of the noise modelling, it was concluded that compliance with nominated criteria is predicted at all sensitive receptors and the acoustic quality objectives of the EPP Noise are predicted to be met.

It is recommended that EA noise conditions set noise limits for the project in line with the EPP Noise and the current limits set out in the Ensham Mine EA.

4.9 Hazards and safety

EIS Chapter 19 Hazard and safety was used to assess the proposed project hazards and risk. The

EIS described the potential hazards and risk to people and property that may be associated with the project based on qualitative risk assessments. The natural hazards were also outlined in EIS Chapter 6 Climate.

TOR section 9.10 required that the EIS describe the potential risks to people and property and detail the proposed safeguards that would reduce the likelihood and severity of hazards. Details of emergency planning and communication and consultation with emergency services were required.

Mining activities and the associated transport of materials and product to and from the project area were proposed to accord with relevant hazards and safety legislation, standards, and guidelines.

4.9.1 Assessment

A qualitative environmental risk assessment was undertaken of natural and man-made hazards and risks to the community from the construction and operation phases of the proposed project. Mitigation measures were proposed to minimise the identified risks.

The project area is known to experience natural hazards including flooding, droughts, cyclones and storms. A natural hazard assessment considered the potential adverse impacts from natural and man-made hazards as outlined below.

- Bushfires may be caused from project activities such as accidental ignition, explosions or spontaneous combustion of existing fuel loads. The hot and seasonal dry conditions can increase the risk of bushfires. Consequences include damage to mining infrastructure, combustion of coal stockpiles and human injury or fatality.
- Cyclones and storms are relatively uncommon and generally form during summer months.
- Flooding may be caused by extreme rainfall events or from changes to land use and overland flow paths from mining activities. Consequences can lead to equipment failure, design capacity exceedances leading to unauthorised releases and levee failure.
- Earthquakes are geophysical hazards, usually caused by movements along faults as a result of compression in the earth’s crust (QFES, 2019). Risks include wall collapse, damage to mining infrastructure, dam or levee failure, rupture or damage to a dangerous goods storage facility and human injury or fatality.

The proposed project activities are inherently hazardous given the nature of underground bord and pillar mining. The EIS proposes to manage such hazards by having appropriate design, training of staff, inspection and maintenance of equipment and emergency procedures in accordance with existing practices at the Ensham Mine. In addition, for bushfire risk, an exclusion zone of 80m by 20m will be put in place around each flare. The extended underground mining activity will not alter the current profile of this risk.

The existing Ensham Mine Integrated Management System provides the framework to implement a documented and systematic approach to managing risks associated with safety, health and the environment. Specifically, that the proponent undertakes preparedness activities, including emergency response planning and coordination with local authorities, and, in accordance with EA EPML00732813, ensure all hazardous substances are stored and handled in accordance with Australian Standards (G5). These measures are proposed to be extended to the proposed project to ensure risks are reduced as far as reasonably practicable.

Coal mining operational hazards related to the potential adverse impacts from spontaneous combustion, explosions and the inhalation of coal dust were assessed. The EIS outlined five main hazards related to coal mining operations: fire, leakage, spills, strata failure and vehicle accidents. These hazards could potentially lead to property damages, injuries or fatalities to site workers as well as the public, and health impacts from contamination of soil, water and air.

The mitigation measures included training of staff; emergency management plan; design, installation and maintenance of equipment; installation of adequate dimensions of pillars; traffic management plan; and following standards for procedures and designs. The current risk control measures were considered adequate by the EIS; no new risk control measures were recommended. The extended underground mining activity does not introduce new coal mining operation hazards. However, it will alter the locations of existing underground mining hazards.

Queensland Ambulance Service noted that their paramedics participate in yearly emergency training scenarios with the existing Ensham Mine and will be continuing to participate for the proposed project.

4.9.2 Conclusions and recommendations

The EIS adequately assessed the potential impacts of natural and project induced hazards on people and property and their management, addressing section 9.10 of the TOR. Commitments have been made in the EIS to address hazard and safety issues raised in emergency services submissions.

4.10 Waste management

Waste assessment can be found in EIS chapters 18 Waste management, 8 Land resources, 10 Surface water resources, 15 Air quality and 16 Greenhouse gas. EIS Chapter 18 Waste management addressed the TOR by describing non-mining waste streams expected to be generated by the proposed project's activities including sewage, and associated management infrastructure and measures. Chapter 8 Land resources provided background information on the geochemistry of overburden, rejects and tailings and their management. Chapter 10 Surface water resources described the mine water balance and potential discharges. Chapter 15 Air Quality and Chapter 16 Greenhouse gas addressed air emissions. Relevant appendices are Appendix B-1 Land resources. Appendix B-3 Geochemical Data, Appendix E-1 Surface water quality and Appendix E-2 Water balance model development.

4.10.1 Assessment

Waste streams and quantities have been characterised in some detail based on waste generated at the existing Ensham Mine. The EIS indicated that the proposed project will be utilising the existing infrastructure, hence the only construction required will be the four flares which will have negligible waste generated.

The current waste types and annual generation rates are summarised in Table 18-2 in Chapter 18 of the EIS.

During operation, the following non-mining waste is expected to be generated:

- general domestic waste
- plant and equipment waste such as tyres, batteries, oil filters and hydrocarbon contaminated waste
- electrical and electronic wastes
- solvents, paints, drums and packaging
- sewage
- minor amounts of medical and clinical wastes.

General wastes would be transported by an authorised waste management contractor and disposed at the CHRC operated Lochlees landfill. Regulated wastes would also be transported by a licenced waste contractor. The proponent has advised that they do not have any agreement in place with CHRC regarding waste disposal at the Lochlees landfill. However, the proponent is confident that the waste stream will not increase from levels produced in the existing Ensham Mine operation and therefore will continue to be accepted at the landfill.

Sewage would be treated at the existing onsite sewage treatment plants with effluent used for the irrigation of rehabilitated areas as per the existing EA.

Predicted mine waste generated during the mining and the processing of coal, includes:

- overburden waste rock (up to 18,000m^3 per annum)
- mine affected water (up to 9800ML per annum).

Management of mine waste from the proposed project is anticipated to continue as per management practices at the existing Ensham Mine. Waste rock generated during mining and dry processing at the CHPP will continue to be placed in Pit C and Pit D as occurs under the current waste management plan (WMP) for the existing Ensham Mine. The volume of waste rock generated by the proposed project is anticipated to remain similar to the volumes generated at existing Ensham Mine (18,000m^3 per annum) with an estimated 225,000m^3 of waste rock over the life of mine to be placed in existing pits C and D. This represents approximately 0.6% of the total volume of waste rock estimated for the existing Ensham Mine for placement in the rehabilitation of these pits.

The department is concerned by the absence of samples to characterise the geochemistry of the rock from the proposed project footprint. Data presented in the EIS on the geochemical characteristics of waste rock at the proposed project is based on data presented in previous studies (URS 2005 and URS 2015 found in Appendix E of this assessment report). Thirty-six geochemical samples were taken from 11 boreholes adjacent to the existing open cut mine area, five of them above the existing underground mining area. However, there has not been any geochemical sampling or characterisation within the proposed project footprint. In addition, the data from these 11 bores does not appear to support the conclusions of geochemical homogeneity between the existing and proposed mine sites, as put forward in the EIS. Concerns about the lack of geochemical characterisation of the project area were also raised by other state agencies and the public in their submissions during the public notification period. These are further discussed in the land section (section 4.3) and the rehabilitation section (section 4.4) of this assessment report.

Mine water generated, as part of the operation of the proposed mine expansion, will continue to be managed using the existing WMP and 9800ML of mine water is predicted per annum. There is an existing water and salt balance model which simulates the site water balance to enable assessment of overall performance of the water management system. This model can be applied to the proposed project for ongoing monitoring of water management performance.

The existing mine water management system (MWMS) comprises of open-cut pit storages, water storage dams on the Nogoa River and Boggy Creek, a water treatment plant and pumping systems. By 2023 open cut mine pit (Pit B) will become available, increasing the surface water storage capacity to 48,000ML. The existing Ensham Mine EA allows for controlled releases to the Nogoa River at two release points. The model predicts that there will be no net increase in average annual release to the Nogoa River from the proposed project. In the EIS, the predicted 50th percentile annual release volume for the proposed project, was 200ML greater than the annual release volume of the existing Ensham Mine.

In addition to storage of MAW in the existing mine voids and dams, the EIS proposes to use the underground mined area for groundwater storage. The current underground capacity is approximately 6,000ML. As the underground mine progresses, the completed areas will be sealed off and filled with water, expanding the underground storage capacity progressively. It is assumed that the underground water storage capacity will increase from 6,000ML to 48,000ML by the end of the mining life (Figure 11).

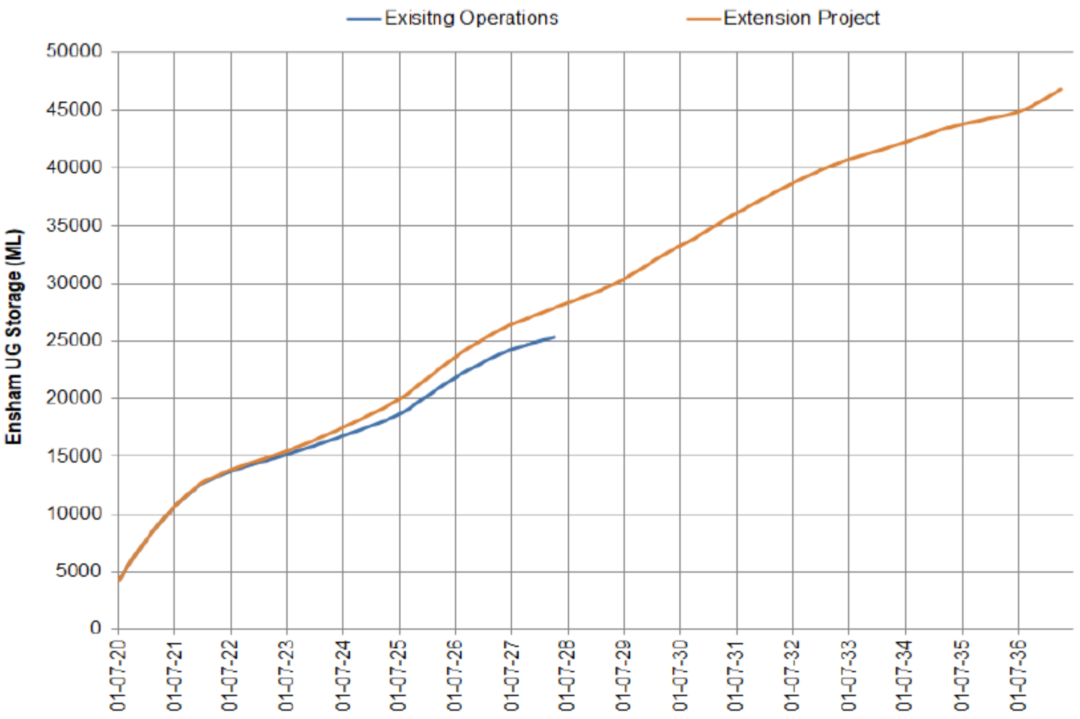


Figure 11. Underground water storage capacity of Ensham LOME (from AEIS Appendix E-2 Figure 17)

4.10.2 Conclusions and recommendations

For non-mining waste, the EIS has adequately identified waste streams based on data from the existing Ensham Mine and has addressed how the waste would be managed and transported in line with current waste management practices. As a precautionary measure, I recommend further conditioning to ensure that the waste will not be disposed of outside that proposed in the AEIS.

The mine waste water is proposed to be managed through the existing MWMS and released to Nogoa River as per the existing Ensham Mine EA. To better monitor the impacts from the release and storage of mine water, I recommend inclusion of additional upstream surface monitoring points and groundwater bores as discussed in the water quality and resources section (section 3) of this assessment report.

The waste rock is proposed to be placed in Pit C and Pit D, and progressively characterised during disposal for net acid producing potential, salinity and other parameters as noted in the Mine WMP of the existing Ensham Mine EA. Since the geochemistry of the project area was not characterised in the EIS, I recommend waste rock characterisation to be conducted as per the existing Ensham Mine WMP. Mitigation measures and contingency plans will also be required to be in place before mining commences, in the event contaminants are found in the waste rock. This is also addressed in the land and rehabilitation sections (sections 5 and 6respectively) of this assessment report.

4.11 Cultural heritage

Assessment of Indigenous and non-indigenous cultural heritage for the project area was described in EIS Chapter 20 Cultural Heritage and Chapter 7 Land use and tenure.

Section 9.11 of the TOR required that the EIS conduct the impact assessment in accordance with the department's latest EIS information guidelines: Aboriginal and Torres Strait Islander cultural heritages and Non-Indigenous cultural heritage; develop a Cultural Heritage Management Plan (CHMP) in accordance with Part 7 of the *Aboriginal Cultural Heritage Act 2003* (ACH Act); undertake a study to describe known and potential non-Indigenous cultural and landscape heritage values by an appropriately qualified cultural heritage practitioner; and provide strategies to mitigate and manage impacts to non-Indigenous cultural heritage values.

4.11.1 Assessment

The proposed project is located within the Bowen Basin, in the Central Highlands Regional Council local government area (LGA), known as an area of historical mining and grazing related communities. The proposed project area consists of resource tenures and freehold land, predominantly used for grazing.

4.11.1.1 Aboriginal and Torres Strait Islander cultural heritage

To undertake the assessment of the Aboriginal and Torres Strait Islander cultural heritage values of the proposed project, the proponent reviewed the information on heritage registers and previous reports. A search was undertaken of the Aboriginal and Torres Strait Islander Cultural Heritage Database and Register to identify any registered cultural heritage within the project area. Additionally, a review of available historical and archaeological research in the area was undertaken by the proponent to identify any places of cultural heritage significance, previous land use and high sensitivity landforms.

Six registered Aboriginal cultural heritage sites within zone 2 were recorded in the EIS. These sites include six culturally modified trees, which provide potential for further culturally modified trees to be present along the Nogoa River. A further 81 sites, the majority of which are artefact scatters, were identified within a 20km buffer of the proposed project area.

A total of 208 cultural heritage sites have been identified in zone 1 during the exploration activities in 2018 and 2019, the majority of which are stone artefacts within 100m of a drainage line. A review of historical and archaeological information suggests that Aboriginal cultural heritage sensitivity is highest in areas within 100m of a watercourse, with the largest and most complex sites likely to occur along the banks of the Nogoa River.

The EIS indicated that the cultural heritage within zone 1, was to be managed under a native title agreement with the Western Kangoulu People as defined under the ACH Act (Part 7, Division 2, s.86). The Western Kangoulu People note that the EIS is misleading as there is currently no native title agreement in place. The Western Kangoulu People also highlight that an agreement has not been reached between their people and the proponent. In their response, the proponent stated that the arrangements for zones 1, 2, and 3 are already in compliance with the ACH Act.

On 21 May 2021, Justice Dowsett, President of NNTT made a future act determination that the proposed project may be undertaken pursuant to section 38 of the Commonwealth *Native Title Act 1993* (NT Act) (Bligh Coal Limited, Idemitsu Australia Resources Pty Ltd and Bowen Investment (Australia) Pty Ltd v Jonathon Malone & Ors on behalf of the Western Kangoulu People & Another [2021] NNTT 19 (21 May 2021) [QF2020/0003]). I am satisfied that section 86(b) of the ACH Act has been addressed by the determination made by Justice Dowsett, and subsequently, this addresses the cultural heritage requirement of the EIS.

The proponent has established goals to increase participation in the areas of employment and opportunities for businesses of the First Nations peoples. The proponent claims that they have an existing long-term relationship with the Western Kangoulu People and the Garingbal and Kara Kara People. A Memorandum of Understanding (MOU) has been established which commits to the following:

- education and training to support First Nations peoples into jobs and business opportunities in the resources sector
- employment of First Nations peoples in the resources sector
- participation by First Nations owned and operated businesses in resources sector supply chains.

For zones 2 and 3, Aboriginal cultural heritage is proposed to be managed under the existing CHMPs. There are two current CHMPs for the existing Ensham Mine (CLH000419) between Ensham Resources Pty Ltd and the relevant people: Garingbal and Kara Kara People signed in 2006; and the Western Kangoulu People signed in 2007. Following this, a CHMP was developed with the Western Kangoulu People for activities under MDL 217 and 218 in 2018.

4.11.1.2 Non-indigenous cultural heritage

Historical accounts of the proposed project area commenced with the Leichhardt expedition in 1845, seeking a route from Moreton Bay to Port Essington in the Northern Territory. The EIS undertook desktop assessment including Heritage register searches on World, National and Commonwealth heritage registers, the Queensland heritage register and the local heritage register. Additionally, a review of historical studies, historical documents and previous historical cultural heritage assessments of the proposed site and its surroundings was undertaken. The EIS suggests that there are no likely historical archaeologically sensitive areas within the proposed project area.

The EIS concluded that the proposed project will not impact any non-indigenous cultural heritage values. Any risk of impact will be managed under the existing CHMP. The proposed project will undertake cultural heritage inductions for all ground workers and put procedures in place in case of unexpected findings.

4.11.2 Conclusion and recommendations

I have determined that the EIS and the AEIS has adequately addressed the cultural heritage section of the TOR.

Although the proponent has satisfied the requirements of the ACH Act, from reviewing the EIS submissions made by the Western Kangoulu People, I have concerns about whether the relationship with the proponent is a constructive one. Therefore, I recommend that the commitments outline withing the MOU listed above, as made in the proponent’s response to submissions, is followed through. This is also discussed in the social impact section of this assessment report (section 4.12).

I consider the non-indigenous cultural heritage assessment sufficient for the proposed project. I recommend the development and implementation of a protocol for unexpected archaeological finds and the provision of cultural heritage inductions for employees and contractors in accordance with the *Queensland Heritage Act 1992.*

4.12 Social impact assessment process

Chapter 21 Social and Appendix I-1 Social Impact Assessment (SIA) of the environmental impact statement (EIS) provided a detailed SIA for the proposed project. The SIA described the potential social impacts (both positive and negative) of the proposed project and identified relevant impact mitigation and benefit enhancement measures.

The Coordinator-General required the SIA to address the requirements of the *Strong and Sustainable Resource Communities Act 2017* (SSRC Act) and the Coordinator-General’s SIA Guideline (SIA Guideline) (DSDMIP 2018), which outlines five key matters that must be addressed in the SIA:

- community and stakeholder engagement
- workforce management
- housing and accommodation
- local business and industry procurement
- health and community wellbeing.

The following social assessment does not report on all social matters identified in Chapter 21 or Appendix I-1 of the EIS, rather it identifies the key social issues for the proposed project and identifies outstanding matters requiring further information and for which the Coordinator-General has stated conditions. The Coordinator-General completed a full evaluation of the proposed project's SIA under section 11 of the SSRC Act. This is also available online at the DSDILGP website (*https://www.statedevelopment.qld.gov.au/enshamlome*).

4.12.1 Summary of key social issues and submissions

The SIA determined the proposed project is likely to have impacts and provide opportunities for the local communities of Comet (approximately 17km south), Emerald (approximately 35km south-west) and Blackwater (approximately 40km south-east). These towns are located within a safe daily commute distance (maximum one-hour drive time) from the project area and are likely to experience most of the social impacts and benefits from the proposed project.

The proposed project would support local employment with the proponent committing to a recruitment strategy that would preferentially employ workers from the existing Ensham Mine, then local and regional workers.

Submissions on the EIS requested the opportunity to engage more closely with the proponent on the following matters:

- opportunities for Aboriginal and Torres Strait Islander peoples' employment, training, and local business and industry procurement
- potential for impacts to directly affected and adjacent landholders due to land access, subsidence, diminution of land value and groundwater drawdown
- employment opportunities for people with disabilities and seniors
- community development and investment priorities
- management of Indigenous cultural heritage across the site.

The proponent responded to the EIS submissions on the social issues in the amended EIS.

4.12.2 Management measures

The EIS, proposed measures to avoid the potential social impacts and enhance potential social benefits of the proposed project. These measures were collated in a social impact management plan (SIMP) as part of the SIA. The SIMP provides for the management of social impacts throughout the operation, progressive rehabilitation, and decommissioning of the proposed project.

The Coordinator-General's proposed conditions to manage the potential social impacts of the proposed project are discussed below.

4.12.3 Stakeholder engagement

The SIA demonstrates that an appropriate level of community and stakeholder engagement informed the SIA process. In response to submissions on the draft SIA, the proponent has committed to revising the Community and Stakeholder Engagement Plan to include results of further engagement with key stakeholders, including affected landholders and Traditional Owners.

The Coordinator-General has stated a condition requiring the proponent to develop a revised Community and Stakeholder Engagement Plan. This plan must include outcomes of further consultation with stakeholders and an updated plan and program of further consultation, including agreed impact management measures, and input into ongoing implementation and monitoring of the SIMP actions.

4.12.4 Workforce management

As the proposed project would not involve construction activities, there would be no construction workforce. The EIS proposes that during operations, the proposed project would support continued employment of approximately 603 FTE personnel from the existing Ensham Mine. The SIA estimates that 34 per cent (207 workers) of the total operational workforce would be sourced from the towns within a one-hour commute distance to the proposed project (Comet, Emerald and Blackwater), with the remaining 66 per cent (396 workers) on a drive-in, drive-out (DIDO) or fly-in, fly-out (FIFO) arrangement, based on the recruitment hierarchy. The SIA estimates that if the existing Ensham Mine's current staff attrition rate is maintained (four per cent per annum), approximately 24 positions would become vacant each year to 2036. The SIA confirms the local and regional labour markets have capacity to support the proposed project's projected labour requirements.

The SIA identifies that an existing confidential agreement between the proponent and Western Kangoulu People includes agreed targets for employment of the First Nations people, and the SIMP commits to offering one apprenticeship or traineeship to the First Nations people at least every two years. In response to submissions on the EIS, the proponent has committed to ongoing consultation with representatives of relevant Traditional Owners on matters relating to cultural heritage, targets for First Nations owned and operated businesses in resource sector supply chains.

The Coordinator-General has stated a condition requiring the proponent to develop a target for employment of Aboriginal and Torres Strait Islander peoples, to be included in a revised SIMP, and reported on annually.

4.12.5 Housing and accommodation

The SIA describes that as the proposed project is a continuation of the existing underground mine and would support continued employment of operational personnel from the existing Ensham Mine. It is not anticipated that there would be significant changes to existing housing and accommodation arrangements. Further, as the proposed project would not require a construction workforce, there would be no temporary change to population size or characteristics, nor impact on the availability of short-term accommodation.

The SIA describes the existing housing trends in the Central Highlands LGA and concludes that the regional housing market appears to be stable. The SIA notes the rental markets in Emerald, Blackwater and Comet currently have low reported rental vacancy rates (less than two per cent), however, rents are currently affordable for most households. The proponent has committed to implementing a range of strategies to encourage new personnel to live locally, including subsidised housing, relocation expenses and assistance with accessing housing and local services. The proponent acknowledges that attraction of non-local personnel to the region may result in some demand for local housing. However, the SIA predicts this would be incremental over the proposed project life, and likely offset by housing being released to the market as former personnel leave the region. The SIA concludes the proposed project would be unlikely to significantly affect housing availability in the region.

The SIA proposes that DIDO and FIFO personnel who reside more than one-hour's drive from the project area would stay in the Ensham Mine workforce accommodation village whilst on shift to comply with the proponent's Fatigue Management procedure. The existing Ensham Mine workforce accommodation village has a capacity of 625 rooms, with a current utilisation rate of approximately 80 per cent. The SIA provides that while the proposed project is unlikely to result in an increased demand for utilisation of the accommodation village, the accommodation village has sufficient capacity to accommodate all project personnel, if required.

4.12.6 Local business and industry procurement

The SIA proposes that the proposed project would maintain continued use of the existing Ensham Mine supplier network while maximising the opportunities for local and regional businesses.

The EIS has committed to:

- developing and maintaining a Local Business Register
- initiating local business capacity building programs (through engagement with CHRC, Central Highlands Development Corporation, and Central Highlands Community Services)
- reviewing the existing Ensham Mine's procurement strategies to further identify and promote local supply opportunities with local businesses, Aboriginal and Torres Strait Islander businesses and social enterprises.

The Coordinator-General has stated conditions requiring the proponent to establish targets for procurement of local and Aboriginal and Torres Strait Islander businesses, and to develop a Local Content Strategy consistent with requirements of the Queensland Resources and Energy Sector Code of Practice for Local Content 2013. These conditions will ensure that opportunities for local businesses are enhanced by the proposed project.

4.12.7 Health and community wellbeing

The SIA describes that as the proposed project would maintain the existing Ensham Mine workforce, the proposed project would not change the population profile of the Central Highlands LGA and is therefore not expected to have any additional impacts on existing infrastructure, utilities and services. The SIA recognises that the proposed project workforce may still access and generate additional demand on local health and emergency services, and proposes measures to manage these potential impacts. This includes provision of on-site health services, mental health wellness programs, and review and update of the existing Ensham Emergency Response Plan in collaboration with emergency services.

The EIS has also committed to developing a Complaints Register to ensure community complaints and concerns are responded to respectfully and systematically, and continuing the existing Ensham Mine's Community Sponsorship and Donations program and in-kind donations.

The Coordinator-General has stated a condition requiring the proponent to update the SIMP in consultation with CHRC, DSDSATSIP and other community organisations to identify the proposed annual contribution to community investment initiatives, and the outcomes to be achieved.

4.12.8 Assessment and conclusions

The department has considered the evaluation of the EIS undertaken by the Coordinator-General (*https://www.statedevelopment.qld.gov.au/enshamlome*) and determined that the EIS adequately addressed the TOR by preparing an SIA that was consistent with the requirements of the SSRC Act and SIA Guideline (DSDILGP, 2018).

The effective implementation of the SIMP will address the potential negative social impacts identified in the SIA, such as impacts to health care and emergency services, and enhance potential social benefits, such as local employment, community investment and First Nations people's employment and business procurement.

The Coordinator-General has stated conditions (Appendix B) and listed proponent's commitments to ensure that potential negative social impacts of the proposed project are avoided, minimised and/or mitigated, and potential social benefits are realised. The Coordinator-General requires that outstanding social matters are addressed by the proponent through the stated conditions prior to commencement of the proposed project and that the proponent delivers on commitments made in the EIS.

The Coordinator-General also requires the proponent to submit for approval an annual Social Impact Management Report on the implementation and effectiveness of social impact management measures and proponent's commitments.

4.12.9 Identification and nomination of nearby regional communities

The proposed project is defined as a large resource project by the SSRC Act because it is a resource project that requires an EIS under the EP Act and is anticipated to have 100 or more workers (Schedule 1 of the SSRC Act). A project must have at least one nearby regional community for the SSRC Act 100 per cent FIFO prohibition (section 6) and anti-discrimination (section 8) provisions to apply. The Coordinator-General may, however, decide to include a town that is not strictly based on the thresholds in the SSRC Act, such as, one that has a greater or lesser radius or with a population of less than 200 people.

Fourteen towns meet the definition of a nearby regional community for the proposed project under Schedule 1 of the SSRC Act: Blackwater, Bluff, Capella, Clermont, Duaringa, Dysart, Emerald, Middlemount, Rubyvale, Sapphire, Springsure, Tieri, Willow Gemfields and Woorabinda.

Comet has also been included as a nearby regional community for the proposed project by the Coordinator-General as it is located in the vicinity of the proposed project and identified in the SIA as a potentially impacted town with potential to source relevant skilled labour. Accordingly, the Coordinator-General has included 15 towns (including Comet) as nearby regional communities for which the 100 per cent FIFO prohibition and anti-discrimination provisions of the SSRC Act apply to the proposed project's operational workforce.

4.13 Economics

An economic assessment for the project was provided in EIS Chapter 22 Economics, and Appendix J1 Economic Assessment of Ensham Coal Mine. The AEIS Chapter 22 noted that Appendix J1 assesses an earlier project definition, while Chapter 22 provides the correct project definition. The AEIS did not consider changes to Appendix J1 were necessary as the inconsistency does not affect the outcome of the economic assessment.

Section 9.13 of the TOR required the EIS to identify the potential adverse and beneficial economic impacts of the proposed project on the local and regional area and the state; and to estimate the costs, benefits and economic impacts of the proposal using both regional impact analysis and cost-benefit analysis. The TOR required these analyses to be undertaken in accordance with the Economic impact assessment guideline (DSDMIP 2017). In addition, consultation with fisheries stakeholders and an analysis of impacts on and costs to land values, agricultural activities and associated supply chains were required. Consultation with fisheries stakeholders was not specifically addressed in the economics section of the EIS, however, the proponent has broadly consulted with DAF, landholders and First Nations peoples for the proposed project.

4.13.1 Assessment

The project proposes to continue mining at similar rates to the current operation with ROM production of approximately 4.5 million tonnes per annum with an estimated 38 million tonnes of thermal coal produced over the life of the proposed project for export to Asian markets. The EIS concludes that there were economic benefits at a national, state and regional level which outweighed project associated costs. Additionally, the levels of local income and employment together with demand for goods and services generated by the current Ensham Mine would be maintained through the implementation of the proposed project.

4.13.1.1 Baseline assessment

A detailed economic baseline assessment was presented with data on multiple economic factors for the Central Highlands LGA, Central Queensland Statistical Area 4 (SA4) and Queensland. This provided context for consideration of the economic impacts of the proposed project. The EIS presented the combined baseline production and activities of the agriculture forestry and fishing industry. The baseline economics of fisheries and the subsequent economic impacts on fisheries were not presented separately from agriculture and forestry in the EIS and it is not clear whether First Nations or recreational fisheries were considered.

4.13.1.2 Regional impact analysis

A regional impact analysis using input-output modelling was presented in the EIS. The regional impact assessment estimated the direct and indirect economic impacts on the regional, state and national economies. The limitations of the input-output model are highlighted in the *Economic impact assessment guideline* (DSDMIP 2017), which recommends the input-output model should not be used in isolation. Limitations of the input-output model were also discussed in the EIS, which stated that the input-output model may overestimate impacts because of its assumptions or limitations. However, these limitations were considered more relevant when the activity introduces a novel driver with significant structural change for the region, as opposed to the proposed project, which is the expansion of an existing coal mine at the same location.

Measures of the economic impact of the proposed project were based on:

- output, being the increase in gross sales through all sectors of the economy – this measure can overstate the economic impact as the contribution from goods and services feeding into multiple stages of production may be counted more than once
- household incomes, measuring the additional household income because of the proposed project including from other associated industries
- employment being the number of FTE created (directly and indirectly) by the proposed project stimulus – the measure can also overstate levels of employment generated as it does not account for existing employees working more overtime as a response to project demand
- value added, or Gross Regional Product representing the total of consumption, investment and government expenditure plus net exports from a region, i.e. the net impact of the project.

The EIS indicated that these measures are all Type 1 Multipliers, as preferred by Queensland Treasury, with value added being the measure of economic impact preferred by economists.

Inputs into the model were estimated over the life of the mine to 2037. However, these did not appear to account for rehabilitation and closure costs or subsequent monitoring beyond the cessation of mining in 2037. Inputs were in 2020 Australian dollars and were:

- capital costs or expenditure, broken down into costs within Central Queensland SA4, rest of Queensland, rest of Australia and overseas, totalling $314.9 million (expenditure incurred overseas that would not make an economic contribution within Australia were excluded from the economic impact analysis)
- operational costs, broken down into costs within Central Queensland SA4, rest of Queensland, rest of Australia, totalling $2,726.2 million.

The model provided estimates of economic impacts from the capital and operational expenditure of the mine in terms of the chosen measures on businesses and industries in regional (Central Queensland SA4), Queensland and national economies. Economic impacts in the capital and operational phases were recorded for all measures, in all economies, direct and indirect, for every year and over the total life of the mine. Positive economic impacts were predicted for all measures, for instance, total value added impacts as a result of capital expenditure for regional (Central Queensland SA4), Queensland and national economies were estimated at $60.8 million, $72.6 million and $26.9 million and employment impacts (FTEs) totalled 53, 71 and 20 FTEs respectively. During operation, total value added impacts for regional, Queensland and national economies were estimated at $911.1 million, $984.1 million and $444.2 million and total employment impacts of 603, 754 and 348 FTEs respectively. Positive impacts on total output and household income from both capital and operational expenditure were also quantified and presented in the EIS.

Total coal export values were estimated at $3.66 billion over the life of the proposed project based on current forecasting for thermal coal prices and world currencies over the life of the mine, with royalties of $256 million payable to the Queensland Government based on current royalty rates. While the EIS acknowledged that commodity prices are subject to fluctuation, the risks from changes in prices and markets for thermal coal were not addressed in the regional impact analysis.

Other potential adverse impacts were examined but concluded to be limited. Opportunity costs were considered negligible on the basis that current farming practices can continue unimpacted given the predicted subsidence impacts of less than 40mm and lack of permanent disturbance in zone 1. The assessment also concluded that there would be no impacts to land values. The assessment also looked at the potential for ecosystem services to be disrupted by the project and concluded that direct and indirect impacts on these would be limited. Impacts to ecological and physical values have been considered elsewhere in this report. Based on these considerations there are potential ecological impacts to hydrology, subsidence and drawdown from this project which were not considered in the EIS.
The potential for local and regional labour markets to tighten and labour costs to increase as a result of the proposed project was determined unlikely as the proposed project enables continuation of the existing workforce during operations. Impacts to the labour market during construction were not specifically addressed, however (above-ground) construction is confined to installation of four flares in zone 2 and 3, with likely limited impacts to the labour market. Similarly, impacts on property markets were assessed as limited as the proposed project is a continuation of existing operations and workforce. Impacts on local and regional infrastructure as a result of the proposed project, were assessed as unlikely to increase. However, the assessment did not specifically address impacts on local and regional infrastructure because of the proposed increased longevity of the mine.

Project economic impacts were assessed using a risk-based assessment framework that concluded almost certain positive impacts with medium consequences (e.g., with benefit maintained over the medium term) and a with high level of (positive) impact as a result of the proposed project. These included economic stimulus to the regional economy, the state economy, and the national economy over the mine life as well as an increased regional supply chain with employment opportunities. The assessment did not identify adverse impacts requiring mitigation measures as a result of the proposed project.

4.13.1.3 Cost benefit analysis

A cost benefit analysis (CBA) was required to evaluate the overall benefits and costs of the proposed project over its life. These were presented in the EIS in 2020 Australian dollars. The CBA assessment extended to 2057 to incorporate greenhouse gas emissions associated with decommissioning of the mining activity. Real discount rates of 4%, 7% and 10% were used in the analysis to compare net present values (NPV), based on those rates being used by Australian and state government agencies for project evaluation.

Costs were capital costs such as one-off infrastructure costs and ongoing costs such as replacement of major mining equipment and operational costs associated with mining the coal, its transport etc. The costs of make-good agreements, which incorporate road compensation contributions, groundwater and surface water impacts as well as an allowance for mine closure, rehabilitation and decommissioning were not included in the CBA. This was on the basis that the cost of make-good agreements for the Ensham Mine would be the same whether the proposed project proceeds. However, it is not clear whether compensation agreements for impacts on landholders in zone 1 or landholders affected by potential changes to hydrology or by subsidence because of the proposed project were already factored into the cost of make-good or other compensation agreements for the Ensham Mine. Section 4.3 of this assessment report addresses the need to progress compensation agreements between the proponent and affected landholders because of the proposed project.

Benefits and disbenefits (increase in environmental and social externalities) for the proposed project were:

- value of coal production over the life of the mine ($3.66 billion)
- greenhouse gas emissions (the assessment assigned a dollar value per tonne of $CO2^{-e}$ from $15 in 2020 up to $20 in 2025 to 2057 with a total disbenefit value for the period of $130.87 million)
- opportunity cost of land use (a value of $0 was assigned)
- loss of vegetation communities (a value of $0 was assigned).

Two submissions raised the necessity to include the social cost of GHG in the CBA. The EIS uses an economic value of $15 per tonne of $CO2^{-e}$ emissions cost, based on the current market price for Australian Carbon Credit Units used by large emitters to offset emissions. This price is considerably lower (less than half) than other pricing mechanisms such as the European Union Emissions Trading System and the United States social cost of carbon metric. The disbenefit of $130.87 million assigned to GHG for the project, may therefore be an underestimate in terms of social cost, although reflective of current Australian carbon trading markets.

The CBA, under all three discount rates, showed a positive net benefit with an NPV for the proposed project ranging from $217 million to $344 million and with a cost benefit ratio ranging from 1.19 to 1.17, i.e. the benefits outweigh the costs under all discount rates.

As per the Economic impact assessment guideline (DSDMIP 2017), a sensitivity analysis was performed with three scenarios: an increase in project costs of 10%, a decrease in project benefits of 10%, and a combined 10% increase in costs and 10% decrease in benefits for the proposed project. The combined increase/decrease scenario resulted in negative NPVs at all discount rates and a benefit cost ratio less than 1 (i.e. costs outweighed benefits). The other two scenarios retained positive NPVs and benefit cost ratios greater than 1 for all discount rates, although these values were all reduced in comparison to the original CBA.

4.13.2 Conclusion

The EIS has undertaken an economic assessment as required by the TOR, although the sole use of an input output model for the regional impact assessment is contrary to the recommended guidance. However, the proposed project would be an extension of an existing activity, so the model limitations are less significant. Assessment of the economic impacts on fisheries were presented at a very broad scale and combined with impacts on agriculture and forestry, therefore, impacts on fisheries are unclear.

Both the regional impact assessment and cost benefit analysis considered impacts on opportunity costs, land values and ecosystems to be negligible. This conclusion is arguable and has been addressed elsewhere in relevant sections of this report. As raised in the submissions, the costing of GHG at market prices may not factor in the social costs of this by-product of the proposed project. It is also not clear whether rehabilitation costs were factored into the input output model. Costs (and disbenefits) may therefore be underestimated by this assessment. However, the sensitivity analysis showed that even with an increase in costs by 10%, the cost benefit ratio and NPV was still positive for the proposed project at all modelled discount rates.

The potential impacts from a reduction in thermal coal prices were not addressed in detail in the EIS despite a policy shift in some countries away from thermal coal. However, the sensitivity analysis also showed that a decrease in benefits (such as value of production) by 10% also maintained a positive cost benefit ratio and NPV for the proposed project at all modelled discount rates. A combination of 10% cost increase and 10% benefit decrease would, however, lead to a negative cost benefit ratio and NPV. The potential for this scenario to occur and the level of uncertainty for some inputs into the model was not explored further in the EIS.

The proposed project, as assessed, would contribute positively, directly and indirectly to regional, Queensland and Australian economies through capital and operational expenditure particularly in mining, transport, manufacturing, construction and postal and warehousing sectors. Although this figure is not included in the EIS, the total value added impacts of the proposed project within Australia are estimated at approximately $2.5 billion. The proposed project would also provide continuity of employment and incomes for up to 603 FTE within the local economy as well as continued demand for goods and services, by transitioning the Ensham Mine workforce into the proposed project workforce. The proposed project is also predicted to provide significant direct and indirect employment at state and national levels. Furthermore, significant export revenues of $3.2 billion would yield mining royalties of $256 million (based on current rates), paid by the proposed project to the Queensland Government for the benefit of the State.

4.14 Transport

A transport assessment for the proposed project was provided in EIS Chapter 23 Transport.

Section 9.14 of the TOR required that the EIS was to conduct the impact assessment in accordance with the department's *EIS information guideline–Transport*, undertake a road impact assessment in accordance with the Department of Transport and Main Roads (DTMR) *Guide to traffic impact assessment*, and discuss how identified impacts will be mitigated for each transport mode.

4.14.1 Assessment

The EIS undertook a traffic impact assessment, broadly following the steps in the DTMR Guide, for the relevant sections of the state-controlled Capricorn Highway and local government controlled CHRC Duckponds Road, as well as the key intersection of the Capricorn Highway/Duckponds Road.

The EIS established the background traffic volumes for the relevant sections of these roads using annual average daily traffic data provided by DTMR for the highway, and from a 12-hour traffic volume recording at the Duckponds Road intersection. In addition, a traffic movement count at the Capricorn Highway/Duckponds Road intersection provided details of traffic use of this intersection.

The EIS concludes that the Capricorn Highway and Duckponds Road segments in the vicinity of the proposed project and to the west are currently operating satisfactorily and within capacity. However, there is no reference point for the nominated road classifications and what is an acceptable traffic volume range for the respective road types.

The EIS indicates that the proposed project is not anticipated to lead to an increase in traffic volumes on the basis that the project will utilise existing infrastructure, although additional flaring infrastructure for gas drainage is required. There is no information on the traffic impacts of installing the gas flares for the proposed project. Traffic volumes are predicted to decrease over time as operational staff numbers reduce in the transition to underground mining and then to rehabilitation activities. The EIS concludes that there will be no impact on the road link capacity of the surrounding road network, which is currently operating within capacity.

Access from public roads to the site will be via the existing gated access on Duckponds Road, approximately 10km north-east of the intersection of Duckponds Road with the Capricorn Highway. An analysis of that intersection performance, incorporating projected future traffic volumes that included project traffic, predicted that the key intersection of the Capricorn Highway/Duckponds Road would operate satisfactorily until 2043 (the planned date for the completion of rehabilitation), with a level of service value of ‘A’, being the highest possible level of service.

All coal product is proposed to be transported from the mine site by rail, except for coal for marketing and quality control purposes, which may be transported by road. Road transport of sample coal is estimated not to exceed 20 tonnes per annum (1 tonne per item.) This volume of heavy vehicles was considered unlikely to be significant and no pavement impacts because of the proposed project were predicted. The proponent included a commitment about the transport of coal by rail, however, the wording does not preclude the transport of coal product by road. This commitment should be amended to limit the transport of product coal for marketing and quality control purposes to a maximum of 20 tonnes per annum (1 tonne per item).

Coal product from the proposed project will be transported by the Aurizon managed Central Queensland Coal Network (Blackwater) rail system to the Port of Gladstone coal terminal and Gladstone Power Station, directly from the existing Ensham Mine rail spur rail line. DTMR’s EIS submission raised the matter of impacts from bulk carriers operating in the Great Barrier Reef from the additional nine years of export of coal because of the proposed project. The AEIS estimated between 60 to 80 individual shipments per year would take place. The DTMR submission recommended that the proponent require vetting for ships contracted by the proposed project be in accordance with the Maritime Safety Queensland (MSQ) *Guideline for vetting Bulk Carriers intended for travel through the Great Barrier Reef* (ship vetting guideline). This is to ensure that high safety standards and protection of the marine environments are considerations in the project’s shipping operation. The AEIS committed to contractually require all vessels to meet all performance and vetting requirements published by Gladstone Ports Corporation in alignment with MSQ (and other) prescribed code and legislation. However, I note that Port Procedures and Information for Shipping for Gladstone Port and the Ship Vetting Guideline are published by MSQ, not the Gladstone Ports Corporation.

4.14.2 Conclusions and recommendations

The EIS has demonstrated that the proposed project is unlikely to have a significant impact on traffic volumes or road capacities in the surrounding public road network. The key intersection between Duckponds Road and the Capricorn Highway is predicted to continue to perform at the highest level of service with the implementation of the proposed project. The EIS predicts road haulage of coal products would be confined to a maximum of 20 tonnes per annum of sample coal. This volume should mean no pavement impacts because of the proposed project. It is recommended that a maximum road transport limit of 20 tonnes of sample coal per annum (1 tonne per item) should be a clear commitment by the proponent and is not exceeded during the life of the proposed project.

Shipping of product will result in 60 to 80 shipments per annum through the Great Barrier Reef. A recommended action (item MTR EBA1) under the Australian and Queensland government’s *Reef 2050 Long-Term Sustainability Plan* is for the adoption of ship vetting practices for bulk carriers in Great Barrier Reef waters to meet high safety standards and with marine environment considerations. I recommend this be actioned through a proponent commitment to contractually require all vessels to meet vetting requirements published by MSQ.

4.15 Matters of national environmental significance (MNES)

The EIS documents used to assess MNES included EIS Chapter 25 Matters of National Environmental Significance, Chapter 1 Terrestrial Ecology, Chapter 14 Aquatic Ecology, Appendix C-1 and C-2 Terrestrial Ecology Impact Assessment, Appendix D-1 Aquatic Ecology and Appendix D-2 Stygofauna Assessment.

This section assesses the potential impacts of the proposed project on MNES protected under the EPBC Act. DAWE and the department have considered the information provided in the EIS, AEIS and other relevant information to assess the likelihood of occurrence of MNES and potential impacts on MNES.

The assessment and recommendations in this assessment report have been made in accordance with the bilateral agreement. DAWE will consider these recommendations and decide on the acceptability of identified and potential impacts on MNES, and if approved, the conditions that would apply to an approval under the EPBC Act.

4.15.1 EPBC referral

On 6 May 2020, the proponent referred the proposed project under the EPBC Act to the Commonwealth Minister for the Environment, for the development and operation of an underground coal mine and associated infrastructure at the referral area (within the project area).

On 24 July 2020, the proposed project was determined to be a controlled action requiring assessment and approval under the EPBC Act. A delegate of the Minister determined that the proposed action was likely to have a significant impact on the following controlling provisions:

- sections 18 and 18A (listed threatened species and communities)
- sections 24D and 24E (a water resource in relation to a large coal mining development or coal seam gas development)

The MNES appendix in the TOR required habitat assessments and impact assessments for listed threatened species and communities:

- Koala (*Phascolarctos cinereus*) (combined populations of Queensland, NSW and the ACT) – listed as vulnerable
- Fitzroy River turtle (*Rheodytes leukops*) – listed as vulnerable
- Southern snapping turtle (*Elseya albagula*) – listed as critically endangered
- Greater glider (*Petauroides volans*) – listed as vulnerable
- Squatter pigeon (Southern) (*Geophaps scripta scripta*) – listed as vulnerable
- Ornamental snake (*Denisonia maculata*) – listed as vulnerable
- Australian painted snipe (*Rostratula australis*) – listed as endangered
- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC) – listed as endangered.

The MNES TOR defined that the following are considered within the assessment of water resources:

- Groundwater: Section 25.6.1
- Groundwater-dependent ecosystems: Section 25.6.2
- Stygofauna: Section 25.6.3
- Surface water: Section 25.6.4
- Subsidence: Section 25.6.5
- Significant impact assessment: Section 25.6.6.

4.15.2 Listed threatened species and communities

In deciding whether or not to approve the taking of an action and what conditions to attach to such an approval, for the purposes of sections 18 and 18A of the EPBC Act, it is noted that the Commonwealth Minister for the Environment must not act inconsistently with Australia's obligations under a recovery plan or threat abatement plan (TAP).

The Minister must also, in deciding whether to approve the taking of the action, have regard to any approved conservation advice for the threatened species, or ecological community that is likely to be or would be significantly impacted by the proposed project.

This section assesses the proposed project against the objectives and priority actions of conservation advice, recovery plans and TAPs for the relevant threatened species and communities. The significant impacts of the proposed project on threatened species and TECs are also considered in this section. Out of the seven EPBC Act threatened species, recovery plans only existed for the southern snapping turtles, and a draft recovery plan existed for koalas.

4.15.2.1 Existing environmental values (MNES) identified in the EIS

The following section is a summary of the predicted occurrence of MNES relevant to the proposed project based on database searches, field surveys and habitat assessments documented in the EIS.

4.15.2.2 Threatened ecological communities

An EPBC Protected Matters Report identified four endangered TECs that have the potential to occur in the project area:

- Brigalow TEC (*Acacia harpophylla* dominant and co-dominant)
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (Natural Grasslands TEC)
- Poplar box grassy woodlands on alluvial plains
- Weeping Myall Woodlands.

Desktop searches were undertaken in May 2019, October 2019 and January 2020 which included review of the following:

- Protected Matters Search Tool (PMST), to identify MNES within a search area extending at least 10km from the project area (Commonwealth of Australia 2019)
- The Queensland Wildlife Online search results for flora and fauna species records within a search area extending 50km from the project area (DES 2019f)
- Atlas of Living Australia (ALA) for threatened flora and fauna species records (CSIRO 2019)
- Regional Ecosystem (RE) mapping version 11 to determine the nature and extent of vegetation within and surrounding the project area (DES 2019c)
- VM Act wetland mapping (DES 2019e)
- VM Act watercourse mapping (DNRME, 2019b)
- High Ecological Significance wetland mapping (DES 2019b)
- Essential habitat mapping to identify vegetation in which a threatened species has been known to occur (DNRME 2019a)
- Previous ecological assessments undertaken at the existing Ensham Mine.

As a result of the desktop assessment, the only REs associated with the project area was brigalow community.

4.15.2.3 Terrestrial flora

Field flora surveys were carried out in May 2019 (autumn) and between October to

November 2019 (spring and early summer) in zone 1; and between December 2019 to January 2020 in zones 2 and 3. Surveys on 125 sites including 10 tertiary transects and 115 quaternary sites were undertaken in accordance with Methodology for Surveying and Mapping RE and Vegetation Communities in Queensland (Neldner et al., 2019) which is now superseded by version 5.1 (Neldner et al., 2020).

Targeted searches for threatened flora species identified in the desktop assessment were undertaken in areas of potentially suitable habitat confirmed during vegetation community assessments across the project area.

The surveys examined the accuracy of current RE mapping and looked for TECs. A total of 64.12 ha ground-truthed TEC vegetation which comprised of 5.14 ha of remnant RE 11.3.1 and 40.98 ha of high value regrowth (HVR) 11.3.1 was identified on the project area.

4.15.2.4 Terrestrial fauna

The EPBC Act PMST and other desktop resources identified 25 species as potentially occurring within the project area; one of these, the greater glider (*P. volans*), was identified during field surveys. Based on the preferred habitat of these species, a likelihood assessment was completed to identify which other EPBC Act listed fauna species could be considered ‘likely’ or ‘potential’ to occur on site. The assessment identified seven species which were included in the targeted fauna survey:

- Australian painted snipe (*R. australis*)
- Squatter pigeon (southern) (*G. scripta scripta*)
- Koala (*P. cinereus*)
- Ornamental snake (*D. maculata*)
- Greater glider (*P. volans*)
- Fitzroy River turtle (*R. leukops*)
- Southern snapping turtle (*E. albagula*).

4.15.2.5 Migratory fauna

Sixteen listed migratory fauna (bird) species were predicted from desktop surveys. A likelihood of occurrence assessment identified six migratory species with a potential likelihood of occurrence in the study area. The glossy ibis (*Plegadis falcinellus*) was the only migratory bird species recorded within the project area during fauna surveys. As provisions for this proposed project were determined to be 18/18A and 24D/24E, migratory species are not further assessed in this section.

4.15.2.6 Aquatic fauna

The following listed threatened aquatic fauna species were identified using the PMST, as potentially occurring in or surrounding the project area:

- Fitzroy River turtle (*R. leukops*) – listed as vulnerable
- White-throated snapping turtle also known as Southern snapping turtle (*E. albagula*) – listed as critically endangered

4.15.2.7 Conclusion on description of values

The MNES in the project area have been adequately identified and described in the EIS. Threatened species with a moderate, high or present likelihood of occurrence considered at risk of impacts from the proposed project were subject to impact assessment. Species that were considered unlikely to occur in the project area were not further assessed.

The targeted fauna survey identified habitat for six threatened species and the flora field survey identified one ecological community within the project area.

4.15.2.8 Potential impacts on EPBC Act listed species and communities

The following impact assessment is confined to the MNES threatened species and communities with a moderate, high or present likelihood of occurrence within the project area.

4.15.2.9 Threatened ecological communities

4.15.2.9.1 Brigalow TEC (*Acacia harpophylla* dominant and co-dominant)

EPBC Act Listing Status

Endangered

Distribution

The listed Brigalow TEC extends from south of Charters Towers in Queensland and in a broad swathe east of Blackall, Charleville and Cunnamulla south to northern NSW near Narrabri and Bourke. Within the project area, Brigalow TEC occurs on alluvial plains, adjacent to the floodplain of the Nogoa River and other tributaries.

Description

The Brigalow TEC is characterised by the presence of *A. harpophylla* as one of the three most abundant tree species. It is either dominant in the tree canopy or co-dominant with species such as *Casuarina cristata,* other *Acacias* or eucalypts. The community has a wide range of vegetation structure and composition united by a suite of species that tend to occur on acidic and salty clay soils.

Occurrence in study area

The brigalow community at the study area occurs north and south of the Nogoa River, adjacent to areas of remnant vegetation. A total of 5.14 ha of remnant and 40.98 ha of high value regrowth Brigalow TEC was ground-truthed within the project area.

Vegetation within this community is dominated by *A. harpophylla* (Brigalow) with occasional *Eucalyptus coolabah* (coolibah). A lower sub canopy is often present and is composed of younger *A. harpophylla* with the addition of *Terminalia oblongata* (yellow-wood) and *Lysiphyllum carronii* (red bauhinia). *Acacia harpophylla* is also present in the shrub layer along with a diversity of other native species including: *Geijera parviflora* (wilga), *Eremophila mitchelli* (false sandalwood), *Cassia brewsteri* (leichhardt bean), *Alectryon diversifolius* (scrub boonaree) and *Carissa ovata* (currant bush).

Impacts of the proposed action

The EIS indicated that impacts associated with vegetation clearing, such as fragmentation, edge effects, erosion and sedimentation are unlikely to occur. The EIS proposed that there will be no impacts to Brigalow TEC from subsidence or associated surface cracking as there is no predicted subsidence greater than 40mm. The only surface disturbance is outside the TEC.

Mitigation of impacts

The EIS lists site control measures established under the existing Ensham Mine EA:

- continuation of existing bord and pillar method of mining operations to reduce surface impacts
- maintain dust suppression in accordance with the existing dust management plan SOP.09.12.01 Maintaining and Watering Mine Roads

- continue to undertake refuelling and chemical storage in accordance with the existing management plans: SOP.09.01.04 Using Hazardous Substances, SOP.09.06.06 Servicing and Refuelling Equipment and EIMP.05.00.02 Hydrocarbons
- weed and pest management strategies to continue to be implemented for controlling the spread of weeds and pests, particularly vehicles traversing the project area, as per the existing management plans: EOP.06.00.03 Weed and Feral Animal Management and EIMP.06.00.01 Land.

DAWE's submission noted that impacts on water resources are uncertain and that the possible impacts need to be considered.

The EIS lacked mitigation measures for potential vegetation impacts and instead simply noted that it will continue to follow the mitigation measures proposed in the existing Ensham Mine EA without highlighting how and which mitigation measures will be sufficient for each of the identified potential impacts. For example, it is insufficient to list the chemical storage management, dust suppression and weed and feral animal management plans without including the details of those plans. The EIS should highlight the part of the plans that will achieve the stated mitigation for each of the listed species.

Assessment

The Commonwealth *Approved Conservation Advice for the Brigalow* (*Acacia harpophylla* dominant and co-dominant) ecological community (2013) lists the main threats to the Brigalow TEC as (in order of importance): clearing, fire, weeds, feral animals, inappropriate grazing, and climate change. The TAP that is relevant to management of the species in the community is the *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads* (Commonwealth of Australia, 2011).

There is no adopted or made Recovery Plan for this TEC.

The EIS assessed the impacts to Brigalow TEC against the EPBC significant impact criteria. The proposed project will have minor surface disturbance for exploration and flaring infrastructure but there will be no direct impacts through vegetation clearing.

The project area supports batches of brigalow community (*A. harpophylla)* as well as coolibah (*E. coolabah*) and red gum (*E. camaldulensis*). The EIS concluded that these species were not GDEs as there was no observed water stress, leading to an assumption that vegetation on alluvial sediments and along the watercourses is not using groundwater and therefore will not be affected by drawdown. The IESC advice on the EIS recommends that this is validated using direct techniques to assess potential groundwater use by these species.

The EIS indicated the proponent will continue to implement weed and pest management strategies for controlling of weeds.

Conclusion

The EIS concludes that the proposed project will not result in clearing of Brigalow TEC.

4.15.2.10 Terrestrial and aquatic fauna

The EIS conducted significant impact assessments for seven EPBC listed threatened fauna species that were known to occur on the project area or considered likely to occur based on field assessments.

Field surveys were undertaken in May 2019 and November 2019. Although potential habitat for all listed species were present, only greater glider was recorded.

The EIS indicated that there will be no clearing of habitat of any of the above threatened fauna, and therefore no significant impact will occur.

These assessments, impacts and proposed mitigations are set out below.

4.15.2.10.1 Squatter pigeon (southern subspecies) (*Geophaps scripta scripta)*

EPBC Act Listing Status

Vulnerable

Distribution and population

The squatter pigeon (southern subspecies) historically occurred from central NSW north to the Burdekin catchment in the southern region of Cape York Peninsula. However, its range has been contracting since the 1870s with few sightings in NSW since the 1970s and only three confirmed reports since 2000. The species' current range extends from the Burdekin-Lynd divide to south-east Queensland and north-west through Goondiwindi and the Brigalow Belt to Charleville, as well as parts of north-east NSW.

The subspecies is considered common north of the Carnarvon Ranges in Central Queensland (the project area is north of the Carnarvon Ranges) with an estimated total population of 40,000 adult birds (although this estimate is of low reliability).

Habitat

The squatter pigeon is a seed-eater that forages and nests on the ground. Natural foraging habitat for the species is open woodlands and open forests or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils and typically within 3km of permanent or seasonal water bodies or watercourses. Squatter pigeons feed primarily on seeds that have fallen to the ground from low vegetation such as grasses, herbs and shrubs, including *Acacia* species.

Breeding habitat occurs on stony rises within 1km of permanent water. This species breeds throughout the year; however, breeding is influenced by heavy rainfall and most commonly occurs during the dry season between May to June.

The species also occurs in heavily grazed country and in regrowth or partly modified vegetation communities. Dispersal habitat is considered any forest or woodland occurring between foraging or breeding habitat that facilitates the local movement of the subspecies between these habitats or in the wider search for water sources.

Surveys

Habitat

The squatter pigeon (southern) was not recorded within the project area during EIS field surveys. However, suitable habitat to support the foraging, breeding and dispersal requirements of the species was recorded. The habitat determination used is based on modelling rules developed from the Species Profile and Threats database (SPRAT) for squatter pigeon (southern) (SPRAT 2021b) as well as referral guidelines, approved conservation advice, management plans and peer-reviewed journal articles. The EIS considered the areas of *Eucalyptus* or *Acacia*-dominated woodland on lateritic duricrust (remnant and HVR RE 11.7.1 and 11.7.2) within 1km of water resources as breeding and foraging habitats for the squatter pigeon. The EIS found the Nogoa River, creeks within the project area and farm dams to be suitable waterbodies for this species. In total 1,158,25ha of deemed suitable habitat was identified within the project area.

DAWE's EIS submission noted that the identification of squatter pigeon dispersal habitat appears to be suitable breeding/foraging habitat and advised that the habitat mapping requires amending to reflect this. The proponent amended the EIS to include further explanation on how the dispersal habitat for this project area is not a suitable breeding and foraging habitat.

Impacts of the proposed action

The EIS concluded that there will be no direct impact from vegetation clearing related to the proposed project due to the nature of the underground mining extension. The EIS highlights that there may be direct mortality of squatter pigeon and destruction of their ground-based nests through vehicle traverses.

Mitigation of impacts

The EIS concluded that there will be no significant impact as a result of the proposed project. The EIS justified that although there are potential breeding, foraging and dispersal habitat present in the project area, the surface of the area will not be altered by the activities. The review of the EIS noted the following.

- There is no important population of squatter pigeon in the project area.
- The proposed project will not reduce the area of occupancy of a population, nor fragmentation of their habitat.
- Indirect impacts such as light and noise are generally consistent with current levels, hence it is considered unlikely to disrupt the breeding cycle of an important population.
- The species was not recorded within the project area with a significant survey effort; hence it is unlikely that the proposed project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- The project area is already impacted by grazing, clearing and mining activities; invasive species are already present in the area. Weed and pest management measures will be developed as part of management of the project area.
- The EIS lacks mitigation measures, simply stating that the proponent will continue to follow the mitigation measures contained in the existing Ensham Mine EA without highlighting how and which mitigation measures will be sufficient for each of the identified potential impacts. For example, the EIS lists the chemical storage management, dust suppression and weed and feral animal management plans without including the details of those plans and therefore does not sufficiently address mitigation of potential impacts. The EIS should specify relevant sections of existing management plans and how it will mitigate impacts to each of the animals listed in the MNES chapter.

Assessment

The approved *Conservation Advice Geophaps scripta scripta squatter pigeon (southern)* (Threatened Species Scientific Committee, 2015) lists ongoing vegetation clearing and fragmentation, overgrazing of habitat, introduction of weeds, inappropriate fire regimes, thickening of understorey vegetation, predation by feral cats and foxes, trampling of nests by livestock and illegal shooting as the primary current threats to the subspecies. Threat abatement plans that are relevant to management of the squatter pigeon include the following:

- Threat abatement plan for predation by feral cats (Department of Environment, 2015)
- Threat abatement plan for competition and land degradation by rabbits (Department of Environment and Energy, 2016)
- Threat abatement plan for predation by the European red fox (Department of the Environment, Water Heritage and the Arts, 2008b)

There is no adopted or made Recovery Plan for this species.

DAWE’s EIS submission identified uncertainties around the likely impacts on water resources and that the possible impacts need to be considered in that context. Noting that impacts on terrestrial and aquatic species would occur through water loss, an appropriate monitoring and mitigation plan should be provided to manage the uncertainty around the impacts. This applies to other MNES listed threatened species.

The EIS provided a significant impact assessment against the Commonwealth Significant Impact Guidelines. The EIS does not consider the population of squatter pigeon at the study area to be an ‘important population’ as per the significant impact criteria and those significance criteria relating to important populations would not apply. The assessment also did not identify the other significance criteria as being met for impacts on this species.

4.15.2.10.2 Greater glider *(Petauroides Volans)*

EPBC Act Listing Status

Vulnerable

Distribution and population

The greater glider is found in eastern Australia from the Windsor Tableland in North Queensland through to central Victoria from sea level to 1200m above sea level. There are isolated inland subpopulations in the Gregory Range west of Townsville and the Einasleigh Uplands (TSSC 2016).

Population declines have been recorded in all states within the greater glider range, although there are no population estimates or trends across its total distribution. In the Emerald district of Central Queensland an 89% decline was recorded between the mid-1970s and 2001-2. The Threatened Species Scientific Committee concluded that an overall population decline in greater gliders of 30% over three generations has taken place and that the decline is ongoing (TSSC 2016).

Habitat

The EIS described the greater glider as an arboreal nocturnal species that utilises tree hollows during the day to rest. It prefers taller, montane and moist eucalypt forests with older trees providing hollows. It does not use rainforest habitats. West of the Dividing Range it also occurs in low woodlands. Greater glider feed almost exclusively on eucalypt leaves, occasionally on flowers or buds. This species is particularly sensitive to forest clearance due to their relatively small home range and low dispersal ability (TSSC 2016).

DAWE’s EIS submission noted that the habitat description for greater glider should not be restricted to remnant woodland as they are known to use any woodland with sufficient hollows. This has been amended in the AEIS.

Surveys

Habitat

There is no SPRAT profile for important populations of greater glider, nor species-specific guidelines for determining critical habitat to the survival of greater glider, therefore, the generic Significant Impact Guidelines Policy Statement (Department of Environment 2013) definition was used. The EIS reported that the potential habitat types within the project area include eucalyptus-dominated woodland on alluvial plains, comprising of 161.98ha, and brigalow open forest and low brigalow open forest comprising of 25.34ha, equating to total of 187.32ha.

Fauna

The greater glider was identified within the project area in riparian habitat where two eucalypt species were present (*Eucalyptus coolabah* and *Eucalyptus camaldulensis*) with an abundance of large hollows.

The EIS has concluded that the project area is unlikely to support an important population given that:

- The population of greater gliders is not necessarily unique, isolated or genetically distinct from other populations in the region.
- The project area is not near the edge of the species range.
- The project area does not fall within tall, montane moist eucalypt forest with old abundant tree hollows.

Impacts of the proposed action

The EIS concludes that with the proposed underground mining extension, there will be limited surface disturbance and any indirect impacts associated with vegetation clearing are unlikely.

Mitigation of impacts

The EIS indicated that there will be no significant impacts to greater glider from the proposed project as:

- Greater gliders in the project area do not meet the definition of an important population.
- No habitat fragmentation is likely to occur due to the proposed project.
- The proposed project is unlikely to adversely affect critical habitat as no direct impact is likely to occur within the project area and indirect impacts are consistent with current levels.
- Large trees with hollows will not be impacted, nor will connectivity, and hence the proposed project is unlikely to disrupt the breeding cycle of the greater glider population.
- There will be no clearing within suitable habitat.
- It is unlikely that the proposed project will introduce a disease to the extent that this species would decline. Weed and pest management measures will ensure best practice site hygiene measures will be implemented.

Assessment

The approved *Conservation Advice Petauroides volans (greater glider)* (TSSC, 2016) lists habitat loss and fragmentation as a primary current threat to the species. As there will be limited clearing for the underground mining operation, it is unlikely the proposed project will have significant impacts on the population of this species. DAWE notes the lack of confidence in the water resources impact assessment. This is further discussed in the conclusion of the threatened species.

No Threat Abatement Plans have been identified as relevant for this species.

There is no adopted or made Recovery Plan for this species.

4.15.2.10.3 Koala (Phascolarctos cinereus) (combined populations of Qld, NSW and ACT)

EPBC Act Listing Status

Vulnerable

Distribution and population

The combined home range for koala populations of Queensland, NSW and ACT extends from approximately the latitude of Cairns in northern Queensland to the NSW-Victoria border and includes inland and island populations. The distribution is not continuous, and some populations are isolated due to development or unsuitable habitat.

In Queensland, the koala population extends over the eastern half of the state from the NSW border to the Wet Tropics bioregion and inland bioregions, including the Brigalow Belt. Koalas occur at naturally low density ($\geq$0.01 koalas/ha) and have large home ranges in the central Queensland region, where the proposed project is located.

Population estimates by the SPRAT database for the Brigalow Belt koalas, range from 69,000 to 80,500 individuals in 2010, with an estimated decline of 30-40% since 1990 (TSSC 2012).

Habitat

The koala inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid vegetation communities dominated by *Eucalyptus* species.

Habitat is broadly defined as any forest or woodland that contains known koala food tree species, or shrubland with emergent food trees, including modified and regenerating native vegetation. Shelter trees are also considered important habitat components for koala, however, there is no identified sub-set of trees known to be shelter trees.

Based on the geographical location and the annual rainfall of the proposed project, koala habitat was assessed with respect to the inland context described in koala EPBC referral guidelines (DoE, 2014c).

In their submission on the EIS, DAWE noted that habitat description for koalas refers to food trees with more than 50% cover, whilst koalas are known to use areas with scattered tree cover.

Surveys

Habitat

In the EIS, Koala habitat was defined for the purposes of the field survey as any refuge, foraging or dispersal including *E. camaldulensis*, *E. populnea, E. coolabah* and *E. thozetiana*. The EIS identified a total area of 450.23ha as koala habitat within the project area.

Fauna

The EIS field assessments did not detect koalas or characteristic scats and scratches. This species, however, is expected to utilise the eucalypt woodlands within the project area, hence the riparian zone of the Nogoa River is likely to provide an important dispersal corridor and refuge habitat for the species in a regional context.

Impacts of the proposed action

The EIS concludes that with the proposed underground mining extension, there will be limited surface disturbance and any indirect impacts associated with vegetation clearing are unlikely.

Mitigation of impacts

The EIS has proposed the following mitigation measures relevant to impacts on the koala:

- implementation of vegetation clearing management measures to minimise impacts on vegetation communities and their habitat values such as:
  - clear demarcation of the clearance area
  - sequential clearing
  - felling towards the centre of the approved clearing area to minimise encroachment into the adjacent remaining vegetation
- dust minimisation strategies

- implementation of a Species Management Program under the Queensland Nature Conservation (Wildlife Management) Regulation 2006 (this would include pre-clearance surveys and presence of spotter catchers during clearing)
- procedures to manage weeds and pest animals.

Assessment

The *Approved Conservation Advice for P. cinereus (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (TSSC 2012) lists habitat loss and fragmentation as a primary current threat to the species population. Drought and extreme heat events can also cause very significant mortality and Bell Miner Associated Dieback and myrtle rust can damage forests containing koalas.

No Threat Abatement Plans have been identified as relevant for this species.

There is no recovery plan adopted or made for koala, however, a recovery plan is required following the expiration of the National Koala Conservation and Management Strategy in 2014.

DAWE notes the lack of confidence in the water resources impact assessment. This is further discussed in the conclusion of the threatened species.

4.15.2.10.4 Fitzroy River turtle (*Rheodytes leukops*)

EPBC Act Listing Status

Vulnerable

Distribution and population

The Fitzroy River turtle is only found in the drainage system of the Fitzroy River, occurring in a total area of less than 10,000km^2 (SPRAT database). Their aging population distribution is due to low survival rate of the young with threats such as egg predation, nest destruction and habitat modification.

Habitat

The species is found in rivers with large deep pools with rock, gravelly or sandy substrates, connected by shallow riffles. Common riparian vegetation associated with the Fitzroy River turtle are blue gums (*Eucalyptus tereticornis*), river oaks (*Casuarina cunninghamiana*), weeping bottlebrushes (*Callistemon viminalis*) and paperbarks (*Melaleuca linariifolia*).

They generally nest on river sandbanks of 1-4m above water level, preferably on banks with a steep slope, low ground and understorey vegetation and partial shade cover (Limpus 2008).

Surveys

Habitat

The EIS produced a habitat map for this species in Chapter 25 (Figure 25-48) of the EIS. As there are no species-specific guidelines for determining habitat critical to the survival of this species, nor a recovery plan, breeding habitat was considered habitat critical to the survival of the species. As such, the EIS identified sandy banks along the Nogoa River which were suitable for nesting to be habitat critical for the survival of this species.

Fauna

The Fitzroy River turtle was not recorded during field surveys undertaken in May 2019 and November 2019. Although the Fitzroy River turtle was not confirmed during field surveys it is known to inhabit the Nogoa River (based on previous records on Atlas of Living Australia)

Suitable habitat for breeding, foraging and dispersal was identified in association with the river.

Impacts of the proposed action

The EIS concluded that due to the nature of underground mining, there will be no significant impacts on the Fitzroy River turtle from the proposed project, although there will be a minor temporary disturbance associated with exploration activities in the three zones.

The EIS also asserted that current environmental flows will not be impacted as the flow will continue to be dependent on Fairbairn Dam releases for irrigation purposes. It also noted that there will be no increase in release of mine affected water from the current level as the discharge will continue to be in accordance with the existing Ensham Mine EA conditions.

Mitigation of impacts

The EIS noted that there will be no significant impacts to Fitzroy River turtle from the proposed project as there will be:

- No significant hydrological impacts, subsidence, increase in release of mine affected water, nor clearing of riparian vegetation leading to long-term decrease in the size of population.
- No habitat fragmentation is likely to occur due to the proposed project.
- No direct impact is likely to occur within the project area and indirect impacts are consistent with current levels and as such the proposed project is unlikely to adversely affect critical habitat.
- There will be no clearing within suitable habitat.
- It is unlikely that the proposed project will introduce a disease to the extent that this species would decline. Weed and pest management measures will ensure best practice site hygiene measures will be implemented.

Assessment

The *Approved Conservation Advice for Rheodytes leukops (*Fitzroy Tortoise*)* (DoE 2008a) includes the following as known threats:

- loss and disturbance of habitat from agriculture
- mining and salinity
- damming of rivers
- pollution and siltation of rivers and creek habitats
- predation of eggs.

There are regional priority recovery actions and local priority actions for this species.

DAWE notes the lack of confidence in the water resources impact assessment. This is further discussed in the conclusion of the threatened species.

4.15.2.10.5 Southern snapping turtle (*Elseya albagula*)

EPBC Act Listing Status

Critically endangered

Distribution and population

Southern snapping turtles are only found in the Fitzroy, Mary, Burnett Rivers and small drainages in south-eastern Queensland.

Habitat

The species is known to reside in riverine systems with permanent water, including waterholes. Within the river systems, it prefers clear, flowing, well-oxygenated waters with subsurface structures such as logs, undercut banks and irregular rocky substrata.

Surveys

Habitat

The Nogoa River provides foraging, dispersal, breeding and nesting habitat for this species. The river is suitable for dispersal and there are suitable undercut banks, log tangles, riffles and macrophytes that are potential habitat for this species. The sand bars and low gradient banks along the river also represent potential breeding habitat. The EIS calculated a total of 24.18ha of potential habitat within the proposed project area.

Fauna

No southern snapping turtles were found during the EIS field survey.

Impacts of the proposed action

As per impacts on the Fitzroy River turtle (above).

Mitigation of impacts

As per the mitigation of impacts on the Fitzroy River turtle (above).

Assessment

The Approved Conservation Advice for *Elseya albagula* southern snapping turtle (DoE 2014b) lists the following as principal threats to the species:

- loss of eggs and hatchlings due to predation and trampling
- construction of dams and weirs causing fragmentation of preferred habitat
- obstruction of up and downstream migration within rivers
- water regulation leading to insufficient flow
- Inundation of nesting areas and riparian vegetation.

The submitted EIS lacked information relating to a recovery plan for white-throated snapping turtle. The proponent has since included the National Recovery Plan for this species in the AEIS.

DAWE notes the lack of confidence in the water resources impact assessment. This is further discussed in the conclusion of the threatened species.

4.15.2.10.6 Ornamental snake (*Denisonia maculate)*

EPBC Act Listing Status

Vulnerable

Distribution and population

The ornamental snake is endemic to Queensland and occurs within the BRB, primarily in the Fitzroy River basin. The distribution of the species is associated with the Brigalow TEC. The population size is unknown; ornamental snakes are considered sparsely distributed and the extent of habitat clearance in their range is considered likely to be threatening their long-term survival (DoE 2014a).

Habitat

Ornamental snakes are found on floodplains, clay pans and along margins of watercourses and wetlands. They can also be found on adjacent elevated ground including open woodlands associated with gilgai mounds and depressions. During dry periods, refuge habitats consist of soil cracks on gilgai mounds (SPRAT 2021a). Microhabitat features include logs, coarse woody debris and leaf litter. Ornamental snakes feed almost exclusively on frogs.

Surveys

Habitat

The EIS identified habitat critical to the survival of the species as defined as important habitat in the Draft Referral Guidelines for the national Listed Brigalow Belt Reptiles (Department of Sustainability Environment Water Population and Communities, 2011).

The EIS identified a total of 200.72ha critical habitat, comprised of 37.13ha of breeding and foraging habitat and 163.59ha of dispersal habitat, within the project area. This included gilgai depressions and mounds, and open forest and low Brigalow woodlands connecting gilgai habitat.

Fauna

Ornamental snake was not recorded within the project area during the EIS field surveys undertaken in May 2019 and November 2020. The peak activity levels are typically restricted to summer rainfall events. Although there was surface water present within wetlands and gilgai, it may not have been the ideal season to find this species. As such, ornamental snake may be present within the project area but avoided detection during surveys.

Impacts of the proposed action

The EIS concludes that with the proposed underground mining extension, there will be limited surface disturbance and any indirect impacts associated with this species are unlikely.

Mitigation of impacts

The EIS indicated that there will be no significant impacts to Ornamental Snake from the proposed project as there will be:

- No direct impacts to the identified important habitat as less than 1ha will be cleared. This is unlikely to lead to long-term decrease in the size of an important population.
- No reduction of the area of occupancy of an important population.
- No fragmentation of an important population.
- No direct or significant indirect impacts within habitat critical to the survival of the species.
- No changes to hydrology or further degradation of habitat, hence it is unlikely to disrupt a breeding cycle of an important population.
- Unlikely to modify, destroy, remove, isolate or decrease the habitat to the extent that the species is likely to decline.
- Unlikely to introduce pest and disease to the extent that this species would decline. Weed and pest management measures will help control and prevent invasive species.

Assessment

The EIS indicated that the suitable habitat for ornamental snake is low-lying areas with deep-cracking clay soils as they live in soil cracks and under fallen timber. The primary threat is continued modification of habitat through extractive industries.

The proposed project failed to complete its soil survey study during the EIS process which could have assisted in predicting the extent of this species’ habitat in the project area.

DAWE notes the lack of confidence in the water resources impact assessment. This is further discussed in the conclusion of the threatened species.

Although the proposed project is an underground mine and will have limited impacts to the surface, a mitigation plan should be in place for when impacts occur due to subsidence and groundwater drawdown.

4.15.2.10.7 Australian painted snipe (*Rostratula australis)*

EPBC Act Listing Status

Endangered

Distribution and population

The Australian painted snipe has been recorded at wetlands in all states of Australia but is most common in eastern Australia. While the extent of occurrence is not considered to have changed, the area of occupancy is considered likely to have declined given the removal of approximately 50% of wetlands in Australia since European settlement (SPRAT 2021c). Additionally, there has been a prolonged and widespread decline by more than 90% in reporting rates of Australian painted snipe since the 1950s. The total population estimate is between a few hundred and 500 breeding adults.

Habitat

Australian painted snipes occur in shallow terrestrial freshwater or occasionally brackish wetlands, typically with a good cover of emergent vegetation, low scrub and grasses. Breeding habitats are described as shallow wetlands with areas of bare wet mud and nearby canopy cover, with nearly all nest records from or near islands in freshwater wetlands (SPRAT 2021c). The Fitzroy Basin and Channel Country in Queensland are identified as important (past) areas for the species. Snipes feed on a range of invertebrates as well as seeds and vegetation. The EIS describes the species as mainly crepuscular (active at dawn and dusk).

Surveys

The EIS did not detect any Australian painted snipe within the project area, however, informed that this species is known to be cryptic and difficult to find. The EIS found potential habitat for this species including gilgai formation and backwaters of the Nogoa River. The EIS considered 8.1ha of freshwater wetlands with wet mud and canopy cover area as foraging and roosting habitat. It also considered 37.13ha of ephemeral shallow waterbodies as foraging habitat.

Impacts of the proposed action

The EIS concludes that with the proposed underground mining extension, there will be limited surface disturbance and any indirect impacts associated with this species are unlikely.

Mitigation of impacts

The EIS indicated that there will be no significant impacts to Australian painted snipe from the proposed project as there will be:

- No potential impacts identified that would lead to a long-term decrease in the size of the population.
- No impact on the habitat and it is unlikely to reduce the area of occupancy of species.
- No fragmentation of an important population.
- No direct or significant indirect impacts within habitat critical to the survival of the species.
- No changes to hydrology or further degradation of habitat, hence it is unlikely to disrupt a breeding cycle of an important population.

- Unlikely to modify, destroy, remove, isolate or decrease the habitat to the extent that the species is likely to decline.
- Unlikely to introduce pest and disease to the extent that this species would decline. Weed and pest management measures will help control and prevent invasive species.

Assessment

The EIS indicated that the threats to this species include loss and degradation of wetlands through drainage and diversion of water and replacement of native wetland vegetation by invasive weed. The EIS noted that there are no predicted significant impacts to this species, due to reasons listed above. This is discussed in the conclusion section for listed threatened species below. With this lack of confidence and the potential for the wetland to be impacted if the predictions are inaccurate, mitigation measures should be in place for this species prior to commencement of proposed project activities.

No Threat Abatement Plans have been identified as relevant for this species.

There is no Recovery Plan adopted or made for Australian painted snipe.

4.15.2.11 Cumulative impacts

The AEIS failed to address DAWE’s concern regarding the inclusion of surrounding mines in the groundwater modelling to predict the cumulative drawdown impact assessment. For this reason, there is still some uncertainty around the cumulative predicted drawdown. The AEIS indicated that the mines that were excluded from the groundwater model were either further than 30km from the proposed project area or will not have an interaction with the proposed project due to the differences in the formations, as shown in the predictive hydrographs.

As highlighted in the land section of this assessment report, the verification for the predicted subsidence is lacking. As the drawdown and subsidence can affect the relevant listed threatened species, potential impacts to them cannot be ruled out.

4.15.2.12 Conclusion and recommendations—listed threatened species.

All listed threatened species and communities that were present or considered likely to occur in the project area were subject to an impact assessment. All recovery plans, threat abatement plans and approved conservation advice relevant to these species were considered in the assessment process.

Although the EIS noted that there are no predicted significant impacts to the MNES listed threatened species, IESC and DAWE’s assessment highlighted that there were still outstanding issues with the verification of groundwater modelling and the prediction of groundwater drawdown and subsidence. DAWE notes that the significant impact assessment for MNES listed threatened species is partially dependent on the outcomes of the revised water resources impacts assessment and will be conditioning under the EPBC Act to cater for the uncertainty of the water resource impacts.

Although major subsidence may be unlikely due to the nature of bord and pillar underground mining, until such time that the predicted subsidence can be verified, I recommend having a subsidence monitoring program in place. Mitigation measures in the form of an adaptive management plan should be implemented prior to commencement of proposed project activities.

4.15.2.12.1 Terrestrial flora

The EIS concluded that the proposed project would not impact on EPBC Act threatened flora because all listed flora species have a low likelihood of occurrence within the study area. In addition, field surveys conducted in the study area did not identify any threatened flora species listed under the EPBC Act.

Based on the results of flora field surveys, an assessment of the likelihood of occurrence and the limited proposed clearing, I am satisfied that the project is unlikely to significantly impact EPBC listed threatened flora species.

4.15.2.12.2 Terrestrial and aquatic fauna

The EIS undertook significant impact assessments for the seven threatened fauna species that were considered likely to occur in the project area (as listed in TOR Appendix 3). The EIS concluded that the proposed project would be unlikely to significantly impact on these species.

I agree with the AEIS that there will be no significant residual impacts on EPBC listed threatened species from the underground mining operation if the drawdown and subsidence predictions are correct. If subsidence greater than the predicted amount is to occur, or groundwater drawdown is greater than what is predicted in the AEIS, then the proponent will be required to mitigate the impacts to the species. I recommend further monitoring of subsidence and drawdown and to have a mitigation measure in place should impacts occur. I also expect that the land will be rehabilitated post mining as per PRC Plan.

4.15.2.13 Additional recommendations

Management of impacts on threatened species and communities

The proponent must implement measures to avoid, mitigate and manage impacts on EPBC listed species and their habitat during vegetation clearing, construction, operation, and decommissioning of the proposed project. The proponent must undertake vegetation clearing for each project phase in a manner that avoids or minimises the potential for impacts on EPBC listed fauna species. The proponent must ensure that management actions are carried out in a manner that takes into consideration approved conservation advice and is consistent with relevant recovery plans and threat abatement plans.

Disturbance limits

The EPBC approval is expected to set limits on the disturbance of habitat for EPBC Act listed threatened species and communities.

Commitments

Where the proponent’s commitments outlined in the AEIS do not conflict with any subsequent approval conditions and any recommendations of this assessment report, I recommend that the proponent implement the commitments as stated.

4.15.2.14 EPBC offset requirements

The EIS concludes that there will be no significant impacts on threatened species.

4.15.3 Water resources

The EPBC Act includes water resources as an MNES. Due to the size and purpose of the proposed project, it was referred as being a potential controlled action for the purposes of the water trigger. On 29 June 2020, a delegate of the Commonwealth Minister for the Environment, determined that the proposed action was likely to have a significant impact on the controlling provisions under the EPBC Act that are sections 24D and 24E (a water resource in relation to a large coal mining development or coal seam gas development). The EIS was required to describe current water resources and their use in the region and assess impacts on water resources as a result of the proposed project:

- giving consideration to the *‘Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources and Significant Impact Guidelines 1.3: Coal seam gas and large coal* *mining developments—impacts on water* (Commonwealth of Australia 2013)*'*; and

- addressing the information requirements in the *Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (IESC Guidelines).

The EIS refers to both guidelines in its assessment and provides a table showing how the IESC Guidelines have been addressed.

4.15.3.1 Existing environmental values identified in the EIS

4.15.3.1.1 Surface water

The existing Ensham Mine is located within the floodplain of the Nogoa River. The Nogoa River forms part of the Nogoa Mackenzie water supply scheme, supplying water to agriculture, industry and towns in Central Queensland. Fairbairn Dam, the major water storage in the scheme, is located on the Nogoa River, approximately 60km upstream of the mine. Since its construction in 1973, Fairbairn Dam releases are regulated to supply downstream users. The Nogoa River flows adjacent to B and C pits of the mine in southeasterly direction, and Mosquito Creek, a tributary of the river, flows through the project area. Boggy Creek, the main tributary within the existing mine is permanently diverted to flow around the mine footprint.

The existing Ensham Mine pits extend into the floodplain and are protected from flooding by earth levees which provide protection for up to a 0.1% AEP event. The Nogoa River is 10m deep and about 500m wide except for the anabranch where it narrows to 150m. There are two flood channels, Channel 1 and 2, which drain into Winton Creek. Winton Creek has a steep bed gradient, and its water levels are impacted by backwater flows from the Nogoa River. Flood Channel 2 is up to 5m deep and 40m wide. Mosquito Creek, another flood channel which is 5m deep and 200m wide, drains into Crinum Creek.

Publicly available water quality and flow datasets from gauging stations on the Nogoa River upstream and downstream of the project area were analysed. A hydraulic model for the proposed project has been used to characterise existing flooding and assess changes to flooding characteristics (such as extent, depth, velocities and shear stress) and impacts on beds, banks and floodplains during operational and post-mining flood conditions.

The EIS compared the existing monitoring data (for Ensham Mine) to the WQOs of the Lower Nogoa, Theresa Creek and Mackenzie River catchments. Results showed, that for most indicators monitoring points exceeded these WQOs even at the upstream monitoring sites. This indicates that site-specific trigger values are required for the existing Ensham Mine and potentially for the proposed project areas. This is discussed further in the water quality section (section 4.5) of this assessment report.

4.15.3.1.2 Groundwater

The proposed project is located in the western part of Bowen Basin. Stratigraphic sequence of the project area comprises of unconsolidated quaternary aged sediments overlying Permian Tertiary aged sequences. The quaternary alluvium layer comprises of clay, silt and sand, underlain by discontinuous basal sands and gravel. The groundwater water quality monitoring for the existing Ensham Mine shows variability in the EC levels, ranging from 1,000µS/cm to 30,000µS/cm.

The Rewan Group formation overlies the Rangal Coal Measures and acts as an aquitard, separating the Nogoa River and alluvium floodplain from the underlying sediments. The Rewan Group is made up of low permeability siltstones, mudstones and lithic sandstones and can be up to 200m thick. Groundwater monitoring data shows that this group is generally saline with median EC of 6,000µS/cm.

The uppermost Permian unit contains the Rangal Coal Measures which is targeted by both the existing Ensham Mine and the proposed project. Groundwater monitoring indicates the salinity of this layer has a median of 7,700µS/cm

The Nogoa River floodplain comprises of silt and clay underlain by a discontinuous basal unit of sand and gravel. The alluvium floodplain is overlain by a deep clay-rich black soil, which tends to be highly absorbent during rainfall events. The alluvial sequence varies in thickness, with a maximum observed depth of 25m.

The EIS concluded that the alluvium groundwater has high salinity, which makes it unsuitable for groundwater uses such as stock watering and irrigation. Slow infiltration recharge and evapotranspiration are likely to be the dominant processes of the alluvium groundwater, resulting in increase in salt content of the alluvium.

For the existing Ensham Mine, there are 21 monitoring bores in the groundwater monitoring plan. In addition, there are 19 private registered bores, 12 of which are currently in use for irrigation and stock purposes. The bores use groundwater sourced from different geological formations, including the alluvium, undifferentiated Tertiary sediments and the Rewan Group, but none from the Rangal Coal Measures where the dewatering will occur for the proposed project. As discussed in the water quality section (section 4.5) of this assessment report, the proponent will be undertaking bore sensor monitoring as an EIS submission highlighted it was out of date.

4.15.3.1.3 Groundwater dependent ecosystems

The EIS desktop assessment reviewed the GDE Atlas (BOM 2020) and GDE spatial data (QSpatial 2020) to identify the likelihood of GDEs. The terrestrial GDE survey area was selected based on the desktop assessment. The following four Queensland RE were identified as potential GDEs and surveyed:

- *Acacia harpophylla* low open forest on alluvial plains (RE 11.3.1 HVR)
- *Acacia harpophylla* open forest on alluvial plains (RE 11.3.1)
- *Eucalyptus coolabah* woodland on alluvial plains (RE 11.3.3)
- *Eucalyptus camaldulensis* woodland fringing drainage lines (RE 11.3.25).

Whilst the above REs were identified within the project area and they have the ability to utilise groundwater sources, the EIS concluded that the identified hydrogeological characteristics of the alluvium groundwater are not highly suitable for use by the communities.

4.15.3.1.4 Stygofauna

A desktop review based on previous studies, hydrogeological data and groundwater quality within and surrounding the project area were followed by a pilot field study. Of the 15 bores surveyed between 6 and 10 November 2019, two bores contained stygofauna, Oligochaeta.

4.15.3.1.5 Aquatic habitats

The EIS identified palustrine wetlands of high significance within the study area, located 2.6km south of the existing mine, outside the proposed project area. The watercourses of the study area mapped as a riverine wetlands including the Nogoa River, Mosquito Creek, Winton Creek and Corksrew Creek.

4.15.3.1.6 Conclusion on description of values

Taking into consideration the above limitations and based on the information provided in the submitted EIS, AEIS and submissions made on the EIS, I believe that the environmental values for water resources as a controlling provision have been sufficiently identified and described for the purposes of this assessment. Conceptual ecohydrological models were presented in the EIS for use in assessing potential impacts on water resources and associated ecosystems.

4.15.3.2 Potential impacts on water resources

The EIS presented an assessment of potential impacts on water resources and related ecosystem functions and environmental assets. The EIS predicted no significant impacts from the proposed project, therefore the EIS did not discuss the avoidance, mitigation nor the management intent for potential impacts. In the assessment of the EIS, however, I have noted the following potential impacts of the proposed project:

- changes to groundwater and surface water quality and levels including at the Nogoa River, floodplain and residual void
- changes to the Nogoa River, tributaries and floodplain hydrology, geomorphology and ecology
- localised drawdown of the groundwater including interaction with potential GDEs and landholder bores
- loss of GDEs along the Nogoa River riparian zone that is threatened wildlife habitat and provides connectivity for threatened and other wildlife and
- impacts to stygofauna.

4.15.3.2.1 Surface water

The modelling undertaken in the EIS, as part of the Mine Water Balance Assessment, predicted water extraction of 546.7ML/year compared to the current extraction of 546ML/year, both of which are substantially lower than their current licenced water allocation limit of 1,500ML/year from the Nogoa River.

The EIS explained how the total volume of release will be managed under the existing Ensham Mine EA conditions, thus the proposed project is not expected to have any additional impact on the flows or flow regime of the Nogoa River.

The EIS predicted minor changes to water quality due to additional groundwater inflow to the surface water. The groundwater inflow is proposed to be managed within the existing mine's water management system and monitoring under the existing Ensham Mine EA to ensure protection of environmental values. The water balance modelling in the EIS demonstrates that the mine water management system will be sufficient to manage mine affected water in accordance with the existing Ensham Mine EA conditions.

The EIS relies predominantly on the existing water quality data collected for Ensham Mine monitoring scheme. The closest flow data is from the upstream and downstream government gauges, there are no flow gauges in the vicinity of the site or on the tributaries.

The existing Ensham Mine uses an EC calculator to model expected EC at downstream sites during releases, using the water quality of the upstream monitoring point. However, the current upstream monitoring point, Duckpond gauging station 130219A, has elevating EC. The department has recommended that the proponent investigate the rising EC level at this monitoring point and obtain additional upstream monitoring points for the proposed project.

In their submission, DAWE advised that metals be included in routine water quality monitoring program for upstream and downstream monitoring points. I agree that the metal concentration should be monitored for background data. However, once the baseline concentration is known, water quality will only be required to be collected at the time of the mine water release as per the existing Ensham Mine EA condition.

4.15.3.2.2 Groundwater

The proposed project, combined with the existing Ensham Mine, will continue to have inflow rates between 5ML/day to 16ML/day, with the proposed project inflow rate between 3ML/day and 12ML/day.

The EIS undertook groundwater impact assessment in two stages: a desktop study to describe the project area and a numerical groundwater model to simulate the groundwater regime and the potential alteration of the groundwater resources.

For conceptualisation of the groundwater regime, geological data, existing groundwater level and quality data, hydrogeological data and long-term transient groundwater level trends were analysed.

For the numerical groundwater model, the existing Ensham Mine Residual Void Project model was used as the base for the model. Although the report that the model was based on was not presented in the EIS, additional information has been included in the AEIS as required by the IESC. Effects of climate change were incorporated into the model using the Climate Future Tool.

The EIS did not identify additional impacts to groundwater from the proposed extension of the existing Ensham Mine

Groundwater flow and drawdown

The mine affected water capacity indicates that the proposed project has sufficient capacity to manage increased groundwater inflows without the need to release to surface water. It is proposed that the underground void will be filled with water to prevent methane build-up, and this will provide further water storage up to 48,000ML for the proposed project. In addition, as the open cut mine comes to an end in 2023, additional 48,000ML will be available from the pits for surface water storage.

The EIS used the groundwater model to assess potential impacts on groundwater resources and users. The groundwater level drawdown predictions were based on the estimated groundwater inflow. Drawdown in both the alluvium and Rangal Coal Measures were assessed.

The EIS predicted limited drawdown of 10cm to 17cm in the landholder’s bores. The model did not identify any impacts on GDEs or wetlands from the predicted drawdown. Furthermore, the model did not predict any changes to the Nogoa River stream nor leakage into the alluvium.

The EIS predicted drawdown within the Rangal Coal Measures to extend up to 10km to the west of the proposed project footprint. However, there were no identified groundwater users extracting from the Rangal Coal Measures.

The EIS presented drawdown of several intervals ranging from 0.5m to 5m. Since there is not enough baseline data to form a drawdown threshold level, the AEIS proposes not to have an interim drawdown threshold level. However, the department does not support the lack of a threshold levels. I recommend using 0.5m as the interim threshold level which allows for climatic variability.

Furthermore, DAWE questioned the lack of cumulative drawdown impact assessment from the surrounding mines as discussed above in the cumulative impact section.

Groundwater quality

The proposed project does not include any additional open voids or spoil emplacement, and the EIS did not predict impacts on groundwater quality because of the underground mining operation. The excavated underground void will naturally fill over time from groundwater ingress. In addition, the EIS did not predict any alteration to the alluvium water quality due to induced flow or surface water loss to the alluvium.

As the EIS predicts no drawdown in the alluvium across the underground mining footprint, the EIS justifies that there will be no vertical groundwater movement between the hydrostratigraphic units to cause any blending or mixing of groundwater types.

The EIS indicated that interaction between surface water in the Nogoa River and the underlying alluvium is unlikely due to the nature of the sediments. The EIS also points out that groundwater quality and quantity in the alluvium is primarily influenced by surface irrigation and rainfall. The AEIS provided further historical information on the irrigation of the area which intensified in late 1980s. However, the AEIS incorporated some errors in the figures. Figures 6 to 8 in Appendix F-1a should show the open cut mining commencing prior to 1993 and underground mining commencing in 2011. The AEIS noted that the figures indicate that irrigation was the cause of increase in of EC and water level. However, the graphs provided do not clearly support this conclusion as data from the bores plotted vary in the timing and severity of the increase of EC and water level. Some of the graphs plotting EC over time show an increase in EC as the open cut mining commenced in 1993. Although the irrigation is likely to have had an impact on rising groundwater levels and increasing EC in these bores, the department is not satisfied that impacts from mining operation can be ruled out entirely. For this reason, I recommend further monitoring of the water level and water quality from the additional bores shown in Figure 12, and RN 13020172 in Figure 13.

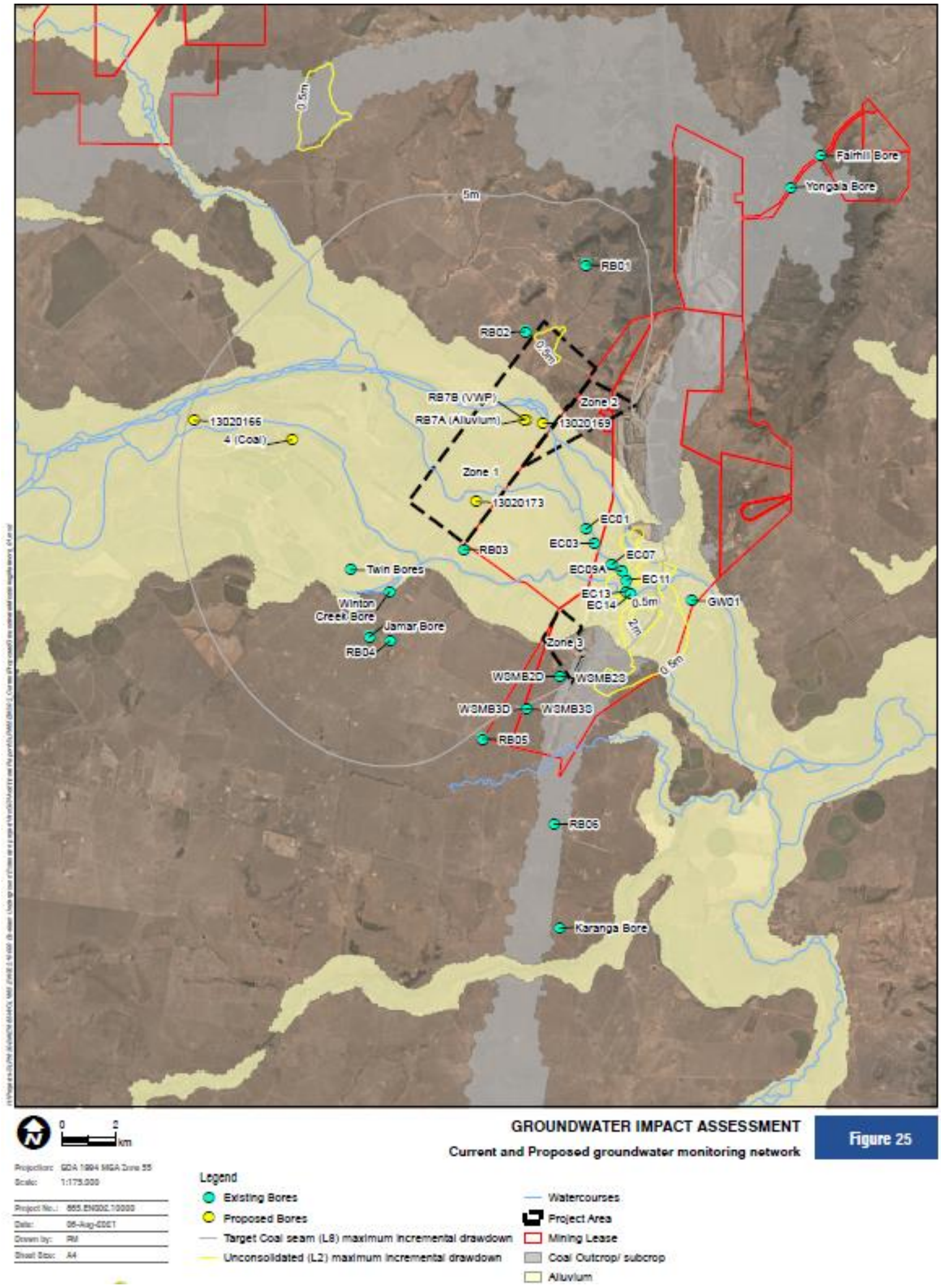


Figure 12. Existing (green circles) and proposed (yellow circles) alluvium bores (from Figure 25 of Appendix F-1a)

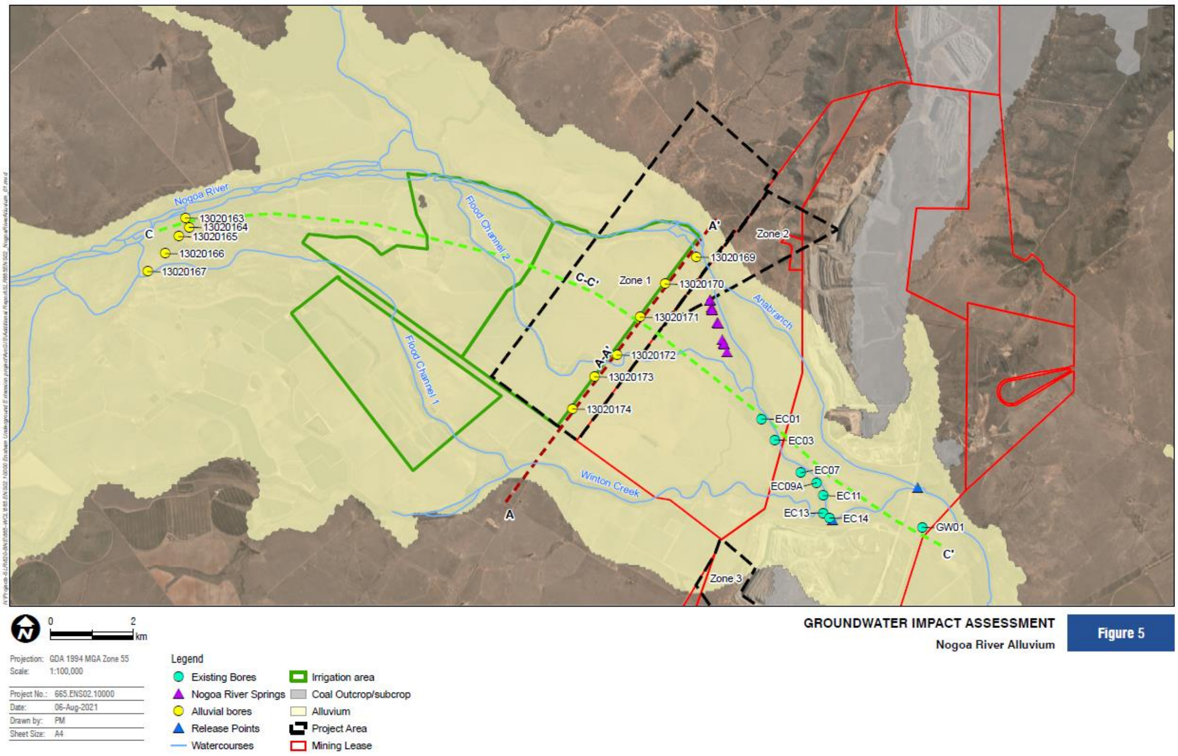


Figure 13. Existing (green circles) and proposed (yellow circles) alluvium bores showing the location of RN 13020172 (from Figure 5 of Appendix F-1a)

The EIS indicated that any discharge of mine affected water will be undertaken as per the existing Ensham Mine approval. The department's submission on the EIS raised concerns regarding the existing Ensham Mine EA conditions for the existing bores. These limits were derived specifically to monitor the existing bores which already had high contaminant levels. In the department's submission, it was recommended that the proponent obtain bore specific monitoring data as per the department's guideline 'Using monitoring data to assess groundwater quality and potential environmental impacts', and in the interim to adopt the water quality objectives of the Nogoa River Sub-Basin Environmental Values and Water Quality Objectives (Basin No. 130) catchment (DEHP 2011).

The department's submission on the EIS also raised concerns related to the lack of upgradient monitoring point for the proposed project. This was not rectified in the AEIS.

4.15.3.2.3 Groundwater dependent ecosystems

Drawdown within the unconsolidated sediments is predicted outside of the proposed project footprint. The EIS concludes that it will have limited impacts on any potential terrestrial GDEs. The EIS further explains that the groundwater associated with the unconsolidated sediments have an average EC of 5,000µS/cm at depths greater than 10m and are not suitable for most species.

The EIS concludes that there is an unlikely occurrence of GDEs due to limited drawdown and unfavourable habitat, therefore GDEs do not require avoidance, mitigation, management or monitoring.

4.15.3.2.4 Stygofauna

The EIS indicated that the stygofauna were only found in the alluvium where the mining operation will not have an impact, indicating that it is unlikely there will be physical disturbance to stygofauna habitat.

The EIS noted that the only surface disturbance from the proposed project will be associated with flaring infrastructure and exploration activities and therefore it is unlikely for the proposed project to increase any localised watercourse contamination. The stygofauna community of the proposed project area was assessed as having low environmental value. The AEIS revised the statement indicating that stygofauna within the alluvium has a moderate environmental value. DAWE recommends further monitoring of these stygofauna. The AEIS committed to ongoing groundwater level and water quality monitoring, however, no ongoing monitoring of stygofauna has been proposed.

4.15.3.2.5 Aquatic habitats

The EIS has assessed the impacts from water quality changes and changes to hydrology and fluvial geomorphology as minor or negligible (taking into account proposed management systems).

4.15.3.3 Cumulative impacts

The proposed project is close to other existing or proposed mines in the Bowen Basin, including the Gregory-Crinum Coal Project, Kestrel Coal Project, Wilton and Fairhill Projects, and the Curragh Project. Consequently, the proposed project may contribute to the cumulative impacts of these mines and the existing Ensham Mine. The EIS predicted no additional impacts from the proposed project.

The IESC recommended that impacts from surrounding mines should be included in the cumulative drawdown impacts and assessed quantitatively. The analytical solution should show the lateral extent of the drawdown from these surrounding mines. This will increase confidence in qualitative assessment that cumulative impacts from surrounding existing or planned major projects will be non-material.

4.15.3.4 Proposed mitigation measures

The EIS relies on the existing Ensham Mine management plans and EA trigger levels to manage water quantity and quality impacts and notes that the proposed project will not cause any additional impacts to the environmental values than what has already been approved for the existing Ensham Mine. For this reason, they have not provided any mitigation measures.

4.15.3.5 IESC advice

In their response to the joint referral on the project from the department and DAWE, the IESC provided detailed advice on the adequacy of the: groundwater and surface water assessments; assessments of impacts to water-dependent ecological assets; and the adequacy of mitigation, management and monitoring measures presented in the April 2021 EIS. The advice and IESC recommendations were addressed in the AEIS and the proponent's response to submissions (Table 8).

4.15.3.5.1 Subsidence

Further to water resources, potential subsidence could impact on EPBC Act listed threatened species.

The issues related to subsidence are discussed in detail in the land section (section 4.3) of this assessment report. Briefly, the proponent has predicted the subsidence of 40mm using the industry accepted University of New South Wales Pillar Design procedure. DAWE's submission raised some of the issues found in Table 8, including the lack of sensitivity of measuring subsidence using LiDAR. The department requested an SMP to be incorporated, which the proponent provided in the AEIS. The SMP incorporated further LiDAR survey data which varied between 200mm and 500m. The proponent suggested using 300mm as the subsidence trigger values. The department, along with Resources, DAWE and the OCG are concerned with the LiDAR technique and requested a more sensitive methodology.

In their response, the proponent has advised Real Time Kinematics (RTK- GPS) will be used. I recommend that further subsidence monitoring using control sites, reference sites and test sites be undertaken as well as implementing sensitive methodology, such as the use of RTK- GPS on varying soil types.

There is a risk, based on the previous monitoring data that subsidence caused by the proposed project will greater than the predicted value, if this does occur, the risk of potential impacts to the threatened species and to the irrigators increase.

Until such time that the IESC advice on groundwater modelling has been considered in full by the proponent, it is difficult to predict whether there will be further impacts posed on threatened species. Threatened species impact assessment heavily depended on the impact assessment for water resources which was based on the groundwater modelling presented in the EIS. For example, an uncertainty analysis of horizontal hydraulic conductivity in the Rewan Group has not been completed, therefore it is difficult to assess the predicted drawdown within the alluvium. If the revised groundwater model indicates a greater extent and magnitude of drawdown than the current prediction, reassessment of cumulative impacts on the potential GDEs is required.

Table 8. Key IESC advice and AEIS/proponent response

IESC Advice	AEIS/proponent response
Improve confidence in the modelling - hydrogeological conceptual model, groundwater numerical model and water salt balance model	
Provide additional **hydrogeological conceptual model** to inform the design of the numerical groundwater model cross-sections that show the locations of groundwater expressions and subcropping Rewan Group and Rangal Coal Measures. Adequately capture heterogeneity of underlying geology, spatial variability of interactions of flows between alluvium and Nogoa River. Rangal Coal Measures subcrop exists in localised zones beneath alluvium and may intermittently connect with Nogoa River (IESC paragraph 2).	Additional cross section provided along Nogoa River alluvium. Historical commencement of irrigation. A new cross section was created, based on the numerical groundwater model. This cross section shows the sub-crop of the coal was included the groundwater numerical model, consistent with the conceptual model.
Numerical groundwater model should be updated to reflect and be consistent with the conceptual models. Undertake the following to increase confidence in predictions of the numerical groundwater model. Include sensitivity and uncertainty analysis of the model (IESC paragraph 3).	Another sensitivity run for an increase in horizontal hydraulic conductivity of the Rewan Group has been undertaken and reported on. The hydraulic conductivity was increased by a factor of 10, the resulting underground mine inflow predictions increased by 2% and the Nogoa River base flow changed by 4%.
In the **numerical groundwater model**, include cumulative drawdown impacts from surrounding mines quantitatively (IESC paragraph 3, 14). *Not addressed by AEIS	The AEIS showed that a hydrograph of Burngrove formation, targeted by Wilton Mine showed zero drawdown dur to this project. The German Creek formation, mined by Kestrel Mine could not be calculated. DAWE commented that the IESC advice has not been addressed and that the proponent should assess cumulative drawdown impacts of surrounding mines quantitatively.
For **water salt balance model** (WSBM) calibrate to historical data to increase confidence in predictions. Also, for climate change sensitivity analysis, use a worst-case scenario as it will be most sensitive to an increase in target coal seam horizontal hydraulic conductivity (IESC paragraph 5).	AEIS did not address the climate change sensitivity analysis of the salt balance model (WSBM) however, a sensitivity analysis of the WSBM parameters has been undertaken.

Monitoring and mitigation management	
The water balance model indicates peak inflow of 26ML/day which is higher than the base case scenario of 10ML/day. Explain how mine affected water is managed when releases cannot take place during period of flood (IESC paragraph 6).	Sensitivity simulations including changes to groundwater inflows to the Underground workings (+/- 25%) have been carried out in line with other sensitivity assumptions for potential changes in assumed runoff and salinity parameters. Furthermore, the groundwater consultant (SLR) has carried out 20 sensitivity runs and a range of +/- 25% encompasses all but 2 of these scenarios. The effect of the +25% groundwater inflows to the Underground workings on the 95th percentile stored water inventory is a maximum difference of 19% (refer Figure 3 of Appendix E-2a Mine Water Balance Addendum) and all releases would be made in accordance with the site's existing environmental authority on which model simulations are based.
Include metals in the downstream monitoring scheme (IESC paragraph 9).	Metals are included in event-based release monitoring for downstream and upstream monitoring points.
Include impacts to remnant pools along the watercourses (IESC paragraph 10).	Physical disturbance of watercourses has been included as a potential impact on Aquatic Ecology values within the study area.
Require reference bores in areas of alluvium to the west of the mine area where drawdown is not predicted (IESC paragraph 18).	An additional bore to the West of Zone 1 was added as an upstream reference bore for the Nogoa River Alluvium. There are now six new bores, five of which are already installed.
Additional stygofauna sampling to be undertaken. (IESC paragraph 21). *not addressed by AEIS	AEIS did not undertake a ground-truthed GDE assessment. It would be prudent for the proponent to undertake a ground-truthed GDE assessment using direct techniques, in accordance with Paragraph 11 of the IESC advice. Direct

	techniques could validate many of the underlying assumptions that the proponent has made in regard to a lack of GDEs within and surrounding the project area. Should these direct techniques demonstrate groundwater dependence of these ecological communities, a suitable GDE management plan should be developed in accordance with Paragraph 21 of the IESC advice.
Further assess GDEs or riparian vegetation and Brigalow on alluvium sediments by using direct techniques as described in Doody et al 2019 and Jones et al 2019 (IESC paragraph 11). *not addressed by AEIS	AEIS did not undertake a direct technique for GDEs or riparian vegetation.
Subsidence	
For subsidence, accuracy of LIDAR monitoring is limited (given that the accuracy (+/-50mm) is higher than the predicted subsidence (40mm). Use of further accurate survey technique is recommended (Hebblewhite conclusion #7; s3.3(b) and s3.3e; IESC paragraphs 1 and 17).	The AEIS has provided a subsidence management plan, which provides a subsidence trigger value of 400mm. This is based on historical LiDAR data which indicates that there is natural variation of surface elevations of between 200mm and 500mm due to the shrink-swell properties of soils. However, no specific TARPs (trigger action response plan) were provided as part of this management plan. This subsidence management plan, including the proposed trigger values (and TARPs), should be assessed for adequacy and fitness by a suitably qualified mining or geotechnical engineer.
Addition of a depth loading supplement (6 m) to all design figures to provide for the potential maximum weight of floodwater above the majority of the project area which lies under the flood plain (Hebblewhite conclusion #2; s3 of use ‘use of diagrams’ page 21-22).	The AEIS has applied 6 m to the load calculation to the pillars under the flood plain.

Adoption of a lower probability of failure/higher FoS (2.11) criteria for the pillar panels that lie beneath the Nogoa River and an adjacent angle of draw corridor on either side (Hebblewhite conclusion # 3; s3.4b and s2 of use 'use of diagrams' page 20-21).	The AEIS has adopted FoS of 2.11 below the Nogoa River channel equating to probability failure of 1 in 1 million.
Consideration of wider barrier pillars between sub-panels, designed to a higher FoS value (Hebblewhite conclusion #4; s3.4d).	The barrier pillars between panels and sub-panels are now designed to ensure FoS values greater than 2.11, equating to a probability of failure of 1 in 1 million.
Provision of clarity and guidance to the mine operator to enable a simple but reliable and effective means of managing mining heights (and bell-out geometries) in each panel to avoid any exceedances (Hebblewhite conclusion #5; s4 of use 'use of diagrams' page 22). *not addressed by AEIS	This has not been addressed.
Further clarity with respect to known geological structures across the project area and how these have been taken account of within the design (Hebblewhite conclusion #6). *not addressed by AEIS	The AEIS has not undertaken geochemical characterisation of the project area.

*Issues have not been addressed fully in the AEIS.

4.15.3.6 Conclusions and recommendations—water resources

4.15.3.6.1 Surface Water

The EIS indicated that the proposed project will not alter the water requirement of the existing Ensham Mine, and it will utilise the existing water allocation and the Mine Water Balance Management Plan. The proposed project does not require an additional water allocation except in the event of potential future climatic change and therefore is low risk of impacting on availability of water resources in the region.

I am confident that impacts on flow hydraulics, channel and floodplain geomorphologies from the operational and final landforms are likely to be negligible. The surface water quality and resources can be managed in accordance with the conditions of the existing Ensham Mine EA with a couple of additional upstream monitoring points to capture the additional footprint of the proposed project.

4.15.3.6.2 Groundwater

The uncertainty in the cause of rising EC and groundwater levels in some of the alluvium bores adjacent to the open cut mines has not been resolved. I am recommending on-going monitoring of the bores listed in Figure 12 as existing and proposed monitoring bores plus an additional, RN13020173.

The cumulative drawdown model has insufficient information on adjacent coal mines. I recommend further modelling incorporating the surrounding mines.

Until such time that the IESC advice has been taken and water resource models provide further confidence, I recommend that a conservative approach is taken in the planning of mitigation and management of potential impacts, and to include the significant impact offset management plan for the MNES matters.

4.15.3.6.3 GDEs

The EIS has not addressed the concerns raised by DAWE regarding the lack of ground-truthing GDEs in the proposed project area using direct techniques. I support DAWE’s request that further sampling of GDEs should be undertaken using direct techniques to validate the proponent’s statement that GDEs are not present in the proposed project area.

The AEIS indicated that there is no predicted drawdown in the alluvium along the riparian corridors. However, there is still uncertainty about whether riparian vegetation along watercourses draining the proposed project area may be influenced by drawdown, altered flooding regimes and/or reduced water quality. If the further field investigation indicates that riparian or other vegetation on alluvial sediments is perennially or intermittently groundwater-dependent, a GDE management plan should be developed which outlines suitable mitigation and monitoring strategies for this vegetation.

4.15.3.6.4 Stygofauna

Despite the presence of stygofauna in two of the bores, the EIS considered stygofauna to be of low environmental value in the proposed project area. As per DAWE’s submission, I recommend routine monitoring of stygofauna in bores RN13020177, EC11, EC13 and EC14 be continued.

4.15.3.6.5 Cumulative impacts

The EIS indicated that there will be no cumulative impacts on groundwater resources resulting due to the proposed project as the water intake will not alter from the existing Ensham Mine. During the IESC review of the proposed project, it was identified that the model used for the prediction of cumulative drawdown lacked inclusion of surrounding mines. Until the cumulative drawdown prediction includes the drawdown impacts from surrounding mines, the department cannot be certain that there are no cumulative drawdown impacts.

4.15.3.6.6 Subsidence

As discussed in the land section of this assessment report, without additional data collected using adequate methodologies and statistical analysis, I cannot properly assess the conclusions on subsidence levels. The subsidence monitoring to date lacks sensitivity in the methodology and hence further monitoring will be required. The monitoring would include reference sites located outside of the mining footprint; control sites within the mining footprint; sites where underground mining will be conducted in the future; and sites where underground mining has already commenced. As recommended by Resources, DAWE and the department, a methodology more sensitive than LiDAR is to be used for subsidence monitoring.

In the AEIS, the proponent suggested having 300mm subsidence as a trigger value for the monitoring of subsidence. However, in the absence of reliable site-specific data, I recommend using subsidence trigger value of 40mm as predicted in the EIS. The SMP should also include a map showing soil types overlaid with the locations of subsidence monitoring transects, including within laser levelled paddocks.

5 Recommendation on the suitability of the project

In completing my assessment of the EIS for the Ensham Life of Mine Extension Project, I have considered the EIS (comprising EIS and AEIS), submissions from stakeholders, the public, and advice from relevant state and commonwealth government agencies. I am satisfied that the proponent has met the statutory requirements of Chapter 3 of the EP Act for the EIS process.

The assessment acknowledges that the proposed project will likely result in impacts to the local environment during the life of the project. These impacts will need to be managed effectively in line with the conditions of an environmental authority to ensure the project supports a sustainable local and regional landscape.

I have considered the submitted material and concluded that the proposed project would significantly contribute to regional and Queensland economies, provide social and economic benefits and maintain opportunities for direct and flow-on employment and export trade for Queensland and Australia. Impacts to land, water, flora and fauna, air, noise, waste, cultural heritage, human rights, social, economic and transport were identified. Key impacts are summarised in Table 9**Error! Reference source not found.**.

Table 9. Key known and potential impacts of the proposed project

Matter	Key impacts
Land and waste	• Project area comprises of 2,737ha of underground mining and flare infrastructure • Post mining land use includes grazing and irrigation and cropping land • Potential impacts to irrigators from subsidence • Generation of overburden and tailings and rejects for disposal • Generation and disposal of mine affected water and sediment affected water • Generation and disposal of general waste in local government waste disposal facilities
Water	• Potential changes to surface water and groundwater quantity, quality and flows • Predicted permanent groundwater drawdown including in the adjacent alluvium • Potential impacts on fluvial geomorphology and river and floodplain hydrology from the final landform • Discharge of mine affected waters into the Nogoa River in the Fitzroy River catchment
Ecology	Significant impacts on MNES and MSES including threatened fauna and vegetation communities • MNES threatened ecological communities – Brigalow TEC • MNES listed threatened species – ornamental snake, squatter pigeon, greater glider, koala, Fitzroy turtle, snapping turtle, painted snipe • MSES protected wildlife habitat - ornamental snake, squatter pigeon, greater glider, koala, Fitzroy turtle, snapping turtle, painted snipe • MSES regulated vegetation – endangered and of concern, watercourse, wetland

Matter	Key impacts
	Potential impacts on riparian vegetation and groundwater dependent ecosystems adjacent to the proposed project footprint
Human rights	• The link between greenhouse gas emissions, and contribution of the project to climate change and the risk to human life. • Potential impacts on landholders located in close proximity to the proposed project • Potential impacts on land and cultural interests of traditional owners
Social and economic	• Contribution to the local, regional, state and national economies through royalties, taxes, charges and wages • Potential opportunities and flow-on effects for local businesses, regional development and investment • The value of the proposed project to the Queensland economy would be approximately $256 million NPV • Provide ongoing employment through utilisation of a similar workforce to the existing Ensham Mine • Employ approximately 603 FTE personnel from the existing Ensham Mine for the 16-year life of mine • Contribute to cumulative impacts on local housing demand in Emerald • Adverse dust and noise impacts to the surrounding landholders • Potential impacts on First Nation’s cultural heritage, to be managed under the existing Cultural Heritage Management Plan
Other impacts:	• Potential impacts on existing roads during the construction phase

I consider the measures proposed to avoid and minimise adverse environmental and social impacts were generally adequate and that the potential impacts to human rights identified in Appendix C have been adequately assessed and mitigated. I am satisfied that with the implementation of appropriate and effective avoidance, mitigation and management measures largely captured as commitments of the AEIS (amended commitments table Appendix D), potential impacts to environmental and social values can be minimised, consistent with State and Commonwealth legislation and policy.

The AEIS has addressed the TOR and provided sufficient detail for the assessment of the proposed project. However, additional, and ongoing actions would need to be undertaken in the planning, design, regulation and implementation of the proposed project to address minor data deficiencies and management measures. These recommended actions are summarised in Table 10.

Table 10. Recommended actions for the proposed project

Matter	Action
Water	
Surface water	• Collect further baseline data for two additional upstream monitoring points sufficient to provide local water quality data for deriving baseline surface water quality • Collect further EC and water quantity data for the model calibration • Investigate further, the link between upstream irrigation and the increase

	in EC levels in surface waters at the site
REMP	• Install two additional upstream surface water monitoring points • Monitor stream bed and banks to detect any impacts to fish passage and riparian ecosystems
Groundwater	• Incorporate the most up to date baseline data set into groundwater triggers and limits for the EA conditions • Include any additional bores constructed to collect baseline data into the existing monitoring network • Investigate the increasing EC and groundwater levels in the alluvium bores adjacent to the existing storage pits • Undertake a landholder bore census by 30 November 2021. If additional bores are identified, the predicted drawdown for those bores will need to be determined and any impacts be compensated • Investigate further ground-truthing of GDEs
Land	
Subsidence	• Implement a Subsidence Management Plan that must: o be revised annually with additional subsidence survey data o use an appropriately sensitive methodology for subsidence survey monitoring o include sufficient reference, control and impacted sites o include a map of soil survey types overlaid with locations of subsidence monitoring transects o undertake an investigation if subsidence above 40mm is detected o where an investigation determines the cause of the subsidence is mining activities, the EA holder must submit a report to the administering authority upon request • Enter into a Compensation Agreement with relevant parties for any subsidence impacts due to mining activities • Undertake restoration of waterways if a fish passage is impacted by subsidence caused by mining activities. Implement additional mitigation measures to reduce the risk of further impacts.
Soil survey	• Complete a soil survey and amend the soil type tables and mapping resulting from the soil survey by 11 December 2021
Geochemistry/waste	• Characterise the geochemistry of the waste rock/ and provide the results to the department upon request • Implement proactive management measures in the event contaminants are detected in the waste rock
Rehabilitation	
	• Implement commitments to: o provide updates on mine closure and rehabilitation plans to key stakeholders o rehabilitate zone 1 to grazing for the PML o amend the Ensham Mine PRC Plan and schedule if an EA is granted for the proposed project

	• Consider further subsidence monitoring as part of the Ensham Mine EA and ensure additional rehabilitation is considered for areas found to be impacted by subsidence
Air	
	• Include EA conditions on dust management for: o ambient dust monitoring o limits and monitoring requirements for dust levels o dust exceedance reporting o dust management plan o air quality complaint investigation procedures o site weather monitoring • Include EA conditions on flare management for: o flaring infrastructure design and performance o flare operation o odours • Include an EA condition requiring an emissions reduction management plan
Cultural heritage	
	Implement commitments for: • education and training to support First Nations peoples into jobs and business opportunities in the resources sector • employment of First Nations peoples in the resources sector • participation by First Nations owned and operated businesses in resources sector supply chains • the development and implementation of a protocol for unexpected archaeological finds • the provision of cultural heritage inductions for employees and contractors in accordance with the *Queensland Heritage Act 1992*
Hazards and safety	
	• Continue annual emergency training scenarios with the Queensland Ambulance Service

Despite the matters raised in this assessment and the information gaps identified, no issues, or unmitigated/ uncontrolled risks of sufficient magnitude have been identified that are contrary to Queensland government legislation or policy that would prevent the proposed project from proceeding. I am satisfied that the outstanding matters can be resolved by recommending conditions to be placed on subsequent approvals that would require the proponent to meet necessary levels of environmental and social performance and to take any recommended actions.

In determining the suitability of the proposed project, I considered all commitments made by the proponent in the AEIS including, but not limited to the amended commitments in Appendix D of this assessment report. A number of these commitments would be regulated through recommended conditions in an EA and other State, Commonwealth legislation and Australian Standards. If the proposed project proceeds, I expect all commitments made by the proponent to be delivered where they do not conflict with any subsequent regulatory approval conditions. As this is an extension to an existing mine, the AEIS also references conditioning under the current mine's EA. The effectiveness of this, in managing comparable impacts to date was considered in my assessment of the suitability of the proposed project.

Consequently, I have determined that the proposed project is suitable to proceed to obtaining all necessary approvals, including those required under the EP Act, as per Table 11.

6 Project approvals and recommended conditions

6.1 Environmental authority (EP Act)

Recommended environmental authority conditions have been tailored for the proposed project to regulate risks to environmental values and capture key commitments made by the proponent in the EIS. I consider the recommended conditions (Appendix A) are necessary to achieve the environmental objectives and desirable for the regulation of known and potential environmental impacts identified in this assessment. The recommended conditions are not complete or finalised until the outstanding matters identified by the assessment have been adequately addressed by the proponent.

6.2 Australian Government approval (EPBC Act)

The EIS provided an assessment of the likelihood of occurrence of MNES and significant impacts. These matters have been assessed in this report and recommendations have been made for the Commonwealth Minister for the Environment to consider when deciding about the action and any conditions that might be placed on such an approval (section 4.15).

6.3 Approvals

Other than approvals under the EP Act and the EPBC Act, the proposed project requires additional approvals as identified in Table 11. Where possible, advice and recommendations have been made concerning key matters regulated by these approvals. Specific conditions for these approvals would be developed during the application and assessment processes under the relevant legislation. There may be additional approval requirements not included in this table.

Table 11. Approvals required for the proposed Ensham Life of Mine Extension Project

Approval	Legislation (administering authority)	Detail
Key state approvals		
Granting of MLs	*Mineral Resources Act 1989* (Resources)	Resource tenure is sought in the form of one ML (MLA 700061) for minerals and infrastructure pursuant to the MR Act.
Environmental authority (mining activities) (EA)	*Environmental Protection Act 1994* (the department)	A granted site-specific EA for the proposed project would allow the proponent to mine under schedule 3 (mining black coal) of the Environmental Protection Regulation 2019 (EP Regulation). The EA would also cover the following

Approval	Legislation (administering authority)	Detail
		activities that are directly associated with, or facilitate or support, the mining activities, and which would otherwise require approval under the EP Act as 'prescribed ERAs', listed under schedule 2 of the EP Regulation: • ERA 8 (1)(a) – Chemical storage -storing more than 500m^3 of chemical class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c) • ERA 60 – Waste disposal - operating a facility for disposing of the waste mentioned in subsection (1)(a) (d) more than 200,000t in a year • ERA 63 (1)(b)(i) – Sewage Treatment – operating sewage treatment works, other than no-release works with a total daily peak design capacity of more than 100 but not more than 1500EP equivalent persons - if treated effluent is discharged from works to an infiltration trench or irrigation scheme
Commonwealth approvals		
Approval to undertake an action that may impact on MNES (Controlled Action)	*Environment Protection and Biodiversity Conservation Act 1999* (DAWE): • listed threatened species and communities (sections 18 & 18A) • a water resource, in relation to a large coal mining development or coal seam gas development (sections 24D & 24E)	The proposed project was referred on 6 May 2020 (EPBC 2020/8669) and on 29 June 2020, DAWE declared the proposed project a controlled action under the EPBC Act. This assessment report includes an assessment of impacts on MNES resulting from the proposed action. This assessment will be provided to the Commonwealth Environment Minister to inform decision-making about whether to approve the proposed action and any conditions that should be applied under part 9 of the EPBC Act. This assessment report also includes the department's recommended conditions of approval for the proposed project to manage and offset impacts to MNES (not addressed through State imposed conditions).
Indigenous heritage	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)*	Any requirements for the proponent to take actions under the Act will be determined during proposed project activities when the need arises. Where a discovery is made,

Approval	Legislation (administering authority)	Detail
		notification to the Commonwealth Department is required as soon as practical and is to include the location and description of the discovery.
Native Title	*Native Title Act 1993 (Commonwealth)*	The proponent may enter a future ancillary agreement with Native Title Parties. The ancillary agreement would include a Cultural Heritage Management Agreement (CHMA) which covers the protection and management of all Aboriginal Cultural Heritage in the CHMA area for the purposes of the proposed mining activities.
Greenhouse gas emissions, energy production and consumption reporting	*National Greenhouse and Energy Report Act 2007* National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015	A single national framework for the reporting of information relating to greenhouse gas emissions requires the submission of an annual report to the relevant Commonwealth Department recording GHG emissions, energy produced, and energy consumed.
Offsets (State and Commonwealth)		
Offset requirements for MNES and MSES	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999;* EPBC Act Environmental Offsets Policy 2012 (DAWE) - assessment of MNES Queensland *Environmental Offsets Act 2014 (EO Act)*, Environmental Offsets Regulation 2014, Queensland Environmental Offsets Policy 2021 (the department) - assessment of MSES	The state does not require offsets for the proposed project. It is noted however, that until groundwater numerical modelling is completed as advised by the IESC, MNES offsets maybe required. As such, it is recommended that a significant impact offset management plan for the MNES matters is developed and implemented.
Other State Approvals		
Cultural heritage management plan	*Aboriginal Cultural Heritage Act 2003 (DSDSATSIP)*	The proponent has a duty of care by which all reasonable and practicable measures must be implemented to ensure the activity does not harm Aboriginal cultural heritage.
Biosecurity management strategies, e.g. weeds and pests	*Biosecurity Act 2014* (DAF)	The proponent has an obligation to undertake all reasonable steps to ensure no spread of pest, disease or contaminants. There are seven categories of restricted matters listed under the Biosecurity Act. Each category

Approval	Legislation (administering authority)	Detail
		places restrictions on the biosecurity matter or requires actions to be taken to minimise the spread and adverse impact of the matter.
Obligations and approvals for hazards and safety	*Coal Mining Safety and Health Act 1999* (Resources)	The proponent is required to comply with the obligations and approvals of the Act to protect the health and safety of people at, or who may be impacted by, a coal mine and to monitor and ensure that the risk of injury or illness is at an acceptable level.
Species management program for tampering with animal breeding places	*Nature Conservation Act 1992* (the department)	If pre-clearing surveys indicate the presence of breeding places, then a species management program for tampering with a protected animal breeding place will be required.
Protected Plants permit	*Nature Conservation Act 1992 (*the department)	A clearing permit is required if the pre-clearing flora survey identifies protected plants in the impact area. A clearing permit is not required if impacts to protected plants can be avoided (i.e. there is no clearing to take place within 100m of the protected plants).
Land use planning and development assessments	*Planning Act 2016 (*DSDILGP)	If any activities are proposed off the proposed project's MLs, a development approval under *Planning Act 2016* may be required. No off tenement activities are currently proposed.
Assessment reporting of previously unrecorded sites of non–Indigenous cultural heritage significance	*Queensland Heritage Act 1992* (the department)	No areas have been identified on the project area which are listed on the Queensland Heritage Register. The proponent is required to notify the department in accordance with the Act's requirements if any non–Indigenous cultural heritage artefacts are found as soon as practical and must include location and description of discovery.
RIDA	*Regional Planning Interests Act 2014 (*DSDILGP)	The project area consists of SCL and PAA and will be assessed under the RPI Act.
Social impacts	*Strong and Sustainable Resource Communities Act 2017 (*DSDILGP)	The proposed project will be a 'large resource project', and therefore requires a social impact assessment. The CG has provided conditions to manage social impacts of large resource projects.
Operations to construct, maintain, operate	*Transport Infrastructure Act 1994* (DTMR)	The proposed project will involve works to construct, maintain, operate or conduct ancillary works and encroachment on the

Approval	**Legislation (administering authority)**	**Detail**
or conduct ancillary works		State road (Capricorn Highway/Duckponds Road).
Approval for transport of heavy loads by road	*Transport Operations (Road Use Management) Act 1995* (DTMR*)*	The proposed project may require transport of over dimensional loads. The proponent will be required to obtain the necessary permits for transport of over-dimension loads by road.
End of waste codes	*Waste Reduction and Recycling Act 2011* (the department)	End of waste codes have been made for associated water and irrigation of associated water. If the proponent identifies a suitable use for associated water, the relevant requirements of the Act and the end of waste code will be required to be implemented. Any future reuse opportunities identified for associated water would require an EA amendment for appropriate conditioning.
Clearing of vegetation	*Vegetation Management Act 1999* (Resources)	The clearing of native vegetation for the proposed project will be exempt from the provisions of the VM Act where clearing occurs within the proposed project's ML areas for a mining activity. Clearing of vegetation outside of the ML is not proposed.
Water licence – to take or interfere with water Water permit to take water (surface water or groundwater) for an activity with a reasonably foreseeable conclusion date Riverine protection permit – for the excavation or placement of fill in a watercourse (applies to non-tidal watercourses, lakes and springs)	*Water Act 2000* (DRDMW) Water Plan (Fitzroy Basin) 2011	The proponent does not propose to take surface water or groundwater, other than associated water (groundwater inflows into the pit area) which is allowable without a licence under the Water Act. The environmental impacts of the take of associated water will be assessed as part of the EA application. Chapter 3 of the Water Act, which regulates the take of underground water, will apply to proposed project activities. The proponent will be required to prepare underground water impact reports (UWIRs), conduct baseline assessments and enter make good agreements with owners of affected bores.

7 Approved by

Chris Loveday	9 November 2021
Signature	**Date**

Christopher Loveday
Director, Technical and Assessment Services
Department of Environment and Science
Delegate of the chief executive
Environmental Protection Act 1994

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Appendix A - Recommended conditions for an environmental authority (resource activity)

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Recommended conditions of an environmental authority

The environmentally relevant activities for the project must be conducted in accordance with the following site-specific conditions of approval. This environmental authority consists of the following Schedules and Appendices:

Schedule A	General
Schedule B	Air
Schedule C	Water
Schedule D	Dams and Levees
Schedule E	Noise
Schedule F	Waste
Schedule G	Land
Schedule H	Rehabilitation
Appendix 1	Environmental Authority Water Monitoring Points
Appendix 2	Groundwater Monitoring Network
Appendix 3	Rehabilitation Success Criteria
Appendix 4	Overall Site Layout Indicative Domain Plan
Appendix 5	2km Floodplain Widening

Schedule A: General	
Condition number	**Condition**
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	Conditions of this environmental authority continue to apply in the event that this environmental authority is suspended.
A3	Unless otherwise authorised by this environmental authority, contaminants must not be released to the receiving environment.
A4	**Prevent and /or minimise likelihood of environmental harm** In carrying out the environmentally relevant activities, you must take all reasonable and practicable measures to prevent and/or minimise the likelihood of environmental harm being caused.
A5	**Scope of activity** This environmental authority authorises the mining of **twelve (12) million tonnes** of run of mine (ROM) coal per annum.
A6	**Maintenance of measures, plant and equipment** The environmental authority holder must: (a) install, maintain and operate, in a proper manner, all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; and (b) ensure all instruments and devices used on site for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
A7	**Monitoring and records** Except where specified otherwise in another condition of this environmental authority, all monitoring records and reports required by this environmental authority must be kept for a period of not less than **five (5) years**.
A8	Monitoring and determinations required under any condition of this environmental authority must be conducted by an appropriately qualified person(s).

A9	**Management Plans and Reports** Unless otherwise specified in another condition of this environmental authority all management plans, reports, programs and documents required under any condition of this environmental authority must be developed by an appropriately qualified person.
A10	Copies of monitoring results, records, registers, management plans, reports, programs, documents and spatial information required by the conditions of this environmental authority must be made available to the administering authority for inspection, or if requested provided to the administering authority within **fourteen (14) days** or otherwise agreed timeframe.
A11	Within **thirty (30) days** of receiving comments from the administering authority for a management plan, report or document required under any condition of this environmental authority, the environmental authority holder must amend the management plan, report or document to address the comment(s) and any recommendations.
A12	**Notification of emergencies, incidents and exceedances** The environmental authority holder must notify the administering authority in writing within **twenty-four (24) hours** after becoming aware of any emergency or incident that results in the release of contaminants not in accordance, or reasonably expected not to be in accordance with the conditions of this environmental authority.
A13	Within **fourteen (14) days** following a notification in accordance with condition **A12,** further written advice must be provided to the administering authority, including the following: (a) results and interpretation of any samples taken and analysed; (b) outcomes of any actions taken at the time to prevent or minimise unlawful environmental harm; and (c) proposed actions to prevent a recurrence of the emergency or incident.
A14	All monitoring results related to the notified emergency or incident must be provided to the administering authority within **four (4) weeks** after they are received by the environmental authority holder.
A15	**Complaints** The environmental authority holder must record in a register all complaints received about the mining activities.

A16	The register required by condition **A15** must include: (a) complainant details: (i) name; (ii) address; (iii) contact number; and (b) time and date of complaint; (c) the complainant's observations (statement, photo and/ or video); (d) reasons for the complaint; (e) investigations undertaken by the holder; (f) conclusions formed by the holder; (g) actions taken to resolve the complaint by the holder; (h) any abatement measures implemented by the holder; and (i) the person responsible for resolving the complaint.
A17	When requested by the administering authority, the environmental authority holder must investigate any complaint that is neither frivolous nor vexatious in the opinion of the administering authority, of nuisance or environmental harm, by: (a) undertaking monitoring in the timeframes specified by the administering authority; (b) completing an analysis and interpretation of the monitoring results; and (c) identifying any relevant abatement measures.
A18	The results of the investigation undertaken in accordance with condition **A17** must be reported to the administering authority within **thirty (30) days** of completion of the monitoring undertaken under condition **A17(a)**, or an alternative timeframe agreed to by the administering authority.
A19	If the investigation undertaken in accordance with condition **A17** indicates environmental harm has been or is likely to be caused, the environmental authority holder must: (a) address any complaint including the use of dispute resolution if appropriate; and (b) immediately implement abatement measures to prevent environmental harm.

A20	**Definitions** Words and phrases used throughout this environmental authority are defined in the Definitions section of this environmental authority. Where a definition for a term used in this environmental authority is sought and the term is not defined within this environmental authority, the definitions in the *Environmental Protection Act 1994*, its Regulations and Environmental Protection Policies are to be used.

Schedule B: Air	
Condition number	**Condition**
B1	**Dust nuisance** The release of dust or particulate matter or both, as a result of the mining activity must not cause environmental nuisance at any sensitive or commercial place.
B2	When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the administering authority), dust and particulate monitoring must be undertaken by the environmental authority holder.
B3	The release of dust or particulate matter or both, as a result of the mining activity must not cause exceedances of the following levels when measured at any sensitive or commercial place: i. Dust deposition of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 *Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter – Gravimetric method*. ii. A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, monitored in accordance with the most recent version of either: a. Australian Standard AS3580.9.6 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} high volume sampler with size-selective inlet – Gravimetric method*; or b. Australian Standard AS3580.9.9 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} low volume sampler—Gravimetric method*; or c. Australian Standard AS3580.9.11 *Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM_{10} beta attenuation monitors*. iii. A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres ($PM_{2.5}$) suspended in the atmosphere of 25 micrograms per cubic metre over a

	24-hour averaging time, when monitored in accordance with the most recent version either of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM (sub)2.5(/sub) low volume sampler—Gravimetric method or AS/NZS3580.9.12 (2013): Determination of suspended particulate matter – PM2.5 beta attenuation monitors. iv. A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a one (1) year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air- Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method.
B4	If the monitoring indicates an exceedance of the relevant limits in **Condition B3**, then an investigation must be undertaken to determine whether the exceedance is due to emissions from the activity. If the authorised mining activities are found to be the cause of the exceedance, then dust abatement measures must be implemented as soon as reasonably practicable so that emissions of dust from the mining activities do not result in further environmental nuisance. Where monitoring indicates that the air quality objectives detailed in B3 have been exceeded, the holder of this environmental authority must investigate the matter and report to the administering authority within 14 days of receipt of monitoring results: (a) the concentration of TSP, PM10 particulates or dust deposition rate recorded; (b) a description of meteorological conditions occurring at the time; (c) the measures taken to reduce dust generated by the mining activities; and (d) address the complaint including the use of dispute resolution if appropriate.
B5	**Odour** The release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.
B6	When requested by the administering authority, odour monitoring must be undertaken, within the timeframe nominated or agreed to by the administering authority, to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the administering authority) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
B7	If the monitoring indicates environmental harm has occurred, the environmental authority holder must: (a) address the complaint including the use of dispute resolution if appropriate; and (b) immediately implement odour abatement measures to prevent further complaints and environmental harm.

B8	**Flaring** Flares must not be installed within 100 m of a watercourse.
B9	Gas flares must be designed, installed and operated to meet the following: (a) the flare tip must be equipped to provide good mixing with air, flame stability and achieve a minimum methane destruction efficiency of ≥98% under varied gas flow rate and meteorological conditions. (b) the flare must be equipped with a continuously burning pilot or other automatic ignition system that assures gas ignition and provides immediate notification to appropriate personnel when the ignition system ceases to function. (c) the flare must be able to handle large fluctuations in both the volume and the chemical content of gases. (d) visible emissions must not be permitted for more than five minutes in any two-hour period.
B10	**Weather monitoring** The environmental authority holder must install and maintain an automatic meteorological station at the premises to continuously measure and record wind speed, wind direction, temperature, relative humidity, solar radiation, pressure and rainfall intensity. The monitoring locations must comply with the Australian Standard AS/NZS 3580.14:2014- Methods for sampling and analysis of ambient air Meteorological monitoring for ambient air quality monitoring applications.
B11	**Greenhouse gas emissions reduction management plan** A Greenhouse gas emission reduction management plan must be developed by an appropriately qualified person and implemented for the life of the project. The plan must include the following: (a) details of the intended objectives, measures and performance standards to avoid, minimise and control emissions (b) a process for regularly reviewing new technologies to identify opportunities to further reduce emissions and energy use, consistent with best practice environmental management (c) any voluntary initiatives or research into reducing the lifecycle and embodied energy of the project’s processes or products (d) annual energy audits with a view to progressively improving energy efficiency, including monitoring, auditing and reporting on GHG emissions from all relevant activities and the success of abatement and offsetting measures.
Schedule C: Water	
Condition number	**Condition**

C1	**Contaminant Release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the mining activities, except as permitted under the conditions of this environmental authority.
C2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table C1 – Mine affected water release points, sources and receiving waters** and **Appendix 1** attached to this environmental authority.

Table C1 – Mine affected water release points, sources and receiving waters

Release Point (RP)	Easting (GDA94)	Northing (GDA94)	Mine Affected Water Source and Location	Monitoring Point	Receiving Waters description
RP 1	653731	7401335	Ramp 24 Fill Point Dam, Ramp ¾ Drain, A, B, C, D, E, F and Y Pits	End of pipe	Nogoa River
RP3	651680	7400608	Ramp 24 Fill Point Dam, Ramp ¾ Drain, A, B, C, D, E, F and Y Pits	End of pipe	Nogoa River

C3	The release of mine affected water to internal water management infrastructure is permitted so long as the infrastructure is installed and operated in accordance with the water management plan required by condition **C31**.
C4	The release of mine affected water to waters in accordance with condition **C2** must not exceed the release limits for each quality characteristic stated in **Table C2 – Mine Affected Water Release Limits** when measured at the monitoring point specified in **Table C1 – Mine affected water release points, sources and receiving waters**.

Table C2 – Mine Affected Water Release Limits

Quality Characteristic	Release Limits	Monitoring Frequency
Electrical conductivity (µS/cm)	12,500 (end of pipe)	Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits. Daily grab samples if telemetry not available. The first sample must be taken as soon as practicable and within **two (2) hours** following the commencement of release.
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	
Sulfate (SO_4^{2-}) (mg/L)	1,000	Commencement of release and thereafter weekly during release. The first sample must be taken as soon as practicable and within **two (2) hours** following the commencement of release.
Turbidity (NTU)	360	Daily during release (the first sample must be taken within **two (2) hours** of commencement of release).

C5	The release of mine affected water to waters from the release points must be monitored at the monitoring points specified in **Table C1 – Mine affected water release points, sources and receiving waters** and **Appendix 1** for each quality characteristic and at the monitoring frequency specified in **Table C2 – Mine Affected Water Release Limits** and **Table C3 – Release contaminant trigger investigation levels**. *NOTE: The administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition **C4** is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table C3 – Release contaminant trigger investigation levels

Quality Characteristic	Trigger Levels[1] (μg/L)	Monitoring Frequency
Aluminium	300	The first sample must be taken as soon as practicable and within **two (2) hours** following commencement of release and thereafter weekly during release.
Ammonia	900	
Arsenic	13	
Boron	370	
Cadmium	0.2	
Chromium	1.0	
Cobalt	90	
Copper	10	
Fluoride (total)	2000	
Iron	300	
Lead	4	
Manganese	1900	
Mercury	0.2	
Molybdenum	34	
Nickel	11	
Nitrate	1100	
Selenium	10	
Silver	1	
Sodium	TBA	
Petroleum hydrocarbons (C6-C9)	20	
Petroleum hydrocarbons (C10-C36)	100	
Uranium	20	

Vanadium	20	
Zinc	20	

NOTE:

1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.

C6	If any trigger levels specified in **Table C3 – Release contaminant trigger investigation levels** are exceeded for any quality characteristic during a release, the environmental authority holder must compare results of the downstream monitoring points (MP5 **Table C5 – Receiving water upstream background sites and downstream monitoring points**) to the trigger levels specified in **Table C3 – Release contaminant trigger investigation levels** and: (a) where the trigger levels are not exceeded, no further action is to be taken; or (b) where the results of the downstream monitoring points outlined in **Table C5 – Receiving water upstream background sites and downstream monitoring points** exceed the trigger levels specified in **Table C3 – Release contaminant trigger investigation levels for any quality characteristic**, compare the results of the downstream monitoring points (MP5, **Table C5 – Receiving water upstream background sites and downstream monitoring points**) to the background monitoring data and: (i) if the result is less than or equal to the background monitoring site data, then no further action needs to be taken; or (ii) if the result is greater than the background monitoring site (MP2, **Table C5 – Receiving water upstream background sites and downstream monitoring points**) data recorded during the release, complete an investigation into the potential for environmental harm and provide a written report to the administering authority within **ninety (90) days**, outlining: (1) details of the investigation carried out; and (2) actions taken to prevent environmental harm. *NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with condition **C6 (b) (ii)** of this condition, no further reporting is required for subsequent trigger level exceedances for that release.*
C7	If an exceedance in accordance with condition **C6 (b) (ii)** is identified, the environmental authority holder must notify the administering authority in writing within **twenty-four (24) hours** of receiving the result.

C8	**Mine Affected Water Release Events** The environmental authority holder must ensure a stream flow gauging station/s is installed, operated and maintained that records stream flows at the locations and flow recording frequency specified in **Table C4 – Contaminant Release during Flow Events**.

Table C4 – Contaminant Release during Flow Events

Locations					**Receiving water flow recording frequency**	**Receiving water flow criteria for discharge (m^3/s)**	**Electrical conductivity and Sulfate release limits (µs/cm)**
Receiving waters	**Release point (RP)**	**Gauging Station**	**Gauging Station Easting (GDA94)**	**Gauging Station Northing (GDA94)**			
Nogoa River	RP1 RP3	"GS2" DNRME Gauging Station 130219A Nogoa River at Duck Ponds.	650482	7402403	Continuous real time	>30	**Electrical conductivity (µS/cm):** ≤12,500 **Sulfate (SO_4^{2-}) (mg/L)**: ≤1,000

C9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition **C2** must only take place during periods of natural flow events, and in accordance with the receiving water flow criteria for discharge specified in **Table C4 – Contaminant Release during Flow Events** for the release point(s) specified in **Table C1 – Mine affected water release points, sources and receiving waters**.
C10	The environmental authority holder is prohibited from releasing mine affected water into releases made from Fairbairn Dam for entitlement holders or environmental flows in accordance with the *Water Act 2000*, *Water Regulation 2002*, *Water Resource (Fitzroy Basin) Plan 2011* or *Fitzroy Basin Resource Operations Plan*.
C11	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring point in **Table C1 – Mine affected water release points, sources and receiving waters**.
C12	Releases to waters must not cause erosion of the bed and banks of the receiving waters or cause a material build-up of sediment in such waters.

C13	Electrical conductivity (EC) at MP5 must not exceed **850µS/cm** at any time during the release influence period.
C14	If EC at MP6 exceeds **650µS/cm** during a release event, the environmental authority holder must immediately notify the administering authority and only continue to release mine affected water if the administering authority gives approval.
C15	**Notification of Release Event** The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than **twenty-four (24) hours** after commencing a release of mine affected water to the receiving environment. Notification must include the following information: (a) release commencement date/time; (b) details regarding the compliance of the release with the conditions of Schedule C: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume etc.); (c) release point/s; (d) release rate; (e) release volume (estimated); (f) release salinity; and (g) details of the receiving water/s including the natural flow rate.
C16	The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than **twenty-four (24) hours** after cessation of a release event notified under condition **C15**. The release cessation notification must include the following information: (a) release cessation date and time; (b) details of the receiving water/s including the natural flow rate; and (c) volume of water released. *NOTE: Successive or intermittent releases occurring within **twenty-four (24) hours** of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions **C15**, **C16** and **C17**, provided the relevant details of the release are included within the notification provided in accordance with conditions **C15**, **C16** and **C17**.*

C17	Within **twenty-eight (28) days** of notification under condition **C16**, the environmental authority holder must provide the administrating authority the following information via WaTERS: (a) confirmation of: (i) the release commencement date and time; (ii) the release cessation date and time; (iii) details of the receiving water/s including the natural flow rate; (iv) volume of water released; (b) all in-situ and laboratory water quality monitoring results; (c) details regarding the compliance of the release with the conditions of Schedule C: Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume); (d) whether the release resulted in any impacts to the receiving environment; and (e) any other matter(s) pertinent to the water release event.
C18	**Notification of Release Event Exceedance** If the release limits defined in **Table C2 – Mine Affected Water Release Limits** are exceeded, the environmental authority holder must notify the administering authority via WaTERS within **twenty-four (24) hours** of receiving the results.
C19	The environmental authority holder must, within **twenty-eight (28) days** of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority via WaTERS detailing: (a) the reason for the release; (b) the location of the release; (c) the total volume of the release and which (if any) part of this volume was non-compliant; (d) the total duration of the release and which (if any) part of this period was non-compliant; (e) all water quality monitoring results (including all laboratory analyses); (f) identification of any environmental harm as a result of the non-compliance; (g) all calculations; and (h) any other matters pertinent to the water release event.

C20	**Release notification – potentially affected stakeholder** The environmental authority holder must notify all potentially affected stakeholders within **two (2) hours** of the commencement, or another timeframe as agreed to in writing with the relevant potentially affected stakeholder, of releasing mine affected water to the receiving environment. Notification must be in the form agreed to by the potentially affected stakeholder or at least include the following: (a) release commencement date/time; (b) release location (release point/s); (c) release rate; (d) receiving waters for the release; (e) receiving water flow rate; (f) water quality of the release including salinity and pH; and (g) estimated duration of the release.
C21	**Receiving environment monitoring and contaminant trigger levels** The quality of the receiving waters must be monitored at the monitoring points specified in **Table C5 – Receiving water upstream background sites and downstream monitoring points** for each quality characteristic and at the monitoring frequency stated in **Table C6 – Receiving water contaminant trigger levels**.

Table C5 – Receiving water upstream background sites and downstream monitoring points

Monitoring Points	Receiving Waters Location Description	Easting (GDA94)	Northing (GDA94)
Upstream background monitoring point			
ENMP07	Bridge Flats	636009	7408032
ENMP01	Nogoa River upstream of mine at western boundary of ML 70365	TBA*	TBA*
MP2	Nogoa River at Duckponds (130219A flow monitoring station)	650482	7402403
Downstream monitoring points			
MP5	Nogoa River at Ensham Lease Boundary	654688	7400679
MP6	Mackenzie River at Riley’s Crossing (130113A)	663861	7395396

Notes: *To be provided in the EA amendment application

C22

If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels for pH, suspended solids or Sulfate specified in **Table C6 – Receiving water contaminant trigger levels** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and:

(a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no further action needs to be taken; or

(b) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority via WaTERS by **1 March** each year, outlining:

  (i) details of the investigations carried out; and

  (ii) actions taken to prevent environmental harm.

NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with condition ***C22 (b)*** *of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*

Table C6 – Receiving water contaminant trigger levels

Quality Characteristic	Contaminant Trigger Levels	Monitoring Frequency	Comments
Electrical conductivity (µS/cm)	Cease Release: >850 (MP5) Approval Trigger 650 (MP6)	Real time telemetry. Daily grab samples if telemetry not available (the first sample must be taken as soon as practicable).	Grab samples shall be taken only when safe to do so and access permits. Refer to condition **C13** and **C14**.
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)		
Suspended solids (mg/L)	1,000	Grab samples at commencement and weekly thereafter.	
Sulfate (SO_4^{2-}) (mg/L)	250		

C23

Receiving Environment Monitoring Program (REMP)

The environmental authority holder must maintain and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows as a result of the mining activities. The REMP must provide for monitoring of the receiving environment periodically (under natural flow conditions) and while mine affected water is being released.

C24	For the purposes of the REMP, the only receiving environment is the waters of the Nogoa River, downstream of Ensham Coal Mine to Riley's Crossing of the Mackenzie River and downstream of the Comet River junction (the area of the REMP). The REMP must encompass any sensitive receiving waters or environmental values within the area of the REMP that will potentially be directly affected by an authorised release of mine affected water.
C25	The REMP must: (a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality); (b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected; (c) include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release (as a minimum, the locations specified in **Table C5 – Receiving water upstream background sites and downstream monitoring points**); (d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site-specific background reference values in accordance with the Queensland Water Quality Guidelines 2006. This should include monitoring during periods of natural flow irrespective of mine or other discharges; (e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in **Table C2 – Mine Affected Water Release Limits** and **Table C3 – Release contaminant trigger investigation levels**; (f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZG 2018, BATLEY and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments); (g) include, where appropriate, monitoring of macroinvertebrates in accordance with the Australian River Assessment System (AusRivas) methodology; (h) apply procedures and/or guidelines from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) and other relevant guideline documents; (i) describe sampling and analysis methods and quality assurance and control; (j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data; (k) include monitoring for and management of barriers to fish passage; and (l) include monitoring and management of riparian vegetation.

C26	A report on the REMP must be prepared annually and made available on request to the administering authority. The report must include all monitoring results, an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and analysis on the suitability of current release limits to protect downstream environmental values.
C27	**Water reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of: (a) supplying stock water only where there is compliance with the release limits specified in **Table C7 – Stock Water Release Limits**; or (b) supplying irrigation water only where there is compliance with the release limits specified in **Table C8 – Irrigation Release Limits**.

Table C7 – Stock Water Release Limits

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	5000

Table C8 – Irrigation Release Limits

Quality Characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	Site-specific value determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines

C28	Mine affected water may be piped, trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, for the purpose of supplying water to any operation licensed for either ERA13 (mining black coal) or ERA31 (mineral processing). The volume, pH and electrical conductivity of water transferred must be monitored and recorded.

C29	If mine affected water is given or transferred to another person in accordance with conditions **C27** or **C28**, the transfer must be in accordance with a written agreement (the third-party agreement) that: (a) includes a commitment from the transferee to use it in such a way so as to prevent environmental harm or public health incidents; (b) reflects the General Environmental Duty (GED) under section 319 of the *Environmental Protection Act 1994*, environmental sustainability of the water disposal and protection of environmental values of waters; and (c) is signed by both parties to the agreement.
C30	**Annual water monitoring reporting** The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority via WaTERS in the specified format by **1 March** each year: (a) the date on which the sample was taken; (b) the time at which the sample was taken; (c) the location or monitoring point at which the sample was taken; (d) the measured or estimated daily quantity of the contaminants released from all release points; (e) the release flow rate at the time of sampling for each release point; (f) the results of all monitoring and details of any exceedances with the conditions of this environmental authority; and (g) water quality monitoring data where required by the environmental authority (release, receiving environment, REMP, water storages, sewage treatment plants and groundwater) must be provided to the administering authority in the specified electronic format via WaTERS.
C31	**Water Management Plan** A Water Management Plan must be developed by an appropriately qualified person and implemented at all times that mining activities are being carried out.
C32	The release of any contaminants as permitted by this environmental authority, directly or indirectly to waters, other than in accordance with condition **C31** must not result in any: (a) visible discolouration of receiving waters; and (b) slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.

C33	**Saline and acid rock drainage** The environmental authority holder must ensure proper and effective measures are taken to avoid, or otherwise minimise, the generation and/or release of: (a) saline drainage; (b) acid rock drainage.
C34	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
C35	Stormwater, other than mine affected water, is permitted to be released to waters from: (a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition **C34**; and (b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan and that complies with condition **C31**, for the purpose of ensuring water does not become mine affected water.
C36	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.
C37	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.
C38	**Sewage effluent** Sewage effluent used for dust suppression or irrigation must not exceed the release limits in **Table C9 – Sewage effluent quality standards**.

Table C9 – Sewage effluent quality standards

Quality	Release limit	Units	Limit type	Monitoring frequency
5 Day BOD	20	mg/L	max	On release
pH	6 - 8		range	On release
Free Chlorine residuals	1.0	mg/L	max	On release
Faecal coliforms (based on the average of a minimum of 5 samples)	1,000	Colonies per 100ml	max	On release

C39 **Groundwater**

Mining activities (including rehabilitation activities) must not adversely impact the groundwater receiving environment unless otherwise authorised under this environmental authority.

C40 Groundwater must be monitored quarterly at all monitoring points specified in **Table C10 – Quarterly groundwater monitoring requirements and location**.

C41 Groundwater drawdown fluctuations of greater than 2m from the standing water levels specified in **Table C10 – Quarterly groundwater monitoring requirements and location** not resulting from the pumping of licensed bores, must be notified to the administering authority via WaTERS within **twenty eight (28) days** following detection of drawdown.

C42 The environmental authority holder must notify the administering authority within **twenty-four (24) hours** via WaTERS of receiving any monitoring result that shows an exceedance of any limit for any quality characteristic specified in **Table C11 – Groundwater quality limits**.

For condition **C42**, an exceedance is when a limit for any quality characteristic specified in **Table C11 – Groundwater quality limits** is exceeded on any **three (3)** consecutive sampling occasions.

C43	Within **fourteen (14) days** of the notification given under condition **C41** or **C42**, the environmental authority holder must commence an investigation to determine if the exceedance is a result of: (a) the mining activities including rehabilitation activities; (b) seasonal / natural variation; (c) neighbouring land use resulting in groundwater impacts; (d) any other potential cause of exceedance; or (e) an investigation is only required if the mining affected drawdown fluctuations reported in C41 are outside of modelled values; (f) any combination of (a) to (d) the above.
C44	The investigation required by condition **C43** must be completed and submitted to the administering authority via WaTERS within **three (3) months** of notification under condition **C41** or **C42.**
C45	If the investigation under condition **C43** determines that the exceedance was a result of the mining activities, including rehabilitation, in accordance with condition **C43(a)** or a combination that includes condition **C43(a)** then a further investigation must be undertaken by the environmental authority holder to establish whether environmental harm has occurred, and the extent thereof.
C46	Within **one (1) month** of the investigation under **C45**, the environmental authority holder must have: (a) implemented short-term measures to mitigate the potential for environmental harm; (b) developed long-term mitigation measures to address any existing groundwater contamination; and (c) if environmental harm has occurred as a result of groundwater drawdown exceedances, the environmental authority holder must: (i) determine any actions required to reduce the potential for environmental harm; and (ii) determine any mitigation measures required to limit the drawdown in the affected groundwater resource.

C47	**Groundwater Management and Monitoring Program** A Groundwater Management and Monitoring Program must be developed and implemented at all times mining activities, including rehabilitation, are being carried out to meet the following requirements: (a) identifies all potential sources of contamination to groundwater from mining activities and rehabilitated areas; (b) provides a hydrogeological conceptual groundwater model that details the interactions and direction of flow between the Permian coal measures, the Triassic Rewan Group, the Quaternary alluvial aquifers and the Nogoa River system including its tributaries within a 5km radius of the residual voids; (c) identifies all environmental values (including the Nogoa River) that must be protected; (d) details groundwater levels in all identified aquifers present across and adjacent to the site to confirm existing groundwater flow paths; (e) estimates the groundwater inflow to any rehabilitated landforms and surface water ingress to groundwater from flooding events in the form of a groundwater model; (f) details a water balance model; (g) ensures all potential adverse groundwater impacts due to mining and rehabilitation activities are identified, monitored and mitigated; (h) ensures groundwater monitoring and data analysis is undertaken to: (i) detect any impacts to groundwater levels due to mining and rehabilitation activities; (ii) detect any impacts to groundwater quality due to mining and rehabilitation activities; (iii) determine compliance with condition **C39**; and (iv) determine trends in groundwater quality; (i) provides an appropriate quality assurance and quality control program; (j) documents groundwater management and monitoring methodologies undertaken for the duration of all mining activities and rehabilitation activities; and (k) includes a review process to identify improvements to the program that includes addressing any comments provided by the administering authority.

C48	The Groundwater Management and Monitoring Program required by condition **C47** must be updated by **30 November 2023** to incorporate data collected from the Residual Void monitoring bores as detailed in **Table C10 – Quarterly groundwater monitoring requirements and locations**. The update must: (a) include limits calculated in accordance with the Guideline: Using monitoring data to assess groundwater quality and potential environmental impacts; (b) be based on a statistically robust dataset; and (c) include a minimum of 18 samples taken over **twenty-four (24) months**.
C49	The Groundwater Management and Monitoring Program required by condition **C47** must be reviewed at least every **two (2) years** by an appropriately qualified person to determine if it continues to meet the requirements stated in condition **C47.**
C50	The following information must be recorded in relation to all groundwater water sampling: (a) the date on which the sample was taken; (b) the time at which the sample was taken; (c) the monitoring point at which the sample was taken; and (d) the results of all monitoring.

Table C10 – Quarterly groundwater monitoring requirements and locations

Location Description	Monitoring Bore	Monitoring Required	Easting	Northing	Aquifer Type	Standing Water Levels (mAHD)
			GDA94			
Nogoa River Alluvium	EC01	Water level and quality	650018	7403059	Alluvium	143.63
	EC03	Water level and quality	650338	7402547		143.18
	EC07	Water level and quality	650973	7401746		141.39
	EC09A	Water level and quality	651354	7401504		140.33
	EC11	Water level and quality	651517	7401192		139.54
	EC13	Water level and quality	651517	7400776		138.95
	EC14	Water level and quality	651676	7400653		138.76
	GW01	Water level and quality	653934	7400423		139.50
	RN13020166	Water level and quality	635532	7407076		TBD#
	RB07A (RN165935)	Water level and quality	647738	7407169		TBD#
	RN13020169	Water level	648435	7406991		TBD#
	RN13020173	Water level and quality	645968	7404080		TBD#
Project Area	RB07B	Water level	647737	7407177	Alluvium, Rewan Group and Rangal Coal	TBC#

					Measures.	
Residual Void Bores*	WSMB2S- Down gradient of Pit A South	Water level and quality	649062	7397630	TBD[#]	TBD[#]
	WSMB2D- Down gradient of Pit A South	Water level and quality	649059	7397630	TBD[#]	TBD[#]
	WSMB3S- Down gradient of Pit A South	Water level and quality	647826	7396413	TBD[#]	TBD[#]
	WSMB3D- Down gradient of Pit A South	Water level and quality	647826	7396410	TBD[#]	TBD[#]
	P2- Down gradient of Pit B	Water level and quality	-23.51530 (Easting TBC)[#]	148.49249 (Northing TBC)[#]	Alluvium	TBD[#]
	P3- Located between Pit D and the Nogoa River	Water level and quality	-23.45638 (Easting TBC)[#]	148.46698 (Northing TBC)[#]	Alluvium	TBD[#]
	P4- Located between Pit C and the Nogoa River	Water level and quality	-23.49248 (Easting TBC)[#]	148.51735 (Northing TBC)[#]	Alluvium	TBD
	P5 (GW02) - Located down gradient of Pit C and Pit D, adjacent to Nogoa River	Water level and quality	-23.48097 (Easting TBC)[#]	148.47860 (Northing TBC)[#]	Alluvium	TBD[#]
	P6 - Down gradient of Pit Y between Pit and RB2	Water level and quality	-23.39889 (Easting TBC)[#]	148.49623 (Northing TBC)[#]	Permian	TBD[#]
Regional Bores	Fairhills (RN89380)	Water level	658696	7416877	Burngrove Formation	213.75

(Private Property)	Yongala (RN89383)	Water level	657586	7415693	Burngrove Formation	213.47
	Karanga (Bore A)	Water level	649043	7388304	Coal Measures	133.15
	Winton Creek (Bore 4)	Water level	642771	7400758	Rewan Formation	137.76
	Twin Bore (Bore 5)	Water level	641319	7401567	Alluvium	153.25
	Jamar Bore (Bore 7)	Water level	642025	7399084	Rewan Formation	115.02
	Railway (RN90140)	Water level	663591	7412470	Fairhills Formation	162.61
Regional Bores (Ensham Mine)	RB01	Water level and quality	650018	7412835	Coal seams	146.24
	RB02	Water level and quality	647787	7410365		135.29
	RB03	Water level and quality	645503	7402324		136.42
	RB04	Water level and quality	642784	7398932		136.06
	RB05	Water level and quality	646209	7395311		137.21
	RB06	Water level and quality	648836	7392168		139.44
	Bore 4 Monitoring the predicted extent of the drawdown in the coal seam. Bore located within 5m predicted drawdown	Water level and quality	638970.1	7405677	Rangal Coal Measures (Coal)	TBC#

*Locations to be updated in accordance with the update of the Groundwater Monitoring and Management Plan required by **30 November 2023** in accordance with condition **C48**.

#To be provided in the EA amendment application

Table C11 – Groundwater quality limits

Location	Quality Characteristic	pH	EC	Sulfate	Iron	Arsenic	Aluminium	Molybdenum	Selenium	*TRH C6-C9	*TRH C10-C36	Major ions
	Trigger level type	Range	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Interpretation Only
	Unit	pH units	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(µg/L)	N/A
EC01		6.5-8.5^A	20,000^D	650^D	0.7^C	0.013^C	0.055^C	0.034 ^{C}	0.005 ^{C}	≤20	≤100	Bicarbonate, sodium, carbonate, calcium, chloride, potassium, magnesium.
EC03			20,000^D	650^D	1^D	0.013^C						
EC07			30,100^D	826^B	3.5^D	0.024^B						
EC09A			20,000^D	650^D	0.7^C	0.013^C						
EC11			20,000^D	650^D	20.7^B	0.013^C						
EC13			20,800^D	650^D	3^D	0.013^C						
EC14			1,621^B	27^B	1.4^B	0.013^C						
GW01			6,426^B	328^B	0.7^C	0.013^C						
RB1			3818^B	25^A	0.7^C	0.013^C						
RB2			11626^B	25^A	0.7^C	0.013^C						
RB3			10600^B	25^A	0.7^C	0.013^C						
RB4			8070^B	25^A	0.7^C	0.013^C						
RB5			7450^B	25^A	0.7^C	0.013^C						

RB6		7730^{B}	157^{B}	1.3^{B}	0.013^{C}						
WSMB2S, WSMB2D, WSMB3S, WSMB3D, P2, P3, P4, P5, P6.		1,606^{B,E}	27^{B,E}	0.7^{C,E}	0.013^{C,E}						
RN13020166	6.5-8.5^{A}	2509^{F}	125^{F}	0.7^{C}	0.013^{C}						
RN13020169		15495 ^{G}	387^{G}	0.7^{C}	0.013^{C}						
RB07A (RN165935)		15495^{G}	387^{G}	0.7^{C}	0.013^{C}						
RN13020173		15495 ^{G}	387^{G}	0.7 ^{C}	0.013^{C}						
Bore 4		7720^{H}	362^{H}	0.7^{C}	0.013^{C}						

***Notes:** All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Limits for metal/metalloids apply if dissolved results exceed value.*

** Total Recoverable Hydrocarbons (TRH)*

A – Lower Nogoa River Water Quality Objectives

B – Site-specific 95%ile

C – Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)

D – Other Trigger Levels

*E – Indicative quality limits, to be updated in accordance with the update of the Groundwater Monitoring and Management Plan required by **30 November 2023** in accordance with condition **C48***

F -- Fitzroy groundwater quality objectives, zone 13 shallow groundwater chemistry zone.,

G -- Fitzroy groundwater quality objectives, zone 43 shallow groundwater chemistry zone.,

H -- Fitzroy groundwater quality objectives, zone 43 deep groundwater chemistry zone.

C51	The environmental authority holder must provide an equivalent (in quality and quantity), alternative water supply to the owner of the privately owned bore/s in **Table C10 – Groundwater monitoring locations and frequency**, where adverse impacts are caused by the mining activities.
C52	**Groundwater Management and Monitoring Program Report** The environmental authority holder must: (a) complete a Groundwater Management and Monitoring Program Report every two years which outlines how the program meets the requirements specified in condition **C47**; (b) submit the Groundwater Management and Monitoring Program Report to the administering authority via WaTERS by **1 March of 2024**, and subsequently every second year thereafter; and (c) submit all groundwater monitoring data from January to December of the previous calendar year to the administering authority via WaTERS by **1 March** of each calendar year.
C53	The Groundwater Management and Monitoring Program Report required by condition **C52** must include: (a) the standing water level of all groundwater bores within **Table C10 – Quarterly groundwater monitoring requirements and** location; (b) an assessment of long-term water quality and water level trends at all groundwater bores in **Table C11 – Quarterly groundwater monitoring requirements and location**; (c) maps showing the actual water level drawdown contours caused by the take of associated water for each groundwater aquifer; (d) details of any review undertaken of the numerical groundwater model and conceptual model; (e) an assessment of any differences between the groundwater level impact predicted and actual impacts for corresponding periods in the most current numerical groundwater model; (f) details of any bores which are predicted by the most current numerical groundwater model to be located within the depressurisation zone; and (g) an investigation into any interconnection and direction of flow between the alluvial aquifer and the Permian coal measures, including any recharge.
C54	**Residual Voids Groundwater Monitoring Bore Investigation** The environmental authority holder must complete an investigation which: (a) determines any groundwater aquifers which could be impacted by mining activities and the rehabilitation activities specified in **Appendix 3**; (b) proposes a network of groundwater bores to detect changes, impacts and long term threats on groundwater aquifers potentially affected by the mining activities and the rehabilitation activities specified in **Appendix 3**; and (c) at a minimum, includes the residual void bores at the locations in **Table C10 – Quarterly groundwater monitoring requirements and location**.

C55	A report documenting the outcomes of the investigation required by **condition C54** must be provided to the administering authority via WaTERS by **26 February 2021** and must include at a minimum: (a) the location of the proposed groundwater bores to detect potential impacts from the mining and rehabilitation activities; (b) the target groundwater aquifer for each of the proposed groundwater bores; (c) the conceptual model used to determine the location of groundwater bores; (d) the methodology used to determine an appropriate number of groundwater bores to be installed; (e) a schedule for the construction and commissioning of the groundwater bores; (f) how impacts to prescribed environmental matters will be avoided as a result of the disturbance associated with the installation of the proposed bores; and (g) standing water level for each of the groundwater bores.
C56	The following residual voids must act as groundwater sinks to the receiving groundwater environment into perpetuity: (a) A Central pit; (b) A North pit; (c) B pit; (d) C pit; and (e) D pit.
C57	Should any monitoring or modelling required under this environmental authority show that any of the Groundwater Daylighting Water Areas specified in condition **C56** and **Appendix 3** do not act as groundwater sinks, or are likely to not act as groundwater sinks, then the environmental authority holder must: (a) undertake an investigation to determine the necessary actions to ensure that no contamination of groundwater aquifers occurs; (b) provide the investigation report to the administering authority and reach agreement with the administering authority on the corrective actions; and (c) implement the agreed corrective actions.
C58	**Bore construction, maintenance and decommissioning** The construction, maintenance, management and decommissioning of groundwater bores (including groundwater monitoring bores) identified in the Groundwater Management and Monitoring Program Report must be undertaken in a manner that prevents or minimises impacts to the receiving environment and ensures the integrity of the bores to obtain accurate monitoring.

Schedule D: Dams and Levee	
Condition number	**Condition**
D1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933) at the following times: (a) prior to the design and construction of the structure, if it is not an existing structure; or (b) prior to any change in its purpose or the nature of its stored contents.
D2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
D3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933).
D4	Design and construction[1] of a regulated structure (conditions **D5** to **D9** inclusive) do not apply to existing structures. *Note:[1] Construction of a dam includes modification of an existing dam – refer to the definitions.*
D5	All regulated structures must be designed by, and constructed[2] under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933). *Note:[2] Certification of design and construction may be undertaken by different persons.*
D6	Construction of a regulated structure is prohibited unless the holder has submitted a consequence category assessment report and certification to the administering authority which has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this authority.
D7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933), and must be recorded in the Regulated Dams/Levees register.

D8	Regulated structures must: (a) be designed and constructed in accordance with and conform to the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933); (b) be designed and constructed to ensure the design is not compromised by: (i) floodwaters entering the regulated dam from any watercourse or drainage line; and (ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line. (c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
D9	Certification by the suitably qualified and experienced person who supervises the construction of a register must be submitted to the administering authority on the completion of construction of the regulated structure, and certify that: (a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; (b) construction of the regulated structure is in accordance with the design plan.
D10	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless: (a) the holder has submitted to the administering authority: (i) an electronic copy of the design plan and certification of the ‘design plan’ in accordance with condition **D6**, and (ii) the ‘as constructed’ drawings and specifications certified in accordance with condition **D9**, and (iii) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan. (iv) the requirements of this authority relating to the construction of the regulated structure have been met; (v) the environmental authority holder has entered the details required under this authority, into a register of regulated structures; and (vi) there is a current operational plan for the regulated structures.

D11	For existing structures that are regulated structures: (a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within **twelve (12) months** of the commencement of this condition a copy of the certified system design plan including that structure; and (b) there must be a current operational plan in place.
D12	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
D13	**Mandatory reporting level** Conditions **D14** to **D17** inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
D14	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
D15	The environmental authority holder must, as soon as practical and within **forty-eight (48) hours** of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
D16	The environmental authority holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised release from the regulated dam.
D17	The environmental authority holder must record any changes to the MRL in the Register of Regulated Structures.
D18	**Design storage allowance** The environmental authority holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to **1 July** of each year.
D19	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
D20	The environmental authority holder must, as soon as practicable and within **forty-eight (48) hours** of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, notify the administering authority.

D21	The environmental authority holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised release from the regulated dam or linked containment systems.
D22	**Annual inspection report** Each regulated structure must be inspected **each calendar year** by a suitably qualified and experienced person.
D23	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.
D24	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933).
D25	The environmental authority holder must: (a) within **twenty (20) business days** of receipt of the annual inspection report, provide to the administering authority: (i) the recommendations section of the annual inspection report; and (ii) if applicable, any actions being taken in response to those recommendations; and (b) if, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the environmental authority holder, provide this to the administering authority within **ten (10) business days** of receipt of the request.
D26	**Transfer arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
D27	**Register of regulated structures** A Register of Regulated Structures must be established and maintained by the environmental authority holder for each regulated dam.
D28	The environmental authority holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.

D29	The environmental authority holder must enter the required information in the Register of Regulated Structures once compliance with conditions **D10** and **D11** has been achieved.
D30	The environmental authority holder must ensure that the information contained in the Register of Regulated Structures is current and complete.
D31	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the environmental authority holder, or their delegate, as being accurate and correct.
D32	The environmental authority holder must, by **1 March** each year, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the format required by the administering authority.
D33	**Transitional arrangements** All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance with the Manual within **six (6) months** of amendment of the authority adopting this schedule.
D34	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in **Table D34 – Transitional hydraulic performance requirements for existing structures**, depending on the consequence category for each existing structure assessed in the most recent certification for that structure.

Table D34 – Transitional hydraulic performance requirements for existing structures

Transition period required for existing structures to achieve the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Dams			
Compliance with criteria	**High**	**Significant**	**Low**
>90% and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70% - ≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 20 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50-≤70%	Within 5 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50%	Within 5 years or as per Compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing)	Review consequence assessment every 5 years.

D35 **Table D34 – Transitional hydraulic performance requirements for existing structures** ceases to apply for a structure once any of the following events has occurred:

it has been brought into compliance with the hydraulic performance criteria applicable to the

(a) structure under the Manual; or

(b) it has been decommissioned; or

(c) it has been certified as no longer being assessed as a regulated structure.

D36 Certification of the transitional assessment required by conditions **D33** and **D34** (as applicable) must be provided to the administering authority within **six (6) months** of amendment of the authority adopting this schedule.

D37	**Flood Protection Levees** Design requirements for the levee and adjacent mining excavation must meet the following: (a) the design level of the levee crest must be at least **one (1) metre** above the estimated 1 in 1,000 ARI flood event for the adjacent watercourses; and (b) mining excavation slopes adjacent to the levee must remain stable and are to be designed with a factor of safety of one point five (1.5) (calculated from the levee toe) or above based on an accepted stability analysis.
D38	Design requirements for the levee and adjacent mining excavation must: (a) not result in increased erosion of the bank or bed of the Nogoa River; (b) not significantly impact upon riparian or existing remnant vegetation; and (c) not erode during any flood events up to any 1 in 1,000 ARI event.
D39	As part of the authorised rehabilitation activities required by Schedule H: Rehabilitation and Appendix 3, the flood protection levee must be optimised to widen the floodplain from 1.4km to 2km between the northern section of B Pit and the southern section of C Pit as detailed in **Appendix 4**. The design and construction of the flood protection landform alignment must ensure the requirements of condition **D38** are maintained and are supported by relevant hydrology, geomorphology, landform, geotechnical and risk management assessment studies.

Schedule E: Acoustic	
Condition number	**Condition**
E1	**Noise nuisance** Noise from mining activities must not cause an environmental nuisance at any sensitive receptor or commercial place.
E2	Noise from mining activities must not exceed the levels for the time periods specified in **Table E2 – Noise limits** at any sensitive or commercial place.

Table E2 – Noise limits

Noise Level dB(A)	7am – 6pm	6pm – 10pm	10pm – 7am
	Noise measured at a 'Noise sensitive place'		
$L_{\text{A 10, adj, 10 mins}}$	B/g + 5	B/g + 5	B/g + 3
$L_{\text{A 1, adj, 10 mins}}$	N/A	N/A	B/g + 8
	Noise measured at a 'Commercial place'		
$L_{\text{A 10, adj, 10 mins}}$	B/g + 10	B/g + 10	B/g + 5

Notes:

B/g = background noise level ($L_{\text{A90, adj, 15 mins}}$) measured over 3-5 days at the nearest sensitive receptor

E3	**Noise monitoring** When requested by the administering authority, noise monitoring must be undertaken to investigate any compliant of noise nuisance, and the results notified within **fourteen (14) days** to the administering authority. Monitoring must include: (a) $L_{\text{A 10, adj, 10 mins}}$ (b) $L_{\text{A 1, adj, 10 mins}}$ (c) the level and frequency of occurrence of impulsive or tonal noise; (d) atmospheric conditions including wind speed and direction; (e) effects due to extraneous factors such as traffic noise; and (f) location date and time of recording.
E4	Noise is not considered to be a nuisance under condition **E1** if monitoring shows that noise does not exceed the levels in the time periods specified in **Table E2 – Noise limits**.
E5	The method of measurement and reporting of noise monitoring must comply with the current edition of the administering authority's Noise Measurement Manual (ESR/2016/2195).

E6	If monitoring indicates exceedance of the limits in **Table E2 – Noise limits**, the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; and (b) immediately implement noise abatement measures so that emissions of noise from the mining activities does not result in further environmental nuisance.
E7	**Vibration nuisance** Vibration from the licensed activities must not cause an environmental nuisance at any sensitive or commercial place.
E8	When requested by the administering authority, vibration monitoring must be undertaken within the timeframe nominated or agreed to by the administering authority, to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the administering authority) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
E9	If the environmental authority holder can provide monitoring that the limits in **Table E9 – Vibration limits** are not being exceeded, the environmental authority holder is not in breach of condition **E7.** Monitoring must include: (a) location of the blast(s) within the mining area (including which bench level); and (b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and (c) location, date and time of recording.

Table E9 – Vibration limits

Location	Vibration measured
Sensitive or commercial place	**5 mm/s** peak particle velocity for **nine (9) out of ten (10) consecutive blasts** and not greater than **10 mm/s** peak particle velocity at any time

E10	If monitoring indicates exceedance of the limits in **Table E9 – Vibration limits** then the environmental authority holder must: (a) address the complaint including the use of dispute resolution if appropriate; and (b) immediately implement vibration abatement measures so that vibration from the activity does not result in further environmental nuisance.
E11	**Airblast overpressure nuisance** The airblast overpressure level from blasting operations on the premises must not exceed the limits defined in **Table E11 – Airblast overpressure level** at any sensitive or commercial place.

Table E11 – Airblast overpressure level

Location	**Airblast Overpressure Measured**
Sensitive or commercial place	Air blast overpressure level of **115db** (Linear peak) for **nine (9) out of ten (10) consecutive blasts** initiated and not greater than **120db** (Linear peak) at any time.

E12	When requested by the administering authority, airblast overpressure monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the administering authority) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
E13	Airblast overpressure monitoring must include the following descriptors, characteristics and conditions: (a) location of the blast(s) within the mining area (including which bench level); (b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and (c) location, date and time of recording.
E14	If monitoring indicates exceedance of the limits in **Table E11**, then the environmental authority holder must: (a) address the complaint including the use of dispute resolution if appropriate; and (b) immediately implement airblast overpressure abatement measures so that airblast overpressure from the activity does not result in further environmental nuisance.
E15	The method of measurement and reporting of airblast overpressure levels must comply with the current edition of the administering authority’s Noise Measurement Manual (ESR/2016/2195).

Schedule F: Waste	
Condition number	**Condition**
F1	**Storage of tyres** Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste-to-energy options must be stored in stable stacks and at least **ten (10) metres** from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
F2	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a **ten (10) metres** radius of the scrap tyre storage area.
F3	Disposing of scrap tyres resulting from the mining activities is not permitted in spoil emplacements unless tyres are placed as deep in the spoil as reasonably practicable.
F4	A record must be kept of the number and location for tyres disposed.
F5	Scrap tyres resulting from the mining activities disposed of within the site must not impede saturated aquifers or compromise the stability of the consolidated landform.

F6	**Waste Management** A Waste Management Plan must be implemented that: (a) describes how the Ensham mine recognises and applies the waste management hierarchy; (b) characterises wastes generated from the project and identifies general volume trends over the past **five (5) years**; (c) contains a program for safe recycling or disposal of all wastes - reusing and recycling where possible; (d) contains waste commitments with auditable targets to reduce, reuse and recycle; (e) has waste management control strategies which addresses: (i) the type of wastes; (ii) segregation of the wastes; (iii) storage of the wastes; (iv) transport of the wastes; (v) monitoring and reporting matters concerning the wastes; (vi) emergency response planning; (vii) disposal, reused and recycling options; (f) identifies the potential adverse and beneficial impacts of the wastes generated; (g) details the hazardous characteristics of the waste generated (if any); (h) contains a disposal procedure for hazardous wastes; (i) outlines the process to be implemented to allow for continuous improvement of the waste management systems; (j) identifies responsible staff (positions) for implementing, managing and reporting the Waste Management Plan; and (k) contains a staff awareness and induction program that encourages re-use and recycling.
F7	Waste must not be burned or allowed to be burned on the licensed site unless by written approval of the administering authority.
F8	A designated area must be set aside for the segregation of economically viable, recyclable solid and liquid waste.

F9	Records must be kept for **five (5) years**, and must include the following information: (a) date of pickup of waste; (b) description of waste; (c) cross reference to relevant waste transport documentation; (d) quantity of waste; (e) origin of the waste; (f) destination of the waste; and (g) intended fate of the waste, for example, type of waste treatment, reprocessing or disposal. *NOTE: Records of documents maintained in compliance with a waste tracking system established under the Environmental Protection Act 1994 or any other law for regulated waste will be deemed to satisfy this condition.*
F10	Records of trade and regulated wastes or material leaving the mining lease for recycling or disposal, including the final destination and method of treatment, must be in accordance with the *Environmental Protection Act 1994.*
F11	The environmental authority holder must ensure that all regulated waste received at and removed from the site must be transported by a person who holds a current authority to transport such waste under the provisions of the *Environmental Protection Act 1994*.
F12	Except as otherwise provided by the conditions of this authority, all waste removed from the site must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the *Environmental Protection Act 1994*.

Schedule G: Land	
Condition number	**Condition**
G1	**Preventing contaminant release to land** Contaminants must not be released to land in a manner which constitutes nuisance, material or serious environmental harm.
G2	**Bord and pillar – factors of safety** The environmental authority holder will determine relevant pillar and roadway dimensions to ensure that the following factors of safety are achieved: a) 2.11 for bord and pillar workings beneath the Nogoa River anabranch; b) 2.11 for access roadways beneath the Nogoa River to connect the bord and pillar and longwall mining areas; and c) 1.6 for all other bord and pillar workings beneath the floodplain of the Nogoa River.
G3	Operational management protocols must be implemented to ensure that minimum pillar and roadway dimensions are calculated to achieve condition **G2** during the life of the bord and pillar operation.

G4	**Mine Waste** A Mine Waste Management Plan must be developed by an appropriately qualified person for every stage of the mining activities. The Mining Waste Management Plan must at a minimum include: (a) characterisation programs to ensure that all mining waste is progressively characterised during disposal for net acid producing potential, salinity and the following parameters: pH, Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), Net Acid Generation (NAG) (reporting NAG capacity and NAG pH after oxidation), Total Sulfur (S), Chromium Reducible Sulfur (Scr), Boron (B) Cadmium (Cd), Iron (Fe), Aluminium (Al), Copper (Cu), Magnesium (Mg), Manganese (Mn), Calcium (Ca), Sodium (Na), Zinc (Zn) and Sulfate (SO_4); (b) individual parameters in a) above can be removed following sufficient mine waste characterisation to demonstrate that certain individual parameters are not present in sufficient quantities to warrant further characterisation; (c) characterisation programs to ensure that the physical properties of the mining waste is progressively characterised during disposal; (d) the availability or leachability of metals from the mining waste; (e) quantification of PAF from mining waste present; (f) review impacts of the PAF mining waste on the rehabilitation; (g) management actions for mining waste that has been identified as having a high availability or leachability of metals; (h) management actions for mining waste that has been defined as PAF; (i) identification of environmental impacts and potential environmental impacts; (j) control measures for routine operations to minimise likelihood of environmental harm; (k) contingency plans and emergency procedures for non-routine situations; and (l) periodic review of environmental performance and continual improvement.
G5	The Mine Waste Management Plan required by **Condition G4** must be implemented for all stages of the mining activity.

G6	A subsidence monitoring and management plan must be developed by an appropriately qualified person for every stage of the mining activities**.** The subsidence monitoring and management plan must at a minimum include: a) subsidence modelling prior to mining; b) rehabilitation methodology; c) land management practices pre and post mining to ensure achievement of authorised post mining land use; d) monitoring program that specifies location, frequency and type; e) Include map of soil survey types overlaid with locations of subsidence monitoring transects; f) investigation to be undertaken if subsidence monitoring detects changes in excess of modelled subsidence (interim of 40mm). Identification of environmental impacts and potential environmental impacts; g) control measures for routine operations to minimise likelihood of environmental harm; h) contingency plans and emergency procedures for non-routine situations; and i) periodic review of environmental performance and continual improvement.
G7	The subsidence management and monitoring plan required by Condition G6 must be implemented for all stages of the mining activity.
G8	**Storage and handling of chemicals and flammable or combustible liquids** All chemicals and flammable or combustible liquids must be stored and handled in accordance with the most recent version of an Australian Standard where such is applicable. Where no relevant Australian Standard exists, storage of such materials must be within an effective on-site containment system.
G9	**Exploration** Disturbance due to exploration activities in areas not authorised to be mined must be rehabilitated in accordance with provisions detailed in the *Eligibility criteria and standard conditions for exploration and mineral development projects* or its successor.

Schedule H: Rehabilitation	
Condition number	**Condition**
H1	**Rehabilitation – Surface** All surface areas significantly disturbed by mining activities must be rehabilitated in accordance with **Schedule H: Rehabilitation** and **Appendix 3** of this environmental authority.
H2	**Residual voids** Residual voids must not cause any serious environmental harm to land, surface waters or any regional groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself unless otherwise permitted by any other condition within this environmental authority.
H3	**Rehabilitation Management Plan** A Rehabilitation Management Plan must: (a) be developed for all significant disturbance associated with mining activities; (b) implemented for the duration of mining activities; and (c) be implemented by a suitably qualified person.

H4	The Rehabilitation Management Plan required by condition **H3**, must address all relevant requirements within this environmental authority, and at a minimum include: (a) details of how all land significantly disturbed by the mining activities will be rehabilitated to ensure that it is; (i) safe for humans and wildlife; (ii) non-polluting (iii) stable; and (iv) able to sustain an agreed post mining land use, unless specified as having no use in **Appendix 3** (Domain 5: Groundwater Daylighting Water Areas and Domain 6: Highwalls); and (b) details of how all land significantly disturbed by mining activities that will not have a land use will be managed to prevent environmental harm into the foreseeable future; (c) an indicative plan of each domain area identified in Appendix 3. (d) a map of existing areas of rehabilitation including classification of stage (i.e. time since establishment) and quality; (e) a strategy for progressive rehabilitation, including a progressive rehabilitation schedule; (f) details of the design objectives for rehabilitation of each domain to achieve rehabilitation success criteria as specified in **Appendix 3**; (g) specify the spoil characteristics, soil analysis and soil separation for use on rehabilitation; (h) specify the topsoil requirements for the site and how topsoil will be managed for use in rehabilitation; (i) details of any topsoil deficit and how any deficit will be managed for successful rehabilitation; (j) details of a balance material and how any topsoil deficit will be managed for successful rehabilitation; balance includes – rock, topsoil, gypsum, lime and all other ameliorates. (k) details of landform design including end of mine design; (l) details of how landform design will be consistent with surrounding topography; (m) identification of planned native vegetation rehabilitation areas and corridors; (n) a description of rehabilitation indicators and how these will be monitored; (o) a description of management actions to address unsuccessful rehabilitation or redesign; and (p) a description of end of mine landform design planning and post mining land uses across the mine.
H5	Land significantly disturbed by mining activities must be progressively rehabilitated in accordance with the Rehabilitation Management Plan required by condition **H3**.

H6	Rehabilitation activities must comply with the Rehabilitation Management Plan required by condition **H3**.
H7	**Rehabilitation Monitoring** The environmental authority holder must implement an annual rehabilitation monitoring program that details the outcomes of the previous year's rehabilitation activities in an annual rehabilitation report and submit it to the administering authority by **1 March** each year.
H8	Annual rehabilitation reports must: (a) be developed by a suitably qualified person; (b) include the rehabilitation monitoring results; (c) include any actions and recommendation to rectify or improve, areas of rehabilitation that are of concern; and (d) be consistent with the Rehabilitation Management Plan requirements specified by condition **H3**.
H9	**Flood Protection Landform Design** The design of the flood protection landform must be supported by relevant hydrology, geomorphology, landform, geotechnical and risk management assessment studies of the Nogoa River Floodplain, and must: (a) incorporate the pre-mining hydrologic characteristics of surface water and groundwater systems for the area in which the floodplain is located; (b) incorporate the pre-mining hydraulic characteristics of the flood plain for the area for which it is located in without using artificial structures that require on-going maintenance; (c) maintain sediment transport and water quality regimes that allow the floodplain to be self-sustaining, which prevents any impacts to upstream and downstream water quality, geomorphology and vegetation; (d) maintain equilibrium and functionality in all substrate conditions at the location of the floodplain; and (e) allow the free and safe passage of fauna, both aquatic and terrestrial, upstream and downstream. For the purposes of this environmental authority the Flood Protection Landform does not need to be decommissioned or rehabilitated as per condition **D12**.
H10	A certified design plan and any technical reports that consider the requirements of condition **H9**, and that will meet the requirements of **Appendix 3** for the flood protection landforms must be submitted to the administering authority at least **ninety (90) days** before commencing construction of the flood protection landforms.

H11	After **ninety (90) days** following the submission of documents in accordance with condition **H10**, the environmental authority holder may commence construction of the flood protection landforms. Construction may commence prior with the written agreement from the administering authority.
H12	**Retainment of Infrastructure** Infrastructure, constructed by or for the environmental authority holder during the licensed activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining landowner / holder.
H13	Condition **H12** does not apply where the landowner or landholder is also the environmental authority holder.
H14	Where the landowner or landholder is also the environmental authority holder, the administering authority must give its consent to the retainment of infrastructure, constructed by or for the environmental authority holder as a result of the authorised mining activities.
H15	**Post Closure Management Plan** A Post Closure Management Plan for the site must be prepared at least **eighteen (18) months** prior to the final coal processing on site and implemented for a nominal period of: (a) at least **thirty (30) years** following final coal processing on site; or (b) a shorter period if the site is proven to be geotechnically and geochemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants from the site will result in environmental harm.

Definitions

Key terms and/or phrases bolded in this environmental authority are defined in this section. Where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

“acceptance criteria” means the measures by which actions implemented are deemed to be complete. The acceptance criteria indicate the success of the decommissioning and rehabilitation outcomes or remediation of areas which have been significantly disturbed by the environmentally relevant activities. Acceptance criteria may include information regarding:

(a) stability of final landforms in terms of settlement, erosion, weathering, pondage and drainage;

(b) control of geochemical and contaminant transport processes;

(c) quality of runoff waters and potential impact on receiving environment;

(d) vegetation establishment, survival and succession;

(e) vegetation productivity, sustained growth and structure development;

(f) fauna colonisation and habitat development;

(g) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;

(h) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;

(i) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;

(j) resilience of vegetation to disease, insect attack, drought, and fire; and

(k) vegetation water use and effects on ground water levels and catchment yields.

“accepted engineering standards” in relation to dams, means those standards of design, construction, operation and maintenance that are broadly accepted within the profession of engineering as being good practice for the purpose and application being considered. In the case of dams, the most relevant documents would be publications of the Australian National Committee on Large Dams (ANCOLD), guidelines published by Queensland government departments, and relevant Australian and New Zealand Standards.

“acid rock drainage” means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

“administering authority” means the Department of Environment and Science or its successor.

“affected person” is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

“airblast overpressure” means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dB).

“ambient (or total) noise” at a place, means the level of noise at the place from all sources (near and far), measured as the Leq for an appropriate time interval.

"annual exceedance probability" or **"AEP"** means the probability that at least one event in excess of a particular magnitude will occur in any given year.

"annual inspection report" means a **report** prepared by a **suitably qualified and experienced person** that **assessed** the most recent consequence assessment report and design plan (or system design plan):

(a) against recommendations contained in previous annual inspections reports;

(b) against recognised dam safety deficiency indicators;

(c) for changes in circumstances potentially leading to a change in consequence category;

(d) for conformance with the conditions of this authority;

(e) for conformance with the 'as constructed' drawings;

(f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the **dam** (or network of linked containment systems);

(g) for conformance with the current operational plan.

"ANZECC irrigation guidelines" means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality published by the Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)

"ANZG" means the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018*.

"appropriately qualified person" means a person who has professional qualifications and experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis relative to the subject matter using the relevant protocols, standards, methods or literature.

"assessed" or **"assessment"** by a **suitably qualified and experienced person** in relation to a hazard assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

(a) exactly what has been assessed and the precise nature of that assessment;

(b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

(c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

(d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

"associated works" in relation to a dam, means:

(a) construction, installation or operations of any kind for that dam; and

(b) any land used for the associated works.

"authority" means environmental authority (mining activities) under the *Environmental Protection Act 1994*.

“bed and banks” for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

“beneficial use” in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that:

(a) has value to the owner’s business or to the general community;
(b) is in accordance with relevant provisions of the *Environmental Protection Act 1994;*
(c) is the subject of a written undertaking or agreement given by that owner to maintain that dam; and
(d) the transfer and use have been approved or authorised under any relevant legislation.

“blasting” means the use of explosive materials to fracture-

(a) rock, coal and other minerals for later recovery; or

(b) structural components or other items to facilitate removal from a site or for reuse.

“certification” means **assessment** must be undertaken by a **suitably qualified and experienced person** in relation to any **assessment** or documentation required by the **manual**, including design plans, ‘as constructed’ drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

“certifying, **certify or certified”** have a corresponding meaning as ‘certification’.

“chemical” means –

(a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth); or

(b) a dangerous good under the dangerous goods code; or

(c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulations 1997*; or

(d) a drug or poison in the *Standard for the Uniform Scheduling of Medicines and Poisons* prepared by the Australian Health Ministers’ Advisory Council and published by the Commonwealth; or

(e) any substance used as, or intended for use as –

  (i) a pesticide, insecticide, fungicide, herbicide, rodenticide, nematicide, miticide, fumigant or related product; or

  (ii) a surface active agent, including, for example, soap or related detergent; or

  (iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or

  (iv) a fertiliser for agricultural, horticultural or garden use; or

(f) a substance used for, or intended for use for –

  (i) mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

  (ii) manufacture of plastic or synthetic rubber.

“commercial place” means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity or employee accommodation; and excludes public roads.

“competent person” means a person with the demonstrated skill and knowledge required to carry out the relevant task to a standard necessary for the reliance upon collected data or protection of the environment.

“consecutive sampling occasion” means consecutive sequential **sampling occasions** regardless of frequency

“consequence category” means the category of dame, either low, significant or high, following the consequence assessment. into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

“consequence” in relation to a structure means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances

“construction” or "constructed" in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purposes of preparing a design plan.

“contaminant” A contaminant can be –

(a) a gas, liquid or solid; or

(b) an odour; or

(c) an organism (whether alive or dead), including a virus; or

(d) energy, including noise, heat, radioactivity and electromagnetic radiation; or

(e) a combination of contaminants.

“contaminated” means **a** substance has come into contact with a contaminant.

“dam crest volume” means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

“dam” means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and **associated works**.

“design plan” is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

“design storage allowance or DSA” means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an **annual exceedance probability** (AEP) specified in that Manual.

“designer” for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

“document” has the same meaning in the *Acts Interpretation Act 1954.*

“effluent” treated waste water discharged from sewage treatment plants.

“emergency action plan” means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions, procedures and actions to be followed in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact.

“end of pipe” means the location at which water is released to waters or land.

“environmental authority holder” means the holder of this environmental authority.

“environmental authority” means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

“environmental harm” has the meaning in section 14 of the *Environmental Protection Act 1994*.

“environmental nuisance” has the meaning in section 15 of the *Environmental Protection Act 1994*.

“environmentally relevant activity” means an environmentally relevant activity as defined under Section 18 of the *Environmental Protection Act 1994* and listed under Schedule 3 of the *Environmental Protection Regulation* 2019*.*

“existing structure” means a structure that was in existence prior to the adoption of this schedule of conditions under the authority.

“extreme storm storage” means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* published by the administering authority.

“flood protection landform” means an area of land that:

(a) when compared to current conditions does not materially increase afflux upstream, or velocity downstream beyond the boundary of Lot 32 Plan RP908643 and Lot 31 Plan CP864573;

(b) is not a regulated structure under the Manual; and

(c) is safe, stable, non-polluting, and is able to sustain an agreed post-mining land use.

“flowable substance” means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquid, fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

“foreseeable future” is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

“groundwater receiving environment” means any part of the regional groundwater, including any part of the alluvium aquifer, exclusive of groundwater contained within the residual voids.

“GDA94” means the Geocentric Datum of Australia 1994.

“**hazardous waste”** means any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that may endanger health, or impair or destroy life.

“holder” means:

(a) where this document is an environmental authority, any person who is the holder of, or is acting under, that environmental authority; or

(b) where this document is a development approval, any person who is the registered operator for that development approval.

“hydraulic performance” means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*.

“infrastructure” means water storage dams, roads and tracks, buildings and other structures built for the purpose and duration of the conduct of the environmentally relevant activities, but does not include other facilities required for the long term management of the impact of those activities or the protection of potential resources. Such other facilities include dams other than water storage dams, waste dumps, voids, or stockpiles and assets, that have been decommissioned, rehabilitated, and lawfully recognised as being subject to subsequent transfer with ownership of the land.

“$L_{A\ 1,\ adj,\ 10\ mins}$” means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response.

“$L_{A\ 10,\ adj,\ 10\ mins}$” means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

“$L_{A,\ max\ adj,\ T}$” means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

“lake” includes –

(a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and

(b) the bed and banks and any other element confining or containing the water.

“land capability” as defined in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995).

“land suitability” as defined in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995).

“land use” term to describe the selected post mining use of the land, which is identified to occur after the cessation of mining operations.

“levee” means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of **water** or **flowable substances** at any other times.

"low consequence dam" means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933).*

"mandatory reporting level or MRL" means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* published by the administering authority.

"manual" means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* published by the administering authority.

"mg/L" means milligrams per litre.

"mine affected water"

(a) means the following types of water:
  (i) pit water, tailings dam water, processing plant water;
  (ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2019* if it had not formed part of the mining activity;
  (iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
  (iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
  (v) groundwater from the mine's dewatering activities;
  (vi) a mix of mine affected water (under any of paragraphs i)-v)) and other water.

(b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:
  (i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success; or
  (ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:
    (1) areas that have been capped and have monitoring data demonstrating hazardous material is adequately contained on site;
    (2) evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff; or both.

"mineral" means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes—

(a) clay if mined for use for its ceramic properties, kaolin and bentonite;

(b) foundry sand;

(c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from;

(d) limestone if mined for use for its chemical properties;

(e) marble;

(f) mineral oil or gas extracted or produced from shale or coal by in situ processes;

(g) peat;

(h) salt including brine;

(i) shale from which mineral oil may be extracted or produced;

(j) silica, including silica sand, if mined for use for its chemical properties;

(k) rock mined in block or slab form for building or monumental purposes;

but does not include—

(a) living matter;

(b) petroleum within the meaning of the *Petroleum Act 1923*;

(c) soil, sand, gravel or rock (other than rock mined in block or slab form for building purposes) to be used or to be supplied for use as such, whether intact or in broken form;

(d) water.

"mining activities"

(a) means the activities:

  (i) authorised as per the definition in section 110 of the *Environmental Protection Act 1994*; and

  (ii) all environmentally relevant activities authorised under this environmental authority.

(b) to avoid doubt, includes care and maintenance and rehabilitation.

"modification or modifying" (see definition of 'construction').

"natural flow" means the flow of water through waters caused by nature.

"nature" includes:

(a) ecosystems and their constituent parts; and

(b) all natural and physical resources; and

(c) natural dynamic processes.

"noxious" means harmful or injurious to health or physical well-being, other than trivial harm.

"offensive" means causing offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"operational plan" includes:

(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance);

(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

"peak particle velocity (ppv)" means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms^{-1}).

"potentially affected stakeholders" includes (but should not be limited to)

(a) the administering authority;

(b) a local landholder whose property is riparian, downstream of the release point specified in Table C1 of the environmental authority and is identified to be potentially impacted by mine affected water releases;

(c) other party nominated by the administering authority;

(d) the relevant local government authority;

(e) a Resource Operations Licence (ROL) holder or other water entitlement holder under the *Water Act 2000* located between the nearest compliance point listed in Table 1 of the operational policy and the release point specified in Table C1 of the environmental authority; and

(f) does not include a landholder or other party who by written agreement with the environment authority holder has declined to be notified for the purpose of this condition.

"progressive rehabilitation" means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation.

"protected area" means a protected area under:

(a) the *Nature Conservation Act 1992*; or
(b) a marine park under the *Marine Parks Act 1992*; or

(c) a World Heritage Area.

"receiving environment" means all receiving waters, land, and sediments that are not disturbed areas authorised by this environmental authority.

"receiving waters" means all groundwater and surface water that are not disturbed areas authorised by this environmental authority.

"reference site" (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

“register of regulated structures” includes**:**

- (a) date of entry in the register;
- (b) name of the structure, its purpose and intended/actual contents;
- (c) the consequence category of the structure as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*;
- (d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the structure;
- (e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
- (f) for the regulated structure, other than in relation to any levees –
    - (i) the dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
    - (ii) coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
    - (iii) dam crest volume (megalitres);
    - (iv) spillway crest level (metres AHD).
    - (v) maximum operating level (metres AHD);
    - (vi) storage rating table of stored volume versus level (metres AHD);
    - (vii) design storage allowance (megalitres) and associated level of the dam (metres AHD);
    - (viii) mandatory reporting level (metres AHD);
- (g) the design plan title and reference relevant to the structure;
- (h) the date construction was certified as compliant with the design plan;
- (i) the name and details of the suitably qualified and experienced person who certified that the constructed structure was compliant with the design plan;
- (j) details of the composition and construction of any liner;
- (k) the system for the detection of any leakage through the floor and sides of the dam;
- (l) dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
- (m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
- (n) dam water quality as obtained from any monitoring required under this authority as of 1 November of each year.

“regulated dam” means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)* published by the administering authority.

“regulated structure” includes dams which are regulated dams, land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.

“regulated waste” means non-domestic waste mentioned in Division 1 of the *Environmental Protection Regulation 2019* (whether or not it has been treated or immobilised), and includes:

(a) for an element – any chemical compound containing the element; and

(b) anything that has contained the waste.

“rehabilitation” is the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the success criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

“release influence period” is the period during which the downstream monitoring points specified in **Table C5 – Receiving water upstream background sites and downstream monitoring points** are influenced by mine affected water released from Ensham Coal Mine and includes both the duration of release and any lag time between release point/s and downstream monitoring points.

“residual void” means an open pit where coal and/or spoil has been removed, which will remain following the cessation of mining activities and completion of rehabilitation processes.

"representative” means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

“resampling event” means the resampling that is required to take place within 10 business days of receipt of the results.

“saline drainage” The movement of waters, contaminated with salt(s), as a result of the mining activity.

“sampling occasion” means the collection of a sample undertaken in accordance with the sampling frequency specified in a condition of this environmental authority, and where an exceedance is recorded the **sampling occasion** together with the **resampling event.**

“self sustaining” means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

“sensitive place” means;

(a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

(b) a motel, hotel or hostel; or

(c) an educational institution; or

(d) a medical centre or hospital; or

(e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 2004* or a World Heritage Area; or

(f) a public park or gardens.

“sewage” means the used water of persons to be treated at a sewage treatment plant.

“significant disturbance” – includes land

(a) if it is contaminated land; or

(b) land that has been disturbed by mining activities and human intervention is needed to rehabilitate it:

  (i) to a state required under the relevant environmental authority; or

  (ii) if the environmental authority does not require the land to be rehabilitated to a particular state – to its state immediately before the disturbance.

Some examples of disturbed land include:

(a) areas where soil has been compacted, removed, covered, exposed or stockpiled by mining activities;

(b) areas where vegetation has been removed or destroyed by mining activities to an extent where the land has been made susceptible to erosion; (vegetation & topsoil)

(c) areas where land use suitability or capability has been diminished by mining activities;

(d) areas within a watercourse, waterway, wetland or lake where mining activities occur;

(e) areas submerged by tailings or hazardous contaminant storage and dam walls in all cases;

(f) where temporary mining infrastructure is or has been located. Temporary mining infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after mining activities have ceased; or

(g) areas where land has been contaminated by mining activities and a suitability statement has not been issued.

However, the following areas are not included:

(a) areas off lease (e.g. roads or tracks which provide access to the mining lease);

(b) areas previously significantly disturbed which have achieved the rehabilitation outcomes;

(c) by agreement with the administering authority, areas previously significantly disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);

(d) areas under permanent infrastructure where the infrastructure is to be left by agreement with the landholder. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner. The agreement to leave permanent infrastructure must be recorded in a written and signed Landowner Agreement and lodged with the administering authority; and

(e) disturbances that pre-existed the grant of the tenure unless those areas are disturbed during the term of the tenure.

“site” means the land associated with the project for which this environmental authority has been issued.

“spillway” means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form a dam, under flood conditions or in anticipation of flood conditions.

“stable” in relation to land, means landform dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

“structure” means dam or levee.

“suitably qualified and experienced person” in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and for:

(a) regulated dams, an RPEQ with experience and qualifications in dam safety and dam design;

(b) regulated levees, an RPEQ with experience and qualifications in the design of flood protection embankments;

(c) for geotechnical stability, an RPEQ with experience and qualifications in the assessment of stability of slopes and factors of safety.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has qualifications and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

“suitably qualified person” in relation to rehabilitation means a person who holds relevant professional qualifications to the satisfaction of the administering authority; and:

(a) has demonstrated knowledge, experience and expertise in relevant fields as set out below:

(b) rehabilitation practices for resource activities; and

(c) a minimum of five years of suitable experience and demonstrated expertise in the following categories:

   (i) coal mine site rehabilitation;

   (ii) development of rehabilitation management plans and monitoring programs; and

   (iii) assessment of rehabilitation performance indicators in the resources industry.

“system design plan” means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

“tolerable limits” means a range of parameters regarded as being sufficient to meet the objective of protecting relevant environmental values. For example, a range of settlement for a tailings capping, rather than a single value, could still meet the objective of draining the cap quickly, preventing pondage and limiting infiltration and percolation.

“void” means any constructed, open excavation in the ground.

“waste water” means used water from the activity, process water or contaminated stormwater.

“waste” as defined in section 13 of the *Environmental Protection Act 1994*.

“water year” means the 12-month period from 1 July to 30 June.

“water” means –

(a) water in waters or spring;

(b) underground water;

(c) overland flow water; or

(d) water that has been collected in a dam.

“watercourse” has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means a river, creek or stream in which water flows permanently or intermittently—

(a) in a natural channel, whether artificially improved or not; or

(b) in an artificial channel that has changed the course of the watercourse.

Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

“waters” includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

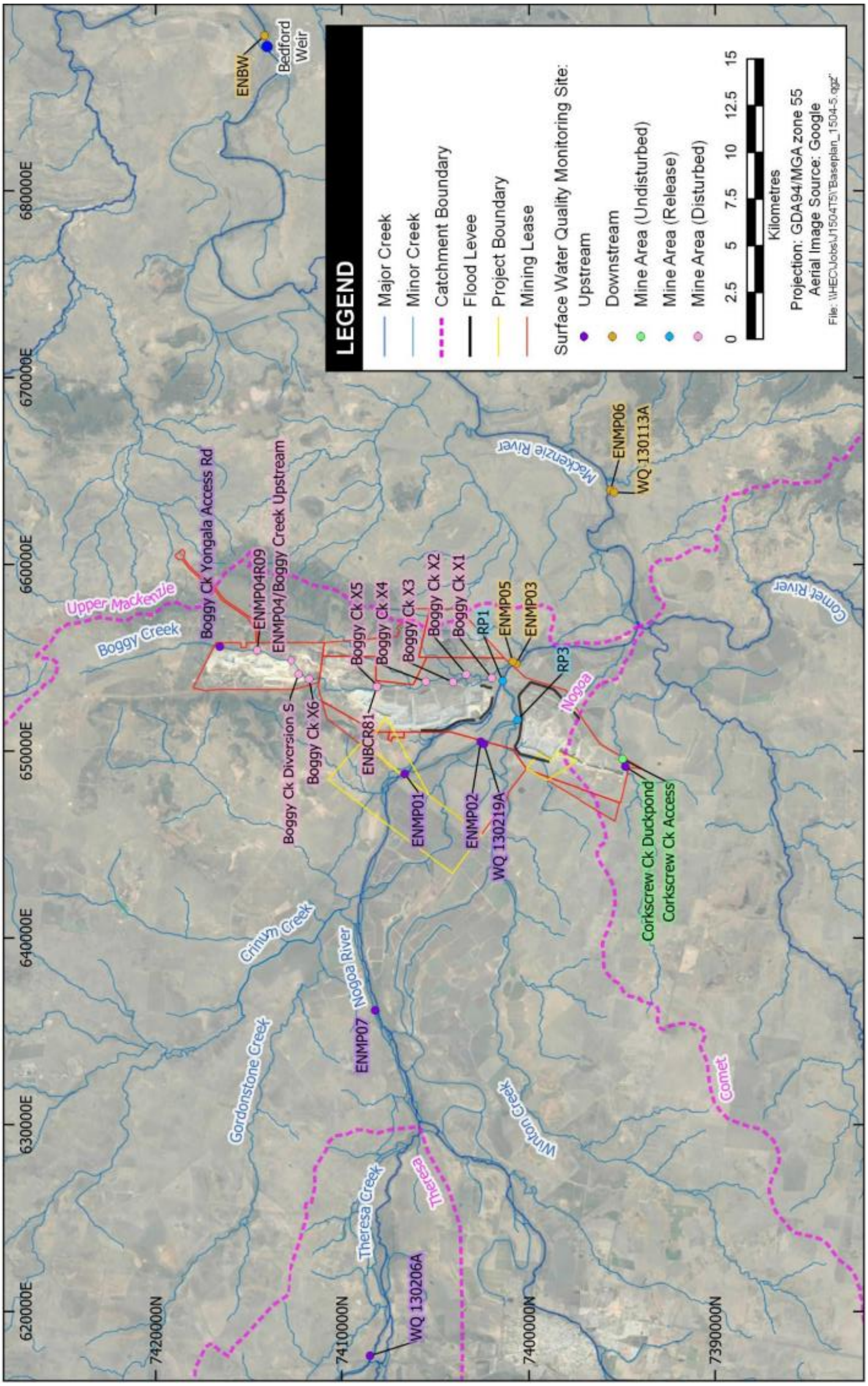
“WaTERS” means the Water Tracking and Electronic Reporting System, used to submit monitoring data and notify the Queensland Government. [https://waters.ehp.qld.gov.au/] or contact psd.help@qld.gov.au.

“Wet season” means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

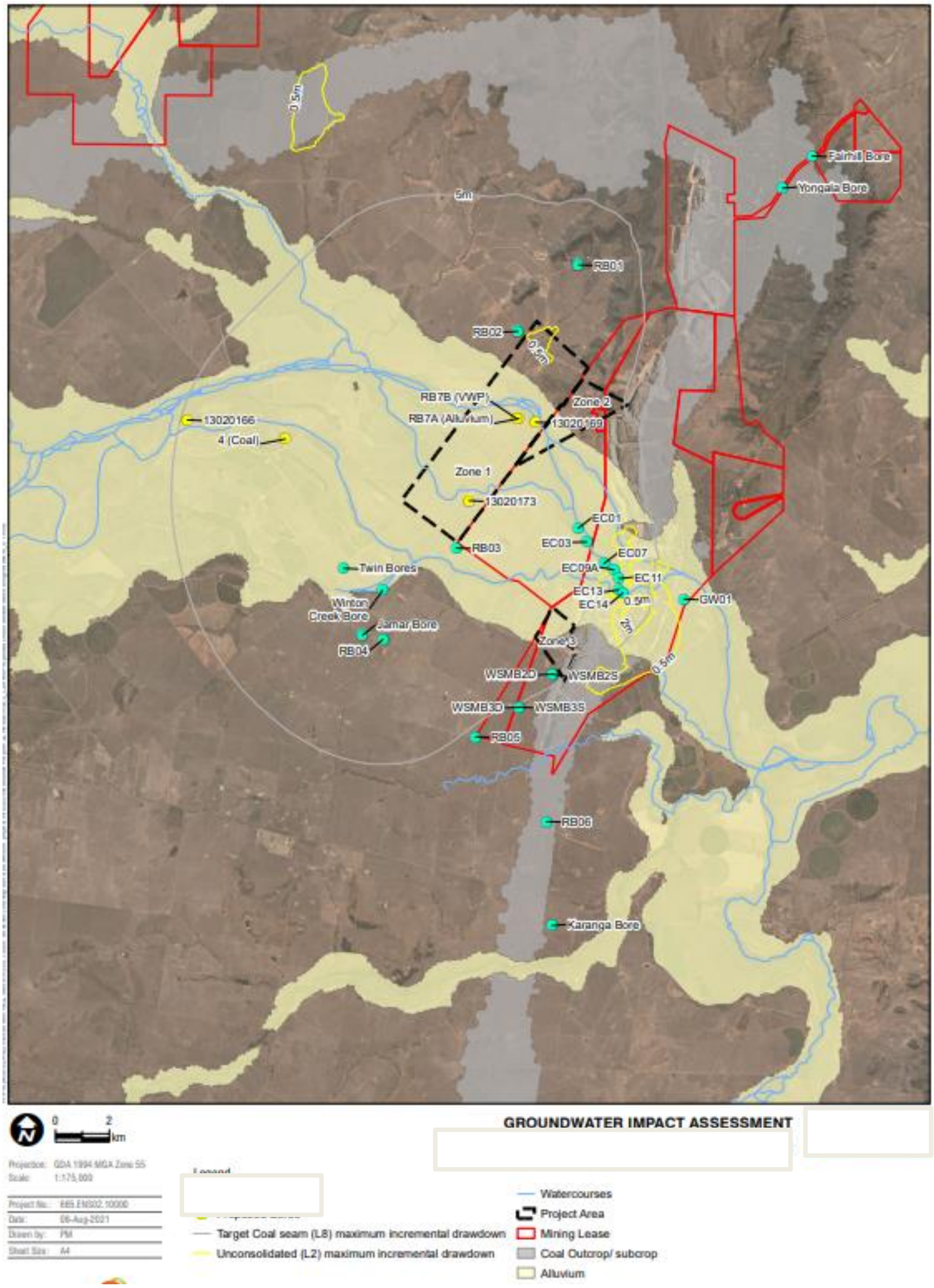
“year” has the meaning in the *Acts Interpretation Act 1954*.

“µg/L” means micrograms per litre.

Appendix 1: Surface water monitoring and release points



Appendix 2: Groundwater monitoring bore network



Appendix 3: Rehabilitation success criteria

Mine Domain	Rehabilitation Feature Name	Goals	Objective	Indicators	Completion Criteria
1	Overburden / infrastructure, including: - Overburden emplacement areas; - Low walls; - Mine infrastructure areas; and - Surface disturbance associated with underground mining (excluding Zone 1) Indicative location generally in accordance with Appendix 4 and Appendix 6.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
		Non-polluting	Surface runoff leaving rehabilitation is non-polluting to receiving waters	pH	7.1 – 8.2
				EC (salinity)	<403 µs/cm
				Total Suspended Solids (TSS) (sediment loss)	<405 mg/L
				Arsenic	≤13 µg/L
				Molybdenum	≤34 µg/L
				Selenium	≤5 µg/L
				Sulfate (SO_4^{2+})	<16.34 mg/L
		Stable	Landforms are both geotechnically and erosionally stable	Factor of safety	≥ 1.5
				Slope gradient	All outward facing overburden slopes to achieve 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials. 90% of the inward facing slopes within Domain 1 achieving 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials. Up to 10% of the inward facing slopes within Domain 1 may include slopes between 15% to 25%, subject to these areas being fully contained within areas of 0-15% slopes.
				Groundcover	≥ 50% established and persistent vegetative groundcover for all slopes from 0-15%. ≥ 80% established and persistent vegetative cover for slopes from 15% to 25%.
		Land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment by a suitably	Class 2 to 4 as defined in the *Guidelines for Agricultural Land Evaluation in Queensland (State Department of Queensland 2013).*

				qualified person	
2	Landholder retained infrastructure on mining infrastructure areas. Located generally in accordance with Appendix 4.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
		Non-polluting	Surface runoff leaving domain is non-polluting to receiving waters	pH	7.1 – 8.2
				EC (salinity)	<403 µs/cm
				TSS (sediment loss)	<405mg/L
				Arsenic	≤13µg/L
				Molybdenum	≤34µg/L
				Selenium	≤5µg/L
				Sulfate (SO_4^{2+})	16.34mg/L
		Stable	Landholder accepts the condition of infrastructure, including its structural integrity	Legally binding agreement	Executed by each party
		Land use	Landholder formally accepts infrastructure for his/her ongoing beneficial use	Legally binding agreement or by consent with the administering authority where the landholder is also the environmental authority holder.	Executed by each party
3	Watercourse bed, banks and riparian vegetation of the Boggy Creek diversion. Located generally in accordance with Appendix 4.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
		Non-polluting	Surface runoff leaving domain is non-polluting to receiving waters	pH	7.1 – 8.2
				EC (salinity)	<403 µs/cm
				TSS (sediment loss)	<405mg/L
				Arsenic	≤13µg/L
				Molybdenum	≤34µg/L
				Selenium	≤5µg/L
				Sulfate (SO_4^{2+})	16.34mg/L
		Stable	Landforms are both	Factor of safety	≥ 1.5

			geotechnically and erosionally stable	Index of diversion condition assessed by a suitably qualified geomorphologist	> 10 as defined in *Criteria for functioning river landscape units in mining and post-mining landscapes* (ACARP Project number C20017).
		Land use	Riparian vegetation is suitable for conservation of rehabilitated creek diversion areas	Index of diversion condition assessed by a suitably qualified geomorphologist	> 10 as defined in *Criteria for functioning river landscape units in mining and post-mining landscapes* (ACARP Project number C20017).
4	Native Bushland Corridor Indicative location generally in accordance with Appendix 4.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
		Non-polluting	Surface runoff leaving domain is non-polluting to receiving waters	pH	7.1 – 8.2
				EC (Salinity)	<403 µs/cm
				TSS (sediment loss)	<405mg/L
				Arsenic	≤13µg/L
				Molybdenum	≤34µg/L
				Selenium	≤5µg/L
				Sulfate (SO_4^{2+})	<16.34mg/L
		Stable	Landforms are both geotechnically and erosionally stable	Factor of safety	≥ 1.5
				Slope gradient	Maximum 25% slope. Areas >15% to be certified by a suitably qualified person as being stable long term, with rock mulch applied as required.
				Groundcover	≥ 50% established and persistent vegetative groundcover for all slopes from 0-20%. ≥ 80% established and persistent cover (vegetative and/or rock mulch) for slopes from 20% to 25%.
		Land use	Rehabilitation to have some native species and some native bush land characteristics	Native species richness	≥ 2 tree species at relevant benchmark density ≥ 3 shrub species at relevant benchmark density ≥ 5 groundcover species at relevant benchmark density (as per relevant Regional Ecosystem BioCondition Benchmark = 11.10.1 and/or 11.10.3)

5	Groundwater daylighting water areas The only areas authorised to have groundwater daylighting are located generally in accordance with Appendix 4. and includes: A Pit Central A Pit North B Pit C Pit D Pit	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	Fenced and signed from humans and stock.
		Non-polluting	Environmental harm	Deep drainage from the domain is non-polluting to regional groundwater resources and any potential regional groundwater dependent ecosystems. Ensure groundwater daylighting in this domain remain sinks into perpetuity. For the avoidance of doubt accumulation of contaminants in this domain is authorised.	Regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in **Table C11 – Groundwater quality limits** as a result of mining activities.
		Stable	Existing	Water height, volume and area until surrender / relinquishment.	Maximum dimensions: A Central – Surface Water Level -133mAHD, Water storage Volume - 0.5GL, and Water Area – 3ha A North – Surface Water Level – 133mAHD, Water storage volume – 1.2GL, and Water Area – 16ha B – Surface Water Level – 123mAHD, Water Storage Volume – 3.1GL and Water Area – 33ha C and D – Surface Water Level – 125mAHD, Water Storage Volume – 22.1GL and Water Areas – 65ha for C and 75ha for D

		Land use	Existing	No land use beyond containment of water Note for the avoidance of doubt, regrading, top soiling and seeding is not required.	
6	Highwalls The only areas authorised to have highwalls remaining are located generally in accordance with Appendix 4 and include: A Pit Central A Pit North B Pit C Pit D Pit E Pit	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	Bunded, fenced and signed to exclude humans and stock. All areas to be certified by suitably qualified person as being safe long-term.
		Non-polluting	High walls do not cause environmental harm	Does not cause environmental harm to the regional groundwater environment Note for the avoidance of doubt, the existence of the highwalls themselves does not constitute environmental harm	Regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in **Table C11 – Groundwater quality limits** as a result of mining activities.
		Stable	Highwalls are both geotechnically and erosionally stable	Factor of safety	≥ 1.5
				Slope gradient	Maximum of 275% slopes for competent high walls. Maximum of 50% slopes for incompetent material A south pit, F Pits and Y Pits highwall must be reshaped to a maximum of 25% slopes. Northern Endwall of B Pit maximum 15% slope

				Erosion control	Water run-off from above the highwall is channelled to the groundwater daylighting water areas of Domain 5 through design pathways.
		Land use	No use	No use	No use
7	Flood protection landform Located generally in accordance with Appendix 4.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
			Maintenance requirements are similar to surrounding unmined landscapes	Maintenance assessment by a suitably qualified and experienced person	Maintenance carried out as required and specified by annual inspection by SQEP.
		Non-polluting	Flood protection landform does not cause environmental harm	No ingress of floodwaters to residual voids	Permanent flood structure in place.
			Floodplain reinstated between flood protection landforms	Minimum 2km width between the northern section of B Pit and the southern section of C Pit as located generally in accordance with Appendix 5	Floodplain width re-instated.
			Surface water runoff does not cause environmental harm	pH	7.1 – 8.2
				EC (salinity)	<403 µs/cm
				TSS (sediment loss)	<405mg/L
				Arsenic	≤13µg/L
				Molybdenum	≤34µg/L
				Selenium	≤5µg/L

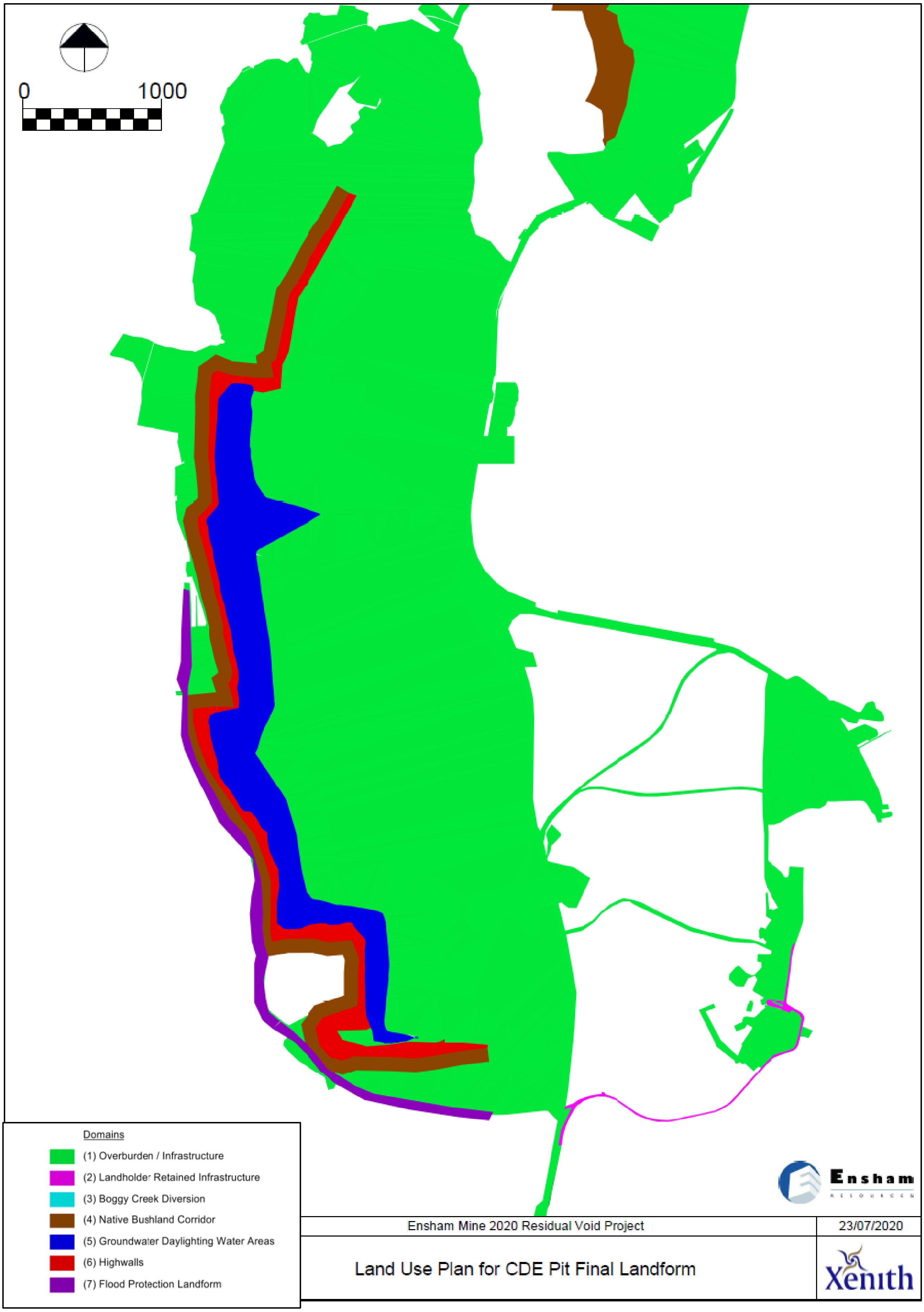
				Sulfate (SO_4^{2+})	<16.34mg/L
		Stable	Flood protection levee is both geotechnically and erosionally stable	Factor of safety	≥ 1.5
				Able to function as a flood protection structure in the long-term	Watercourse facing slopes ≤15% Void facing slopes ≤15%, except where constrained by proximity to void regrade, batters can be reduced to ≤25% Bench of 10m to separate inward toe embankment from adjacent edge of void stabilisation regrade Landform – 0.1%AEP +0.5m freeboard Line the river facing embankments at sharp changes in alignment where turbulence could occur with hard, durable rock rip rap.
			Exclusion of stock	Must be fenced to exclude stock	Permanent fencing in place post construction and maintained.
		Land use	Protection of residual voids from floodwaters	The design level of the landform crest must be at least one (1) metre above the estimated 1 in 1,000 year ARI event for the adjacent watercourses	Constructed as per certified designs provided under condition **H11**, and certified by a suitably qualified and experienced person
8	Surface disturbance associated with underground mining (Zone 1). Indicative location generally in accordance with Appendix 4 and Appendix 6.	Safe	Safety hazards in rehabilitation are similar to surrounding unmined landscapes	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in *AS/NZS ISO 31000:2009 Risk Management*
		Non-polluting	Surface runoff leaving rehabilitation is non-polluting to receiving waters	pH	7.1 – 8.2
				EC (salinity)	<403 µs/cm

				Total Suspended Solids	<405 mg/L
				Arsenic	≤13 µg/L
				Molybdenum	≤34 µg/L
				Selenium	≤5 µg/L
				Sulfate (SO42+)	<16.34 mg/L
		Stable	Landforms are both geotechnically and erosionally stable	Factor of safety	≥1.5 No visible surface cracking or ponding
		Land use	Rehabilitation is suitable for sustainable cropping	Land suitability assessment for irrigated cropping	Land suitability Cass 1 cropping. Assessment completed in accordance with the most recent edition of the *Regional Land Suitability Frameworks for Queensland* unless otherwise agreed in writing between the administering authority and the environmental authority holder. No change in pre-mining surface flatness such that no changes to flood irrigation requirements is incurred. Should deviation in pre-mining surface flatness occur then laser levelling must be undertaken
		Safe	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment by a suitably qualified and experienced person	0 (zero) significant difference as defined in AS/NZS ISO 31000:2009 Risk Management.

Appendix 4: Overall site layout indicative domain plan

Approximate area (ha) involved in the Domain 6 Highwalls = 200 ha

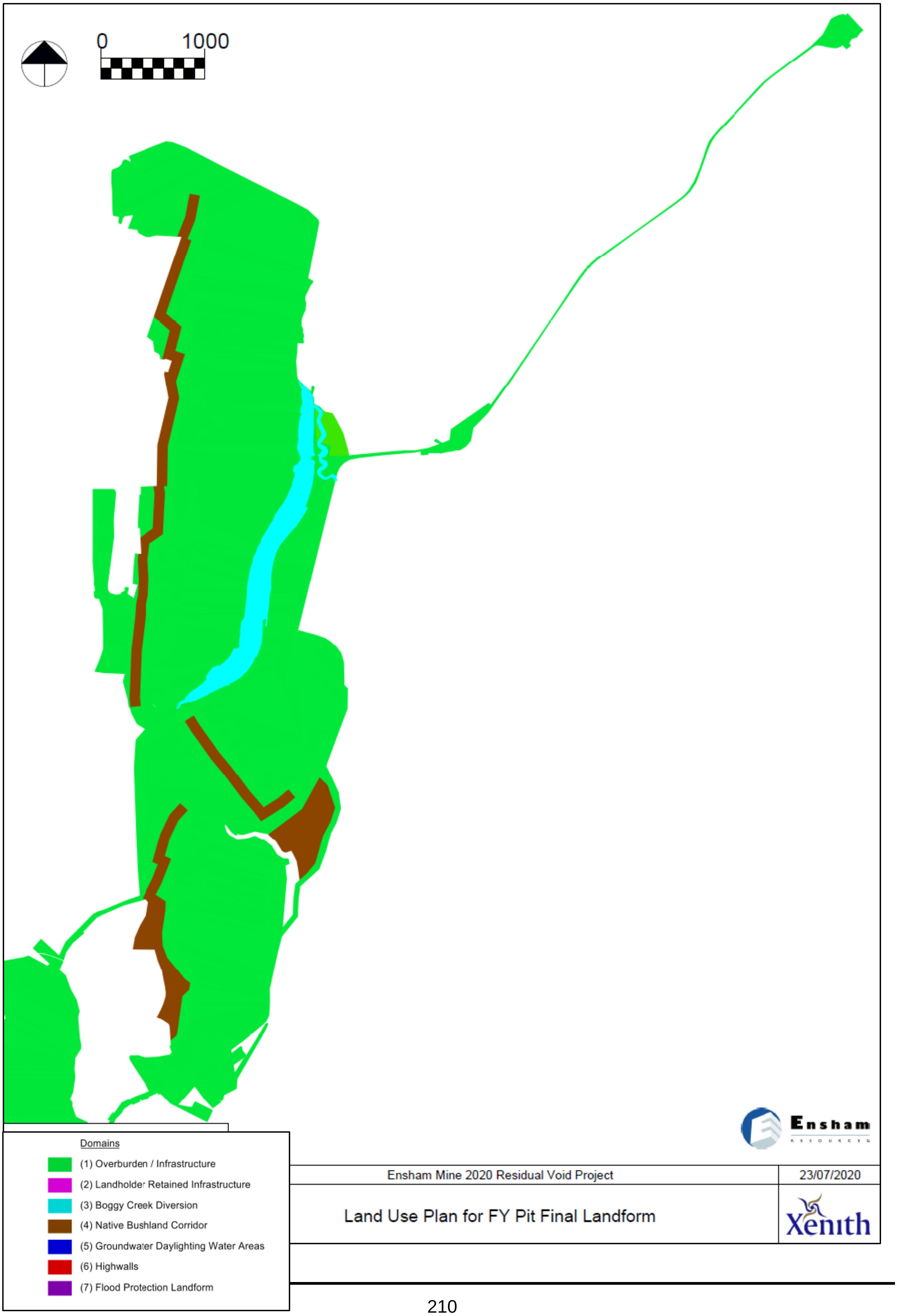
Approximate area (ha) involved in the Domain 5 Groundwater Daylighting Water Areas = 200 ha



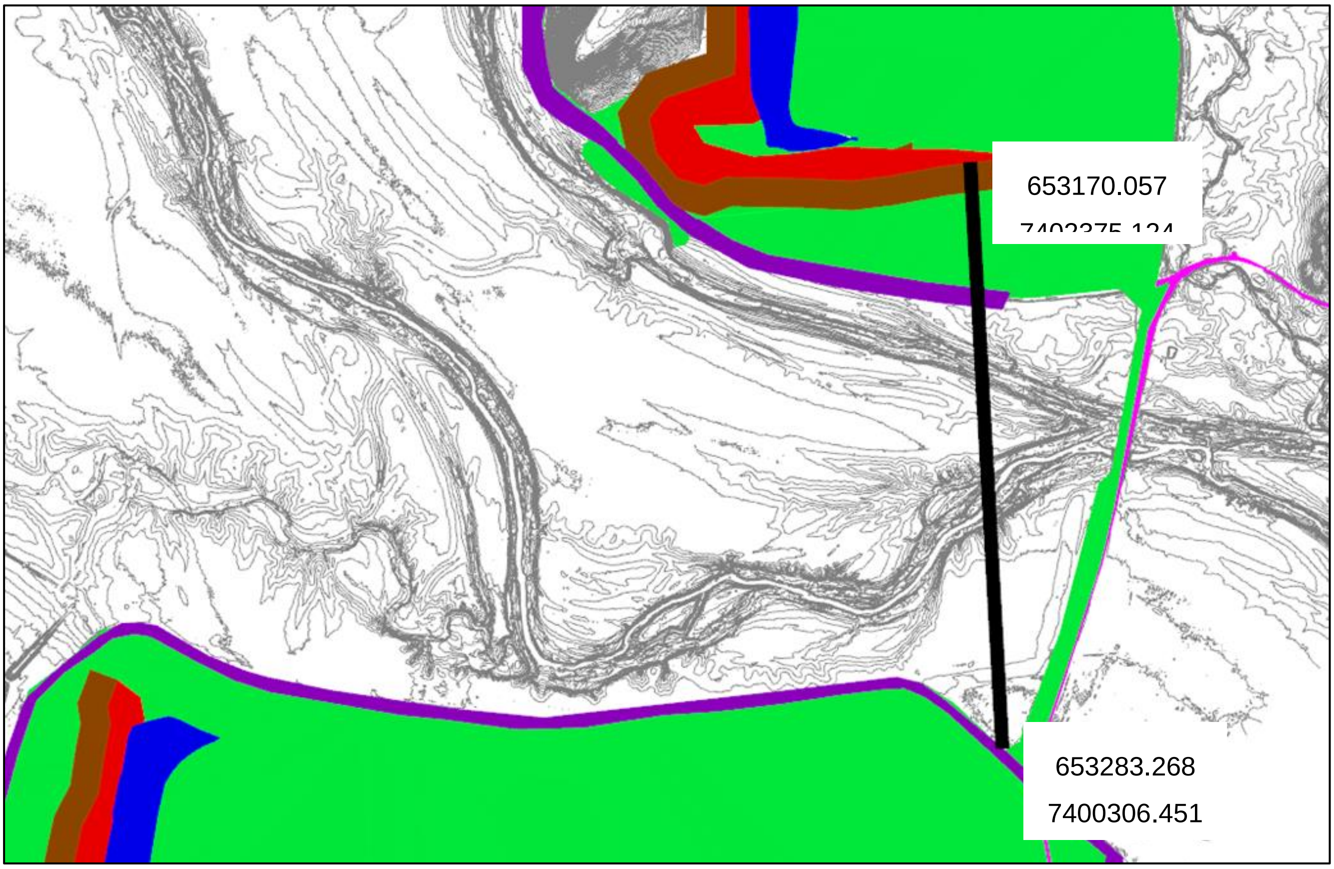
Ensham Mine 2020 Residual Void Project

23/07/2020

Land Use Plan for CDE Pit Final Landform


0
1000
Ensham
RESOURCES
Domains
🟩 (1) Overburden / Infrastructure
🟪 (2) Landholder Retained Infrastructure
🟦 (3) Boggy Creek Diversion
🟫 (4) Native Bushland Corridor
🟦 (5) Groundwater Daylighting Water Areas
🟥 (6) Highwalls
🟪 (7) Flood Protection Landform
Ensham Mine 2020 Residual Void Project
23/07/2020
Land Use Plan for FY Pit Final Landform
Xenith

Appendix 5: 2km floodplain widening



Appendix 6: Proposed project area (Zones 1, 2 and 3).

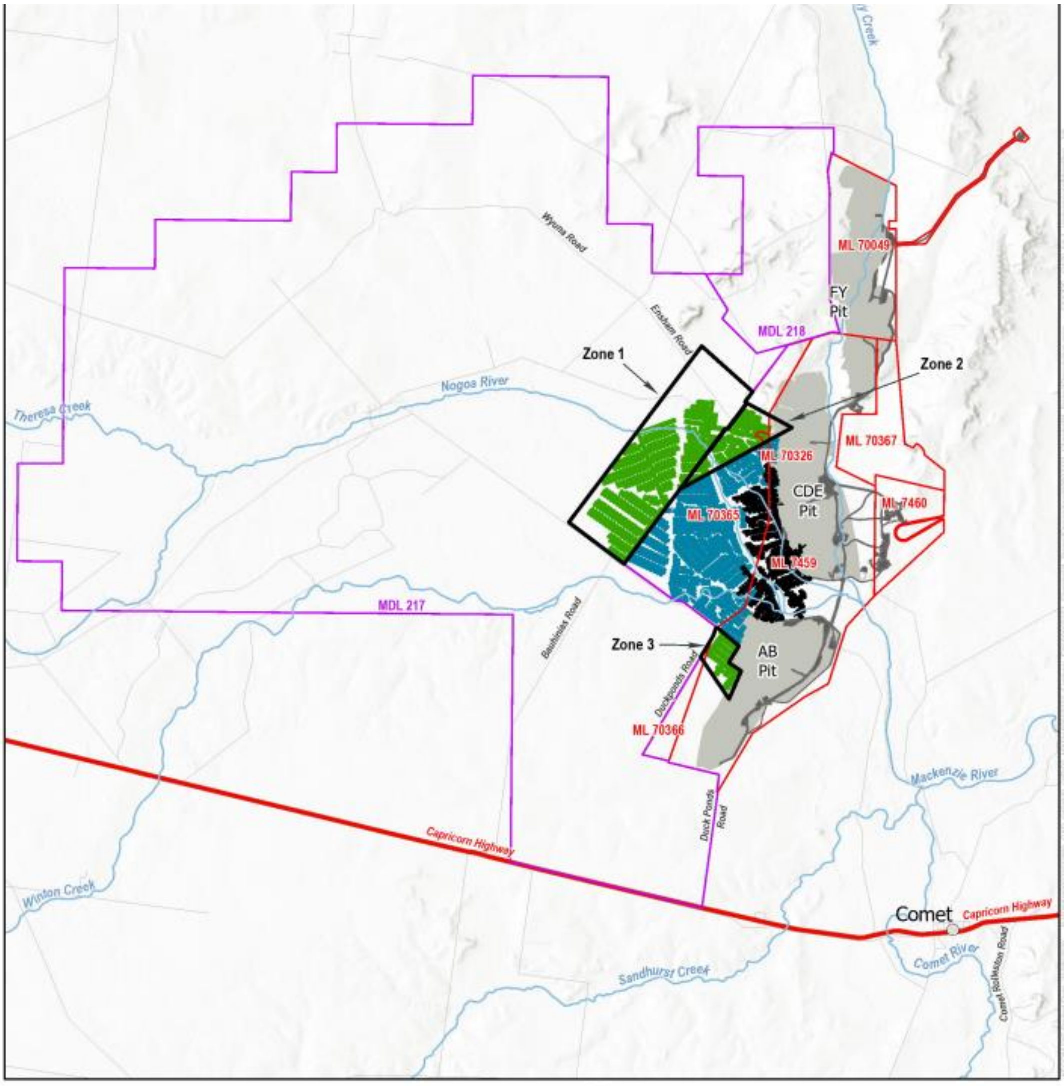


Figure 4-1
Underground mine plan (Approved and the Project)

Legend

- ☐ Project Area
- 🟥 Mining leases
- 🟪 Mineral development licence
- ▨ Pit
- ■ Mine infrastructure footprint

Mine Plan

- ■ Mined out
- 🟦 Approved to be mined
- 🟩 The Project

Ensham RESOURCES

0 4 7 km

ENSHAM LIFE OF MINE EXTENSION PROJECT

END OF ENVIRONMENTAL AUTHORITY

Appendix B Coordinator-General's stated conditions under the SSRC Act and proponent commitments

This appendix includes conditions stated by the Coordinator-General under section 11(2) of the *Strong and Sustainable Resource Communities Act 2017* (SSRC Act). In accordance with section 11(3)(a) of the SSRC Act, these conditions are enforceable conditions under the *State Development and Public Works Organisation Act 1971* (SDPWO Act). The entity with jurisdiction for the conditions in this appendix is the Coordinator-General.

All the conditions stated in this appendix take effect from the date the Department of Environment and Science completed the environmental impact statement (EIS) assessment report for the Ensham Life of Mine Extension project.

Condition 1. **General conditions – operation**

(a) The proponent must advise the Coordinator-General in writing that operation of the project has commenced within five (5) business days of commencement of project activities.

Condition 2. **Social impact management plan**

(a) The proponent must submit to the Coordinator-General for approval a social impact management plan (SIMP) at least three (3) months prior to commencement of project activities.

(b) The SIMP must include the following updated plans:

   (i) Community and Stakeholder Engagement Plan in accordance with Condition 3

   (ii) Workforce Management Plan

   (iii) Workforce Housing and Accommodation Plan

   (iv) Local Business and Industry Procurement Plan in accordance with Condition 4

   (v) Health and Community Wellbeing Plan in accordance with Condition 6.

(c) The SIMP must be made publicly available on the proponent's website within thirty (30) business days of the Coordinator-General's approval of the SIMP.

Condition 3. **Community and Stakeholder Engagement Plan**

(a) The Community and Stakeholder Engagement Plan must provide an updated program of stakeholder engagement that includes:

   (i) the outcomes of further consultation with relevant stakeholders on the implementation of the proposed management strategies, the results of which should inform the updated plans at Condition 2(b)

   (ii) processes for providing advanced notice to relevant stakeholders of operational activities with potential for disturbance, including: land access; periods of predicted high noise or dust; and any works which may occur outside of standard working hours

(iii) an updated plan and program for further consultation with all relevant stakeholders, including agreed impact management measures and input into ongoing implementation and monitoring of the SIMP actions.

Condition 4. Local Business and Industry Procurement Plan

(a) The proponent must ensure that opportunities for local businesses to provide goods and services for the project are maximised during the operational, progressive rehabilitation and mine closure phases and must consult with the Department of State Development, Infrastructure, Local Government and Planning, to develop a target for local business procurement on the project.

(b) The proponent must develop and submit a Local Content Strategy consistent with the Queensland Resources and Energy Sector Code of Practice for Local Content 2013, which includes actions to maximise local business opportunities.

Condition 5. Maximising outcomes for Aboriginal and Torres Strait Islander peoples

(a) The proponent must consult with the Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships to develop:

(i) a target for Aboriginal and Torres Strait Islander employment on the project

(ii) a target for Aboriginal and Torres Strait Islander business procurement on the project.

(b) The Aboriginal and Torres Strait Islander employment target, including justification for the target, must be included in the workforce management plan (Condition 2(b)(ii)) as part of the SIMP.

(c) The Aboriginal and Torres Strait Islander business procurement target, including justification for the target must be included in the local business and industry procurement plan (Condition 2(b)(iv)) as part of the SIMP.

Condition 6. Health and Community Wellbeing Plan

(a) The Health and Community Wellbeing Plan must provide a proposed annual contribution to community investment initiatives, and the outcomes to be achieved.

(b) Community investment opportunities are to be identified in consultation with Central Highlands Regional Council, Department of Seniors, Disability Services, Aboriginal and Torres Strait Islander Peoples and other community organisations.

Condition 7. Reporting on the implementation and effectiveness of social impact management measures

(a) The proponent must prepare an annual social impact management report (SIMR) for the first five (5) years of operation.

(b) The annual SIMR must be submitted to the Coordinator-General for approval within twenty (20) business days after the end of the relevant twelve (12) month period from the commencement of project activities.

(c) Using the monitoring protocol described in the SIMP, the SIMR must detail:

(i) an assessment of the social impacts of the project against the potential social impacts identified in the SIA including consideration of impacts of other proposed developments in the local communities

(ii) the progress and effectiveness of the social impact management measures detailed in the SIMP

(iii) how social impact management measures have been modified, where monitoring indicates measures have not been effective or in response to changed circumstances or greater knowledge of potential social impacts

(iv) the actions taken to implement commitments made by the proponent in tables A1-A7 listed below.

(d) The SIMR must present the workforce profile of the project including:

(i) total number of workers employed

(ii) proportion (number) of local workers, new local workers, workers from local communities who drive-in, drive-out (DIDO), and fly-in, fly-out (FIFO) workers. These numbers are to be provided in terms of both directly employed and contractors

(iii) proportion of workers identifying as Aboriginal and Torres Strait Islander peoples, including directly employed and contractors.

(e) Each SIMR must be made publicly available on the proponent's website within thirty (30) business days of the Coordinator-General's approval of the relevant SIMR.

(f) The proponent must notify the Coordinator-General within five (5) business days of the SIMR being published on the proponent's website.

Definitions

'mine closure' captures activities associated with the decommissioning and final rehabilitation phases of the project, following cessation of underground mining activities

'commencement of project activities' is the commencement of the operational phase relating to underground mining operations and temporary surface disturbance for exploration and installation of gas flares

'DIDO worker' is a worker for the Ensham Life of Mine Extension project who lives in one of the local communities and must commute to work and stay at the workforce accommodation village

'EIS assessment report' is the assessment report prepared by the Department of the Environment and Science on the project's environmental impact statement in accordance with section 60 of the *Environmental Protection Act 1994*

'FIFO worker' is a worker for the Ensham Life of Mine Extension project who does not live in one of the local communities and must commute to work from outside the local communities (could be DIDO, bus-in, bus-out or FIFO), and stay at the workforce accommodation village while on shift

'local communities' are the fifteen nearby regional communities identified in the evaluation report (Blackwater, Bluff, Capella, Clermont, Comet, Duaringa, Dysart, Emerald, Middlemount, Rubyvale, Sapphire, Springsure, Tieri, Willow Gemfields and Woorabinda)

'**local worker**' is a worker for the Ensham Life of Mine Extension project who lives in a local community

'new local worker' is a worker for the Ensham Life of Mine Extension project who moves to a local community

‘operation’ is underground mining and processing of coal

‘worker’, for a large resource project, means a person employed (as a direct employee or contractor), or to be employed, to perform work during operations, progressive rehabilitation and mine closure activities

Proponent commitments

Table A1 Commitments identified in the EIS Appendix I-1 - Social Impact Assessment (August 2021) (SIA) relevant to this evaluation report

SIA Section	Commitment
Section 6.2.5	Ensham will maintain a record of the nature, location and outcome of complaints and report on complaints that may be received as part of its Social Impact Management Report (SIMR).
Section 6.3.7	The Workforce Accountability and Personal Conduct Procedure will apply to all Project personnel. Workers demonstrating behaviour that does not comply with the procedure will face disciplinary action in line with the terms of their employment.
Section 6.5.7	The Project will continue Ensham Mine's Community Sponsorship and Donations program
Section 6.5.7	Ensham will revise its community investment priorities, in consultation with CHRC, to address community needs identified during the SIA process
Section 6.7.1	the Project will implement: • a Stakeholder Engagement Register to support monitoring of engagement activities and outcomes; • a Local Business Register to support monitoring of local and Indigenous businesses' participation in the supply chain; • Human Resources records identifying the number and percentage of local personnel (Central Highlands residents), female personnel, Indigenous personnel (with the consent of these personnel), and personnel under 25 years, to support the provision of information to stakeholders; • Complaints Register to track complaints and their resolution; • consultative arrangements with CHRC, CHDC, directly affected and adjacent landowners, and landowners whose groundwater bores may be subject to drawdown, to regularly review the effectiveness of SIMP measures; and • engagement with the QPS, QAS and QFES, to a schedule agreed them as part of the EMP review, to seek their input into evaluation of the SIMP's effectiveness; and • provide QRC Local Content Code Industry Reports and AIP Reports to the relevant authorities on an annual basis.
Section 6.7.1	Progress against the KPIs and the targets and outcomes detailed in Tables 6-5, 6-7, 6-9 and 6-11 will be monitored by the General Manager Operations or their delegate on a six monthly basis, and will be reported as part of the Project's SIMRs (see Section 6.7.2). If progress towards targets and outcomes is not positive, the relevant management measures will be reviewed and may need to be revised to improve the outcomes. This would occur as part of annual SIMP reviews, with any updates to management measures as the result of monitoring and engagement results noted as part of the SIMR.
Section 6.7.2	The SIMP will be reviewed annually during the first three years of Project operations, and updated as indicated by monitoring data, including stakeholder feedback.

SIA Section	Commitment
Section 6.7.2	A SIMR will be provided at the end of Year 1 of Project operations, and again at the end of Year 3, or as defined by relevant stated conditions by the Coordinator-General (if any). Preparation of SIMRs will include: • a review of the implementation status of actions and outcomes identified in the SIMP; • a review of progress towards targets and outcomes specified in Tables 6-3, 6-5, 6-7, 6-9 and 6-11) to identify the effectiveness of SIMP measures and any areas where SIMP measures were not wholly effective and required amendments to SIMP measures; and • consultation with CHRC, CHDC, QPS, Queensland Heath, directly affected and adjacent landowners and the Western Kangoulu People, to identify the effectiveness of SIMP strategies, and any changes that need to be made to the SIMP to ensure ongoing effectiveness.

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A2 SIA Table 6-3: Community and stakeholder engagement actions

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
Directly affected and adjacent landholders	EIS findings regarding any impacts on their properties	• Meet with directly affected landowners and lessees within the Project Site and adjacent landowners to discuss the EIS findings and receive direct feedback. • Engage with directly affected landowners to confirm land access and compensation agreements and their preferred engagement process going forward.	Draft EIS display period	Engagements entered to stakeholder register and reported as part of the SIMR
		• Meet with Cowal Agriculture Holdings and the owners of Chelbrook to identify their information needs regarding subsidence and any other concerns that arise when the raft EIS is available.	Draft EIS display period	Engagements entered to stakeholder register and reported as part of the SIMR
		• Work with directly affected landowners to agree measures which will avoid or minimise the impacts of any subsidence on the operation of their properties.	Commencing in draft EIS display period, continuing to a schedule	Engagements entered to stakeholder register and reported as appropriate in the SIMR

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
			agreed with landowners	
	Management of any impacts on the use of land for agriculture	- Maintain engagement through meetings and phone calls throughout the operational period to a schedule agreed with landowners, offering at least annual meetings. - Encourage directly affected adjacent landowners to contact the General Manager Operations immediately if any Project-related issues arise, to ensure that any unanticipated issues or impacts are quickly identified and addressed in Ensham Mine's IMS or as agreed with landowners.	From commencement of Project activities	Engagements entered to stakeholder register Outcomes of any issues and investigations are recorded and reported as part of the SIMR
Other nearby landowners	Management of any impacts on groundwater bores	- Contact the owners of nearby properties where there is potential for groundwater drawdown to affect water bores to explain the EIS findings on this issue (and other areas of interest to landowners) and agree groundwater monitoring arrangements.	Draft EIS display period	Engagements entered to stakeholder register Groundwater monitoring as forecast in EIS Groundwater assessment
		- Maintain open lines of communication with nearby landowners that have bores on their properties including contacting them on at least an annual basis, to ensure that any Project-related changes to groundwater access (or other factors) are identified and any loss of access to water is addressed through makegood arrangements.	From three months prior to commencement of Project activities, for the life of the Project	Engagements entered to stakeholder register Any make good arrangements are reported in the UWIR
Indigenous community members	Cultural heritage management and respect for traditional ownership	- Seek to enter into a Native Title agreement (with an embedded cultural heritage management system) with Western Kangoulu People, and provide regular updates (at least annually) to Western Kangoulu People.	Prior to commencement of Project activities, and annually	Engagements entered to stakeholder register and reported in SIMR
		- Continue engagement with the Garingbal and Kara Kara People with respect to activities within the existing mining lease and provide regular updates (at least annually) to Western Kangoulu People.	Prior to commencement of Project activities, and annually	Engagements entered to stakeholder register and reported in SIMR

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
		• Provide Indigenous cultural heritage inductions for all workers during mandatory site induction and on-boarding programs, in cooperation with Western Kangoulu People and Garingbal and Kara Kara People.	From commencement of Project activities, for the life of the Project	Human Resources' records
	Employment and training options	• Engage with Emerald State High School, Blackwater State High School, Marist College Emerald, Emerald Agricultural College and Emerald Christian College and CDIQ to communicate Project training and employment opportunities and encourage young Indigenous people to consider training pathways which would equip them for Project employment.	From commencement of Project activities, annually	Engagements entered to stakeholder register and reported in SIMR
	Business opportunities	• Utilise DATSIP's 'Deadly Directory' register of Indigenous businesses to develop a list of Indigenous businesses in the Central Queensland region and invite them to attend 'Meet the Buyer' events.	From three months prior to commencement of Project activities, for the life of the Project	Indigenous business participation reported in SIMR
CHRC and CHDC	Project status and any emerging issues	• Engage with CHRC and CHDC at least annually to provide an update on Project progress, workforce numbers, rehabilitation progress with the existing mine and SIMP implementation, and seek their feedback.	From commencement of Project activities, annually	Engagements entered to stakeholder register, record of action in relation to issues raised kept
		• Offer CHRC Councillors the opportunity to visit Ensham Mine for a site tour.	Prior to commencement of Project activities	Engagement entered to stakeholder register and reported in SIMR
	Pre-closure	• Review the progressive rehabilitation plan in consultation with CHRC and CHDC every five years.	From 2021, every five years	Progressive rehabilitation plan identifies stakeholder inputs and Project responses
		• Meet with CHRC to obtain information about CRC-TiME initiatives aimed at supporting good industry practice in closure	2021 or 2022	Meeting record, and the results of any

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
		and rehabilitation planning, and economic transformation postmining closure		consideration of CRC-TiME research findings noted in SIMR
		- Five years prior to the planned closure of the Project, revise the CSEP to guide engagement with stakeholders during the decommissioning and closure stages.	2032	CSEP available to stakeholders on request
		- Provide an update to all Project personnel regarding the closure schedule prior to the workforce ramp-down, and every six months thereafter prior to closure.	Six monthly during the two to three years prior to closure	HR records Project updates provided to personnel
		- Communicate the process and timing for redundancies ahead of the closure of existing open cut operations and the Project's underground operations to CHRC, CHDC and Department of Education.	2022-2023, 2032-2036	Engagements entered to stakeholder register and reported in SIMR
		- Participate in CHDC and/or CHRC initiatives aiming to diversity and grow the Central Highlands' economy ahead of transition from coal mining to other industries as the region's key economic strengths, including the Regional Resources Roundtable convened by CHDC.	From the commencement of Project activities, as initiated by CHDC/CHRC	Engagements entered to stakeholder register and reported in SIMR
		- Engage with CHRC and CHDC to seek their input into the scope of the CSEP for the Project's pre-closure and closure period.	Five years prior to closure	Engagements and outcomes entered to stakeholder register
Project personnel and suppliers	Local supply opportunities	- Join the QLCLN and actively participate in its activities.	Prior to Project activities commencing	Engagements entered to stakeholder register
		- Provide annual 'Meet the Buyer' events in Emerald to provide an update on forecast procurement requirements and encourage and maintain relationships between the Project's procurement team and local businesses.	From commencement of Project activities,	Annual event participation reported in SIMR

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
			annually for three years	
		• Provide an update to all Project personnel regarding the closure schedule prior to the workforce ramp-down, and every six months thereafter prior to closure.	Six monthly during the two to three years prior to closure	HR records Project updates provided to personnel
		• Provide an update to all Project suppliers regarding the closure prior to the ramp-down of production, and annually in the ensuing years to closure.	Annually during the two to three years prior to closure	Stakeholder engagement records reported as part of progressive rehabilitation and closure plan
Government agencies and social infrastructure providers	Site emergency management	• Engage with QPS and QFES prior to Project commencement to review the EMP.	From three months prior to commencement of Project activities, and every three years	Engagements entered to stakeholder register
	Workforce forecasts	• As part of SIMR (and on request by CHRC, CHDC and Government agencies), provide an annual report on workforce numbers and a forecast of workforce numbers for the 12 months ahead.	Annually during Project activities	Human Resource records, reported in SIMR
Community members and organisations in Emerald and Comet	Project status, employment opportunities, community investment	• Communicate the availability of employment vacancies to local community members through employment agencies based in Emerald.	From the commencement of Project activities, for the life of the Project	Engagements entered to stakeholder register
		• Offer to attend and present at Comet State School to let students and teachers know what happens at Ensham Mine and develop the relationship between Ensham and the school.	Annually for the life of the Project	Engagements entered to stakeholder register

Stakeholders	Issues/Information needs	Actions	Timing	Monitoring and reporting requirements
		• Offer to meet with CHRC's Emerald and Comet Community Reference Groups to provide an update on the Project, and promote community sponsorship and donations opportunities, and share the outcomes of Ensham's sponsorships and donations.	From the commencement of Project activities, for annually for five years	Engagements entered to stakeholder register, reported in SIMR
		• Provide an annual newsletter including Project update, community investment activities and community engagement opportunities emailed to stakeholders and made available via the Project website. • Publication of Project updates, SIMRs and Ensham Mine's complaints management process on the Project website.	From the commencement of Project activities, for the life of the Project	Annual community update attached to SIMR
		• Offer presentations on the Project's underground mining, coal processing operations and environmental management to all schools in Emerald and Comet.	Every two years during Project operations	Engagements entered to stakeholder register, reported in SIMR
		• Attend community events such as the Emerald Show, Comet Show and Ag-grow Emerald on an annual basis.	Annually for the life of the Project	
		• Consider requests to join community management committees and contribute Ensham personnel's expertise to community groups.	From the commencement of Project activities, for the life of the Project	

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A3 SIA Table 6-5: Workforce management measures

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Continuation of employment for local residents	• Implement the employment hierarchy detailed in Section 6.3.3. • Provide family-friendly 7 day on, 7 day off and 5 day on, 2 day off rosters.	Maintenance of at least 34.0 percent local employment for the life of the Project	Ensham employees and contractors, CHRC Job seekers in Central Highlands LGA	From commencement of Project activities, for the life of the Project	HR Manager will record the home addresses of all personnel and report to the GM Operations annually on local employment percentages, for provision to CHRC, CHDC and Government agencies on request.
Recruitment of new personnel to the Central Highlands LGA	• Provide family-friendly rosters as above • Advertising staff roles as based in Emerald • Provide local community information pack to all non-local candidates • Provide a housing subsidy for new local staff • Provide relocation assistance for supervisors and above • Provide an Ensham contact to assist families to access housing and services • In cooperation with the Comet School of Arts Hall committee and CHDC, develop an information pack promoting the lifestyle benefits, services available and housing options and contacts in Comet and Emerald to new recruits.	Recruitment of personnel from outside the Central Highlands LGA to fill Project vacancies which can't be filled locally	Ensham employees and contractors, CHRC Job seekers in Central Queensland region and beyond	From commencement of Project activities, for the life of the Project	HR Manager will maintain records of implementation and record the number of new local employees, for reporting in SIMRs annually and provision to CHRC, CHDC and Government agencies on request.

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
	• Make the Comet and Emerald information packs available to newly on-boarded contractors.				
Employment equity and involvement of underrepresented groups	• Increase the number of women employed by Ensham Mine via measures outlined in Section 6.3.4. • Implement Idemitsu's Equal Employment Opportunity (EEO) principles for the Project.	By 2025, five percent of direct employees are women. By 2030, ten percent of direct employees are women.	Ensham employees and contractors	By (a) 2025 and (b) 2030	HR Manager will maintain records of female employment annually, to be reported in the SIMR.
	• Work with Indigenous stakeholders to support continued employment of Indigenous people and encourage Indigenous people to apply for Project vacancies including: ○ advise Western Kangoulu People, Garingbal and Kara Kara People, CDIQ, and all high schools in the Central Highlands LGA of Project vacancies, and encourage promotion of vacancies through their networks ○ offer one apprenticeship or traineeship at least every two years to an Indigenous person ○ encourage and support Ensham's existing Indigenous personnel to mentor new Indigenous recruits.	Employment of Indigenous personnel will be continued for the life of the Project, in accordance with a confidential agreement with Western Kangoulu People. Involvement of Indigenous businesses from the CQ region in Project supply.	Indigenous community members, CDIQ, Emerald State High School, Western Kangoulu People, Garingbal and Kara Kara People	From commencement of Project activities for life of Project	HR Manager will maintain records of implementation and record the number of Indigenous personnel and business suppliers annually, to be reported in the SIMR.
	• Engage with CHCS, Pre-Headspace Emerald (or Headspace as developed) and On Track College Emerald to provide information about training and employment opportunities offered by Ensham Mine and	Graduates of programs for at-risk and disadvantaged young people are considered for	Disadvantaged young people, CHCS, Pre-Headspace Emerald and On	From 2021, for three years	Stakeholder engagement manager will maintain records of implementation and

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
	its contractors, and encourage disadvantaged young people to apply for training and employment positions.	employment as Project trainees or workers.	Track College Emerald		record the number of at-risk program graduates applying and employed annually.
Workforce wellbeing	• Implement Ensham Mine's Fatigue Management Plan, Fitness for Work Guideline and Drug and Alcohol Procedure for the Project. • Consult with workers to improve and implement safe systems of work that will ensure the health, safety and welfare of workers and other people. • On-site provision of health services including first aid-trained persons, casualty rooms, the availability of first aid kits and trauma packs, ambulance, an EAP program, promotion of access to telehealth services and mental health awareness programs.	Zero fatalities associated with Project operations Continual improvement in LTI rate On-site access to services maintained	Ensham employees and contractors	From commencement of Project activities for the life of Project	HR Manager will maintain records of implementation and outcomes in accordance with Ensham Mine's HSE System
Training and development	• Implement Ensham's Training Scheme for the Project including: ○ Induction and Onboarding program ○ Cultural Awareness Training ○ Inexperienced underground miners' 12 month competency training period ○ Access to competency training for existing employees and where necessary new recruits ○ Maintain the availability of apprenticeships and traineeships at the	Project personnel have access to induction, onboarding and cultural awareness training Competency training is made available to employees in accordance with training analysis Approximately five apprentices and five trainees (on an	Ensham employees and contractors, local young people seeking a career in underground mining	From commencement of Project activities for life of Project	HR Manager will maintain records of training participation, traineeships and apprenticeships, to be reported in the SIMR.

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
	current rate (an annual average of five apprentices and five trainees) ○ Maintain availability of study assistance and undergraduate positions.	annual average basis) employed to 2035			
	• Offer to meet with Emerald State High School, Marist College Emerald, Emerald Christian College, CQU/TAFE, Emerald Agricultural College and Blackwater High School representatives on an annual basis to promote the availability of apprenticeships and traineeships at Ensham Mine and encourage local young people including Indigenous young people to seek training and/or employment at Ensham Mine.	People 16 – 25 years from the Central Highlands LGA including Indigenous young people are employed in Project training/ apprenticeship positions	Emerald State High School, Marist College Emerald, Emerald Christian College, CQU/TAFE, Emerald Agricultural College and Blackwater High School	At commencement of Project and at annual intervals to 2035	Records of meetings with schools will be kept and reported in the SIMR. Training and apprenticeship records will be kept to enable tracking and reporting of apprentice/trainee numbers on request.
	• Participate in industry initiatives e.g. forums and partnerships that are identified by the Resources Roundtable to build local resourcing capacity for mining industry work	Collaboration to support mining industry training initiatives, as initiatives become available	Jobseekers in the Central Highlands LGA, training providers, mining industry stakeholders	As and when identified in Resources Roundtable discussions	Any collaboration will be reported in the SIMR
Closure impacts	• Provide regular updates to Project personnel regarding the ramp-down and closure of open cut operations and the ramp-down and closure schedule for the Project	Project personnel are aware of the period of employment available and able to pursue other employment options when appropriate	Project personnel and families	12 months and six months ahead of the open cut operation ceasing production 3 years, 2 years and then six monthly prior to the Project	HR/ communication records will include records of communication with personnel Advice will be provided to OCG that this has occurred

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
				ceasing production	
	- Keep the CHRC and CHDC updated on changes to Ensham Mine's workforce numbers, including providing advice 12 month ahead of the planned closure of the open cut operation, and at least three years prior to the planned cessation of Project operation.	Annual updates to CHRC and CHDC	CHRC and CHDC	From commencement of Project activities for life of Project	General Manager Operations will record details of engagement for reporting in the SIMR

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A4 SIA Table 6-7: Housing and accommodation management actions

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Affordable access to housing for locally based staff	- Provide housing subsidy to all staff living in the Central Highlands LGA	All locally resident staff are supported to access and maintain housing arrangements in the Central Highlands LGA.	Ensham personnel	From commencement of Project activities, for the life of the Project	Internal confidential records of housing subsidies will be kept. The number of staff receiving housing subsidies will be provided to the OCG on request.
Access to high quality workforce accommodation	- Maintain the availability of accommodation, meals, services and recreational facilities within the Ensham workforce accommodation village	Sufficient accommodation is available within the workforce accommodation	Ensham personnel, CHRC	From commencement of Project activities, for the life of the Project	Workforce accommodation village management records the adequacy of accommodation

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
		village for all non-local personnel			capacity, to be reported in the SIMR.

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A5 SIA Table 6-9: Health and community well-being actions

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Workers' health	• Maintain on-site health services including: ○ first aid-trained persons available on site at all times ○ casualty rooms for first aid treatment ○ making first aid kits, trauma packs and Ensham's Ambulance available ○ EAP provider ○ promotion of access to telehealth services ○ maintenance of applicable relevant provisions as directed by Queensland Health with regard to COVID-19.	Support the health and well-being of Project personnel by maintaining Ensham Mine's current on-site health and recreation services.	Project personnel, Queensland Health	From commencement of Project activities, for the life of the Project	Work health and safety records are kept and reported in accordance with Workplace Health and Safety requirements
	• Investigate the availability of 'Mates in Mining' training and awareness courses and make such a course available to Project personnel.	Promote awareness of mental health issues and strategies to maintain health	Project personnel	During the first year of Project activities, and ongoing as determined in consultation with personnel	HR records of mental of mental health program provision will be reported in Year 1 SIMR

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Stress/mental health - impacted and/or nearby landowners	• Maintain engagement with landowners during the EIS process and throughout the life of the Project to ensure they aware of Project progress, can efficiently communicate about any issues of concern, and can participate in engagement towards the development of the Project's progressive rehabilitation plan.	Ensham maintains open and accessible communication which supports cooperative relationships between landowners and the Project.	Directly affected and adjacent landowners	From draft EIS display period for the life of the Project	Stakeholder register records engagement and outcomes of engagement, with an engagement record summary included in SIMRs
Access to natural resources (groundwater)	• Comply with the Water Act's underground water management framework including entering into make good arrangements for any loss of access to water. • Maintain open lines of communication with nearby landowners that have bores to ensure any Project-related changes to groundwater access are identified and addressed.	Any groundwater drawdown is predicted and monitored to enable timely make-good arrangements.	Landowners considered within the Project's groundwater monitoring framework	From commencement of Project activities for the life of the Project	Monitoring and reporting will be undertaken in accordance with the UWIR process
Support for social infrastructure planning	• Share information on the Project's employee numbers and local and DIDO/FIFO percentages on request by CHRC, CHDC or Queensland Government agencies.	Council and Government agencies have sufficient information to support social infrastructure planning.	CHRC, CHDC and Queensland Government agencies	From commencement of Project activities for the life of the Project	Communications will be recorded in the stakeholder engagement register and reported as part of SIMRs.
	• Update Council and Government agencies on changes to workforce numbers one year ahead of (a) the closure of the open-cut operations, (b) the ramp-down of underground mining and (c) Ensham Mine's Closure.	Council and government agencies can anticipate population changes	CHRC, CHDC, Queensland Heath, Department of Education, DSDILGP, QPS, QAS and DCDDS	One year prior to open cut closure, ramp down and Project closure	Communications will be recorded in the stakeholder engagement register and reported as part of SIMRs.

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Co-operation with emergency services	• Engage with QPS, QAS and QFES to review and if necessary, revise the EMP prior to Project commencement. • Invite the engagement QPS, QAS and QFES in annual training exercises and major training exercises every 3-4 years. • As part of annual training engagements, seek input into evaluation of the health and wellbeing plan's effectiveness. • Involve Queensland Health in periodic SIMP reviews.	QPS, QAS and QFES agree with proposed EMP provisions. Queensland Health has the opportunity to provide feedback on SIMP implementation.	QPS, QAS, QFES, Queensland Health	Prior to commencement of Project activities for the life of the Project for the life of the Project	Communications will be recorded in the stakeholder engagement register and reported as part of SIMRs.
Community investment	• Maintain provision of Ensham's Community Donations and Sponsorship program. • Review community investment priorities in cooperation with CHRC during the first year of Project activities and every five years to set priorities for community investment.	Demonstrated contributions to community programs, facilities and events and support for community priorities.	CHRC, CHDC, community members and groups	Within 12 months of Project commencement and for the life of the Project	Communications will be recorded in the stakeholder engagement register and reported as part of the SIMRs.
	• Engage with CHRC to identify and implement a partnership to support quality of life in Emerald and support its attractiveness as a place for people of all ages, in turn supporting attraction and retention of local residents.	Development and implementation of a partnership between Ensham and CHRC with demonstrable outcomes, as agreed between Ensham and CHRC	CHRC, community members and groups	Initiated in 2021, implemented to a timeframe agreed with CHRC	Communications will be recorded in the stakeholder engagement register and reported as part of SIMRs.

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A6 SIA Table 6-11: Local business and industry procurement actions

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Local supply opportunities	Establish and maintain a Local Business Register and promote supply opportunities via the Register and Project website, with a link to company procurement procedures	Maintenance and if possible, improvement of the number of local businesses supplying Ensham Mine's underground operation	CHRC, CHDC, local and regional businesses	Six months prior to commencement of Project activities, and for life of project	Procurement expenditure in the Central Highlands and Central Queensland regions will be tracked and, reported as part of Annual QRC Code Industry Reports
	Meet CHDC to identify additional local suppliers who could be provided with information about Project supply opportunities	An increase in the range of Central Highlands LGA businesses supplying the Project, relative to current supply to Ensham's approved underground operation	Local and regional businesses	2021	The outcomes of local supply strategies will be reported as part of the SIMR.
	Review Ensham Mine's procurement strategies to ensure fitness for Project purpose against the QRC Local Content Code and consideration of QLCLN's better practice guide for resource industry local content	Maintenance and if possible, an increase in Ensham underground operations' expenditure with businesses within the Central Highlands and CQ regions	Local and regional businesses, QRC, QLCLN	Six months prior to commencement of Project activities	Procurement guidelines and frameworks will be regularly reviewed with any enhancements reported in the SIMRs.
	Identify Indigenous businesses located in the Central Queensland region through	Inclusion of Indigenous businesses in the	DSDSATSIP, Indigenous businesses,	Six months prior to commencement	The number of Indigenous

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
Opportunities for Indigenous businesses	DSDSATSIP's Deadly Directory and consultation with Traditional Owners.	Local Business Register	Traditional Owners, DESBT	of Project activities	businesses engaged in Project supply Review Local Business Register annually and will be reported on number as part of SIMRs
	Contact and encourage Indigenous businesses to provide information for the Project's Local Business Register	Inclusion of Indigenous businesses in Ensham Mine's supply chain	Indigenous businesses, Traditional Owners		
	Invite Indigenous businesses to business briefing sessions which include information about capacity building programs	Indigenous businesses are engaged in the Ensham Mine' s supply chain throughout the Project life	DSDSATSIP, Indigenous businesses, Traditional owners, DESBT	Annually as part of local business briefings	
Social enterprise	Consult with CQCS, CHDC and CHRC to identify the potential for existing and emerging social enterprises in the Central Highlands LGA to contribute to the Project's supply chain and/or employment base, and also include social enterprises as a priority for community investment	Social enterprises are supported to develop capacity to participate in the supply chain for mining projects, and encouraged to seek donations or investment from Ensham	CHRC, CHDC, CQCS	Consultation to commence during 2021, promotion of sponsorship and donation opportunities during 2021 – 2023	Support for and involvement of social enterprises in the supply chain will be reported as part of the SIMR for the first three years of Project operation
Business capacity building	Provide briefings to local businesses on upcoming supply opportunities and capacity building programs	Local and Indigenous businesses are aware of Project opportunities and programs to support capacity building	CHDC, DESBT, local businesses	Annually during first three years of Project operations	Local business participation in briefings will be recorded and reported participation as part of annual SIMRs

Impact/benefit	Actions	Targets and outcomes sought	Stakeholders	Timeframes for implementation	Monitoring and reporting process
	Join the QLCLN prior to Project commencement and actively participate in its activities	Build and sustain relationships with businesses and cooperation with industry stakeholders	QLCLN members (business and industry), CHDC	From commencement of Project activities	Record and report participation will be recorded and reported as part of annual SIMRs
	Become a Platinum Partner to CHDC	Support CHDC's networking opportunities for local business, community and industry	CHDC, DESBT, local businesses	From commencement of Project activities	Report This will be reported as part of Year 1 the first SIMR
Closure opportunities (open cut operations and Project)	Provide prior advice of the open cut operations' and underground operations' completion to the local supply network (i.e. Local Business Register) and CHDC network	Local businesses are aware of the cessation of supply opportunities	CHDC, local businesses	At least six months before the intended date of operations' completion	This will be recorded and reported as part of relevant SIMR (2023 or 2024)
	In consultation with Traditional Owners and DSDSATSIP and as part of participation in business forums (e.g. events), identify local and regional businesses who can be invited to be tender for contracting opportunities for closure and rehabilitation	Local businesses are aware of the cessation of open cut supply opportunities	Indigenous businesses, Traditional owners, CHDC, QLCLN DESBT, DSDSATSIP	At least 12 months prior to the intended date of operations' completion	Participation will be recorded and reported as part of the relevant SIMR.

Source: Ensham Life of Mine Extension project, EIS Appendix I-1 - Social Impact Assessment (August 2021)

Table A7 Additional proponent commitments received following public notification of the EIS

Aspect	Targets and outcomes sought
Local supply opportunities	Additional commitment for the Project includes: • During 2022 develop a Community and Stakeholder Engagement Plan to manage and maintain effective relationships with affected stakeholders, including:

Aspect	Targets and outcomes sought
	○ continuing to engage with affected stakeholders to discuss and respond to issues concerning the management of potential social impacts; ○ contributing to the social, economic development of local communities through provision of employment, supply and community investment opportunities; ○ in consultation with Indigenous stakeholders establishing employment goals, achieving ongoing employment of Indigenous people and achieving increased participation by Indigenous businesses in contracts for goods or services with Ensham Mine. • During 2032, five years prior to the planned closure of the Project, Ensham will review the Community Stakeholder Engagement Plan to guide engagement with stakeholders during the decommissioning and closure stages.

Source: Adapted from Ensham Life of Mine Extension project, EIS Chapter 26 - Commitments (as provided by the proponent on 15 September)

Appendix C Assessment Report consideration of the *Human Rights Act 2019*

The delegate for the chief executive of the Department of Environment and Science must consider the human rights listed in the *Human Rights Act* 2019 in any decision-making and action.

Table 1 demonstrates how each of the 23 human rights in the Act were considered in the Assessment Report.

Table 1 Consideration of the human rights in the Assessment Report

Act section	Human Right	Evaluation of which rights are relevant to the Assessment Report	Will the action limit or restrict any of the rights identified?
s15	Recognition and equality before the law	No change	
s16	Right to life	Increased risk due to link between greenhouse gas emissions and climate change. See section 4.7 Air.	There is link between greenhouse gas emissions, climate change and risks to human life. The assessment of the proposed project correctly dealt with the contribution of the proposed project to greenhouse gas emissions and adopted the appropriate projected climate change forecasting model to predict the risk of climate change on key matters including flooding. The level of residual risk identified in the EIS complies with current legislative and best industry practice.
s17	Protection from torture and cruel, inhuman or degrading treatment	No change	
s18	Freedom from forced work	No change	
s19	Freedom of movement	No change	
s20	Freedom of thought, conscience, religion and belief	No change	
s21	Freedom of expression	No change	
s22	Peaceful assembly and freedom of association	No change	
s23	Taking part in public life	No change	
s24	Property rights	Impacts on	The proposed project has the potential to reduce the

		landowners through decreased amenity and tenure changes. See Section 3.3 Consultation and Section 4.13 Social.	human rights of landowners and others living in close proximity to the proposed project. These rights will not be impacted if the recommendations of the assessment report are followed by the proponent.
s25	Privacy and reputation	No change	
s26	Protection of families and children	Longer term indirect changes due to greenhouse gas emissions	See s16 above.
s27	Cultural rights—generally	No change	
s28	Cultural rights—Aboriginal peoples and Torres Strait Islander peoples	Potential change to land access, land degradation and disturbance of cultural sites. See section 4.11 Cultural heritage.	Land and cultural interests of traditional owners were identified in the EIS. The proposed project has the potential to impact these interests and I recommend on-going communication between the proponent and the traditional owners.
s29	Right to liberty and security of person	No change	
s30	Humane treatment when deprived of liberty	No change	
s31	Fair hearing	No change	
s32	Rights in criminal proceedings	No change	
s34	Children in the criminal process	No change	
s35	Right not to be tried or punished more than once	No change	
s36	Retrospective criminal laws	No change	
s37	Right to Education	No change	
s38	Right to health services	No change	

Appendix D Amended commitments table (amendment to Chapter 26 of the AEIS)

Commitments register

Aspect	Existing EA condition	Additional commitment
Climate	Not applicable	No additional commitments for the Project.
Land use and tenure	Ensham Mine currently manages impacts to land in accordance with EA conditions G1 to G6 and H1 to H15, including returning mining areas into safe, stable and non-polluting landforms (H4), removal of infrastructure on cessation of mining (H12) and monitoring of rehabilitation against success criteria (Condition H4 and Appendix 3).	No additional commitments for the Project.
Land resources	Ensham Mine manages impacts to land in accordance with EA conditions in Schedules G and H, including maintaining factors of safety (FoS) in the mine's design (G2), establishing plans and procedures for managing rehabilitation (H3-H6) and mine waste (G4), and ensuring all potentially contaminating substances are stored and handled in accordance with Australian Standards (G5).	Additional commitments for the Project include: • The proponent will conduct a property-scale soil and land resource survey in accordance with the requirements of the Terms of Reference. • The proponent will undertake a land suitability assessment following the soil survey as required by the necessary regulation and guidelines. The study reports would be completed by approximately 21 January 2022.
Rehabilitation and closure	Ensham Mine manages rehabilitation activities in accordance with EA conditions H3 to H6 of EA Impacts on mine waste on rehabilitation (G4), exploration rehabilitation (G6) and flood protection levees (D39).	Additional commitment for the Project includes: • Subsidence monitoring will be undertaken in accordance with the Subsidence Management Plan.
Surface water resources	Ensham Mine currently manages impacts to water in accordance with EA conditions C1 to C58, including complying with the defined release water quality triggers and limits. Condition C21 requires that the quality of the receiving waters must be monitored at the monitoring points specified in Table C5. An additional monitoring point upstream of Zone 1 is proposed.	Additional commitment for the Project includes: – Future mine water management tool (Goldsim model) to be calibrated using collected data from site. – Proponent will monitor the new upstream monitoring point MP7. – REMP to be updated to include the new monitoring point MP7 and water quality data
Flooding	In accordance with conditions D37 and D38 of the EA, Ensham Mine currently have measures in place to ensure that the mine, including	No additional commitments for the Project.

Aspect	Existing EA condition	Additional commitment
	underground portals, are protected be project levees. Condition G5 refers to secure storage of dangerous goods and hazardous substances to prevent loss of containment during flooding events. Condition H9 refers to flood protection landform design.	
Groundwater	Ensham Mine currently manages impacts to groundwater in accordance with EA conditions C39 to C58, including monitoring under condition C47 and Tables C10 and C11.	Additional commitment for the Project includes: – The proponent will include three additional monitoring bores (13020166, 13020169, 13020174) to the current monitoring network by 30 November 2021. – Install a standpipe bore into the Target Coal seam by June 2022. This date is pending council approvals. – New monitoring bores will be monitored at least 18 times during a 24-month period to establish bore specific groundwater quality triggers. – A bore census will be undertaken by February 2022. This date is pending landholder access approval for a baseline survey.
Terrestrial ecology	Not applicable	Additional commitments for the Project include: – Flaring infrastructure in Zone 2 of the Project Site will be outside strategic cropping and priority agricultural areas.
Aquatic ecology	Ensham Mine currently manages impacts to aquatic flora and fauna in accordance with EA condition C25 Receiving Environment Monitoring Program (REMP).	No additional commitments for the Project.
Air quality	Ensham Mine currently manages impacts to air in accordance with EA Schedule B, including dust nuisance (B1 to B4) and odour (B5 to B7).	No additional commitments for the Project.
Greenhouse gas	Not applicable	No additional commitments for the Project.
Noise and vibration	Ensham Mine currently manages noise impacts in accordance with EA conditions E1 to E6, vibration impacts in accordance with conditions E7 to E10, and airblast overpressure nuisance in accordance with conditions E11 to E15	No additional commitments for the Project.
Waste management	Ensham Mine currently manages waste impacts in accordance with EA conditions F1 to F12, including F6 Waste Management Plan.	No additional commitments for the Project.

Aspect	Existing EA condition	Additional commitment
	Condition G4 stipulates the requirements for the Mineral Waste Management Plan.	
Hazards and safety	Ensham Mine currently manages site hazards and safety in accordance with the IMS. Specifically, hazardous materials are managed and stored in accordance with EA condition G5.	No additional commitments for the Project.
Cultural heritage	Not applicable	No additional commitments for the Project.
Social	Not applicable	Additional commitment for the Project includes: During 2022 develop a Community and Stakeholder Engagement Plan to manage and maintain effective relationships with affected stakeholders, including: – continuing to engage with affected stakeholders to discuss and respond to issues concerning the management of potential social impacts; – contributing to the social, economic development of local communities through provision of employment, supply and community investment opportunities; – in consultation with Indigenous stakeholders establishing employment goals, achieving ongoing employment of Indigenous people and achieving increased participation by Indigenous businesses in contracts for goods or services with Ensham Mine. During 2032, five years prior to the planned closure of the Project, Ensham will review the Community Stakeholder Engagement Plan to guide engagement with stakeholders during the decommissioning and closure stages.
Economic	Not applicable	No additional commitments for the Project.
Transport	Not applicable	Additional commitments for the Project include: Product coal from Ensham mine is railed on the Aurizon managed Central Queensland Coal Network known as the Blackwater System for delivery to both the Gladstone Coal Terminal and the Gladstone Power Station. Coal collected for marketing and quality control purposes may be transported by road. Volume to be transported is not forecast to exceed 20 tonnes per annum and around 1 tonne per item. Shipments will be exported from the Port of Gladstone and will continue to contractually require all vessels to meet all performance and vetting requirements published by Gladstone Ports Corporation in alignment with MSQ, AMSA and IMSO prescribed code and legislation.

Aspect	Existing EA condition	Additional commitment
Scenic amenity and lightning	Not applicable	No additional commitments for the Project.
Matters of national environmental significance	Not applicable	No additional commitments for the Project.

Appendix E Additional information provided post EIS

- **URS Report 2005 Geotechnical characterisation and assessment of overburden and potential coal reject material at the Ensham Central Project**
- **URS Report 2015 Geotechnical characterisation of overburden and potential rejects**

FINAL REPORT

Geochemical Characterisation and Assessment of Overburden and Potential Coal Reject Material at the Ensham Central Project

Prepared for

Hansen Consulting

On behalf of Ensham Resources Pty Ltd

24 October, 2005

42625576 / R001-FINAL.DOC

Prepared by

URS Australia Pty Ltd

environmental
and engineering
professional services

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* ALS laboratory results (raw data) are not included herein and can be provided upon request.

1.1 Introduction

URS Australia Pty Ltd (URS) has been commissioned by Hansen Consulting to provide consulting services for an existing coal mine (Ensham Mine), located east of Emerald in Queensland (**Figure 1.1**). These consulting services were required as an integral component of the Environmental Impact Statement (EIS) documentation required for the proposed Ensham Central Project.

URS has geochemically characterised overburden and potential reject material from the proposed Ensham Central Project to be operated by Ensham Resources Pty Ltd. Management strategies have been developed to address overburden mining, potential reject generation, overburden dump construction and rehabilitation.

1.2 Project Description

The Ensham Central Project incorporates an overburden geochemistry study area of approximately 766 Ha (**Figure 1.2**). The depth of overburden cover material at the study area ranges from 20 to 120 m and averages about 60 m. The two main overburden areas are located northeast and southwest of the Nogoa River on land owned by Ensham Resources Pty Ltd. Given that the average depth of overburden cover material at the study area is 60 m (JB Mining Services, 2004), the total volume of overburden likely to be generated by the proposed project is in excess of 500 million m^3.

Geochemical characterisation of potential coal reject material (coal seam, roof and floor samples) has also been incorporated into the URS scope of work to address potential environmental management issues should this material to be generated as part of future coal processing activities.

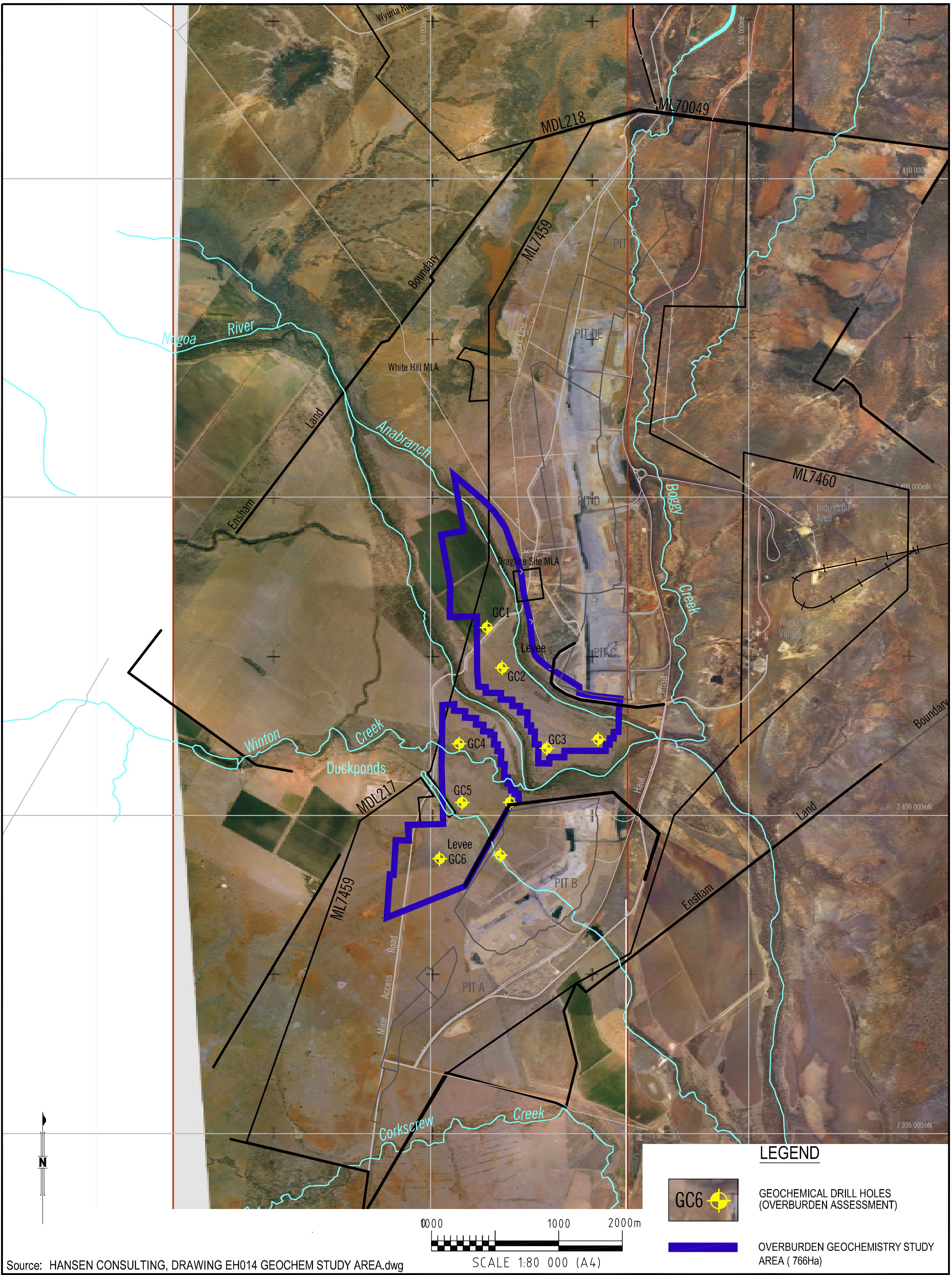
Source: This product incorporates data which is:
ⓒCommonwealth of Australia (Geoscience Australia) 2004.

Client
HANSEN CONSULTING

Project
ENSHAM CENTRAL PROJECT

Title
SITE LOCALITY MAP

Drawn: LL
Approved: IPS
Date: 24-10-2005
Job No: **4262 5576**
File No: 42625576-g-003.wor
Figure: **1.1**
Rev: A
A4



Source: HANSEN CONSULTING, DRAWING EH014 GEOCHEM STUDY AREA.dwg

Client
HANSEN CONSULTING

URS

Project
ENSHAM CENTRAL PROJECT

Title
LOCATION OF DRILL HOLES FOR GEOCHEMICAL STUDY OF OVERBURDEN

Drawn: VH	Approved: IPS	Date: 24-10-2005
Job No.: 4262 5576	File No.: 42625576-g-002c.dwg	

Figure: 1.2

Rev. C

A4

1.3 Objectives

The overall objectives of this project were to:

- Evaluate the geochemical nature of overburden and potential reject materials likely to be produced at the Ensham Central Project and identify potential environmental issues.
- Develop appropriate environmental management strategies to ensure that overburden and potential reject materials are handled, stored and rehabilitated in a manner that mitigates any environmental risk.

1.4 Scope of Work

The scope of the work completed by URS is based on two URS proposals submitted to Hansen Consulting: B04175 / P001-A dated 24 August 2004 and 42625576 / P002-A dated 19 November 2004. Additional geochemical testwork on potential reject materials was undertaken as an amendment to P002-A, based on URS e-mail proposal dated 31 January 2005. The scope of work was also supplemented by preliminary discussions with Hansen Consulting personnel. The scope of work has included the following key tasks:

1.4.1 Desktop Review

A desktop review of available project data including geological data and exploration drilling programs was completed. Discussions were held with Hansen Consulting personnel to identify relevant information.

1.4.2 Development of Sampling and Testing Program

URS developed a cost-effective overburden and potential reject sampling and testing program based on existing data, integrated with the exploration drilling program. The program focussed on acquiring representative samples of the main overburden and potential reject material types, which predominantly comprised sandstone, siltstone, mudstone and coal. A small number of unconsolidated samples (soil, sand, gravel, silt and clay) prevalent in the weathered near surface materials were also collected.

Throughout the proposed open cut area, the depth of weathering averages about 25 m below surface (JB Mining Services, 2004). Therefore, much of the top 25 metres of overburden was expected to be geochemically benign.

The expected geochemical properties of overburden and coal reject material were evaluated. Existing information from mining areas outside the Ensham Central Project study indicated that these materials were likely to be geochemically benign, although some pyritic materials were known to exist in the coal seam roof materials, particularly at the southern end of the mine.

1.4.3 Site Visit and Implementation of Sampling and Testing Program

A site visit was completed in November and December 2004 to gain an appreciation of the study area and to supervise the drilling contractor completing the drilling and sampling program. Details of sample storage and transport requirements were provided to the relevant geochemical testing laboratory. URS coordinated the geochemical testing program with laboratory personnel and reviewed laboratory results to ensure that any requirement for additional testing was identified at an early stage.

The laboratory testing program included static acid-base tests on all samples; multi-element and nutrient testwork on composite samples; and short-term kinetic column leach testwork on selected overburden and potential reject material composite samples.

1.4.4 Interpretation of Results and Development of Management Strategies

URS has interpreted the geochemical test results and determined the current and future potential for overburden and potential reject materials to generate adverse pH conditions, release metals/salts and exhibit sodic characteristics. Appropriate environmental management strategies were developed to ensure that overburden and potential reject materials were handled, stored and rehabilitated in a manner that mitigated any environmental risk to the environment.

1.4.5 Reporting

URS has completed this report describing the overburden and potential reject material sampling and testing program and summarising the results. The results were used to determine any opportunities or constraints related to the development of practical and cost-effective management strategies for overburden and potential reject materials. Conclusions have been drawn regarding the extent of any environmental risks and potential environmental impacts associated with overburden removal, spoil placement and potential reject generation. Operational safeguards or mitigation measures have been recommended based on the potential risk of environmental impact and with consideration to established proponent strategies.

This section provides the methodology used for the geochemical characterisation and assessment of overburden and potential reject materials likely to be produced at the Ensham Project.

2.1 Sampling Strategy

There are currently no specific regulatory requirements regarding the number of samples required to be obtained and tested for overburden or potential reject materials at mines in Queensland. However, URS has been working with the Queensland Environmental Protection Agency (EPA) to update existing technical guidelines for geochemical assessment of mine wastes in Queensland (DME, 1995). The recommended number of samples depends on a number of factors including the geological variability and complexity in rock types; potential for significant environmental or health impacts, the size of the operation, cost, statistical sample representation requirements, the volume of waste and the level of confidence in predictive ability.

The overburden and potential reject sampling strategy developed by URS is based on the above requirements and also takes into account geological and exploration drilling information provided by Hansen Consulting and Ensham personnel. A key requirement of the sampling strategy was to ensure that drill samples were selected to represent the various overburden rock types likely to be associated with the mine development. On the basis of initial information supplied to URS, a total of 66 samples were collected for analysis from 9 drill holes in the proposed open cut area (**Figure 1.2**). The 66 samples comprise 49 overburden samples and 17 potential reject samples (five (5), of which are coal samples). Coal samples are included in the geochemical test program since some uneconomic coal material may report to spoil storage areas or may generate reject materials if coal processing is used in future operations.

2.2 Geochemical Tests

Overburden and potential reject samples were initially screened using a series of standard static geochemical tests including pH, Electrical Conductivity (EC), Acidity or Alkalinity, Total Sulfur, Sulfate Sulfur, Acid Neutralising Capacity (ANC) and Net Acid Producing Potential. (The Net Acid Generation (NAG) test was not used for overburden/potential reject testing as recent research by Stewart *et al.* (2003) into the veracity of the NAG test indicates that the presence of organic matter in samples from coal mining operations can cause erroneous results to be recorded). The ALS laboratory results (raw data) obtained during this study are not included herein and can be provided upon request.

Upon receipt of initial screening results, sixty-four (64) selected samples were combined into fourteen (14) composite samples according to rock type and geochemical nature as described in

Table B1 (**Appendix B**). Where only a few samples of a particular rock-type were collected (*e.g.* coal) due to technical constraints in the drilling program, these samples were grouped into one composite sample. Where many samples of a particular rock-type were collected (*e.g.* siltstone) each composite sample (of that rock-type) generally represented a depth interval of between 5 and 20 m.

The multi-element composition of the composite samples was determined to identify the presence of any elements at concentrations of environmental significance.

Water extracts from the composite samples were also subjected to multi-element analyses to determine the initial solubility and potential mobility of any elements of concern from the overburden materials.

Additional tests were performed on composite samples to determine the suitability of overburden/reject materials for use in rehabilitation and establishment of vegetation. These tests included: pH and EC on 1:5 sample:water extracts, alkalinity, effective Cation Exchange Capacity (eCEC), Exchangeable Sodium Percentage (ESP), Total Nitrogen (Total N), Extractable Phosphorus (Ext. P) and Total Organic Carbon (TOC).

Short-term weathering (leach column) trials were completed for five (5) composite overburden samples and three (3) composite potential reject samples to support the findings of the static geochemical test results. URS has an in-house laboratory set up specifically for short-term weathering trials, which took about 4 weeks to complete (**Appendix C** provides details on URS kinetic leach column design methodology). Table 2.1 summarises the geochemical test program.

Table 2.1 Summary of the Geochemical Test Program

Analytical Tests	Overburden Materials	Potential Reject Materials	
		Coal	Other Reject Materials
Static acid-base	All 49 samples	All 5 samples	All 12 samples
Multi-element and TOC on solids	9 composites (clay, mudstone, sandstone (x2) and siltstone (x5))	1 composite (coal)	4 composites (mudstone floor and roof, siltstone roof and coal/siltstone)
Multi-element, pH, EC and alkalinity on water extracts	9 composites (clay, mudstone, sandstone (x2) and siltstone (x5))	1 composite (coal)	4 composites (mudstone floor and roof, siltstone roof and coal/siltstone)
Total N, Ext P, eCEC and ESP	9 composites (clay, mudstone, sandstone (x2) and siltstone (x5))	1 composite (coal)	4 composites (mudstone floor and roof, siltstone roof and coal/siltstone)
Multi-element, pH, EC and alkalinity on kinetic column leachate	5 composites (mudstone, sandstone and siltstone (x3))	1 composite (coal)	2 composites (mudstone floor and roof)

2.3 Explanation of Geochemical Terminology

Geochemical test results for all of the overburden and potential reject samples obtained from the Ensham Central Project are presented in this section. A brief explanation of the terminology used as part of a geochemical assessment of mine waste materials is provided in Sections 2.3.1 and 2.3.2. A more detailed description of the methodology used by URS for evaluating and interpreting geochemical data is provided at **Appendix D**.

2.3.1 Acid Generation and Prediction

Acid generation from mine waste materials is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum potential acid (MPA) that could be generated by a waste, either directly from pyritic sulfur content, or by assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite oxidises to generate acid according to the following overall reaction:

$$\mathbf{FeS_2 + \tfrac{15}{4}O_2 + \tfrac{7}{2}H_2O \text{ ---> } Fe(OH)_3 + 2\ H_2SO_4}$$

The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralisation, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation and represents the balance between the MPA and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg H_2SO_4/t sample. If the ANC exceeds the MPA, then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive. A strongly positive NAPP result generally indicates that a sample is potentially acid forming (PAF), whereas a strongly negative NAPP generally indicates that a sample is non-acid forming (NAF).

2.3.2 Assessment of Element Enrichment and Solubility

Multi-element scans are carried out to identify any elements (particularly metals) present in a material at concentrations that may be of environmental concern with respect to surface water quality and revegetation. The assay result for each element is compared to potentially relevant guideline criteria to determine any concerns related to mine operation and final rehabilitation. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality, or public health, but their significance should be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (*e.g.* low pH) the geochemical behaviour of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

There are no guidelines and/or regulatory criteria specifically related to total metal concentrations in overburden and coal reject materials. In the absence of these and to provide relevant context, URS has compared the total concentration of each element reported in overburden and potential reject samples (solids) to QLD-EPA (1998) environmental investigation levels (contaminated soils) and NEPM (1999a) health-based investigation levels (HIL's) for parks and recreation (open spaces). The QLD-EPA (1998) guidelines are primarily aimed at contaminated land investigations and, in this context, provide a suitable guideline for an industrial facility, such as a mine. The NEPM (1999a) guidelines for 'open spaces' are less stringent than the QLD-EPA guidelines, however their applicability stems from the likely final land use of the mine following closure (*i.e.* a return to livestock grazing).

The total metals concentration for individual elements in overburden and potential reject materials can be relevant for revegetation activities and/or where the potential exists for human contact (*e.g.* if the material was to be used off-site). Of more importance to the mine is the potential for overburden and potential reject material to leach soluble metals at concentrations that may impact the environment or human health. The water extract tests address this issue.

Water extracts are used to determine the immediate solubility and potential mobility of elements under existing pH conditions. Soluble element concentrations are generally compared with those recommended in relevant surface water and groundwater guideline criteria in order to determine their environmental significance.

Again, there are no guidelines and regulatory criteria specifically related to seepage from overburden and coal reject materials since guidelines (and regulatory criteria) will depend upon the end-use and receiving environment of the seepage. Therefore, to provide relevant context, URS has compared the soluble concentration of each element extracted from overburden and potential reject materials to NEPM (1999b) investigation levels for groundwater and ANZECC (2000) livestock drinking water guidelines. These guidelines allow for higher concentrations of individual parameters (appropriate for an industrial facility in a rural area) and are less prescriptive and more reasonable (in the context of the project) than guidelines designed for water to be used for human consumption or being directly discharged into an aquatic environment (*e.g.* stream, river, lake, etc.).

2.3.3 Sodicity

The relative proportion of the various cations (*e.g.* calcium, magnesium, potassium and sodium) in overburden material can have a significant effect on the physical properties of that material. Potential effects can be indicated by assessment of material sodicity, as measured by the

Exchangeable Sodium Percentage (ESP[1]). ESP is calculated from the effective cation exchange capacity (eCEC) of the material. When the ESP is high or the calcium/magnesium ratio is low, the material is more likely to disperse upon wetting. As the percentage of sodium in the material increases, the tendency for dispersion increases, resulting in crusting, reduced infiltration and consequent reduced plant growth, high runoff and erosion. In general terms, ESP values of less than 6 indicate that a material has a low risk of dispersion and ESP values greater than 12 indicate that a material has a high risk of dispersion. The effect of ESP on dispersion is also influenced by other soil properties such as organic matter content, clay mineralogy, cation composition, and particularly electrolyte concentration of the soil and of any applied irrigation water (Isbell, 2002). Materials with a high risk of dispersion generally require management strategies to be put in place to ensure that slopes are stabilised against erosion.

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[1] ESP can be defined as the proportion of sodium adsorbed onto a material surface as a proportion of the total cation exchange capacity.

3.1 Static Geochemical Testing

3.1.1 Acid-Base Tests: Individual Samples

Overburden

Acid-Base test results for the 49 overburden samples representing specific lithological rock types are presented in Table 3.1 and summarised below.

- The current pH of the overburden samples is slightly alkaline (average pH 8.1) and ranges from 7.0 to 8.8. The current alkalinity is low to moderate (ranges from 0.5 to 39.8 kg H_2SO_4/t) and has an average value of 5.1 kg H_2SO_4/t.
- The current conductivity is relatively low and ranges from 205 to 917 μS/cm, with an average value of 457 μS/cm.
- The total sulfur content of the overburden samples is relatively low, ranging from 0.02 % to 0.15 % (average 0.07 %). Sulfate sulfur generally represents less than 10 % of total sulfur, indicating that sulfur is mostly present in the sulfide (unoxidised) form or as organic sulfur. The Maximum Potential Acidity (MPA) that could be generated by these samples ranges from 0.6 to 4.6 kg H_2SO_4/t and is generally low (average value is 2.2 kg H_2SO_4/t).
- The ANC values range from low to high (14 to 147 kg H_2SO_4/t) and are generally moderate (average ANC value is 44 kg H_2SO_4/t).
- The NAPP values range from -144 to -13 kg H_2SO_4/t, with an average NAPP value of -42 kg H_2SO_4/t.
- On the basis of these results, all of the 49 overburden samples are classified as Non-Acid Forming (NAF). Only three (3) of the overburden samples have total sulfur values greater than 0.1 %, hence approximately 95% of overburden samples are also classified as barren[2].

Potential Reject

Acid-Base test results for the 17 samples that could potential report as reject are presented in Table 3.1 and summarised below. These samples comprise five coal seam samples and 12 roof and floor samples.

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[2] The term 'barren' in this report is used to define materials containing less than 0.1 % total sulfur.

- The current pH of the potential reject samples is slightly alkaline (average pH 8.1) and ranges from 7.2 to 9.0. The current alkalinity is low to moderate (ranges from 0.2 to 57 kg H_2SO_4/t) and has an average value of 9 kg H_2SO_4/t.
- The current conductivity is relatively low and ranges from 168 to 762 µS/cm, with an average value of 416 µS/cm.
- The total sulfur content ranges from low to moderate (0.04 to 0.74%; average 0.24%), and is mostly present in the sulfide (unoxidised) form. Coal samples generally have a higher total sulfur content than other potential reject materials. The MPA that could be generated by potential reject samples ranges from low to moderate (0.58 to 23 kg H_2SO_4/t) and is generally low (average value is 6.9 kg H_2SO_4/t).
- The ANC value is generally moderate, ranging from 24 to 238 kg H_2SO_4/t (average ANC value is 53 kg H_2SO_4/t).
- The NAPP values are all negative, ranging from -215 to -9 kg H_2SO_4/t, (average NAPP value is -46 kg H_2SO_4/t).
- On the basis of these results, all of the potential reject samples are classified as Non-Acid Forming (NAF). 33% of the roof and floor samples have total sulfur values less than 0.1 % and are also classified as barren. Four of the five coal samples have total sulfur values greater than 0.25 %.

The significance of acid base test results for overburden and potential reject material management at the Ensham Central Project is discussed in detail in Section 4.1.

Table 3.1

Acid-Base Test Results for Overburden and Potential Reject Samples - Ensham Central Project

Sample Number	Drillhole ID	Sample Interval	Sample Description	pH[1]	Alkalinity (to pH 5.5)	EC[1]	Total Sulfur	Sulfate Sulfur	MPA[2]	ANC[2]	NAPP[2]	Sample Classification[3]
		(m)			(kg H_2SO_4/t)	(μS/cm)	(%)		(kg H_2SO_4/t)			
Overburden Samples												
1	01	04 - 05	clay	8.4	1.9	272	0.02	0.003	0.61	17	-16	Non Acid Forming
2	01	14 - 15	gravel/sandstone	7.9	2.0	213	0.02	0.004	0.61	15	-15	Non Acid Forming
61	02	07 - 08	sandstone	7.6	1.0	298	0.06	0.004	1.84	57	-55	Non Acid Forming
3	02	22 - 23	mudstone	8.0	3.1	246	0.15	0.004	4.59	26	-21	Non Acid Forming
64	02	34 - 35	siltstone	8.1	6.7	336	0.11	0.005	3.37	66	-62	Non Acid Forming
54	AB9	04 - 05	gravelly clay	7.0	1.3	849	0.09	0.007	2.76	15	-13	Non Acid Forming
55	AB9	11 - 12	sandstone	7.8	1.0	224	0.02	0.003	0.61	17	-16	Non Acid Forming
56	AB9	23 - 24	siltstone	8.2	1.8	340	0.08	0.006	2.45	41	-38	Non Acid Forming
57	AB9	33 - 34	mudstone	7.7	2.3	917	0.08	0.010	2.45	32	-29	Non Acid Forming
58	AB9	49 - 50	siltstone	8.5	1.8	407	0.09	0.003	2.76	45	-42	Non Acid Forming
59	AB9	67 - 68	siltstone	8.3	1.5	561	0.06	0.005	1.84	37	-35	Non Acid Forming
60	AB9	86 - 87	siltstone	8.6	3.2	845	0.09	0.006	2.76	108	-105	Non Acid Forming
5	GC1	07 -08	sandstone	8.8	1.6	267	0.02	0.002	0.61	15	-15	Non Acid Forming
6	GC1	17 - 18	sandstone	8.3	1.2	205	0.02	0.003	0.61	14	-13	Non Acid Forming
7	GC2	07 - 08	sandstone	7.5	1.4	466	0.03	0.009	0.92	17	-16	Non Acid Forming
8	GC2	19 - 20	siltstone	7.8	8.2	453	0.07	0.007	2.14	42	-40	Non Acid Forming
9	GC2	26 - 27	siltstone	8.2	29.3	825	0.06	0.014	1.84	87	-85	Non Acid Forming
10	GC2	35 - 36	siltstone	8.2	9.8	884	0.06	0.012	1.84	41	-39	Non Acid Forming
11	GC2	51 - 52	siltstone	8.0	1.9	852	0.07	0.012	2.14	54	-52	Non Acid Forming
12	GC2	71 - 72	siltstone	7.8	17.9	398	0.07	0.007	2.14	45	-43	Non Acid Forming
13	GC3	30 - 31 (25 - 26)	mudstone	8.2	5.5	261	0.07	0.003	2.14	26	-23	Non Acid Forming
14	GC3	35 - 36 (29 - 30)	siltstone	8.2	2.4	266	0.09	0.005	2.76	42	-39	Non Acid Forming
15	GC3	47 - 48 (39 - 40)	siltstone	8.1	5.5	310	0.07	0.005	2.14	45	-43	Non Acid Forming
19	GC3	60 - 61 (50 - 51)	sandstone	8.3	4.2	527	0.08	0.010	2.45	82	-80	Non Acid Forming
20	GC3	68 - 69 (57 - 58)	siltstone	7.1	2.4	759	0.09	0.019	2.76	32	-29	Non Acid Forming
24	GC4	07 - 08	sandstone	7.8	1.8	436	0.05	0.010	1.53	28	-27	Non Acid Forming
25	GC4	15 - 16	mudstone	8.0	5.9	762	0.09	0.009	2.76	50	-47	Non Acid Forming
26	GC4	26 - 27	gravelly siltstone	8.0	2.6	555	0.09	0.005	2.76	32	-29	Non Acid Forming
27	GC4	40 - 41	siltstone	8.5	1.9	281	0.08	0.001	2.45	35	-33	Non Acid Forming
28	GC4	59 - 60	siltstone	8.4	6.4	331	0.09	0.002	2.76	52	-49	Non Acid Forming
29	GC4	76 - 77	siltstone	8.7	1.2	399	0.08	0.002	2.45	28	-26	Non Acid Forming
30	GC4	87 - 88	siltstone	8.5	3.7	425	0.09	0.002	2.76	42	-39	Non Acid Forming
33	GC5	04 - 05	clay	7.5	0.8	212	0.04	0.003	1.23	18	-16	Non Acid Forming
34	GC5	07 - 08	sandstone	7.8	0.5	210	0.02	0.004	0.61	21	-21	Non Acid Forming
35	GC5	12 - 13	mudstone	8.0	2.9	702	0.02	0.009	0.61	27	-27	Non Acid Forming
36	GC5	17 - 18	siltstone	8.1	2.5	302	0.07	0.002	2.14	29	-27	Non Acid Forming
37	GC5	29 - 30	siltstone	8.3	16.9	275	0.08	0.002	2.45	147	-145	Non Acid Forming
38	GC5	41 - 42	siltstone	8.2	12.3	306	0.07	0.002	2.14	94	-92	Non Acid Forming
65	GC5	53 - 54	mudstone	8.8	1.1	339	0.11	0.003	3.37	25	-21	Non Acid Forming
42	GC5	59 - 60	siltstone	8.8	1.7	463	0.09	0.002	2.76	51	-48	Non Acid Forming
66	GC5	68 - 69	siltstone	8.4	7.5	640	0.09	0.003	2.76	57	-54	Non Acid Forming

Table 3.1

Acid-Base Test Results for Overburden and Potential Reject Samples - Ensham Central Project

Sample Number	Drillhole ID	Sample Interval	Sample Description	pH[1]	Alkalinity (to pH 5.5)	EC[1]	Total Sulfur	Sulfate Sulfur	MPA[2]	ANC[2]	NAPP[2]	Sample Classification[3]
		(m)			(kg H_2SO_4/t)	(µS/cm)	(%)		(kg H_2SO_4/t)			
43	GC6	05 - 06	clay	7.7	2.1	876	0.07	0.009	2.14	21	-19	Non Acid Forming
44	GC6	08 - 09	sandstone	8.4	39.8	456	0.04	0.006	1.23	63	-62	Non Acid Forming
45	GC6	11 - 12	mudstone	8.1	2.7	504	0.10	0.004	3.06	27	-24	Non Acid Forming
46	GC6	16 - 17	siltstone	8.1	3.0	460	0.10	0.004	3.06	37	-34	Non Acid Forming
47	GC6	29 - 30	siltstone	8.5	1.1	334	0.10	0.001	3.06	33	-30	Non Acid Forming
48	GC6	40 - 41	siltstone	8.4	2.7	364	0.08	0.001	2.45	55	-53	Non Acid Forming
49	GC6	50 - 51	siltstone	8.5	8.8	315	0.07	0.002	2.14	87	-84	Non Acid Forming
53	GC6	69 - 70	siltstone	8.8	2.8	484	0.09	0.002	2.76	99	-96	Non Acid Forming
Potential Reject Samples												
62	02	24 - 25	mudstone (roof)	7.9	1.3	225	0.08	0.007	2.45	25	-22	Non Acid Forming
63	02	26 - 27	coal	7.2	0.2	168	0.50	0.006	15.3	25	-9	Non Acid Forming
4	02	29 - 30	mudstone (floor)	8.1	12.7	339	0.08	0.005	2.45	57	-54	Non Acid Forming
16	GC3	48 - 49 (40 - 41)	mudstone (roof)	7.4	6.2	430	<0.02	0.014	0.58	44	-43	Non Acid Forming
17	GC3	49 - 50 (41 - 42)	coal	8.5	7.2	330	0.44	0.008	13.5	24	-10	Non Acid Forming
18	GC3	50 - 51 (42 - 43)	mudstone (floor)	9.0	21.8	400	0.15	0.004	4.59	138	-133	Non Acid Forming
21	GC3	74 - 75 (62 - 63)	mudstone (roof)	8.6	7.9	556	0.74	0.010	22.7	238	-215	Non Acid Forming
22	GC3	77 - 78 (64 - 65)	coal	7.8	6.0	436	0.39	0.010	11.9	29	-17	Non Acid Forming
23	GC3	80 - 81 (67 - 68)	mudstone (floor)	8.0	56.5	762	0.15	0.009	4.59	50	-45	Non Acid Forming
31	GC4	92 - 93	poor coal/siltstone	8.2	6.1	417	0.12	0.003	3.68	55	-51	Non Acid Forming
32	GC4	95 - 96	poor coal/siltstone	8.3	2.5	477	0.11	0.004	3.37	27	-24	Non Acid Forming
39	GC5	47 - 48	siltstone (roof)	8.3	3.6	341	0.09	0.003	2.76	35	-33	Non Acid Forming
40	GC5	48 - 49	coal	7.9	9.4	468	0.04	0.006	1.23	51	-49	Non Acid Forming
41	GC5	49 - 50	mudstone (floor)	8.5	1.1	340	0.18	0.003	5.51	24	-19	Non Acid Forming
50	GC6	54 - 55	siltstone (roof)	8.4	5.2	428	0.11	0.003	3.37	35	-32	Non Acid Forming
51	GC6	55 - 56	coal	7.5	3.7	525	0.47	0.005	14.4	24	-10	Non Acid Forming
52	GC6	56 - 57	siltstone (floor)	8.5	1.3	424	0.14	0.005	4.29	25	-21	Non Acid Forming

Notes:

1. Natural pH and EC provided for 1:5 sample:water extracts
2. MPA = Maximum potential acidity; ANC = Acid neutralising capacity; NAPP = Net acid producing potential
3. Samples classified as Potentially Acid Forming if NAPP is positive and Non-Acid Forming if NAPP is negative.

* Sample depth interval for GC3 has been corrected. ALS received, tested and reported on sample depths provided in brackets.

3.1.2 Multi-Element Tests: Composite Samples

Table 3.2 presents the multi-element test results for the fourteen (14) composite samples, which represent the main overburden (9 samples) and potential reject material (5 samples) types. The results indicate that all materials tested have metal concentrations in solids (excluding Mn) below QLD-EPA (1998) environmental investigation levels (EIL) and NEPM (1999a) health-based investigation levels (HIL) for soils. Mn concentrations in solids were marginally above QLD-EPA EIL values in six (6) of the nine (9) overburden samples and two (2) of the five (5) potential reject samples. Mn concentrations were well below relevant NEPM HIL values for soils.

To evaluate the immediate solubility of multi-elements in solids, water extract (1:5 sample: water) tests were completed for the fourteen (14) composite samples. The results from these tests are provided in Table 3.3 and indicate that initial leachate from composite samples contains metal concentrations below those recommended in ANZECC (2000) livestock drinking water guidelines and NEPM (1999b) groundwater investigation levels, except for a marginally elevated Mo concentration in one potential reject composite sample (sample 14, siltstone roof).

The environmental significance of identified metal concentrations in overburden and potential reject materials and their water solubility in terms of risk is discussed in Section 4.2.

3.1.3 pH, Alkalinity and Salinity: Composite Samples

Results for pH, alkalinity and salinity tests on the fourteen (14) composite overburden samples and potential reject samples (5 samples) from the Ensham Central Project are presented in Table 3.3. The results are summarised below.

- The current pH of the nine composite overburden samples is slightly alkaline (average pH 8.7) and ranges from 7.9 to 9.1. The current pH of potential reject samples is also slightly alkaline (average pH 8.6) and ranges from 7.7 to 8.9.
- The current alkalinity of the composite overburden samples is low to moderate (ranges from 4 to 25 kg H_2SO_4/t) and has an average value of 10.8 kg H_2SO_4/t. The current alkalinity of potential reject samples is similar to the overburden materials and ranges from 7 to 36 kg H_2SO_4/t (average 15.6 kg H_2SO_4/t). Alkalinity in all composite samples (overburden and potential rejects) is almost completely comprised of bicarbonate.
- The current conductivity of composite overburden samples is relatively low and ranges from 268 to 547 µS/cm, with an average value of 413 µS/cm. Similarly, the current conductivity of potential reject samples is also relatively low, ranging from 361 to 476 µS/cm, with an average value of 408 µS/cm.

3.1.4 Cation Exchange Capacity and Sodicity: Composite Samples

The results presented in Table 3.3 indicate that the effective CEC (eCEC) of composite overburden samples ranges from 22 to 47 meq/100g, with lower eCEC values generally associated with sandstone. The eCEC of potential reject material composites ranges from 21 to 37 meq/100g, with the non-coal potential reject materials generally reporting higher eCEC values than those samples containing coal.

The ESP results presented in Table 3.3 indicate that the sodicity of all overburden materials is elevated. ESP values range between 7 % and 14 % with no apparent correlation between ESP value and rock type. ESP results for the potential reject materials range between 5% and 11%.

The environmental significance of elevated sodicity levels in overburden and potential reject materials in terms of risk and revegetation management is discussed in Section 4.3.

3.1.5 Nutrients and Organic Carbon: Composite Samples

The current total organic carbon (TOC) concentration in composite overburden samples is very low to moderate and ranges from 0.15% to 1.31% (average 0.49%). In potential reject materials without coal the TOC concentration in composite samples is moderate, ranging from 1.43% to 3.52% (average 2.4%). The TOC concentration of the potential reject coal composite is very high (26.1%) and also high for the coal/siltstone composite sample (5.01%). These results indicate that the organic content of all non-coal materials is generally low. The organic carbon concentration increases with increased coal content, as would be expected.

Total N concentrations in overburden composite materials range from 170 to 680 mg/kg (average 406 mg/kg). In potential reject materials without coal the total N concentration in composite samples is moderate, ranging from 210 to 730 mg/kg (average 543 mg/kg). The total N concentration of the potential reject coal composite is very high (6,000 mg/kg) and moderate for the coal/siltstone composite sample (1,170 mg/kg).

Bicarbonate extractable phosphorus (extractable P) concentration in overburden materials ranges from 7 to 29 mg/kg (average 12 mg/kg). In potential reject materials the extractable P concentration ranges from 6 to 11 mg/kg (average 8 mg/kg).

The environmental significance of these results is discussed in Section 4.3.

Table 3.2

Multi-Element Concentration in Solids of Overburden and Potential Reject Samples - Ensham Central Project

				Overburden Samples (mg/kg) unless otherwise stated									Potential Reject Samples (mg/kg) unless otherwise stated				
		Composite Number -->		1	4	7	8	9	10	11	12	13	2	3	5	6	14
		Material Type -->		Clay (some gravelly clay)	Mudstone (10-55 m)	Sandstone (<10 m)	Sandstone (some gravel) (>10 m)	Siltstone (<30 m)	Siltstone (30-50 m)	Siltstone (40-50 m)	Siltstone (50-70 m)	Siltstone (70-90 m)	Coal	Coal (poor) / siltstone	Mudstone (floor)	Mudstone (roof)	Siltstone (roof)
Major Elements	Detection Limit	QLD-EPA[1] Environmental Investigation Level	NEPM[2] Health-Based Investigation Level														
	(mg/kg) unless otherwise stated																
Al	50	-	-	9,540	12,600	5,270	3,950	16,700	13,400	1,480	10,800	11,500	4,190	10,700	7,790	9,760	14,500
Fe	50	-	-	17,400	28,100	10,400	12,400	40,000	43,200	40,400	34,400	37,700	10,700	32,000	27,000	25,400	32,400
Minor Elements																	
As	5	20	200	<5	6	<5	<5	6	8	6	7	6	<5	12	11	9	10
B	50	1 to 75 (Background)	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cd	1	3	40	<1	<1	<1	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
Co	2	2 to 170 (background)	-	14	12	6	6	15	16	17	16	13	4	13	10	11	16
Cr	2	50[3]	200	20	23	27	27	26	21	24	16	17	5	18	14	19	25
Cu	5	60	2,000	13	37	7	10	42	48	47	40	42	18	46	44	43	51
Mn	5	500	3,000	582	498	207	287	721	812	775	765	618	214	586	554	420	432
Mo	2	<1 to 20 (background)	-	<2	<2	<2	<2	<2	<2	<2	3	<2	<2	2	2	5	3
Pb	5	300	600	8	12	<5	<5	13	14	13	12	13	8	16	12	14	16
Se	5	-	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zn	5	200	14,000	30	64	19	28	69	82	70	70	67	20	78	80	84	78
Total N	20	-	-	170	680	180	410	540	260	440	480	490	6000	1170	730	210	690
Extractable P	2	-	-	29	14	10	12	8	13	7	8	8	7	7	8	11	6
Total Organic C	0.02%	-	-	0.15	1.31	0.19	0.22	0.29	0.65	0.43	0.71	0.43	26.1	5.01	3.52	2.18	1.43

Notes:

< indicates less than the analytical detection limit.

▨ Shaded cells indicate values which exceed relevant QLD-EPA or NEPM guideline values.

1. Queensland Government. Department of Environment. Draft Guidelines for the Assessment & Management of Contaminated Land in Queensland. May 1998.
2. National Environmental Protection (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater (1999). HIL(E): parks, recreational open space and playing fields.
3. Cr (III). No background or QLD-EPA EIL's are available for Cr (VI).

Table 3.3

Multi-Element Concentration of Water Extracts from Overburden and Potential Reject Samples - Ensham Central Project

		Material Group -->	Overburden Materials									Potential Reject Materials				
		Composite No.	1	4	7	8	9	10	11	12	13	2	3	5	6	14
		Material Type -->	Clay (some gravelly clay)	Mudstone (10-55 m)	Sandstone (<10 m)	Sandstone (some gravel)	Siltstone (<30 m)	Siltstone (30-50 m)	Siltstone (40-50 m)	Siltstone (50-70 m)	Siltstone (70-90 m)	Coal	Coal (poor) / siltstone	Mudstone (floor)	Mudstone (roof)	Siltstone (roof)
Parameters	Detection Limit	ANZECC^3/NEPM^4 Guidelines														
pH^1	0.1	-	7.9	8.5	8.3	8.9	8.7	8.7	9.0	9.1	9.1	7.7	8.9	8.9	8.6	8.9
EC^1 (µS/cm)	1	3000^5	547	495	335	268	382	383	310	478	522	476	417	382	361	402
Alkalinity (kg H_2SO_4 /t)	0.05	-	4	14	25	8	14	10	10	6	6	9	7	36	10	16
ESP (%)^2	0.1	-	14.4	10.7	8.8	7.8	7.5	7.1	8.9	12.9	14.4	5.4	11.1	8.4	7.5	11.2
Effective CEC^2 (meq/100g)	0.1	-	22.7	31.3	22.2	22.5	28.6	28.7	29.1	31.6	47.0	21.0	26.8	30.0	26.8	37.0
Major Elements	(mg/L)	(mg/L)	(mg/L)									(mg/L)				
Ca	2	1000	12	10	17	8	10	10	3	3	<2	45	4	8	10	5
Mg	2	-	6	5	8	3	5	5	<2	<2	<2	11	0	3	5	0
Na	2	-	132	114	81	76	78	75	78	122	135	40	90	96	75	101
K	2	-	6	8	6	8	16	16	10	10	10	7	9	13	13	10
Cl	2	-	150	83	50	14	47	47	13	68	78	58	48	26	21	49
SO_4	10	1000	21	42	42	22	36	42	13	31	29	41	18	36	44	31
Minor Elements	(mg/L)	(mg/L)	(mg/L)									(mg/L)				
Al	0.2	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
As	0.02	0.5	<0.02	<0.02	<0.02	<0.02	0.05	0.05	0.10	0.10	0.05	<0.02	0.13	0.13	0.10	0.13
B	0.2	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cd	0.02	0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Co	0.02	1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	0.02	1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	0.02	0.5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe	0.2	1 (irrigation)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mn	0.02	2 (irrigation)	<0.02	<0.02	0.25	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.13	<0.02	<0.02	<0.02	<0.02
Mo	0.02	0.15	<0.02	0.05	<0.02	<0.02	0.05	0.08	0.05	0.10	0.05	0.04	0.09	0.10	0.13	0.18
Pb	0.02	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Se	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zn	0.02	20	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Notes:

< Indicates concentration less than the analytical detection limit.

▨ Shaded cells indicate values which exceed relevant ANZECC or NEPM guideline values.

1. Natural pH and EC provided for 1:5 sample:water extracts
2. ESP = Exchangeable Sodium Percentage; CEC = Cation Exchange Capacity
3. ANZECC and ARMCANZ, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (2000). Livestock drinking water.
4. National Environment Protection (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater (1999). Groundwater Investigation Levels.
5. Approximate maximum EC (based on TDS of ~2000 mg/L) which sensitive animals (poultry) can tolerate without adverse effects (ANZECC 2000 Livestock drinking water quality). This value increases significantly for most other livestock.

3.2 Kinetic Column Leach Testing

Kinetic leach data from the eight kinetic leach columns containing overburden and potential reject material from the Ensham Central Project are provided at **Appendix E** (Tables E1 to E8). Trends in pH and EC are presented in Figures E1a to E8a (**Appendix E**) and sulfate and net alkalinity trends are presented in Figures E1b to E8b (**Appendix E**). The laboratory results received from ALS are not included with this report and can be provided upon request. Five columns contained overburden material and three contained potential reject material (**Table 3.4**).

Table 3.4

Composition of Materials in Kinetic Leach Columns

Kinetic Leach Column Number	Composite Number	Material Group	Material Type (and sample depth interval)
2	4	Overburden	Mudstone
3	7	Overburden	Sandstone (<10 m)
4	9	Overburden	Siltstone (<30 m)
5	11	Overburden	Siltstone (40-50 m)
6	12	Overburden	Siltstone (50-70 m)
1	2	Potential Reject	Coal
7	5	Potential Reject	Mudstone (floor)
8	6	Potential Reject	Mudstone (roof)

For columns 1 to 6, leachate data was collected over four sampling events from the 23 December 2004 to 13 January 2005. For columns 7 and 8, leachate data was collected over four sampling events from 16 February 2005 to 9 March 2005.

Only two sampling events were conducted for Columns 5, 6 and 8 and three sampling events for Column 7, as the materials contained within these columns were fine-grained resulting in extended leaching times. The overburden and potential reject materials in the kinetic leach columns were periodically stirred to encourage flow through the fine-grained and low permeability materials. Stirring caused soil particles, that would otherwise remain unoxidised, to become exposed to the atmosphere and hence the trends in the kinetic leach data presented in this report represent a “worst-case” scenario.

The ratio of solid sample in each column to leachate volume collected from each column during each leaching event ranged from 5:1 to 5:2. Therefore, the leachate collected from each column is significantly concentrated. To obtain an equivalent 1:5 sample to water extract for each leach event (to allow direct comparison with initial water extract test results and applied water quality guideline criteria) required a dilution factor of between 10 and 38 times (Table E9, **Appendix E**). The leach column water quality results reported represent raw leachate, which essentially describes the pore chemistry of the sample material. Discussion of these results and comparison with initial water extract test results and applied “non leachate” water quality guidelines is provided in Section 4.2. The leach column are summarised in Sections 3.2.1 and 3.2.2.

3.2.1 Overburden Samples

- The pH of leachate from overburden materials is slightly alkaline (pH 7.1 to 8.3) throughout the four week test period. The net alkalinity value ranges from 39 to 374 mg $CaCO_3$/L) throughout the four week test period.
- The EC of the initial leachate is slightly brackish (EC generally less than 4,000 µS/cm) and tends to decrease through the four week test period.
- The residual ANC of the initial leachate remains high throughout the test period.
- Dissolved sulfate concentrations in initial leachate range from 1 to 281 mg/L, well below the applied ANZECC (2000) livestock drinking water guideline value of 1,000 mg/L, and remains fairly constant throughout the test period.
- The concentration of dissolved metals in leachate is well below applied ANZECC (2000) and NEPM (1999b) guideline criteria for livestock drinking water (see Tables E2 to E6 at **Appendix E**). Slightly elevated levels of selenium (Se) are present in leachate from four of the five columns containing overburden (Columns 2, 4, 5 and 6**).** Slightly elevated levels of molybdenum (Mo) are present in leachate from three columns (Columns 4, 5 and 6). When appropriate dilution factors are taken into account, all dissolved metal concentrations are well within the applied livestock drinking water guideline values.

3.2.2 Potential Reject Samples

- The pH of the initial and subsequent leachate from potential reject materials is slightly alkaline (pH 7.4 to 8.58). The net alkalinity value ranges from 46 to 224 mg $CaCO_3$/L throughout the test period.
- The EC of the initial leachate is slightly brackish (EC 1,600 to 3,020 µS/cm) and decreases throughout the test period.
- The residual ANC of the leachate remains high throughout the test period.

- Dissolved sulfate concentrations in initial leachate ranges up to 358 mg/L, well below the applied ANZECC (2000) livestock drinking water guideline value of 1,000 mg/L, and remains fairly constant throughout the test period.
- All dissolved metal concentrations in column leachate are within the applied ANZECC (2000) and NEPM (1999b) guideline criteria for livestock drinking water, except for Se and Mo, which are marginally elevated with respect to the applied criteria. When appropriate dilution factors are considered, the soluble concentrations of Se and Mo are well within the applied livestock drinking water guideline values.

4.1 Geochemical Nature of Mine Materials

4.1.1 Overburden

The results of the acid-base tests (Table 3.1) indicate that overburden from the Ensham Central Project will initially generate slightly alkaline, low-salinity runoff/seepage following surface exposure. Over 88% of overburden material sampled has very low sulfur content (<0.1%) and is essentially barren. A few overburden materials located close to coal seams have marginally elevated sulfur content.

The ANC of overburden is low to moderate, indicating that most material has some buffering capacity, which should be more than adequate to neutralise any acidity generated from sulfide oxidation. All of the overburden has a negative NAPP value and is classified as NAF as illustrated in Figure 4.1.

There is a strong correlation between total sulfur content and NAPP value for overburden as illustrated in Figure 4.2. The results suggest that all overburden with a total sulfur content of <0.2 % is likely to be NAF.

4.1.2 Potential Reject

The results of the acid-base tests (Table 3.1) indicate that potential reject material (represented by coal seam, roof and floor samples) will also initially generate slightly alkaline, low-salinity runoff/seepage following surface exposure.

Most potential reject sampled has a low to moderate low sulfur content. The ANC of potential reject is moderate, indicating that inherent buffering capacity should be more than adequate to neutralise any acidity generated from sulfide oxidation. All of the potential reject has a negative NAPP value and is classified as NAF as illustrated in Figure 4.1. One sample (mudstone roof) produced a sulfur content of 0.74%, however this same sample had very high ANC (238 kg H_2SO_4/t) and consequently low NAPP value (-215 kg H_2SO_4/t).

There is a strong correlation between total sulfur content and NAPP value for potential reject material as illustrated in Figure 4.2. The results suggest that all potential reject material with a total sulfur content of <0.2 % is likely to be NAF. Coal samples tended to have marginally higher sulfur contents compared to other potential reject materials (*e.g.* roof and floor materials). Coal material is the target ore and, therefore, is unlikely to report as waste.

Figure 4.1
Geochemical Nature of Overburden and Potential Reject Samples

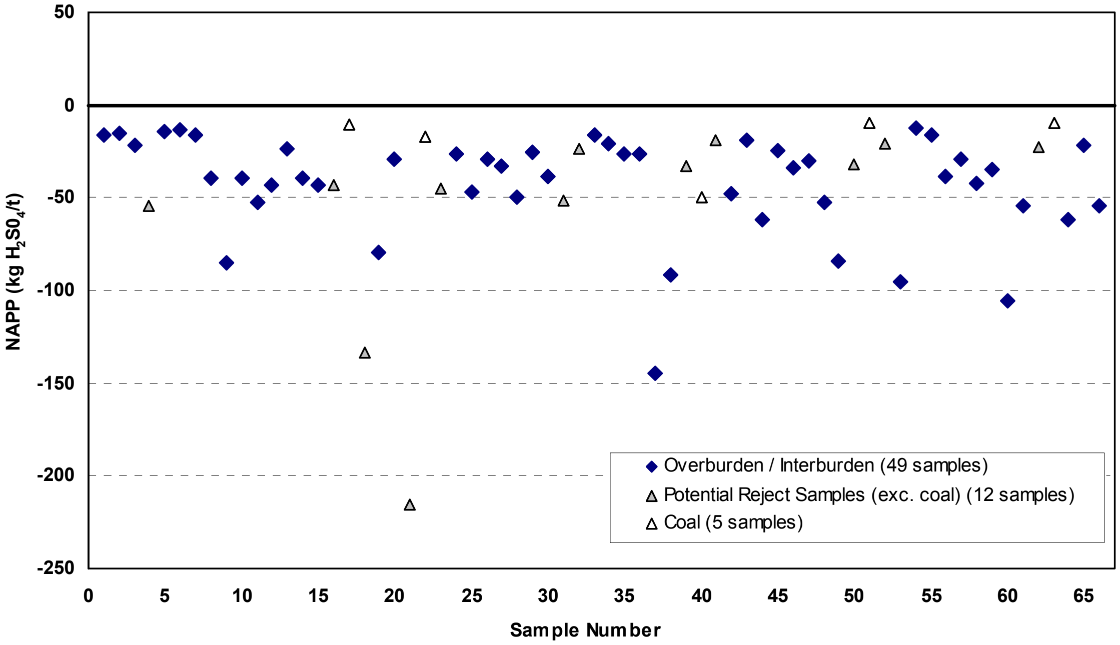
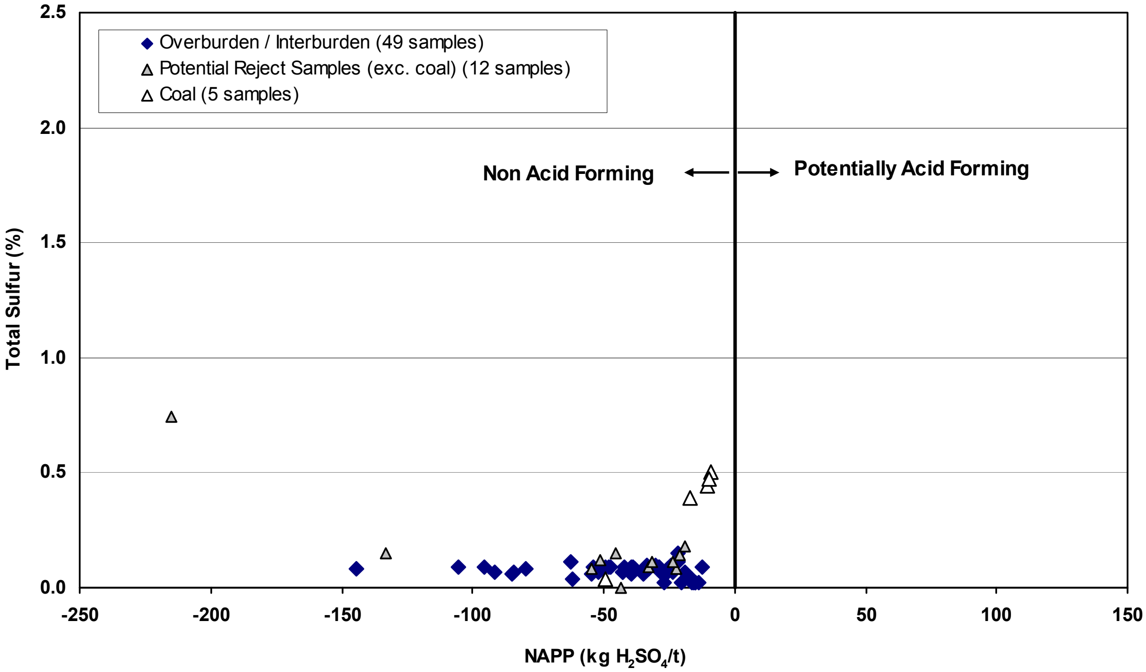


Figure 4.2
Plot of Total Sulfur versus NAPP for Overburden and Potential Reject Samples



4.1.3 Material Classification

The total sulfur content of material represented by the overburden and potential reject samples is generally low compared to other coal mines in Australia. URS has previously established, using data from several coal mines in Australia and overseas, that mine materials with a total sulfur content of less than 0.25 % can generally be classified as non-acid forming (NAF) and mine materials with a total sulfur content of less than 0.5 % can generally be classified as having a low potential for both acid formation and generation of soluble salts, particularly if materials have a significant inherent ANC.

The results displayed in Figure 4.2 indicate that the total sulfur test can be used as a simple, quick and cost-effective method at the Ensham Central Project to determine the likely acid forming nature of overburden and potential reject materials. In some cases, the total sulfur test can be over-conservative and NAF materials with a total sulfur content of greater than 0.5% can be incorrectly classified as PAF, if these materials have significant inherent ANC.

4.2 Multi-Elements Composition and Water Quality

The multi-element composition of composite overburden and potential reject samples is provided in Table 3.2 and allows comparison of any enriched metal concentrations with those described in QLD-EPA (1998) environmental investigation guidelines for contaminated sites and NEPM (1999a) health-based guidelines for soils in ‘open spaces’. Additionally, the multi-element composition of water extracts of overburden and potential reject materials is provided in Table 3.3 and also allows comparison of enriched metal concentrations in solution with applied ANZECC (2000) and NEPM (1999b) livestock drinking water guidelines.

It is important to note that there are no specific regulatory criteria for multi-element concentrations in overburden and coal reject materials nor in leachate derived from such materials on mine sites. URS has compared the multi-element concentrations in overburden and coal reject materials and in leachate from these materials with the above guidelines to provide some context for the discussion of test results.

4.2.1 Overburden Materials

The multi-element results (Table 3.2) indicate that some overburden may contain manganese (Mn) concentrations marginally in excess of the QLD-EPA (1998) Environmental Investigation Levels (EIL) for this element (500 mg/kg), but much less than the Health Based Investigation Level (HIL(E)) for “parks and recreational open spaces” (3,000 mg/kg) advocated in the NEPM (1999a). The concentrations of all other metals tested are below the relevant guideline values for soils.

Water extract results (Table 3.3) indicate that the dissolved salt concentration in initial leachate from overburden is likely to be dominated by sodium and chloride (Na and Cl), with lesser concentrations of calcium (Ca) and sulfate (SO_4). Initial leachate from overburden is also likely to contain dissolved metal and salt concentrations well below those recommended for livestock drinking water (ANZECC, 2000; NEPM, 1999b). It should be noted that the water extract data represents overburden pore water chemistry and further dilution effects from rainfall and natural attenuation are likely occur in the field.

The results of the kinetic leach tests (Tables E2 to E6 at **Appendix E**) confirm that ongoing leachate from overburden is likely have similar water quality characteristics to initial leachate (Table 3.2). The ongoing concentration of most metals and sulfate leached from overburden samples should be within recommended ANZECC (2000) and NEPM (1999b) livestock drinking water criteria. Exceptions include slightly elevated concentrations of Mo and Se. However, when a dilution factor is used to convert the concentrated leachate to an equivalent 1:5 sample:water extract (Tables E2a to E6a, **Appendix E**), the concentrations of Se and Mo in solution are well within the above livestock drinking water guideline criteria.

Hence, multi-element results indicated that the concentration of metals in overburden solids and runoff/seepage is unlikely to present any environmental issues associated with:

- revegetation and rehabilitation of any out-of-pit overburden storage facilities; and
- on-site or downstream water quality.

4.2.2 Potential Reject Materials

The multi-element results (Table 3.2) indicate that some potential reject materials may contain manganese (Mn) concentrations marginally in excess of the QLD-EPA (1998) EIL for this element (500 mg/kg), but much less than the applied NEPM (1999a) HIL(E) (3,000 mg/kg). The concentrations of all other metals tested are below the relevant guideline values for soils.

Water extract results (Table 3.3) indicate that leachate from potential reject material is likely to be Na-Cl dominated, but may also contain Ca and SO_4. Initial leachate from potential reject material is likely to contain dissolved metal and salt concentrations well below those recommended for livestock drinking water (ANZECC, 2000; NEPM, 1999b), except for Mo, which is above the NEPM (1999b) livestock drinking water guideline value (0.01 mg/L) in all samples, and marginally above the ANZECC(2000) livestock drinking water guideline value (0.15 mg/L) in one sample. Given that water extract data represents overburden pore water chemistry and further dilution effects from rainfall and natural attenuation are likely occur in the field, it is expected that the marginally elevated soluble concentrations of these elements in runoff/seepage from potential reject materials will be further attenuated in the field.

Kinetic leach testing on potential reject material (Tables E1, E7 and E8 at **Appendix E**) confirm that ongoing leachate from potential reject materials is likely to have similar water quality characteristics to initial leachate (Table 3.2). The ongoing concentration of most metals and sulfate leached from overburden samples should be within recommended ANZECC (2000) and NEPM (1999b) livestock drinking water criteria. Exceptions include slightly elevated initial concentrations of Mo and Se which should decrease in subsequent runoff/seepage. When an appropriate dilution factor is used to convert column leachate results to an equivalent 1:5 sample:water extract (Tables E1a, E7a and E8a, **Appendix E**), the soluble concentrations of Mo and Se are well within the above livestock drinking water guideline criteria.

Hence, multi-element results indicated that the concentration of metals in potential reject solids and runoff/seepage is unlikely to present any environmental issues associated with:

- revegetation and rehabilitation of any reject storage facilities; and
- on-site or downstream water quality.

4.2.3 Summary

The multi-element results indicate that under natural pH conditions, the concentration of soluble metals and salts in runoff/seepage from overburden and potential reject materials will remain within the applied water quality guideline criteria and should have negligible impact on the on-site and downstream water quality.

The range of analyses included in the water quality monitoring program for runoff/seepage from any constructed overburden or reject storage facility should therefore focus on pH, EC and Total Suspended Solids (TSS). If the pH of runoff/seepage from these storage areas drops below pH 6.0 or the EC value increases by more than 50%, then a more comprehensive range of water quality analyses may be warranted. In any event, periodic sampling and testing of the suite of dissolved metals described in this report (say every two years) should be included in the water quality monitoring program developed for the project.

4.3 Material Suitability for use in Revegetation and Rehabilitation

Overburden and potential reject materials have been assessed to determine any limitations or requirements related to revegetation and rehabilitation of emplacement areas. This has primarily involved an assessment of their sodicity, organic content, nutrient capability and potential to erode. The results of this assessment will be considered in ongoing rehabilitation and revegetation planning to ensure suitable rehabilitation standards are achieved.

From a soil chemistry viewpoint, all of the overburden and potential reject materials are alkaline, and 10 of the 14 materials tested can be classified as strongly alkaline (pH>8.5). The materials are non-saline and display moderate to very high eCEC values.

Potential reject samples typically display a moderate to TOC level, with high total N values observed in the coal and mixed coal samples (Composites 2 and 3). Despite the high nitrogen levels, the carbon to nitrogen (C:N) ratios in these samples (approximately 43:1) suggest nitrogen deficiency. A very high C:N ratio of 104:1 was observed in mudstone roof potential reject material (composite 6), with high amounts of nitrogen application likely required to ameliorate this material, due to its high TOC content. In contrast, a much lower C:N ratio was observed in siltstone roof potential reject (composite 14) and for all of the overburden samples. Notwithstanding, the low total nitrogen levels suggest that these materials would also benefit from the addition of nitrogen. Ideally, nitrogen additions (whether inorganic or organic) should occur using ammonium (*e.g.* NH_4SO_4) as this would result in reductions in the already high soil pH levels observed for all materials tested.

Low to moderate levels of extractable P were observed in most materials tested, with the exception of the clay overburden sample (Composite 1), which had a very high value. Whilst some benefit would likely be achieved through the addition of P, the low to moderate levels observed are similar to those commonly observed in many Australian soils. Additions of P in the form of either super-phosphate or ammonium phosphate would result in reductions in the already high soil pH levels observed for all materials tested.

All of the overburden materials had ESP values that exceeded 6% and are therefore regarded as sodic and prone to dispersion (Isbell, 2002). Four of the five potential reject materials also have ESP values greater than 6%, and are also likely to have structural stability problems related to potential dispersion (Van de Graaff and Patterson, 2001). Whilst an ESP value of 6 % is somewhat arbitrary and highly soil-specific with regards to determining whether dispersion will occur, increased dispersion is typically associated with alkaline pH (McBride, 1994), which was observed for all of the overburden samples ($pH_{(1:5)}$ ranging from 7.9 to 9.1) and potential reject materials ($pH_{(1:5)}$ ranging from 7.7 to 8.9). Treatment of the sodic overburden and potential reject materials would be required if these are to be used as vegetation growth medium.

In addition to potential dispersion problems, sodic soils often have unbalanced nutrient ratios that can lead to macro-nutrient deficiencies (Hazelton and Murphy, 1992). Exchangeable cation values for each of the macro nutrient cations indicate calcium deficiency in some of the overburden materials, particularly in clay and mudstone materials, which have exchangeable Ca:Mg ratios less than 2:1. Exchangeable Ca:Mg ratios in all other overburden materials ranged from 2.4:1 to 7.3:1. Exchangeable Ca:Mg ratios in potential reject materials ranged from 3.7:1 to 6.7:1 in non-coal materials, increasing to approximately 12:1 in coal. Amelioration of calcium deficiencies can be achieved through the application of gypsum ($CaSO_4.2H_2O$). Comparatively, magnesium deficiencies may exist in some materials, particularly those with relatively high exchangeable Ca:Mg ratios. Materials with potential Mg deficiencies can be ameliorated through the addition epsom salts ($MgSO_4.7H_2O$). Gypsum and epsom salts applications would likely be in the range of 2 to 10 tonnes per hectare, with further testing required during coverage to determine the precise dosing requirement.

Due to the potential for causing increases in pH, additions of lime ($CaCO_3$) or dolomite ($MgCaCO_3$) should be avoided for materials with potentially low exchangeable Ca and/or Mg, such as clay and mudstone overburden materials, and coal and mudstone roof potential reject materials (composites 2 and 6). Lime additions are considered unlikely to increase the pH of all other overburden and potential reject materials provided calcitic lime ($CaCO_3$) is used. Calcitic lime is relatively insoluble, with a saturated extract typically having a pH of around 8.3. Other forms of lime ($Ca(OH)_2$) should be avoided as an ameliorant for all materials due to the likelihood of increasing the pH and causing nutrient toxicities (*e.g.* Mo and B) or deficiencies (*e.g.* P, Fe, Mn, Cu and Zn). It should be noted that a $pH_{(1:5)}$ (solid:water) greater than 8.5 is regarded as strongly alkaline and therefore nutrient imbalances likely already exist in the siltstone overburden materials, and in all potential reject materials except coal.

A summary of the required and beneficial ameliorants that would be required for the overburden and potential reject samples is presented in Table 4.1. With regards to the amelioration required, the following materials are considered relatively unsuitable for use as growth medium:

- Potential coal reject material due to a high carbon to nitrogen ratio and the large amount of nitrogen application required to re-balance;
- All other potential reject materials are relatively unsuitable due to the high amounts of nitrogen that would need to be applied and the strongly alkaline pH;

With regards to potential amelioration required, all overburden samples (except clay and sandstone) are regarded as marginal for use as a vegetation growth medium because of the strongly alkaline pH. Clay and sandstone overburden materials are regarded as the most suitable for vegetation growth of all of the materials tested.

For the materials that could be ameliorated for use as a growth medium, if practical, treatment could potentially occur at the surface of the overburden emplacement area. Ensuring that slopes are well stabilised against erosion can also reduce the risk of significant erosion of dispersive sodic materials.

Table 4.1 Limitations and potential ameliorants for use with overburden and potential reject samples.

Material	Primary Limitations	Required Amelioration or treatment	Beneficial Amelioration
Overburden			
Clay and sandstone (<10 m)	Sodic, low calcium	Gypsum	Nitrogen
All other overburden materials	Strongly alkaline, sodic, varying degrees of Ca and Mg deficiencies	Gypsum for most materials; Epsom salts for deep siltstone materials.	Nitrogen, phosphorus
Potential Reject Samples			
Coal	Sodic, nitrogen	Large nitrogen additions, gypsum	Phosphorus
All siltstone potential reject materials	Strongly alkaline, sodic, nitrogen, low magnesium	Large nitrogen additions, Epsom salts	Phosphorus
All mudstone potential reject materials	Strongly alkaline, sodic, nitrogen, low calcium	Large nitrogen additions, gypsum	Phosphorus

These limitations and potential ameliorants will be considered in ongoing rehabilitation work.

5.1 Conclusions

5.1.1 Overburden

- Overburden generated by the proposed Ensham Central Project mine is likely to be relatively benign and will generate slightly alkaline and fresh (non-saline) runoff and seepage following surface exposure.
- The majority of the overburden (88%) is likely to have very low sulfur content (<0.1%) and can be classified as barren. A small amount of overburden has elevated sulfur content (up to 0.15%) and is located close to coal seams.
- Acid generation from overburden is extremely unlikely given the lack of oxidisable sulfur and the excess ANC of these materials.
- The concentration of metals in overburden materials are well below the applied environmental investigation guideline levels for soils[3]. The exception is Mn, which is present in overburden at a concentration marginally in excess of the applied environmental investigation guideline level, but well within the applied health-based investigation guideline level.
- Water extract and kinetic leach column tests indicate that the concentration of soluble metals and salts in runoff and seepage from overburden is likely to remain well within the applied water quality guideline values[3]. Exceptions include slightly elevated concentrations of Mo and Se, however application of a dilution factor to allow direct comparison with the applied water quality guideline values indicate that these elements also meet the applied guideline values.
- The concentration of metals in overburden and runoff/seepage is unlikely to present any environmental risks for rehabilitation and on-site/downstream water quality.

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[3] There are no specific regulatory criteria related to total metal or dissolved metal concentrations in overburden and coal reject materials. Consequently, results for total metal concentrations in soils were compared with QLD-EPA (1998) environmental investigation guidelines for contaminated sites and NEPM (1999a) health-based guidelines for soils in ‘open spaces’. Results for dissolved metal concentrations in leachate and water extracts from soils were compared with ANZECC (2000) and NEPM (1999b) water quality guidelines for livestock drinking water. These comparisons are solely for the purpose of providing context for the results.

- Most overburden is alkaline and sodic and will be prone to crusting, with reduced infiltration and consequent reduced plant growth, high runoff, dispersion and erosion[4].
- Gypsum and fertilizer application may assist in the amelioration of most overburden materials. Epsom salts may also assist in the amelioration of low magnesium siltstone materials.
- Overburden from depth is marginal for use as a vegetation growth medium because of a strongly alkaline pH. Shallow overburden (clay and sandstone) has the greatest potential for use as a growth medium.

5.1.2 Potential Reject Materials

- Most potential reject material should be relatively benign and will generate moderately alkaline and fresh (non-saline) runoff/seepage following surface exposure.
- On the basis of the geochemical test results, all potential reject material will remain net alkaline despite occasionally moderate total sulfur contents.
- The concentration of metals in potential reject materials are well below the applied environmental investigation guideline levels for soils[3]. The exception is Mn, which is present in overburden at a concentration marginally in excess of the applied environmental investigation guideline level, but well within the applied health-based investigation guideline level.
- Water extract and kinetic leach column tests indicate that the concentration of soluble metals and salts in runoff and seepage from potential reject materials is likely to remain well within the applied water quality guideline values[3]. The only exceptions are the slightly elevated concentrations of Se and Mo, however application of a dilution factor to allow direct comparison with the applied water quality guideline values indicate that these elements also meet the applied guideline values.
- The concentration of metals in potential reject materials and runoff/seepage is unlikely to present any environmental risks for rehabilitation and on-site/downstream water quality.
- Most potential reject is alkaline and sodic and will be prone to crusting, with reduced infiltration and consequent reduced plant growth, high runoff, dispersion and erosion[4].

---

[4] Overburden and potential reject materials have been assessed to determine any limitations or requirements related to revegetation and rehabilitation of emplacement areas. This has primarily involved an assessment of their sodicity, organic content, nutrient capability and potential to erode. The results of this assessment will be considered in ongoing rehabilitation and revegetation planning to ensure suitable rehabilitation standards are achieved.

- Gypsum and fertilizer application may assist in the amelioration of most potential reject materials. Epsom salts may also assist in the amelioration of low magnesium siltstone materials.
- Very low total nitrogen levels and very high C:N ratios were observed in all of the potential reject samples. Addition of significant amounts of nitrogen would be required before these materials could be considered used as a vegetation growth medium.
- Potential reject materials are unlikely to be appropriate for use as a growth layer due to sodicity, high nitrogen requirements and alkaline pH.

5.2 Management Measures

- The range of analyses included in the water quality monitoring program for runoff/seepage from overburden and potential reject storage facilities should focus on pH, EC and Total Suspended Solids (TSS).
- If the pH of runoff/seepage from overburden or potential reject materials drops below pH 6.0 or the EC value increases by more than 50 %, then a more comprehensive range of water quality analysis may be warranted. In any event, periodic sampling and testing of the suite of dissolved metals described in this report (say every two years) should be included in the water quality monitoring program developed for the project.
- Management of sodic overburden and potential reject materials will continue as part of the site rehabilitation planning.

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NEPM (1999)a. National Environmental Protection (Assessment of Site Contamination) Measure. Guideline on investigation levels for soil and groundwater. HIL(E); parks, recreation open space and playing fields.

NEPM (1999)b. National Environmental Protection (Assessment of Site Contamination) Measure. Guideline on investigation levels for soil and groundwater. Groundwater Investigations Levels (Agricultural: Livestock).

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Van de Graaff, R. and Patterson, R.A. (2001). *Explaining the Mysteries of Salinity, Sodicity, SAR and ESP in On-site Practice. In:* Proceedings of On-Site '01 Conference: Advancing On-Site Wastewater Systems. Patterson, R.A. & Jones, M.J. (Eds). Lanfax Laboratories, Armidale. pp 361-368.

GLOSSARY of TERMS and ABBREVIATIONS

SECTION 7

The following terms are commonly used throughout this report. Further explanations of these and other terms may be found in the text and appendices of the report.

ANC	Acid Neutralising Capacity. The capacity of a rock or tailings to react with and neutralise acid. Generally reported in units of kg H_2SO_4 /tonne, which is the mass of acid required to neutralise 1 tonne of the sample. Refer to Appendix D for further details.
ARD	Acid Rock Drainage (also called Acid Mine Drainage (AMD)). ARD is the product formed by the atmospheric oxidation of iron-sulphur minerals, commonly pyrite (FeS_2) and pyrrhotite (FeS) in the presence of bacteria (acting as a catalyst). ARD can also form from the oxidation of other relatively common minerals, such as chalcopyrite ($CuFeS_2$) and arsenopyrite (FeAsS).
Barren	A material (sample) with a total sulfur content of less than 0.1 %. Can also refer to a rock sample with no mineralisation.
Coal Reject	Waste material remaining after coal processing. Typically includes poor ranked coal and overburden material associated with the immediate roof and floor of the mined coal seam.
MPA	Maximum Potential Acidity. Calculated by determining the sulphur content of the sample as a percentage and multiplying the sulphur content by a conversion factor. Assuming complete oxidation of all the sulphur, the conversion factor generates kilograms of acid that can theoretically be produced from one tonne of material with that sulphur content.
Overburden	The economically unwanted material overlying a valuable deposit (in this case, coal). Also includes unwanted material situated between coal seams (called interburden).
NAPP	Net Acid Production Potential. Represents the balance between a samples inherent capacity to generate and neutralise acid. If the MPA is greater than the ANC then the NAPP is positive. If the MPA is less than the ANC then the sample then the NAPP is negative.

LIMITATIONS

URS Australia Pty Ltd (URS) has prepared this report for the use of Hansen Consulting and Ensham Resources Pty Ltd in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice indicated in this report.

It is recommended that any plans and specifications prepared by others and relating to the content of this report, or any amendments to those plans and specifications, be reviewed by URS to verify that the intent of our recommendations is properly reflected in the design or specifications.

URS has not verified information sourced from the client or other third parties except as described in this report. Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, circumstances can change in a limited time, this should be borne in mind if the report is used after a protracted delay.

There are always some variations in conditions across a site, which cannot be fully defined by investigation. Hence, it is unlikely that the information presented in this report will represent the extremes of conditions that exist.

This report does not, and does not purport to, give legal advice on the actual or potential liabilities of any individual or organisation, or draw conclusions as to whether any particular circumstances constitute a breach of relevant legislation. Qualified legal practitioners only can give this advice.

Respectfully submitted
URS Australia Pty Ltd

Alan M Robert

Dr. Alan Robertson
Principal Geochemist

Dr. Ian Swane
Senior Hydrogeologist

APPENDIX A
SCHEMATIC REPRESENTATION OF OVERBURDEN/ POTENTIAL REJECT SAMPLE LOCATION AND LITHOLOGY

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE 01

URS Australia Pty. Ltd. Level 240, Queen Street Brisbane, QLD, 4001	Phone (07) 3243 2111 Fax (07) 3242 2199	Project No.: **42625576**	Project Reference: **Ensham Central Development Project**
Drilling Contractor: **IESA**			
Drilling Method: **Air Hole Blasting**	Logged By: **Alan Robertson** Checked By: **ABS** Date Started: **23-11-04** Date Finished: **23-11-04**	Relative Level: **mRL** Coordinates: **7400206.000 mN** **651251.000 mE** Permit No:	Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS				DESCRIPTION OF STRATA								
Sample Type	SAMPLING AND OTHER TESTING	DEPTH (m)	LEGEND	LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		0 5	▨	Clay								
		10	⁙	Gravel/Sandstone								
			☰	Mudstone								

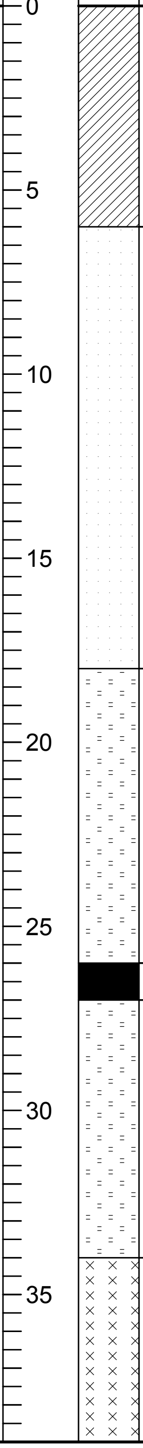
REMARKS:

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE 02

URS Australia Pty. Ltd. Level 240, Queen Street Brisbane, QLD, 4001	Phone (07) 3243 2111 Fax (07) 3242 2199
Drilling Contractor: **IESA**	
Project No.:	**42625576**
Project Reference:	**Ensham Central Development Project**
Drilling Method:	**Air Hole Blasting**
Logged By:	**Alan Robertson**
Checked By:	**ABS**
Date Started:	**30-11-04**
Date Finished:	**30-11-04**
Relative Level:	**mRL**
Coordinates:	**7401194.000 mN** **652637.000 mE**
Permit No:	
Client:	**Hansen Consulting Company Pty Ltd**



SAMPLING DETAILS				DESCRIPTION OF STRATA								
Sample Type	SAMPLING AND OTHER TESTING	LEGEND	LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		▨	Clay								
		⁚	Sandstone								
		=	Mudstone								
		■	Coal								
		=	Mudstone								
		×	Siltstone								

REMARKS:

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE AB9

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001

Phone (07) 3243 2111
Fax (07) 3242 2199

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Contractor: **IESA**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **01-12-04**
Date Finished: **01-12-04**

Relative Level: **mRL**
Coordinates: **7399375.000 mN**
651100.000 mE
Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS		DEPTH (m)	LEGEND	DESCRIPTION OF STRATA								
Sample Type	SAMPLING AND OTHER TESTING			LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		0		Gravelly Clay								
		5		Sandstone								
		10										
		15		Sandstone/Siltstone								
		20		Siltstone								
		25										
		30		Mudstone								
		35		Siltstone								
		40										
		45										
		50										
		55										
		60										
		65										
		70										
		75										
		80										
		85										

REMARKS:

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE GC1

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001
Phone (07) 3243 2111
Fax (07) 3242 2199

Drilling Contractor: **IESA**

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **03-12-04**
Date Finished: **03-12-04**

Relative Level: **mRL**
Coordinates: **7402952.000 mN**
650890.000 mE

Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS		DEPTH (m)	LEGEND	DESCRIPTION OF STRATA								
Sample Type	SAMPLING AND OTHER TESTING			LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		0	▨	Clay								
			▨	Clay/Sand								
		5 10	░	Sandstone								
			○	Gravel								
		15	░	Sandstone								
			▤	Mudstone								

REMARKS:

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE GC2

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001
Phone (07) 3243 2111
Fax (07) 3242 2199

Drilling Contractor: **IESA**

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **30-11-04**
Date Finished: **30-11-04**

Relative Level: **mRL**
Coordinates: **7402318.000 mN**
651127.000 mE

Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS

Sample Type	SAMPLING AND OTHER TESTING	DEPTH (m)
		0
		5
		10
		15
		20
		25
		30
		35
		40
		45
		50
		55
		60
		65
		70

DESCRIPTION OF STRATA

LEGEND	LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
▨	Clay								
⁚	Sandstone								
○	Gravel/Sandstone								
×	Siltstone								

REMARKS:

Sheet 1 of 1

URS Australia Pty Ltd

DRILL HOLE GC3

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001

Phone (07) 3243 2111
Fax (07) 3242 2199

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Contractor: **IESA**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **30-11-04**
Date Finished: **30-11-04**

Relative Level: **mRL**
Coordinates: **7401054.000 mN**
651829.000 mE
Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS

DESCRIPTION OF STRATA

Sample Type	SAMPLING AND OTHER TESTING	DEPTH (m)	LEGEND	LITHOLOGY	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		0	▨	Clay								
		5 10	·	Sandstone								
		15	=	Mudstone								
		20 25 30 35	×	Siltstone								
			=	Mudstone								
		40 45	×	Siltstone								
			=	Mudstone								
			■	Coal								
		50	=	Mudstone								
			·	Sandstone								
		55	·	Minor Coal/Sandstone								
		60 65	·	Sandstone								
		70	×	Siltstone								
		75	=	Mudstone								
			■	Coal								
		80	=	Mudstone								

REMARKS:

Sheet 1 of 1

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DRILL HOLE GC4

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001
Phone (07) 3243 2111
Fax (07) 3242 2199

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Contractor: **IESA**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **01-12-04**
Date Finished: **01-12-04**

Relative Level: **mRL**
Coordinates: **7401125.000 mN**
650451.000 mE
Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS

Sample Type | SAMPLING AND OTHER TESTING

DEPTH (m): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95

DESCRIPTION OF STRATA

LEGEND	LITHOLOGY	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
	Gravel								
	Clay								
	Sandstone								
	Gravel/Sandstone								
	Mudstone								
	Siltstone								
	Gravel/Siltstone								
	Siltstone								
	Poor Coal/Siltstone								
	Siltstone								
	Poor Coal/Siltstone								
	Siltstone								

REMARKS:

Sheet 1 of 1

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DRILL HOLE GC5

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001
Phone (07) 3243 2111
Fax (07) 3242 2199

Drilling Contractor: **IESA**

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Method: **Air Hole Blasting**

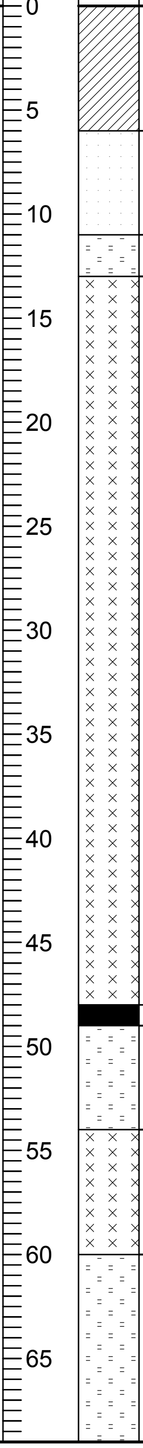
Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **01-12-04**
Date Finished: **01-12-04**

Relative Level: **mRL**
Coordinates: **7400204.000 mN**
650500.000 mE
Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS

Sample Type	SAMPLING AND OTHER TESTING



DESCRIPTION OF STRATA

LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
Clay								
Sandstone								
Mudstone								
Siltstone								
Coal								
Mudstone								
Siltstone								
Mudstone								

REMARKS:

Sheet 1 of 1

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DRILL HOLE GC6

URS Australia Pty. Ltd.
Level 240, Queen Street Brisbane, QLD, 4001
Phone (07) 3243 2111
Fax (07) 3242 2199

Drilling Contractor: **IESA**

Project No.: **42625576**

Project Reference: **Ensham Central Development Project**

Drilling Method: **Air Hole Blasting**

Logged By: **Alan Robertson**
Checked By: **ABS**
Date Started: **02-12-04**
Date Finished: **02-12-04**

Relative Level: **mRL**
Coordinates: **7399320.000 mN**
650144.000 mE

Permit No:

Client: **Hansen Consulting Company Pty Ltd**

SAMPLING DETAILS				DESCRIPTION OF STRATA								
Sample Type	SAMPLING AND OTHER TESTING	DEPTH (m)	LEGEND	LITHOLOGY	Constistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
		0 5	▨	Clay								
		10	⁘	Sandstone								
			-	Mudstone								
		15 20 25 30 35 40 45 50 55	×	Siltstone								
			■	Coal								
		60 65	×	Siltstone								

REMARKS:

APPENDIX B
COMPOSITE SAMPLE MAKE-UP

Table B1

Composite Overburden and Reject Materials Selected for Multi-Element and Kinetic Leach Testing - Ensham Central Project

Sample Number	Drillhole Number	Sample Depth (m)	Sample Description	Sample Classification	Composite Number	Column Number
01	01	04-05	clay	Non-Acid Forming	1	
33	GC5	04-05	clay	Non-Acid Forming		
54	AB9	04-05	gravelly clay	Non-Acid Forming		
43	GC6	05-06	clay	Non-Acid Forming		
63	02	26-27	coal	Non-Acid Forming	2	1 coal
17	GC3	49 - 50 (41 - 42)	coal	Non-Acid Forming		
40	GC5	48-49	coal	Non-Acid Forming		
51	GC6	55-56	coal	Non-Acid Forming		
22	GC3	77 - 78 (64 - 65)	coal	Non-Acid Forming		
31	GC4	92-93	poor coal/siltstone	Non-Acid Forming	3	
32	GC4	95-96	poor coal/siltstone	Non-Acid Forming		
45	GC6	11-12	mudstone	Non-Acid Forming	4	2 mudstone 10-55 m
35	GC5	12-13	mudstone	Non-Acid Forming		
25	GC4	15-16	mudstone	Non-Acid Forming		
03	02	22-23	mudstone	Non-Acid Forming		
13	GC3	30 - 31 (25 - 26)	mudstone	Non-Acid Forming		
57	AB9	33-34	mudstone	Non-Acid Forming		
65	GC5	53-54	mudstone	Non-Acid Forming		
04	02	29-30	mudstone (floor)	Non-Acid Forming	5	7 mudstone (floor)
18	GC3	50 - 51 (42 - 43)	mudstone (floor)	Non-Acid Forming		
41	GC5	49-50	mudstone (floor)	Non-Acid Forming		
23	GC3	80 - 81 (67 - 68)	mudstone (floor)	Non-Acid Forming		
62	02	24-25	mudstone (roof)	Non-Acid Forming	6	8 mudstone (roof)
16	GC3	48 - 49 (40 - 41)	mudstone (roof)	Non-Acid Forming		
21	GC3	74 - 75 (62 - 63)	mudstone (roof)	Non-Acid Forming		
05	GC1	07-08	sandstone	Non-Acid Forming	7	3 sandstone <10 m
07	GC2	07-08	sandstone	Non-Acid Forming		
24	GC4	07-08	sandstone	Non-Acid Forming		
34	GC5	07-08	sandstone	Non-Acid Forming		
61	02	07-08	sandstone	Non-Acid Forming		
44	GC6	08-09	sandstone	Non-Acid Forming		
55	AB9	11-12	sandstone	Non-Acid Forming	8	
02	01	14-15	gravel/sandstone	Non-Acid Forming		
06	GC1	17-18	sandstone	Non-Acid Forming		
19	GC3	60 - 61 (50 - 51)	sandstone	Non-Acid Forming		
46	GC6	16-17	siltstone	Non-Acid Forming	9	4 siltstone <30 m
36	GC5	17-18	siltstone	Non-Acid Forming		
08	GC2	19-20	siltstone	Non-Acid Forming		
56	AB9	23-24	siltstone	Non-Acid Forming		
09	GC2	26-27	siltstone	Non-Acid Forming		
14	GC3	35 - 36 (29 - 30)	siltstone	Non-Acid Forming		
37	GC5	29-30	siltstone	Non-Acid Forming		
47	GC6	29-30	siltstone	Non-Acid Forming		
64	02	34-35	siltstone	Non-Acid Forming	10	
10	GC2	35-36	siltstone	Non-Acid Forming		
15	GC3	47 - 48 (39 - 40)	siltstone	Non-Acid Forming		
27	GC4	40-41	siltstone	Non-Acid Forming	11	6 siltstone 40-50 m
48	GC6	40-41	siltstone	Non-Acid Forming		
38	GC5	41-42	siltstone	Non-Acid Forming		
58	AB9	49-50	siltstone	Non-Acid Forming		
49	GC6	50-51	siltstone	Non-Acid Forming	12	5 siltstone 50-70 m
11	GC2	51-52	siltstone	Non-Acid Forming		
20	GC3	68 - 69 (57 - 58)	siltstone	Non-Acid Forming		
28	GC4	59-60	siltstone	Non-Acid Forming		
42	GC5	59-60	siltstone	Non-Acid Forming		
59	AB9	67-68	siltstone	Non-Acid Forming		
66	GC5	68-69	siltstone	Non-Acid Forming		
53	GC6	69-70	siltstone	Non-Acid Forming		
12	GC2	71-72	siltstone	Non-Acid Forming	13	
29	GC4	76-77	siltstone	Non-Acid Forming		
60	AB9	86-87	siltstone	Non-Acid Forming		
30	GC4	87-88	siltstone	Non-Acid Forming		
26	GC4	26-27	gravelly siltstone	Non-Acid Forming		
52	GC6	56-57	siltstone (floor)	Non-Acid Forming		
39	GC5	47-48	siltstone (roof)	Non-Acid Forming	14	
50	GC6	54-55	siltstone (roof)	Non-Acid Forming		

Notes:

* Sample depth interval for GC3 has been corrected. ALS received, tested and reported on sample depths provided in brackets.

* Columns 7 and 8 commenced 4-week leach test on 16 February 2005. All other columns have completed a 4-week leach test.

APPENDIX C
KINETIC LEACH COLUMN METHODOLOGY AND DESIGN

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Kinetic leach column tests can be used to provide information on the reaction kinetics of mine waste materials. The major objectives of kinetics tests are to:

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

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

In kinetic column leach tests, water is added to a sample and the mixture allowed to leach products and by-products of acid producing and consuming reactions. Leachate samples are then collected and analysed. Intermittent water application is applied to simulate rainfall and heat lamps are used to simulate sunshine.

Kinetic leach column tests provide real-time information and may have to continue for months or years, if required. Monitoring can include trends in pH, EC, acidity or alkalinity, sulfate and soluble metals. The pH of the collected leachate simulates the acid drainage process, acidity or alkalinity levels indicate the rate of acid production and acid neutralisation, and sulfate production can be related to the rate of sulfide oxidation. Metal concentration data provides an assessment of metal solubility and leaching behaviour. Figure 1 shows the kinetic leach column set up used by URS[5]. The columns are placed under heat lamps to allow the sample to dry between water additions to ensure adequate oxygen ingress into the sample material.

Approximately 2-3 kg of sample is generally used in the columns and depending on the physical nature of the material and particle size can be used on an as-received basis (*i.e.* no crushing) or crushed to nominal 5-10 mm particle size. The sample in the column is leached with deionised water at a rate of about 300 ml/kg of sample and the initial leachate from the columns collected and analysed. Subsequent column leaching is carried out on a weekly basis and the leachate collected and analysed as required. The column must be exposed to drying conditions in between watering events. The residual water content and air void content in the column can be determined by comparing the wet and dry column weights. A heat lamp is generally used above the sample to maintain the surface temperature at about 30°C.

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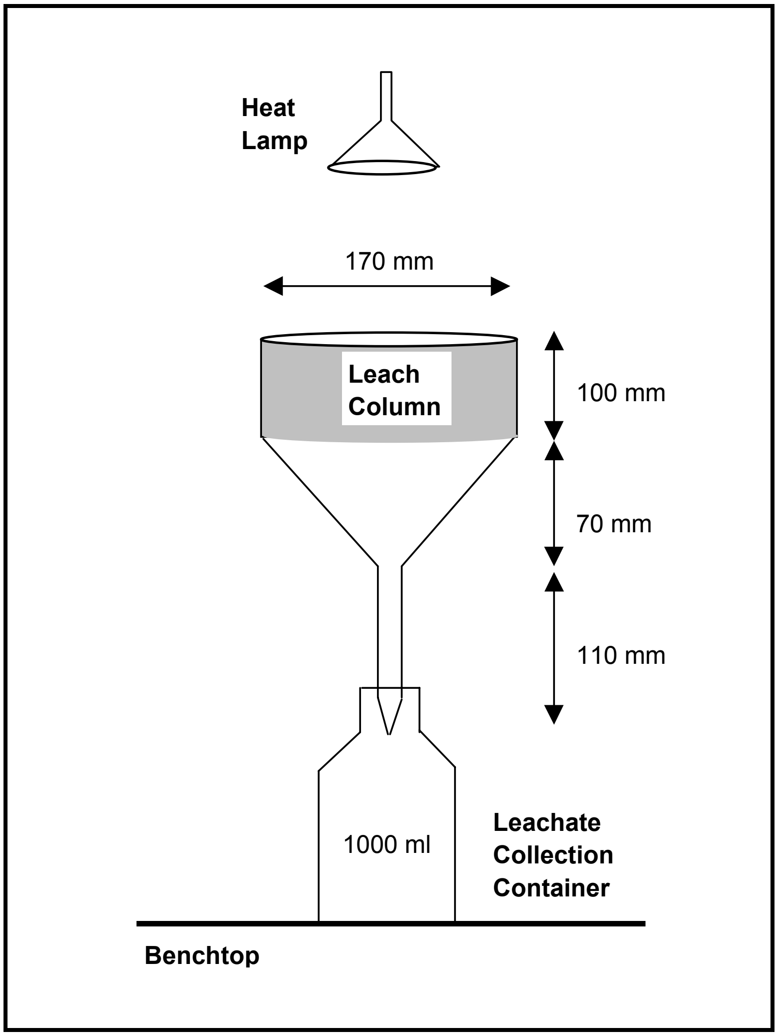
[5] Miller, S. and Jeffery, J. (1995). Advances in the prediction of acid generating mine waste materials. In: Proceedings of the Second Australian Acid Mine Drainage Workshop. (Eds. Grundon, N.J. and Bell, L.C.). Charters Towers, Queensland, March 1995, pp 33-42. (ACMER, Kenmore, Queensland).

Appendix C (Figure C1)

Typical Kinetic Leach Column Setup



APPENDIX D
EVALUATION AND INTERPRETATION OF GEOCHEMICAL DATA

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EVALUATION AND INTERPRETATION OF GEOCHEMICAL DATA

D1 Acid Generation and Prediction

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \text{ ---> } Fe(OH)_3 + 2\ H_2SO_4$$

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1%S as pyrite would be 30.6 kg H_2SO_4/t.

The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralisation, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

Determination of pH and EC

pH and EC measured on 1:5 w/w water extract. This gives an indication of the inherent acidity and salinity of the mine material when initially exposed in an emplacement area.

Total sulfur content and Maximum Potential Acidity (MPA)

Total sulfur content is determined by the Leco high temperature combustion method. The total content is then used to calculate the Maximum Potential Acidity (MPA), which is based on the assumption that the entire sulfur content is present as reactive pyrite. If a more accurate estimate of the MPA is required, this can be achieved by determining pyritic sulfur and other sulfur forms directly.

Acid neutralising capacity (ANC)

The ANC measures the capacity of a sample to react with and neutralise acid by addition of acid to a known weight of sample, then titration with NaOH to determine the amount of residual acid. The ANC can be further evaluated by slow acid titration to a set end-point and then calculation of the amount of acid consumed and evaluation of the resultant titration curve.

Net acid producing potential (NAPP)

Calculated from the MPA and ANC results. The NAPP represents the balance between a samples inherent capacity to generate and neutralise acid. If the MPA is greater than the ANC then the NAPP is positive. If the MPA is less than the ANC then the sample then the NAPP is negative.

D2 Assessment of Element Enrichment and Solubility

In mineralised areas it is common to find a suite of enriched elements that have resulted from natural geological processes. Multi-element scans are carried out to identify any elements that are present in a material at concentrations that may be of environmental concern with respect to surface water quality and revegetation. The samples are generally analysed for the following elements:

Major elements	Al, Ca, Fe, K, Mg, Na, Si, and S
Minor elements	As, B, Cd, Co, Cr, Cu, F, Hg, Mn, Mo, Ni, P, Pb, Sb, Se, Zn

The assay result for each element is compared to relevant environment and health-based investigation levels (*e.g.* QLD-EPA, 1998; NEPM, 1999a) to determine any concerns related to rock emplacement or process residue facility operation and final rehabilitation.

Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality, or public health but their significance should be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (*e.g.* low pH) the geochemical behaviour of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

Water extracts are used to determine the immediate element solubilities under the existing sample pH conditions of the sample. Element concentrations are generally compared with those recommended in relevant water quality guidelines (*e.g.* ANZECC, 2000; NEPM, 1999b) in order to determine their environmental significance. The following tests are normally carried out:

Multi-element composition of solids.

Multi-element composition of solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Multi-element composition of water extracts (1:5 sample:deionised water).

Multi-element composition of water extracts from solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

APPENDIX E
LABORATORY KINETIC LEACH DATA AND FIGURES FOR OVERBURDEN AND POTENTIAL REJECT MATERIALS

Table E1: Column Leach Test Results for Composite Sample 2 (coal): *Potential Reject Material*

Sample Weight (kg)	1.00	**ANC (kg H_2SO_4/t)#**	30.4
TOTAL S (%)#	0.37	**NAPP (kg H_2SO_4/t)#**	-19

	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.505	0.480	0.480	0.490
	Cum. Volume (L)	0.505	0.985	1.465	1.955
	Pore Volumes	0.4	0.7	1.1	1.4
	pH	7.83	7.04	7.97	7.39
	EC (uS/cm)	1,600	890	748	602
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	86	57	46	48
	Net Alkalinity (mg/l)	86	57	46	48
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	42	36	40	36
Mg	-	24	18	18	16
Na	-	200	112	54	38
K	-	13	10	8	7
Cl	-	252	166	91	59
SO_4	1,000	243	136	129	102
Minor Elements					
Al	5	<0.01	<0.01	<0.01	<0.01
As	0.5	0.005	0.004	0.002	0.002
B	5	0.4	0.4	0.4	0.4
Cd	0.01	<0.0001	<0.0001	<0.0001	<0.0001
Co	1	<0.001	<0.001	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.002	<0.001	<0.001	<0.001
Fe	1 (irrigation)	<0.01	<0.01	<0.01	<0.01
Hg	0.002	<0.0001	<0.0001	<0.0001	0.0002
Mn	2 (irrigation)	0.093	0.080	0.071	0.061
Mo	0.15	0.092	0.040	0.036	0.031
Pb	0.1	<0.001	<0.001	<0.001	<0.001
Se	0.02	0.023	<0.010	<0.010	<0.010
Zn	20	0.021	0.004	0.004	0.019
SO_4 Generation Rate		123	65	62	50
Cumulative SO_4 Generation		123	188	250	300
Ca Generation Rate		21	17	19	18
Cumulative Ca Generation		21	38	58	75
Mg Generation Rate		12	8.6	8.6	7.8
Cumulative Mg Generation		12	21	29	37
Residual ANC (%)		99.7	99.4	99.1	98.9
SO_4/Ca		2.4	1.6	1.3	1.2

* Acidity and Alkalinity data calculated in mg $CaCO_3$/L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E2: Column Leach Test Results for Composite Sample 4 (mudstone): *Overburden Material*

	Sample Weight (kg)	1.58	**ANC (kg H_2SO_4/t)[#]**		30.3
	TOTAL S (%)[#]	0.09	**NAPP (kg H_2SO_4/t)[#]**		-28
	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.335	0.415	0.387	0.250
	Cum. Volume (L)	0.335	0.750	1.137	1.387
	Pore Volumes	0.2	0.6	0.8	1.0
	pH	8.14	7.95	8.34	8.36
	EC (uS/cm)	3,790	809	734	652
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	55	67	85	115
	Net Alkalinity (mg/l)	55	67	85	115
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	77	6	5	4
Mg	-	74	4	3	3
Na	-	501	132	107	100
K	-	13	3	3	3
Cl	-	810	97	55	33
SO_4	1,000	281	108	102	88
Minor Elements					
Al	5	<0.01	0.05	0.26	0.37
As	0.5	0.005	0.012	0.013	0.010
B	5	0.3	0.4	0.7	1.0
Cd	0.01	0.0002	<0.0001	<0.0001	<0.0001
Co	1	0.002	0.002	0.001	0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.013	0.008	0.009	0.007
Fe	1 (irrigation)	0.01	0.02	0.08	0.10
Hg	0.002	<0.0001	<0.0001	<0.0001	<0.0001
Mn	2 (irrigation)	0.023	<0.001	<0.001	<0.001
Mo	0.15	0.104	0.108	0.130	0.143
Pb	0.1	0.002	<0.001	<0.001	<0.001
Se	0.02	0.117	0.026	0.025	0.023
Zn	20	0.071	0.018	0.025	0.016
SO_4 Generation Rate		60	28	25	14
Cumulative SO_4 Generation		60	88	113	127
Ca Generation Rate		16	1.6	1.2	0.6
Cumulative Ca Generation		16	18	19	20
Mg Generation Rate		16	1.1	0.7	0.5
Cumulative Mg Generation		16	17	17	18
Residual ANC (%)		99.66	99.63	99.61	99.60
SO_4/Ca		1.5	7.5	8.5	9.2

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E3: Column Leach Test Results for Composite Sample 7 (sandstone <10m): *Overburden Material*

Sample Weight (kg)	1.26	**ANC (kg H_2SO_4/t)[#]**	33.7
TOTAL S (%)[#]	0.04	**NAPP (kg H_2SO_4/t)[#]**	-33

	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.430	0.465	0.455	0.470
	Cum. Volume (L)	0.430	0.895	1.350	1.820
	Pore Volumes	0.3	0.7	1.0	1.3
	pH	7.11	7.21	7.43	7.10
	EC (uS/cm)	2,100	461	207	150
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	67	40	45	47
	Net Alkalinity (mg/l)	67	40	45	47
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	<1	5	2	1
Mg	-	<1	2	<1	<1
Na	-	<1	73	42	33
K	-	<1	1	<1	<1
Cl	-	412	62	11	8
SO_4	1,000	1	56	14	6
Minor Elements					
Al	5	0.02	<0.01	0.06	0.14
As	0.5	0.004	0.009	0.013	0.012
B	5	0.2	0.6	0.8	0.7
Cd	0.01	0.0006	0.0001	<0.0001	<0.0001
Co	1	0.012	0.002	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.038	0.019	0.011	0.007
Fe	1 (irrigation)	0.14	0.05	0.09	0.20
Hg	0.002	<0.0001	<0.0001	<0.0001	<0.0001
Mn	2 (irrigation)	0.085	<0.001	<0.001	<0.001
Mo	0.15	0.005	0.008	0.008	0.007
Pb	0.1	0.002	<0.001	<0.001	<0.001
Se	0.02	<0.010	<0.010	<0.010	<0.010
Zn	20	0.177	0.030	0.019	0.014

SO_4 Generation Rate	0.3	21	5.1	2.2
Cumulative SO_4 Generation	0.3	21	26	28
Ca Generation Rate	0.2	1.8	0.7	0.4
Cumulative Ca Generation	0.2	2.0	2.7	3.1
Mg Generation Rate	0.2	0.7	0.2	0.2
Cumulative Mg Generation	0.2	0.9	1.1	1.3
Residual ANC (%)	100.00	99.97	99.97	99.96
SO_4/Ca	0.8	4.7	2.9	2.5

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E4: Column Leach Test Results for Composite Sample 9 (siltstone <30m): *Overburden Material*

Sample Weight (kg)	1.72	**ANC (kg H_2SO_4/t)**[#]	57.1
TOTAL S (%)[#]	0.08	**NAPP (kg H_2SO_4/t)**[#]	-55

	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.483	0.470	0.445	0.465
	Cum. Volume (L)	0.483	0.953	1.398	1.863
	Pore Volumes	0.4	0.7	1.0	1.4
	pH	8.02	8.84	8.03	8.33
	EC (υS/cm)	590	426	1,626	930
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	39	46	68	110
	Net Alkalinity (mg/l)	39	46	68	110
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	11	6	26	10
Mg	-	6	3	17	7
Na	-	76	75	211	138
K	-	5	5	13	9
Cl	-	90	77	255	95
SO_4	1,000	53	36	186	105
Minor Elements					
Al	5	0.02	0.04	0.01	0.02
As	0.5	0.012	0.031	0.029	0.052
B	5	0.1	0.1	0.5	0.6
Cd	0.01	<0.0001	<0.0001	<0.0001	<0.0001
Co	1	<0.001	<0.001	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.002	<0.001	0.001	0
Fe	1 (irrigation)	0.02	0.02	0.02	0.02
Hg	0.002	<0.0001	<0.0001	<0.0001	
Mn	2 (irrigation)	0.061	0.008	0.038	0.010
Mo	0.15	0.040	0.031	0.164	0.150
Pb	0.1	<0.001	<0.001	<0.001	<0.001
Se	0.02	0.014	<0.010	0.038	0.020
Zn	20	<0.001	<0.001	0.002	0.001
SO_4 Generation Rate		15	10	48	28.4
Cumulative SO_4 Generation		15	25	73	101
Ca Generation Rate		3.1	1.6	6.7	2.7
Cumulative Ca Generation		3.1	4.7	11	14
Mg Generation Rate		1.7	0.8	4.4	1.9
Cumulative Mg Generation		1.7	2.5	6.9	8.8
Residual ANC (%)		99.97	99.96	99.90	99.88
SO_4/Ca		2.0	2.5	3.0	4.4

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E5: Column Leach Test Results for Composite Sample 11 (siltstone 40-50m): *Overburden Material*

	Sample Weight (kg)	1.66	**ANC (kg H_2SO_4/t)$^{\#}$**		57.3
	TOTAL S (%)$^{\#}$	0.08	**NAPP (kg H_2SO_4/t)$^{\#}$**		-55
	Date	23-Dec-04	6-Jan-05		
	Leach Event	1	2		
	Volume Leached (L)	0.370	0.360		
	Cum. Volume (L)	0.370	0.730		
	Pore Volumes	0.3	0.5		
	pH	8.26	8.32		
	EC (υS/cm)	1,168	898		
	Acidity (mg/L)	0	0		
	Alkalinity (mg/L)	93	167		
	Net Alkalinity (mg/l)	93	167		
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	14	8		
Mg	-	6	4		
Na	-	177	146		
K	-	8	7		
Cl	-	202	82		
SO_4	1,000	76	85		
Minor Elements					
Al	5	0.01	0.02		
As	0.5	0.026	0.042		
B	5	0.7	1.1		
Cd	0.01	<0.0001	<0.0001		
Co	1	<0.001	<0.001		
Cr	1	<0.001	<0.001		
Cu	0.5	<0.001	<0.001		
Fe	1 (irrigation)	0.01	<0.01		
Hg	0.002	<0.0001	<0.0001		
Mn	2 (irrigation)	<0.001	<0.001		
Mo	0.15	0.285	0.233		
Pb	0.1	<0.001	<0.001		
Se	0.02	0.027	0.020		
Zn	20	<0.001	<0.001		
SO_4 Generation Rate		17	18		
Cumulative SO_4 Generation		17	35		
Ca Generation Rate		3.1	1.7		
Cumulative Ca Generation		3.1	4.9		
Mg Generation Rate		1.3	0.9		
Cumulative Mg Generation		1.3	2.2		
Residual ANC (%)		99.98	99.96		
SO_4/Ca		2.3	4.4		

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E6: Column Leach Test Results for Composite Sample 12 (siltstone 50-70m): *Overburden Material*

	Sample Weight (kg)	1.82	**ANC (kg H_2SO_4/t)#**		58.5
	TOTAL S (%)#	0.08	**NAPP (kg H_2SO_4/t)#**		-56
	Date	23-Dec-04	30-Dec-04		
	Leach Event	1	2		
	Volume Leached (L)	0.277	0.280		
	Cum. Volume (L)	0.277	0.557		
	Pore Volumes	0.2	0.4		
	pH	8.27	8.76		
	EC (υS/cm)	3,790	1,582		
	Acidity (mg/L)	0	0		
	Alkalinity (mg/L)	243	374		
	Net Alkalinity (mg/l)	243	374		
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	39	8		
Mg	-	23	4		
Na	-	634	274		
K	-	20	9		
Cl	-	880	131		
SO_4	1,000	252	116		
Minor Elements					
Al	5	<0.01	0.02		
As	0.5	0.074	0.059		
B	5	0.8	1.3		
Cd	0.01	0.0002	<0.0001		
Co	1	<0.001	<0.001		
Cr	1	<0.001	<0.001		
Cu	0.5	0.005	0.001		
Fe	1 (irrigation)	<0.01	0.01		
Hg	0.002	<0.0001	<0.0001		
Mn	2 (irrigation)	<0.001	0.004		
Mo	0.15	0.968	0.356		
Pb	0.1	<0.001	<0.001		
Se	0.02	0.093	<0.010		
Zn	20	0.007	0.007		
SO_4 Generation Rate		38	18		
Cumulative SO_4 Generation		38	56		
Ca Generation Rate		5.9	1.2		
Cumulative Ca Generation		5.9	7.2		
Mg Generation Rate		3.5	0.6		
Cumulative Mg Generation		3.5	4.1		
Residual ANC (%)		99.95	99.94		
SO_4/Ca		2.7	6.0		

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E7: Column Leach Test Results for Composite Sample 5 (mudstone floor) *Potential Reject Material*

	Sample Weight (kg)	2.06	**ANC (kg H_2SO_4/t)$^{\#}$**		67.3
	TOTAL S (%)$^{\#}$	0.37	**NAPP (kg H_2SO_4/t)$^{\#}$**		-63
	Date	16-Feb-04	23-Feb-04	2-Mar-04	
	Leach Event	1	2	3	
	Volume Leached (L)	0.275	0.690	0.455	
	Cum. Volume (L)	0.275	0.965	1.420	
	Pore Volumes	0.2	0.7	1.1	
	pH	8.23	8.42	8.58	
	EC (uS/cm)	3,020	1,450	1,610	
	Acidity (mg/L)	0	0	0	
	Alkalinity (mg/L)	171	151	224	
	Net Alkalinity (mg/l)	171	151	224	
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	42	9	11	
Mg	-	42	8	11	
Na	-	516	277	314	
K	-	16	8	10	
Cl	-	651	252	227	
SO_4	1,000	358	142	177	
Minor Elements					
Al	5	<0.01	<0.01	0.02	
As	0.5	0.055	0.092	0.063	
B	5	0.4	0.3	0.4	
Cd	0.01	<0.0001	<0.0001	<0.0001	
Co	1	0.004	<0.001	<0.001	
Cr	1	<0.001	<0.001	<0.001	
Cu	0.5	0.023	0.005	0.003	
Fe	1 (irrigation)	<0.01	<0.01	<0.01	
Hg	0.002	<0.0001	<0.0001	<0.0001	
Mn	2 (irrigation)	0.037	0.007	0.01	
Mo	0.15	0.218	0.108	0.155	
Pb	0.1	<0.001	0.001	<0.001	
Se	0.02	0.099	0.049	0.050	
Zn	20	0.045	0.011	0.008	
SO_4 Generation Rate		48	48	39	
Cumulative SO_4 Generation		48	95	134	
Ca Generation Rate		6	3	2	
Cumulative Ca Generation		6	9	11	
Mg Generation Rate		6	2.7	2.4	
Cumulative Mg Generation		6	8	11	
Residual ANC (%)		99.9	100.0	100.0	
SO_4/Ca		3.6	6.6	6.7	

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E8: Column Leach Test Results for Composite Sample 6 (mudstone roof) *Potential Reject Material*

	Sample Weight (kg)	2.06	**ANC (kg H_2SO_4/t)**#		102.2
	TOTAL S (%)#	0.37	**NAPP (kg H_2SO_4/t)**#		-94
	Date	16-Feb-04	2-Mar-05		
	Leach Event	1	2		
	Volume Leached (L)	0.355	0.555		
	Cum. Volume (L)	0.355	0.910		
	Pore Volumes	0.3	0.7		
	pH	8.25	8.41		
	EC (uS/cm)	1,300	607		
	Acidity (mg/L)	0	0		
	Alkalinity (mg/L)	139	161		
	Net Alkalinity (mg/l)	139	161		
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	21	7		
Mg	-	16	6		
Na	-	226	117		
K	-	13	8		
Cl	-	146	50		
SO_4	1,000	255	80		
Minor Elements					
Al	5	<0.01	0		
As	0.5	0.056	0.032		
B	5	0.6	0.4		
Cd	0.01	<0.0001	<0.0001		
Co	1	<0.001	<0.001		
Cr	1	<0.001	<0.001		
Cu	0.5	0.002	0.001		
Fe	1 (irrigation)	<0.01	<0.01		
Hg	0.002	0.0004	<0.0001		
Mn	2 (irrigation)	0.001	<0.001		
Mo	0.15	0.355	0.159		
Pb	0.1	<0.001	<0.001		
Se	0.02	0.071	<0.010		
Zn	20	0.003	<0.001		
SO_4 Generation Rate		44	22		
Cumulative SO_4 Generation		44	65		
Ca Generation Rate		4	2		
Cumulative Ca Generation		4	6		
Mg Generation Rate		3	1.6		
Cumulative Mg Generation		3	4		
Residual ANC (%)		100.0	100.0		
SO_4/Ca		5.1	4.8		

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Figure E1a: pH and EC trends for Ensham Column 1 (coal): Potential Reject Material

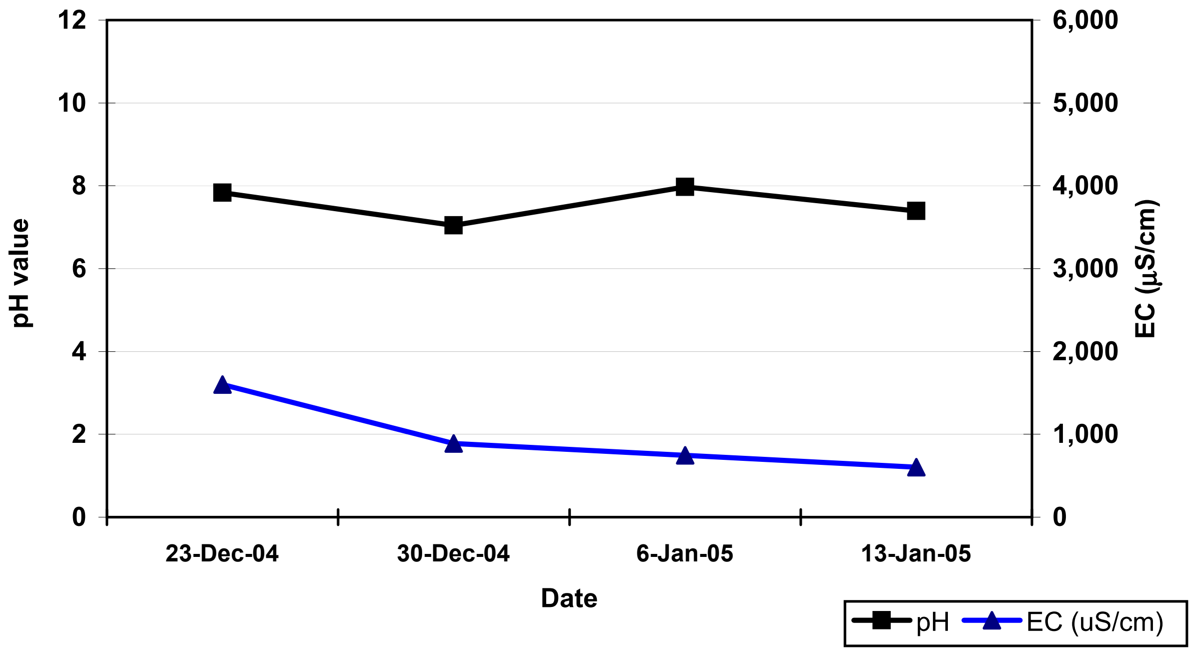


Figure E1b: Sulfate and Net Alkalinity trends for Ensham Column 1 (coal): Potential Reject Material

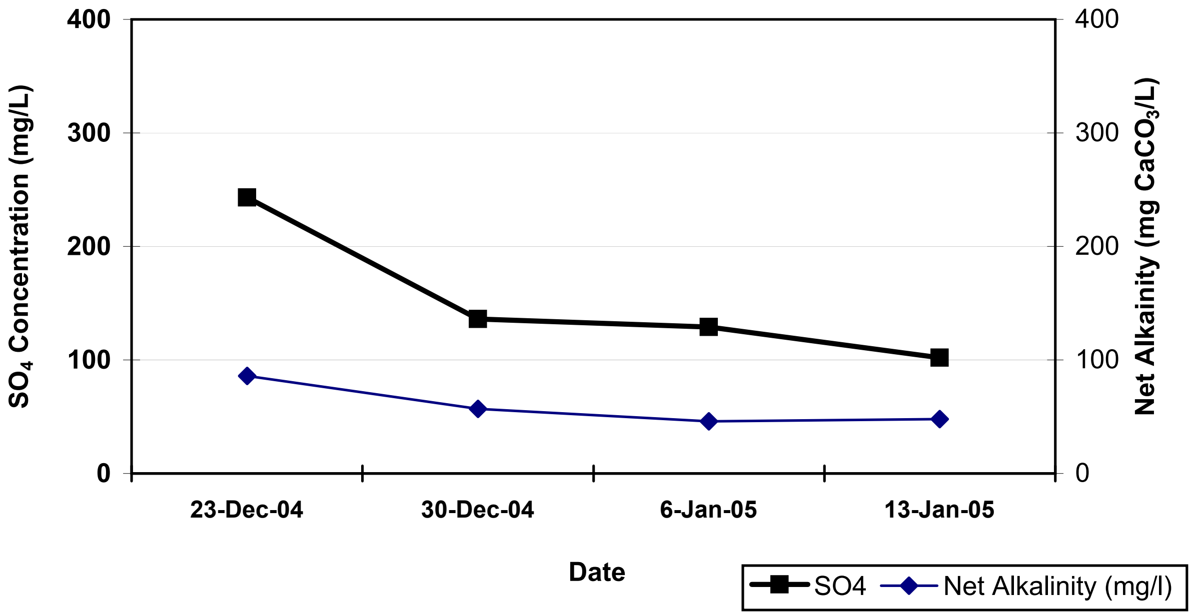


Figure E2a: pH and EC trends for Ensham Column 2 (mudstone): Overburden Material

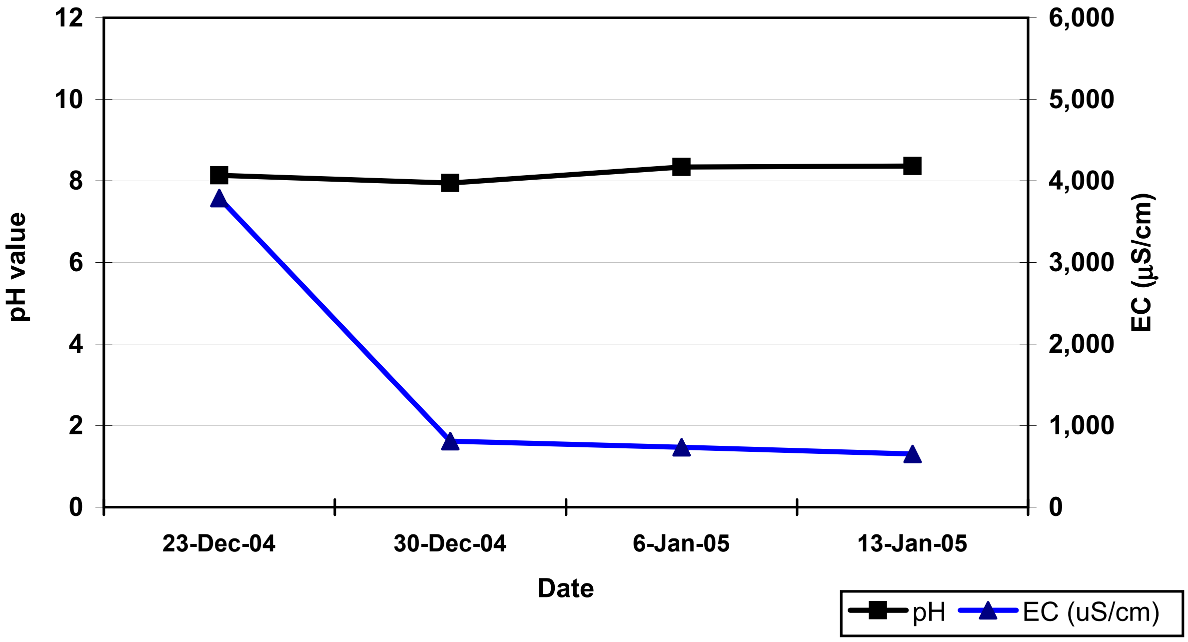


Figure E2b: Sulfate and Net Alkalinity trends for Ensham Column 2 (mudstone): Overburden Material

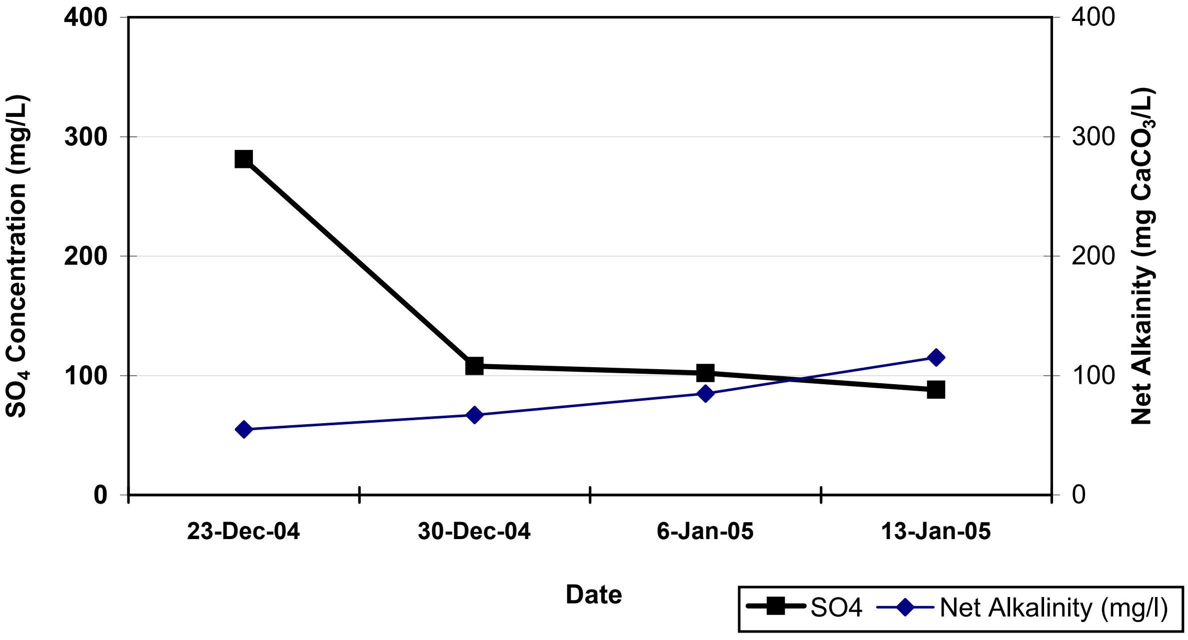


Figure E3a: pH and EC trends for Ensham Column 3 (sandstone): Overburden Material

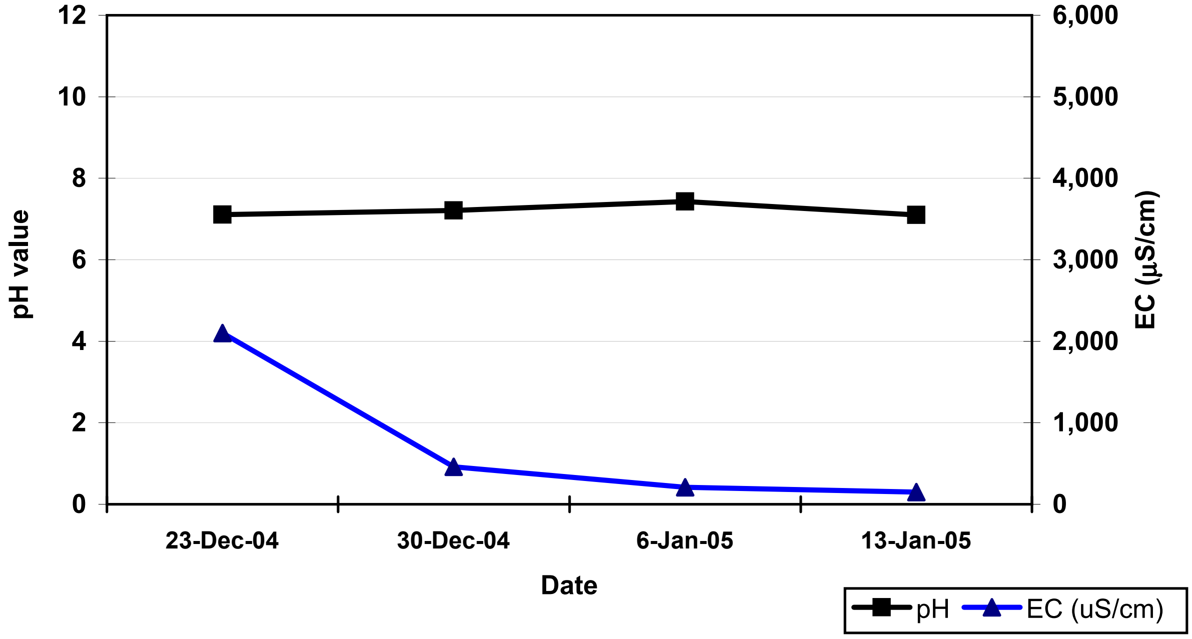


Figure E3b: Sulfate and Net Alkalinity trends for Ensham Column 3 (sandstone): Overburden Material

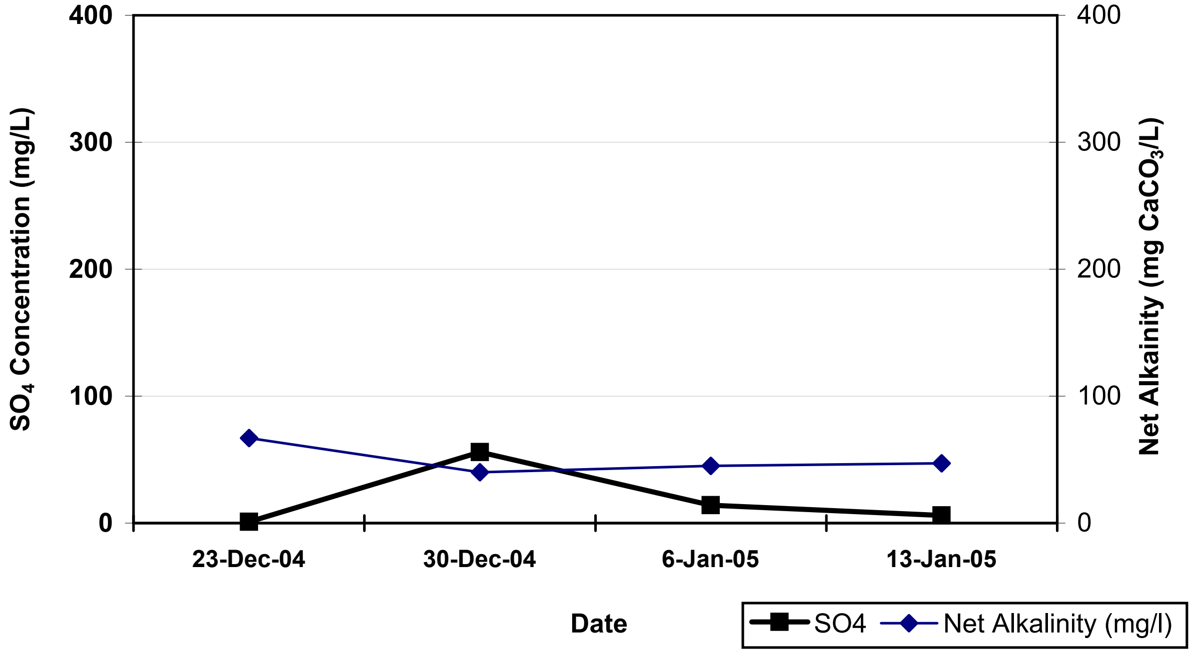


Figure E4a: pH and EC trends for Ensham Column 4 (siltstone <30m): Overburden Material

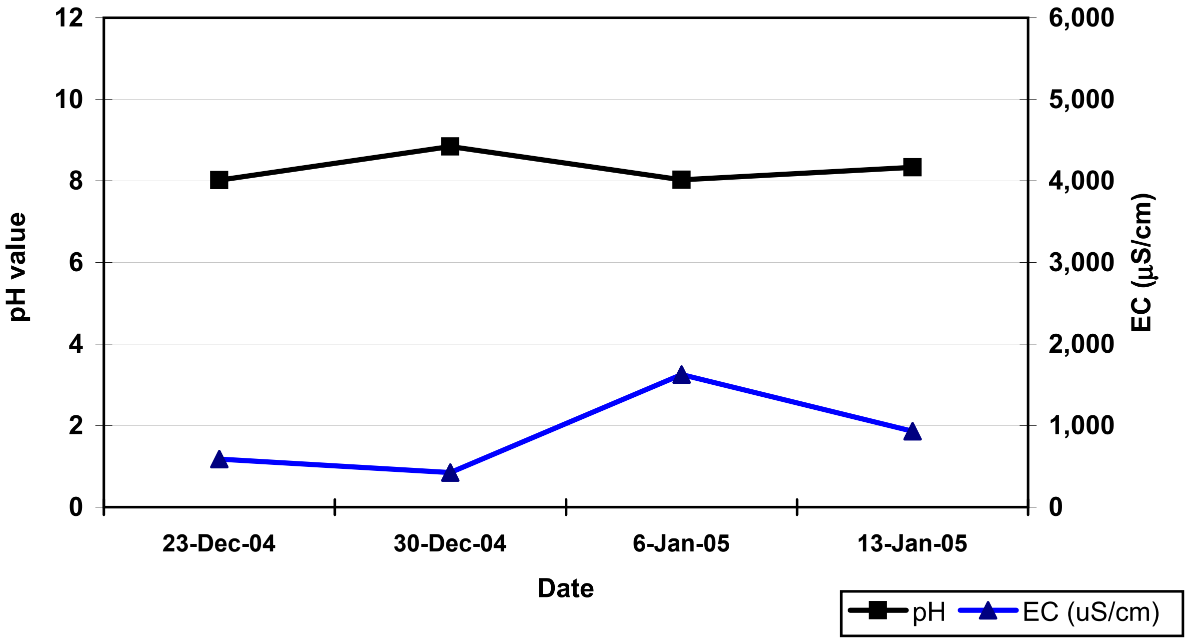


Figure E4b: Sulfate and Net Alkalinity trends for Ensham Column 4 (siltstone <30m): Overburden Material

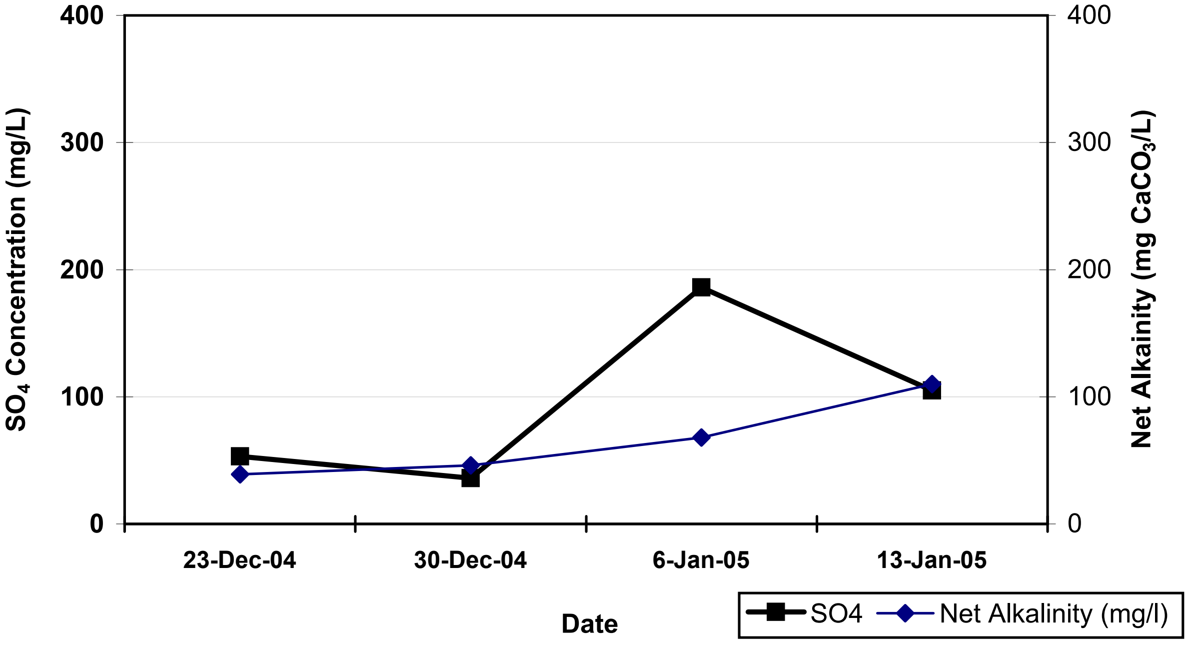


Figure E5a: pH and EC trends for Ensham Column 5 (siltstone 50-70m): Overburden Material

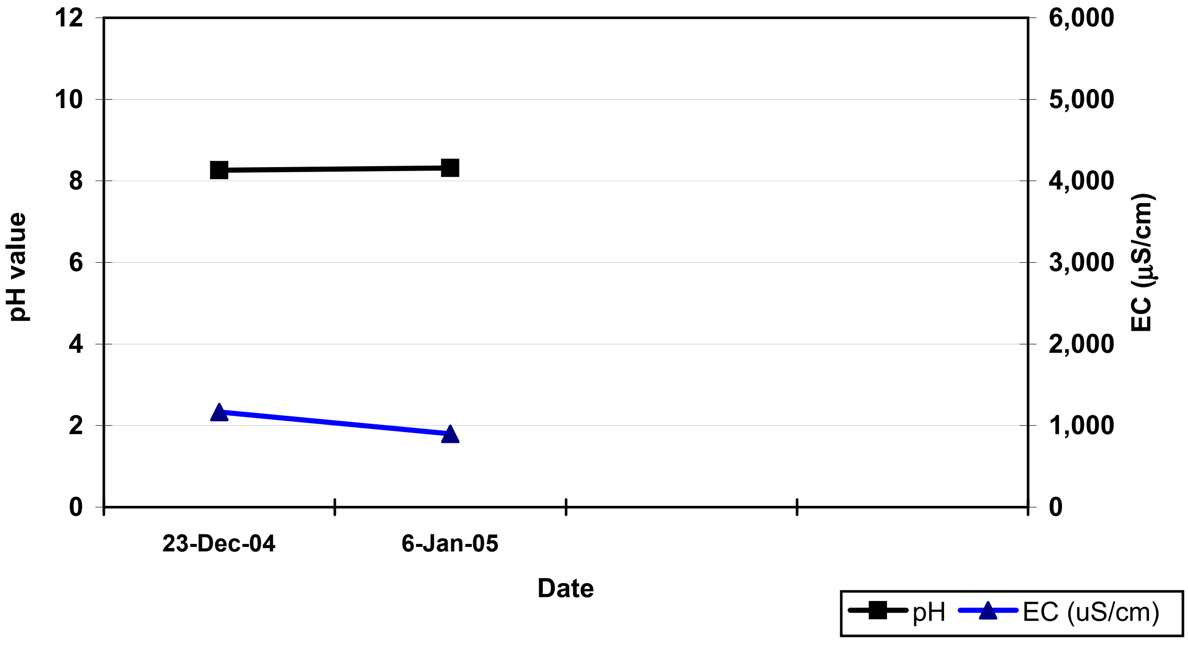


Figure E5b: Sulfate and Net Alkalinity trends for Ensham Column 5 (siltstone 50-70m): Overburden Material

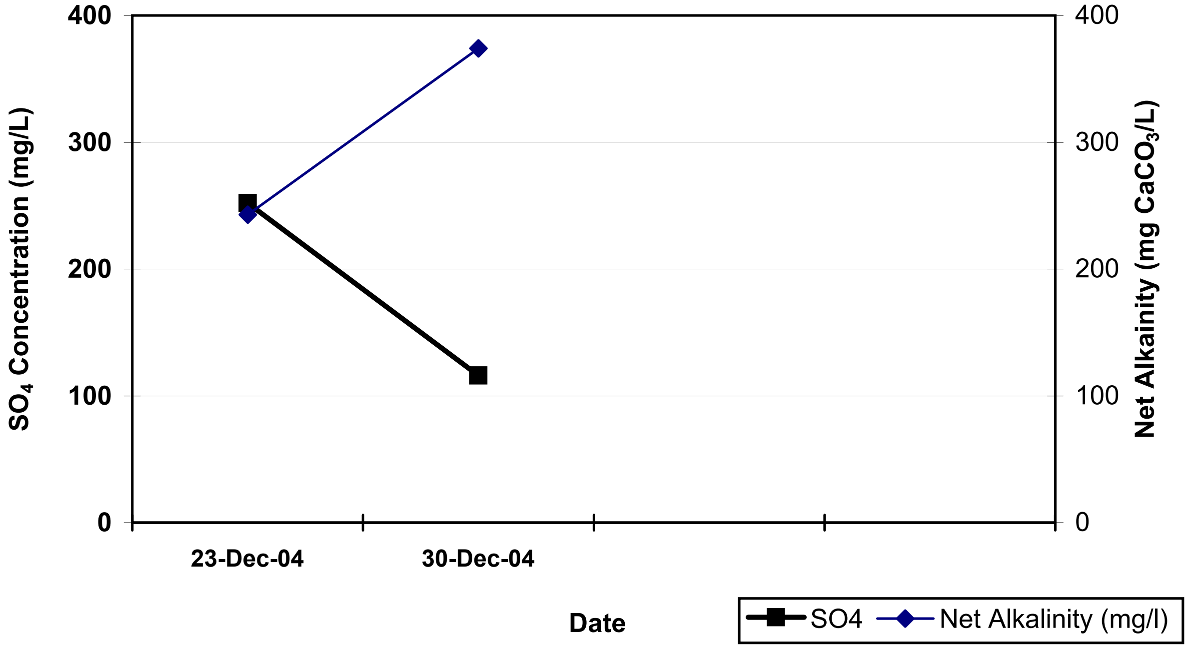


Figure E6a: pH and EC trends for Ensham Column 6 (siltstone 40-50m): Overburden Material

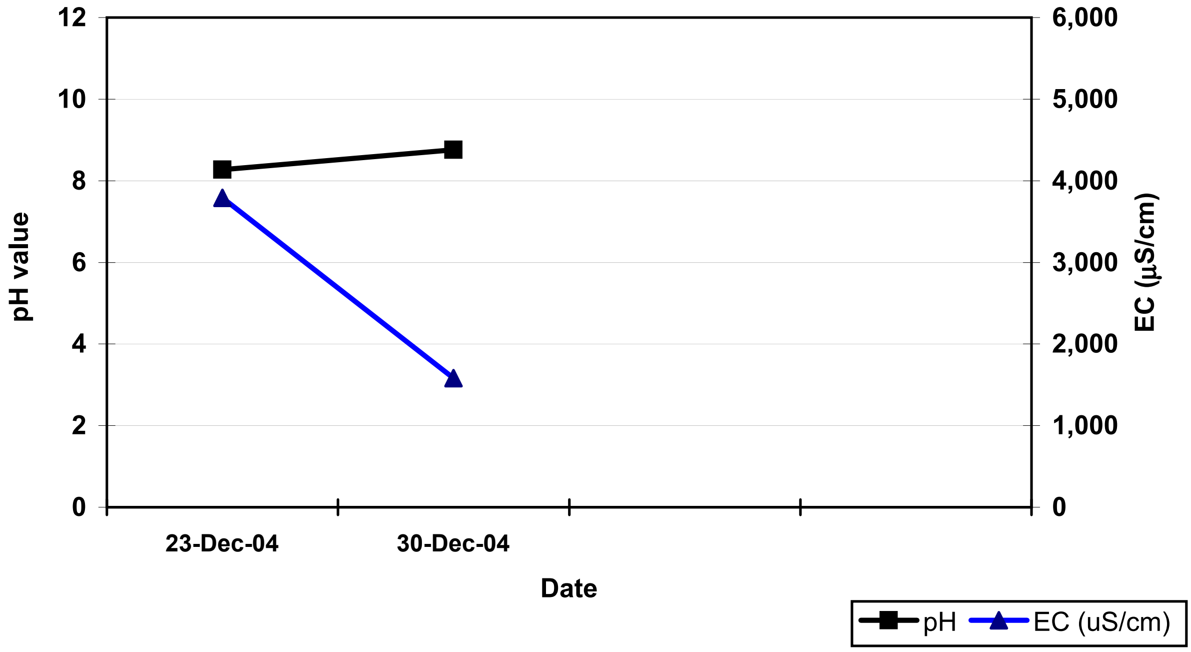
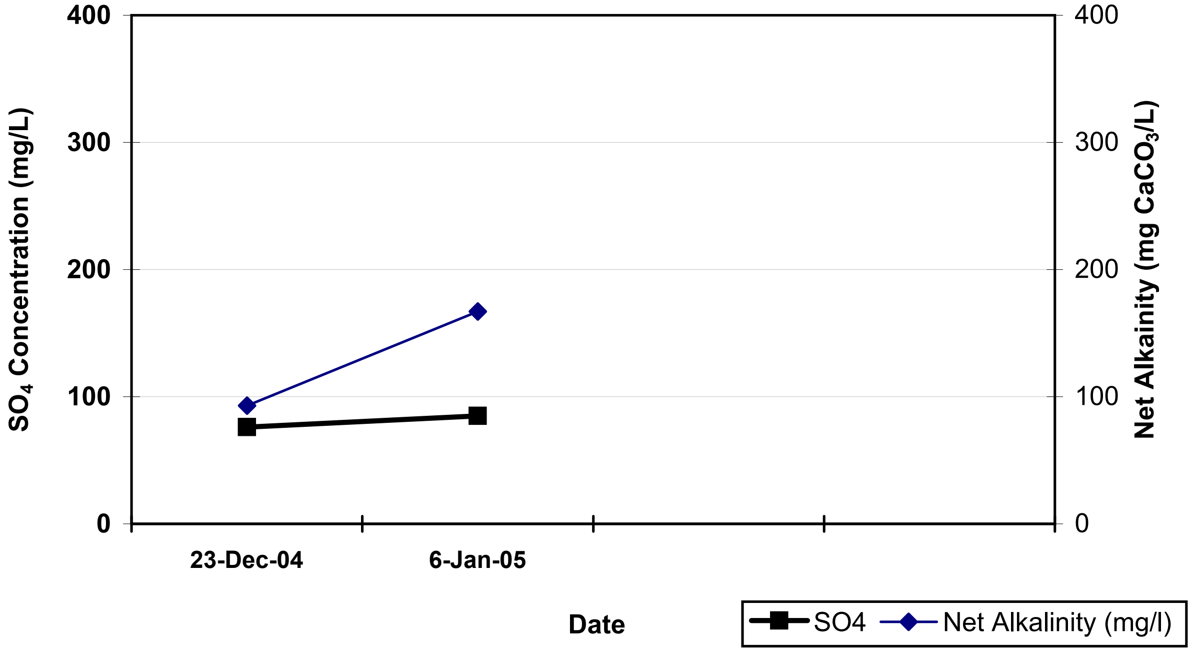


Figure E6b: Sulfate and Net Alkalinity trends for Ensham Column 6 (siltstone 40-50m): Overburden Material



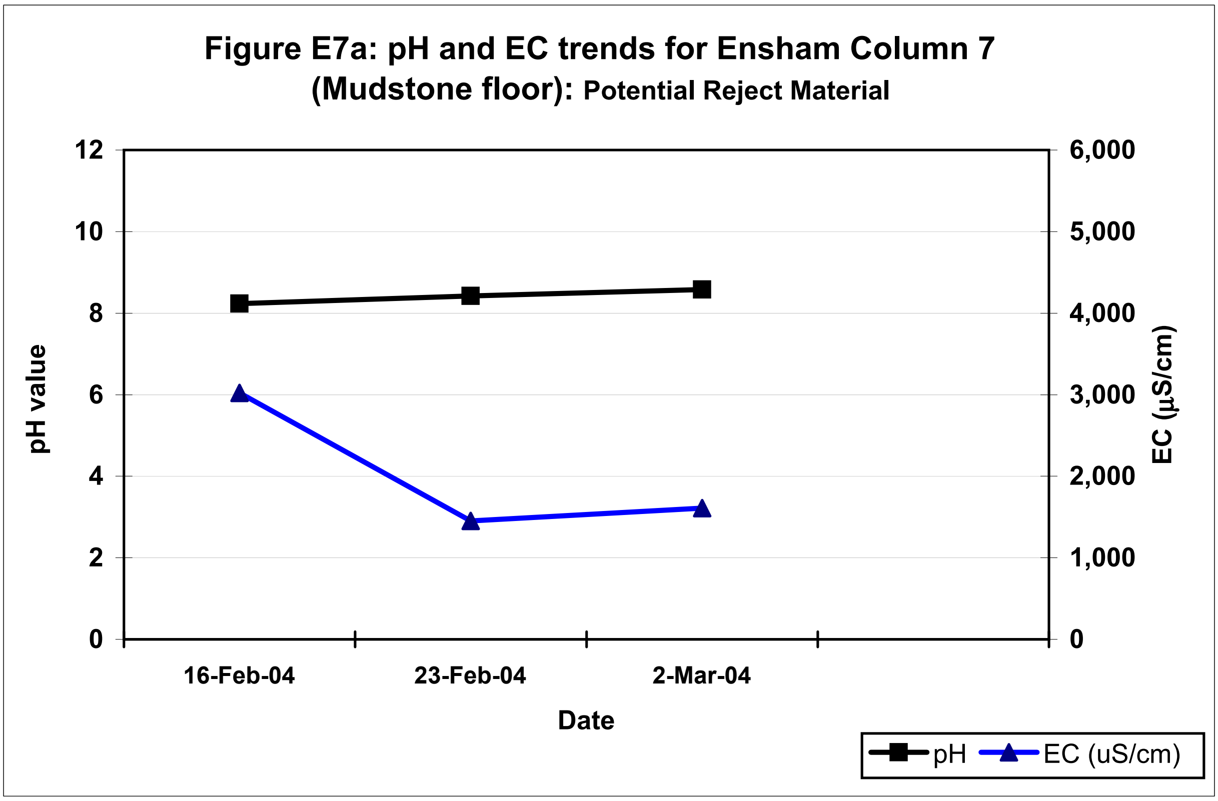


Figure E7a: pH and EC trends for Ensham Column 7
(Mudstone floor): Potential Reject Material
12
10
8
6
4
2
0
pH value
6,000
5,000
4,000
3,000
2,000
1,000
0
EC (µS/cm)
16-Feb-04
23-Feb-04
2-Mar-04
Date
pH
EC (uS/cm)

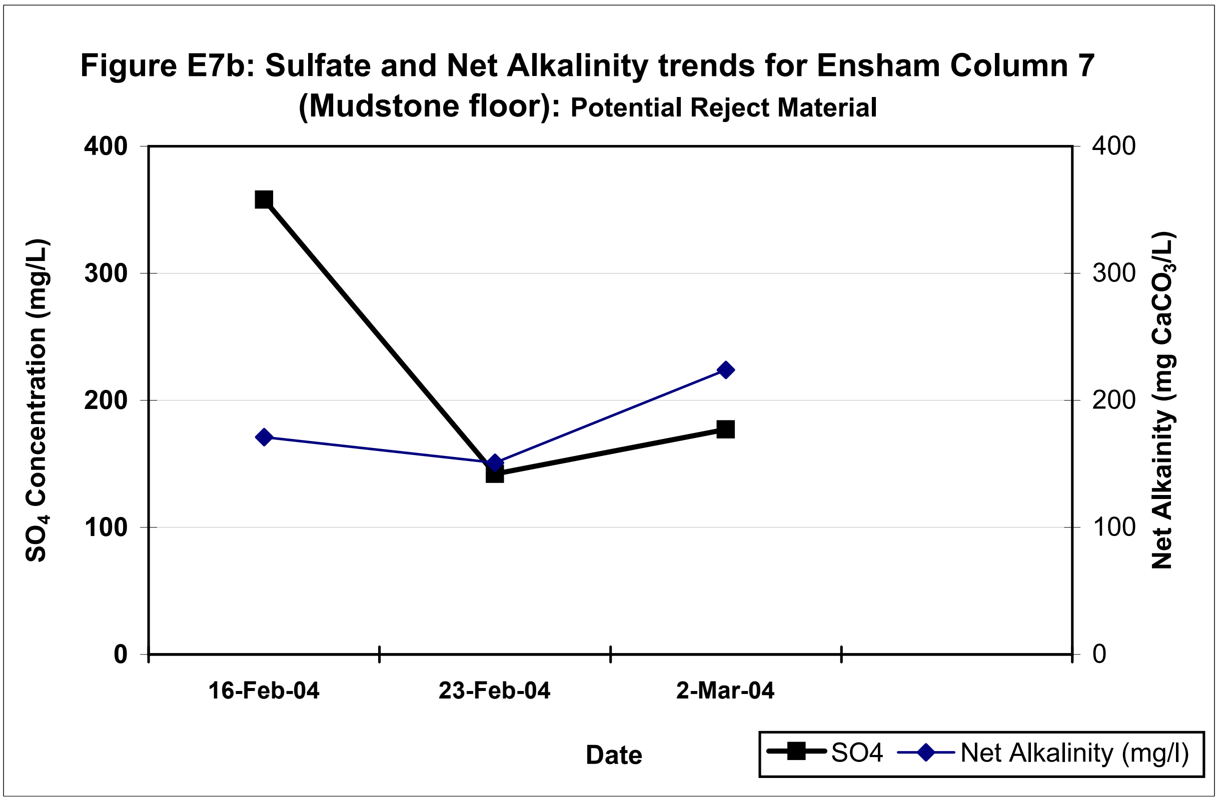


Figure E7b: Sulfate and Net Alkalinity trends for Ensham Column 7
(Mudstone floor): Potential Reject Material
400
300
200
100
0
SO4 Concentration (mg/L)
400
300
200
100
0
Net Alkainity (mg CaCO3/L)
16-Feb-04
23-Feb-04
2-Mar-04
Date
SO4
Net Alkalinity (mg/l)

Figure E8a: pH and EC trends for Ensham Column 8 (Mudstone roof): Potential Reject Material

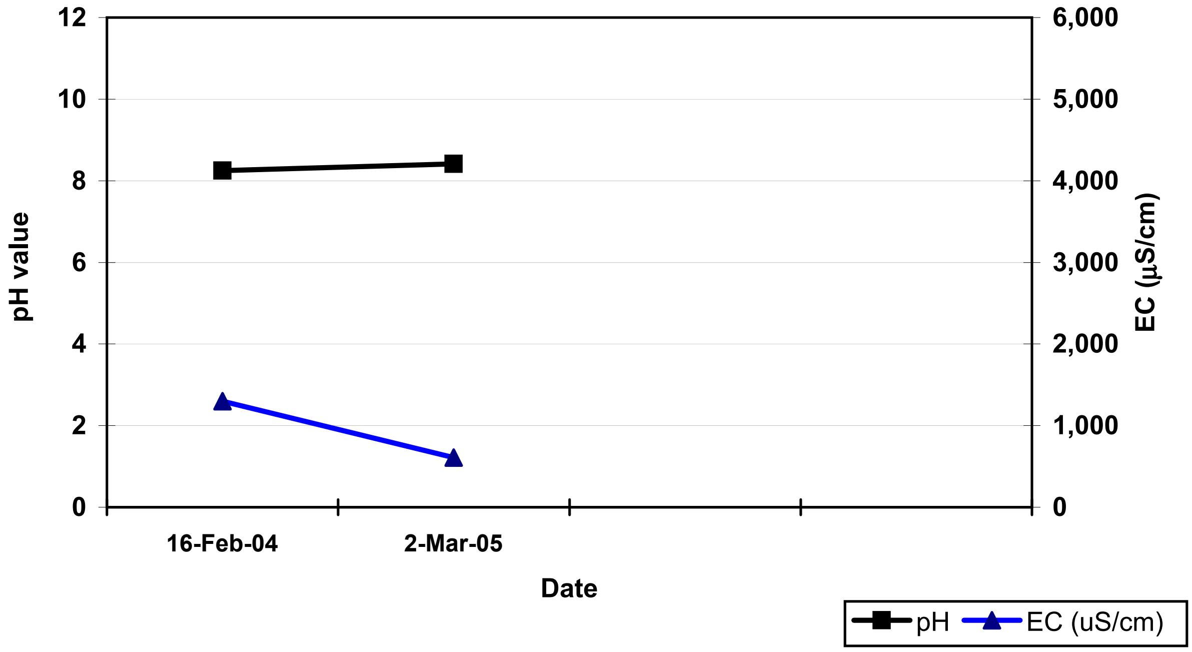


Figure E8b: Sulfate and Net Alkalinity trends for Ensham Column 8 (Mudstone roof): Potential Reject Material

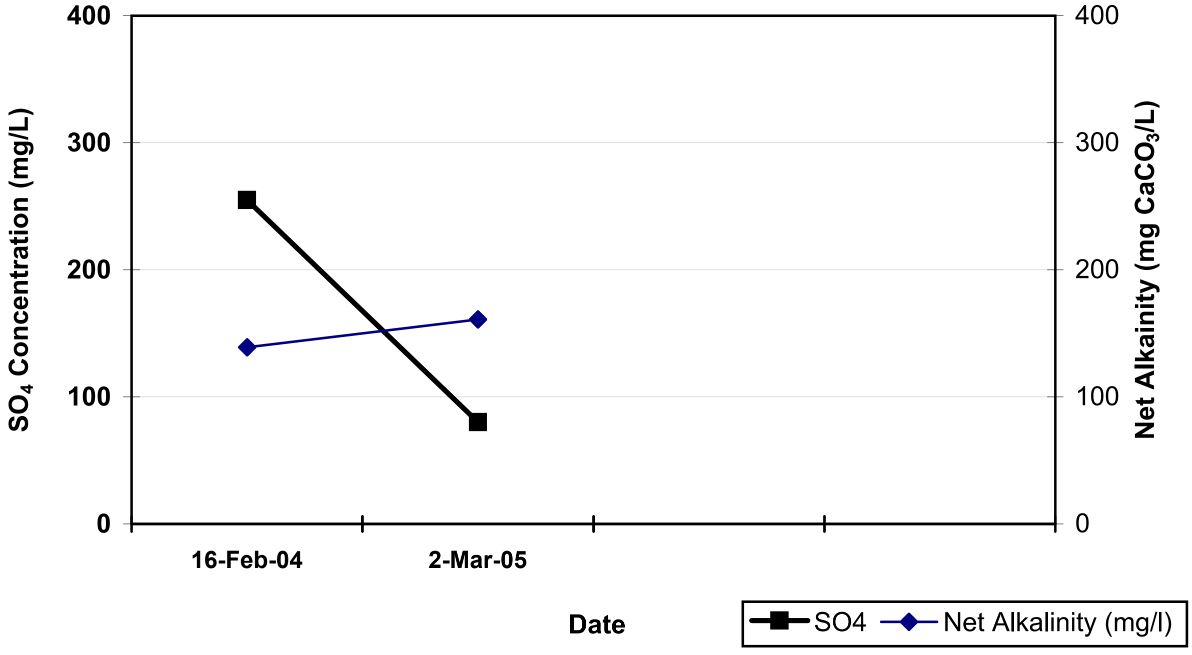


Table E1a: Column Leach Test Results for Composite Sample 2 (coal): *Potential Reject Material*

	Sample Weight (kg)	1.00	**ANC (kg H_2SO_4/t)#**		30.4
	TOTAL S (%)#	0.37	**NAPP (kg H_2SO_4/t)#**		-19
	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.505	0.480	0.480	0.490
	Cum. Volume (L)	0.505	0.985	1.465	1.955
	Pore Volumes	0.4	0.7	1.1	1.4
	pH	7.83	7.04	7.97	7.39
	EC (uS/cm)	1,600	890	748	602
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	86	57	46	48
	Net Alkalinity (mg/l)	86	57	46	48
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	42	36	40	36
Mg	-	24	18	18	16
Na	-	200	112	54	38
K	-	13	10	8	7
Cl	-	252	166	91	59
SO_4	1,000	243	136	129	102
Minor Elements					
Al	5	<0.01	<0.01	<0.01	<0.01
As	0.5	0.005	0.004	0.002	0.002
B	5	0.4	0.4	0.4	0.4
Cd	0.01	<0.0001	<0.0001	<0.0001	<0.0001
Co	1	<0.001	<0.001	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.002	<0.001	<0.001	<0.001
Fe	1 (irrigation)	<0.01	<0.01	<0.01	<0.01
Hg	0.002	<0.0001	<0.0001	<0.0001	0.0002
Mn	2 (irrigation)	0.093	0.080	0.071	0.061
Mo	0.15	0.092	0.040	0.036	0.031
Pb	0.1	<0.001	<0.001	<0.001	<0.001
Se	0.02	0.023	<0.010	<0.010	<0.010
Zn	20	0.021	0.004	0.004	0.019
SO_4 Generation Rate		123	65	62	50
Cumulative SO_4 Generation		123	188	250	300
Ca Generation Rate		21	17	19	18
Cumulative Ca Generation		21	38	58	75
Mg Generation Rate		12	8.6	8.6	7.8
Cumulative Mg Generation		12	21	29	37
Residual ANC (%)		99.7	99.4	99.1	98.9
SO_4/Ca		2.4	1.6	1.3	1.2

ratio	ratio	ratio	ratio
0.51	0.48	0.48	0.49
therefore	therefore	therefore	therefore
dilute by	dilute by	dilute by	dilute by
9.9	10.4	10.4	10.2
times	times	times	times
to get 1:5	to get 1:5	to get 1:5	to get 1:5

<0.01

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E2a: Column Leach Test Results for Composite Sample 4 (mudstone): *Overburden Material*

	Sample Weight (kg)	1.58	**ANC (kg H_2SO_4/t)$^{\#}$**		30.3
	TOTAL S (%)$^{\#}$	0.09	**NAPP (kg H_2SO_4/t)$^{\#}$**		-28
	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.335	0.415	0.387	0.250
	Cum. Volume (L)	0.335	0.750	1.137	1.387
	Pore Volumes	0.2	0.6	0.8	1.0
	pH	8.14	7.95	8.34	8.36
	EC (uS/cm)	3,790	809	734	652
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	55	67	85	115
	Net Alkalinity (mg/l)	55	67	85	115
Dissolved Elements	ANZECC^1/NEPM^2 Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	77	6	5	4
Mg	-	74	4	3	3
Na	-	501	132	107	100
K	-	13	3	3	3
Cl	-	810	97	55	33
SO_4	1,000	281	108	102	88
Minor Elements					
Al	5	<0.01	0.05	0.26	0.37
As	0.5	0.005	0.012	0.013	0.010
B	5	0.3	0.4	0.7	1.0
Cd	0.01	0.0002	<0.0001	<0.0001	<0.0001
Co	1	0.002	0.002	0.001	0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.013	0.008	0.009	0.007
Fe	1 (irrigation)	0.01	0.02	0.08	0.10
Hg	0.002	<0.0001	<0.0001	<0.0001	<0.0001
Mn	2 (irrigation)	0.023	<0.001	<0.001	<0.001
Mo	0.15	0.104	0.108	0.130	0.143
Pb	0.1	0.002	<0.001	<0.001	<0.001
Se	0.02	0.117	0.026	0.025	0.023
Zn	20	0.071	0.018	0.025	0.016
SO_4 Generation Rate		60	28	25	14
Cumulative SO_4 Generation		60	88	113	127
Ca Generation Rate		16	1.6	1.2	0.6
Cumulative Ca Generation		16	18	19	20
Mg Generation Rate		16	1.1	0.7	0.5
Cumulative Mg Generation		16	17	17	18
Residual ANC (%)		99.66	99.63	99.61	99.60
SO_4/Ca		1.5	7.5	8.5	9.2

ratio	ratio	ratio	ratio
0.21	0.26	0.24	0.16
therefore	therefore	therefore	therefore
dilute by	dilute by	dilute by	dilute by
23.6	19.0	20.4	31.6
times	times	times	times
to get 1:5	to get 1:5	to get 1:5	to get 1:5

<0.01	<0.01	<0.01	<0.01

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E3a: Column Leach Test Results for Composite Sample 7 (sandstone <10m): *Overburden Material*

	Sample Weight (kg)	1.26	**ANC (kg H_2SO_4/t)#**		33.7
	TOTAL S (%)#	0.04	**NAPP (kg H_2SO_4/t)#**		-33
	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.430	0.465	0.455	0.470
	Cum. Volume (L)	0.430	0.895	1.350	1.820
	Pore Volumes	0.3	0.7	1.0	1.3
	pH	7.11	7.21	7.43	7.10
	EC (uS/cm)	2,100	461	207	150
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	67	40	45	47
	Net Alkalinity (mg/l)	67	40	45	47
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	<1	5	2	1
Mg	-	<1	2	<1	<1
Na	-	<1	73	42	33
K	-	<1	1	<1	<1
Cl	-	412	62	11	8
SO_4	1,000	1	56	14	6
Minor Elements					
Al	5	0.02	<0.01	0.06	0.14
As	0.5	0.004	0.009	0.013	0.012
B	5	0.2	0.6	0.8	0.7
Cd	0.01	0.0006	0.0001	<0.0001	<0.0001
Co	1	0.012	0.002	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.038	0.019	0.011	0.007
Fe	1 (irrigation)	0.14	0.05	0.09	0.20
Hg	0.002	<0.0001	<0.0001	<0.0001	<0.0001
Mn	2 (irrigation)	0.085	<0.001	<0.001	<0.001
Mo	0.15	0.005	0.008	0.008	0.007
Pb	0.1	0.002	<0.001	<0.001	<0.001
Se	0.02	<0.010	<0.010	<0.010	<0.010
Zn	20	0.177	0.030	0.019	0.014
SO_4 Generation Rate		0.3	21	5.1	2.2
Cumulative SO_4 Generation		0.3	21	26	28
Ca Generation Rate		0.2	1.8	0.7	0.4
Cumulative Ca Generation		0.2	2.0	2.7	3.1
Mg Generation Rate		0.2	0.7	0.2	0.2
Cumulative Mg Generation		0.2	0.9	1.1	1.3
Residual ANC (%)		100.00	99.97	99.97	99.96
SO_4/Ca		0.8	4.7	2.9	2.5

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

ratio	ratio	ratio	ratio
0.34	0.37	0.36	0.37
therefore	therefore	therefore	therefore
dilute by	dilute by	dilute by	dilute by
14.7	13.5	13.8	13.4
times	times	times	times
to get 1:5	to get 1:5	to get 1:5	to get 1:5

Table E4a: Column Leach Test Results for Composite Sample 9 (siltstone <30m): *Overburden Material*

Sample Weight (kg)	1.72	**ANC (kg H_2SO_4/t)#**		57.1
TOTAL S (%)#	0.08	**NAPP (kg H_2SO_4/t)#**		-55

	Date	23-Dec-04	30-Dec-04	6-Jan-05	13-Jan-05
	Leach Event	1	2	3	4
	Volume Leached (L)	0.483	0.470	0.445	0.465
	Cum. Volume (L)	0.483	0.953	1.398	1.863
	Pore Volumes	0.4	0.7	1.0	1.4
	pH	8.02	8.84	8.03	8.33
	EC (υS/cm)	590	426	1,626	930
	Acidity (mg/L)	0	0	0	0
	Alkalinity (mg/L)	39	46	68	110
	Net Alkalinity (mg/l)	39	46	68	110
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	11	6	26	10
Mg	-	6	3	17	7
Na	-	76	75	211	138
K	-	5	5	13	9
Cl	-	90	77	255	95
SO_4	1,000	53	36	186	105
Minor Elements					
Al	5	0.02	0.04	0.01	0.02
As	0.5	0.012	0.031	0.029	0.052
B	5	0.1	0.1	0.5	0.6
Cd	0.01	<0.0001	<0.0001	<0.0001	<0.0001
Co	1	<0.001	<0.001	<0.001	<0.001
Cr	1	<0.001	<0.001	<0.001	<0.001
Cu	0.5	0.002	<0.001	0.001	0
Fe	1 (irrigation)	0.02	0.02	0.02	0.02
Hg	0.002	<0.0001	<0.0001	<0.0001	
Mn	2 (irrigation)	0.061	0.008	0.038	0.010
Mo	0.15	0.040	0.031	0.164	0.150
Pb	0.1	<0.001	<0.001	<0.001	<0.001
Se	0.02	0.014	<0.010	0.038	0.020
Zn	20	<0.001	<0.001	0.002	0.001
SO_4 Generation Rate		15	10	48	28.4
Cumulative SO_4 Generation		15	25	73	101
Ca Generation Rate		3.1	1.6	6.7	2.7
Cumulative Ca Generation		3.1	4.7	11	14
Mg Generation Rate		1.7	0.8	4.4	1.9
Cumulative Mg Generation		1.7	2.5	6.9	8.8
Residual ANC (%)		99.97	99.96	99.90	99.88
SO_4/Ca		2.0	2.5	3.0	4.4

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

ratio	ratio	ratio	ratio
0.28	0.27	0.26	0.27
therefore	therefore	therefore	therefore
dilute by	dilute by	dilute by	dilute by
17.8	18.3	19.3	18.5
times	times	times	times
to get 1:5	to get 1:5	to get 1:5	to get 1:5

0.008

<0.01

Table E5a: Column Leach Test Results for Composite Sample 11 (siltstone 40-50m): *Overburden Material*

	Sample Weight (kg)	1.66	**ANC (kg H_2SO_4/t)#**		57.3
	TOTAL S (%)#	0.08	**NAPP (kg H_2SO_4/t)#**		-55
	Date	23-Dec-04	6-Jan-05		
	Leach Event	1	2		
	Volume Leached (L)	0.370	0.360		
	Cum. Volume (L)	0.370	0.730		
	Pore Volumes	0.3	0.5		
	pH	8.26	8.32		
	EC (υS/cm)	1,168	898		
	Acidity (mg/L)	0	0		
	Alkalinity (mg/L)	93	167		
	Net Alkalinity (mg/l)	93	167		
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	14	8		
Mg	-	6	4		
Na	-	177	146		
K	-	8	7		
Cl	-	202	82		
SO_4	1,000	76	85		
Minor Elements					
Al	5	0.01	0.02		
As	0.5	0.026	0.042		
B	5	0.7	1.1		
Cd	0.01	<0.0001	<0.0001		
Co	1	<0.001	<0.001		
Cr	1	<0.001	<0.001		
Cu	0.5	<0.001	<0.001		
Fe	1 (irrigation)	0.01	<0.01		
Hg	0.002	<0.0001	<0.0001		
Mn	2 (irrigation)	<0.001	<0.001		
Mo	0.15	0.285	0.233		
Pb	0.1	<0.001	<0.001		
Se	0.02	0.027	0.020		
Zn	20	<0.001	<0.001		
SO_4 Generation Rate		17	18		
Cumulative SO_4 Generation		17	35		
Ca Generation Rate		3.1	1.7		
Cumulative Ca Generation		3.1	4.9		
Mg Generation Rate		1.3	0.9		
Cumulative Mg Generation		1.3	2.2		
Residual ANC (%)		99.98	99.96		
SO_4/Ca		2.3	4.4		

* Acidity and Alkalinity data calculated in mg $CaCO_3$/L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

ratio	ratio
0.22	0.22
therefore	therefore
dilute by	dilute by
22.4	23.1
times	times
to get 1:5	to get 1:5

0.013	0.010
<0.01	

Table E6a: Column Leach Test Results for Composite Sample 12 (siltstone 50-70m): *Overburden Material*

	Sample Weight (kg)	1.82	**ANC (kg H_2SO_4/t)$^\#$**		58.5		
	TOTAL S (%)$^\#$	0.08	**NAPP (kg H_2SO_4/t)$^\#$**		-56		
	Date	23-Dec-04	30-Dec-04			ratio	ratio
	Leach Event	1	2			0.15	0.15
	Volume Leached (L)	0.277	0.280			therefore	therefore
	Cum. Volume (L)	0.277	0.557			dilute by	dilute by
	Pore Volumes	0.2	0.4			32.9	32.5
	pH	8.27	8.76			times	times
	EC (υS/cm)	3,790	1,582			to get 1:5	to get 1:5
	Acidity (mg/L)	0	0				
	Alkalinity (mg/L)	243	374				
	Net Alkalinity (mg/l)	243	374				
Dissolved Elements	ANZECC^1/NEPM^2 Guidelines (mg/L)	mg/L					
Major Elements							
Ca	1,000	39	8				
Mg	-	23	4				
Na	-	634	274				
K	-	20	9				
Cl	-	880	131				
SO_4	1,000	252	116				
Minor Elements							
Al	5	<0.01	0.02				
As	0.5	0.074	0.059				
B	5	0.8	1.3				
Cd	0.01	0.0002	<0.0001				
Co	1	<0.001	<0.001				
Cr	1	<0.001	<0.001				
Cu	0.5	0.005	0.001				
Fe	1 (irrigation)	<0.01	0.01				
Hg	0.002	<0.0001	<0.0001				
Mn	2 (irrigation)	<0.001	0.004				
Mo	0.15	0.968	0.356			0.029	0.011
Pb	0.1	<0.001	<0.001				
Se	0.02	0.093	<0.010			<0.01	
Zn	20	0.007	0.007				
SO_4 Generation Rate		38	18				
Cumulative SO_4 Generation		38	56				
Ca Generation Rate		5.9	1.2				
Cumulative Ca Generation		5.9	7.2				
Mg Generation Rate		3.5	0.6				
Cumulative Mg Generation		3.5	4.1				
Residual ANC (%)		99.95	99.94				
SO_4/Ca		2.7	6.0				

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E7a: Column Leach Test Results for Composite Sample 5 (mudstone floor): *Potential Reject Material*

Sample Weight (kg)	2.06	**ANC (kg H_2SO_4/t)#**	67.3
TOTAL S (%)#	0.37	**NAPP (kg H_2SO_4/t)#**	-63

Date		16-Feb-04	23-Feb-04	2-Mar-04		ratio	ratio	ratio
Leach Event		1	2	3		0.13	0.33	0.22
Volume Leached (L)		0.275	0.690	0.455		therefore	therefore	therefore
Cum. Volume (L)		0.275	0.965	1.420		dilute by	dilute by	dilute by
Pore Volumes		0.2	0.7	1.1		37.5	14.9	22.6
pH		8.23	8.42	8.58		times	times	times
EC (uS/cm)		3,020	1,450	1,610		to get 1:5	to get 1:5	to get 1:5
Acidity (mg/L)		0	0	0				
Alkalinity (mg/L)		171	151	224				
Net Alkalinity (mg/l)		171	151	224				
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L						
Major Elements								
Ca	1,000	42	9	11				
Mg	-	42	8	11				
Na	-	516	277	314				
K	-	16	8	10				
Cl	-	651	252	227				
SO_4	1,000	358	142	177				
Minor Elements								
Al	5	<0.01	<0.01	0.02				
As	0.5	0.055	0.092	0.063				
B	5	0.4	0.3	0.4				
Cd	0.01	<0.0001	<0.0001	<0.0001				
Co	1	0.004	<0.001	<0.001				
Cr	1	<0.001	<0.001	<0.001				
Cu	0.5	0.023	0.005	0.003				
Fe	1 (irrigation)	<0.01	<0.01	<0.01				
Hg	0.002	<0.0001	<0.0001	<0.0001				
Mn	2 (irrigation)	0.037	0.007	0.01				
Mo	0.15	0.218	0.108	0.155		<0.01		<0.01
Pb	0.1	<0.001	0.001	<0.001				
Se	0.02	0.099	0.049	0.050		<0.01	0.003	0.002
Zn	20	0.045	0.011	0.008				
SO_4 Generation Rate		48	48	39				
Cumulative SO_4 Generation		48	95	134				
Ca Generation Rate		6	3	2				
Cumulative Ca Generation		6	9	11				
Mg Generation Rate		6	2.7	2.4				
Cumulative Mg Generation		6	8	11				
Residual ANC (%)		99.9	100.0	100.0				
SO_4/Ca		3.6	6.6	6.7				

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

Table E8a: Column Leach Test Results for Composite Sample 6 (mudstone roof): *Potential Reject Material*

	Sample Weight (kg)	2.06	**ANC (kg H_2SO_4/t)#**		102.2
	TOTAL S (%)#	0.37	**NAPP (kg H_2SO_4/t)#**		-94
	Date	16-Feb-04	2-Mar-05		
	Leach Event	1	2		
	Volume Leached (L)	0.355	0.555		
	Cum. Volume (L)	0.355	0.910		
	Pore Volumes	0.3	0.7		
	pH	8.25	8.41		
	EC (uS/cm)	1,300	607		
	Acidity (mg/L)	0	0		
	Alkalinity (mg/L)	139	161		
	Net Alkalinity (mg/l)	139	161		
Dissolved Elements	ANZECC[1]/NEPM[2] Guidelines (mg/L)	mg/L			
Major Elements					
Ca	1,000	21	7		
Mg	-	16	6		
Na	-	226	117		
K	-	13	8		
Cl	-	146	50		
SO_4	1,000	255	80		
Minor Elements					
Al	5	<0.01	0		
As	0.5	0.056	0.032		
B	5	0.6	0.4		
Cd	0.01	<0.0001	<0.0001		
Co	1	<0.001	<0.001		
Cr	1	<0.001	<0.001		
Cu	0.5	0.002	0.001		
Fe	1 (irrigation)	<0.01	<0.01		
Hg	0.002	0.0004	<0.0001		
Mn	2 (irrigation)	0.001	<0.001		
Mo	0.15	0.355	0.159		
Pb	0.1	<0.001	<0.001		
Se	0.02	0.071	<0.010		
Zn	20	0.003	<0.001		
SO_4 Generation Rate		44	22		
Cumulative SO_4 Generation		44	65		
Ca Generation Rate		4	2		
Cumulative Ca Generation		4	6		
Mg Generation Rate		3	1.6		
Cumulative Mg Generation		3	4		
Residual ANC (%)		100.0	100.0		
SO_4/Ca		5.1	4.8		

* Acidity and Alkalinity data calculated in mg $CaCO_3$ /L

**Ca, Mg and SO_4 generation rates calculated in mg/kg/flush.

1. ANZECC. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, 2000.
2. National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM). Guideline on Investigation Levels for Soil and Groundwater. December 1999.

\# Total S, ANC, NAPP data averaged for composite sample.

Shaded cells indicate values which exceed ANZECC/NEPM guideline values.

ratio	ratio
0.17	0.27
therefore	therefore
dilute by	dilute by
29.0	18.6
times	times
to get 1:5	to get 1:5

0.01	<0.01
<0.01	

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URS

Report

Ensham Coal
Mine
Geochemical
Characterisation
Program

AUSTRALIA

Geochemical Characterisation of Overburden and Potential Rejects

19 March 2015
42627460/R001/A

Prepared for:
Ensham Resources Pty Ltd

Prepared by URS Australia Pty Ltd

URS

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APPENDICES

ABBREVIATIONS

Abbreviation	Description
%	per cent
% S	per cent sulfur (by weight)
µm	micrometre
µS/cm	microSiemens per centimetre
ABA	acid base account
AC	acid consuming
Al	aluminium
ALS	Australian Laboratory Services
AMD	acid and metalliferous drainage
AMIRA	Australian Mineral Industries Research Association International Limited
ANC	acid neutralising capacity
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	arsenic
$CaSO_4 \cdot 2H_2O$	gypsum
Cd	cadmium
eCEC	effective cation exchange capacity
Co	cobalt
Cr	chromium
CRS	chromium reducible sulfide
Cu	copper
DERM	Department of Environment and Resource Management
DITR	Department of Industry, Tourism and Resources
dS/m	deciSiemens per metre
EA	Environmental Authority
EC	electrical conductivity
eCEC	effective cation exchange capacity
ECM	Ensham Coal Mine
EC_{se}	average root zone salinity
EHP	Department of Environment and Heritage Protection
ESP	exchangeable sodium percentage
EVs	environmental values
Fe	iron
g	gram
GAI	geochemical abundance index
HIL C	health-based investigation levels for land used as for parklands and recreational open spaces
HILs	health-based investigation levels
kg H_2SO_4/t	kilogram sulfuric acid per tonne
LOR	limit of reporting

Abbreviation	**Description**
meq/100g	milliequivalents per 100 grams
mg/kg	milligram per kilogram
mg/L	milligram per litre
mm	millimetre
Mn	manganese
Mo	molybdenum
MPA	maximum potential acid
MPA_{CRS}	maximum potential acid based on sulfide-sulfur
NAF	non-acid forming
NAG	net acid generation
NAPP	net acid producing potential
$NAPP_{CRS}$	net acid producing potential based on sulfide-sulfur
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
Ni	nickel
NST	not sufficiently toxic
PAF	potentially acid forming
PAF-LC	potentially acid forming – low capacity
Pb	lead
pH	'per hydrogen' (a measure of hydrogen ion concentration in an aqueous solution)
pHe	pH measured on a saturated soil paste
Sb	antimony
S_{CR}	chromium reducible sulfur (a measure of sulfide-sulfur concentration)
Se	selenium
t/m^3	tonnes per cubic metre
the environmental authority	ECM Environmental Authority EPML00732813 (27 June 2014)
U	uranium
UC	uncertain
URS	URS Australia Pty Ltd
V	vanadium
WQOs	water quality objectives
Zn	zinc
$EC_{1:5}$	EC measured on a solid to water ratio of 1:5 (water extract)
$pH_{1:5}$	pH measured on a solid to water ratio of 1:5 (water extract)
NEPM 2013	National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended on 16 May 2013

EXECUTIVE SUMMARY

Ensham Resources Pty Ltd (Ensham) commissioned URS Australia Pty Ltd (URS) to conduct its 2014 annual geochemical assessment of overburden and potential reject materials.

Thirty-four drill chip samples, comprising of 19 overburden and 15 potential rejects samples, were selected from three drill holes for geochemical characterisation. The samples included eight sandstone, one coaly-sandstone, five siltstones, six sandstone/siltstone, six carbonaceous siltstone, two carbonaceous sandstone, two carbonaceous mudstone, one siltstone/carbonaceous mudstone, two coal and one weathered soil samples.

Testing included pH, electrical conductivity (EC), acid neutralising capacity (ANC), total sulfur, sulfide-sulfur, net acid producing potential (NAPP), net acid generation (NAG) test, total metal concentrations, soluble cations and metals, effective cation exchange capacity (eCEC) and exchangeable sodium percentage (ESP)

The results from this study indicate that overburden and potential rejects samples have low sulfide-sulfur concentrations (<0.05% S) and contain up to two orders of magnitude more acid buffering capacity compared to its acid generating capacity. Thirty-three of the thirty-four (97%) samples tested were classified as non-acid forming (NAF) or acid consuming (AC). The remaining sample (A1 seam coal sample) was classified as uncertain (UC), but is expected to be NAF based on its low sulfide-sulfur concentration. All mine waste (i.e. overburden and potential rejects) samples tested have negligible risk of acid generation and a very high factor of safety in terms of its potential to generate acid.

Total metal concentrations in the overburden and potential rejects samples are generally not enriched relative to the mean upper continental crust abundances, and are below the National Environmental Protection (Assessment of Site Contamination) Measure 2013 health-based investigation guideline values (where such guideline levels exist) for land used for parklands and recreational open spaces (HIL C).

Based on 1:5 solids to deionised water extractions, the mine wastes may initially generate alkaline drainage water with pH values that may marginally exceed the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000) and Condition W4 of the environmental authority, but is unlikely to contain significant existing salinity. Common pasture plants are generally expected to tolerate the drainage water salinity. The calculated average root zone salinity (EC_{se}) did not exceed the EC_{se} threshold (the level causing yield reduction) for 13 common pasture species for the four broad soil textures. The exception was for white clover (*Trifolium repens*), which exceeded the EC_{se} for heavy clay soil texture.

The dissolved metal and sulfate concentrations in the drainage water were well below the Australian livestock drinking water guidelines. The exception is for molybdenum, which marginally exceeded the guideline concentrations in leachates generated by two coal seam roof and floor samples derived from the A1 seam.

The median $EC_{1:5}$, $pH_{1:5}$ and soluble sulfate concentrations in the drainage water exceeded the water quality objectives (WQOs) for the protection of moderately disturbed aquatic ecosystems in the Lower Nogoa /Theresa Creek Sub-basin catchment. Notwithstanding and to provide further context, the median $EC_{1:5}$ value for overburden (547 µS/cm) and potential rejects (533 µS/cm) samples do not exceed the cease release (1440 µS/cm) and 80th percentile (1200 µS/cm) values specified in Condition W20 of the environmental authority for downstream receiving waters. The median soluble sulfate concentration in the drainage water was eight times lower than the trigger levels for downstream and upstream receiving waters. The median $pH_{1:5}$ value in the drainage water (pH 9.2); however, marginally exceeded the upper pH trigger limit (pH 9.0) for downstream and upstream receiving waters.

The overburden and potential reject materials are considered to be non-saline sodic materials containing moderate to high eCEC values. As such, although they have greater water holding capacity, greater capacity to store and hold nutrients against leaching, and greater capacity to resist changes to soil pH caused by land use, they have high risk of dispersion (median ESP 18%). This increases the risk of erosion, compaction, surface crusting, low infiltration and hydraulic conductivity, and subsequently can effect plant growth.

Treatment of the sodic overburden would be required if these materials are to be used as an additional source of revegetation media. Mass-balance calculations suggest that potentially high gypsum treatment rates are required, which may preclude the practical use of these materials as a final cover material without overlain with a stable topsoil or growth medium layer.

The risk of the overburden and potential reject materials to cause significant downstream water quality impacts is low, and is unlikely to present any environmental issues associated with revegetation and rehabilitation in terms of adverse effects on plant growth. However, the high risk of dispersion will require strategies to manage potential erosion hazards.

Based on the geochemical characterisation results, mine waste disposal methodologies or activities have been recommended to help further assess and develop management strategies for mine wastes at ECM.

1 INTRODUCTION

Ensham Resources Pty Ltd (Ensham) operates the existing Ensham Coal Mine (ECM), which is a large open cut coal mine situated 40 kilometres (km) east of Emerald, Queensland. ECM commissioned URS Australia Pty Ltd (URS) to undertake its 2014 geochemical characterisation assessment of overburden and potential rejects materials.

The objective of the geochemical characterisation program is to assist ECM meet its requirements under its environmental authority conditions in relation to ensuring that all mine waste is progressively characterised ahead of mining or during disposal. The information obtained will be used to update the Mining Waste Management Plan (where appropriate).

The geochemical assessment program consists of two components:

- Testing of overburden, interburden, and coal roof and floor materials likely to be disturbed by mining in order to assess their acid and metalliferous drainage (AMD) potential.
- Assessing the potential environmental risks associated with mining, handling and management of these materials, and outlining possible re-use and rehabilitation constraints.

1.1 Geological Setting

Ensham Coal Mine is situated in the Bowen Basin of Queensland, a coal rich sedimentary structure some 600 km long and up to 250 km wide (Mutton 2003). The basin extends south beneath Mesozoic sediments of the Surat Basin, and connects with the Gunnedah and Sydney Basins in New South Wales.

The major coal bearing geological formation within the ECM coalfield is the late Permian Rangal Coal Measures. The Rangal Coal Measures are overlain by unconsolidated Quarternary sediments consisting mainly quartzose sand and gravels with some bands of sandy silt and clay. The Pollux and Orion seams in the Rangal Coal Measures are relatively thin and considered to be uneconomic. The economic coal seams mined at ECM are within the Aries and Castor seams:

- Aries 1 (A1)
- Aries 2 (A2), comprising Aries 21 and Aries 22 seams
- Castor (C) seam, which is coalesced with the A22 seam over most of the ECM area
- Castor 22 (C22), which is separated from the main C seam by a claystone or carbonaceous mudstone referred to as the Main Unit Divider (MUD)

1.2 Acid and Metalliferous Drainage

Coal is deposited within environments that may have some potential to produce sulfides within the sediments. The mining or disturbance of coal deposits containing sulfides can expose these sulfides to air and water, resulting in their oxidation. This can potentially lead to the generation of typically acidic waters with elevated metal and sulfate concentrations; however, sometimes near-neutral but metalliferous and/or saline drainage can also occur. The resulting drainage is referred to as AMD.

Acid generation from mine waste materials is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. The oxidation of pyrite is in itself a complex process; however, it can be represented by the following overall reaction (Equation 1):

$$FeS_2 + \frac{15}{4}O_2 + \frac{7}{2}H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+ \qquad [1]$$

As acid (H^+) water migrates through a site (e.g. tailings or waste rock piles), it further reacts with other minerals in the surrounding tailings or rock material, and may dissolve a range of metals and salts. As a result, acid drainage is characterised by low pH and elevated dissolved metals.

When the acid generated is completely neutralised by the dissolution of common carbonate minerals (such as calcite, dolomite and ankerite), it can lead to precipitation and thus removal of metals such as Al, Cu and Pb from the drainage.

However, at near-neutral pH, concentrations of arsenic, antimony, nickel, cadmium and zinc can be elevated and thus result in metalliferous drainage. Even when no dissolved metal residues remain, the potential exists for drainage to contain high (sulfate) salinity. Generally, metalliferous drainage will also contain high sulfate salinity.

1.3 Geochemical Terminology Overview

A number of procedures have been developed to assess the acid forming characteristics of mine waste materials. However, ultimately the overall acid generating potential of a sample is mainly evaluated by its acid base account (ABA) and the net acid generation (NAG) test. A general description and overview of the AMD test methods and calculations described in this report are provided below.

1.3.1 Acid Base Account

The ABA involves determining a samples' maximum capacity to generate acid (MPA) due to the oxidation of sulfide minerals (such as pyrite) relative to its acid neutralising capacity (ANC) due to the dissolution of carbonates (such as calcite) and to a lesser extent silicate minerals. That is, it is a theoretical balance between the potential for a sample to generate acid and neutralise acid.

The total sulfur content is commonly used as an estimate of pyritic sulfur to calculate MPA, which is expressed as kilograms of sulfuric acid per tonne (kg H_2SO_4/t). Based on the stoichiometry of Equation 1, the amount of acid that could be produced by a sample containing 1 per cent sulfur by weight (% S) as pyrite is given by Equation 2. The ANC is typically determined by addition of hydrochloric acid to a sample, then back-titrating with sodium hydroxide to determine the amount of acid consumed.

$$MPA\ (kg\ H_2SO_4/t) = S(\%) \times 30.625 \qquad [2]$$

The Net Acid Production Potential (NAPP) and the ANC/MPA ratio are two measures of the ABA. The ratio between the ANC and MPA (ANC/MPA ratio) provides an indication of the relative margin of safety (or risk) within a material to generate acid. The ANC/MPA ratio for indicating safe values for prevention of acid generation typically range between 1.5 and 3 (DITR 2007).

The NAPP is the difference between the MPA and ANC. It indicates if a material has potential to produce acidic drainage and is determined using Equation 3.

$$NAPP\ (kg\ H_2SO_4/t)\ = [S(\%) \times 30.625] - [ANC\ (kg\ H_2SO_4/t)] \qquad [3]$$

A sample with NAPP > 0 is potentially acid forming (PAF), while a sample with NAPP ≤ 0 is non-acid forming (NAF) or potentially acid consuming (AC).

A better estimation of the NAPP value can be obtained if chromium reducible sulfur (S_{CR}) is analysed to approximate the sulfur concentration (in Equation 2) of a sample due to sulfide mineral oxidation. In this case, the resulting net acid producing potential is referred to as $NAPP_{CRS}$.

1.3.2 Net Acid Generation Test

The single NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulfide minerals contained within a sample. During the NAG test both acid generation and acid neutralisation reactions can occur simultaneously. The end result represents a direct measurement of the net amount of acid generated by the sample.

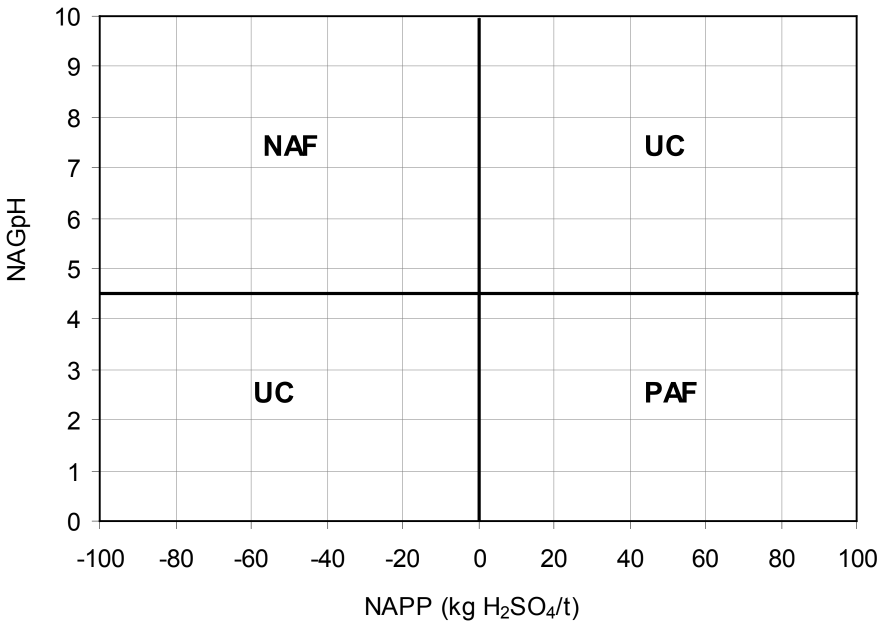
The final pH is referred to as the NAGpH and the amount of acid produced is commonly referred to as the NAG capacity, and is expressed in the same units as the NAPP (kg H_2SO_4/t). A pH after reaction (NAGpH) of less than 4.5 indicates that the sample is net acid-generating.

1.3.3 AMD Sample Classification

In general, the NAG test is used in conjunction with the NAPP to enhance the reliability of classifying the acid-generating potential of the mine waste sample. A geochemical classification plot (Figure 1-1), showing NAGpH versus the NAPP value, is often used to depict whether the mine waste sample lies within the PAF, NAF or Uncertain (UC) domains.

A sample classified as PAF has acid generating potential that exceeds the inherent acid neutralising capacity of the material. A sample classified as NAF has available ANC that can neutralise all the acid that theoretically could be generated by the sample. A sample classified as uncertain has an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤ 4.5). Uncertain samples require more detailed investigation to determine their acid generating potential.

Figure 1-1 Geochemical classification plot



1.4 Previous Geochemical Characterisation

URS (2006) completed a geochemical assessment of overburden and potential rejects materials from the ECM. The study was a component of the Environmental Impact Assessment for the Ensham Central Project.

Sixty-six samples were obtained from nine drill holes located in the open cut mining area. The 66 samples comprised:

- 49 overburden samples
- 17 potential rejects samples (12 coal roof and floor samples, and 5 coal samples from the A1 and A21 seams)

The analytical program included measuring pH and electrical conductivity (EC) in 1:5 solid-to-water suspensions, total sulfur, ANC and NAPP. Fourteen composite samples were analysed for total metal concentrations, cation exchange capacity (CEC), exchangeable sodium percentage (ESP) and water-extractable dissolved metal concentrations derived from 1:5 solid/water suspensions. Short-term (~ 4 weeks) kinetic leach column testing was conducted on five composite overburden and three composite rejects samples.

The pH (1:5) of the overburden samples was low to moderately alkaline ranging from 7.0 to 8.8. The EC (1:5) ranged from 205 to 917 microSiemens per centimetre (µS/cm), with a mean EC (1:5) value of 457 µS/cm. The total sulfur content of the overburden samples was low, ranging from 0.02% S to 0.15% S (average 0.07% S). The majority (88%) of total sulfur concentration was less than 0.1% S. The corresponding NAPP values ranged from -144 kg H_2SO_4/t to -7 kg H_2SO_4/t (average -42 kg H_2SO_4/t). On the basis of these results, all of the 49 overburden samples were classified as NAF.

The ABA results for potential rejects samples indicate that all of the samples tested were NAF (NAPP -215 kg H_2SO_4/t to -9 kg H_2SO_4/t), with an average NAPP value of -46 kg H_2SO_4/t. The pH (1:5) and EC (1:5) ranged between 7.2 and 9.0, and 168 µS/cm to 762 µS/cm, respectively. The total sulfur concentration varied from 0.04% S to 0.74% S, with coal samples (generally having higher total sulfur concentrations compared to coal roof and coal floor samples. Twelve of the seventeen rejects samples (71%) have total sulfur concentrations greater than 0.1% S.

The total metal concentrations in nine composite overburden and five potential composite rejects samples were below the National Environment Protection Council (NEPC) health-based investigation levels (HILs) for soils (NEPC 1999). The water-extractable dissolved metal concentrations, except molybdenum (Mo), were below the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000). Dissolved Mo concentration (0.18 milligram per litre (mg/L)) in one of the five potential rejects composite samples was marginally higher than the livestock drinking water guideline value (0.15 mg/L).

The leachable dissolved metal concentrations derived from kinetic leach column testing were generally consistent with the 1:5 solid-to-water extractions. Marginally elevated dissolved Mo and selenium (Se) concentrations, compared to livestock drinking water guidelines, were measured in leachate samples from kinetic columns containing composite overburden and composite rejects samples. However, no exceedances were observed when appropriate dilution factors were considered. The seepage and surface runoff, derived from overburden and potential rejects materials, thus is unlikely to impact the water quality of receiving aquatic environments.

2 STUDY METHODOLOGY

This section describes the rationale and methodology used to evaluate the AMD potential of overburden, coal, and coal roof and floor materials. The geochemical characterisation program is consistent with the following sources or guidelines:

- ECM's Environmental Authority EPML00732813 (the environmental authority) dated 27 June 2014.
- Department of Environment and Resource Management (DERM) (1995). Assessment and management of acid drainage, Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Qld, Australia.
- DERM (1995), Assessment and Management of Exploration and Saline and Sodic Wastes, Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Qld, Australia.
- Department of Industry, Tourism and Resources (DITR) (2007). Managing acid and metalliferous drainage, Leading Practice Sustainable Development Program for the Mining Industry, Canberra, Australia.
- Australian Mineral Industries Research Association International Limited (AMIRA) (2002). Prediction and Kinetic Control of Acid Mine Drainage (P387A). ARD Test Handbook, May 2002.
- International Network for Acid Prevention (INAP) (2009). Global Acid Rock Drainage Guide (GARD Guide).

In this report, the waste rock material located above (overburden) and between the coal seams (interburden) that is removed during mining in order to access the coal seams is collectively called spoil (or overburden). Partings or layers of rock strata located immediately above and below the coal seams are referred to as coal seam roof and floor materials. These materials are more or less included in the mined coal, and are called dilution because they dilute the in-place coal quality. Therefore, they represent potential rejects materials.

2.1 Sampling Strategy

The 2014 ECM geochemical sampling strategy is based on:

- The geochemical nature of materials in the area of planned mining disturbance is expected to be similar and comparable to the geochemical nature of the materials previously tested at ECM, as the geology and conditions of sediment deposition are relatively uniform throughout the site; and
- The geochemical information available from previous geochemical characterisation studies, suggest the geologic materials are geochemically benign.

Therefore, the sampling strategy focussed on ensuring the area of planned mining disturbance was spatially covered by acquiring samples from available drill cores that represented the various mine waste types produced by the ECM operation. The mine waste types sampled include:

- Overburden overlying the A1 seam
- Interburden between the A1 and A2, and A21 and A22 seams;
- Coal seam roof and floor material from A1 and A22 seams

- Coal from A21 seam

Coal samples were obtained because some uneconomic coal material may be placed in spoil dumps or are representative of potential rejects materials derived from coal processing.

2.2 Mine Waste Samples

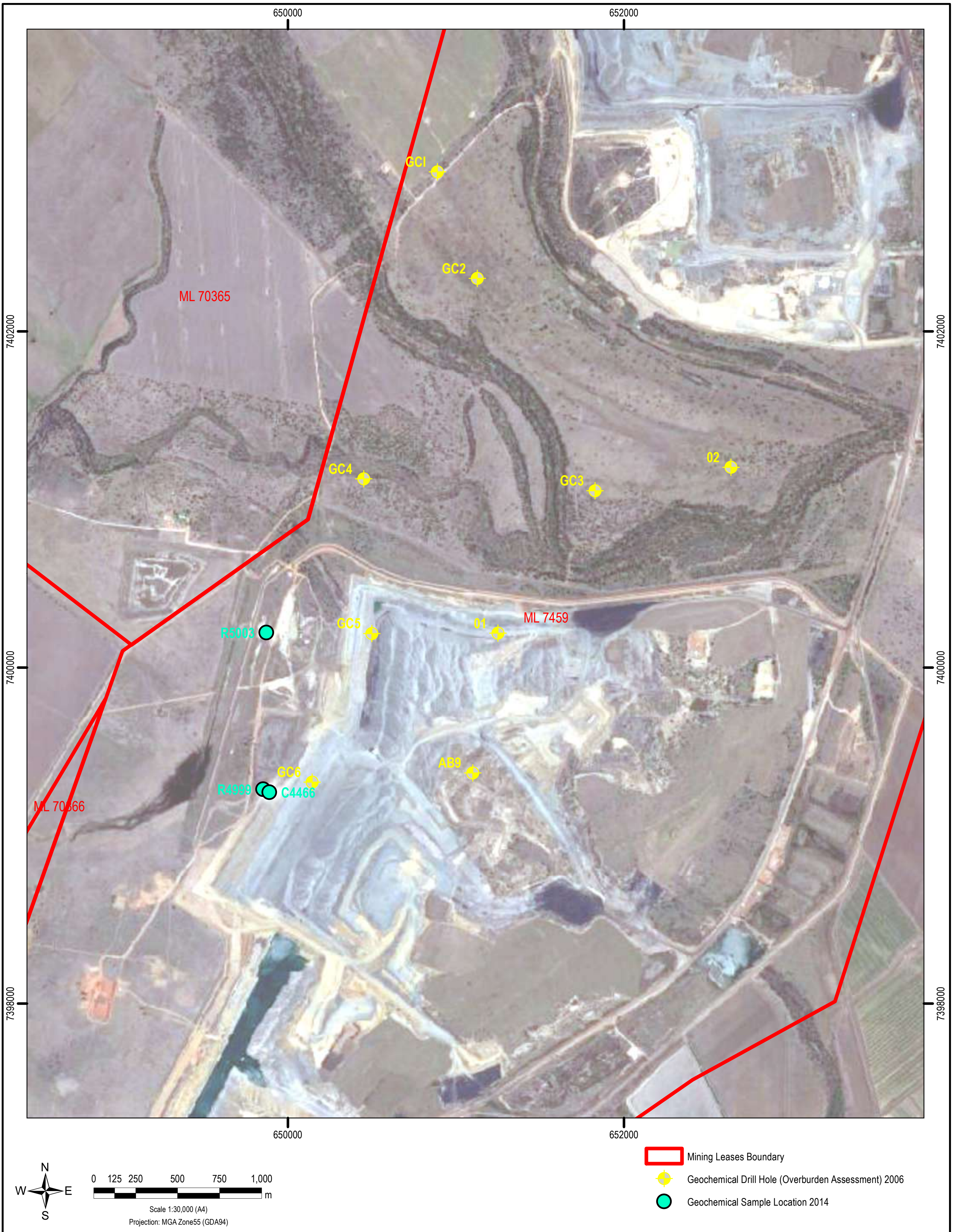
Based on the supplied drill core logs and the material available for sampling, and in consultation with ECM site geologists, URS selected 34 rotary drill chip samples, comprising of 19 overburden and 15 potential rejects samples, from three drill holes for geochemical characterisation. The location of each sampled drill hole is shown in Figure 2-1. The drill hole locations referred in URS (2006) are also shown in Figure 2-1.

Sample intercepts (0.30 to 57.5 m) from each particular interval was obtained for each main lithology for analysis. The selected samples include nine sandstone (including one coaly sandstone), five siltstone, six sandstone/siltstone, six carbonaceous siltstone, two carbonaceous sandstone, two carbonaceous mudstone, one siltstone/carbonaceous mudstone, two coal and one weathered soil samples (Table 2-1).

All samples were submitted in a single batch to Australian Laboratory Services (ALS), in Brisbane. ALS is a National Association of Testing Authority (NATA) accredited laboratory for the required analysis.

Table 2-1 Overburden Samples Selected for Geochemical Testing

Drill Hole ID	Client Sample ID	Depth From (m)	Depth To (m)	Sample Type	Dominant Lithology
R4999	4999-1	0.00	24.00	Overburden-fresh	Sandstone/Siltstone
R4999	4999-2	24.00	32.67	Overburden-fresh	Sandstone/Siltstone
R4999	4999-3	32.67	33.17	A1 roof	Carbonaceous Siltstone
R4999	4999-4	33.17	33.70	A1 seam	Coal
R4999	4999-5	33.70	34.20	A1 Floor	Carbonaceous Siltstone
R4999	4999-6	34.20	37.00	Interburden	Siltstone
R4999	4999-7	37.00	37.35	A211 Horizon	Carbonaceous Mudstone
R4999	4999-8	37.35	44.30	Interburden	Sandstone/Siltstone
R4999	4999-9	44.30	44.60	A212 horizon	Carbonaceous Mudstone
R4999	4999-10	44.60	48.00	Interburden	Siltstone
R4999	4999-11	48.00	54.00	Interburden	Sandstone/Siltstone
R4999	4999-12	54.00	62.00	Interburden	Sandstone
R4999	4999-13	62.00	62.45	A22C roof	Coaly Sandstone
R4999	4999-14	66.63	67.00	A22C floor	Carbonaceous Siltstone
R5003	5003-1	0.00	16.50	Overburden - Cenozoic	Weathered Soil
R5003	5003-2	16.50	18.00	Overburden - weathered	Sandstone
R5003	5003-3	18.00	75.50	Overburden-fresh	Sandstone/Siltstone
R5003	5003-4	75.50	76.11	A1 roof	Siltstone/Carbonaceous Mudstone
R5003	5003-5	76.61	77.00	A1 floor	Carbonaceous Siltstone
R5003	5003-6	77.00	78.00	Interburden	Siltstone
R5003	5003-7	78.00	79.00	Interburden	Sandstone
R5003	5003-8	79.00	82.00	Interburden	Siltstone
R5003	5003-9	82.00	97.00	Interburden	Sandstone
R5003	5003-10	97.00	105.50	Interburden	Siltstone
R5003	5003-11	105.50	108.50	Interburden	Sandstone/Siltstone
R5003	5003-12	108.50	109.08	A22C roof	Sandstone
R5003	5003-13	113.03	113.50	A22C floor	Carbonaceous Siltstone
C4466	4466-21	22.47	23.04	Overburden-fresh	Sandstone
C4466	4466-22	60.48	62.82	Overburden-fresh	Sandstone
C4466	4466-23	64.21	64.73	A1 floor	Carbonaceous Siltstone
C4466	4466-24	67.78	68.15	A211 horizon	Coal
C4466	4466-25	87.35	87.80	Interburden	Sandstone
C4466	4466-26	92.11	92.62	A22C roof	Carbonaceous Sandstone
C4466	4466-27	97.15	97.59	A22C floor	Carbonaceous Sandstone



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ENSHAM
RESOURCES
PTY LTD

OVERBURDEN AND POTENTIAL
REJECTS GEOCHEMISTRY

LOCATION OF DRILL HOLES

URS

ENSHAM COAL MINE GEOCHEMISTRY

Figure: **2-1**

File No: **42627460-g-002.mxd** Drawn: **VH** Approved: **TJ** Date: **20-03-2015** Rev.**A** A4

2.3 Laboratory Testing

Upon delivery at ALS, samples were crushed to at least 90 % passing 2 millimetres (mm) size, then riffle split to produce a 300 to 500 grams (g) sub-sample for pulverising to <75 micrometres (µm) for geochemical testing.

All samples were initially screened using a series of standard static geochemical tests as outlined in Table 2-2. Based on the initial screening results, rock type and depth, selected samples were combined into 12 composite overburdens and 10 composite potential rejects samples (Table 2-3). The composite samples were analysed for the parameters shown in Table 2-2, including total metal concentrations, water-extractable dissolved metal concentrations, major cations and anions concentrations, effective cation exchange capacity (eCEC) and exchangeable sodium percentage (ESP).

Table 2-2 Laboratory Analysis

Parameter	Reference Method
Initial Static Geochemical Analysis	
Moisture Content	In-house
1:5 solid to deionised water leach	In-house
pH (1:5)	APHA 4500-H+ B
Electrical Conductivity (EC (1:5))	APHA 2510 B
Chromium reducible sulfur (S_{CR})	Ahern et al (2004)
NAPP (includes ANC and Total S)	Coastech Research (Canada)
Net Acid Generation (includes NAG capacity and NAG pH)	AMIRA (2002)
Composite Sample Analysis	
Total aluminium (Al), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), nickel (Ni), manganese (Mn), molybdenum (Mo), antimony (Sb), selenium (Se), uranium (U), vanadium (V) and zinc (Zn)	In-house aqua regia (ME-MS41) or four acid ‘near total’ (ME-MS61) digest with ICP-MS finish
Soluble Al, As, Cd, Co, Cr, Cu, Fe, Pb, Ni, Mn, Mo, Sb, Se, U, V and Zn (based on 1:5 water leach)	US EPA 6010 ICP-AES
Soluble chloride and sulfate (based on 1:5 water leach)	APHA 4500-Cl- E; USEPA 6010 ICP-AES
Soluble Ca, Mg, Na, K (based on 1:5 water leach)	APHA 3120; USEPA SW 846 - 6010 (ICP-AES)
Effective cation exchange capacity (eCEC) and Exchangeable Sodium Percentage (ESP)	Rayment and Lyons 2011 (15A1)

APHA = American Public Health Association

USEPA = Unites States Environmental Protection Agency

Table 2-3 Selected composite samples for geochemical testing

Client Sample ID	Depth From (m)	Depth To (m)	Sample Type	Dominant Lithology	Composite Sample Number
4999-1	0.00	24.00	Overburden-fresh	Sandstone/Siltstone	ECM01
4999-2	24.00	32.67	Overburden-fresh	Sandstone/Siltstone	
5003-3	18.00	75.50	Overburden-fresh	Sandstone/Siltstone	ECM02
4999-6	34.20	37.00	Interburden	Siltstone	ECM03
4999-10	44.60	48.00	Interburden	Siltstone	
5003-6	77.00	78.00	Interburden	Siltstone	ECM04
5003-8	79.00	82.00	Interburden	Siltstone	
5003-10	97.00	105.50	Interburden	Siltstone	
4999-8	37.35	44.30	Interburden	Sandstone/Siltstone	ECM05
4999-11	48.00	54.00	Interburden	Sandstone/Siltstone	
4999-12	54.00	62.00	Interburden	Sandstone	ECM06
5003-11	105.50	108.50	Interburden	Sandstone/Siltstone	ECM07
5003-1	0.00	16.50	Overburden - Cenozoic	Weathered Soils	ECM08
5003-2	16.50	18.00	Overburden - weathered	Sandstone	ECM09
5003-7	78.00	79.00	Interburden	Sandstone	ECM10
5003-9	82.00	97.00	Interburden	Sandstone	
4466-21	22.47	23.04	Overburden-fresh	Sandstone	ECM11
4466-22	60.48	62.82	Overburden-fresh	Sandstone	
4999-3	32.67	33.17	A1 roof	Carbonaceous Siltstone	ECM12
4999-4	33.17	33.70	A1 seam	Coal	ECM13
4999-5	33.70	34.20	A1 Floor	Carbonaceous Siltstone	ECM14
4999-7	37.00	37.35	A211 Horizon	Carbonaceous Mudstone	ECM15
4999-9	44.30	44.60	A212 horizon	Carbonaceous Mudstone	
4999-13	62.00	62.45	A22C roof	Coaly Sandstone	ECM16
4999-14	66.63	67.00	A22C floor	Carbonaceous Siltstone	ECM17
5003-4	75.50	76.11	A1 roof	Siltstone/Carbonaceous Mudstone	ECM18
5003-5	76.61	77.00	A1 floor	Carbonaceous Siltstone	ECM19
5003-13	113.03	113.50	A22C floor	Carbonaceous Siltstone	
5003-12	108.50	109.08	A22C roof	Sandstone	ECM20
4466-23	64.21	64.73	A1 floor	Carbonaceous Siltstone	ECM21
4466-27	97.15	97.59	A22C floor	Carbonaceous Sandstone	
4466-26	92.11	92.62	A22C roof	Carbonaceous Sandstone	ECM22

3 RESULTS AND DISCUSSION

This section presents and discusses the geochemical results for the overburden and potential rejects samples, including their AMD potential, environmental risks and implications for mine waste management. The complete ALS laboratory reports are provided in Appendix A and Appendix B. Where analytical results were less than limit of reporting (LOR), the LOR value was used for calculation purposes.

3.1 Acid Base Accounting

The ABA evaluates the balance between acid generation processes (oxidation of sulfide minerals) and acid neutralising processes (dissolution of carbonates). The ABA is based on 'static' geochemical tests, which determines the chemical status of the sample at one point in time, irrespective of how the AMD may develop over time. In coal waste materials, calcium and magnesium bearing carbonates such as calcite, dolomite and ankerite will be the main sources of acid buffering. Calcium and magnesium carbonates are readily reactive and generally buffers the pH to above 6. Not all carbonate minerals; however, contribute to neutralisation (iron and manganese carbonates do not provide a net buffering capacity). Other neutralising minerals such as silicates (e.g. clays) tend to react slowly or only at low pH values that occur well after the onset of acidic drainage.

Table 3-1 shows that the overburden samples (<0.01% S to 0.04% S) contained lower total sulfur concentrations compared to potential rejects (0.02% S to 0.38% S). Based on S_{CR} concentrations, the average proportion of pyritic sulfur content relative to the total sulfur concentration was similar for both overburden (36%) and potential rejects (31%) samples. The concentration of sulfide in these samples is low, with approximately 56% of all sulfide concentrations less than or equal to 0.01% S and the remaining 44% distributed between 0.01% S and 0.05% S. The limited sulfide concentration present in the mineral waste materials suggest there is minimal source of potential acidity that can be generated under natural oxidation processes.

The use of the total sulfur assay to estimate the MPA (and hence NAPP) is a conservative approach and may overestimate the AMD potential because some sulfur can occur in forms other than pyrite. For a higher level of confidence with regards to the MPA of the mine waste materials, if the sulfide mineral forms are known, then allowance can be made for non- and lesser acid generating sulfur forms to provide a better estimate of the MPA (and NAPP).

Alternatively, the chromium reducible sulfide (i.e. S_{CR}) concentration could be used to provide a better estimate of the MPA. The S_{CR} value provides an estimate of the pyritic sulfur content (i.e. FeS_2) and is not subject to interference from sulfate-sulfur and organic sulfur. For this reason, a second MPA value (MPA_{CRS}) was calculated for each sample using sulfide-sulfur instead of total sulfur concentrations. Twenty-eight of the thirty-four mine waste samples (82 %) had MPA_{CRS} of less than or equal to 0.5 kg H_2SO_4/t, with the remaining six samples (18%) containing between 0.5 kg H_2SO_4/t and 1.0 kg H_2SO_4/t (Table 3-1). The mean MPA_{CRS} was highest in the potential rejects materials (0.44 kg H_2SO_4/t) compared to the overburden samples (0.29 kg H_2SO_4/t).

Table 3-1 Summary of ABA results for overburden and potential rejects samples

Drill Hole ID	Client Sample ID	Depth From (m)	Depth To (m)	Sample Type	Dominant Lithology	$pH_{1:5}$	$EC_{1:5}$	Total Sulfur (% S)	S_{CRS} (% S)	MPA (kg H_2SO_4/t)	MPA_{CRS} (kg H_2SO_4/t)	ANC (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)	$NAPP_{CRS}$ (kg H_2SO_4/t)	$NAG_{pH4.5}$ (kg H_2SO_4/t)	$NAG_{pH7.0}$ (kg H_2SO_4/t)	NAG_{pH}
R4999	4999-1	0.00	24.00	Overburden-fresh	Sandstone/Siltstone	6.8	669	0.03	0.007	0.92	0.21	46.8	-45.9	-46.6	<0.1	<0.1	9.9
R4999	4999-2	24.00	32.67	Overburden-fresh	Sandstone/Siltstone	9.0	514	0.02	0.006	0.61	0.18	65.8	-65.2	-65.6	<0.1	<0.1	10.7
R4999	4999-3	32.67	33.17	A1 roof	Carbonaceous Siltstone	9.0	668	0.04	0.022	1.23	0.67	16.0	-14.8	-15.3	<0.1	<0.1	9.7
R4999	4999-4	33.17	33.70	A1 seam	Coal	7.8	1040	0.38	0.026	11.64	0.80	17.5	-5.9	-16.7	69.6	139	3
R4999	4999-5	33.70	34.20	A1 Floor	Carbonaceous Siltstone	9.0	513	0.07	0.024	2.14	0.74	7.0	-4.8	-6.3	<0.1	7	4.6
R4999	4999-6	34.20	37.00	Interburden	Siltstone	9.0	587	0.04	0.012	1.23	0.37	12.0	-10.8	-11.6	<0.1	<0.1	7.8
R4999	4999-7	37.00	37.35	A211 Horizon	Carbonaceous Mudstone	8.9	638	0.08	0.008	2.45	0.25	12.5	-10.0	-12.3	<0.1	<0.1	7.9
R4999	4999-8	37.35	44.30	Interburden	Sandstone/Siltstone	9.2	633	0.04	0.01	1.23	0.31	65.0	-63.8	-64.7	<0.1	<0.1	10.6
R4999	4999-9	44.30	44.60	A212 horizon	Carbonaceous Mudstone	9.4	625	0.05	0.008	1.53	0.25	39.8	-38.3	-39.6	<0.1	<0.1	9.8
R4999	4999-10	44.60	48.00	Interburden	Siltstone	9.2	627	0.04	0.009	1.23	0.28	28.0	-26.8	-27.7	<0.1	<0.1	9.5
R4999	4999-11	48.00	54.00	Interburden	Sandstone/Siltstone	9.3	612	<0.01	0.008	0.31	0.25	43.9	-43.9	-43.7	<0.1	<0.1	10.2
R4999	4999-12	54.00	62.00	Interburden	Sandstone	9.5	608	0.03	<0.005	0.92	0.15	109.0	-108.0	-108.8	<0.1	<0.1	10.8
R4999	4999-13	62.00	62.45	A22C roof	Coaly Sandstone	9.4	657	0.04	0.006	1.23	0.18	101.0	-99.8	-100.8	<0.1	<0.1	10.7
R4999	4999-14	66.63	67.00	A22C floor	Carbonaceous Siltstone	9.6	627	0.04	0.012	1.23	0.37	46.6	-45.4	-46.2	<0.1	<0.1	10.1
R5003	5003-1	0.00	16.50	Overburden - Cenozoic	Weathered soil	7.4	641	0.02	<0.005	0.61	0.15	1.2	-0.6	-1.0	<0.1	0.2	6.9
R5003	5003-2	16.50	18.00	Overburden -	Sandstone	9.2	93	<0.01	<0.005	0.31	0.15	1.3	-1.3	-1.1	<0.1	6.2	6

Drill Hole ID	Client Sample ID	Depth From (m)	Depth To (m)	Sample Type	Dominant Lithology	$pH_{1:5}$	$EC_{1:5}$	Total Sulfur (% S)	S_{CRS} (% S)	MPA (kg H_2SO_4/t)	MPA_{CRS} (kg H_2SO_4/t)	ANC (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)	$NAPP_{CRS}$ (kg H_2SO_4/t)	$NAG_{pH4.5}$ (kg H_2SO_4/t)	$NAG_{pH7.0}$ (kg H_2SO_4/t)	NAG_{pH}
				weathered													
R5003	5003-3	18.00	75.50	Overburden-fresh	Sandstone/Siltstone	9.0	465	0.03	0.016	0.92	0.49	37.4	-36.5	-36.9	<0.1	<0.1	10.5
R5003	5003-4	75.50	76.11	A1 roof	Siltstone/Carbonaceous Mudstone	9.3	494	0.04	0.014	1.23	0.43	9.6	-8.4	-9.2	<0.1	<0.1	7.3
R5003	5003-5	76.61	77.00	A1 floor	Carbonaceous Siltstone	9.0	553	0.02	0.015	0.61	0.46	9.9	-9.3	-9.4	<0.1	<0.1	6.9
R5003	5003-6	77.00	78.00	Interburden	Siltstone	8.9	474	0.02	0.015	0.61	0.46	7.9	-7.3	-7.4	<0.1	0.4	6.8
R5003	5003-7	78.00	79.00	Interburden	Sandstone	8.7	305	0.03	0.009	0.92	0.28	9.6	-8.7	-9.3	<0.1	<0.1	7
R5003	5003-8	79.00	82.00	Interburden	Siltstone	8.8	459	0.03	0.016	0.92	0.49	9.4	-8.5	-8.9	<0.1	<0.1	7.5
R5003	5003-9	82.00	97.00	Interburden	Sandstone	9.3	616	0.03	0.007	0.92	0.21	77.8	-76.9	-77.6	<0.1	<0.1	10.5
R5003	5003-10	97.00	105.50	Interburden	Siltstone	9.2	575	0.03	0.009	0.92	0.28	32.5	-31.6	-32.2	<0.1	<0.1	9.8
R5003	5003-11	105.50	108.50	Interburden	Sandstone/Siltstone	9.3	547	0.03	0.006	0.92	0.18	47.4	-46.5	-47.2	<0.1	<0.1	10.7
R5003	5003-12	108.50	109.08	A22C roof	Sandstone	9.4	518	0.03	0.006	0.92	0.18	79.3	-78.4	-79.1	<0.1	<0.1	10.8
R5003	5003-13	113.03	113.50	A22C floor	Carbonaceous Siltstone	9.2	571	0.03	0.017	0.92	0.52	10.8	-9.9	-10.3	<0.1	<0.1	7.6
C4466	4466-21	22.47	23.04	Overburden-fresh	Sandstone	8.7	312	0.04	0.015	1.23	0.46	11.6	-10.4	-11.1	<0.1	<0.1	7.6
C4466	4466-22	60.48	62.82	Overburden-fresh	Sandstone	9.2	301	0.03	0.011	0.92	0.34	16.4	-15.5	-16.1	<0.1	<0.1	9.7
C4466	4466-23	64.21	64.73	A1 floor	Carbonaceous Siltstone	8.8	224	0.05	0.017	1.53	0.52	4.6	-3.1	-4.1	<0.1	0.4	6.7
C4466	4466-24	67.78	68.15	A211 horizon	Coal	9.2	285	0.07	0.006	2.14	0.18	11.8	-9.6	-11.6	<0.1	0.4	6.8
C4466	4466-25	87.35	87.80	Interburden	Sandstone	9.5	398	0.03	0.006	0.92	0.18	106.0	-105.0	-105.8	<0.1	<0.1	10.8
C4466	4466-26	92.11	92.62	A22C roof	Carbonaceous Sandstone	9.3	432	0.03	<0.005	0.92	0.15	120.0	-119.0	-119.8	<0.1	<0.1	10.9

Drill Hole ID	Client Sample ID	Depth From (m)	Depth To (m)	Sample Type	Dominant Lithology	$pH_{1:5}$	$EC_{1:5}$	Total Sulfur (% S)	S_{CRS} (% S)	MPA (kg H_2SO_4/t)	MPA_{CRS} (kg H_2SO_4/t)	ANC (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)	$NAPP_{CRS}$ (kg H_2SO_4/t)	$NAG_{pH4.5}$ (kg H_2SO_4/t)	$NAG_{pH7.0}$ (kg H_2SO_4/t)	NAG_{pH}
C4466	4466-27	97.15	97.59	A22C floor	Carbonaceous Sandstone	9.1	303	0.05	0.028	1.53	0.86	10.8	-9.3	-9.9	<0.1	<0.1	7.2

Where values were less than the limit of reporting (LOR), the LOR value was used for calculation purposes

MPA = maximum potential acidity; CRS = chromium reducible sulfur

MPA_{CRS} = maximum potential acidity determined using the S_{CR} value

ANC = acid neutralising capacity; NAPP = net acid producing potential

$NAPP_{CRS}$ = net acid producing potential determined using the S_{CR} value

NAG = net acid generation

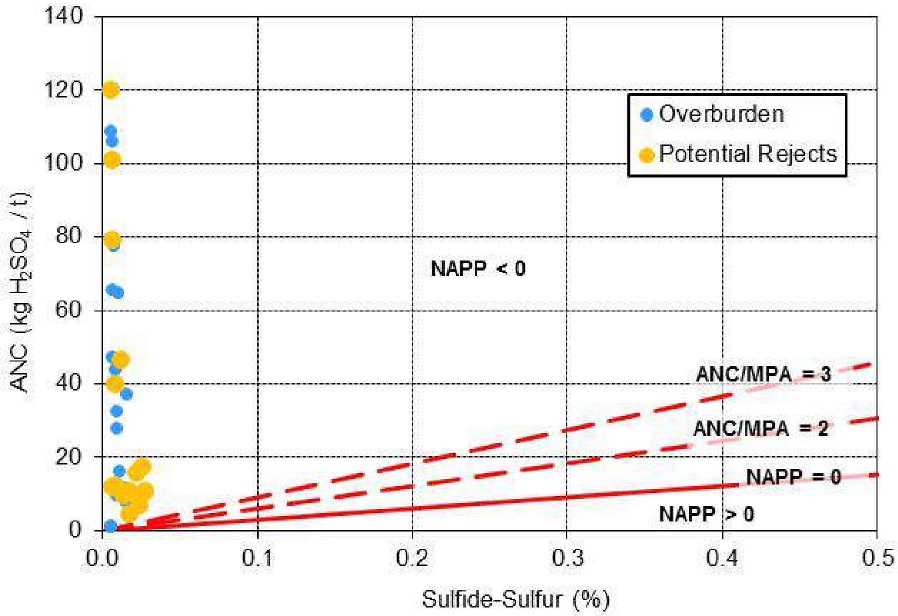
The data indicates there is available ANC present in the mineral waste samples tested (Table 3-1). Approximately 62 % of the mine waste samples tested had an ANC value ranging from 10 kg H_2SO_4/t to 100 kg H_2SO_4/t, with a further 26% having ANC ranging between 1.0 kg H_2SO_4/t and 10 kg H_2SO_4/t. The remaining 12 % of the mine waste samples had ANC greater than 100 kg H_2SO_4/t.

The overburden (mean of 38.5 kg H_2SO_4/t) and potential rejects (mean of 33.1 kg H_2SO_4/t) samples have an order to two orders of magnitude more acid buffering capacity compared to the acid that can be generated (based on MPA_{CRS}). The ANC data suggests that most of the inherent primary neutralising capacity present in the mineral waste has not been exhausted. Slower reacting neutralising minerals such as the silicates (e.g. clays) may provide some long term neutralising capacity, but this process is slow and expected to contribute minimally to buffering capacity of the mineral waste to offset any acid generation resulting in the oxidation of sulfides.

Table 3-1 shows that similar NAPP values were obtained for overburden (-0.6 kg H_2SO_4/t to -108 kg H_2SO_4/t) and potential rejects samples (-3.1 kg H_2SO_4/t to -119 kg H_2SO_4/t). There was marginal difference between the NAPP and corresponding $NAPP_{CRS}$ values. The range in NAPP values was consistent with the historical results for overburden and potential rejects materials (URS 2006).

Figure 3-1 is a plot showing S_{CR} versus ANC, with $NAPP_{CRS}$ positive and $NAPP_{CRS}$ negative domains indicated. Samples that plot above the ANC/MPA = 2 line have at least a two-fold excess in acid neutralising capacity over acid generating potential, and those that plot above the ANC/MPA = 3 line have a three-fold excess. All overburden and potential rejects samples tested fall within the $NAPP_{CRS}$ negative domain and have an acid neutralising capacity that is greater than three times their acid generating potential. Generally, samples with an ANC/MPA ratio of greater than 2 are considered to have low or negligible risk of acid generation and a high probability that the material will remain circum-neutral in pH (AMIRA 2002; DITR 2007). The high mean ANC to MPA_{CRS} ratio for overburden (177) and potential rejects samples (154) indicate they have negligible risk of acid generation and a very high factor of safety in terms of its potential to generate acid.

Figure 3-1 ANC versus S_{CR} for overburden and potential rejects samples



3.2 Net Acid Generation

Standard single addition NAGpH, and NAG capacity to pH 4.5 ($NAG_{pH4.5}$) and pH 7.0 ($NAG_{pH7.0}$) results are summarised in Table 3-1.

The NAGpH (or pH_{ox}) of the overburden and potential rejects samples for most (84%) lithologies tested was greater than pH 7.0, with effectively no NAG capacity. The exceptions were for overburden samples collected from drill hole R5003, comprising of weathered soil (NAGpH of 6.9) and sandstone (NAGpH of 6.0) from the top 18 metres (m), and a single siltstone sample (NAGpH of 6.8). The corresponding $NAG_{pH\ 7.0}$ capacities of these samples ranged between 0.2 kg H_2SO_4/t and 6.2 kg H_2SO_4/t.

Most potential rejects samples did not have measurable NAG capacity (Table 3-1). The exceptions were for one coal sample from A1 seam (4999-4), one coal sample from A211 seam (4466-24), and two A1 seam floor carbonaceous siltstone samples (4999-5 and 4466-23). The NAG capacity results (< 0.1 kg H_2SO_4/t) for all overburden and potential rejects samples tested, apart from one sample (4999-4), indicates that acidity due to free acid (i.e. H_2SO_4) and the release of iron and aluminium at pH <4.5 was negligible. Acidity generated from other metallic ions (such as copper and zinc) that precipitate out as hydroxides at pH values between 4.5 and 7.0 was negligible, except for one overburden (5003-1) and two potential rejects samples (4999-4 and 4999-5).

The NAGpH result is consistent with ABA results for 33 of the 34 samples tested, indicating the mineral waste materials tested were mostly non-acid generating. Any acid generated through oxidation was consumed by neutralising components in the samples.

In samples with low sulfide-sulfur (<1%), organic matter acidity may give misleadingly low NAGpH values and a false measure of the sulfidic acid potential. The organic acidity produced in the single addition NAG test does not occur under normal environmental conditions where atmospheric oxidation occurs. Therefore, organic acidity does not contribute to AMD. Generally, some indicators of organic acid effects on the NAG test include a large difference between the $NAG_{pH4.5}$ and $NAG_{pH7.0}$ capacities, and NAGpH4.5 values that exceed NAPP and MPA or $NAPP_{CRS}$ and MPA_{CRS} values. On this basis, the low NAGpH value of 3.0 obtained for the A1 coal seam sample (4999-4) is likely due to mostly organic acid effects.

3.3 Mineral Waste Geochemical Classification

The NAPP and NAG tests were used to predict the potential of the mineral waste samples to generate acid. Individually, the NAPP and NAG tests have limitations; however, in combination the reliability of AMD prediction is greatly enhanced. For this study, the acid generating potential of a sample is classified based on the geochemical classification criteria adopted by DITR (2007) (Table 3-2).

Table 3-2 Geochemical classification criteria

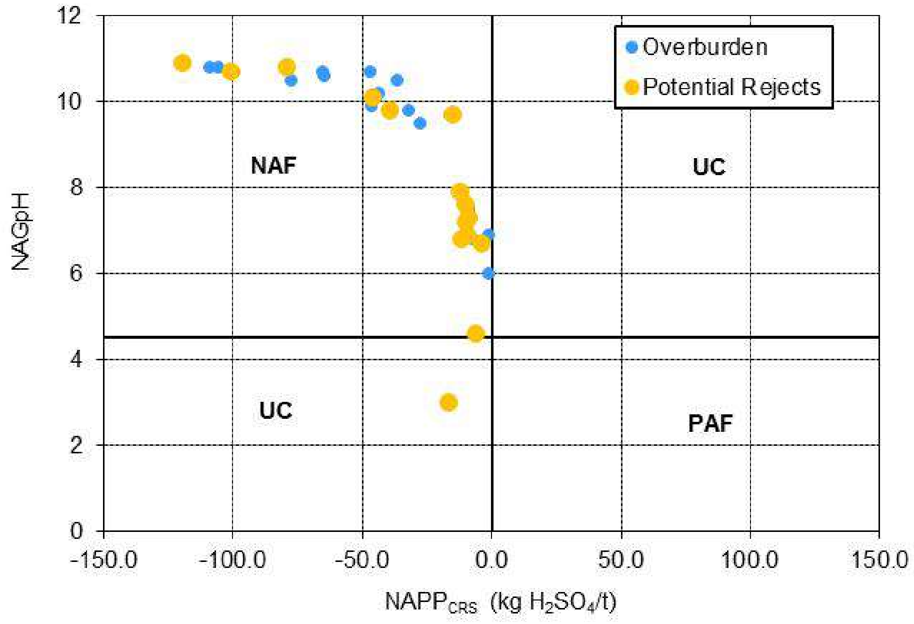
Geochemical Classification	$NAPP_{CRS}$ (kg H_2SO_4/t)	NAGpH
Potentially Acid Forming (PAF)	>10	<4.5
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	<4.5
Non-Acid Forming (NAF)	-100 to <0	≥4.5
Acid Consuming (AC)	<-100	≥4.5
Uncertain (UC)[1]	>0	≥4.5
	<0	<4.5

Note 1: Further testing may be required to confirm material classification

Figure 3-2 shows a geochemical classification plot of NAGpH versus the $NAPP_{CRS}$ value for the overburden and potential rejects samples tested. It shows that most mineral waste samples have sufficient ANC that can neutralise all the acid that could be theoretically generated by the sample. Overall, 33 of the 34 (97%) samples tested were NAF (or AC), with the remaining sample (3%) classified as UC. The geochemical classification does not appear to be dependent of lithology (i.e. rock type) or sample depth.

The samples classified as UC was a coal sample (4999-4) from the A1 seam obtained from drill hole R4999. This sample is expected to be NAF based on the low sulfide-sulfur concentrations (0.026% S) and $NAG_{pH4.5}$ value that exceed the $NAPP_{CRS}$ and MPA_{CRS}, indicating the possible effects of organic matter on acid potential. Therefore, on this basis, none of the mine waste samples tested are expected to be acid generating.

Figure 3-2 Geochemical classification plot for overburden and potential rejects samples



3.4 Total Metal Concentrations

The total metal concentrations in composited overburden samples (for each lithology) compared to the mean upper continental crust abundance (Taylor and McLennan, 1995) are shown in Table 3-3. The level of metal enrichment relative to the mean upper continental crust abundance was assessed using the geochemical abundance index (GAI) (Förstner *et al* 1993). The GAI is expressed on a log 2 scale which includes 7 integer grades or class (0 through to 6, respectively). A GAI of 0 indicates the element is present at a concentration similar to, or less than, mean upper continental crust abundances; a GAI of 3 corresponds to a 12-fold enrichment; and so forth, up to a GAI of 6, which corresponds to a 96-fold, or greater, enrichment above mean upper continental crust abundances.

Generally, samples with a GAI value of 3 or greater are considered as enriched to a level that warrants further examination to assess their environmental significance (DERM 1995; DITR 2007). The total metal concentration results indicate limited metal enrichment in the samples tested relative to the mean upper continental crust abundances (Table 3-4). Table 3-4 shows that the mine waste samples have total metal concentrations below, or close to, the corresponding mean upper continental crust abundance, except for four overburden, four coal seam roof and two coal seam floor samples, which showed enrichment in As (GAI = 3). One coal seam roof sample, comprised of siltstone/carbonaceous mudstone, was enriched in antimony (GAI = 3). Both arsenic and antimony can be mobilised under oxidising near neutral pH conditions.

There are no guidelines and/or regulatory criteria in Queensland specifically related to total metal concentrations in mine waste samples. To provide some context, the total metal concentrations were compared to the National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended on 16 May 2013 by the National Environment Protection Council (NEPC 2013) (referred to as the 'NEPM 2013'). The NEPM 2013 provides national standards for a variety of environmental issues, including guideline on investigation levels for soil.

An initial assessment of potential risk to human health from exposure to contaminants via all relevant pathways of exposure was conducted by comparing to the NEPM 2013 Health-based Investigation Levels (HILs) for contaminated soil assessments for land used for parklands and recreational open spaces (referred to as HIL C). These guidelines are conservative and are based on a reasonable worst-case scenario, and considered reasonable given that the final land use of the mine following closure may possibly include livestock grazing and rainfed cropping. Table 3-3 shows that the total metal concentrations in all mine waste samples were one to three orders of magnitude lower than the HIL C guideline values, where such guideline levels exist. Therefore, the materials represented by the composited overburden and potential rejects samples, are not expected to present a substantial risk with respect to beneficial re-use.

It should be noted that the GAI itself does not assess the mobility or reactivity of metals, and while the $NAPP_{CRS}$ and NAG values (and ANC/MPA_{CRS} ratio) provide an indication of the potential for acid generation from a sample, additional test work is required to predict the potential for metalliferous or saline drainage. In view of this, leachability tests based on 1:5 solid to deionised water extractions were conducted.

Table 3-3 Summary of total metal concentrations in composited overburden and potential rejects samples

Parameter[1]	NEPM 2013 **HIL C**[2]	Mean Upper Continental Crust Abundance[3]	**ECM01**	**ECM02**	**ECM03**	**ECM04**	**ECM05**	**ECM06**	**ECM07**	**ECM08**	**ECM09**	**ECM10**	**ECM11**	**ECM12**	**ECM13**	**ECM14**	**ECM15**	**ECM16**	**ECM17**	**ECM18**	**ECM19**	**ECM20**	**ECM21**	**ECM22**
			Overburden – fresh	**Overburden** – fresh	**Interburden**	**Interburden**	**Interburden**	**Interburden**	**Interburden**	**Overburden - Cenozoic**	**Overburden - weathered**	**Interburden**	**Overburden** – fresh	**A1 roof**	**A1 seam**	**A1 Floor**	**A211 Horizon**	**A22C roof**	**A22C floor**	**A1 roof**	**A1 & A22C floor**	**A22C roof**	**A1 & A22C floor**	**A22C roof**
			Sandstone/ Siltstone	**Sandstone/ Siltstone**	**Siltstone**	**Siltstone**	**Sandstone/ Siltstone**	**Sandstone**	**Sandstone/ Siltstone**	**Weathered Soil**	**Sandstone**	**Sandstone**	**Sandstone**	**Carbonaceous Siltstone**	**Coal**	**Carbonaceous Siltstone**	**Carbonaceous Mudstone**	**Coaly Sandstone**	**Carbonaceous Siltstone**	**Siltstone/ Carbonaceous**	**Carbonaceous Siltstone**	**Sandstone**	**Carbonaceous Siltstone/ Sandstone**	**Carbonaceous Sandstone**
Al	--	8.04	7.99	8.18	9.79	8.7	7.59	6.61	7.67	2.93	1.18	7.53	9	8.38	0.33	8.31	1.47	7	8.49	9.19	9.73	0.82	10.15	7.59
As	300	1.5	8.5	6.7	14	8.8	7.6	6.7	10.3	3.5	1.7	11	16	13.4	1.1	11	5.3	11.1	6.9	14	7.9	6.5	14.3	11.9
Cd	90	0.098	0.09	0.07	0.12	0.11	0.08	0.05	0.06	<0.02	<0.02	0.07	0.14	0.12	0.04	0.11	0.1	0.07	0.12	0.16	0.16	0.06	0.14	0.06
Co	300	10	16.7	14.7	20.2	16.6	14.5	13.2	12.3	5.9	2.3	20.4	18.9	20.4	3.9	9.9	10.3	16.2	22.2	11.8	17	7	9.8	15.1
Cr	300	35	80	69	68	58	56	49	52	62	111	68	87	63	7	61	19	62	51	71	58	27	58	36
Cu	17000	25	35.2	39.9	51.9	42.6	38.9	19.5	24.9	9	3.1	28.5	45	43	22.6	55.8	44.4	21.2	49.1	55.9	59.2	17.8	58.8	18.9
Fe	--	3.50	4.81	4.24	4.16	4.06	4.67	4.56	2.31	1.6	0.58	5.27	4.19	3.03	0.35	1.71	3.97	3.27	4.62	2.3	1.84	1.43	1.74	3.42
Mn	19000	600	1100	1070	592	547	785	862	469	163	99	1100	524	306	113	100	814	756	1020	181	119	373	131	717
Mo	--	1.5	0.69	0.54	1.48	0.79	0.72	0.45	0.82	0.42	0.26	0.99	0.93	3.08	0.51	0.87	0.37	0.95	1.18	1.1	1.28	0.79	1.24	1.3
Ni	1200	20	37.8	39.1	42	31.7	29	20.7	22	13.5	4.5	30.2	51.5	38.9	7.8	36.8	22.5	23.3	37.6	40.6	40.1	12.2	31.7	20.3
Pb	600	20	19.8	16.9	21.8	18.1	15.4	10.9	14.6	7.7	4.5	14	23.3	21.5	5.9	21.8	13.2	14.5	17.6	23.8	23.6	9.9	22.7	12.2
Sb	--	0.2	0.82	0.71	1.08	0.79	0.67	0.55	0.83	0.36	0.25	0.69	0.98	1.18	0.86	1.17	0.2	0.66	0.74	1.22	1.02	0.14	0.97	0.57
Se	--	50	1	1	1	1	1	1	1	<1	<1	1	1	1	0.3	1	0.5	1	1	1	1	0.3	1	1
U	--	2.8	2.5	3.3	2.8	2.3	2.1	1.8	1.9	1.2	0.5	1.7	3	3.5	0.23	3.1	0.53	1.6	2.4	3	3	0.33	2.9	1.6
V	--	60	117	119	144	135	128	108	104	40	12	157	138	128	22	128	45	100	128	141	145	23	139	91
Zn	30000	71	83	82	96	89	78	64	73	24	5	74	100	94	12	100	66	80	85	99	103	59	111	63

Note 1: All values in mg/kg except for Al (wt%) and Fe (wt%)

Note 2: National Environment Protection Council (2013) Health Investigation Levels C for parks and recreational open spaces; guideline value for chromium value for chromium (VI); "—" means no guideline value

Note 3: Taylor and McLennan (1995)

Table 3-4 Geochemical abundance indices for composited overburden and potential rejects samples

Parameter[1]	ECM01	ECM02	ECM03	ECM04	ECM05	ECM06	ECM07	ECM08	ECM09	ECM10	ECM11	ECM12	ECM13	ECM14	ECM15	ECM16	ECM17	ECM18	ECM19	ECM20	ECM21	ECM22
	Overburden – fresh	Overburden – fresh	Interburden	Interburden	Interburden	Interburden	Interburden	Overburden- Cenozoic	Overburden - weathered	Interburden	Overburden – fresh	A1 roof	A1 seam	A1 Floor	A211 Horizon	A22C roof	A22C floor	A1 roof	A1 & A22C floor	A22C roof	A1 & A22C floor	A22C roof
	Sandstone/ Siltstone	Sandstone/ Siltstone	Siltstone	Siltstone	Sandstone/ Siltstone	Sandstone	Sandstone/ Siltstone	Weathered Soil	Sandstone	Sandstone	Sandstone	Carbonaceous Siltstone	Coal	Carbonaceous Siltstone	Carbonaceous Mudstone	Coaly Sandstone	Carbonaceous Siltstone	Siltstone/ Carbonaceous Mudstone	Carbonaceous Siltstone	Sandstone	Carbonaceous Siltstone/ Sandstone	Carbonaceous Sandstone
Al	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	2	2	**3**	2	2	2	**3**	1	0	**3**	**3**	**3**	0	**3**	2	**3**	2	**3**	2	2	**3**	**3**
Ba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Co	1	0	1	1	0	0	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	1
Cr	1	1	1	1	1	0	0	1	2	1	1	1	0	1	0	1	0	1	1	0	1	0
Cu	0	1	1	1	1	0	0	0	0	0	1	1	0	1	1	0	1	1	1	0	1	0
Fe	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mn	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Mo	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ni	1	1	1	1	0	0	0	0	0	1	1	1	0	1	0	0	1	1	1	0	1	0
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sb	2	2	2	2	2	1	2	1	0	2	2	2	2	2	0	2	2	**3**	2	0	2	1
Se	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V	1	1	1	1	1	1	1	0	0	1	1	1	0	1	0	1	1	1	1	0	1	1
Zn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

3.5 Drainage Water Quality

The drainage water quality derived from runoff or seepage from spoil piles was assessed by evaluating its inherent acidity and salinity, risk to soil structure degradation, and metal and sulfate leachability.

3.5.1 Acidity and Salinity

The inherent acidity and salinity of the overburden and potential rejects samples were assessed by equilibrating crushed solid sample in deionised water for approximately 1 hour at a solid to deionised water ratio of 1:5 (solid/water), than measuring the pH and electrical conductivity (EC), respectively.

The $pH_{1:5}$ values for overburden (6.8 to 9.5) and potential rejects (7.8 to 9.6) were similar (Table 3-1). The $pH_{1:5}$ values for overburden and potential rejects samples are classed as neutral to very strongly alkaline (Hazelton and Murphy 2007), indicating a lack of immediately available or inherent acidity. Pyrite oxidation; therefore, would therefore be the main source of acidity in overburden and potential rejects samples materials. Seventeen of the nineteen (89%) of the overburden samples had pH values greater than 8.5. Fifty-nine per cent of those had pH values greater than 9.0, which is classed as very high according to the Queensland Guidelines for the Assessment and Management of Acid Drainage (DERM 1995a and 1995b). Approximately 93% of the rejects samples (i.e. 14 of the 15 samples) had pH values greater than 8.5.

Overburden materials contained marginally lower $EC_{1:5}$ values (93 µS/cm to 669 µS/cm) compared to potential rejects (224 µS/cm to 1040 µS/cm) (Table 3-1). The overburden samples are considered to have very low to medium salinity according to the Queensland guidelines (DERM 1995a and 1995b), whereas potential rejects have low to high salinity.

These $pH_{1:5}$ and $EC_{1:5}$ values are consistent with historical results (URS 2006). In general, livestock health will not be affected by water with pH in the range of 4 to 9 (ANZECC and ARMCANZ, 2000). The lower and upper end-of-pipe pH limits for mine affected waters released at RP1 to the Nogoa River and at RP2 to Boggy Creek specified in Condition W4 of the environmental authority is pH 6.5 and 9.0, respectively. The results suggest overburden and potential rejects samples may initially generate alkaline drainage with pH values (median pH 9.2) that may marginally exceed the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000), and Condition W4 of the environmental authority.

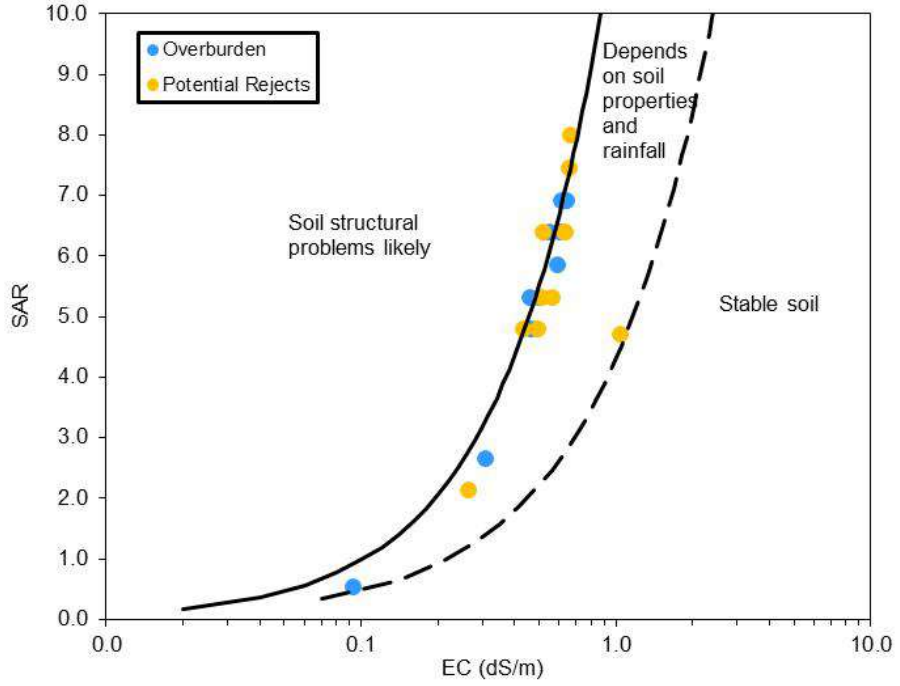
The drainage water derived from the overburden and potential rejects samples is unlikely to contain significant existing salinity. The current $EC_{1:5}$ levels are within the salinity range (0 to 7460 µS/cm) recommended for livestock drinking water in Australia (ANZECC & ARMCANZ, 2000) and Condition W4 (10000 µS/cm) of the environmental authority.

3.5.2 Risk to Soil Structure Degradation

The impact of drainage water quality on receiving soil structure can be predicted using EC and sodium adsorption ratio (SAR) values as shown in Figure 3-3 (adapted from ANZECC and ARMCANZ (2000)). The calculated SAR and average $EC_{1:5}$ values obtained for the composite mine waste samples were superimposed on Figure 3-3 to evaluate how the predicted drainage will affect soil structure (through clay aggregate breakdown).

The predicted drainage water quality for most overburden and potential rejects falls between the solid and dashed line, indicating marginal drainage water quality and should be treated with caution. This suggests that runoff water from spoil piles may cause structural problems (through clay aggregate breakdown by sodium) in receiving soils. Therefore, corrective management may be required to reduce the dispersion risk of soils receiving drainage water by preventing or minimising surface flow or by reducing the SAR by gypsum (or lime) amendment. The use of lime can also be beneficial to extend the lag period in the unlikely event of acid generation.

Figure 3-3 **Predicted impact of drainage water on receiving soil structural stability**



3.5.3 *Metal and Sulfate Leachability*

The mobility of metals and sulfate in the composited overburden samples were evaluated by analysing the dissolved metal and sulfate concentrations in the 1:5 solids to deionised water extracts (or leachates). The leachability results provide an indication of any possible weakly-bound forms of metals and sulfate that is susceptible to release to solution upon initial contact with rainfall (i.e. ‘first flush’).

The metal and sulfate leachability results are summarised in Table 3-5. Also shown are the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000) and end-of-pipe trigger levels for some contaminants in mine affected water released at RP1 and RP2 specified in Condition W4 and W5 of the environmental authority.

Table 3-5 shows that the soluble metal concentrations reported in the water extract solutions for all overburden and potential rejects samples were below the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000), where guideline values exist. The exception was for molybdenum, which marginally exceeded the guideline concentrations in leachates derived from one coal seam roof (ECM12) and one coal seam floor (ECM14) sample from the A1 seam. These results are consistent with those obtained by URS (2006).

Comparison with the Australian livestock drinking water guidelines is considered reasonable because the site is located in a sparsely populated rural area where surrounding areas have historically, and are currently, used for cattle grazing where mining activity is not currently occurring. The majority of the landscape not disturbed by mining activity has previously been cleared and maintained for grazing. Therefore, the principle use of surface and groundwater in the region is for stock watering.

The soluble arsenic concentrations in four of the eleven composite overburden samples and six of the eleven potential composite rejects samples exceeded the end-of-pipe trigger levels for mine affected water released at RP1 and RP2 specified in Condition W5 of the environmental authority. Soluble uranium and manganese concentrations in the leachate samples were below the end-of-pipe trigger levels. In general, the metal leachability data should be interpreted with care since the LOR for some metals exceed the end-of-pipe release contaminant trigger levels.

The drainage water is unlikely to contain substantial soluble sulfate (SO_4^{2-}). The soluble sulfate concentrations measured in leachate samples ranged from 10 milligram per litre (mg/L) to 60 mg/L (Table 3-5). These sulfate concentrations are less than the 1000 mg/L limit recommended for both livestock drinking water in Australia (ANZECC and ARMCANZ 2000) and end-of-pipe trigger levels specified in Condition W5 of the environmental authority.

The above comparisons place the metal and sulfate leachability data into a broader perspective in terms of potential seepage and runoff water-quality for receiving environments. It represents a worst case scenario in that the metal and sulfate leachability analysis was completed on continuously agitated pulverised sample suspensions.

It should be noted that solution pH is a primary factor in determining the solubility and mobility of many trace metals in aquatic environments. Metal mobility is controlled by the solubility of hydrous oxides, and shows minimum values from approximately pH 7 to 10 (Stumm and Morgan 1996). The $pH_{1:5}$ values of water extracts from all mineral waste samples tested ranged from 6.8 to 9.6 (median pH 9.2). Further dilution effects from meteoric water and natural attenuation process are likely to occur in the field, and thus it is expected that marginally elevated dissolved metal in run-off and seepage will be further reduced in the field.

Therefore, any runoff and seepage water quality arising from these mine waste materials is predicted to contain low dissolved metal and sulfate concentrations. This combined with the low salinity and expected NAF nature of the mineral waste samples, suggests the materials represented by the samples tested are unlikely to generate acid or sufficient readily mobilised metals and sulfate to cause exceedance of the selected water quality guideline criteria.

Table 3-5 Summary of water-extractable dissolved metal and sulfate concentrations in composited overburden and potential rejects samples

Parameter[1]	ANZECC (2000) Livestock Drinking Water[2]	W4 and W5 Environmental Authority[3]	ECM01	ECM02	ECM03	ECM04	ECM05	ECM06	ECM07	ECM08	ECM09	ECM10	ECM11	ECM12	ECM13	ECM14	ECM15	ECM16	ECM17	ECM18	ECM19	ECM20	ECM21	ECM22
			Overburden – fresh	Overburden – fresh	Interburden	Interburden	Interburden	Interburden	Interburden	Overburden- Cenozoic	Overburden - weathered	Interburden	Overburden – fresh	A1 roof	A1 seam	A1 Floor	A211 Horizon	A22C roof	A22C floor	A1 roof	A1 & A22C floor	A22C roof	A1 & A22C floor	A22C roof
			Sandstone/ Siltstone	Sandstone/ Siltstone	Siltstone	Siltstone	Sandstone/ Siltstone	Sandstone	Sandstone/ Siltstone	Weathered Soil	Sandstone	Sandstone	Sandstone	Carbonaceous Siltstone	Coal	Carbonaceous Siltstone	Carbonaceous Mudstone	Coaly Sandstone	Carbonaceous Siltstone	Siltstone/ Carbonaceous Mudstone	Carbonaceous Siltstone	Sandstone	Carbonaceous Siltstone/ Sandstone	Carbonaceous Sandstone
SO_4^{2-}	1000	1000	20	20	40	30	30	30	30	60	10	20	20	40	40	40	20	30	0	30	30	20	30	20
Ca	1000[4]	--	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	50	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mg	2000[5]	--	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Na	--	--	110	90	120	100	120	130	120	130	10	100	50	150	140	100	120	140	120	90	100	120	40	90
K	--	--	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Al	5	0.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
As	0.5-5[6]	0.013	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	0.1	0.1	0.1	0.2	<0.1
Cd	0.01	0.0002	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Co	1	0.09	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cu	0.4-5[7]	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fe	NST	0.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mn	NST	1.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mo	0.15	0.034	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ni	1	0.011	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb	0.1	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Se	0.02	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sb	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
U	0.2	0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
V	--	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zn	20	0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note 1: All values in mg/L; "—" means no guideline value or no value provided by reference source
Note 2: ANZECC and ARMCANZ (2000) Livestock drinking water guideline;
Note 3: Condition W4 and W5 Environmental Authority EPML00732813 dated 27 June 2014
Note 4: Stock should tolerate concentration if calcium is the dominant cation and dietary phosphorus levels are adequate
Note 5: Insufficient information is available to set trigger value; however, concentrations up to 2000 mg/L have been found to have no adverse effects on cattle
Note 6: May be tolerated if not provided as a food additive and natural level in the diet are low
Note 7: Dependent on livestock species

3.5.4 Nogoa River Sub-basin Model Water Conditions

ECM is located within the Lower Nogoa /Theresa Creek catchment, which is within the broader Fitzroy Basin. The environmental values (EVs) for fresh surface waters located in the Lower Nogoa main channel and water quality objectives (WQOs) to protect or enhance those EVs in the Lower Nogoa /Theresa Creek Sub-basin waters are applicable for the mine. The EVs identified for the Lower Nogoa main channel include aquatic ecosystems, irrigation, farm supply use, stockwater, drinking water and industrial use.

Since the aquatic ecosystem EV is a default applying to all water (Department of Environment and Heritage Protection (EHP) 2013), this report focuses on the predicted drainage water quality (based on 1:5 solids to deionised water extracts) within the context of the WQOs for the protection of moderately disturbed aquatic ecosystems in the Lower Nogoa main channel. The predicted drainage water was evaluated against the Lower Nogoa /Theresa Creek Sub-basin WQOs (or model water conditions) for EC, pH and sulfate. The WQOs for metal and metalloid toxicants are not discussed in this report since the LOR for some metals exceed the WQOs, which make interpretation of the results difficult.

In accordance with EHP (2013), the median water quality value is compared against the water quality objective of the same indicator. Table 3-6 shows the median $EC_{1:5}$ and $pH_{1:5}$ values, and soluble sulfate concentrations in both composited overburden and potential rejects samples compared to the Lower Nogoa /Theresa Creek Sub-basin WQOs (EHP 2013). The median $EC_{1:5}$, $pH_{1:5}$ and soluble sulfate concentrations in the drainage water derived from the mine waste samples exceed the WQOs for the protection of moderately disturbed aquatic ecosystems in the Lower Nogoa /Theresa Creek Sub-basin catchment (Table 3-6).

Table 3-6 Drainage water quality compared to Selected Lower Nogoa /Theresa Creek Sub-basin WQOs

Water Area / Type	Management Intent / Mineral Waste Type	EC (µS/cm)	pH	Sulfate (mg/L)
Lower Nogoa /Theresa Creek Sub-basin WQOs[1]	Protection of moderately disturbed aquatic ecosystems	340 (baseflow) 250 (high flow)	6.5–8.5	25
Median drainage water[2]	Overburden	547	9.2	30
	Potential rejects	553	9.2	30

Note 1: EHP (2013)

Note 2: Based on 1:5 solids to deionised water extracts

Notwithstanding, the median $EC_{1:5}$ values do not exceed the cease release (1440 µS/cm) and 80th percentile (1200 µS/cm) values specified in Condition W20 of the environmental authority for downstream receiving waters at monitoring point MP5, located at the Nogoa River at the Ensham lease boundary, and approval trigger value (650 µS/cm) at MP6 located at Mackenzie River at Riley's Crossing. The median soluble sulfate concentrations in the drainage water (30 mg/L) are well below the trigger levels (250 mg/L) for receiving waters at downstream monitoring points (MP5 and MP6) and upstream (background) receiving water monitoring point MP2 (at Nogoa River at Duckponds) and MP4 (at Boggy Creek – Ramp 9 crossing at Yongala). The median $pH_{1:5}$ values in the drainage water (pH 9.2) marginally exceed the upper pH trigger limit (pH 9.0) for downstream and upstream receiving waters.

Since the median $EC_{1:5}$, $pH_{1:5}$ and soluble sulfate concentrations in the drainage water exceed the WQOs for the Lower Nogoa /Theresa Creek Sub-basin catchment, the historical receiving water flow rates and water quality measured at RP1 and RP2 should be reviewed. This data can be used to estimate contaminant loads transported to environments downstream of the confluence of Anabranch, Nogoa River and Boggy Creek, and assess the possible long-term environmental impact risk.

3.6 Revegetation and Erosion

In terms of plant growth and erosion hazard, the geochemical characteristics that also need to be considered during revegetation and rehabilitation works include pH, EC, eCEC and ESP. It should be noted that the eCEC and ESP are primarily intended for the analysis of soils rather than sedimentary overburden and other mine waste materials. However, it does provide some insight into the exchangeable cation chemistry and sodicity of the mineral waste materials tested.

Table 3-7 shows that the eCEC of the composited overburden samples ranged from 1.2 milliequivalents per 100 grams (meq/100g) to 21.1 meq/100g, which is class as very low to moderate (Hazelton and Murphy 2007). For composited potential rejects samples the eCEC ranged from 11.4 meq/100g to 26.1 meq/100g, which is considered low to high (Hazelton and Murphy 2007). Twenty of the twenty-two composite mine waste samples (91%) had moderate to high eCEC values ($12 \leq \text{eCEC} \leq 40$ meq/100g). As such, the mine waste samples have relatively high clay contents, greater water holding capacity, greater capacity to store and hold cations and nutrients against leaching, and greater capacity to resist changes to soil pH and chemistry caused by land use. A high CEC implies that the soil is generally more fertile than one with a low CEC.

Sodicity is the concentration of exchangeable sodium adsorbed onto clay mineral surfaces as a proportion of the eCEC. When sodicity is high the clay structures that bind the fine aggregates and large particles (e.g. sand and silt) break down and disperse when it becomes wet or after applied mechanical work such as raindrop impact, irrigation or tillage. This increases the risk of erosion, compaction, surface crusting, low infiltration and hydraulic conductivity, and subsequently can effect plant growth.

The ESP is a direct measure of sodicity. The critical ESP above which dispersion risks increases depends on the EC of the soil water solution and the amount of work applied to the soil (Hazelton and Murphy 2007). In general, a soil with an ESP value less than 6 % is considered non-sodic and has low risk dispersion (Hazelton and Murphy 2007; Isbell, 2002), whereas an ESP value greater than 14 % indicates that a material is strongly sodic and has a higher risk of dispersion (Hazelton and Murphy, 2007). On this basis, most of the composite overburden and potential rejects samples tested (77%) can be considered strongly sodic and have high risk of dispersion (median ESP 18%). Mine waste materials with a high risk of dispersion generally require management strategies to ensure that slopes are stabilised against erosion.

Table 3-7 Summary of eCEC and ESP in composited overburden and potential rejects samples

Parameter	ECM01	ECM02	ECM03	ECM04	ECM05	ECM06	ECM07	ECM08	ECM09	ECM10	ECM11	ECM12	ECM13	ECM14	ECM15	ECM16	ECM17	ECM18	ECM19	ECM20	ECM21	ECM22
	Overburden – fresh	Overburden – fresh	Interburden	Interburden	Interburden	Interburden	Interburden	Overburden-Cenozoic	Overburden - weathered	Interburden	Overburden – fresh	A1 roof	A1 seam	A1 Floor	A211 Horizon	A22C roof	A22C floor	A1 roof	A1 & A22C floor	A22C roof	A1 & A22C floor	A22C roof
	Sandstone/ Siltstone	Sandstone/ Siltstone	Siltstone	Siltstone	Sandstone/ Siltstone	Sandstone	Sandstone/ Siltstone	Weathered Soil	Sandstone	Sandstone	Sandstone	Carbonaceous Siltstone	Coal	Carbonaceous Siltstone	Carbonaceous Mudstone	Coaly Sandstone	Carbonaceous Siltstone	Siltstone/ Carbonaceous Mudstone	Carbonaceous Siltstone	Sandstone	Carbonaceous Siltstone/ Sandstone	Carbonaceous Sandstone
eCEC (meq/100g)	27.3	25	21.4	18.9	33.4	31.4	27.2	21.6	1.2	23.1	18.9	22.1	11.4	22.9	21.9	26.1	22.9	19.3	16	25.4	16	25.6
ESP (%)	11.4	11.6	22.7	26	15.9	13.3	15	28.4	18.6	18	13.9	17.7	17.8	21.6	20.5	14.9	21.6	20.2	31.5	12.5	31.5	14.2

Note 1: All values in mg/L; "—" means no guideline value or no value provided by reference source

The optimum pH for native plants depends on the species, but a pH of 5.5 to 7.0 is considered desirable for many species (DERM, 1995). For pasture grass the optimum pH is 6.0 to 7.0. The median $pH_{1:5}$ of the overburden and potential rejects samples was 9.2, which is marginally higher than the upper pH limit considered likely to have direct effects on plant growth (DERM 1995b).

High salinity levels in soils may reduce availability of water and essential nutrients to plants, which affects germination and growth or, in extreme cases, the elimination of crops and native vegetation (ANZECC and ARMCANZ 2000). The median $EC_{1:5}$ for overburden and potential rejects samples were 547 µS/cm and 533 µS/cm, respectively. To assess the tolerance of common pasture plants to the salinity of drainage water, derived by the contact of rainwater with mine waste materials, the average root zone salinity (EC_{se}) from the $EC_{1:5}$ values and average root zone leaching fraction for four broad soil types (ANZECC and ARMCANZ 2000) were calculated.

Table 3-8 shows that the calculated EC_{se} ranged from 100 to 2400 µS/cm (mean 700 µS/cm) and is generally suitable for moderately tolerant crops sensitive to drainage (or irrigation) water salinity (ANZECC and ARMCANZ 2000). The calculated EC_{se} generally did not exceed the EC_{se} threshold (the level causing yield reduction) for 13 common pasture species for the four broad soil textures. The exception was for white clover (*Trifolium repens*), which exceeded the EC_{se} for heavy clay soil texture.

Table 3-8 Tolerance of common pasture species to mine waste drainage water salinity

Common Name	Scientific Name	Average Root Zone Salinity Threshold (EC_{se}) (dS/cm)	Average Root Zone Salinity (EC_{se}) (dS/cm)			
			Sand	Loam	Light Clay	Heavy Clay
Wheatgrass, tall	*Agropyron elongatum*	7.5	0.5	0.9	0.9	1.5
Rhodes grass	*Chloris gayana*	7	0.4	0.7	0.7	1.2
Couch grass	*Cynodon dactylon*	6.9	0.5	0.9	0.9	1.5
Buffel grass	*Cenchrus ciliaris var Gayndah*	5.5	0.8	1.4	1.4	2.4
Phalaris	*Phalaris tuberosa (aquatica)*	4.2	0.4	0.7	0.7	1.2
Fescue	*Festuca clatior*	3.9	0.4	0.8	0.8	1.3
Green panic, Petri	*Petri Panicum maximum*	3	0.5	0.9	0.9	1.5
Townsville stylo	*Stylosanthes humilis*	2.4	0.5	0.9	0.9	1.4
Clover, Berseem Clover	*Trifolium alexandrinum*	2	0.5	0.9	0.9	1.4
Lucerne, Hunter River	*Medicago sativa*	2	0.5	0.9	0.9	1.4
Clover, strawberry (Palestine)	*Trifolium fragiferum*	1.6	0.5	0.8	0.8	1.4
Snail medic	*Medicago scutellata*	1.5	0.5	0.8	0.8	1.4
Clover, white (New Zealand)	*Trifolium repens*	1	0.5	0.9	0.9	1.5

The low salinity and alkaline pH combined with the high ESP (and predominance of sodium in the drainage water) suggest the mine waste samples tested can be classed as non-saline sodic materials (DERM 1995). These mine waste materials are predicted to have structural stability problems related to potential dispersion.

Treatment of the sodic overburden would be required if these are to be used as an additional source of revegetation media. Materials with sodic or dispersion potential can be treated with gypsum ($CaSO_4 \cdot 2H_2O$) to provide a source of calcium, which can reduce the relative quantity of sodium and thus decrease the ESP. It is estimated that about 3 meq Ca^{2+}/100g of mine waste is required to reduce the ESP from 18% to 6% based on the median ESP value obtained for the mine waste material tested. Assuming that thickness of the mine waste layer is 0.5 m with an average bulk density of 2.6 tonnes per cubic metre (t/m^3), then the amount of gypsum (95% purity) required to treat the mine waste material is estimated at 31 tonnes per hectare (t/ha).

The high gypsum treatment rate required may preclude the practical use of these mine waste as a final cover material without overlain with a stable topsoil or growth medium layer. Ideally, sodic and dispersive materials should be identified, selectively handled and placed within the core of the overburden emplacements or pits away from final surfaces, or returned to voids during mining.

4 CONCLUSIONS

Mine waste samples comprising of 19 overburden and 15 potential rejects samples have been tested to assess their AMD forming characteristics. The results obtained are consistent with previous investigations and indicate that:

- Overburden and potential rejects samples have low sulfide-sulfur concentrations, with approximately 56% of all sulfide concentrations less than or equal to 0.01% S and the remaining 44% distributed between 0.01% S and 0.05% S.
- Overburden and potential rejects samples have an order to two orders of magnitude more acid buffering capacity compared to the acid that can be generated based on sulfide-sulfur concentrations.
- Thirty-three of the thirty-four (97%) samples tested were NAF or AC, with the remaining sample (A1 seam coal sample) classified as UC, but is expected to be NAF based on the low sulfide-sulfur concentrations (0.026% S) and $\mathrm{NAG}_{\mathrm{pH}4.5}$ value that exceed the $\mathrm{NAPP}_{\mathrm{CRS}}$ and $\mathrm{MPA}_{\mathrm{CRS}}$, indicating the possible effects of organic matter on acid potential.
- All mine waste samples tested have negligible risk of acid generation and a very high factor of safety in terms of its potential to generate acid.
- Total metal concentrations in the overburden and potential rejects samples are generally not enriched relative to the mean upper continental crust abundances, and are below NEPM 2013 HIL C guideline values (where such guideline levels exist) for land used for parklands and recreational open spaces.
- Overburden and potential rejects samples may initially generate alkaline drainage with pH values (median pH 9.2) that may marginally exceed the Australian livestock drinking water guidelines (ANZECC and ARMCANZ 2000) and Condition W4 of the environmental authority.
- Drainage water derived from the overburden and potential rejects samples is unlikely to contain significant existing salinity that would exceed the range (0 to 7460 µS/cm) recommended for livestock drinking water in Australia and Condition W4 (10000 µS/cm) of the environmental authority.
- Mine waste materials are non-saline sodic materials with high risk of dispersion based on high ESP values combined with the relatively low salinity, alkaline pH and predominance of sodium in the drainage water.
- Drainage water quality resulting from the contact between the mine waste materials and rainwater is expected to contain dissolved metal and sulfate concentrations that are well below the Australian livestock drinking water guidelines. The exception is for molybdenum, which marginally exceeded the guideline concentrations in leachates generated by two coal seam roof and floor samples (carbonaceous siltstones) derived from the A1 seam.
- Soluble arsenic concentrations in 4 of the 11 composite overburden samples and 6 of the 11 potential composite rejects samples exceeded the end-of-pipe trigger levels for mine affected water released at RP1 and RP2 specified in Condition W5 of the environmental authority.
- Soluble uranium and manganese concentrations in the leachate samples were below the end-of-pipe trigger levels. In general, the metal leachability data should be interpreted

with care since the LOR for some metals exceed the end-of-pipe release contaminant trigger levels.

- Median $EC_{1:5}$, $pH_{1:5}$ and soluble sulfate concentrations in the drainage water derived from the mine waste samples exceed the WQOs for the protection of moderately disturbed aquatic ecosystems in the Lower Nogoa /Theresa Creek Sub-basin catchment.
- Median $EC_{1:5}$ value do not exceed the cease release (1440 µS/cm) and 80th percentile (1200 µS/cm) values specified in Condition W20 of the environmental authority for downstream receiving waters at monitoring point MP5, located at the Nogoa River at the Ensham lease boundary, and approval trigger value (650 µS/cm) at MP6 located at Mackenzie River at Riley's Crossing.
- Median soluble sulfate concentration (based on1:5 solids to deionised water extractions) in the drainage water (30 mg/L) are well below the trigger levels (250 mg/L) for receiving waters at downstream monitoring points (MP5 and MP6) and upstream (background) receiving water monitoring point MP2 (at Nogoa River at Duckponds) and MP4 (at Boggy Creek – Ramp 9 crossing at Yongala).
- Median $pH_{1:5}$ value in the drainage water (pH 9.2) marginally exceed the upper pH trigger limit (pH 9.0) for downstream and upstream receiving waters.
- Runoff water from spoil piles may cause soil structural problems (through clay aggregate breakdown by sodium) in receiving soils.
- Twenty of the twenty-two composite mine waste samples (91%) had moderate to high eCEC values (12 ≤ eCEC ≤ 40 meq/100g), thus have relatively high clay contents, greater water holding capacity, greater capacity to store and hold cations and nutrients against leaching, and greater capacity to resist changes to soil pH and chemistry caused by land use.
- Most of the composite overburden and potential rejects samples tested (77%) are considered strongly sodic and have high risk of dispersion (median ESP 18%), thus require appropriate management strategies to ensure that slopes are stabilised against erosion.
- Common pasture plants are generally expected to tolerate the drainage water salinity. The calculated average root zone salinity did not exceed the EC_{se} threshold (the level causing yield reduction) for 13 common pasture species for the four broad soil textures. The exception was for white clover (*Trifolium repens*), which exceeded the EC_{se} for heavy clay soil texture.
- Potentially high gypsum treatment rate are required for the mine wastes, which may preclude the practical use of these materials as a final cover material without overlain with a stable topsoil or growth medium layer.
- Risk of the overburden and potential reject materials to cause significant downstream water quality impacts is low, and is unlikely to present any environmental issues associated with revegetation and rehabilitation in terms of adverse effects on plant growth. However, the high risk of dispersion will require strategies to manage potential erosion hazards.

5 RECOMMENDATIONS

The following mine waste disposal methodologies or activities are recommended to help further assess and develop management strategies for mine wastes at ECM:

- Ongoing management of mine waste (including overburden, coal seam roof and floor materials, coarse rejects and tailings materials) should consider the geochemistry of materials with respect to their potential risk to cause environmental harm, and their suitability for use in revegetation and rehabilitation.
- On-going sampling and geochemical testing of mine waste samples collected (from exploration drilling programs) ahead of mining, at least on an annual basis, to confirm the NAF nature or delineate any PAF materials prior to mining.
- Overburden emplacements areas or pits should be managed to maximise the mass of saline and/or sodic materials stored within the core of storage facilities, with measures in place to prevent or minimise water flow over potentially dispersive materials and by avoiding, where possible, placement at the final top surface and final surface of the outer slopes and batters.
- Consider placing coarse overburden material at the base of overburden emplacements areas or pits to assist in overburden drainage. Some rock mulching may be required on final batters to reduce potential erosion from surface runoff.
- Characterising the mine waste materials on an annual basis in accordance with Condition F16 an F17 of the environmental authority, with a view to reducing the number of parameters tested in the medium-term by collecting sufficient mine waste characterisation data to demonstrate that certain individual parameters are not present in sufficient quantities to warrant further characterisation in future geochemistry programs.
- Monitoring of potential drainage/seepage water quality from overburden emplacement areas or pits in line with Condition W4 and W5 of the environmental authority.
- Updating the Mining Waste Management Plan in view of all the geochemical data collected to date for mine wastes, including overburden, coal seam roof and floor materials, coarse rejects and tailings materials.
- Reviewing the historical receiving water flow rates and water quality measured at RP1 and RP2 to provide insight into the contaminant loads transported to environments downstream of the confluence of Anabranch, Nogoa River and Boggy Creek, and possible long-term environmental impact risk.

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URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Ensham Resources Pty Ltd (Ensham) and only those third parties who have been authorised in writing by URS to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work outlined in the Ensham Coal Mine 2014 Geochemical Characterisation Program proposal dated 23 September 2014 and for the purpose outlined in the contract dated 11 September 2014.

Where this Report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information except as expressly stated in the Report. URS assumes no liability for any inaccuracies in or omissions to that information.

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

APPENDIX A ALS LABORATORY REPORTS – OVERBURDEN AND POTENTIAL REJECTS

ALS GROUP - Brisbane

EB1446022 CT

Telephone : +61-7-3243 7222

Submit samples to: ALS Environmental 07 3243 7222
2 Byth St, Stafford QLD 4053

FROM:
c/o URS Australia: Level 17, 240 Queen Street Brisbane QLD 4000
Contact: Tony Jong
Ph: 07 3243 2119 / 0409 130 088

RESULTS REQUIRED:

Project Name: ECM_Mineral Waste
Project No: 42627460
Project Manager: Tony Jong
Agreement No.: EN/001/14
Quote No.:

Sampler Name: Eloise Winch / Andrew Wheeler
Sampler Contact: Eloise Winch - 0459186308

Released by:
Date: **Time:**

Received for Laboratory by:
Date: **Time:**

Container Type, Preservative and Analysis

Container Identification

Type*	PsB	PsB	PsB	PsB	PsB	PsB	PsB
Preservative Code	none	none	none	none	none	none	none
Analytes	Sample Preparation - refer attached Sample Split & Preparation Spreadsheet	Moisture (EA055)	1:5 Leach (EN/34)	pH and EC (1:5) (IN-4S)	NAPP (ASS-1)	NAG (EA011)	Chromium Reducible Sulfur [SCR] (EA026)

Drill Hole ID	Sample Date	Depth from (m)	Depth to (m)	Sample ID	Matrix	Type	Lithology	No of bags		Sample Preparation	Moisture (EA055)	1:5 Leach (EN/34)	pH and EC (1:5) (IN-4S)	NAPP (ASS-1)	NAG (EA011)	Chromium Reducible Sulfur [SCR] (EA026)
R4999	29/10/2014	0.00	24.00	4999-1		OB-fresh	VF to FN SS with SL bands. Sideritic in part	1		X	X	X	X	X	X	X
R4999	29/10/2014	24.00	32.67	4999-2		OB-fresh	VF to FN SS with SL bands. Sideritic in part	1		X	X	X	X	X	X	X
R4999	29/10/2014	32.67	33.17	4999-3		A1 roof	SL PC	1		X	X	X	X	X	X	X
R4999	29/10/2014	33.17	33.70	4999-4		A1 seam	Coal, dull with bright bands	1		X	X	X	X	X	X	X
R4999	29/10/2014	33.70	34.20	4999-5		A1 Floor	SL minor SS, partly carbonaceous	1		X	X	X	X	X	X	X
R4999	29/10/2014	34.20	37.00	4999-6		IB	Siltstone, partly carbonaceous. Minor SS	1		X	X	X	X	X	X	X
R4999	29/10/2014	37.00	37.35	4999-7		A211 Horizon	XM (some roof & floor material present)	1		X	X	X	X	X	X	X
R4999	29/10/2014	37.35	44.30	4999-8		IB	fine -med grained SS with SN bands	1		X	X	X	X	X	X	X
R4999	29/10/2014	44.30	44.60	4999-9		A212 horizon	XM (some roof & floor material present)	1		X	X	X	X	X	X	X
R4999	29/10/2014	44.60	48.00	4999-10		IB	Siltstone, partly carb, sideritic in part	1		X	X	X	X	X	X	X
R4999	29/10/2014	48.00	54.00	4999-11		IB	Fine grained SS, minor SL, partly carb	1		X	X	X	X	X	X	X
R4999	29/10/2014	54.00	62.00	4999-12		IB	Fine medium grained sandstone	1		X	X	X	X	X	X	X
R4999	29/10/2014	62.00	62.45	4999-13		A22C roof	FN-MD grained SS, few coaly lenses	1		X	X	X	X	X	X	X
R4999	29/10/2014	66.63	67.00	4999-14		A22C floor	SL, partly carbonaceous, minor siderite	1								
R5003	1/11/2014	0.00	16.50	5003-1		OB - Cenerzoic	Soil, clay, sand and gravels.	1		X	X	X	X	X	X	X
R5003	1/11/2014	16.50	18.00	5003-2		OB - weathered	FN SS, lithic	1		X	X	X	X	X	X	X
R5003	1/11/2014	18.00	75.50	5003-3		OB - Fresh	Fine-med SS interbedded with SN	1		X	X	X	X	X	X	X
R5003	1/11/2014	75.50	76.11	5003-4		A1 roof	SL grading to carb mudstone	1		X	X	X	X	X	X	X
R5003	1/11/2014	76.61	77.00	5003-5		A1 floor	SL, partly carbonaceous, minor SS	1		X	X	X	X	X	X	X
R5003	1/11/2014	77.00	78.00	5003-6		IB	Siltstone	1		X	X	X	X	X	X	X
R5003	1/11/2014	78.00	79.00	5003-7		IB	SS, fine to coarse grained, lithic	1		X	X	X	X	X	X	X
R5003	1/11/2014	79.00	82.00	5003-8		IB	SL, minor SS bands	1		X	X	X	X	X	X	X
R5003	1/11/2014	82.00	97.00	5003-9		IB	SS, fine to coarse grained, lithic. Rare SL	1		X	X	X	X	X	X	X
R5003	1/11/2014	97.00	105.50	5003-10		IB	SL, minor sideritic bands, minor SS	1		X	X	X	X	X	X	X
R5003	1/11/2014	105.50	108.50	5003-11		IB	SS, fine-coarse, lithic, minor SL	1		X	X	X	X	X	X	X
R5003	1/11/2014	108.50	109.08	5003-12		A22C roof	SS, fine-coarse grained, lithic	1		X	X	X	X	X	X	X
R5003	1/11/2014	113.03	113.50	5003-13		A22C floor	SL, partly carbonaceous	1		X	X	X	X	X	X	X
								1								

ALS Environmental: 2 Byth St, Stafford QLD 4053 Ph: 3243 7222

FROM:

c/o URS Australia: Level 17, 240 Queen Street Brisbane QLD 4000
Contact: Tony Jong
Ph: 07 3243 2119 / 0409 130 088

RESULTS REQUIRED:

Project Name: ECM_Mineral Waste
Project No: 42627460
Project Manager: Tony Jong
Agreement No.: EN/001/14
Quote No.:

Sampler Name: Eloise Winch / Andrew Wheeler
Sampler Contact: Eloise Winch - 0459186308

Released by:
Date: **Time:**

Received for Laboratory by:
Date: **Time:**

Container Type, Preservative and Analysis

	Container Identification						
Type*	PsB	PsB	PsB	PsB	PsB	PsB	PsB
Preservative Code	none	none	none	none	none	none	none
Analytes	Sample Preparation - refer attached Sample Split & Preparation Spreadsheet	Moisture (EA055)	1:5 Leach (EN/34)	pH and EC (1:5) (IN-4S)	NAPP (ASS-1)	NAG (EA011)	Chromium Reducible Sulfur [SCR] (EA026)

Drill Hole ID	Sample Date	Depth from (m)	Depth to (m)	Sample ID	Matrix	Type	Lithology	No of bags		Sample Preparation	Moisture (EA055)	1:5 Leach (EN/34)	pH and EC (1:5) (IN-4S)	NAPP (ASS-1)	NAG (EA011)	Chromium Reducible Sulfur [SCR] (EA026)
C4466	3/11/2014	22.47	23.04	4466-21		OB - fresh	SS, very fine - fine, minor SL laminae	1		X	X	X	X	X	X	X
C4466	3/11/2014	60.48	62.82	4466-22		OB - fresh	SS very fine - fine, minor SL bands	1		X	X	X	X	X	X	X
C4466	3/11/2014	64.21	64.73	4466-23		A1 floor	SL, partly carb, SS at base	1		X	X	X	X	X	X	X
C4466	3/11/2014	67.78	68.15	4466-24		A211 horizon	5cm coal, SL and SS roof and floor	1		X	X	X	X	X	X	X
C4466	3/11/2014	87.35	87.80	4466-25		IB	SS, fine - med grained, minor carb wisps	1		X	X	X	X	X	X	X
C4466	3/11/2014	92.11	92.62	4466-26		A22C roof	SS, fine - med grained, minor carb wisps	1		X	X	X	X	X	X	X
C4466	3/11/2014	97.15	97.59	4466-27		A22C floor	SS fine-med, partly carb, minor SL	1		X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
										X	X	X	X	X	X	X
Remarks to Lab:	**Sample preparation as per attached Sample Split & Preparation Spreadsheet**						**TOTAL number of bags**		**TOTAL number of each analyte**	52	52	52	52	52	52	52

Courier Job No.

* Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glas Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; PsB = Neutral Plastic Bag

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1446022**

Client	: **URS AUSTRALIA PTY LTD (QLD)**	Laboratory	: Environmental Division Brisbane
Contact	: DR TONY JONG	Contact	: Customer Services EB
Address	: LEVEL 14, 240 QUEEN STREET GPO BOX 302 BRISBANE QLD, AUSTRALIA 4001	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: tony.jong@urs.com	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 07 3243 2119	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 32432199	Facsimile	: +61-7-3243 7218
Project	: ECM_Mineral Waste 42627460	Page	: 1 of 4
Order number	: ----	Quote number	: ES2014URSQLD0355 (EN/001/14)
C-O-C number	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
Sampler	: ANDREW WHEELER, ELOISE WINCH		

Dates

Date Samples Received	: 07-Nov-2014	Issue Date	: 12-Nov-2014
Client Requested Due Date	: 20-Nov-2014	Scheduled Reporting Date	: **20-Nov-2014**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 5	Temperature	: 26.4, 28.5, 23.7, 25.4, 26.8°C
Receipt Detail	: LARGE BAGS	No. of samples received / analysed	: 34 / 34

General Comments

- This report contains the following information:
    - Sample Container(s)/Preservation Non-Compliances
    - Summary of Sample(s) and Requested Analysis
    - Proactive Holding Time Report
    - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **The COC for this work orde was received via email from Lawrie Duck on 10/11/14 at 16:49. The TAT has been calculated from this date.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Any sample identifications that cannot be displayed entirely in the analysis summary table will be listed below.

EB1446022-001 : [29-Oct-2014] : 4999-1 - R4999 0.00-24.00m
EB1446022-002 : [29-Oct-2014] : 4999-2 - R4999 24.00-32.67m
EB1446022-003 : [29-Oct-2014] : 4999-3 - R4999 32.67-33.17m
EB1446022-004 : [29-Oct-2014] : 4999-4 - R4999 33.17-33.70m
EB1446022-005 : [29-Oct-2014] : 4999-5 - R4999 33.70-34.20m
EB1446022-006 : [29-Oct-2014] : 4999-6 - R4999 34.20-37.00m
EB1446022-007 : [29-Oct-2014] : 4999-7 - R4999 37.00-37.35m
EB1446022-008 : [29-Oct-2014] : 4999-8 - R4999 37.35-44.30m
EB1446022-009 : [29-Oct-2014] : 4999-9 - R4999 44.30-44.60m
EB1446022-010 : [29-Oct-2014] : 4999-10 - R4999 44.60-48.00m
EB1446022-011 : [29-Oct-2014] : 4999-11 - R4999 48.00-54.00m
EB1446022-012 : [29-Oct-2014] : 4999-12 - R4999 54.00-62.00m
EB1446022-013 : [29-Oct-2014] : 4999-13 - R4999 62.00-62.45m
EB1446022-014 : [29-Oct-2014] : 4999-14 - R4999 66.63-67.00m
EB1446022-015 : [01-Nov-2014] : 5003-1 - R5003 0.00-16.50m
EB1446022-016 : [01-Nov-2014] : 5003-2 - R5003 16.50-18.00m
EB1446022-017 : [01-Nov-2014] : 5003-3 - R5003 18.00-75.50m
EB1446022-018 : [01-Nov-2014] : 5003-4 - R5003 75.50-76.11m
EB1446022-019 : [01-Nov-2014] : 5003-5 - R5003 76.61-77.00m
EB1446022-020 : [01-Nov-2014] : 5003-6 - R5003 77.00-78.00m
EB1446022-021 : [01-Nov-2014] : 5003-7 - R5003 78.00-79.00m
EB1446022-022 : [01-Nov-2014] : 5003-8 - R5003 79.00-82.00m
EB1446022-023 : [01-Nov-2014] : 5003-9 - R5003 82.00-97.00m
EB1446022-024 : [01-Nov-2014] : 5003-10 - R5003 97.00-105.50m
EB1446022-025 : [01-Nov-2014] : 5003-11 - R5003 105.50-108.50m
EB1446022-026 : [01-Nov-2014] : 5003-12 - R5003 108.50-109.08m
EB1446022-027 : [01-Nov-2014] : 5003-13 - R5003 113.03-113.50m
EB1446022-028 : [03-Nov-2014] : 4466-21 - C4466 22.47-23.04m
EB1446022-029 : [03-Nov-2014] : 4466-22 - C4466 60.48-62.82m
EB1446022-030 : [03-Nov-2014] : 4466-23 - C4466 64.21-64.73m
EB1446022-031 : [03-Nov-2014] : 4466-24 - C4466 67.78-68.15m
EB1446022-032 : [03-Nov-2014] : 4466-25 - C4466 87.35-87.80m
EB1446022-033 : [03-Nov-2014] : 4466-26 - C4466 92.11-92.62m
EB1446022-034 : [03-Nov-2014] : 4466-27 - C4466 97.15-97.59m

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - ASS1 NAPP	SOIL - EA011 Net Acid Generation (NAG)	SOIL - EA026 Chromium Reducible Sulphur	SOIL - EA055-103 Moisture Content	SOIL - IN-4S pH plus EC (1:5)
EB1446022-001	[29-Oct-2014]	4999-1 R4999 0.00-2...	✓	✓	✓	✓	✓
EB1446022-002	[29-Oct-2014]	4999-2 R4999 24.00-...	✓	✓	✓	✓	✓
EB1446022-003	[29-Oct-2014]	4999-3 R4999 32.67-...	✓	✓	✓	✓	✓
EB1446022-004	[29-Oct-2014]	4999-4 R4999 33.17-...	✓	✓	✓	✓	✓
EB1446022-005	[29-Oct-2014]	4999-5 R4999 33.70-...	✓	✓	✓	✓	✓

			SOIL - ASS1 NAPP	SOIL - EA011 Net Acid Generation (NAG)	SOIL - EA026 Chromium Reducible Sulphur	SOIL - EA055-103 Moisture Content	SOIL - IN-4S pH plus EC (1:5)
EB1446022-006	[29-Oct-2014]	4999-6 R4999 34.20-...	✓	✓	✓	✓	✓
EB1446022-007	[29-Oct-2014]	4999-7 R4999 37.00-...	✓	✓	✓	✓	✓
EB1446022-008	[29-Oct-2014]	4999-8 R4999 37.35-...	✓	✓	✓	✓	✓
EB1446022-009	[29-Oct-2014]	4999-9 R4999 44.30-...	✓	✓	✓	✓	✓
EB1446022-010	[29-Oct-2014]	4999-10 R4999 44.60...	✓	✓	✓	✓	✓
EB1446022-011	[29-Oct-2014]	4999-11 R4999 48.00...	✓	✓	✓	✓	✓
EB1446022-012	[29-Oct-2014]	4999-12 R4999 54.00...	✓	✓	✓	✓	✓
EB1446022-013	[29-Oct-2014]	4999-13 R4999 62.00...	✓	✓	✓	✓	✓
EB1446022-014	[29-Oct-2014]	4999-14 R4999 66.63...	✓	✓	✓	✓	✓
EB1446022-015	[01-Nov-2014]	5003-1 R5003 0.00-1...	✓	✓	✓	✓	✓
EB1446022-016	[01-Nov-2014]	5003-2 R5003 16.50-...	✓	✓	✓	✓	✓
EB1446022-017	[01-Nov-2014]	5003-3 R5003 18.00-...	✓	✓	✓	✓	✓
EB1446022-018	[01-Nov-2014]	5003-4 R5003 75.50-...	✓	✓	✓	✓	✓
EB1446022-019	[01-Nov-2014]	5003-5 R5003 76.61-...	✓	✓	✓	✓	✓
EB1446022-020	[01-Nov-2014]	5003-6 R5003 77.00-...	✓	✓	✓	✓	✓
EB1446022-021	[01-Nov-2014]	5003-7 R5003 78.00-...	✓	✓	✓	✓	✓
EB1446022-022	[01-Nov-2014]	5003-8 R5003 79.00-...	✓	✓	✓	✓	✓
EB1446022-023	[01-Nov-2014]	5003-9 R5003 82.00-...	✓	✓	✓	✓	✓
EB1446022-024	[01-Nov-2014]	5003-10 R5003 97.00...	✓	✓	✓	✓	✓
EB1446022-025	[01-Nov-2014]	5003-11 R5003 105.5...	✓	✓	✓	✓	✓
EB1446022-026	[01-Nov-2014]	5003-12 R5003 108.5...	✓	✓	✓	✓	✓
EB1446022-027	[01-Nov-2014]	5003-13 R5003 113.0...	✓	✓	✓	✓	✓
EB1446022-028	[03-Nov-2014]	4466-21 C4466 22.47...	✓	✓	✓	✓	✓
EB1446022-029	[03-Nov-2014]	4466-22 C4466 60.48...	✓	✓	✓	✓	✓
EB1446022-030	[03-Nov-2014]	4466-23 C4466 64.21...	✓	✓	✓	✓	✓
EB1446022-031	[03-Nov-2014]	4466-24 C4466 67.78...	✓	✓	✓	✓	✓
EB1446022-032	[03-Nov-2014]	4466-25 C4466 87.35...	✓	✓	✓	✓	✓
EB1446022-033	[03-Nov-2014]	4466-26 C4466 92.11...	✓	✓	✓	✓	✓
EB1446022-034	[03-Nov-2014]	4466-27 C4466 97.15...	✓	✓	✓	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **SOIL**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method **Client Sample ID(s)**	**Container**	**Due for extraction**	**Due for analysis**	**Samples Received**		**Instructions Received**	
				Date	**Evaluation**	**Date**	**Evaluation**
EA002: pH (1:5)							
4999-10	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-11	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-12	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-13	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-14	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-1	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘

4999-2	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-3	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-4	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-5	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-6	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-7	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-8	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-9	Soil Glass Jar - Unpreserved	05-Nov-2014	05-Nov-2014	07-Nov-2014	✘	07-Nov-2014	✘
EA010: Electrical Conductivity (1:5)							
4999-10	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-11	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-12	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-13	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-14	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-1	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-2	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-3	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-4	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-5	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-6	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-7	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-8	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
4999-9	Soil Glass Jar - Unpreserved	05-Nov-2014	03-Dec-2014	07-Nov-2014	✘	07-Nov-2014	✘
ED042T: Sulfur - Total as S (LECO)							
4999-10	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-11	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-12	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-13	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-14	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-1	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-2	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-3	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-4	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-5	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-6	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-7	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-8	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘
4999-9	Pulp Bag	05-Nov-2014	04-May-2015	07-Nov-2014	✘	07-Nov-2014	✘

Requested Deliverables

ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	APAC.ap@urs.com

LAWRIE DUCK

- *AU Certificate of Analysis - NATA (COA)	Email	lawrie.duck@urs.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	lawrie.duck@urs.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	lawrie.duck@urs.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	lawrie.duck@urs.com
- Chain of Custody (CoC) (COC)	Email	lawrie.duck@urs.com
- EDI Format - ENMRG (ENMRG)	Email	lawrie.duck@urs.com
- EDI Format - EQUIS V5 URS (EQUIS_V5_URS)	Email	lawrie.duck@urs.com
- EDI Format - ESDAT (ESDAT)	Email	lawrie.duck@urs.com
- EDI Format - MRED (MRED)	Email	lawrie.duck@urs.com

TONY JONG

- *AU Certificate of Analysis - NATA (COA)	Email	tony.jong@urs.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	tony.jong@urs.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	tony.jong@urs.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	tony.jong@urs.com
- Chain of Custody (CoC) (COC)	Email	tony.jong@urs.com
- EDI Format - ENMRG (ENMRG)	Email	tony.jong@urs.com
- EDI Format - EQUIS V5 URS (EQUIS_V5_URS)	Email	tony.jong@urs.com
- EDI Format - ESDAT (ESDAT)	Email	tony.jong@urs.com
- EDI Format - MRED (MRED)	Email	tony.jong@urs.com

ALS Environmental

CERTIFICATE OF ADVANCED ANALYSIS

Work Order : **EB1446022**
Client : **URS AUSTRALIA PTY LTD (QLD)**
Contact : DR TONY JONG
Address : LEVEL 14, 240 QUEEN STREET GPO BOX 302
BRISBANE QLD, AUSTRALIA 4001
E-mail : tony.jong@urs.com
Telephone : +61 07 3243 2119
Facsimile : +61 07 32432199
Project : ECM_Mineral Waste 42627460
Order number : ----
C-O-C number : ----
Sampler : ANDREW WHEELER, ELOISE WINCH
Site : ----
Quote number : ----

Page : 1 of 10
Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 07-Nov-2014 10:20
Date Analysis Commenced : 12-Nov-2014
Issue Date : 20-Nov-2014 16:38
No. of samples received : 34
No. of samples analysed : 34

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED
ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Satishkumar Trivedi	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

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.

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.

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

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**4999-1** **R4999 0.00-24.00m**	**4999-2** **R4999 24.00-32.67m**	**4999-3** **R4999 32.67-33.17m**	**4999-4** **R4999 33.17-33.70m**	**4999-5** **R4999 33.70-34.20m**
			Client sampling date / time	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]
Compound	CAS Number	LOR	Unit	**EB1446022-001**	**EB1446022-002**	**EB1446022-003**	**EB1446022-004**	**EB1446022-005**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**6.8**	**9.0**	**9.0**	**7.8**	**9.0**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-45.9**	**-65.2**	**-14.8**	**-5.9**	**-4.8**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**669**	**514**	**668**	**1040**	**513**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**9.9**	**10.7**	**9.7**	**3.0**	**4.6**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	**69.6**	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	**139**	**7.0**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**46.8**	**65.8**	**16.0**	**17.5**	**7.0**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**4.8**	**6.7**	**1.6**	**1.8**	**0.7**
Fizz Rating	----	0	Fizz Unit	**2**	**2**	**1**	**1**	**1**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.007**	**0.006**	**0.022**	**0.026**	**0.024**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	<1.0	**1.2**	**1.4**	**1.9**	**1.8**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.02**	**0.04**	**0.38**	**0.07**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**4999-6** **R4999 34.20-37.00m**	**4999-7** **R4999 37.00-37.35m**	**4999-8** **R4999 37.35-44.30m**	**4999-9** **R4999 44.30-44.60m**	**4999-10** **R4999 44.60-48.00m**
			Client sampling date / time	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-006**	**EB1446022-007**	**EB1446022-008**	**EB1446022-009**	**EB1446022-010**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.0**	**8.9**	**9.2**	**9.4**	**9.2**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-10.8**	**-10.0**	**-63.8**	**-38.3**	**-26.8**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**587**	**638**	**633**	**625**	**627**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.8**	**7.9**	**10.6**	**9.8**	**9.5**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**12.0**	**12.5**	**65.0**	**39.8**	**28.0**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**1.2**	**1.3**	**6.6**	**4.0**	**2.9**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**2**	**2**	**2**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.012**	**0.008**	**0.010**	**0.008**	**0.009**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	**1.2**	**1.4**	**1.2**	**1.7**	**1.6**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.08**	**0.04**	**0.05**	**0.04**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**4999-11** **R4999 48.00-54.00m**	**4999-12** **R4999 54.00-62.00m**	**4999-13** **R4999 62.00-62.45m**	**4999-14** **R4999 66.63-67.00m**	**5003-1** **R5003 0.00-16.50m**
			Client sampling date / time	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[29-Oct-2014]	[01-Nov-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-011**	**EB1446022-012**	**EB1446022-013**	**EB1446022-014**	**EB1446022-015**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.3**	**9.5**	**9.4**	**9.6**	**7.4**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-43.9**	**-108**	**-99.8**	**-45.4**	**-0.6**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**612**	**608**	**657**	**627**	**641**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**10.2**	**10.8**	**10.7**	**10.1**	**6.9**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	**0.2**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**43.9**	**109**	**101**	**46.6**	**1.2**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**4.5**	**11.2**	**10.4**	**4.8**	**0.1**
Fizz Rating	----	0	Fizz Unit	**2**	**3**	**2**	**2**	**0**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.008**	<0.005	**0.006**	**0.012**	<0.005
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	**1.3**	**1.2**	**1.9**	**1.6**	<1.0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.03**	**0.04**	**0.04**	**0.02**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Client sample ID	**5003-2 R5003 16.50-18.00m**	**5003-3 R5003 18.00-75.50m**	**5003-4 R5003 75.50-76.11m**	**5003-5 R5003 76.61-77.00m**	**5003-6 R5003 77.00-78.00m**
			Client sampling date / time	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-016**	**EB1446022-017**	**EB1446022-018**	**EB1446022-019**	**EB1446022-020**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.2**	**9.0**	**9.3**	**9.0**	**8.9**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-1.3**	**-36.5**	**-8.4**	**-9.3**	**-7.3**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**93**	**465**	**494**	**553**	**474**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**6.0**	**10.5**	**7.3**	**6.9**	**6.8**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**6.2**	<0.1	<0.1	<0.1	**0.4**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1.3**	**37.4**	**9.6**	**9.9**	**7.9**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**0.1**	**3.8**	**1.0**	**1.0**	**0.8**
Fizz Rating	----	0	Fizz Unit	**0**	**2**	**1**	**1**	**1**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	**0.016**	**0.014**	**0.015**	**0.015**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	<1.0	<1.0	**1.8**	**1.5**	**1.3**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.03**	**0.04**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Client sample ID	**5003-7 R5003 78.00-79.00m**	**5003-8 R5003 79.00-82.00m**	**5003-9 R5003 82.00-97.00m**	**5003-10 R5003 97.00-105.50m**	**5003-11 R5003 105.50-108.50m**
			Client sampling date / time	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]	[01-Nov-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-021**	**EB1446022-022**	**EB1446022-023**	**EB1446022-024**	**EB1446022-025**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.7**	**8.8**	**9.3**	**9.2**	**9.3**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-8.7**	**-8.5**	**-76.9**	**-31.6**	**-46.5**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**305**	**459**	**616**	**575**	**547**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.0**	**7.5**	**10.5**	**9.8**	**10.7**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**9.6**	**9.4**	**77.8**	**32.5**	**47.4**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**1.0**	**1.0**	**7.9**	**3.3**	**4.8**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**2**	**2**	**2**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.009**	**0.016**	**0.007**	**0.009**	**0.006**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	**1.0**	**1.2**	<1.0	**1.1**	<1.0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL)**

			Client sample ID	**5003-12 R5003 108.50-109.08m**	**5003-13 R5003 113.03-113.50m**	**----**	**----**	**----**
			Client sampling date / time	[01-Nov-2014]	[01-Nov-2014]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-026**	**EB1446022-027**	**--------**	**--------**	**--------**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.4**	**9.2**	**----**	**----**	**----**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-78.4**	**-9.9**	**----**	**----**	**----**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**518**	**571**	**----**	**----**	**----**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**10.8**	**7.6**	**----**	**----**	**----**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	**----**	**----**	**----**
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	**----**	**----**	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**79.3**	**10.8**	**----**	**----**	**----**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**8.1**	**1.1**	**----**	**----**	**----**
Fizz Rating	----	0	Fizz Unit	**2**	**1**	**----**	**----**	**----**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.006**	**0.017**	**----**	**----**	**----**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	<1.0	<1.0	**----**	**----**	**----**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

			Client sample ID	**4466-21 C4466 22.47-23.04m**	**4466-22 C4466 60.48-62.82m**	**4466-23 C4466 64.21-64.73m**	**4466-24 C4466 67.78-68.15m**	**4466-25 C4466 87.35-87.80m**
			Client sampling date / time	[03-Nov-2014]	[03-Nov-2014]	[03-Nov-2014]	[03-Nov-2014]	[03-Nov-2014]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-028**	**EB1446022-029**	**EB1446022-030**	**EB1446022-031**	**EB1446022-032**
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.7**	**9.2**	**8.8**	**9.2**	**9.5**
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-10.4**	**-15.5**	**-3.1**	**-9.6**	**-105**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**312**	**301**	**224**	**285**	**398**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.6**	**9.7**	**6.7**	**6.8**	**10.8**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	**0.4**	**0.4**	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**11.6**	**16.4**	**4.6**	**11.8**	**106**
^ **ANC as CaCO3**	----	0.1	% CaCO3	**1.2**	**1.7**	**0.5**	**1.2**	**10.8**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**0**	**1**	**3**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.015**	**0.011**	**0.017**	**0.006**	**0.006**
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	**1.2**	**1.1**	**1.1**	**1.1**	**1.0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.03**	**0.05**	**0.07**	**0.03**

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOIL)**			*Client sample ID*	**4466-26** **C4466 92.11-92.62m**	**4466-27** **C4466 97.15-97.59m**	----	----	----
			Client sampling date / time	[03-Nov-2014]	[03-Nov-2014]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1446022-033**	**EB1446022-034**	--------	--------	--------
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.3**	**9.1**	----	----	----
EA009: Nett Acid Production Potential								
^ **Net Acid Production Potential**	----	0.5	kg H2SO4/t	**-119**	**-9.3**	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**432**	**303**	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**10.9**	**7.2**	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**120**	**10.8**	----	----	----
^ **ANC as CaCO3**	----	0.1	% CaCO3	**12.3**	**1.1**	----	----	----
Fizz Rating	----	0	Fizz Unit	**3**	**1**	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	**0.028**	----	----	----
EA055: Moisture Content								
^ **Moisture Content (dried @ 103°C)**	----	1	%	<1.0	<1.0	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.05**	----	----	----

QUALITY CONTROL REPORT

Work Order : **EB1446022**

Client : **URS AUSTRALIA PTY LTD (QLD)**
Contact : DR TONY JONG
Address : LEVEL 14, 240 QUEEN STREET GPO BOX 302
BRISBANE QLD, AUSTRALIA 4001
E-mail : tony.jong@urs.com
Telephone : +61 07 3243 2119
Facsimile : +61 07 32432199
Project : ECM_Mineral Waste 42627460
Order number : ----
C-O-C number : ----
Sampler : ANDREW WHEELER, ELOISE WINCH
Site : ----
Quote number : ----

Page : 1 of 5

Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 07-Nov-2014
Date Analysis Commenced : 12-Nov-2014
Issue Date : 20-Nov-2014
No. of samples received : 34
No. of samples analysed : 34

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Satishkumar Trivedi	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA002 : pH (Soils) (QC Lot: 34328)									
EB1446022-001	4999-1 R4999 0.00-24.00m	EA002: pH Value	----	0.1	pH Unit	6.8	6.8	0.00	0% - 20%
EB1446022-011	4999-11 R4999 48.00-54.00m	EA002: pH Value	----	0.1	pH Unit	9.3	9.3	0.00	0% - 20%
EA002 : pH (Soils) (QC Lot: 34331)									
EB1446022-021	5003-7 R5003 78.00-79.00m	EA002: pH Value	----	0.1	pH Unit	8.7	8.7	0.00	0% - 20%
EB1446022-031	4466-24 C4466 67.78-68.15m	EA002: pH Value	----	0.1	pH Unit	9.2	9.2	0.00	0% - 20%
EA010: Conductivity (QC Lot: 34329)									
EB1446022-001	4999-1 R4999 0.00-24.00m	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	669	664	0.750	0% - 20%
EB1446022-011	4999-11 R4999 48.00-54.00m	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	612	620	1.30	0% - 20%
EA010: Conductivity (QC Lot: 34330)									
EB1446022-021	5003-7 R5003 78.00-79.00m	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	305	310	1.63	0% - 20%
EB1446022-031	4466-24 C4466 67.78-68.15m	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	285	274	3.94	0% - 20%
EA011: Net Acid Generation (QC Lot: 36146)									
EB1446022-001	4999-1 R4999 0.00-24.00m	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
EB1446022-012	4999-12 R4999 54.00-62.00m	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
EA011: Net Acid Generation (QC Lot: 36148)									
EB1446022-021	5003-7 R5003 78.00-79.00m	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
EB1446022-032	4466-25 C4466 87.35-87.80m	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.00	No Limit
EA013: Acid Neutralising Capacity (QC Lot: 36144)									
EB1446022-001	4999-1 R4999 0.00-24.00m	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	46.8	46.0	1.61	0% - 20%
EB1446022-012	4999-12 R4999 54.00-62.00m	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	109	109	0.345	0% - 20%

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA013: Acid Neutralising Capacity (QC Lot: 36147)									
EB1446022-021	5003-7 R5003 78.00-79.00m	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.6	9.2	4.96	0% - 50%
EB1446022-032	4466-25 C4466 87.35-87.80m	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	106	104	2.15	0% - 20%
EA026 : Chromium Reducible Sulfur (QC Lot: 36145)									
EB1446022-001	4999-1 R4999 0.00-24.00m	EA026: Chromium Reducible Sulphur	----	0.005	%	0.007	0.007	0.00	No Limit
EB1446022-012	4999-12 R4999 54.00-62.00m	EA026: Chromium Reducible Sulphur	----	0.005	%	<0.005	0.005	0.00	No Limit
EA026 : Chromium Reducible Sulfur (QC Lot: 36149)									
EB1446022-021	5003-7 R5003 78.00-79.00m	EA026: Chromium Reducible Sulphur	----	0.005	%	0.009	0.009	0.00	No Limit
EB1446022-032	4466-25 C4466 87.35-87.80m	EA026: Chromium Reducible Sulphur	----	0.005	%	0.006	0.005	0.00	No Limit
EA055: Moisture Content (QC Lot: 35998)									
EB1446022-004	4999-4 R4999 33.17-33.70m	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	1.9	2.1	8.70	No Limit
EB1446022-011	4999-11 R4999 48.00-54.00m	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	1.3	1.4	11.8	No Limit
EA055: Moisture Content (QC Lot: 35999)									
EB1446022-024	5003-10 R5003 97.00-105.50m	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	1.1	1.1	0.00	No Limit
EB1446022-031	4466-24 C4466 67.78-68.15m	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	1.1	1.2	15.4	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 35620)									
EB1446022-001	4999-1 R4999 0.00-24.00m	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.00	No Limit
EB1446022-010	4999-10 R4999 44.60-48.00m	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.04	0.00	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 35621)									
EB1446022-021	5003-7 R5003 78.00-79.00m	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.03	0.00	No Limit
EB1446022-030	4466-23 C4466 64.21-64.73m	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.05	0.04	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA002 : pH (Soils) (QCLot: 34328)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	100	98	102
EA002 : pH (Soils) (QCLot: 34331)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	100	98	102
EA010: Conductivity (QCLot: 34329)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	100	86	110
EA010: Conductivity (QCLot: 34330)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	100	86	110
EA011: Net Acid Generation (QCLot: 36146)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	23 kg H2SO4/t	100	70	130
EA011: Net Acid Generation (QCLot: 36148)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	23 kg H2SO4/t	99.6	70	130
EA013: Acid Neutralising Capacity (QCLot: 36144)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	103	82	120
EA013: Acid Neutralising Capacity (QCLot: 36147)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	100 kg H2SO4 equiv./t	106	82	120
EA026 : Chromium Reducible Sulfur (QCLot: 36145)								
EA026: Chromium Reducible Sulphur	----	0.005	%	<0.005	0.265 %	94.3	70	130
EA026 : Chromium Reducible Sulfur (QCLot: 36149)								
EA026: Chromium Reducible Sulphur	----	0.005	%	<0.005	0.265 %	91.7	70	130
ED042T: Total Sulfur by LECO (QCLot: 35620)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	101	70	130
ED042T: Total Sulfur by LECO (QCLot: 35621)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.15 %	98.7	70	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1446022**	Page	: 1 of 12
Client	: **URS AUSTRALIA PTY LTD (QLD)**	Laboratory	: Environmental Division Brisbane
Contact	: DR TONY JONG	Telephone	: +61-7-3243 7222
Project	: ECM_Mineral Waste 42627460	Date Samples Received	: 07-Nov-2014
Site	: ----	Issue Date	: 20-Nov-2014
Sampler	: ANDREW WHEELER, ELOISE WINCH	No. of samples received	: 34
Order number	: ----	No. of samples analysed	: 34

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits for regular samples are based on control limits obtained from matrix spike data.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	**Days overdue**	*Date analysed*	*Due for analysis*	**Days overdue**
EA002 : pH (Soils)						
Soil Glass Jar - Unpreserved 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	12-Nov-2014	08-Nov-2014	**3**	19-Nov-2014	12-Nov-2014	**6**
Soil Glass Jar - Unpreserved 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	12-Nov-2014	10-Nov-2014	**1**	19-Nov-2014	12-Nov-2014	**6**
Soil Glass Jar - Unpreserved 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	12-Nov-2014	05-Nov-2014	**6**	19-Nov-2014	12-Nov-2014	**6**
EA010: Conductivity						
Soil Glass Jar - Unpreserved 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	12-Nov-2014	08-Nov-2014	**3**	----	----	----
Soil Glass Jar - Unpreserved 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	12-Nov-2014	10-Nov-2014	**1**	----	----	----

Matrix: **SOIL**

Method **Container** / Client Sample ID(s)	*Extraction / Preparation* *Date extracted*	 *Due for extraction*	 ***Days overdue***	*Analysis* *Date analysed*	 *Due for analysis*	 ***Days overdue***
EA010: Conductivity - Analysis Holding Time Compliance						
Soil Glass Jar - Unpreserved 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	12-Nov-2014	05-Nov-2014	**6**	----	----	----
EA055: Moisture Content						
Soil Glass Jar - Unpreserved 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	----	----	----	19-Nov-2014	15-Nov-2014	**3**
Soil Glass Jar - Unpreserved 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	----	----	----	19-Nov-2014	17-Nov-2014	**1**
Soil Glass Jar - Unpreserved 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	----	----	----	19-Nov-2014	12-Nov-2014	**6**
ED042T: Total Sulfur by LECO						
Pulp Bag 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	18-Nov-2014	08-Nov-2014	**9**	----	----	----

Matrix: **SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
ED042T: Total Sulfur by LECO - Analysis Holding Time Compliance						
Pulp Bag 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	18-Nov-2014	10-Nov-2014	**7**	----	----	----
Pulp Bag 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	18-Nov-2014	05-Nov-2014	**12**	----	----	----

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA002 : pH (Soils)							
Soil Glass Jar - Unpreserved (EA002) 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	**01-Nov-2014**	**12-Nov-2014**	08-Nov-2014	✗	**19-Nov-2014**	12-Nov-2014	✗
Soil Glass Jar - Unpreserved (EA002) 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	**03-Nov-2014**	**12-Nov-2014**	10-Nov-2014	✗	**19-Nov-2014**	12-Nov-2014	✗
Soil Glass Jar - Unpreserved (EA002)							

Matrix: **SOIL**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA002 : pH (Soils) - Continued							
4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	**29-Oct-2014**	**12-Nov-2014**	05-Nov-2014	✘	**19-Nov-2014**	12-Nov-2014	✘
EA010: Conductivity							
Soil Glass Jar - Unpreserved (EA010)							
5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	**01-Nov-2014**	**12-Nov-2014**	08-Nov-2014	✘	**19-Nov-2014**	10-Dec-2014	✓
Soil Glass Jar - Unpreserved (EA010)							
4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	**03-Nov-2014**	**12-Nov-2014**	10-Nov-2014	✘	**19-Nov-2014**	10-Dec-2014	✓
Soil Glass Jar - Unpreserved (EA010)							
4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	**29-Oct-2014**	**12-Nov-2014**	05-Nov-2014	✘	**19-Nov-2014**	10-Dec-2014	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EA011: Net Acid Generation							
Pulp Bag (EA011) 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	**01-Nov-2014**	**19-Nov-2014**	01-Nov-2015	✓	**20-Nov-2014**	18-May-2015	✓
Pulp Bag (EA011) 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	**03-Nov-2014**	**19-Nov-2014**	03-Nov-2015	✓	**20-Nov-2014**	18-May-2015	✓
Pulp Bag (EA011) 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	**29-Oct-2014**	**19-Nov-2014**	29-Oct-2015	✓	**20-Nov-2014**	18-May-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** / *Client Sample ID(s)*		***Sample Date***	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA013: Acid Neutralising Capacity								
Pulp Bag (EA013)								
5003-1 - R5003 0.00-16.50m,	5003-2 - R5003 16.50-18.00m,	**01-Nov-2014**	**19-Nov-2014**	01-Nov-2015	✓	**20-Nov-2014**	18-May-2015	✓
5003-3 - R5003 18.00-75.50m,	5003-4 - R5003 75.50-76.11m,							
5003-5 - R5003 76.61-77.00m,	5003-6 - R5003 77.00-78.00m,							
5003-7 - R5003 78.00-79.00m,	5003-8 - R5003 79.00-82.00m,							
5003-9 - R5003 82.00-97.00m,	5003-10 - R5003 97.00-105.50m,							
5003-11 - R5003 105.50-108.50m,	5003-12 - R5003 108.50-109.08m,							
5003-13 - R5003 113.03-113.50m								
Pulp Bag (EA013)								
4466-21 - C4466 22.47-23.04m,	4466-22 - C4466 60.48-62.82m,	**03-Nov-2014**	**19-Nov-2014**	03-Nov-2015	✓	**20-Nov-2014**	18-May-2015	✓
4466-23 - C4466 64.21-64.73m,	4466-24 - C4466 67.78-68.15m,							
4466-25 - C4466 87.35-87.80m,	4466-26 - C4466 92.11-92.62m,							
4466-27 - C4466 97.15-97.59m								
Pulp Bag (EA013)								
4999-1 - R4999 0.00-24.00m,	4999-2 - R4999 24.00-32.67m,	**29-Oct-2014**	**19-Nov-2014**	29-Oct-2015	✓	**20-Nov-2014**	18-May-2015	✓
4999-3 - R4999 32.67-33.17m,	4999-4 - R4999 33.17-33.70m,							
4999-5 - R4999 33.70-34.20m,	4999-6 - R4999 34.20-37.00m,							
4999-7 - R4999 37.00-37.35m,	4999-8 - R4999 37.35-44.30m,							
4999-9 - R4999 44.30-44.60m,	4999-10 - R4999 44.60-48.00m,							
4999-11 - R4999 48.00-54.00m,	4999-12 - R4999 54.00-62.00m,							
4999-13 - R4999 62.00-62.45m,	4999-14 - R4999 66.63-67.00m							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** */ Client Sample ID(s)*		***Sample Date***	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA026 : Chromium Reducible Sulfur								
Pulp Bag (EA026)								
5003-1 - R5003 0.00-16.50m,	5003-2 - R5003 16.50-18.00m,	**01-Nov-2014**	**19-Nov-2014**	01-Nov-2015	✓	**20-Nov-2014**	17-Feb-2015	✓
5003-3 - R5003 18.00-75.50m,	5003-4 - R5003 75.50-76.11m,							
5003-5 - R5003 76.61-77.00m,	5003-6 - R5003 77.00-78.00m,							
5003-7 - R5003 78.00-79.00m,	5003-8 - R5003 79.00-82.00m,							
5003-9 - R5003 82.00-97.00m,	5003-10 - R5003 97.00-105.50m,							
5003-11 - R5003 105.50-108.50m,	5003-12 - R5003 108.50-109.08m,							
5003-13 - R5003 113.03-113.50m								
Pulp Bag (EA026)								
4466-21 - C4466 22.47-23.04m,	4466-22 - C4466 60.48-62.82m,	**03-Nov-2014**	**19-Nov-2014**	03-Nov-2015	✓	**20-Nov-2014**	17-Feb-2015	✓
4466-23 - C4466 64.21-64.73m,	4466-24 - C4466 67.78-68.15m,							
4466-25 - C4466 87.35-87.80m,	4466-26 - C4466 92.11-92.62m,							
4466-27 - C4466 97.15-97.59m								
Pulp Bag (EA026)								
4999-1 - R4999 0.00-24.00m,	4999-2 - R4999 24.00-32.67m,	**29-Oct-2014**	**19-Nov-2014**	29-Oct-2015	✓	**20-Nov-2014**	17-Feb-2015	✓
4999-3 - R4999 32.67-33.17m,	4999-4 - R4999 33.17-33.70m,							
4999-5 - R4999 33.70-34.20m,	4999-6 - R4999 34.20-37.00m,							
4999-7 - R4999 37.00-37.35m,	4999-8 - R4999 37.35-44.30m,							
4999-9 - R4999 44.30-44.60m,	4999-10 - R4999 44.60-48.00m,							
4999-11 - R4999 48.00-54.00m,	4999-12 - R4999 54.00-62.00m,							
4999-13 - R4999 62.00-62.45m,	4999-14 - R4999 66.63-67.00m							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA055: Moisture Content							
Soil Glass Jar - Unpreserved (EA055-103) 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	**01-Nov-2014**	**----**	----	----	**19-Nov-2014**	15-Nov-2014	×
Soil Glass Jar - Unpreserved (EA055-103) 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	**03-Nov-2014**	**----**	----	----	**19-Nov-2014**	17-Nov-2014	×
Soil Glass Jar - Unpreserved (EA055-103) 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	**29-Oct-2014**	**----**	----	----	**19-Nov-2014**	12-Nov-2014	×

Matrix: **SOIL**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED042T: Total Sulfur by LECO							
Pulp Bag (ED042T) 5003-1 - R5003 0.00-16.50m, 5003-2 - R5003 16.50-18.00m, 5003-3 - R5003 18.00-75.50m, 5003-4 - R5003 75.50-76.11m, 5003-5 - R5003 76.61-77.00m, 5003-6 - R5003 77.00-78.00m, 5003-7 - R5003 78.00-79.00m, 5003-8 - R5003 79.00-82.00m, 5003-9 - R5003 82.00-97.00m, 5003-10 - R5003 97.00-105.50m, 5003-11 - R5003 105.50-108.50m, 5003-12 - R5003 108.50-109.08m, 5003-13 - R5003 113.03-113.50m	**01-Nov-2014**	**18-Nov-2014**	08-Nov-2014	✗	**19-Nov-2014**	17-May-2015	✓
Pulp Bag (ED042T) 4466-21 - C4466 22.47-23.04m, 4466-22 - C4466 60.48-62.82m, 4466-23 - C4466 64.21-64.73m, 4466-24 - C4466 67.78-68.15m, 4466-25 - C4466 87.35-87.80m, 4466-26 - C4466 92.11-92.62m, 4466-27 - C4466 97.15-97.59m	**03-Nov-2014**	**18-Nov-2014**	10-Nov-2014	✗	**19-Nov-2014**	17-May-2015	✓
Pulp Bag (ED042T) 4999-1 - R4999 0.00-24.00m, 4999-2 - R4999 24.00-32.67m, 4999-3 - R4999 32.67-33.17m, 4999-4 - R4999 33.17-33.70m, 4999-5 - R4999 33.70-34.20m, 4999-6 - R4999 34.20-37.00m, 4999-7 - R4999 37.00-37.35m, 4999-8 - R4999 37.35-44.30m, 4999-9 - R4999 44.30-44.60m, 4999-10 - R4999 44.60-48.00m, 4999-11 - R4999 48.00-54.00m, 4999-12 - R4999 54.00-62.00m, 4999-13 - R4999 62.00-62.45m, 4999-14 - R4999 66.63-67.00m	**29-Oct-2014**	**18-Nov-2014**	05-Nov-2014	✗	**19-Nov-2014**	17-May-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acid Neutralising Capacity (ANC)	EA013	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chromium Reducible Sulphur	EA026	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Net Acid Generation	EA011	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Acid Neutralising Capacity (ANC)	EA013	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chromium Reducible Sulphur	EA026	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Net Acid Generation	EA011	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chromium Reducible Sulphur	EA026	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfur - Total as S (LECO)	ED042T	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH (1:5)	EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3) (Method 103)
Net Acid Production Potential	EA009	SOIL	Coastech Research (Canada)(Mod.). NAPP = Acid Production Potential (APP or MAP- Maximum Acid Potential) minus Neutralising Capacity (ANC). NAPP may be +ve, zero or -ve.
Electrical Conductivity (1:5)	EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3) (Method 104)
Net Acid Generation	EA011	SOIL	Miller (1998) Titremetric procedure determines net acidity in a soil following peroxide oxidation. Titrations to both pH 4.5 and pH 7 are reported.
Acid Neutralising Capacity (ANC)	EA013	SOIL	USEPA 600/2-78-054, I. Miller (2000). A fizz test is done to semiquanititatively estimate the likely reactivity. The soil is then reacted with an known excess quanitity of an appropriate acid. Titration determines the acid remaining, and the ANC can be calculated from comparison with a blank titration.
Chromium Reducible Sulphur	EA026	SOIL	Sullivan et al (1998) The CRS method converts reduced inorganic sulfur to H2S by CrCl2 solution ; the evolved H2S is trapped in a zinc acetate solution as ZnS which is quantified by iodometric titration.
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Sulfur - Total as S (LECO)	ED042T	SOIL	In-house. Dried and pulverised sample is combusted in a high temperature furnace in the presence of strong oxidants / catalysts. The evolved S (as SO2) is measured by infra-red detector

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Sieving (fine to -75µm)	GEO26G	SOIL	In-house. The sample is sieved to -75µm and the fines are then analysed per the client's request.
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

APPENDIX B ALS LABORATORY REPORTS - COMPOSITE SAMPLES

Chain of C

Environmental Division
Brisbane
Work Order
EB1422140
Telephone : +61-7-3243 7222

Submit samples to: ALS Environmental 07 3243 7222
2 Byth St, Stafford QLD

FROM: Tony Jong
URS Australia: Level 17, 240 Queen Street Brisbane QLD 4000
Contact: Tony Jong or Lawrie Duck
Ph: 07 3243 2119

RESULTS REQUIRED

Project Name: Ensham Coal Mine
Project No: 42427460
Project Manager: Tony Jong
Agreement No.: EN/001/14
Quote No.:

Sampler Name: Samples at ALS under EB1446022
Sampler Contact:

Released by: Tony Jong
Date: 2/12/2014 **Time:** 9:50

Received for Laboratory by:
Date: **Time:**

												Container Type, Preservative and Analysis								
												Container Identification								
											Type*	PsB	PsB	PsB	PsB	PsB	PsB	PsB	PsB	
											Preservative Code	none	none	none	none	none	none	none	none	
ALS Code	**Previous ALS Code**	**Client Sample Name**	**Date**	**Depth from (m)**	**Depth to (m)**	**Sample Interval (m)**	**Drill Hole**	**Sample Type**	**Lithology**	**URS Composite Number**	**Analytes**	Composting of samples (EN020)	ESP and CEC (ED007)	Exchangeable (Ca, Mg, Na, K) (ED007)	Four Acid 'Near Total' Digest with ICPAES/ICPMS finish (ME-MS61)	1:5 Leach (EN34)	Soluble Cations (Ca, Mg, Na, K) (NT-1S)	Soluble Anions (Major - Cl, SO4) on 1:5 Leach (NT-2S)	Soluble Al, As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, U, V, Zn on 1:5 Leach	**NOTES**
	EB1446022001 1	4999-1	2/12/2014	0.00	24.00	24.00	R4999	OB-fresh	Sandstone/Siltstone	ECM01	33	X	X	X	X	X	X	X	X	
	EB1446022002 2	4999-2	2/12/2014	24.00	32.67	8.67	R4999	OB-fresh	Sandstone/Siltstone											
	EB1446022017 3	5003-3	2/12/2014	18.00	75.50	57.50	R5003	OB - Fresh	Sandstone/Siltstone	ECM02	3	X	X	X	X	X	X	X	X	
	EB1446022006 4	4999-6	2/12/2014	34.20	37.00	2.80	R4999	Interburden	Siltstone	ECM03	34	X	X	X	X	X	X	X	X	
	EB1446022010 5	4999-10	2/12/2014	44.60	48.00	3.40	R4999	Interburden	Siltstone											
	EB1446022020 6	5003-6	2/12/2014	77.00	78.00	1.00	R5003	Interburden	Siltstone	ECM04	35	X	X	X	X	X	X	X	X	
	EB1446022022 7	5003-8	2/12/2014	79.00	82.00	3.00	R5003	Interburden	Siltstone											
	EB1446022024 8	5003-10	2/12/2014	97.00	105.50	8.50	R5003	Interburden	Siltstone											
	EB1446022008 9	4999-8	2/12/2014	37.35	44.30	6.95	R4999	Interburden	Sandstone/Siltstone	ECM05	36	X	X	X	X	X	X	X	X	
	EB1446022011 10	4999-11	2/12/2014	48.00	54.00	6.00	R4999	Interburden	Sandstone/Siltstone											
	EB1446022012 11	4999-12	2/12/2014	54.00	62.00	8.00	R4999	Interburden	Sandstone	ECM06	11	X	X	X	X	X	X	X	X	
	EB1446022025 12	5003-11	2/12/2014	105.50	108.50	3.00	R5003	Interburden	Sandstone/Siltstone	ECM07	12	X	X	X	X	X	X	X	X	
	EB1446022015 13	5003-1	2/12/2014	0.00	16.50	16.50	R5003	OB - Canozoic	Weathered Soils	ECM08	13	X	X	X	X	X	X	X	X	
	EB1446022016 14	5003-2	2/12/2014	16.50	18.00	1.50	R5003	OB - weathered	Sandstone	ECM09	14	X	X	X	X	X	X	X	X	
	EB1446022021 15	5003-7	2/12/2014	78.00	79.00	1.00	R5003	Interburden	Sandstone	ECM10	37	X	X	X	X	X	X	X	X	
	EB1446022023 16	5003-9	2/12/2014	82.00	97.00	15.00	R5003	Interburden	Sandstone											
	EB1446022028 17	4466-21	2/12/2014	22.47	23.04	0.57	C4466	OB - fresh	Sandstone	ECM11	38	X	X	X	X	X	X	X	X	
	EB1446022029 18	4466-22	2/12/2014	60.48	62.82	2.34	C4466	OB - fresh	Sandstone											
	EB1446022003 19	4999-3	2/12/2014	32.67	33.17	0.50	R4999	A1 roof	Carbonaceous Siltstone	ECM12	19	X	X	X	X	X	X	X	X	
	EB1446022004 20	4999-4	2/12/2014	33.17	33.70	0.53	R4999	A1 seam	Coal	ECM13	20	X	X	X	X	X	X	X	X	
	EB1446022005 21	4999-5	2/12/2014	33.70	34.20	0.50	R4999	A1 Floor	Carbonaceous Siltstone	ECM14	21	X	X	X	X	X	X	X	X	
	EB1446022007 22	4999-7	2/12/2014	37.00	37.35	0.35	R4999	A211 Horizon	Carbonaceous Mudstone	ECM15	39	X	X	X	X	X	X	X	X	
	EB1446022009 23	4999-9	2/12/2014	44.30	44.60	0.30	R4999	A212 horizon	Carbonaceous Mudstone											
	EB1446022013 24	4999-13	2/12/2014	62.00	62.45	0.45	R4999	A22C roof	Coaly Sandstone	ECM16	24	X	X	X	X	X	X	X	X	
	EB1446022014 25	4999-14	2/12/2014	66.63	67.00	0.37	R4999	A22C floor	Carbonaceous Siltstone	ECM17	25	X	X	X	X	X	X	X	X	
	EB1446022018 26	5003-4	2/12/2014	75.50	76.11	0.61	R5003	A1 roof	Siltstone/Carbonaceous Mudstone	ECM18	26	X	X	X	X	X	X	X	X	
	EB1446022019 27	5003-5	2/12/2014	76.61	77.00	0.39	R5003	A1 floor	Carbonaceous Siltstone	ECM19	40	X	X	X	X	X	X	X	X	
	EB1446022027 28	5003-13	2/12/2014	113.03	113.50	0.47	R5003	A22C floor	Carbonaceous Siltstone											
	EB1446022026 29	5003-12	2/12/2014	108.50	109.08	0.58	R5003	A22C roof	Sandstone	ECM20	29	X	X	X	X	X	X	X	X	
	EB1446022030 30	4466-23	2/12/2014	64.21	64.73	0.52	C4466	A1 floor	Carbonaceous Siltstone	ECM21	41	X	X	X	X	X	X	X	X	
	EB1446022034 31	4466-27	2/12/2014	97.15	97.59	0.44	C4466	A22C floor	Carbonaceous Sandstone											
	EB1446022033 32	4466-26	2/12/2014	92.11	92.62	0.51	C4466	A22C roof	Carbonaceous Sandstone	ECM22	32	X	X	X	X	X	X	X	X	
Remarks to Lab:		**Samples at ALS under EB1446022** **Please report 1:5 Leach concentrations in both mg/L and mg/kg**										22	22	22	22	22	22	22	22	

Courier Job No.

N/A - Samples on hand

* Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; PsB = Neutral Plastic Bag

Email Results to: tony.jong@urs.com lawrie.duck@urs.com

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order : **EB1422140**

Client	: **URS AUSTRALIA PTY LTD (QLD)**	Laboratory	: Environmental Division Brisbane
Contact	: DR TONY JONG	Contact	: Rebecca Kleinschmidt
Address	: LEVEL 14, 240 QUEEN STREET GPO BOX 302 BRISBANE QLD, AUSTRALIA 4001	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: tony.jong@urs.com	E-mail	: rebecca.kleinschmidt@alsglobal.com
Telephone	: +61 07 3243 2119	Telephone	: +61 3552 8668
Facsimile	: +61 07 32432199	Facsimile	: +61 7 3352 3662
Project	: 42427460 Ensham Coal Mine	Page	: 1 of 4
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2014URSQLD0355 (EN/001/14)
Site	: ----		
Sampler	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 02-DEC-2014	Issue Date	: 10-DEC-2014 12:52
Client Requested Due Date	: 09-DEC-2014	Scheduled Reporting Date	: **19-DEC-2014**

Delivery Details

Mode of Delivery	: Samples on hand	Temperature	: 4.0°C
No. of coolers/boxes	: REBATCH	No. of samples received	: 41
Security Seal	: N/A	No. of samples analysed	: 22

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- ***SRN Reissued 10/12/14: This SRN has been reissued to reflect the ID change of ALS sample 19 from 'ECM22' to 'ECM12'.**
- ***SRN Reissued 05/12/14: SRN has been resent to acknowledge changes to sampling dates, these have been adjusted as per COC.**
- **This is a rebatch of EB1446022.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' etc. suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com)
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958),
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Any sample identifications that cannot be displayed entirely in the analysis summary table will be listed below.

EB1422140-001	: 02-DEC-2014 15:00	: 4999-1 - R4999 0.00-24.00m
EB1422140-002	: 02-DEC-2014 15:00	: 4999-2 - R4999 24.00-32.67m
EB1422140-003	: 02-DEC-2014 15:00	: (ECM02) 5003-3 - R5003 18.00-75.50m
EB1422140-004	: 02-DEC-2014 15:00	: 4999-6 - R4999 34.20-37.00m
EB1422140-005	: 02-DEC-2014 15:00	: 4999-10 - R4999 44.60-48.00m
EB1422140-006	: 02-DEC-2014 15:00	: 5003-6 - R5003 77.00-78.00m
EB1422140-007	: 02-DEC-2014 15:00	: 5003-8 - R5003 79.00-82.00m
EB1422140-008	: 02-DEC-2014 15:00	: 5003-10 - R5003 97.00-105.50m
EB1422140-009	: 02-DEC-2014 15:00	: 4999-8 - R4999 37.35-44.30m
EB1422140-010	: 02-DEC-2014 15:00	: 4999-11 - R4999 48.00-54.00m
EB1422140-011	: 02-DEC-2014 15:00	: (ECM06) 4999-12 - R4999 54.00-62.00m
EB1422140-012	: 02-DEC-2014 15:00	: (ECM07) 5003-11 - R5003 105.50-108.50m
EB1422140-013	: 02-DEC-2014 15:00	: (ECM08) 5003-1 - R5003 0.00-16.50m
EB1422140-014	: 02-DEC-2014 15:00	: (ECM09) 5003-2 - R5003 16.50-18.00m
EB1422140-015	: 02-DEC-2014 15:00	: 5003-7 - R5003 78.00-79.00m
EB1422140-016	: 02-DEC-2014 15:00	: 5003-9 - R5003 82.00-97.00m
EB1422140-017	: 02-DEC-2014 15:00	: 4466-21 - C4466 22.47-23.04m
EB1422140-018	: 02-DEC-2014 15:00	: 4466-22 - C4466 60.48-62.82m
EB1422140-019	: 02-DEC-2014 15:00	: (ECM12) 4999-3 - R4999 32.67-33.17m
EB1422140-020	: 02-DEC-2014 15:00	: (ECM13) 4999-4 - R4999 33.17-33.70m
EB1422140-021	: 02-DEC-2014 15:00	: (ECM14) 4999-5 - R4999 33.70-34.20m
EB1422140-022	: 02-DEC-2014 15:00	: 4999-7 - R4999 37.00-37.35m
EB1422140-023	: 02-DEC-2014 15:00	: 4999-9 - R4999 44.30-44.60m
EB1422140-024	: 02-DEC-2014 15:00	: (ECM16) 4999-13 - R4999 62.00-62.45m
EB1422140-025	: 02-DEC-2014 15:00	: (ECM17) 4999-14 - R4999 66.63-67.00m
EB1422140-026	: 02-DEC-2014 15:00	: (ECM18) 5003-4 - R5003 75.50-76.11m
EB1422140-027	: 02-DEC-2014 15:00	: 5003-5 - R5003 76.61-77.00m
EB1422140-028	: 02-DEC-2014 15:00	: 5003-13 - R5003 113.03-113.50m
EB1422140-029	: 02-DEC-2014 15:00	: (ECM20) 5003-12 - R5003 108.50-109.08m
EB1422140-030	: 02-DEC-2014 15:00	: 4466-23 - C4466 64.21-64.73m
EB1422140-031	: 02-DEC-2014 15:00	: 4466-27 - C4466 97.15-97.59m
EB1422140-032	: 02-DEC-2014 15:00	: (ECM22) 4466-26 - C4466 92.11-92.62m

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	(On Hold) SOIL No analysis requested	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - EG005S Soluble Metals by ICPAES	SOIL - EG020S Soluble Metals by ICPMS	SOIL - ME-MS61 (Subcontracted) Merged 4-Acid Metals package	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1422140-001	02-DEC-2014 15:00	4999-1 R4999 0.00-2...	✓						
EB1422140-002	02-DEC-2014 15:00	4999-2 R4999 24.00-...	✓						
EB1422140-003	02-DEC-2014 15:00	(ECM02) 5003-3 R500...		✓	✓	✓	✓	✓	✓
EB1422140-004	02-DEC-2014 15:00	4999-6 R4999 34.20-...	✓						
EB1422140-005	02-DEC-2014 15:00	4999-10 R4999 44.60...	✓						
EB1422140-006	02-DEC-2014 15:00	5003-6 R5003 77.00-...	✓						
EB1422140-007	02-DEC-2014 15:00	5003-8 R5003 79.00-...	✓						

			(On Hold) SOIL No analysis requested	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - EG005S Soluble Metals by ICPAES	SOIL - EG020S Soluble Metals by ICPMS	SOIL - ME-MS61 (Subcontracted) Merged 4-Acid Metals package	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1422140-008	02-DEC-2014 15:00	5003-10 R5003 97.00...	✓						
EB1422140-009	02-DEC-2014 15:00	4999-8 R4999 37.35-...	✓						
EB1422140-010	02-DEC-2014 15:00	4999-11 R4999 48.00...	✓						
EB1422140-011	02-DEC-2014 15:00	(ECM06) 4999-12 R49...		✓	✓	✓	✓	✓	✓
EB1422140-012	02-DEC-2014 15:00	(ECM07) 5003-11 R50...		✓	✓	✓	✓	✓	✓
EB1422140-013	02-DEC-2014 15:00	(ECM08) 5003-1 R500...		✓	✓	✓	✓	✓	✓
EB1422140-014	02-DEC-2014 15:00	(ECM09) 5003-2 R500...		✓	✓	✓	✓	✓	✓
EB1422140-015	02-DEC-2014 15:00	5003-7 R5003 78.00-...	✓						
EB1422140-016	02-DEC-2014 15:00	5003-9 R5003 82.00-...	✓						
EB1422140-017	02-DEC-2014 15:00	4466-21 C4466 22.47...	✓						
EB1422140-018	02-DEC-2014 15:00	4466-22 C4466 60.48...	✓						
EB1422140-019	02-DEC-2014 15:00	(ECM12) 4999-3 R499...		✓	✓	✓	✓	✓	✓
EB1422140-020	02-DEC-2014 15:00	(ECM13) 4999-4 R499...		✓	✓	✓	✓	✓	✓
EB1422140-021	02-DEC-2014 15:00	(ECM14) 4999-5 R499...		✓	✓	✓	✓	✓	✓
EB1422140-022	02-DEC-2014 15:00	4999-7 R4999 37.00-...	✓						
EB1422140-023	02-DEC-2014 15:00	4999-9 R4999 44.30-...	✓						
EB1422140-024	02-DEC-2014 15:00	(ECM16) 4999-13 R49...		✓	✓	✓	✓	✓	✓
EB1422140-025	02-DEC-2014 15:00	(ECM17) 4999-14 R49...		✓	✓	✓	✓	✓	✓
EB1422140-026	02-DEC-2014 15:00	(ECM18) 5003-4 R500...		✓	✓	✓	✓	✓	✓
EB1422140-027	02-DEC-2014 15:00	5003-5 R5003 76.61-...	✓						
EB1422140-028	02-DEC-2014 15:00	5003-13 R5003 113.0...	✓						
EB1422140-029	02-DEC-2014 15:00	(ECM20) 5003-12 R50...		✓	✓	✓	✓	✓	✓
EB1422140-030	02-DEC-2014 15:00	4466-23 C4466 64.21...	✓						
EB1422140-031	02-DEC-2014 15:00	4466-27 C4466 97.15...	✓						
EB1422140-032	02-DEC-2014 15:00	(ECM22) 4466-26 C44...		✓	✓	✓	✓	✓	✓
EB1422140-033	02-DEC-2014 15:00	ECM01		✓	✓	✓	✓	✓	✓
EB1422140-034	02-DEC-2014 15:00	ECM03		✓	✓	✓	✓	✓	✓
EB1422140-035	02-DEC-2014 15:00	ECM04		✓	✓	✓	✓	✓	✓
EB1422140-036	02-DEC-2014 15:00	ECM05		✓	✓	✓	✓	✓	✓
EB1422140-037	02-DEC-2014 15:00	ECM10		✓	✓	✓	✓	✓	✓
EB1422140-038	02-DEC-2014 15:00	ECM11		✓	✓	✓	✓	✓	✓
EB1422140-039	02-DEC-2014 15:00	ECM15		✓	✓	✓	✓	✓	✓
EB1422140-040	02-DEC-2014 15:00	ECM19		✓	✓	✓	✓	✓	✓
EB1422140-041	02-DEC-2014 15:00	ECM21		✓	✓	✓	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

DR LAWRIE DUCK

- *AU Certificate of Analysis - NATA	Email	lawrie.duck@urs.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep)	Email	lawrie.duck@urs.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA	Email	lawrie.duck@urs.com
- A4 - AU Sample Receipt Notification - Environmental HT	Email	lawrie.duck@urs.com
- Attachment - Report (SUBCO)	Email	lawrie.duck@urs.com
- Chain of Custody (CoC)	Email	lawrie.duck@urs.com
- EDI Format - ENMRG	Email	lawrie.duck@urs.com
- EDI Format - EQUIS V5 URS	Email	lawrie.duck@urs.com
- EDI Format - ESDAT	Email	lawrie.duck@urs.com
- EDI Format - MRED	Email	lawrie.duck@urs.com

DR TONY JONG

- *AU Certificate of Analysis - NATA (COA)	Email	tony.jong@urs.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	tony.jong@urs.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	tony.jong@urs.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	tony.jong@urs.com
- Attachment - Report (SUBCO)	Email	tony.jong@urs.com
- Chain of Custody (CoC) (COC)	Email	tony.jong@urs.com
- EDI Format - ENMRG (ENMRG)	Email	tony.jong@urs.com
- EDI Format - EQUIS V5 URS (EQUIS_V5_URS)	Email	tony.jong@urs.com
- EDI Format - ESDAT (ESDAT)	Email	tony.jong@urs.com
- EDI Format - MRED (MRED)	Email	tony.jong@urs.com

THE ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	APAC.ap@urs.com

CERTIFICATE OF ANALYSIS

Work Order	: **EB1422140**	Page	: 1 of 16
Amendment	: **1**		
Client	: **URS AUSTRALIA PTY LTD (QLD)**	Laboratory	: Environmental Division Brisbane
Contact	: DR TONY JONG	Contact	: Rebecca Kleinschmidt
Address	: LEVEL 14, 240 QUEEN STREET GPO BOX 302 BRISBANE QLD, AUSTRALIA 4001	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: tony.jong@urs.com	E-mail	: rebecca.kleinschmidt@alsglobal.com
Telephone	: +61 07 3243 2119	Telephone	: +61 3552 8668
Facsimile	: +61 07 32432199	Facsimile	: +61 7 3352 3662
Project	: 42427460 Ensham Coal Mine	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 02-DEC-2014
Sampler	: ----	Issue Date	: 09-JAN-2015
Site	: ----		
		No. of samples received	: 63
Quote number	: EN/001/14	No. of samples analysed	: 44

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Greg Vogel	Laboratory Manager	Brisbane Inorganics

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

- **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) is a more suitable method for the determination of exchange acidity (H+ + Al3+).**
- **This report has been amended and re-released to allow the reporting of additional analytical data. Soluble results have now also been provided in mg/L.**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	(ECM02) 5003-3 R5003 18.00-75.50m	(ECM06) 4999-12 R4999 54.00-62.00m	(ECM07) 5003-11 R5003 105.50-108.50m	(ECM08) 5003-1 R5003 0.00-16.50m	(ECM09) 5003-2 R5003 16.50-18.00m
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-003**	**EB1422140-011**	**EB1422140-012**	**EB1422140-013**	**EB1422140-014**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	<1.0	<1.0	<1.0	<1.0
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**18.8**	**23.1**	**20.0**	**4.6**	**0.6**
Exchangeable Magnesium	----	0.1	meq/100g	**2.7**	**3.6**	**2.7**	**4.1**	**0.4**
Exchangeable Potassium	----	0.1	meq/100g	**0.5**	**0.4**	**0.4**	**0.3**	<0.1
Exchangeable Sodium	----	0.1	meq/100g	**2.9**	**4.2**	**4.1**	**3.6**	**0.2**
Cation Exchange Capacity	----	0.1	meq/100g	**25.0**	**31.4**	**27.2**	**12.6**	**1.2**
Exchangeable Sodium Percent	----	0.1	%	**11.6**	**13.3**	**15.0**	**28.4**	**18.6**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**100**	**140**	**140**	**310**	**20**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**400**	**530**	**430**	**830**	**60**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**10**	<10	<10	**20**	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	**20**	<10
Sodium	7440-23-5	10	mg/kg	**440**	**630**	**610**	**670**	**60**
Potassium	7440-09-7	10	mg/kg	**30**	**30**	**20**	**20**	<10
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	<0.1	**0.1**	**0.6**	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	**0.4**	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**(ECM02) 5003-3 R5003 18.00-75.50m**	**(ECM06) 4999-12 R4999 54.00-62.00m**	**(ECM07) 5003-11 R5003 105.50-108.50m**	**(ECM08) 5003-1 R5003 0.00-16.50m**	**(ECM09) 5003-2 R5003 16.50-18.00m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	CAS Number	LOR	Unit	**EB1422140-003**	**EB1422140-011**	**EB1422140-012**	**EB1422140-013**	**EB1422140-014**
EG005S : Soluble Metals by ICPAES - Continued								
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	(ECM12) 4999-3 R4999 32.67-33.17m	(ECM13) 4999-4 R4999 33.17-33.70m	(ECM14) 4999-5 R4999 33.70-34.20m	(ECM16) 4999-13 R4999 62.00-62.45m	(ECM17) 4999-14 R4999 66.63-67.00m
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	CAS Number	LOR	Unit	EB1422140-019	EB1422140-020	EB1422140-021	EB1422140-024	EB1422140-025
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	1.0	1.7	1.1	1.5	1.9
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	14.7	8.4	8.3	18.5	13.6
Exchangeable Magnesium	----	0.1	meq/100g	3.1	0.9	3.5	3.4	3.8
Exchangeable Potassium	----	0.1	meq/100g	0.4	<0.1	0.5	0.3	0.5
Exchangeable Sodium	----	0.1	meq/100g	3.9	2.0	4.0	3.9	4.9
Cation Exchange Capacity	----	0.1	meq/100g	22.1	11.4	16.4	26.1	22.9
Exchangeable Sodium Percent	----	0.1	%	17.7	17.8	24.7	14.9	21.6
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	190	190	200	160	180
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	820	1180	460	700	340
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	20	240	<10	20	<10
Magnesium	7439-95-4	10	mg/kg	<10	70	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	730	720	520	710	600
Potassium	7440-09-7	10	mg/kg	30	30	20	30	20
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	0.3	<0.1	1.0	0.2	0.3
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	0.6	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	0.8	<0.1	0.3	<0.1	0.2
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	0.1	0.1	<0.1	0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**(ECM12) 4999-3 R4999 32.67-33.17m**	**(ECM13) 4999-4 R4999 33.17-33.70m**	**(ECM14) 4999-5 R4999 33.70-34.20m**	**(ECM16) 4999-13 R4999 62.00-62.45m**	**(ECM17) 4999-14 R4999 66.63-67.00m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	CAS Number	LOR	Unit	**EB1422140-019**	**EB1422140-020**	**EB1422140-021**	**EB1422140-024**	**EB1422140-025**
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**(ECM18) 5003-4 R5003 75.50-76.11m**	**(ECM20) 5003-12 R5003 108.50-109.08m**	**(ECM22) 4466-26 C4466 92.11-92.62m**	**ECM01**	**ECM03**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-026**	**EB1422140-029**	**EB1422140-032**	**EB1422140-033**	**EB1422140-034**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**1.6**	**1.1**	<1.0	<1.0	**1.0**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**12.0**	**20.0**	**17.7**	**21.1**	**12.6**
Exchangeable Magnesium	----	0.1	meq/100g	**2.9**	**2.0**	**3.8**	**2.6**	**3.3**
Exchangeable Potassium	----	0.1	meq/100g	**0.4**	**0.2**	**0.3**	**0.4**	**0.6**
Exchangeable Sodium	----	0.1	meq/100g	**3.9**	**3.2**	**3.6**	**3.1**	**4.8**
Cation Exchange Capacity	----	0.1	meq/100g	**19.3**	**25.4**	**25.6**	**27.3**	**21.4**
Exchangeable Sodium Percent	----	0.1	%	**20.2**	**12.5**	**14.2**	**11.4**	**22.7**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**130**	**120**	**120**	**100**	**180**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**340**	**480**	**130**	**580**	**560**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	**20**	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**460**	**580**	**470**	**550**	**610**
Potassium	7440-09-7	10	mg/kg	**20**	**20**	**10**	**40**	**30**
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	**1**	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	**0.6**	**0.6**	<0.1	**0.2**	**0.5**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	**0.2**	**0.2**	<0.1	<0.1	**0.3**
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**(ECM18) 5003-4 R5003 75.50-76.11m**	**(ECM20) 5003-12 R5003 108.50-109.08m**	**(ECM22) 4466-26 C4466 92.11-92.62m**	**ECM01**	**ECM03**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-026**	**EB1422140-029**	**EB1422140-032**	**EB1422140-033**	**EB1422140-034**
EG005S : Soluble Metals by ICPAES - Continued								
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**ECM04**	**ECM05**	**ECM10**	**ECM11**	**ECM15**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-035**	**EB1422140-036**	**EB1422140-037**	**EB1422140-038**	**EB1422140-039**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**1.0**	<1.0	<1.0	<1.0	<1.0
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**10.2**	**23.6**	**15.4**	**10.7**	**13.7**
Exchangeable Magnesium	----	0.1	meq/100g	**3.1**	**3.8**	**3.0**	**5.0**	**3.2**
Exchangeable Potassium	----	0.1	meq/100g	**0.6**	**0.6**	**0.5**	**0.5**	**0.5**
Exchangeable Sodium	----	0.1	meq/100g	**4.9**	**5.3**	**4.2**	**2.6**	**4.5**
Cation Exchange Capacity	----	0.1	meq/100g	**18.9**	**33.4**	**23.1**	**18.9**	**21.9**
Exchangeable Sodium Percent	----	0.1	%	**26.0**	**15.9**	**18.0**	**13.9**	**20.5**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**140**	**150**	**110**	**80**	**120**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**430**	**510**	**320**	**60**	**580**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**520**	**610**	**480**	**240**	**600**
Potassium	7440-09-7	10	mg/kg	**20**	**20**	**20**	**10**	**20**
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	**1**	**2**	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	**0.5**	**0.3**	**0.9**	**0.4**	**0.3**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	**0.2**	**0.1**	**0.2**	**0.1**	**0.1**
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	**0.1**	<0.1	**0.2**	**0.1**	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**ECM04**	**ECM05**	**ECM10**	**ECM11**	**ECM15**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	CAS Number	LOR	Unit	**EB1422140-035**	**EB1422140-036**	**EB1422140-037**	**EB1422140-038**	**EB1422140-039**
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**ECM19**	**ECM21**	**(ECM02) 5003-3 R5003 18.00-75.50m**	**(ECM06) 4999-12 R4999 54.00-62.00m**	**(ECM07) 5003-11 R5003 105.50-108.50m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-040**	**EB1422140-041**	**EB1422140-042**	**EB1422140-043**	**EB1422140-044**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	<1.0	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**7.4**	**7.0**	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	**3.1**	**4.0**	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	**0.5**	**0.6**	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	**5.0**	**4.9**	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	**16.0**	**16.6**	----	----	----
Exchangeable Sodium Percent	----	0.1	%	**31.5**	**29.7**	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**150**	**160**	----	----	----
Sulfate as SO4 2-	14808-79-8	10	mg/L	----	----	**20**	**30**	**30**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**560**	**70**	----	----	----
Chloride	16887-00-6	10	mg/L	----	----	**80**	**110**	**90**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	----	----	----
Calcium	7440-70-2	10	mg/L	----	----	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	----	----	----
Magnesium	7439-95-4	10	mg/L	----	----	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**500**	**210**	----	----	----
Sodium	7440-23-5	10	mg/L	----	----	**90**	**130**	**120**
Potassium	7440-09-7	10	mg/kg	**10**	<10	----	----	----
Potassium	7440-09-7	10	mg/L	----	----	<10	<10	<10
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	**2**	----	----	----
Aluminium	7429-90-5	1	mg/L	----	----	<1	<1	<1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	----	----	----
Antimony	7440-36-0	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/kg	**0.5**	**1.1**	----	----	----
Arsenic	7440-38-2	0.1	mg/L	----	----	<0.1	<0.1	**0.1**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	----	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**

			Client sample ID	**ECM19**	**ECM21**	**(ECM02) 5003-3** **R5003 18.00-75.50m**	**(ECM06) 4999-12** **R4999 54.00-62.00m**	**(ECM07) 5003-11** **R5003 105.50-108.50m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-040**	**EB1422140-041**	**EB1422140-042**	**EB1422140-043**	**EB1422140-044**
EG005S : Soluble Metals by ICPAES - Continued								
Cadmium	7440-43-9	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	----	----	----
Chromium	7440-47-3	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	----	----	----
Cobalt	7440-48-4	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	----	----	----
Copper	7440-50-8	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/kg	<1	<1	----	----	----
Iron	7439-89-6	1	mg/L	----	----	<1	<1	<1
Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	----	----	----
Lead	7439-92-1	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	----	----	----
Manganese	7439-96-5	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/kg	**0.4**	**0.2**	----	----	----
Molybdenum	7439-98-7	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	----	----	----
Nickel	7440-02-0	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/kg	<0.1	**0.2**	----	----	----
Selenium	7782-49-2	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/kg	<0.1	**0.2**	----	----	----
Vanadium	7440-62-2	0.1	mg/L	----	----	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	----	----	----
Zinc	7440-66-6	0.1	mg/L	----	----	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Uranium	7440-61-1	0.01	mg/L	----	----	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**(ECM08) 5003-1** **R5003 0.00-16.50m**	**(ECM09) 5003-2** **R5003 16.50-18.00m**	**(ECM12) 4999-3** **R4999 32.67-33.17m**	**(ECM13) 4999-4** **R4999 33.17-33.70m**	**(ECM14) 4999-5** **R4999 33.70-34.20m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-045**	**EB1422140-046**	**EB1422140-047**	**EB1422140-048**	**EB1422140-049**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/L	**60**	<10	**40**	**40**	**40**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/L	**170**	**10**	**160**	**240**	**90**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/L	<10	<10	<10	**50**	<10
Magnesium	7439-95-4	10	mg/L	<10	<10	<10	**10**	<10
Sodium	7440-23-5	10	mg/L	**130**	**10**	**150**	**140**	**100**
Potassium	7440-09-7	10	mg/L	<10	<10	<10	<10	<10
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/L	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	**0.2**
Cadmium	7440-43-9	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/L	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/L	<0.1	<0.1	**0.1**	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/L	<0.1	<0.1	**0.2**	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**(ECM16) 4999-13** **R4999 62.00-62.45m**	**(ECM17) 4999-14** **R4999 66.63-67.00m**	**(ECM18) 5003-4** **R5003 75.50-76.11m**	**(ECM20) 5003-12** **R5003 108.50-109.08m**	**(ECM22) 4466-26** **C4466 92.11-92.62m**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1422140-050**	**EB1422140-051**	**EB1422140-052**	**EB1422140-053**	**EB1422140-054**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/L	**30**	**40**	**30**	**20**	**20**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/L	**140**	**70**	**70**	**100**	**30**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/L	<10	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/L	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/L	**140**	**120**	**90**	**120**	**90**
Potassium	7440-09-7	10	mg/L	<10	<10	<10	<10	<10
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/L	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/L	<0.1	<0.1	**0.1**	**0.1**	<0.1
Cadmium	7440-43-9	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/L	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**ECM01**	**ECM03**	**ECM04**	**ECM05**	**ECM10**
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00
Compound	CAS Number	LOR	Unit	**EB1422140-055**	**EB1422140-056**	**EB1422140-057**	**EB1422140-058**	**EB1422140-059**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/L	**20**	**40**	**30**	**30**	**20**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/L	**120**	**110**	**90**	**100**	**60**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/L	<10	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/L	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/L	**110**	**120**	**100**	**120**	**100**
Potassium	7440-09-7	10	mg/L	<10	<10	<10	<10	<10
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/L	<1	<1	<1	<1	<1
Antimony	7440-36-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	7440-38-2	0.1	mg/L	<0.1	**0.1**	**0.1**	<0.1	**0.2**
Cadmium	7440-43-9	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	7439-89-6	1	mg/L	<1	<1	<1	<1	<1
Lead	7439-92-1	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	7439-96-5	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	7439-98-7	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	7440-02-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	7782-49-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**ECM11**	**ECM15**	**ECM19**	**ECM21**	----
			Client sampling date / time	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	02-DEC-2014 15:00	----
Compound	CAS Number	LOR	Unit	**EB1422140-060**	**EB1422140-061**	**EB1422140-062**	**EB1422140-063**	**----**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/L	**20**	**20**	**30**	**30**	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/L	**10**	**120**	**110**	**10**	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/L	<10	<10	<10	<10	----
Magnesium	7439-95-4	10	mg/L	<10	<10	<10	<10	----
Sodium	7440-23-5	10	mg/L	**50**	**120**	**100**	**40**	----
Potassium	7440-09-7	10	mg/L	<10	<10	<10	<10	----
EG005S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/L	<1	<1	<1	<1	----
Antimony	7440-36-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Arsenic	7440-38-2	0.1	mg/L	<0.1	**0.1**	**0.1**	**0.2**	----
Cadmium	7440-43-9	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Chromium	7440-47-3	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Cobalt	7440-48-4	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Copper	7440-50-8	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Iron	7439-89-6	1	mg/L	<1	<1	<1	<1	----
Lead	7439-92-1	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Manganese	7439-96-5	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Molybdenum	7439-98-7	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Nickel	7440-02-0	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Selenium	7782-49-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Vanadium	7440-62-2	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
EG020S: Soluble Metals by ICPMS								
Uranium	7440-61-1	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order : **EB1422140**
Amendment : **1**

Client : **URS AUSTRALIA PTY LTD (QLD)**
Contact : DR TONY JONG
Address : LEVEL 14, 240 QUEEN STREET
GPO BOX 302
BRISBANE QLD, AUSTRALIA 4001

E-mail : tony.jong@urs.com
Telephone : +61 07 3243 2119
Facsimile : +61 07 32432199

Project : 42427460 Ensham Coal Mine
Site : ----
C-O-C number : ----
Sampler : ----
Order number : ----

Quote number : EN/001/14

Page : 1 of 11

Laboratory : Environmental Division Brisbane
Contact : Rebecca Kleinschmidt
Address : 2 Byth Street Stafford QLD Australia 4053

E-mail : rebecca.kleinschmidt@alsglobal.com
Telephone : +61 3552 8668
Facsimile : +61 7 3352 3662

QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Date Samples Received : 02-DEC-2014
Issue Date : 09-JAN-2015

No. of samples received : 63
No. of samples analysed : 44

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Greg Vogel	Laboratory Manager	Brisbane Inorganics

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.

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	***Client sample ID***	***Method: Compound***	***CAS Number***	***LOR***	***Unit***	***Original Result***	***Duplicate Result***	***RPD (%)***	***Recovery Limits (%)***
EA055: Moisture Content (QC Lot: 3745587)									
EB1422140-013	(ECM08) 5003-1 R5003 0.00-16.50m	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	<1.0	<1.0	0.0	No Limit
EB1422140-026	(ECM18) 5003-4 R5003 75.50-76.11m	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	1.6	1.8	12.1	No Limit
ED007: Exchangeable Cations (QC Lot: 3744043)									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	ED007: Exchangeable Calcium	----	0.1	meq/100g	18.8	18.3	2.2	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	2.7	2.7	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	2.9	2.8	0.0	0% - 20%
EB1422140-024	(ECM16) 4999-13 R4999 62.00-62.45m	ED007: Exchangeable Calcium	----	0.1	meq/100g	18.5	19.0	3.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	3.4	3.5	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.3	0.3	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	3.9	4.0	4.5	0% - 20%
ED007: Exchangeable Cations (QC Lot: 3744044)									
EB1422140-040	ECM19	ED007: Exchangeable Calcium	----	0.1	meq/100g	7.4	7.4	0.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	3.1	3.1	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	5.0	5.0	0.0	0% - 20%
ED040S: Soluble Major Anions (QC Lot: 3744000)									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	100	100	0.0	0% - 50%
EB1422140-029	(ECM20) 5003-12 R5003 108.50-109.08m	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	120	110	11.4	0% - 50%
ED040S: Soluble Major Anions (QC Lot: 3745589)									
EB1422140-033	ECM01	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	100	100	0.0	0% - 50%
ED040S: Soluble Major Anions (QC Lot: 3768415)									
EB1422140-042	(ECM02) 5003-3 R5003 18.00-75.50m	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	20	0.0	No Limit
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	40	40	0.0	No Limit
ED040S: Soluble Major Anions (QC Lot: 3768420)									
EB1422140-062	ECM19	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	30	30	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 3744004)									

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 3744004) - continued									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	ED045G: Chloride	16887-00-6	10	mg/kg	400	440	9.1	0% - 20%
EB1422140-029	(ECM20) 5003-12 R5003 108.50-109.08m	ED045G: Chloride	16887-00-6	10	mg/kg	480	490	0.0	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 3745593)									
EB1422140-033	ECM01	ED045G: Chloride	16887-00-6	10	mg/kg	580	580	0.0	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 3768419)									
EB1422140-042	(ECM02) 5003-3 R5003 18.00-75.50m	ED045G: Chloride	16887-00-6	10	mg/kg	80	80	0.0	0% - 20%
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	ED045G: Chloride	16887-00-6	10	mg/kg	70	70	0.0	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 3768424)									
EB1422140-062	ECM19	ED045G: Chloride	16887-00-6	10	mg/kg	110	110	0.0	0% - 20%
ED093S: Soluble Major Cations (QC Lot: 3744002)									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	ED093S: Calcium	7440-70-2	10	mg/kg	10	20	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	440	470	7.7	0% - 20%
		ED093S: Potassium	7440-09-7	10	mg/kg	30	40	0.0	No Limit
EB1422140-029	(ECM20) 5003-12 R5003 108.50-109.08m	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	580	560	3.4	0% - 20%
		ED093S: Potassium	7440-09-7	10	mg/kg	20	20	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 3745591)									
EB1422140-033	ECM01	ED093S: Calcium	7440-70-2	10	mg/kg	20	20	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	550	540	0.0	0% - 20%
		ED093S: Potassium	7440-09-7	10	mg/kg	40	40	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 3768417)									
EB1422140-042	(ECM02) 5003-3 R5003 18.00-75.50m	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	90	90	0.0	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	120	120	0.0	0% - 50%
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED093S: Soluble Major Cations (QC Lot: 3768422)									
EB1422140-062	ECM19	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	100	100	0.0	0% - 50%
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit
EG005S : Soluble Metals by ICPAES (QC Lot: 3744001)									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EB1422140-029	(ECM20) 5003-12 R5003 108.50-109.08m	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	0.6	0.5	0.0	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	0.2	0.2	0.0	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EG005S : Soluble Metals by ICPAES (QC Lot: 3745590)									
EB1422140-033	ECM01	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	0.2	0.2	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005S : Soluble Metals by ICPAES (QC Lot: 3745590) - continued									
EB1422140-033	ECM01	EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EG005S : Soluble Metals by ICPAES (QC Lot: 3768416)									
EB1422140-042	(ECM02) 5003-3 R5003 18.00-75.50m	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005S : Soluble Metals by ICPAES (QC Lot: 3768416) - continued									
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EG005S : Soluble Metals by ICPAES (QC Lot: 3768421)									
EB1422140-062	ECM19	EG005S: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Arsenic	7440-38-2	0.1	mg/kg	0.1	0.1	0.0	No Limit
		EG005S: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Chromium	7440-47-3	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Cobalt	7440-48-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Copper	7440-50-8	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Lead	7439-92-1	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Manganese	7439-96-5	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Nickel	7440-02-0	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Zinc	7440-66-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG005S: Aluminium	7429-90-5	1	mg/kg	<1	<1	0.0	No Limit
		EG005S: Iron	7439-89-6	1	mg/kg	<1	<1	0.0	No Limit
EG020S: Soluble Metals by ICPMS (QC Lot: 3744003)									
EB1422140-003	(ECM02) 5003-3 R5003 18.00-75.50m	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EB1422140-029	(ECM20) 5003-12 R5003 108.50-109.08m	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EG020S: Soluble Metals by ICPMS (QC Lot: 3745592)									
EB1422140-033	ECM01	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EG020S: Soluble Metals by ICPMS (QC Lot: 3768418)									
EB1422140-042	(ECM02) 5003-3 R5003 18.00-75.50m	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EB1422140-051	(ECM17) 4999-14 R4999 66.63-67.00m	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EG020S: Soluble Metals by ICPMS (QC Lot: 3768423)									
EB1422140-062	ECM19	EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED007: Exchangeable Cations (QCLot: 3744043)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	94.4	79	113
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	96.7	85	115
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	93.4	70	122
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	87.5	76	112
ED007: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	93.8	82	112
ED007: Exchangeable Cations (QCLot: 3744044)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	1 meq/100g	101	79	113
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.67 meq/100g	102	85	115
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.52 meq/100g	97.8	70	122
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.87 meq/100g	91.7	76	112
ED007: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	4.06 meq/100g	99.2	82	112
ED040S: Soluble Major Anions (QCLot: 3744000)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	97.6	90	114
ED040S: Soluble Major Anions (QCLot: 3745589)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	500 mg/kg	97.3	90	114
ED040S: Soluble Major Anions (QCLot: 3768415)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	0	500 mg/kg	97.3	90	114
ED040S: Soluble Major Anions (QCLot: 3768420)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	0	500 mg/kg	97.3	90	114
ED045G: Chloride by Discrete Analyser (QCLot: 3744004)								
ED045G: Chloride	16887-00-6	10	mg/kg	----	50 mg/kg	106	83	115
				<10	5000 mg/kg	107	83	115
ED045G: Chloride by Discrete Analyser (QCLot: 3745593)								
ED045G: Chloride	16887-00-6	10	mg/kg	----	5000 mg/kg	90.7	83	115
				<10	50 mg/kg	89.0	83	115
ED045G: Chloride by Discrete Analyser (QCLot: 3768419)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	50 mg/kg	100	83	119
				----	5000 mg/kg	100	83	119
ED045G: Chloride by Discrete Analyser (QCLot: 3768424)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	50 mg/kg	100	83	119
				----	5000 mg/kg	100	83	119
ED093S: Soluble Major Cations (QCLot: 3744002)								

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED093S: Soluble Major Cations (QCLot: 3744002) - continued								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	500 mg/kg	101	80	120
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	500 mg/kg	106	80	120
ED093S: Sodium	7440-23-5	10	mg/kg	<10	500 mg/kg	102	80	120
ED093S: Potassium	7440-09-7	10	mg/kg	<10	500 mg/kg	97.5	80	120
ED093S: Soluble Major Cations (QCLot: 3745591)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	500 mg/kg	97.8	80	120
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	500 mg/kg	102	80	120
ED093S: Sodium	7440-23-5	10	mg/kg	<10	500 mg/kg	99.7	80	120
ED093S: Potassium	7440-09-7	10	mg/kg	<10	500 mg/kg	99.1	80	120
ED093S: Soluble Major Cations (QCLot: 3768417)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	500 mg/kg	97.8	80	120
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	500 mg/kg	102	80	120
ED093S: Sodium	7440-23-5	10	mg/kg	<10	500 mg/kg	99.7	80	120
ED093S: Potassium	7440-09-7	10	mg/kg	<10	500 mg/kg	99.1	80	120
ED093S: Soluble Major Cations (QCLot: 3768422)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	500 mg/kg	97.8	80	120
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	500 mg/kg	102	80	120
ED093S: Sodium	7440-23-5	10	mg/kg	<10	500 mg/kg	99.7	80	120
ED093S: Potassium	7440-09-7	10	mg/kg	<10	500 mg/kg	99.1	80	120
EG005S : Soluble Metals by ICPAES (QCLot: 3744001)								
EG005S: Aluminium	7429-90-5	1.00	mg/kg	<1	5.00 mg/kg	97.6	78	112
EG005S: Antimony	7440-36-0	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.10	mg/kg	<0.1	5.00 mg/kg	103	83	111
EG005S: Cadmium	7440-43-9	0.10	mg/kg	<0.1	5.00 mg/kg	106	87	112
EG005S: Chromium	7440-47-3	0.10	mg/kg	<0.1	5.00 mg/kg	101	91	110
EG005S: Cobalt	7440-48-4	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.10	mg/kg	<0.1	5.00 mg/kg	101	84	111
EG005S: Iron	7439-89-6	1.00	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.10	mg/kg	<0.1	5.00 mg/kg	104	90	112
EG005S: Manganese	7439-96-5	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Molybdenum	7439-98-7	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.10	mg/kg	<0.1	5.00 mg/kg	104	82	112
EG005S: Selenium	7782-49-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Vanadium	7440-62-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.10	mg/kg	<0.1	5.00 mg/kg	100	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 3745590)								

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EG005S : Soluble Metals by ICPAES (QCLot: 3745590) - continued								
EG005S: Aluminium	7429-90-5	1.00	mg/kg	<1	5.00 mg/kg	96.1	78	112
EG005S: Antimony	7440-36-0	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.10	mg/kg	<0.1	5.00 mg/kg	99.7	83	111
EG005S: Cadmium	7440-43-9	0.10	mg/kg	<0.1	5.00 mg/kg	101	87	112
EG005S: Chromium	7440-47-3	0.10	mg/kg	<0.1	5.00 mg/kg	97.6	91	110
EG005S: Cobalt	7440-48-4	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.10	mg/kg	<0.1	5.00 mg/kg	99.8	84	111
EG005S: Iron	7439-89-6	1.00	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.10	mg/kg	<0.1	5.00 mg/kg	99.8	90	112
EG005S: Manganese	7439-96-5	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Molybdenum	7439-98-7	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.10	mg/kg	<0.1	5.00 mg/kg	101	82	112
EG005S: Selenium	7782-49-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Vanadium	7440-62-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.10	mg/kg	<0.1	5.00 mg/kg	98.8	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 3768416)								
EG005S: Aluminium	7429-90-5	1.00	mg/kg	<1	5.00 mg/kg	96.0	78	112
EG005S: Antimony	7440-36-0	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	83	111
EG005S: Cadmium	7440-43-9	0.10	mg/kg	0	5 mg/kg	101.1	87	112
EG005S: Chromium	7440-47-3	0.10	mg/kg	<0.1	5.00 mg/kg	97.0	91	110
EG005S: Cobalt	7440-48-4	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	84	111
EG005S: Iron	7439-89-6	1.00	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	90	112
EG005S: Manganese	7439-96-5	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Molybdenum	7439-98-7	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.10	mg/kg	<0.1	5.00 mg/kg	98.0	82	112
EG005S: Selenium	7782-49-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Vanadium	7440-62-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.10	mg/kg	<0.1	5.00 mg/kg	98.0	94	110
EG005S : Soluble Metals by ICPAES (QCLot: 3768421)								
EG005S: Aluminium	7429-90-5	1.00	mg/kg	<1	5.00 mg/kg	96.0	78	112
EG005S: Antimony	7440-36-0	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Arsenic	7440-38-2	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	83	111
EG005S: Cadmium	7440-43-9	0.10	mg/kg	0	5 mg/kg	101.1	87	112

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005S : Soluble Metals by ICPAES (QCLot: 3768421) - continued								
EG005S: Chromium	7440-47-3	0.10	mg/kg	<0.1	5.00 mg/kg	97.0	91	110
EG005S: Cobalt	7440-48-4	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Copper	7440-50-8	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	84	111
EG005S: Iron	7439-89-6	1.00	mg/kg	<1	----	----	----	----
EG005S: Lead	7439-92-1	0.10	mg/kg	<0.1	5.00 mg/kg	99.0	90	112
EG005S: Manganese	7439-96-5	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Molybdenum	7439-98-7	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Nickel	7440-02-0	0.10	mg/kg	<0.1	5.00 mg/kg	96.8	82	112
EG005S: Selenium	7782-49-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Vanadium	7440-62-2	0.10	mg/kg	<0.1	----	----	----	----
EG005S: Zinc	7440-66-6	0.10	mg/kg	<0.1	5.00 mg/kg	98.0	94	110
EG020S: Soluble Metals by ICPMS (QCLot: 3744003)								
EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	----	----	----	----
EG020S: Soluble Metals by ICPMS (QCLot: 3745592)								
EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	----	----	----	----
EG020S: Soluble Metals by ICPMS (QCLot: 3768418)								
EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	----	----	----	----
EG020S: Soluble Metals by ICPMS (QCLot: 3768423)								
EG020X-S: Uranium	7440-61-1	0.01	mg/kg	<0.01	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

INTERPRETIVE QUALITY CONTROL REPORT

Work Order : **EB1422140**

Amendment : **1**

Page : 1 of 23

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Project : 42427460 Ensham Coal Mine
Site : ----
C-O-C number : ----
Sampler : ----
Order number : ----

Quote number : EN/001/14

Laboratory : Environmental Division Brisbane
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QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Date Samples Received : 02-DEC-2014
Issue Date : 09-JAN-2015

No. of samples received : 63
No. of samples analysed : 44

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with recommended holding times (USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EA055: Moisture Content							
Soil Glass Jar - Unpreserved (EA055-103) (ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, ECM01, ECM03, ECM04, ECM05, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, ECM10, ECM11, ECM15, (ECM22) 4466-26 - C4466 92.11-92.62m, ECM19, ECM21	**02-DEC-2014**	**----**	----	----	**08-DEC-2014**	16-DEC-2014	✓
ED007: Exchangeable Cations							
Soil Glass Jar - Unpreserved (ED007) (ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, ECM01, ECM03, ECM04, ECM05, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, ECM10, ECM11, ECM15, (ECM22) 4466-26 - C4466 92.11-92.62m, ECM19, ECM21	**02-DEC-2014**	**08-DEC-2014**	30-DEC-2014	✓	**08-DEC-2014**	30-DEC-2014	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** */ Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED040S : Soluble Sulfate by ICPAES							
Soil Glass Jar - Unpreserved (ED040S)							
(ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, (ECM22) 4466-26 - C4466 92.11-92.62m	**02-DEC-2014**	**06-DEC-2014**	30-DEC-2014	✓	**09-DEC-2014**	03-JAN-2015	✓
Soil Glass Jar - Unpreserved (ED040S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED040S : Soluble Sulfate by ICPAES - Continued							
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	**02-DEC-2014**	**07-JAN-2015**	30-DEC-2014	×	**07-JAN-2015**	04-FEB-2015	✓
Soil Glass Jar - Unpreserved (ED040S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED040S : Soluble Sulfate by ICPAES - Continued								
ECM01, ECM04, ECM10, ECM15, ECM21	ECM03, ECM05, ECM11, ECM19,	**02-DEC-2014**	**08-DEC-2014**	30-DEC-2014	✓	**08-DEC-2014**	05-JAN-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
ED045G: Chloride Discrete analyser							
Soil Glass Jar - Unpreserved (ED045G) (ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, (ECM22) 4466-26 - C4466 92.11-92.62m	**02-DEC-2014**	**06-DEC-2014**	30-DEC-2014	✓	**09-DEC-2014**	03-JAN-2015	✓
Soil Glass Jar - Unpreserved (ED045G)							

Matrix: **SOIL**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method ***Container** / Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation* ***Date extracted***	 *Due for extraction*	 *Evaluation*	*Analysis* ***Date analysed***	 *Due for analysis*	 *Evaluation*
ED045G: Chloride Discrete analyser - Continued							
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	**02-DEC-2014**	**07-JAN-2015**	30-DEC-2014	✗	**08-JAN-2015**	04-FEB-2015	✓
Soil Glass Jar - Unpreserved (ED045G)							

Matrix: **SOIL** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		**Sample Date**	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*			***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED045G: Chloride Discrete analyser - Continued								
ECM01, ECM04, ECM10, ECM15, ECM21	ECM03, ECM05, ECM11, ECM19,	**02-DEC-2014**	**08-DEC-2014**	30-DEC-2014	✓	**08-DEC-2014**	05-JAN-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
ED093S: Soluble Major Cations							
Soil Glass Jar - Unpreserved (ED093S) (ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, (ECM22) 4466-26 - C4466 92.11-92.62m	**02-DEC-2014**	**06-DEC-2014**	31-MAY-2015	✓	**09-DEC-2014**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (ED093S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** */ Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED093S: Soluble Major Cations - Continued							
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	**02-DEC-2014**	**07-JAN-2015**	31-MAY-2015	✓	**07-JAN-2015**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (ED093S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)		**Sample Date**	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
ED093S: Soluble Major Cations - Continued								
ECM01, ECM04, ECM10, ECM15, ECM21	ECM03, ECM05, ECM11, ECM19,	**02-DEC-2014**	**08-DEC-2014**	31-MAY-2015	✓	**08-DEC-2014**	31-MAY-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EG005S : Soluble Metals by ICPAES							
Soil Glass Jar - Unpreserved (EG005S)							
(ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, (ECM22) 4466-26 - C4466 92.11-92.62m	**02-DEC-2014**	**06-DEC-2014**	31-MAY-2015	✓	**09-DEC-2014**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (EG005S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container** / Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EG005S : Soluble Metals by ICPAES - Continued							
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	**02-DEC-2014**	**07-JAN-2015**	31-MAY-2015	✓	**07-JAN-2015**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (EG005S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)		**Sample Date**	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EG005S : Soluble Metals by ICPAES - Continued								
ECM01, ECM04, ECM10, ECM15, ECM21	ECM03, ECM05, ECM11, ECM19,	**02-DEC-2014**	**08-DEC-2014**	31-MAY-2015	✓	**08-DEC-2014**	31-MAY-2015	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EG020S: Soluble Metals by ICPMS							
Soil Glass Jar - Unpreserved (EG020X-S)							
(ECM02) 5003-3 - R5003 18.00-75.50m, (ECM06) 4999-12 - R4999 54.00-62.00m, (ECM07) 5003-11 - R5003 105.50-108.50m, (ECM08) 5003-1 - R5003 0.00-16.50m, (ECM09) 5003-2 - R5003 16.50-18.00m, (ECM12) 4999-3 - R4999 32.67-33.17m, (ECM13) 4999-4 - R4999 33.17-33.70m, (ECM14) 4999-5 - R4999 33.70-34.20m, (ECM16) 4999-13 - R4999 62.00-62.45m, (ECM17) 4999-14 - R4999 66.63-67.00m, (ECM18) 5003-4 - R5003 75.50-76.11m, (ECM20) 5003-12 - R5003 108.50-109.08m, (ECM22) 4466-26 - C4466 92.11-92.62m	**02-DEC-2014**	**06-DEC-2014**	31-MAY-2015	✓	**09-DEC-2014**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (EG020X-S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EG020S: Soluble Metals by ICPMS - Continued							
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	**02-DEC-2014**	**07-JAN-2015**	31-MAY-2015	✓	**09-JAN-2015**	31-MAY-2015	✓
Soil Glass Jar - Unpreserved (EG020X-S)							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020S: Soluble Metals by ICPMS - Continued								
ECM01, ECM04, ECM10, ECM15, ECM21	ECM03, ECM05, ECM11, ECM19,	**02-DEC-2014**	**08-DEC-2014**	31-MAY-2015	✓	**09-DEC-2014**	31-MAY-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Cations - soluble by ICP-AES	ED093S	6	44	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	6	44	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	3	22	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	6	44	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	2	20	**10.0**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	6	44	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICP-MS - Suite X	EG020X-S	6	44	**13.6**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Cations - soluble by ICP-AES	ED093S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	8	44	**18.2**	**10.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	2	22	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICP-MS - Suite X	EG020X-S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Cations - soluble by ICP-AES	ED093S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	2	22	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICPAES	EG005S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Soluble Metals by ICP-MS - Suite X	EG020X-S	4	44	**9.1**	**5.0**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Moisture Content	EA055-103	SOIL	In-house. A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Exchangeable Cations	ED007	SOIL	In house: Referenced to Rayment & Lyons (2011) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Major Anions - Soluble	ED040S	SOIL	In-house. Soluble Anions are determined off a 1:5 soil / water extract by ICPAES.
Chloride Soluble By Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 21st edition 4500-Cl- E. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm. Analysis is performed on a 1:5 soil / water leachate.
Cations - soluble by ICP-AES	ED093S	SOIL	In house: Referenced to APHA 21st ed., 3120; USEPA SW 846 - 6010 (ICPAES) Water extracts of the soil are analyzed for major cations by ICPAES. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Soluble Metals by ICPAES	EG005S	SOIL	In house: Referenced to APHA 21st ed., 3120; USEPA SW 846 - 6010. Soluble metals are determined following an appropriate soil / water extraction of the soil. The ICPAES technique ionises samples in a plasma, emitting characteristic spectrums based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.
Soluble Metals by ICP-MS - Suite X	EG020X-S	SOIL	In house: Referenced to APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Exchangeable Cations Preparation Method	ED007PR	SOIL	Rayment & Higginson (1992) method 15A1. A 1M NH4Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix**: SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
ED040S : Soluble Sulfate by ICPAES						

Matrix: **SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
ED040S : Soluble Sulfate by ICPAES - Analysis Holding Time Compliance						
Soil Glass Jar - Unpreserved						
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	07-JAN-2015	30-DEC-2014	**8**	----	----	----
ED045G: Chloride Discrete analyser						

Matrix: **SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
ED045G: Chloride Discrete analyser - Analysis Holding Time Compliance						
Soil Glass Jar - Unpreserved						
(ECM02) 5003-3 - R5003 18.00-75.50m , (ECM06) 4999-12 - R4999 54.00-62.00m , (ECM07) 5003-11 - R5003 105.50-108.50m , (ECM08) 5003-1 - R5003 0.00-16.50m , (ECM09) 5003-2 - R5003 16.50-18.00m , (ECM12) 4999-3 - R4999 32.67-33.17m , (ECM13) 4999-4 - R4999 33.17-33.70m , (ECM14) 4999-5 - R4999 33.70-34.20m , (ECM16) 4999-13 - R4999 62.00-62.45m , (ECM17) 4999-14 - R4999 66.63-67.00m , (ECM18) 5003-4 - R5003 75.50-76.11m , (ECM20) 5003-12 - R5003 108.50-109.08m , (ECM22) 4466-26 - C4466 92.11-92.62m , ECM01, ECM03, ECM04, ECM05, ECM10, ECM11, ECM15, ECM19, ECM21	07-JAN-2015	30-DEC-2014	**8**	----	----	----

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Australian Laboratory Services Pty. Ltd.

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Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
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CERTIFICATE BR14189591

Project: EB1422140

This report is for 22 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 9- DEC- 2014.

The following have access to data associated with this certificate:

SUB RESULTS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG- 22	Sample login - Rcd w/ o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME- MS61	48 element four acid ICP- MS
ME- MS41	51 anal. aqua regia ICPMS

To: **ALS ENVIRONMENTAL**
ATTN: SUB RESULTS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

Australian Laboratory Services Pty. Ltd.

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Project: EB1422140

Finalized Date: 19-DEC-2014
Account: ALSENV

CERTIFICATE OF ANALYSIS BR14189591

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
Sample Description															
EB1422140-003															
EB1422140-011															
EB1422140-012															
EB1422140-013															
EB1422140-014															
EB1422140-019															
EB1422140-020	0.05	0.33	1.1	<0.2	10	10	0.74	0.15	0.63	0.04	7.70	3.9	7	1.24	22.6
EB1422140-021															
EB1422140-024															
EB1422140-025															
EB1422140-026															
EB1422140-029	0.04	0.82	6.5	<0.2	<10	60	0.55	0.10	3.13	0.06	19.15	7.0	27	1.36	17.8
EB1422140-032															
EB1422140-033															
EB1422140-034															
EB1422140-035															
EB1422140-036															
EB1422140-037															
EB1422140-038															
EB1422140-039	0.10	1.47	5.3	<0.2	<10	100	1.14	0.27	0.87	0.10	30.1	10.3	19	2.99	44.4
EB1422140-040															
EB1422140-041															

CERTIFICATE OF ANALYSIS BR14189591

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
EB1422140-003															
EB1422140-011															
EB1422140-012															
EB1422140-013															
EB1422140-014															
EB1422140-019															
EB1422140-020	0.35	1.23	2.99	0.11	0.02	0.015	0.04	2.9	3.2	0.09	113	0.51	0.08	0.08	7.8
EB1422140-021															
EB1422140-024															
EB1422140-025															
EB1422140-026															
EB1422140-029	1.43	3.74	0.05	0.12	0.04	0.034	0.10	7.9	9.0	0.47	373	0.79	0.09	<0.05	12.2
EB1422140-032															
EB1422140-033															
EB1422140-034															
EB1422140-035															
EB1422140-036															
EB1422140-037															
EB1422140-038															
EB1422140-039	3.97	5.61	0.07	0.15	0.05	0.045	0.16	12.2	17.1	0.58	814	0.37	0.13	<0.05	22.5
EB1422140-040															
EB1422140-041															

CERTIFICATE OF ANALYSIS BR14189591

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Sample Description **Units**	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
EB1422140-003															
EB1422140-011															
EB1422140-012															
EB1422140-013															
EB1422140-014															
EB1422140-019															
EB1422140-020	80	5.9	4.3	<0.001	0.12	0.86	2.2	0.3	0.3	28.1	<0.01	0.03	1.7	0.008	<0.02
EB1422140-021															
EB1422140-024															
EB1422140-025															
EB1422140-026															
EB1422140-029	620	9.9	6.5	<0.001	0.02	0.14	6.4	0.3	0.5	145.0	<0.01	0.01	3.6	<0.005	0.04
EB1422140-032															
EB1422140-033															
EB1422140-034															
EB1422140-035															
EB1422140-036															
EB1422140-037															
EB1422140-038															
EB1422140-039	550	13.2	12.3	<0.001	0.03	0.20	8.3	0.5	0.8	160.0	<0.01	0.03	5.0	<0.005	0.04
EB1422140-040															
EB1422140-041															

CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
Analyte	U	V	W	Y	Zn	Zr	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description / LOR	0.05	1	0.05	0.05	2	0.5	0.01	0.01	0.2	10	0.05	0.01	0.01	0.02	0.01
EB1422140- 003							0.10	8.18	6.7	260	1.87	0.27	1.67	0.07	60.0
EB1422140- 011							0.09	6.61	6.7	380	1.27	0.12	4.16	0.05	45.0
EB1422140- 012							0.06	7.67	10.3	370	1.37	0.16	2.07	0.06	49.7
EB1422140- 013							0.02	2.93	3.5	240	0.72	0.09	0.29	<0.02	25.0
EB1422140- 014							0.02	1.18	1.7	130	0.35	0.03	0.24	<0.02	11.40
EB1422140- 019							0.11	8.38	13.4	280	1.85	0.34	0.60	0.12	47.0
EB1422140- 020	0.23	22	0.10	2.81	12	2.6									
EB1422140- 021							0.10	8.31	11.0	340	1.92	0.34	0.24	0.11	35.0
EB1422140- 024							0.07	7.00	11.1	380	1.31	0.13	3.62	0.07	40.5
EB1422140- 025							0.11	8.49	6.9	660	1.93	0.32	1.78	0.12	56.4
EB1422140- 026							0.09	9.19	14.0	1030	2.07	0.37	0.40	0.16	52.6
EB1422140- 029	0.33	23	<0.05	6.68	59	2.9									
EB1422140- 032							0.04	7.59	11.9	460	1.22	0.13	4.28	0.06	42.4
EB1422140- 033							0.08	7.99	8.5	240	1.90	0.29	2.89	0.09	48.2
EB1422140- 034							0.11	9.79	14.0	430	2.08	0.35	0.79	0.12	61.8
EB1422140- 035							0.13	8.70	8.8	420	1.87	0.29	0.81	0.11	43.1
EB1422140- 036							0.10	7.59	7.6	400	1.78	0.25	1.77	0.08	35.7
EB1422140- 037							0.05	7.53	11.0	390	1.39	0.19	2.62	0.07	42.1
EB1422140- 038							0.07	9.00	16.0	330	2.20	0.33	0.59	0.14	41.4
EB1422140- 039	0.53	45	0.05	11.05	66	3.6									
EB1422140- 040							0.10	9.73	7.9	590	2.16	0.37	0.33	0.16	65.0
EB1422140- 041							0.08	10.15	14.3	650	1.96	0.35	0.33	0.14	58.1

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Sample Description	Method Analyte Units LOR	ME- MS61 Co ppm 0.1	ME- MS61 Cr ppm 1	ME- MS61 Cs ppm 0.05	ME- MS61 Cu ppm 0.2	ME- MS61 Fe % 0.01	ME- MS61 Ga ppm 0.05	ME- MS61 Ge ppm 0.05	ME- MS61 Hf ppm 0.1	ME- MS61 In ppm 0.005	ME- MS61 K % 0.01	ME- MS61 La ppm 0.5	ME- MS61 Li ppm 0.2	ME- MS61 Mg % 0.01	ME- MS61 Mn ppm 5	ME- MS61 Mo ppm 0.05
EB1422140- 003		14.7	69	6.09	39.9	4.24	18.70	0.20	3.8	0.061	1.32	30.0	36.0	0.62	1070	0.54
EB1422140- 011		13.2	49	3.90	19.5	4.56	13.30	0.14	2.4	0.043	1.31	20.0	16.1	0.90	862	0.45
EB1422140- 012		12.3	52	4.65	24.9	2.31	16.95	0.13	2.9	0.049	1.36	22.0	24.5	0.74	469	0.82
EB1422140- 013		5.9	62	1.89	9.0	1.60	6.86	0.09	1.6	0.018	0.81	12.6	10.5	0.23	163	0.42
EB1422140- 014		2.3	111	0.65	3.1	0.58	2.30	0.06	0.6	<0.005	0.49	5.8	7.1	0.05	99	0.26
EB1422140- 019		20.4	63	5.17	43.0	3.03	21.2	0.15	4.6	0.072	1.29	19.4	45.4	0.61	306	3.08
EB1422140- 020																
EB1422140- 021		9.9	61	6.73	55.8	1.71	21.4	0.15	4.4	0.068	1.51	14.1	39.4	0.52	100	0.87
EB1422140- 024		16.2	62	3.61	21.2	3.27	15.75	0.14	3.1	0.045	1.31	18.9	22.0	1.01	756	0.95
EB1422140- 025		22.2	51	9.62	49.1	4.62	21.6	0.15	4.1	0.061	1.88	26.0	37.8	0.94	1020	1.18
EB1422140- 026		11.8	71	7.82	55.9	2.30	23.9	0.13	5.1	0.077	1.48	22.9	41.4	0.60	181	1.10
EB1422140- 029																
EB1422140- 032		15.1	36	3.07	18.9	3.42	16.90	0.13	2.8	0.039	1.19	20.0	22.0	1.23	717	1.30
EB1422140- 033		16.7	80	5.20	35.2	4.81	20.6	0.18	4.5	0.063	1.10	21.0	37.7	0.66	1100	0.69
EB1422140- 034		20.2	68	9.64	51.9	4.16	24.6	0.17	4.9	0.071	1.78	28.5	42.3	0.97	592	1.48
EB1422140- 035		16.6	58	8.81	42.6	4.06	22.3	0.16	4.3	0.066	1.68	18.8	38.7	0.91	547	0.79
EB1422140- 036		14.5	56	7.16	38.9	4.67	20.9	0.20	3.9	0.061	1.57	15.3	35.8	0.95	785	0.72
EB1422140- 037		20.4	68	4.88	28.5	5.27	17.05	0.16	3.2	0.053	1.54	19.3	22.2	1.05	1100	0.99
EB1422140- 038		18.9	87	6.43	45.0	4.19	23.8	0.23	5.5	0.074	1.52	17.5	46.9	0.75	524	0.93
EB1422140- 039																
EB1422140- 040		17.0	58	9.65	59.2	1.84	24.9	0.16	5.0	0.073	1.87	28.9	42.0	0.59	119	1.28
EB1422140- 041		9.8	58	10.25	58.8	1.74	25.7	0.17	4.8	0.077	1.89	26.5	46.7	0.61	131	1.24

CERTIFICATE OF ANALYSIS BR14189591

	Method	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
	Analyte	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description	LOR	0.01	0.1	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05
EB1422140- 003		0.40	7.7	39.1	910	16.9	63.3	<0.002	0.03	0.71	17.3	1	2.2	143.5	0.65	0.05
EB1422140- 011		1.12	4.7	20.7	640	10.9	54.5	<0.002	0.02	0.55	13.7	1	1.3	315	0.38	<0.05
EB1422140- 012		1.07	5.8	22.0	660	14.6	51.2	<0.002	0.02	0.83	13.3	1	1.5	233	0.47	<0.05
EB1422140- 013		0.48	5.5	13.5	120	7.7	39.0	<0.002	0.01	0.36	5.0	<1	0.9	84.6	0.41	<0.05
EB1422140- 014		0.29	1.1	4.5	150	4.5	19.1	<0.002	<0.01	0.25	1.2	<1	0.3	48.1	0.09	<0.05
EB1422140- 019		0.51	9.7	38.9	520	21.5	52.2	<0.002	0.04	1.18	15.6	1	2.8	126.5	0.80	0.06
EB1422140- 020																
EB1422140- 021		0.57	8.8	36.8	340	21.8	56.5	<0.002	0.07	1.17	15.7	1	2.4	158.0	0.70	0.08
EB1422140- 024		1.16	5.2	23.3	740	14.5	59.7	<0.002	0.04	0.66	18.6	1	1.2	294	0.41	<0.05
EB1422140- 025		0.97	7.8	37.6	1040	17.6	89.4	<0.002	0.05	0.74	19.3	1	2.0	322	0.59	0.08
EB1422140- 026		0.61	9.6	40.6	430	23.8	76.0	<0.002	0.06	1.22	20.9	1	2.5	178.5	0.73	0.08
EB1422140- 029																
EB1422140- 032		1.11	5.3	20.3	840	12.2	50.6	<0.002	0.02	0.57	13.4	1	1.2	314	0.40	<0.05
EB1422140- 033		0.55	8.8	37.8	1040	19.8	51.6	<0.002	0.03	0.82	17.9	1	2.3	171.0	0.66	0.06
EB1422140- 034		0.80	9.5	42.0	930	21.8	95.1	<0.002	0.04	1.08	22.1	1	2.6	241	0.73	0.09
EB1422140- 035		0.87	8.2	31.7	720	18.1	77.5	<0.002	0.03	0.79	18.7	1	2.2	238	0.62	0.07
EB1422140- 036		0.86	7.5	29.0	720	15.4	53.2	<0.002	0.03	0.67	17.0	1	1.9	300	0.56	0.07
EB1422140- 037		0.91	5.6	30.2	760	14.0	70.3	<0.002	0.02	0.69	18.7	1	1.5	300	0.40	0.07
EB1422140- 038		0.52	10.6	51.5	580	23.3	67.9	<0.002	0.03	0.98	20.0	1	2.9	134.5	0.82	0.08
EB1422140- 039																
EB1422140- 040		0.70	9.4	40.1	620	23.6	94.2	<0.002	0.05	1.02	21.2	1	2.5	229	0.71	0.09
EB1422140- 041		0.83	9.8	31.7	570	22.7	96.5	<0.002	0.07	0.97	20.2	1	2.5	249	0.75	0.08

CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method Analyte Units LOR	ME- MS61 Th ppm 0.2	ME- MS61 Ti % 0.005	ME- MS61 Tl ppm 0.02	ME- MS61 U ppm 0.1	ME- MS61 V ppm 1	ME- MS61 W ppm 0.1	ME- MS61 Y ppm 0.1	ME- MS61 Zn ppm 2	ME- MS61 Zr ppm 0.5
EB1422140- 003		18.0	0.435	0.46	3.3	119	3.3	30.9	82	135.0
EB1422140- 011		7.0	0.321	0.33	1.8	108	2.2	18.8	64	85.8
EB1422140- 012		8.9	0.374	0.39	1.9	104	1.4	16.3	73	98.9
EB1422140- 013		5.7	0.243	0.22	1.2	40	1.4	8.5	24	61.5
EB1422140- 014		2.4	0.038	0.10	0.5	12	0.3	4.9	5	19.8
EB1422140- 019		9.6	0.517	0.49	3.5	128	2.6	18.8	94	157.0
EB1422140- 020										
EB1422140- 021		7.9	0.538	0.47	3.1	128	2.1	16.3	100	149.5
EB1422140- 024		6.2	0.359	0.35	1.6	100	3.0	19.3	80	106.5
EB1422140- 025		8.9	0.438	0.53	2.4	128	2.0	26.3	85	142.5
EB1422140- 026		9.4	0.543	0.49	3.0	141	2.3	25.9	99	169.0
EB1422140- 029										
EB1422140- 032		6.1	0.366	0.33	1.6	91	1.1	18.5	63	90.7
EB1422140- 033		8.8	0.473	0.39	2.5	117	2.2	24.7	83	151.5
EB1422140- 034		10.5	0.543	0.53	2.8	144	2.4	29.5	96	165.0
EB1422140- 035		8.1	0.497	0.49	2.3	135	2.0	20.2	89	142.0
EB1422140- 036		6.3	0.461	0.46	2.1	128	1.9	18.7	78	130.5
EB1422140- 037		6.4	0.450	0.38	1.7	157	1.5	19.7	74	110.0
EB1422140- 038		8.5	0.554	0.49	3.0	138	2.3	20.1	100	183.0
EB1422140- 039										
EB1422140- 040		10.3	0.522	0.57	3.0	145	2.3	26.5	103	163.0
EB1422140- 041		10.3	0.572	0.52	2.9	139	2.0	21.8	111	157.5

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).
Applies to Method: ME- MS41

REE's may not be totally soluble in this method.
Applies to Method: ME- MS61

LABORATORY ADDRESSES

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia.

Applies to Method:	LOG- 22	ME- MS41	ME- MS61

Australian Laboratory Services Pty. Ltd.

32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
www.alsglobal.com

Page: 1
Total # Pages: 3 (A - G)
Plus Appendix Pages
Finalized Date: 19-DEC-2014
Account: ALSENV

QC CERTIFICATE BR14189591

Project: EB1422140

This report is for 22 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 9-DEC-2014.

The following have access to data associated with this certificate:

SUB RESULTS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG-22	Sample login - Rcd w/o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME-MS61	48 element four acid ICP-MS
ME-MS41	51 anal. aqua regia ICPMS

To: **ALS ENVIRONMENTAL**
ATTN: SUB RESULTS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

Project: EB1422140

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS															
GBM908-10	2.95	0.91	53.0	0.3	<10	100	0.31	1.12	0.67	1.65	86.9	13.7	24	0.80	3450
Target Range - Lower Bound	2.69	0.85	49.4	<0.2	<10	70	0.17	1.09	0.62	1.52	79.3	12.9	20	0.66	3380
Upper Bound	3.31	1.06	60.6	0.9	30	140	0.40	1.35	0.79	1.88	97.0	15.9	27	0.94	3880
GBM908-10															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	4.33	2.66	30.8	<0.2	<10	450	0.85	0.69	1.11	2.20	74.5	17.9	90	10.60	626
Target Range - Lower Bound	4.00	2.44	28.9	<0.2	<10	370	0.66	0.62	1.00	2.01	66.7	17.5	81	9.85	587
Upper Bound	4.92	3.00	35.5	0.6	20	530	0.94	0.78	1.24	2.47	81.5	21.6	102	12.15	675
MRGeo08															
Target Range - Lower Bound															
Upper Bound															
OGGeo08															
Target Range - Lower Bound															
Upper Bound															
OREAS-45e															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK	<0.01	<0.01	<0.1	<0.2	<10	<10	<0.05	0.02	<0.01	0.01	<0.02	<0.1	1	<0.05	0.2
Target Range - Lower Bound	<0.01	<0.01	<0.1	<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound	0.02	0.02	0.2	0.4	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS															
GBM908- 10	2.51	4.22	0.13	0.69	0.01	0.029	0.42	46.5	6.2	0.51	283	60.9	0.12	0.42	2190
Target Range - Lower Bound	2.35	4.18	<0.05	0.62	<0.01	0.012	0.37	42.6	5.5	0.47	259	57.9	0.09	0.38	2030
Upper Bound	2.89	5.22	0.25	0.80	0.04	0.034	0.48	52.5	6.9	0.59	327	70.9	0.15	0.63	2480
GBM908- 10															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	3.54	9.43	0.18	0.73	0.06	0.155	1.30	36.7	35.3	1.14	414	15.15	0.33	0.89	686
Target Range - Lower Bound	3.22	8.89	0.10	0.67	0.04	0.142	1.12	33.2	30.2	1.03	378	13.10	0.30	0.79	622
Upper Bound	3.96	10.95	0.32	0.87	0.10	0.184	1.40	41.0	37.2	1.29	473	16.10	0.39	1.09	760
MRGeo08															
Target Range - Lower Bound															
Upper Bound															
OGGeo08															
Target Range - Lower Bound															
Upper Bound															
OREAS- 45e															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
								STANDARDS								
GBM908- 10		880	2030	28.9	<0.001	0.40	1.48	1.9	0.7	1.7	31.4	<0.01	0.05	15.3	0.291	0.20
Target Range - Lower Bound		760	1860	26.4	<0.001	0.33	1.06	1.8	0.5	1.2	30.8	<0.01	0.02	15.2	0.276	0.15
Upper Bound		960	2270	32.4	0.003	0.43	1.55	2.4	1.3	2.2	38.0	0.03	0.07	19.0	0.348	0.27
GBM908- 10																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		1070	1080	149.0	0.007	0.32	3.08	7.4	1.2	3.5	79.8	0.01	0.03	21.1	0.376	0.74
Target Range - Lower Bound		900	959	132.0	0.007	0.27	2.80	6.8	0.9	2.8	73.2	<0.01	<0.01	19.5	0.350	0.66
Upper Bound		1130	1175	162.0	0.011	0.36	3.90	8.6	1.9	4.0	89.9	0.04	0.04	24.3	0.439	0.94
MRGeo08																
Target Range - Lower Bound																
Upper Bound																
OGGeo08																
Target Range - Lower Bound																
Upper Bound																
OREAS- 45e																
Target Range - Lower Bound																
Upper Bound																
								BLANKS								
BLANK		<10	<0.2	<0.1	<0.001	0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound		20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method Analyte Units LOR	ME- MS41 U ppm 0.05	ME- MS41 V ppm 1	ME- MS41 W ppm 0.05	ME- MS41 Y ppm 0.05	ME- MS41 Zn ppm 2	ME- MS41 Zr ppm 0.5	ME- MS61 Ag ppm 0.01	ME- MS61 Al % 0.01	ME- MS61 As ppm 0.2	ME- MS61 Ba ppm 10	ME- MS61 Be ppm 0.05	ME- MS61 Bi ppm 0.01	ME- MS61 Ca % 0.01	ME- MS61 Cd ppm 0.02	ME- MS61 Ce ppm 0.01
STANDARDS																
GBM908- 10		1.20	47	1.83	17.60	1000	26.1									
Target Range - Lower Bound		1.15	41	1.62	17.55	939	23.5									
Upper Bound		1.51	53	2.32	21.6	1155	32.9									
GBM908- 10								2.78	7.09	51.5	1100	1.43	1.13	3.76	1.70	111.0
Target Range - Lower Bound								2.69	6.40	51.1	930	1.27	1.12	3.33	1.53	99.0
Upper Bound								3.31	7.84	62.9	1280	1.66	1.39	4.10	1.91	121.0
MRGeo08		5.58	102	2.85	18.50	780	20.8									
Target Range - Lower Bound		4.99	90	2.44	17.85	708	18.1									
Upper Bound		6.21	112	3.42	21.9	870	25.7									
MRGeo08								4.08	7.29	32.9	1090	3.14	0.65	2.65	2.18	64.2
Target Range - Lower Bound								4.00	6.64	29.7	920	2.91	0.62	2.35	2.05	66.7
Upper Bound								4.92	8.14	36.7	1270	3.67	0.78	2.90	2.55	81.5
OGGeo08								19.65	6.92	121.0	890	3.24	10.45	2.21	19.90	74.9
Target Range - Lower Bound								18.15	6.07	106.0	700	2.59	9.44	1.98	16.70	64.8
Upper Bound								22.2	7.44	130.0	980	3.27	11.55	2.44	20.5	79.2
OREAS- 45e								0.29	5.78	17.4	260	0.63	0.37	0.06	0.02	19.80
Target Range - Lower Bound								0.27	6.09	14.5	200	0.49	0.24	0.04	<0.02	21.1
Upper Bound								0.35	7.47	18.1	300	0.75	0.32	0.09	0.07	25.9
BLANKS																
BLANK		<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound		<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound		0.10	2	0.10	0.10	4	1.0									
BLANK								<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01
BLANK								<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01
Target Range - Lower Bound								<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01
Upper Bound								0.02	0.02	0.4	20	0.10	0.02	0.02	0.04	0.02

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
Analyte	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.1	1	0.05	0.2	0.01	0.05	0.05	0.1	0.005	0.01	0.5	0.2	0.01	5	0.05
STANDARDS															
GBM908- 10															
Target Range - Lower Bound															
Upper Bound															
GBM908- 10	25.1	138	3.70	3560	5.51	20.0	0.22	3.7	0.073	2.10	56.9	10.6	1.77	795	61.8
Target Range - Lower Bound	23.3	125	3.44	3380	4.98	18.65	0.18	3.3	0.064	1.87	49.0	9.8	1.61	715	57.9
Upper Bound	28.7	155	4.32	3880	6.10	22.9	0.40	4.3	0.092	2.31	61.0	12.4	1.99	885	70.9
MRGeo08															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	18.5	87	11.10	611	3.94	18.15	0.17	3.1	0.165	3.15	28.6	30.6	1.27	551	14.10
Target Range - Lower Bound	17.7	81	11.00	587	3.55	17.50	<0.05	2.8	0.161	2.79	31.1	30.4	1.17	497	13.65
Upper Bound	21.9	102	13.60	675	4.37	21.5	0.27	3.6	0.207	3.43	39.1	37.6	1.45	619	16.75
OGGeo08	97.7	85	11.60	8390	5.35	17.85	0.33	3.2	1.485	3.01	37.5	35.5	1.27	504	888
Target Range - Lower Bound	87.2	78	9.85	7800	4.81	16.05	0.25	2.5	1.320	2.59	31.0	29.7	1.11	447	841
Upper Bound	107.0	98	12.15	8980	5.91	19.75	0.49	3.3	1.620	3.19	39.0	36.7	1.38	557	1030
OREAS- 45e	57.2	982	1.22	792	23.2	17.20	0.39	3.4	0.091	0.33	8.8	6.9	0.13	537	2.51
Target Range - Lower Bound	51.2	880	1.08	725	21.7	14.80	0.88	2.7	0.084	0.28	9.4	5.7	0.13	490	2.11
Upper Bound	62.8	1080	1.44	835	26.5	18.20	1.18	3.5	0.114	0.37	12.6	7.4	0.18	610	2.69
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.1	<1	<0.05	0.2	<0.01	<0.05	<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05
BLANK	<0.1	<1	<0.05	0.3	<0.01	<0.05	<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05
Target Range - Lower Bound	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05
Upper Bound	0.2	2	0.10	0.4	0.02	0.10	0.10	0.2	0.010	0.02	1.0	0.4	0.02	10	0.10

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	**Method**	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
	Analyte	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.1	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05
								STANDARDS								
GBM908- 10																
Target Range - Lower Bound																
Upper Bound																
GBM908- 10		2.11	10.0	2230	980	2010	159.0	<0.002	0.37	1.71	17.9	1	3.1	296	0.73	0.06
Target Range - Lower Bound		1.93	9.5	2030	880	1860	153.0	<0.002	0.33	1.40	17.0	<1	2.7	258	0.68	<0.05
Upper Bound		2.38	11.9	2480	1100	2270	187.0	0.006	0.43	2.01	21.0	4	3.9	316	0.97	0.16
MRGeo08																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		1.93	19.0	687	1040	1080	158.0	0.007	0.30	4.33	11.3	1	3.8	309	1.49	<0.05
Target Range - Lower Bound		1.76	19.0	622	930	971	173.5	0.006	0.27	3.89	11.1	<1	3.5	277	1.39	<0.05
Upper Bound		2.18	23.4	760	1160	1185	212	0.016	0.36	5.39	13.7	4	4.7	339	1.81	0.14
OGGeo08		1.84	18.3	8680	850	7310	196.5	1.445	2.80	27.8	11.0	12	13.9	259	1.39	0.39
Target Range - Lower Bound		1.62	15.4	8000	760	6520	164.5	1.285	2.51	22.8	9.2	8	12.5	224	1.19	0.09
Upper Bound		2.00	19.0	9770	950	7970	201	1.575	3.09	31.0	11.4	14	15.7	274	1.57	0.31
OREAS- 45e		0.06	7.0	456	310	17.7	20.9	<0.002	0.04	1.10	84.4	4	1.3	16.4	0.61	0.20
Target Range - Lower Bound		0.04	6.0	408	300	15.9	19.0	<0.002	0.02	0.80	83.6	<1	0.9	14.1	0.43	0.07
Upper Bound		0.08	7.6	500	380	20.5	23.4	0.004	0.07	1.20	102.5	5	1.8	17.7	0.69	0.28
								BLANKS								
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	<0.05	<0.1	<1	<0.2	<0.2	<0.05	<0.05
BLANK		<0.01	<0.1	0.3	<10	<0.5	0.1	<0.002	<0.01	0.06	<0.1	<1	<0.2	<0.2	<0.05	<0.05
Target Range - Lower Bound		<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	<0.05	<0.1	<1	<0.2	<0.2	<0.05	<0.05
Upper Bound		0.02	0.2	0.4	20	1.0	0.2	0.004	0.02	0.10	0.2	5	0.4	0.4	0.10	0.10

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method Analyte Units LOR	ME- MS61 Th ppm 0.2	ME- MS61 Ti % 0.005	ME- MS61 Tl ppm 0.02	ME- MS61 U ppm 0.1	ME- MS61 V ppm 1	ME- MS61 W ppm 0.1	ME- MS61 Y ppm 0.1	ME- MS61 Zn ppm 2	ME- MS61 Zr ppm 0.5
						STANDARDS				
GBM908- 10										
Target Range - Lower Bound										
Upper Bound										
GBM908- 10		18.8	0.643	1.23	2.5	140	3.1	37.9	1060	145.0
Target Range - Lower Bound		16.4	0.591	1.00	2.0	123	2.9	35.2	939	117.5
Upper Bound		20.4	0.733	1.40	2.6	153	4.1	43.2	1155	160.5
MRGeo08										
Target Range - Lower Bound										
Upper Bound										
MRGeo08		17.9	0.481	0.99	5.0	110	4.5	24.1	793	105.5
Target Range - Lower Bound		17.7	0.454	0.89	4.9	97	4.1	23.8	722	92.2
Upper Bound		22.1	0.566	1.25	6.3	121	5.8	29.3	886	126.0
OGGeo08		18.9	0.421	1.73	5.5	86	4.9	25.2	7190	100.0
Target Range - Lower Bound		16.7	0.353	1.43	4.5	77	3.9	21.1	6500	78.6
Upper Bound		20.9	0.443	1.98	5.8	97	5.4	26.0	7950	107.5
OREAS- 45e		9.5	0.517	0.15	2.5	310	1.0	6.6	43	111.5
Target Range - Lower Bound		11.4	0.498	0.10	2.1	289	0.8	6.7	40	93.0
Upper Bound		14.4	0.620	0.21	2.8	355	1.4	8.5	53	127.0
						BLANKS				
BLANK										
Target Range - Lower Bound										
Upper Bound										
BLANK		<0.2	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
BLANK		<0.2	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
Target Range - Lower Bound		<0.2	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5
Upper Bound		0.4	0.010	0.04	0.2	2	0.2	0.2	4	1.0

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
									DUPLICATES							
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
EB1422140-011																
DUP																
Target Range - Lower Bound																
Upper Bound																
EB1422140-038																
DUP																
Target Range - Lower Bound																
Upper Bound																
EB1422140-039		0.10	1.47	5.3	<0.2	<10	100	1.14	0.27	0.87	0.10	30.1	10.3	19	2.99	44.4
DUP		0.09	1.43	5.0	<0.2	<10	100	1.05	0.26	0.87	0.09	28.6	10.0	20	2.88	42.5
Target Range - Lower Bound		0.08	1.37	4.8	<0.2	<10	80	0.99	0.24	0.82	0.08	27.9	9.5	18	2.74	41.7
Upper Bound		0.11	1.53	5.5	0.4	20	120	1.20	0.29	0.92	0.11	30.8	10.8	21	3.13	45.2
ORIGINAL		0.03	0.33	0.6	<0.2	<10	20	0.20	0.02	8.22	0.10	7.41	2.7	16	0.37	4.7
DUP		0.03	0.32	0.7	<0.2	<10	20	0.20	0.02	8.11	0.09	7.22	2.7	15	0.35	4.4
Target Range - Lower Bound		0.02	0.30	0.5	<0.2	<10	<10	0.14	<0.01	7.75	0.08	6.93	2.5	14	0.29	4.2
Upper Bound		0.04	0.35	0.8	0.4	20	30	0.26	0.03	8.58	0.11	7.70	2.9	17	0.43	4.9
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140- 011															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140- 038															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140- 039	3.97	5.61	0.07	0.15	0.05	0.045	0.16	12.2	17.1	0.58	814	0.37	0.13	<0.05	22.5
DUP	3.95	5.22	0.08	0.16	0.05	0.042	0.15	11.7	16.8	0.57	822	0.36	0.13	<0.05	21.9
Target Range - Lower Bound	3.75	5.09	<0.05	0.13	0.04	0.036	0.14	11.2	16.0	0.54	772	0.30	0.11	<0.05	20.9
Upper Bound	4.17	5.74	0.10	0.18	0.06	0.051	0.17	12.7	17.9	0.61	864	0.43	0.15	0.10	23.5
ORIGINAL	0.79	1.09	<0.05	0.03	0.02	0.007	0.06	4.7	5.7	0.17	179	0.12	0.01	0.06	8.3
DUP	0.76	1.05	<0.05	0.03	0.02	0.006	0.06	4.7	5.4	0.17	179	0.11	0.01	0.05	8.1
Target Range - Lower Bound	0.73	0.97	<0.05	<0.02	<0.01	<0.005	0.05	4.3	5.2	0.15	165	0.06	<0.01	<0.05	7.6
Upper Bound	0.82	1.17	0.10	0.04	0.03	0.010	0.07	5.1	5.9	0.19	193	0.17	0.02	0.10	8.8
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
	DUPLICATES														
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140-011															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140-038															
DUP															
Target Range - Lower Bound															
Upper Bound															
EB1422140-039	550	13.2	12.3	<0.001	0.03	0.20	8.3	0.5	0.8	160.0	<0.01	0.03	5.0	<0.005	0.04
DUP	550	12.8	11.7	<0.001	0.03	0.19	7.9	0.5	0.8	155.0	<0.01	0.04	4.9	<0.005	0.04
Target Range - Lower Bound	510	12.2	11.3	<0.001	0.02	0.13	7.6	0.3	0.6	149.5	<0.01	0.02	4.5	<0.005	<0.02
Upper Bound	590	13.9	12.7	0.002	0.04	0.26	8.6	0.7	1.0	165.5	0.02	0.05	5.4	0.010	0.06
ORIGINAL	400	1.8	5.2	<0.001	0.13	0.08	1.9	0.3	<0.2	227	<0.01	0.01	0.6	<0.005	0.02
DUP	390	1.7	5.1	<0.001	0.12	0.07	1.8	0.3	<0.2	225	<0.01	0.01	0.6	<0.005	0.02
Target Range - Lower Bound	370	1.5	4.8	<0.001	0.11	<0.05	1.7	<0.2	<0.2	215	<0.01	<0.01	0.4	<0.005	<0.02
Upper Bound	420	2.0	5.5	0.002	0.14	0.10	2.0	0.4	0.4	238	0.02	0.02	0.8	0.010	0.04
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
Analyte	U	V	W	Y	Zn	Zr	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.05	1	0.05	0.05	2	0.5	0.01	0.01	0.2	10	0.05	0.01	0.01	0.02	0.01
DUPLICATES															
ORIGINAL							0.16	5.63	60.4	470	2.63	0.35	0.13	<0.02	54.9
DUP							0.14	5.53	51.0	460	2.62	0.31	0.13	<0.02	56.6
Target Range - Lower Bound							0.13	5.29	52.7	420	2.44	0.30	0.11	<0.02	53.0
Upper Bound							0.17	5.87	58.7	510	2.81	0.36	0.15	0.04	58.5
EB1422140- 011							0.09	6.61	6.7	380	1.27	0.12	4.16	0.05	45.0
DUP							0.07	6.65	7.5	380	1.32	0.11	4.12	0.05	42.0
Target Range - Lower Bound							0.07	6.29	6.5	340	1.18	0.10	3.92	0.03	41.3
Upper Bound							0.09	6.97	7.7	420	1.41	0.13	4.36	0.07	45.7
EB1422140- 038							0.07	9.00	16.0	330	2.20	0.33	0.59	0.14	41.4
DUP							0.09	8.65	14.7	300	2.01	0.30	0.57	0.11	44.8
Target Range - Lower Bound							0.07	8.37	14.4	280	1.95	0.29	0.54	0.10	40.9
Upper Bound							0.09	9.28	16.3	350	2.26	0.34	0.62	0.15	45.3
EB1422140- 039	0.53	45	0.05	11.05	66	3.6									
DUP	0.50	45	0.05	10.50	66	3.8									
Target Range - Lower Bound	0.44	42	<0.05	10.20	61	2.9									
Upper Bound	0.59	48	0.10	11.35	71	4.5									
ORIGINAL	0.37	12	<0.05	4.65	19	0.6									
DUP	0.34	11	<0.05	4.68	17	0.6									
Target Range - Lower Bound	0.29	10	<0.05	4.38	15	<0.5									
Upper Bound	0.42	13	0.10	4.95	21	1.0									
ORIGINAL							0.04	6.41	1.1	380	1.41	0.05	0.22	0.02	54.4
DUP							0.02	5.52	1.1	330	1.32	0.05	0.20	<0.02	49.4
Target Range - Lower Bound							0.02	5.66	0.8	320	1.25	0.04	0.19	<0.02	49.3
Upper Bound							0.04	6.27	1.4	390	1.48	0.06	0.23	0.04	54.5

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QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
Analyte	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description / **LOR**	0.1	1	0.05	0.2	0.01	0.05	0.05	0.1	0.005	0.01	0.5	0.2	0.01	5	0.05
	DUPLICATES														
ORIGINAL	17.0	61	3.35	53.9	3.66	17.20	0.13	1.9	0.055	2.59	25.6	24.1	0.70	502	1.46
DUP	16.4	58	3.45	51.3	3.61	17.85	0.13	2.0	0.060	2.57	26.3	25.3	0.68	502	1.24
Target Range - Lower Bound	15.8	56	3.18	50.6	3.44	16.60	0.07	1.8	0.050	2.44	24.2	23.3	0.65	472	1.23
Upper Bound	17.6	63	3.62	54.6	3.83	18.45	0.19	2.1	0.065	2.72	27.7	26.1	0.73	532	1.47
EB1422140- 011	13.2	49	3.90	19.5	4.56	13.30	0.14	2.4	0.043	1.31	20.0	16.1	0.90	862	0.45
DUP	14.0	46	4.09	20.0	4.50	13.95	0.13	2.5	0.042	1.34	19.1	16.7	0.90	854	0.47
Target Range - Lower Bound	12.8	44	3.75	18.9	4.29	12.90	0.08	2.2	0.035	1.25	18.1	15.4	0.85	810	0.39
Upper Bound	14.4	51	4.24	20.6	4.77	14.35	0.19	2.7	0.050	1.40	21.0	17.4	0.96	906	0.53
EB1422140- 038	18.9	87	6.43	45.0	4.19	23.8	0.23	5.5	0.074	1.52	17.5	46.9	0.75	524	0.93
DUP	17.3	81	6.25	43.7	3.94	22.1	0.19	5.0	0.072	1.44	19.7	44.2	0.71	491	0.83
Target Range - Lower Bound	17.1	79	5.97	42.6	3.85	21.8	0.15	4.9	0.064	1.40	17.2	43.1	0.68	477	0.79
Upper Bound	19.1	89	6.71	46.1	4.28	24.1	0.27	5.6	0.082	1.56	20.0	48.0	0.78	538	0.97
EB1422140- 039															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.5	3	1.33	1.2	0.79	12.10	0.14	2.9	0.007	2.80	28.2	2.3	0.04	73	0.42
DUP	0.5	3	1.19	1.3	0.70	11.10	0.11	2.7	0.008	2.54	25.5	2.1	0.04	69	0.44
Target Range - Lower Bound	0.4	2	1.15	1.0	0.70	10.95	0.07	2.6	<0.005	2.53	25.0	1.9	0.03	62	0.36
Upper Bound	0.6	4	1.37	1.5	0.79	12.25	0.18	3.0	0.010	2.81	28.7	2.5	0.05	80	0.50

QC CERTIFICATE OF ANALYSIS BR14189591

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.1	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05
		DUPLICATES														
ORIGINAL		0.06	7.6	36.0	450	6.0	145.5	<0.002	0.09	0.78	9.7	<1	3.4	19.7	0.64	<0.05
DUP		0.06	8.0	34.8	430	5.5	150.5	<0.002	0.08	0.79	9.9	<1	3.4	21.5	0.66	<0.05
Target Range - Lower Bound		0.05	7.3	33.4	410	5.0	140.5	<0.002	0.07	0.68	9.2	<1	3.0	19.4	0.57	<0.05
Upper Bound		0.07	8.3	37.4	470	6.5	155.5	0.004	0.10	0.89	10.4	2	3.8	21.8	0.73	0.10
EB1422140-011		1.12	4.7	20.7	640	10.9	54.5	<0.002	0.02	0.55	13.7	1	1.3	315	0.38	<0.05
DUP		1.15	4.8	22.1	650	13.4	57.5	<0.002	0.02	0.57	14.1	1	1.3	317	0.37	<0.05
Target Range - Lower Bound		1.07	4.4	20.1	600	11.0	53.1	<0.002	<0.01	0.47	13.1	<1	1.0	300	0.31	<0.05
Upper Bound		1.20	5.1	22.7	690	13.3	58.9	0.004	0.03	0.65	14.7	2	1.6	332	0.44	0.10
EB1422140-038		0.52	10.6	51.5	580	23.3	67.9	<0.002	0.03	0.98	20.0	1	2.9	134.5	0.82	0.08
DUP		0.48	9.8	47.3	540	23.6	68.8	<0.002	0.03	0.93	18.9	1	2.7	127.0	0.75	0.05
Target Range - Lower Bound		0.47	9.6	46.7	520	21.8	64.8	<0.002	0.02	0.83	18.4	<1	2.5	124.0	0.70	<0.05
Upper Bound		0.54	10.8	52.1	600	25.1	71.9	0.004	0.04	1.08	20.5	2	3.1	137.5	0.87	0.10
EB1422140-039																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		3.38	10.5	0.5	50	12.6	120.5	<0.002	0.02	0.18	3.9	<1	3.1	82.4	1.11	<0.05
DUP		3.04	9.7	0.8	50	11.6	110.0	<0.002	0.01	0.14	3.4	<1	2.8	73.2	1.06	<0.05
Target Range - Lower Bound		3.04	9.5	0.4	40	11.0	109.5	<0.002	<0.01	0.10	3.4	<1	2.6	73.7	0.98	<0.05
Upper Bound		3.38	10.7	0.9	60	13.2	121.0	0.004	0.02	0.22	3.9	2	3.3	81.9	1.19	0.10

QC CERTIFICATE OF ANALYSIS BR14189591

Method	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61	ME- MS61
Analyte	Th	Ti	Tl	U	V	W	Y	Zn	Zr
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description **LOR**	0.2	0.005	0.02	0.1	1	0.1	0.1	2	0.5
DUPLICATES									
ORIGINAL	10.7	0.182	0.78	2.4	73	3.7	7.4	67	64.5
DUP	10.9	0.189	0.78	2.5	72	3.7	7.7	65	68.7
Target Range - Lower Bound	10.1	0.171	0.70	2.2	68	3.3	7.1	61	62.8
Upper Bound	11.5	0.200	0.86	2.7	77	4.1	8.0	71	70.4
EB1422140- 011	7.0	0.321	0.33	1.8	108	2.2	18.8	64	85.8
DUP	6.6	0.322	0.34	1.7	106	2.2	17.5	70	90.6
Target Range - Lower Bound	6.3	0.300	0.29	1.6	101	1.9	17.1	62	83.3
Upper Bound	7.3	0.343	0.38	1.9	113	2.5	19.2	72	93.1
EB1422140- 038	8.5	0.554	0.49	3.0	138	2.3	20.1	100	183.0
DUP	9.0	0.521	0.51	2.8	130	2.0	20.4	93	167.0
Target Range - Lower Bound	8.1	0.506	0.44	2.7	126	1.9	19.1	90	166.0
Upper Bound	9.4	0.569	0.56	3.1	142	2.4	21.4	103	184.5
EB1422140- 039									
DUP									
Target Range - Lower Bound									
Upper Bound									
ORIGINAL									
DUP									
Target Range - Lower Bound									
Upper Bound									
ORIGINAL	23.5	0.043	0.44	3.1	4	1.1	16.1	8	65.1
DUP	21.2	0.039	0.45	2.7	3	1.0	14.5	8	58.2
Target Range - Lower Bound	21.0	0.034	0.39	2.7	2	0.9	14.4	6	58.1
Upper Bound	23.7	0.048	0.50	3.1	5	1.2	16.2	10	65.2

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QC CERTIFICATE OF ANALYSIS BR14189591

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).
Applies to Method: ME- MS41

REE's may not be totally soluble in this method.
Applies to Method: ME- MS61

LABORATORY ADDRESSES

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia.
Applies to Method: LOG- 22 ME- MS41 ME- MS61

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