Permit

Environmental Protection Act 1994

Environmental authority EPML00297613

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00297613

Environmental authority takes effect on 2 December 2022

Environmental authority holder(s)

Name(s)	Registered address
WANDOAN HOLDINGS PTY LIMITED	Level 44 Gateway Building 1 Macquarie Place SYDNEY NSW 2000
SCAP WANDOAN PTY LTD	C/- Sumitomo Australia Level 33 225 George Street SYDNEY NSW 2000

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Resource Activity, Schedule 3, 13: Mining black coal	ML50229 ML50230 ML50231
Resource Activity, Ancillary 6 – Asphalt manufacturing – manufacturing more than 1,000t of asphalt in a year.	
Resource Activity, Ancillary 8 – Chemical storage, 3: Storing more than 500m^3 of chemicals C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).	
Resource Activity, Ancillary 8 – Chemical storage, 4: Storing 200t or more of chemicals that are solids or gases, other than chemicals mentioned in items 1 to 3, under subsection (1)(d).	
Resource Activity, Ancillary 8 – Chemical storage, 5: Storing 200m^3 or more of chemicals that are liquids, other than chemicals mentioned in items 1 to 3, under subsection (1)(d).	
Resource Activity, Ancillary 14 – Electricity generation, 2: Generating electricity by using fuel, other than gas at a rated capacity of (a) 10MW electrical to 150MW electrical.	
Resource Activity, Ancillary 15 – Fuel burning: Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour.	

Queensland Government

Environmentally relevant activity/activities	Location(s)
Resource Activity, Ancillary 20 – Metal recovery; Recovering 100t or more of metal in a day, or 10,000t or more of metal in a year, without using a fragmentiser.	
Resource Activity, Ancillary 38 – Surface coating, 1: Anodising, electroplating, enamelling or galvanising using, in a year, the following quantity of surface coating materials (d) more than 10,000t.	
Resource Activity, Ancillary 38 – Surface coating, 2: Coating, painting or powder coating, using, in a year, more than 100t of surface coating materials.	
Resource Activity, Ancillary 31 - Mineral processing, 2: Processing, in a year, the following quantities of mineral products, other than coke, (b) more than 100,000t	

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days)

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term ‘duty to notify’.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise- on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within five (5) business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Signature

02 December 2022

Date

Alison Cummings
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Date Issued*:* 2 December 2022

Enquiries:
Business Centre (Coal)
Department of Environment and Science
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

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)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Obligations under the *Mining and Quarrying Safety and Health Act 1999*

If you are operating a quarry, other than a sand and gravel quarry where there is no crushing capability, you will be required to comply with the *Mining and Quarrying Safety and Health Act 1999*. For more information on your obligations under this legislation contact Mine Safety and Health at https://www.resources.qld.gov.au/, or phone 13 QGOV (13 74 68) or your local Mines Inspectorate Office.

Development Approval

This permit is not a development approval under the *Planning Act 2016*. The conditions of this environmental authority are separate, and in addition to, any conditions that may be on the development approval. If a copy of this environmental authority is attached to a development approval, it is for information only, and may not be current. Please contact the Department of Environment and Science to ensure that you have the most current version of the environmental authority relating to this site.

Additional comment:

With reference to Order 2(c) of the Land Court of Queensland decision *Xstrata Coal Queensland Pty Ltd & Ors v. Friends of the Earth - Brisbane Co-Op Ltd & Ors, and Department of Environment and Resource Management [2012] QLC 013* and the recommendation "that, as a pre-requisite to the grant of the environmental authority, the applicants are to reach mutually suitable make-good agreements with landowners potentially affected by adverse impacts on the availability and quality of groundwater as a result of the mining operations":

On 1 September 2011, the Applicants' closing submissions to the Land Court at paragraph 279 acknowledged as follows.

"The Applicants cannot disturb the groundwater without a water licence obtained under the Water Act. Section 235(3) of the MRA makes this clear. The question of make good arrangements can therefore properly be resolved in the course of the processes under the Water Act. There is no risk of harm to the landowners prior to that ... There can be no impact, and therefore no adverse impact, without a water licence."

In relation to this submission by the Applicants, the Coordinator-General has recommended conditions pursuant to section 52 of the State Development and Public Works Organisation Act 1971 as follows:

Schedule 8 Recommended conditions for other approvals

Condition 4 Potential groundwater impacts

I recommend to the Minister responsible for administration of the Water Act 2000 that the following conditions be attached to any licence, permit or approvals required by the proponent associated with groundwater impacts of the project:

(a) Mechanisms should be implemented to ensure that the project does not result in an undue adverse impact on the availability and quality of groundwater supplies to neighbouring landholders. Dewatering will take place and impacts on groundwater levels within the coal seam aquifers and limited alluvium aquifers are predicted. Monitoring and water replacement has been envisaged to manage this impact.

(b) The proponent should reach mutually agreeable arrangements with landholders potentially affected by groundwater drawdown for the provision of alternative supplies throughout the mine life, and after mine closure. Alternative supplies should be put in place before supplies from relevant existing landholder bores are adversely affected and the costs associated with changes to landholder extraction of groundwater from bores on affected land should be covered by the proponent.

(c) Prior to the surrender of mining leases, post-mining, pursuant to the Mineral Resources Act 1989 and the EP Act, the conditions under which an alternative supply of groundwater would be provided to any landholders potentially adversely affected by impacts to groundwater directly attributable to the mine dewatering program must be agreed to between the proponent and the relevant regulators."

Conditions of environmental authority

The environmentally relevant activity(ies) conducted at the location as described above 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 W	Groundwater
Schedule D	Noise and vibration
Schedule E	Waste
Schedule F	Land
Schedule G	Dams
Definitions	
Appendix 1	Figures

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	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: (a) that all measures, plant and equipment necessary to ensure compliance with conditions of this environmental authority are installed; (b) that such measures, plant and equipment are maintained in a proper conditions; and (c) that such measures, plant and equipment are operated in a proper manner.
A3	**Monitoring** Record, compile and keep for a minimum of **five (5) years** all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
A4	Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.
A5	**Spillages** Spillage of all chemicals and fuels must be contained within an on-site containment system and controlled in a manner that prevents environmental harm. *Note: All petroleum product storage's must be designed, constructed and maintained in accordance with AS 1940 - The storage and handling of flammable and combustible liquids of 2004 or later versions.*

A6	**Notification of Emergencies, Incidents and Exceptions** All reasonable and practicable actions are to be taken to minimise environmental harm, or the risk thereof, resulting from any emergency, incident or circumstances not in accordance with the conditions of this environmental authority.
A7	The environmental authority holder must notify the administering authority, within **twenty-four (24) hours,** after becoming aware of any emergency, incident or information about circumstances which results or may result in environmental harm not in accordance with the conditions of this environmental authority.
A8	Within **ten (10) business days** following the notification under condition **A7**, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
A9	**Complaints** The environmental authority holder must record all environmental complaints received about the mining activities including: a) name, address and contact number for of the complainant; b) time and date of complaint; c) reasons for the complaint; d) investigations undertaken; e) conclusions formed; f) actions taken to resolve the complaint; g) any abatement measures implemented; and h) person responsible for resolving the complaint.
A10	When requested by the administering authority, the environmental authority holder must investigate any nuisance, or contaminant release, or environmental harm, or complaint that is neither frivolous nor vexatious in the opinion of the authorised person, by: a) undertaking the monitoring specified by the administering authority; b) undertaking the monitoring in the timeframe nominated or agreed to by the administering authority; c) completing an analysis and interpretation of the monitoring results; and d) implementing abatement measures, where required.
A11	The results of the investigation undertaken in accordance with condition **A10** must be provided to the administering authority within **twenty (20) business days** of completion of the investigation.

A12	Within **twenty (20) business days** after the commencement of Stage One activities, advise the administering authority in writing of the actual date of commencement of Stage One activities.
A13	Within **twenty (20) business days** after the commencement of Stage Two activities, advise the administering authority in writing of the actual date of commencement of Stage Two activities.

Schedule B: Air	
Condition number	**Condition**
B1	**Odour nuisance** The release of noxious or offensive odours, or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause a nuisance at any sensitive place or commercial place.
B2	**Dust and particulate matter** The environmental authority holder must implement and maintain best practice dust control procedures that incorporate a program for continuous improvement for the management of dust resulting from the mining activities.
B3	**Dust and particulate matter monitoring** The environmental authority holder must ensure that all reasonable and feasible avoidance and mitigation measures are employed so that dust deposition or particulate matter emissions, or both, generated by the mining activities do not cause exceedances of the air quality limits stated in **Table B1 – Air Quality Limits** when measured at any sensitive place or commercial place, or both.
B4	Where monitoring identifies instances where the PM10 concentration specified in **Table B1 – Air Quality Limits** is exceeded, the environmental authority holder must report to the administering authority within **fourteen (14) days**: a) a description of meteorological conditions occurring at the time; b) the concentration of PM10 particulates upwind of the mining activities (if known); and c) measures taken to reduce dust generated by the mining activities.
B5	**Dust and particulate matter monitoring, control and reporting** A dust and particulate matter monitoring and control program must be: a) developed by an appropriately qualified person; and b) implemented for the duration of the mining activities.

B6	The dust and particulate matter monitoring and control program required by condition **B5** must include: (a) the collection of air quality and meteorological data at locations and using the monitoring methods described in **Table B2 - Dust and particulate matter monitoring**, **Table B3 - Dust and particulate matter monitoring description** and **Figure B1 - Dust and particulate matter monitoring locations** (or suitable alternative location as agreed with the administering authority); (b) a forecasting system to identify adverse meteorological conditions likely to produce elevated levels of PM10 at a sensitive place or commercial place due to the mining activities; and (c) a dust control strategy that would activate the timely implementation of high management dust control actions (listed in **Table B4 - Dust and particulate control actions**) in addition to the best practice dust control measures during periods identified in (b).
B7	The dust and particulate matter monitoring and control program must be submitted to the administering authority within **twenty (20) business days** after the commencement of Stage One activities.
B8	Notwithstanding **condition B6**, if requested by the administering authority, dust and particulate monitoring must be undertaken for a stated period at a specified sensitive place or commercial place, and the results provided to the administering authority within **fourteen (14) days** following completion of monitoring.
B9	If the monitoring required by **condition B8** is undertaken for over **one (1) month**, then monthly interim reports must be provided to the administering authority.
B10	By 1 September each year after commencement of Stage One activities, the environmental authority holder must report to the administering authority: (a) the results and an analysis of dust and particulate matter monitoring, including consideration of the relevant meteorological data; (b) details of the use of high management control measures including the dust and atmospheric conditions that triggered the action, when, where and what action was applied, and the effectiveness of the action meeting the air quality limits stated in **Table B1 – Air Quality Limits**; (c) identification of any trends (daily or seasonally) that should be considered in management of the mining activities and dust management practices; and (d) any changes to the dust and particulate control actions and monitoring resulting from an analysis of (a), (b) and (c).

Table B1 - Air Quality Limits

Quality Characteristic	Air Quality Limit	Averaging Period
Particulate Matter less than 10µm in aerodynamic diameter (PM_{10})	50 µg/m^3	24-hour

Dust deposition	120 mg/m^2/day	Monthly
Total particulate matter	90 mg/ m^3	One (1) year

Table B2 - Dust and particulate matter monitoring

Air Quality Determination	Monitoring method to be used
Concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (PM10) suspended in the atmosphere over a 24 hour averaging time	Real-time monitoring of the 24 hour average. Australian Standard AS3580.9.8: Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 continuous direct mass method using a tapered element oscillating microbalance analyser (or the most recent version), or any alternative method of monitoring PM10 that may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority.
Concentration of particulate matter suspended in the atmosphere in micrograms per cubic metre over a 24 hour averaging time	ASNZS 3580.9.3:2003 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method (or the most recent version)
Deposited Dust	Australian Standard AS 3580.10.1:2003 Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method (or the most recent version)
Meteorological data (including but not limited to wind speed and direction, humidity, temperature and precipitation)	AS 2923-1987: Ambient air - Guide for measurement of horizontal wind for air quality applications or as approved by the administering authority.
Siting of monitoring equipment	ASNZS 3580.1.1:2007 Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment

Table B3 - Dust and particulate matter monitoring description

Monitoring location	Receiving area on the receiving areas plan	Relevant upwind location	Monitoring Point Description
MLA-106	Wandoan township	Turkey Hill AWS	house
MLA-207	Wandoan township	Turkey Hill AWS	house
MLA-450	Wandoan township	Turkey Hill AWS	house
MLA-402	Leichhardt	Turkey Hill AWS, Wandoan AWS	house
MLA-520	North Wandoan township	Turkey Hill AWS	house
MLA-548	Woleebee South	Turkey Hill AWS, Wandoan AWS	feedlot

MLA-505	Woleebee South	Turkey Hill AWS, Wandoan AWS	homestead
MLA-300	Woleebee West	Turkey Hill AWS, Wandoan AWS	house
MLA-50	Mud Creek, Woleebee West	Turkey Hill AWS, Wandoan AWS	house
MLA-355	Woleebee West, Mud Creek	Turkey Hill AWS, Wandoan AWS	house
MLA-595	Turkey Hill	Wandoan AWS	homestead
MLA-693	Mud Creek	Turkey Hill AWS, Wandoan AWS	house
Accommodation facilities	Leichhardt	Turkey Hill AWS, Wandoan AWS	accommodation facilities

Table B4 - Dust and particulate control actions

Activity	High management control [Note 1]
Dragline - overburden	Relocation or Cease activity or limit hours of operation
Truck and Shovel	Relocation or Cease activity or limit hours of operation
Truck loading coal	Relocation or Cease activity or limit hours of operation
Bulldozing - overburden	Relocation or Cease activity or limit hours of operation
Truck dumping overburden	Relocation or Cease activity or limit hours of operation
Tailings disposal area	Water spray
ROM - erosion active stockpile	Regular water sprays
Truck dumping coal	Regular water sprays
Batch drop conveyor	Partial cover of chute
CPP (washplant)	Partial cover
Loading trains	Partial cover of chute and profile coal surface to flat ‘garden bed’ shape
Conveyor	Partial cover
Blasting - coal and overburden	Relocation or Cease activity or limit hours of operation
Drilling - overburden	Relocation or Cease activity or limit hours of operation
Haul roads	Application of chemical dust suppressants or use alternative haul routes or Cease activity or limit hours of operation
Grader	Relocation or Cease activity or limit hours of operation

[Note 1] ***Condition B10(d)*** *should be used to periodically update this table.*

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 except as permitted under the conditions of this environmental authority.
C2	The release of contaminants (that will or have the potential to cause environmental harm) to waters must only occur from the release points specified in **Table C1 - Contaminant release points, sources and receiving waters**.
C3	The release of contaminants to waters must not exceed the release limits stated in Table C2 - Contaminant Release Limits when measured at the monitoring points specified in Table C1 - Contaminant release points, sources and receiving waters for each quality characteristic.
C4	The release of contaminants to waters from the release points must be monitored at the locations specified in Table C1 - Contaminant release points, sources and receiving waters for each quality characteristics and at the frequency specified in Table C2 - Contaminant Release Limits and Table C3 - Release Contaminant Trigger Investigation Levels.

Table C1 - Contaminant release points, sources and receiving waters

Name	Release Point (RP) Easting (GDA94) [Note 1]	Release Point (RP) Northing (GDA94) [Note 1]	Contaminant Source and Location	Monitoring Point	Receiving waters description
AU-E1	789410	7108590	Environmental Dam	Spillway or outlet works	Woleebee Ck
AU-E2	787560	7111460	Environmental Dam	Spillway or outlet works	Woleebee Ck
AU-E4	788300	7112430	Environmental Dam	Spillway or outlet works	Woleebee Ck
FC-E1	792470	7104540	Environmental Dam	Spillway or outlet works	Frank Ck, Juandah Ck
MC-E2	781460	7118470	Environmental Dam	Spillway or outlet works	Mud Creek
SH-E3	773640	7121650	Environmental Dam	Spillway or outlet works	Spring Ck
W-E2	787990	7108360	Environmental Dam	Spillway or outlet works	Woleebee Ck
AU-R1	788240	7111990	Raw Water Storage Dam	Downstream Monitoring Point	Woleebee Ck

[Note 1] Approximate locations.

Table C2 - Contaminant Release Limits

Quality Characteristics	Release Limits for all Release Points	Sampling Frequency
Electrical conductivity (microsiemens per centimetre)	1000	Daily during release (the first sample must be taken within 2 hours of commencement of release)
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)
Turbidity (NTU)	1000	Daily during release (first sample within 2 hours of commencement of release)
Suspended Solids (mg/L)	1200	Daily during release (first sample within 2 hours of commencement of release)
Sulfate (mg/L)	1000	Daily during release (first sample within 2 hours of commencement of release)

Table C3 - Release Contaminant Trigger Investigation Levels

Quality Characteristic	Trigger Levels (micrograms per litre)	Comment on Trigger Level [Note 1]	Sampling Frequency
Aluminium	100	For aquatic ecosystem protection, based on LOR for ICPMS	Commencement of release and thereafter weekly during release (for all Quality Characteristics)
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Mercury	0.2	For aquatic ecosystem protection, based on LOR for CV FIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1900	For aquatic ecosystem protection, based on SMD guideline	
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS	

Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Fluoride (total)	2000	Protection of livestock and short term irrigation guideline	

[Note 1] ICPMS means inductively coupled plasma mass spectrometry; CV means cold vapour; FIMS means flow injection mercury system.

[Note 2] All metal and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal and metalloids apply if dissolved results exceed trigger.

*[Note 3] The list of quality characteristics required to be monitored as per **Table C3 - Release Contaminant Trigger Investigation Levels** will be reviewed once the results of the monitoring data is gathered for the interim period until 31 December 2011 or an earlier date if the data is, or becomes, available and if it is determined that there is no need to monitor for certain individual characteristics these can be removed from **Table C3 - Release Contaminant Trigger Investigation Levels**.*

[Note 4] SMD - slightly moderately disturbed level of protection, guideline refers ANZECC and ARMCANZ (2000).

[Note 5] LOR - typical reporting for method stated. ICPMS, CV FIMS - analytical method required to achieve LOR.

C5	If water quality characteristics of the release exceed any of the trigger levels specified in **Table C3 - Release Contaminant Trigger Investigation Levels** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in **Table C3 - Release Contaminant Trigger Investigation Levels** and: (a) where the trigger values are not exceeded then no action is to be taken; or (b) where the downstream results exceed the trigger values specified in **Table C3 - Release Contaminant Trigger Investigation Levels** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; (i) if the result is less than the background monitoring site data, then no action is to be taken; or (ii) if the result is greater than the background monitoring site data, complete an investigation in accordance with the ANZECC & ARMCANZ 2000 methodology into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining the details of the investigations carried out and actions taken to prevent environmental harm. *Note: Where an investigation is being undertaken in accordance with **C5(2)(ii)** no further reporting is required for subsequent trigger events for that quality characteristic.*
C6	If an exceedance in accordance with **condition C5(2)(ii)** is identified; the environmental authority holder must notify the administering authority within **fourteen (14) days** of receiving the result.
C7	**Contaminant Release Events** The environmental authority holder must install, operate and maintain a stream flow gauging station to determine and record stream flows at the locations upstream of each Release Point for any receiving water into which a release occurs.
C8	The release of contaminants to waters must only take place during periods of natural flow events specified as minimum flow in **Table C4 - Contaminant Release during Flow Events** for the release point(s) specified in **Table C1 - Contaminant release points, sources and receiving waters**.

Table C4 - Contaminant Release during Flow Events

Minimum Flow in Receiving Water Required for a Release Event	Flow recording Frequency
Equal to or greater than 1 cubic metre per second	Daily during discharge

C9	Contaminant release flow rate must not exceed **twenty (20) percent** of receiving water flow rate.
C10	The daily quantity of contaminants released from each release point must be measured and recorded at the monitoring points in **Table C1 - Contaminant release points, sources and receiving waters**.
C11	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters or cause a material build up of sediment in such waters.
C12	The release of contaminants directly or indirectly to waters: (a) must not produce any visible discolouration of receiving waters; and (b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.
C13	**Notification of Release Event** The environmental authority holder must notify the administering authority via WaTERs within **six (6) hours** of having commenced releasing water to the receiving environment, and for every **twenty-four (24) hours** while release of mine affected water are occurring. Notification must be in writing (which may be electronically) and include: (a) release commencement date and time; (b) expected release cessation date and time; (c) release point(s); (d) if the release limits defined in **Table C2 - Contaminant Release Limits** are exceeded; (e) release volume (estimated); (f) receiving water(s) including the natural flow rate; (g) any details (including available data) regarding likely impacts on the receiving water(s); (h) any actions undertaken by the environmental authority holder that may have contributed to the release; and (i) measures that have been taken to prevent or mitigate any potential or actual environmental harm.
C14	**Notification of Release Event Exceedance** If the release limits defined in **Table C2 - Contaminant Release Limits** are exceeded, or are likely to have been exceeded, the environmental authority holder must notify the administering authority within **six (6) hours** of the event.

C15	The environmental authority holder must notify the administering authority within **twenty-four (24) hours** after cessation of a release event, of the cessation of a release notified under **condition C13** and within **twenty eight (28) days** provide the following information in writing to the administering authority via WaTERS: (a) release cessation date and time; (b) natural flow volume in receiving water; (c) volume of water released; (d) 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); (e) all in-situ water quality monitoring results; and (f) any other matters pertinent to the water release event. **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 **condition C13** and **condition C15**, provided the relevant details of the release are included within the notification provided in accordance **with condition C13** and **condition C15**.
C16	**Monitoring of Water Storage Quality** Water storages stated in **Table C5 - Water Storage Monitoring**, which are associated with the release points identified in **Table C1 - Contaminant release points, sources and receiving waters**, must be monitored for the water quality characteristics specified in **Table C6 - Onsite Water Storage Quality** at the monitoring locations and at the sampling frequency specified in **Table C5 - Water Storage Monitoring**. If water quality characteristics in the water storages listed in **Table C5 - Water Storage Monitoring** exceed any of the trigger levels specified in **Table C6 - Onsite Water Storage Quality**, the environmental authority holder must investigate and undertake appropriate management actions to reduce the levels to or below those in **Table C6 - Onsite Water Storage Quality**, and provide a written report to the administering authority in the next Annual Water Monitoring Report required by condition **C25**, outlining the details of the investigations carried out and actions taken.

Table C5 - Water Storage Monitoring

Name	Water Storage Description	Monitoring Location	Frequency of sampling
AU-E1	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
AU-E2	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
AU-E4	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
FC-E1	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
MC-E2	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
SH-E3	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
W-E2	Environmental Dam	within 10 m of spillway or outlet works intake point	Quarterly
AU-R1	Raw Water Storage Dam	within 10 m of spillway or outlet works intake point	Quarterly

Table C6 - Onsite Water Storage Quality

Quality Characteristic	Value	Trigger levels
pH (pH unit)	Range	Greater than 4, less than 9 [Note 2]
EC (microsiemens per centimetre)	Maximum	5970 [Note 1]
Sulfate (mg/L)	Maximum	1000 [Note 1]
Fluoride (mg/L)	Maximum	2 [Note 1]
Aluminium (mg/L)	Maximum	5 [Note 1]
Arsenic (mg/L)	Maximum	0.5 [Note 1]
Cadmium (mg/L)	Maximum	0.01 [Note 1]
Cobalt (mg/L)	Maximum	1 [Note 1]
Copper (mg/L)	Maximum	1 [Note 1]
Lead (mg/L)	Maximum	0.1 [Note 1]
Nickel (mg/L)	Maximum	1 [Note 1]
Zinc (mg/L)	Maximum	20 [Note 1]

[Note 1] Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines.

[Note 2] Page 4.2-15 of ANZECC & ARMCANZ (2000) "Soil and animal health will not generally be affected by water with pH in the range of 4-9".

[Note 3] Total measurements (unfiltered) must be taken and analysed.

C17	In water storages containing coal seam gas associated water exposed to air, the dissolved oxygen shall be greater than 2 milligrams per litre measured in the impounded water.
C18	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored for each quality characteristic and at the monitoring frequency stated in **Table C7 - Receiving Waters Contaminant Trigger Levels** at the locations specified in **Table C8 - Receiving Water Upstream Background Sites and Downstream Monitoring Points**.

Table C7 - Receiving Waters Contaminant Trigger Levels

Quality Characteristic	Investigation Trigger Level	Sampling Frequency
pH	6.5 - 8.0	Continuous
Electrical Conductivity (microsiemens per centimetre)	1000	Continuous
Suspended solids (mg/L)	1200	Daily during release
Sulfate (mg/L)	1000 (Protection of irrigation value)	Daily during release

Table C8 - Receiving Water Upstream Background Sites and Downstream Monitoring Points

Monitoring Points	Receiving Waters Location Description	Northing (GDA94) [Note 1]	Easting (GDA94) [Note 1]
Upstream Background Monitoring Points			
J-UJ	Upper Juandah Ck	7105181	799058
J-UF	Frank Ck Dam	7100536	793760
W-UW	Woleebee Ck	7104135	785187
Alt W-UW	Alternative Woleebee Ck	7102081	783585
M-UMu	Mud Ck	7109591	776940
Alt W-UWa	Alternate Wandoan Ck	7101390	781114
M-UM	Mt Organ Ck	7111479	773829
Downstream Monitoring Points			
J-DJ	Juandah Ck	7114761	790733
J-DF	Frank Ck	7115068	790589
W-DW	Woleebee Ck	7116742	788907
	To replace W-DW Woleebee Ck	7116168	788199
M-DMu	Mud Ck	7122555	783948
	Mud Ck Year 5	7120837	780685
S-DS	Spring Ck	7120213	772325
	Spring Ck Year 9	7125959	771710
D-DS	Duck Ck	7125353	767160

[Note 1] Approximate location.

C19	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C7 - Receiving Waters Contaminant Trigger Levels** during a release event, the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or (b) where the downstream results exceed the upstream results, complete an investigation in accordance with the ANZECC & ARMCANZ 2000 methodology, into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm. *Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
C20	**Receiving environment monitoring program (REMP)** The environmental authority holder must design and implement a REMP within **three (3) months** of the commencement of Stage One activities to identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. The REMP must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Frank Creek, Woleebee Creek, Mud Creek, Duck Creek and Spring Creek and connected waterways within **ten (10) kilometres** downstream of the release. The REMP must encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
C21	A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administrating authority upon request. The REMP Design Document must be prepared **three (3) months** prior to implementation of the REMP.

C22	The REMP Design Document must address (but not necessarily be limited to) the following: (a) Description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); (b) Description of applicable environmental values and water quality objectives to be achieved (i.e. as scheduled pursuant to the Environmental Protection (Water) Policy 2009); (c) Any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed; (d) Water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP; (e) Monitoring for any potential adverse environmental impacts caused by the release; (f) Monitoring of stream flow and hydrology; (g) Monitoring of toxicants should consider the indicators specified in **Table C3 - Release Contaminant Trigger Investigation Levels** to assess the extent of the compliance of concentrations with water quality objectives and or the ANZECC and ARMCANZ (2000) guidelines for slightly to moderately disturbed ecosystems; (h) Monitoring of physical chemical parameters as a minimum those specified in **Table C2 - Contaminant Release Limits** (in addition to dissolved oxygen saturation and temperature); (i) Monitoring biological indicators (for macroinvertebrates in accordance with the AusRivas methodology) and metals and metalloids in sediments (in accordance with ANZECC and ARMCANZ (2000), BATLEY and or the most recent version of ASNZS 5667.12:1999 Water quality - Sampling - Guidance on Sampling of Bottom Sediments) for permanent, semi-permanent water holes and water storages; (j) The locations of monitoring points (including the locations specified in **Table C8 - Receiving Water Upstream Background Sites and Downstream Monitoring Points** which are background and downstream impacted sites for each release point); (k) The frequency or scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within **two (2) years** (depending on wet season flows) in accordance with the Queensland Water Quality Guidelines 2009. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges; (l) Specify sampling and analysis methods and quality assurance and control; (m) Any historical datasets to be relied upon; (n) Description of the statistical basis on which conclusions are drawn; and (o) Any spatial and temporal controls to exclude potential confounding factors.

C23	A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made available on request to the administrating authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.
C24	**Water General** All determinations of water quality must be: (a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; (b) made in accordance with methods prescribed in the latest edition of the administering authority's Monitoring and Sampling Manual 2018, Environmental Protection (Water and Wetland Biodiversity) Policy 2019; (c) collected from the monitoring locations identified within this environmental authority, within **ten (10) hours** of each other where possible; (d) carried out on representative samples; and (e) laboratory testing must be undertaken using a laboratory accredited (e.g. NATA) for the method of analysis being used.
C25	**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 in the specified format upon request: (a) the date on which the sample was taken; (b) the time at which the sample was taken; (c) the monitoring point at which the sample was taken; (d) the measured or estimated daily quantity of the contaminants released from all release points; (e) the release flow rate at the time of sampling for each release point; and (f) the results of all monitoring and details of any exceedances with the conditions of this environmental authority.
C26	**Water Management Plan** A Water Management Plan must be developed prior to the commencement of Stage One activities. The Water Management Plan must be implemented upon commencement of Stage One activities.
C27	The Water Management Plan, required by **condition C26**, must provide for the proper and effective management of the actual and potential environmental impacts resulting from the mining activities and to ensure compliance with the conditions of this environmental authority.

C28	The Water Management Plan must be developed in accordance with the administering authority's Guideline - Preparation of Water Management Plans for Mining Activities (EM324) or any updates that become available from time to time and must include at least the following components: (a) Contaminant Source Study; (b) Site Water Balance and Model; (c) Water Management System; (d) Saline Drainage Prevention and Management Measures; (e) Acid Rock Drainage Prevention and Management Measures (if applicable); (f) Emergency and Contingency Planning; and (g) Monitoring and Review.
C29	The Water Management Plan must also include, in accordance with Order 2(b) of the Land Court of Queensland decision Xstrata Coal Queensland Pty Ltd and Ors v. Friends of the Earth - Brisbane Co-Op Ltd and Ors, and Department of Environment and Resource Management [2012] QLC 013, a monitoring program for the Hutton and Precipice Sandstone Aquifers that is designed and implemented, in consultation with the administering authority, using existing deep bores for the following purposes: (a) to establish the base line yield and water quality of the supply from those bores; and (b) to regularly monitor the bores to identify any change in the yield and quality of the water supply from aquifers.
C30	Each year the environmental authority holder must ensure that proper and effective measures, practices and procedures are in place as outlined in the Water Management Plan prior to the wet season (i.e. by 1 November) and a further review following the wet season (i.e. by 1 May the following year) so that the mine is operated in accordance with the conditions of this environmental authority and that environmental harm is prevented or minimised.
C31	A copy of the Water Management Plan and or revised Water Management Plan must be provided to the administering authority on request.
C32	**Saline Drainage** The environmental authority holder must ensure reasonable and practicable measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
C33	**Acid Rock Drainage** The environmental authority holder must ensure reasonable and practicable measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
C34	**Stormwater and Water Sediment Controls** An Erosion and Sediment Control Plan must be developed by a suitably qualified person prior to the commencement of Stage One activities.

C35	An Erosion and Sediment Control Plan required by **condition C34** must be implemented for the duration of mining activities to minimise erosion and the release of sediment to water and contamination of storm water.
C36	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas that would result in the release of wastes, contaminants or materials to any stormwater drainage system or 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 waters.
C38	**Water Management System** On 1 November each year, the environmental authority holder shall review: (a) the spatial extent of controlled catchments, (b) storage capacity, (c) current storage volumes, (d) transfer capacity, and (e) Standard Operating Procedures of all key infrastructure elements of the mine water management system and update the mine water balance model. An assessment of the mine water balance model must be undertaken to ensure that as at 1 November, the mine water management system has sufficient storage capacity, transfer capacity, and transfer operations to ensure that the frequency of uncontrolled discharges of mine water is less than or equal to the specified AEP in **Table G3 - Hydraulic Performance Dams**. The assessment must be undertaken with an appropriate period of climate data that includes representation of wet season rainfall events up to the AEP specified in **Table G3 - Hydraulic Performance Dams**. The assessment results must be documented and be available for auditing.
C39	The environmental authority holder must notify the administering authority within **fourteen (14) days**, if any assessment of the mine water management system shows that the risk of uncontrolled discharge is greater than the specified AEP in **Table G3 - Hydraulic Performance Dams**.
C40	Notwithstanding the provisions for Mandatory Report Levels in **Table G3 - Hydraulic Performance Dams**, the environmental authority holder must not allow any uncontrolled discharge to be caused by either: (a) failure to stop transferring water to a dam where the transfer into that dam contributes in part, or full, to the overflow (uncontrolled discharge) of that dam; or (b) failure to start and continue transferring water from a mine water dam, where the Standard Operation Procedures require the water transfer from the dam to prevent overflow (uncontrolled discharges).

C41	**Monitoring and Reporting in the event of uncontrolled release** In the event of an uncontrolled release from any component of the mine water system to the receiving environment, the environmental authority holder shall: Sample and monitor the uncontrolled release waters during or as immediately practical after the event (recognising that uncontrolled discharges should only occur during rainfall in excess of the design AEP and site may not be accessible) to determine quality characteristics of the uncontrolled release for parameters specified in **Table C2 – Contaminant Release Limits**, and **Table C3 - Release Contaminant Trigger Investigation Levels**; (a) Sample and monitor the receiving environment monitoring sites listed in **Table C8 - Receiving Water Upstream Background Sites and Downstream Monitoring Points** for sites relevant to the uncontrolled release location; (b) Estimate the quantity of uncontrolled release waters, by a suitably qualified and experienced person(s); (c) Provide a written report to the administering authority within **fourteen (14) days** of the uncontrolled release event, which shall include as a minimum: (i) the time and dates of the uncontrolled release event; (ii) the location of the uncontrolled release; (iii) the monitoring quality of the uncontrolled release waters; or if not available due to site access constraints in wet weather during the event, the quality of waters in the dam that contributed to the uncontrolled release before the event (from monitoring undertaken as part of **condition C16**) and quality in that dam after the release events; (iv) the estimated quantity of uncontrolled release; (v) downstream receiving water monitoring results; (vi) rainfall during, or that contributed to, the uncontrolled release event and dam levels prior to the rainfall event that caused uncontrolled release; (vii) a determination of whether uncontrolled release was solely caused by rainfall exceeding the design AEP events specified in **Table G3 - Hydraulic Performance Dams**; (viii) a determination of whether the uncontrolled release was cause in part of full, by failure to operate the integrated mine water system in accordance with Standard Operating Procedures for the integrated mine water system, or physical failure of one or more components of the integrated mine water system; (ix) a determination of whether the uncontrolled release caused environmental harm; and (x) if determined that the uncontrolled release could have been reasonably prevented, actions that will be taken to ensure uncontrolled releases comply in all respects with this environmental authority.

Agency interest: Groundwater	
Condition number	**Condition**
W1	**Contaminant release** The environmental authority holder must not release contaminants to groundwater.
W2	**Groundwater Monitoring Program** The environmental authority holder must develop and implement a Groundwater Monitoring Program as described in **Table W1 - Groundwater monitoring program** and the locations shown in **Figure W1 - Groundwater monitoring program**. The Groundwater Monitoring Program must be able to detect any significant changes to ground water quality values that may be caused as a result of mining activities.

Table W1 - Groundwater monitoring program

Monitoring Sites	Location		Parameter(s)	Monitoring frequency	Purpose	Target Aquifer
	Latitude	Longitude				
WMB1-D	-26.13523421	149.8695582	Water level	Every 12 hours - electronic loggers	Detect drawdown in shallow coal seam aquifer and any mine induced variation in groundwater quality	Coal seam aquifer
WMB1-S	-26.13523421	149.8695582				
WMB2	-26.13533412	149.9503265				
WMB3-D	-26.10019774	149.8944337				
WMB3-S	-26.10019774	149.8944337	pH, EC, TDS (lab), cations, anions, Sulfate, selected metals (Al, Ba, Fe, As, Cd, Cr, Co, Cu, Ni, Li, Sr, Zn, Bo, Mn)	Every 3 months		
G8011D	-26.080539344	149.928299078				
G8012-D	-26.09905012	149.8647167				
G8013-D	-26.11867143	149.8712221				
G8018-D	-26.002792193	149.804123834				
G8010-S	-26.147012839	149.929377565	Water level	Every 12 hours - electronic loggers	Determine baseline hydrochemistry and groundwater level variation in alluvium aquifer	Alluvium aquifer
G8011-S	-26.080539344	149.928299078				
G8012-S	-26.09905012	149.8647167				
G8013-S	-26.11867143	149.8712221	pH, EC, TDS (lab), cations, anions, Sulfate, selected metals (Al, Ba, Fe, As, Cd, Cr, Co, Cu, Ni, Li, Sr, Zn, Bo, Mn)	Every 3 months		
G8016-S	-26.148855510	149.855645500				
G8017-S	-26.036359803	149.886002295				

W3	The environmental authority holder must, when requested by the administering authority, submit within **thirty (30) days** an assessment report on the results of the groundwater monitoring program. The assessment must address whether the environmental values are being protected with reference to water quality parameters in **Table W1 - Groundwater monitoring program**, and any other monitoring data obtained, and state the basis on which the conclusions are drawn. If necessary, corrective and mitigation measures taken should be described.
W4	**Bore construction and maintenance and decommissioning** All groundwater bores (including groundwater monitoring bores) must be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee, 2011).

Schedule D: Noise and vibration	
Condition number	**Condition**
D1	**Noise nuisance** Noise from the mining activity must not cause a noise nuisance at any sensitive place or commercial place.
D2	All noise from the mining activity must not exceed the levels specified in **Table D1 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)** at any sensitive place or commercial place.
D3	Noise is not considered to be a nuisance under **condition D1** if monitoring shows that noise from the mining activity does not exceed the following levels in the time periods specified in **Table D1** - **Noise Limits for Mining Activity (Sensitive Place or Commercial Place)**.

Table D1 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)

Noise Level [dB(A)] (outside) at a 'Sensitive Place' or 'Commercial Place' expressed as	**Monday to Sunday**		
	7am - 6pm	**6pm - 10pm**	**10pm - 7am**
LAeq,adj,15 mins	42	35	35
LA1,adj,15 mins	55	50	40

D4	**Noise monitoring** Monitoring of the receiving acoustic environment shall be conducted at the locations described in **Table D2 - Noise Monitoring locations and duration** and shown on **Figure D1 – Noise monitoring locations** for the duration shown in **Table D2 - Noise Monitoring locations and duration**, or alternative locations as agreed with the administering authority.

Table D2 - Noise Monitoring locations and duration

No.	Location [Note 1]	Receiving area	Duration	Type
1.	MLA-378	Leichhardt	During the operation of the Project.	Fixed automated, continuous monitoring
2.	N3	Town (Central)	During the operation of the Project.	Fixed automated, continuous monitoring
3.	MLA-520	Town (North)	One month before commencement of mining at Wubagul Pit and at monthly intervals during the operation of the Frank Creek and Wubagul Pits	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
4.	MLA-640	Town (South)	One month before commencement of mining at Wubagul Pit and at monthly intervals during the operation of the Frank Creek and Wubagul Pits	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
5.	MLA-720	Mud creek (West)	Monthly during the operation of Turkey Hill Pit	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
6.	MLA-595	Turkey Hill	Monthly during the operation of Turkey Hill Pit	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
7.	MLA-305	Woleebee West (West)	Monthly once mining of the northern 50 percent of Summer Hill Pit is completed	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
8.	MLA-693	Mud creek (Central)	Monthly during operation of Summer Hill North Pit.	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
9.	MLA-355	Woleebee West (Central)	Monthly once mining of the northern 50 percent of Mud Creek Pit is completed	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period
10.	MLA-300	Woleebee West (East)	Monthly once mining of the northern 50 percent of Woleebee Creek Pit is completed	Mobile or fixed automated continuous monitoring using an unattended noise logger for a defined (minimum seven day) period

*[Note 1] Shown on **Figure D1 – Noise monitoring locations***

D5	Notwithstanding **condition D3**, if requested by the administering authority, noise monitoring must be undertaken for a stated period at a specified sensitive place or commercial place, and the results provided to the administering authority within **fourteen (14) days** following completion of monitoring. Monitoring must include: (a) LAeq,adj,15 mins , LA1,adj,15 mins recorded at 15 minute intervals (b) the level and frequency of occurrence of impulsive or tonal noise; (c) atmospheric conditions including wind speed and direction; and (d) effects due to extraneous factors such as traffic noise, insects, etc; and location date and time of recording.
D6	If the monitoring required by **condition D5** is undertaken for over **one (1) month**, then monthly interim reports must be provided to the administering authority.
D7	The method of measurement and reporting of noise levels must comply with the current edition of the administering authority's Noise Measurement Manual (ESR/2016/2195) and any subsequent versions.
D8	If monitoring indicates exceedance of the relevant limits in **Table D1 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)**, then the environmental authority holder must: (a) if the monitoring is relevant to a complaint, the environmental authority holder must 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 activity do not result in further environmental nuisance.
D9	**Vibration nuisance** Vibration from the mining activity must not cause an environmental nuisance at any sensitive place or commercial place.
D10	If the environmental authority holder can provide evidence through monitoring that the limits defined in **Table D3 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)** are not being exceeded, then the environmental authority holder is not in breach of **condition D9**.
D11	If monitoring indicates exceedance of the relevant limits in **Table D3 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)**, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; and (b) immediately implement vibration abatement measures so that vibrations from the activity do not result in further environmental nuisance.

Table D3 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)

Blast Noise and Vibration Parameter	Monday to Sunday - 8am to 5pm
Airblast overpressure level (dB Linear peak)	115 dB (linear peak) for 4 out of any 5 consecutive blasts regardless of the interval between blasts. Any single blast must not exceed 120 dB (linear peak).
Peak particle velocity (mm/s)	For vibrations of more than 35 Hz - no more than 25 mm/s ground vibration For vibrations of no more than 35 Hz - no more than 10 mm/s ground vibration

D12	If requested by the administering authority, vibration monitoring must be undertaken for a stated period at a specified sensitive place or commercial place, and the results provided to the administering authority within **fourteen (14) days** following completion of monitoring.
D13	The method of measurement and reporting of vibration levels must take into consideration Appendix J of AS 2187.2-2006.
D14	If the monitoring required by **condition D12** is undertaken for over **one (1) month**, then monthly interim reports must be provided to the administering authority.
D15	**Airblast overpressure nuisance** Subject to **condition D16** and **condition D17**, airblast overpressure level from blasting operations must not cause an environmental nuisance, at any sensitive place or commercial place.
D16	If the environmental authority holder can provide evidence through monitoring that the limits defined in **Table D3** are not being exceeded, then the environmental authority holder is not in breach of **condition D15**.
D17	If monitoring indicates exceedance of the relevant limits in **Table D3 - Noise Limits for Mining Activity (Sensitive Place or Commercial Place)**, and the monitoring was undertaken in response to a complaint, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; and (b) immediately implement airblast overpressure abatement measures so that airblast overpressure from the activity do not result in further environmental nuisance.
D18	If requested by the administering authority, monitoring of airblast overpressure must be undertaken for a stated period at a specified sensitive place or commercial place, and the results provided to the administering authority within **fourteen (14) days** following completion of monitoring.
D19	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.
D20	The method of measurement and reporting of airblast overpressure levels must take into consideration Appendix J of AS 2187.2 - 2006.

Schedule E: Waste	
Condition number	**Condition**
E1	**Non-Mineral Waste** **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 less than **three (3) metres** high, and at least **ten (10) metres** from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
E2	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.
E3	**Disposal of tyres** Disposing of scrap tyres resulting from the authorised activities must be consistent with the requirements of the administering authority's operational policy: Disposal and storage of scrap tyres at mine sites (2014) or any later versions.
E4	**Waste management** A Waste Management Program must be: a) developed by an appropriately qualified person; and b) implemented for the duration of the mining activities.

E5	The Waste Management Program must cover: (a) how the environmental authority holder will recognise and apply the waste management hierarchy; (b) identify characterisations of wastes generated from the project and general volume trends over the past **five (5) years**; (c) waste commitments with auditable targets to reduce, reuse and recycle; (d) waste management control strategies including: (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 waste; (vi) emergency response planning; and (vii) disposal, reused and recycling options; (e) identify the potential adverse and beneficial impacts of the wastes generated; (f) hazardous characteristics of the wastes generated including: (i) disposal procedures for hazardous wastes; (ii) processes to be implemented to allow for continuous improvement of the waste management systems; (iii) identification of responsible staff (positions) for implementing, managing and reporting the Waste Management Plan; and (iv) staff awareness and induction programs that encourage re-use and recycling.
E6	**Mineral Waste** Prior to construction of any mineral waste storage facility, undertake a risk assessment, in accordance with generally accepted standards to determine if: (a) the mineral waste is a hazardous waste or has acid producing potential; and (b) the mined pit is a hazardous dam.
E7	**Coal Handling and Preparation Plant Waste** Waste from the Coal Handling and Preparation Plant must be disposed of in regulated dams in accordance with the requirements of **Table G2 - Details of Regulated Dams** of this environmental authority if the residual shear strength of the waste is less than 1 kilopascal prior to disposal.
E8	**Spoil disposal facility - certification and operation** Authorised spoil disposal facilities, used for the disposal of waste are located within the control points defined in **Table E1 - Location of spoil disposal facility**.

Table E1 - Location of spoil disposal facility

Name of spoil disposal facility	Control Points		
	Easting (GDA94)	Northing (GDA94)	Control Point I.D. (Figure E1)
Turkey Hill	772953	7119870	1
	771089	7117667	2
	767092	7119010	3
	767092	7119874	4
	767603	7121769	5
	768643	7122539	6
	769803	7122388	7
Summer Hill	776641	7121418	8
	777081	7117658	9
	776988	7114575	10
	774539	7114582	11
	772421	7116419	12
	772421	7118560	13
	774500	7119962	14
	774516	7122747	15
	775900	7122747	16
Mud Creek	780400	7117632	41
	780654	7117380	42
	783295	7117339	43
	783280	7115553	44
	784204	7115507	45
	784204	7113805	46
	782652	7113790	47
	781362	7113158	48
	777896	7113212	49
	777245	7113426	50
	777360	7115333	51
	778212	7115638	52
	778212	7117678	53

Mud Creek North (satellite pit)	780754	7117301	17
	779760	7118202	18
	777970	7117876	19
	777787	7118506	20
	780122	7119480	21
	781516	7118017	22
Mud Creek East (satellite pit)	785842	7116437	23
	785263	7115828	24
	784525	7116480	25
	783591	7116558	26
	783628	7117859	27
	784969	7117822	28
	785010	7117323	29
Woleebee Creek	786354	7108064	66
	786808	7107611	67
	787139	7106320	68
	787000	7105717	69
	785689	7104389	70
	783296	7106872	71
	785424	7108252	72
Woleebee North	786808	7107611	73
	786354	7108064	74
	785199	7109478	75
	786439	7110751	76
	787108	7110141	77
	787940	7108394	78
Woleebee North (satellite pit)	785093	7109675	91
	784111	7110532	92
	785053	7111543	93
	786022	7110715	94
Wubagul	798500	7103082	54
	796627	7101693	55

	794969	7103936	56
	796854	7105325	57
Frank Creek North	793306	7109510	100
	794567	7109675	101
	794646	7109081	102
	794257	7105260	103
	793013	7108743	104
	793894	7107991	105
	793616	7107938	106
Frank Creek South	794072	7106518	107
	794303	7106221	108
	794211	7105323	109
	793114	7105468	110
	793279	7106756	111
Frank Creek West	793132	7109681	79
	793288	7108810	80
	793016	7107640	81
	791395	7107645	82
	791397	7108818	83
	792387	7109740	84
Woleebee	790635	7104922	58
	788927	7104185	59
	787078	7104211	60
	787000	7105717	61
	787423	7107255	62
	789127	7107270	63
	789823	7108135	64
	791693	7108154	65
Austinvale North	789308	7112611	95
	788373	7113410	96
	789091	7114156	97
	790584	7113892	98

	792278	7112591	99
Austinvale	790783	7112451	30
	792045	7112206	31
	792032	7111515	32
	791340	7111499	33
	791418	7109574	34
	791036	7108981	35
	789373	7108965	36
	788834	7109339	37
	788500	7110187	38
	788507	7111152	39
	789136	7112597	40
Leichhardt	793132	7109681	85
	792387	7109740	86
	791687	7111000	87
	791653	7112207	88
	792866	7112173	89
	793475	7110164	90

E9	Spoil disposal facility(s) shall be designed to prevent environmental harm arising from contaminants being generated in the facility, leachate and runoff from the facility.
E10	Authorised spoil disposal facility(s) must be constructed and maintained in accordance with certified design plans, submitted to the administering authority.
E11	Design plans for the authorised spoil disposal facility(s) must include the following performance indicators: (a) during operations the spoil disposal facility(s) will be operated with minimal or no potential for adverse environmental harm resulting from collapse of any component of the facility; (b) the potential for leachate generation will be minimal or non existent; and (c) adequate drainage structures, erosion protection and storage are provided to manage seasonal and rare rainfall events with minimal or no environmental harm.
E12	Construction of any spoil disposal facility detailed in **Table E1 - Location of spoil disposal facility** must not commence unless: (a) the environmental authority holder has submitted to the administering authority two copies of a design plan; (b) certification from a suitably qualified and experienced person that the design of the spoil disposal facility(s) will deliver the performance stated in that design plan and that it will be compliant in all other respects with this environmental authority, and (c) at least **twenty (20) business days** has passed since the receipt of those documents by the administering authority; or (d) the administering authority notifies the environmental authority holder that a design plan and certification has been submitted for that disposal facility.
E13	**Operational plan - Spoil disposal facility** An operational plan – spoil disposal facility must be: a) developed by an appropriately qualified person; and b) implemented for the duration of the mining activities.
E14	The operational plan must include but not be limited to: (a) description of landform development stages of the spoil disposal facility; (b) placement technique for spoil and waste material from the coal handling and processing plant on the mine site; (c) management of any containment structures within the spoil disposal facility designed to contain materials from the coal handling an processing plant on the mine site (d) demonstration of how operations of the spoil disposal facility are consistent with the accepted design plan for the facility; and (e) decommissioning and rehabilitation strategies for the spoil disposal facility that demonstrate consistency with conditions of this environmental authority.

E15	**Mining waste management** A Mining Waste Management Plan together with the certification by an appropriately qualified person(s) must be developed and implemented within **twelve (12) months** of the commencement of Stage One activities.
E16	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 contaminants: pH, Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), Net Acid Generation (NAG) (reporting NAG capacity and NAG pH after oxidation), Net Acid Producing Potential (NAPP), 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. *[Note: The list of contaminants will be reviewed by an appropriately qualified person after the development of the Mining Waste Management Plan, and if it is determined that certain contaminants are a low risk to the environment, these can be removed from the Mining Waste Management Plan].* (b) characterisation programs to ensure that the physical properties of the mining waste is progressively characterised during disposal;. (c) the availability or leachability of metals from the mining waste; (d) quantity of potentially acid forming (PAF) mining waste; (e) review potential impacts of PAF mining waste on the success of proposed rehabilitation methods; (f) management actions for mining waste that has been identified as having a high availability or leachability of metals; (g) management actions for mining waste that has been defined as PAF; (h) identification of environmental impacts and potential environmental impacts; (i) control measures for routine operations to minimise likelihood of environmental harm; (j) contingency plans and emergency procedures for non-routine situations; and (k) periodic review of environmental performance and continual improvement.

Schedule F: Land	
Condition number	**Condition**
F1	**Final Land Use and Rehabilitation Plan** All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with **Table F1** - **Final Land Use and Rehabilitation Approval Schedule** and **Table F2 - Landform design criteria for Wandoan Coal Mine**.

Table F1 - Final Land Use and Rehabilitation Approval Schedule

Disturbance type	Post-mining land use	Post-mining land suitability class for dry land cropping	Post-mining land suitability class for beef cattle grazing
Exploration	Beef cattle grazing, native bushland, or plantation forestry	Class 3 and Class 4	Class 2 and Class 3
Infrastructure including roads, MIA, etc.	Beef cattle grazing, native bushland, plantation forestry or infrastructure is retained for use.	Class 3 and Class 4	Class 2 and Class 3
Low gradient overburden disposal stockpiles including tailings disposal	Beef cattle grazing, native bushland, or plantation forestry	Class 4	Class 2
Steeper gradient overburden disposal stockpiles	Low density beef cattle grazing or native bushland	Class 5	Class 4
Final voids	Low density beef cattle grazing or native bushland	Class 5	Class 4
Water Storage Dams	Either retained for subsequent agricultural use or remediated and rehabilitated for beef cattle grazing or native bushland	Class 4	Class 2
Sediment Dams	Either retained for subsequent agricultural use or remediated and rehabilitated to beef cattle grazing or native bushland	Class 4	Class 2
Environmental dams	Either retained for subsequent agricultural use or remediated and rehabilitated to beef cattle grazing or native bushland	Class 4	Class 2
Any contaminated land	A use consistent with a contaminated site management plan for the area.	Not Applicable	Not Applicable

Table F2 - Landform design criteria for Wandoan Coal Mine

Disturbance Type	Slope Range (percent)
Residual Voids (high wall)	0 - 214 percent or 65 degrees
Residual Voids (low wall)	0 - 100 percent or 45 degrees
Recontoured Spoil Area	0 - 18 percent or 10 degrees
Waste Rock Dumps	0 - 18 percent or 10 degrees
Infrastructure and ROM areas	0 - 18 percent or 10 degrees
Roads and Tracks	0 - 10 percent or 5.7 degrees

F2	The environmental authority holder is responsible for rehabilitating any land disturbed by mining activities on the pre-requisite tenures as depicted in **Figure F1 – Pre-requisite tenures**, in accordance with the conditions of this environmental authority insofar as they apply to ML50229, ML50230 and ML50231.
F3	Progressive rehabilitation must commence when areas become available within the operational land.
F4	Complete an investigation into the planned rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in **condition F1** and **Table F1 - Final Land Use and Rehabilitation Approval Schedule** and **Table F2 - Landform design criteria for Wandoan Coal Mine** prior to commencement of Stage One activities.
F5	The environmental authority holder must decommission all drill holes identified in **Table F3 - Drill Holes to be Decommissioned by 31 December 2018**, apart from those still required for monitoring purposes on or before 31 December 2018 by undertaking the following actions: (a) where practical dispose of all unused drill chips to the hole or to a sump pit; (b) cap the hole at a depth that is appropriate for the previous land use of the area (unless the owner stipulates a future use which requires the cap to be placed deeper); and (c) backfill the hole above the cap with soil or material similar to the surrounding soil or material.
F6	The environmental authority holder must rehabilitate all drill holes identified in **Table F3 - Drill Holes to be Decommissioned by 31 December 2018** to a stable landform similar to that of surrounding undisturbed areas.

Table F3 – Drill Holes to be Decommissioned by 31 December 2018

Borehole ID	Easting (GDA94, Zone 55)	Northing (GDA94, Zone 55)
C4042	789463.6	7110950.0
C5016	790080.7	7111414.0
C6005	792877.8	7108560.0
C5018	790686.3	7110925.0
C4049	789878.6	7110603.0
C6001	790184.4	7111203.0
C4057	786107.3	7107235.0
L6005	792883.0	7108565.0
C5017	791170.7	7111155.0
R5017	791171.0	7111154.0
C5020	790704.5	7111325.0
C4072	792902.6	7108561.0
L5015	789526.1	7110225.0
L5005	790415.7	7110078.0
R5002	790232.5	7111485.0
R0353	790934.7	7110880.0
G8116	775796.5	7117779.1
C1358	797490.8	7102426.0
C0423	795567.1	7103690.0
C1381	796345.7	7103158.0
C1380	796814.3	7102995.0
R8105	793928.4	7111793.0
R6695	777603.8	7117202.0

F7	**Rehabilitation monitoring program** A Rehabilitation Monitoring Program must be: a) developed by an appropriately qualified person; and b) implemented for the duration of the mining activities.
F8	The Rehabilitation Monitoring Program must: a) describe how the rehabilitation objectives will be achieved; b) describe verification of rehabilitation success; c) be conducted on a **two (2) yearly** basis; and d) be provided to the administering authority upon request.
F9	**Residual Void Outcome** Residual voids must comply with the following outcomes: (a) residual voids must not cause any serious environmental harm to land, surface waters or any recognised ground water aquifer, other than the environmental harm constituted by the existence of the residual void itself, and subject to any other condition within this environmental authority; and (b) residual voids must comply with design specifications in **Table F4 - Residual Void Design** and the locations shown in **Figure F2 – Residual voids**.

Table F4 - Residual Void Design

Void Identification	Void wall - competent rock slope (percent)	Void wall - incompetent rock slope (percent)	Void maximum surface area (ha)
Turkey Hill	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	1,210
Summer Hill	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	1,680
Mud Creek	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	2,080
Mud Creek North (satellite pit)	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	200
Mud Creek East (satellite pit)	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	160
Woleebee Creek	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	640
Woleebee North	0 - 214 percent or	0 - 100 percent or	290

	0 - 65 degrees	0 - 45 degrees	
Woleebee North (satellite pit)	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	140
Wubagul	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	570
Frank Creek North	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	80
Frank Creek South	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	210
Frank Creek West	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	210
Woleebee	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	1,012
Austinvale North	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	163
Austinvale	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	736
Leichhardt	0 - 214 percent or 0 - 65 degrees	0 - 100 percent or 0 - 45 degrees	194

F10	Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in **condition F9** within **twelve (12) months** of the commencement of Stage Two activities.
F11	**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 stable and it can be demonstrated to the satisfaction of the administering authority that the site has been decommissioned and rehabilitated such that it will not cause environmental harm for the foreseeable future (i.e. within 150 years).
F12	The Post Closure Management Plan must include the following elements: (a) operation and maintenance of: (i) wastewater collection and reticulation systems; (ii) wastewater treatment systems; (iii) the groundwater monitoring network; (iv) final cover systems; and (v) vegetative cover. (b) monitoring of: (i) surface water quality; (ii) groundwater quality; (iii) seepage rates; (iv) erosion rates; (v) the integrity and effectiveness of final cover systems; and (vi) the health and resilience of native vegetation cover.

Schedule G: Structures	
Condition number	**Condition**
G1	**All Dams** The hazard category of each dam must be determined by a suitably qualified and experienced person, prior to its construction and at least once every **two (2) years** thereafter.
G2	Construction of any dam determined to be in the significant or high hazard category (a regulated dam) must not be commenced unless the location, basic details, and hydraulic performance of that dam are specifically referenced in this environmental authority.

G3	On cessation of operation of any dam, that dam must be maintained so as to avoid environmental harm until that dam is decommissioned.
G4	Prior to the cessation of the mining activity, each dam must be decommissioned such that it either: (a) becomes a stable landform, that no longer contains flowable substances, or (b) is approved or authorised under relevant legislation for a beneficial use, or (c) is a void authorised by the administering authority to remain after decommissioning; and, (d) is compliant with the rehabilitation requirements of this environmental authority.
G5	**Regulated dams - Location** The following dams must be wholly located within the control points defined in **Table G1**.

Table G1 - Location of regulated dams

Name	Regulated dam description	Easting (GDA94) [Note 1]	Northing (GDA94) [Note 1]
Environmental dam AU-E1	Environmental dam	789420	7108590
Environmental dam AU-E2	Environmental dam	787560	7111460
Environmental dam AU-E4	Environmental dam	788300	7112430
Environmental dam FC-E1	Environmental dam	792470	7104540
Environmental dam MC-E2	Environmental dam	781460	7118470
Environmental dam SH-E3	Environmental dam	773640	7121660
Environmental dam W-E2	Environmental dam	787990	7108360
Raw water storage dam AU-R1	Raw water storage dam	788250	7111990
Potential future tailings dams			
Tailings dam (Woleebee)	In pit tailings disposal	789160	7106110
Tailings dam (Austinvale North)	In pit tailings disposal	790110	7113270
Tailings dam (Austinvale)	In pit tailings disposal	790070	7110780
Tailings dam (Leichhardt)	In pit tailings disposal	792500	7110940
Tailings dam (Turkey Hill)	In pit tailings disposal	769650	7120110
Tailings dam (Summer Hill)	In pit tailings disposal	774930	7117880
Tailings dam (Mud Creek)	In pit tailings disposal	780550	7115270

Tailings dam (Mud Creek North satellite pit)	In pit tailings disposal	780330	7118440
Tailings dam (Mud Creek East satellite pit)	In pit tailings disposal	784550	7116990
Tailings dam (Woleebee North)	In pit tailings disposal	786600	7109130
Tailings dam (Woleebee North satellite pit)	In pit tailings disposal	785070	7110660
Tailings dam (Woleebee Creek)	In pit tailings disposal	785480	7106550
Tailings dam (Frank Creek North)	In pit tailings disposal	793930	7108970
Tailings dam (Frank Creek South)	In pit tailings disposal	793700	7105950
Tailings dam (Frank Creek West)	In pit tailings disposal	792360	7108600
Tailings dam (Wubagul)	In pit tailings disposal	796730	7103510

[Note 1] Approximate centre of dam locations.

G6	Regulated dams must be consistent with the details in **Table G2**.

Table G2 - Details of Regulated Dams

Regulated dam	Maximum surface area [Note 1] (ha)	Maximum volume of dam [Note 1] (ML)	Maximum depth of dam [Note 1] (m)	Purpose of dam
Environmental dam AU-E1	30.0	2,300	8	Environmental dam
Environmental dam AU-E2	1.5	1,400	8	Environmental dam
Environmental dam AU-E4	6.0	727	9	Environmental dam
Environmental dam FC-E1	11.0	1,100	13	Environmental dam
Environmental dam MC-E2	2.2	1,200	10	Environmental dam
Environmental dam SH-E3	57.5	2,400	13	Environmental dam
Environmental dam W-E2	9.3	917	13	Environmental dam
Raw water storage dam AU-R1	8.5	400	8	Raw water storage dam

Tailings dam (Woleebee)	1012	390,800	85	Tailings storage
Tailings dam (Austinvale North)	163	39,500	36	Tailings storage
Tailings dam (Austinvale)	736	281,000	63	Tailings storage
Tailings dam (Leichhardt)	194	63,000	46	Tailings storage
Tailings dam (Turkey Hill)	1,210	486,000	71	Tailings storage
Tailings dam (Summer Hill)	1,680	673,000	71	Tailings storage
Tailings dam (Mud Creek)	2,080	917,500	100	Tailings storage
Tailings dam (Mud Creek North satellite pit)	200	43,600	32	Tailings storage
Tailings dam (Mud Creek East satellite pit)	160	39,900	45	Tailings storage
Tailings dam (Woleebee North)	290	103,800	65	Tailings storage
Tailings dam (Woleebee North satellite pit)	140	51,900	30	Tailings storage
Tailings dam (Woleebee Creek)	640	417,800	92	Tailings storage
Tailings dam (Frank Creek North)	80	21,700	52	Tailings storage
Tailings dam (Frank Creek South)	210	99,300	84	Tailings storage
Tailings dam (Frank Creek West)	210	115,100	78	Tailings storage
Tailings dam (Wubagul)	570	350,600	80	Tailings storage

[Note 1] Approximate area, volume and depth of dams.

G7	All dams must meet the hydraulic performance criteria specified in **Table G3.**

Table G3 - Hydraulic Performance Dams

Dam Type	Hazard Category for Failure to Contain	Design Storage Allowance	Spillway Critical Design Storm AEP	Mandatory Reporting Level
Regulated Dams				
Environmental Dams	Significant	1 in 20 year, 4 month wet season storage	0.001 (1 in 1,000)	0.01 (1 in 100) AEP 72 hour storm volume below spillway level OR 0.01 (1 in 100) AEP wind wave height below spillway level.
Raw Water Storage	Significant	1 in 20 year, 4 month wet season storage	0.001 (1 in 1,000)	(as above)
Tailings Storage Facilities	Significant	1 in 100 year, 4 month wet season storage	0.001 (1 in 1,000)	(as above)
Low Hazard Dams that form part of the mine water management system				
Sediment Dams	Low	NA	0.01 (1 in 100)	NA

G8	**Certification and operation** Every regulated dam must be constructed in accordance with a certified design plan that has been submitted to the administering authority, and such that the resulting dam will deliver the performance stated in that submitted design plan and that dam is compliant in all respects with this environmental authority.
G9	Construction of a regulated dam must not be commenced unless: (a) the licensee has submitted to the administering authority two copies of a design plan, together with the certification of a suitably qualified and experienced person that the design of the regulated dam will deliver the performance stated in that submitted design plan and that dam is compliant in all respects with this environmental authority; and (b) at least **twenty (20) business days** has passed since the receipt of those documents, or the administering authority notifies the licensee that a design plan and certification has been submitted for that dam.
G10	When construction of any regulated dam is complete and prior to commencing operation of that dam, the licensee must submit to the administering authority **two (2) copies** of a set of 'as constructed' drawings, together with the certification of a suitably qualified and experienced person that the dam 'as constructed' will deliver the performance stated in that submitted design plan and that dam is compliant in all respects with this environmental authority.
G11	An operational plan must be kept current for each regulated dam.
G12	Where an operational plan covers decommissioning and rehabilitation, those operations are to be consistent with the design plan for the dam and the rehabilitation requirements of this environmental authority.
G13	The licensee must notify the administering authority as soon as practicable, but within **twenty-four (24) hours**, of the level in any regulated dam reaching the mandatory reporting level (MRL) and must act to prevent or minimize any actual or potential environmental harm.
G14	**Regulated Dams - Annual Inspection and Report** Each regulated dam must be inspected annually by a suitably qualified and experienced person.
G15	At each annual inspection, the condition and adequacy of each regulated dam must be assessed for dam safety and against the necessary structural, geotechnical and hydraulic performance criteria.
G16	At each annual inspection, if a mandatory reporting level is required, it must be determined and marked on each regulated dam.
G17	A final assessment of adequacy of available storage in each regulated dam must be based on a dam level observed within the month of October and result in an estimate of the level in that dam as at 1 November.

G18	For each annual inspection, **two (2) copies** of a report on the condition and adequacy of each regulated dam, certified by the suitably qualified and experienced person and including any recommended actions to be taken to ensure the integrity of each regulated dam; must be provided to the administering authority by 1 December.
G19	The environmental authority holder must, within **one (1) week** of receipt of the annual inspection report, consider the report and its recommendations; and as soon as possible, but within **one (1) month** of receipt of the annual inspection report, formulate and implement actions to ensure that each regulated dam safely performs its intended functions.

Definitions

Key terms and/or phrases used in this document 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.

"20th percentile flow" means the 20th percentile of all daily flow measurements (or estimations) of daily flow over a 10 year period for a particular site. The 20th percentile calculation should only include days where flow has been measured (or estimated), i.e. not dry weather days.

"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.

"acceptance criteria" means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly been disturbed by the mining activities. Acceptance criteria may include information regarding:

a) vegetation establishment, survival and succession;
b) vegetation productivity, sustained growth and structure development;
c) fauna colonisation and habitat development;
d) 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;
e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
g) resilience of vegetation to disease, insect attack, drought and fire; and
h) vegetation water use and effects on ground water levels and catchment yields.

"acid mine drainage (AMD)" means any contaminated discharge emanating from a mining operation formed through a series of chemical and biological reaction, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining operations.

"administering authority" means the Department of Environment and Heritage Protection or its successor.

"AEP" means the Annual Exceedance Probability, which is the probability that at least one event in excess of a particular magnitude will occur in any given year.

"airblast overpressure" means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

"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.

"ANZECC & ARMCANZ" means the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, Australian and New Zealand Guidelines for Fresh Marine Water Quality.

"appropriately qualified person" means a person or persons who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

"assessed" or **"assess"** 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) operations of any kind and all things constructed, erected or installed for that dam; and
b) any land used for those operations.

"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 is:
a) of benefit to that owner in that it adds real value to their business or to the general community,
b) in accordance with relevant provisions of the Environmental Protection Act 1994,
c) sustainable by virtue of written undertakings given by that owner to maintain that dam, and
d) the transfer and use have been approved or authorised under any relevant legislation.

"biosolids" means the treated and stabilised solids from sewage.

"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.

"bunded" means within bunding consistent with Australian Standard 1940.

"certification" or **"certified"** by a suitably qualified and experienced person in relation to a design plan or an annual report regarding dams, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:
a) exactly what is being certified and the precise nature of that certification;
b) the relevant legislative, regulatory and technical criteria on which the certification has been based;
c) the relevant data and facts on which the certification has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
d) the reasoning on which the certification has been based using the relevant data and facts, and the relevant criteria.

"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 Regulation 2008; or
d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or
e) any substance used as, or intended for use as:
    (i) a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or
    (ii) a surface active agent, including, for example, soap or related detergent; or
    (iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or
    (iv) a fertiliser for agricultural, horticultural or garden use; or
    (v) a substance used for, or intended for use for:
    (vi) mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
    (vii) manufacture of plastic or synthetic rubber.

"commercial place" means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees' accommodation or public roads.

"competent person(s)" means (a) persons with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

"construction" includes building a new dam and modifying or lifting an existing dam.

"contaminate" means to render impure by contact or mixture.

"contaminated" means the substance has come into contact with a contaminant within the meaning of the *Environmental Protection Act 1994.*

"**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.

"control measure" means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

"cover material" means any soil or rock suitable as a germination medium or landform armouring.

"dam" means a land-based structure or a void that is designed to contain, divert or control flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works. However, a dam does *not* mean a fabricated or manufactured tank or container designed to a recognised standard, *nor* does a dam mean a land-based structure where that structure is designed to an Australian Standard. In case there is any doubt, a levee (dyke or bund) is a dam, but (for example) a bund designed for spill containment to AS1940 is *not* a dam.

"design plan" is the documentation required to describe the physical dimensions of the dam, the materials and standards to be used for construction of the dam, and the criteria to be used for operating the dam. The documents must include design and investigation reports, specifications and certifications, together with the planned decommissioning and rehabilitation works and outcomes. A design plan may include 'as constructed' drawings.

"design storage allowance (DSA)" means the minimum storage required in a dam at the first of November each year in order to meet the hydraulic performance requirements.

"development approval" means a development approval under the *Sustainable Planning Act 2009* in relation to a matter that involves an environmentally relevant activity under the *Environmental Protection Act 1994*.

"domestic waste" means waste, other than domestic clean-up waste, green waste, recyclable waste, interceptor waste or waste discharged to a sewer, produced as a result of the ordinary use or occupation of domestic premises

"dwelling" means any of the following structures or vehicles that is principally used as a residence:

a) a house, unit, motel, nursing home or other building or part of a building; or
b) a caravan, mobile home or other vehicle or structure on land; or
c) a water craft in a marina.

"effluent" treated waste water discharged from sewage treatment plants.

"end-of-pipe" means the location at which water is released to waters or land.

"environmental authority" means an environmental authority under Chapter 5 of the *Environmental Protection Act 1994.*

"environmental authority holder" means the holder of this environmental authority.

"environmentally relevant activity" means an environmentally relevant activity as defined under Section 18 of the *Environmental Protection Act 1994* and listed under Schedule 2 of the *Environmental Protection Regulation 2008.*

"equipment and plant" means any machinery, equipment or plant (whether movable or stationary) used for carrying out mining activities, and includes monitoring equipment.

"financial assurance" means a security required under the *Environmental Protection Act 1994* by the Administering Authority to cover the cost of rehabilitation or remediation of disturbed land or to secure compliance with the environmental authority.

"floodwater" means water overflowing, or that has overflowed, from waters, river, creek, stream, lake, pond, wetland or dam onto or over riparian land that is not submerged when the watercourse or lake flows between or is contained within its bed and banks.

"flowable substance" means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

"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.

"general waste" means waste other than regulated waste.

"hazard" in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

"hazard category" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *"Manual for Assessing Hazard Categories and Hydraulic Performance of Dams"* or in accordance with generally accepted engineering standards (e.g. Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME 1995)).

"hazardous waste" means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

"hydraulic performance" means the capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in the *"Manual for Assessing Hazard Categories and Hydraulic Performance of Dams"* or in accordance with generally accepted engineering standards (e.g. Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME 1995)).

"infrastructure" means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the operational land or the background land owner.

"$L_{Aeq,\ adj,\ 15\ mins}$" means the A-weighted sound pressure level of a continuous steady sound, (adjusted for tonal character and impulsiveness of the sound) that within a 15 minute has the same mean square sound pressure of a sound that varies with time.

"$L_{A\ 1,\ 15\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 15-minute measurement period, using Fast response.

"lake" includes:

- lagoon, swamp or other natural collection of water, whether permanent or intermittent; and
- the bed and banks and any other element confining or containing the water.

"land" in the **"land schedule"** of this document means land excluding waters and the atmosphere.

"land capability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land suitability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land use" term to describe the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

"landfill" means land used as a waste disposal site for lawfully putting solid waste on the land.

"levee" means a dam, dyke or bund that is designed only to provide for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from unplanned releases from other works of infrastructure, during the progress of those stormwater or flood flows or those unplanned releases; and does not store any significant volume of water or flowable substances at any other times.

"mandatory reporting level (MRL)" means a warning and reporting level determined in accordance with the *"Manual for Assessing Hazard Categories and Hydraulic Performance of Dams"* or in accordance with generally accepted engineering standards (e.g. Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME 1995)).

"mg/L" means milligrams per litre.

"Mine Infrastructure Area" means the indicative area within the MLA areas shown in the Mining Activities Plan where the mine infrastructure will generally be located.

"mine water" means process water and contaminated storm water.

"**mineral waste**" means waste from land generated from the extraction of coal, such as overburden, inter-burden, tailings (fines) coarse rejects and spoil, but does not include non-mineral waste.

"**Mineral Waste Storage Facility**" means mined-out pit voids used for disposal of tailings, rejects and overburden, and includes tailings storage facilities.

"mining activities" means the activities:

a) authorised as per the definition in section 110 of the *Environmental Protection Act 1994*; and
b) all environmentally relevant activities authorised under this environmental authority.

"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.

"non-mineral waste" means waste generated in carrying out the mining activities, including green waste, building and construction waste, general waste and waste tyres, but not including mineral waste.

"noxious" means harmful or injurious to health or physical well being.

"offensive" means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"operational land" means the land associated with the project for which this environmental authority has been issued.

"operational plan" means a document that amongst other things sets out procedures and criteria to be used for operating a dam during a particular time period. The operational plan as defined herein may form part of a plan of operations or plan otherwise required in legislation.

"palletised" means stored on a movable platform on which batteries are placed for storage or transportation.

"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).

"protected area" means:

a) a protected area under the *Nature Conservation Act 1992*; or
b) a marine park under the *Marine Parks Act 2004*; or
c) a World Heritage Area.

"progressive rehabilitation" means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

"process water" means water used or produced during the mineral development activities.

"receiving environment" means all groundwater, surface water, 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.

"recycled water" means appropriately treated effluent and urban stormwater suitable for further use.

"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.

"regulated dam" means any dam in the significant or high hazard category as assessed using the *"Manual for Assessing Hazard Categories and Hydraulic Performance of Dams"* or in accordance with generally accepted engineering standards (e.g. Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME 1995)).

"regulated waste" means non-domestic waste mentioned in schedule 7 of the *Environmental Protection Regulation 2008* (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" the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

"representative" means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

"residual void" means an open pit resulting from the removal of ore and/or waste rock which will remain following the cessation of all mining activities and completion of rehabilitation processes.

"saline drainage" means the movement of waters, contaminated with salt(s), as a result of the mining activity.

"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: or
g) means a work place used as an office or for business or commercial purposes, which is not part of the mining activity.

"sewage" means (a) drainage and other wastes from any form of toilets, urinals, and WC scuppers; (b) drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises; (c) drainage from spaces containing living animals; or (d) other waste waters when mixed with the drainages defined above. Source: MARPOL Annexure IV 73/78

"spillway" means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

"stable" in relation to land, means land form 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.

"Stage One" means mining activities including any physical disturbance like clearing of vegetation or earthworks, with the exclusion of:

a) erection of signage or fencing;
b) exploration or associated rehabilitation activities;

c) minor physical disturbance necessary to undertake pre-clearance surveys or testing, or establish monitoring programs, or associated with the mobilisation of the plant, equipment, materials, machinery and personnel prior to the start of railway and road development or mine construction; or
d) activities that are critical to commencement that are associated with mobilisation of plant and equipment, materials, machinery and personnel prior to the start of railway or road development or mine construction, only if such activities will have no adverse impact on environmental values.

"Stage Two" means the commencement date of the first commercial coal transport from the operational land (excludes any commissioning of plant and equipment, and any coal movements associated with trials or sampling).

"stormwater" means all surface water runoff from rainfall.

"suitably qualified and experienced person(s)" in relation to dams means one/those who is/are a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002 or equivalent*, OR registered as a National Professional Engineer (NPER) with the Institution of Engineers Australia, OR holds equivalent professional qualifications to the satisfaction of the administering authority for the Act; AND the administering authority for the Act is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

a) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams; and
b) a total of five years of suitable experience and demonstrated expertise in at least four of the following categories, with the 'geomechanics of dams' category being compulsory:
    (i) geomechanics of dams with particular emphasis on stability, geology and geochemistry;
    (ii) investigation, design or construction of dams;
    (iii) operation and maintenance of dams;
    (iv) hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;
    (v) hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes;
    (vi) hydrogeology with particular reference to seepage, groundwater;
    (vii) solute transport processes and monitoring thereof;
    (viii) dam safety.

"trackable waste" means a waste or combination of waste stated in Schedule 1 of the *Environmental Protection (Waste Management) Regulation 2000.*

"trivial harm" means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

"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 man-made, open excavation in the ground.

"waste" as defined in section 13 of the *Environmental Protection Act 1994*.

"waste and resource management hierarchy" has the meaning given by the *Waste Reduction and Recycling Act 2011*.

"waste water" means used water from the activity, process water or contaminated storm water.

"water quality" means the chemical, physical and biological condition of water.

"waters" includes:

- river, creek, stream in which water flows permanently or intermittently either:
    a) in a natural channel, whether artificially improved or not; or
    b) in an artificial channel that has changed the course of the river, creek or stream; or
        (i) lake, lagoon, pond, swamp, wetland, dam; or
        (ii) unconfined surface water; or
        (iii) storm water channel, storm water drain, roadside gutter; or

(iv) bed and banks and any other element of a river, creek, stream, lake, lagoon, pond, swamp, wetland, storm water channel, storm water drain, roadside gutter or dam confining or containing water; or
(v) groundwater; or
(vi) non-tidal or tidal waters (including the sea); or
(vii) any part-thereof.

"WaTERS" means the Water Tracking and Electronic Reporting System.

"µg/L" means micrograms per litre.

Appendix 1 - Figures

Figure B1 – Dust and particulate matter monitoring locations

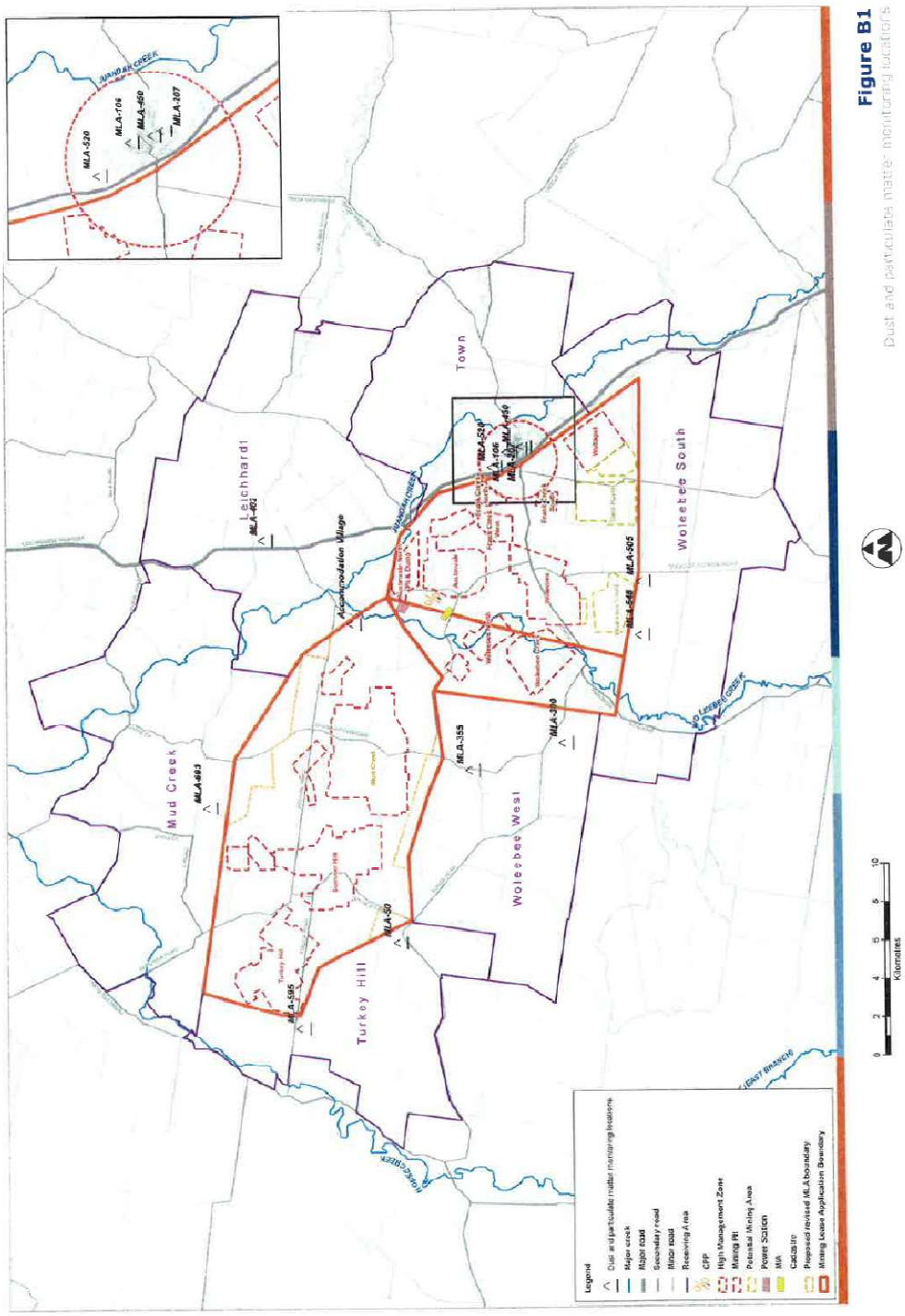


Figure W1 – Groundwater monitoring program

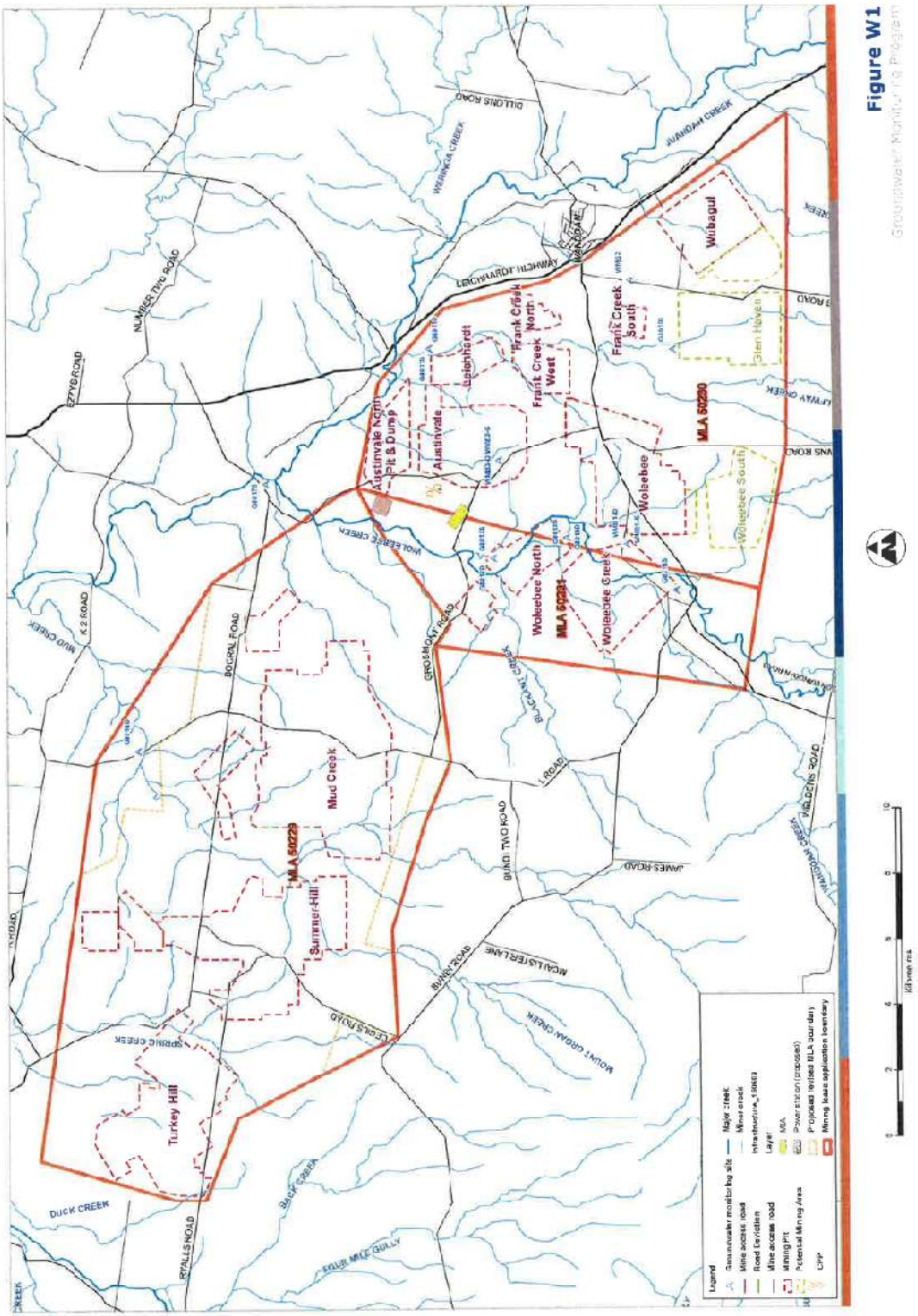


Figure D1 – Noise monitoring locations

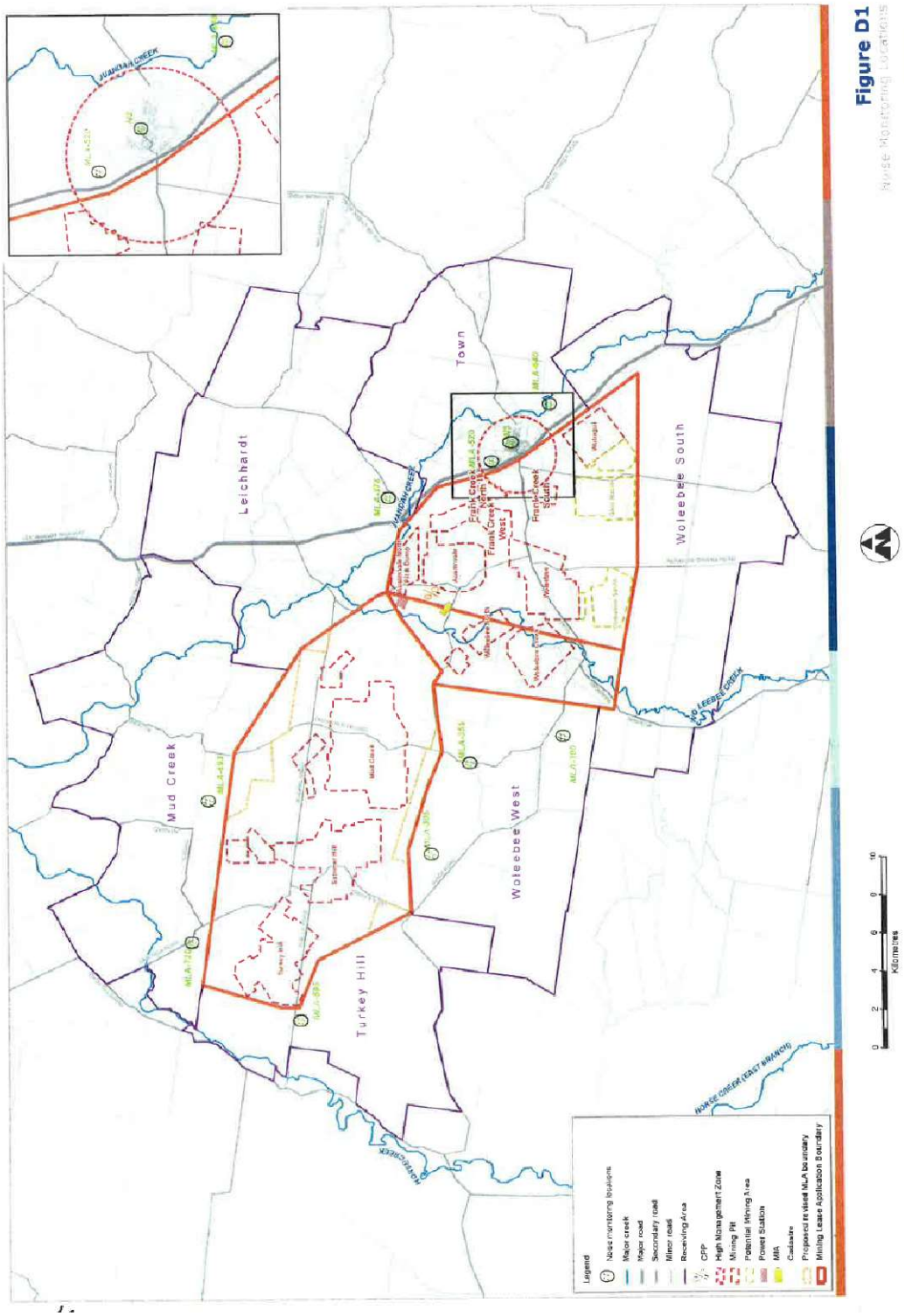


Figure E1 – Spoil disposal facility

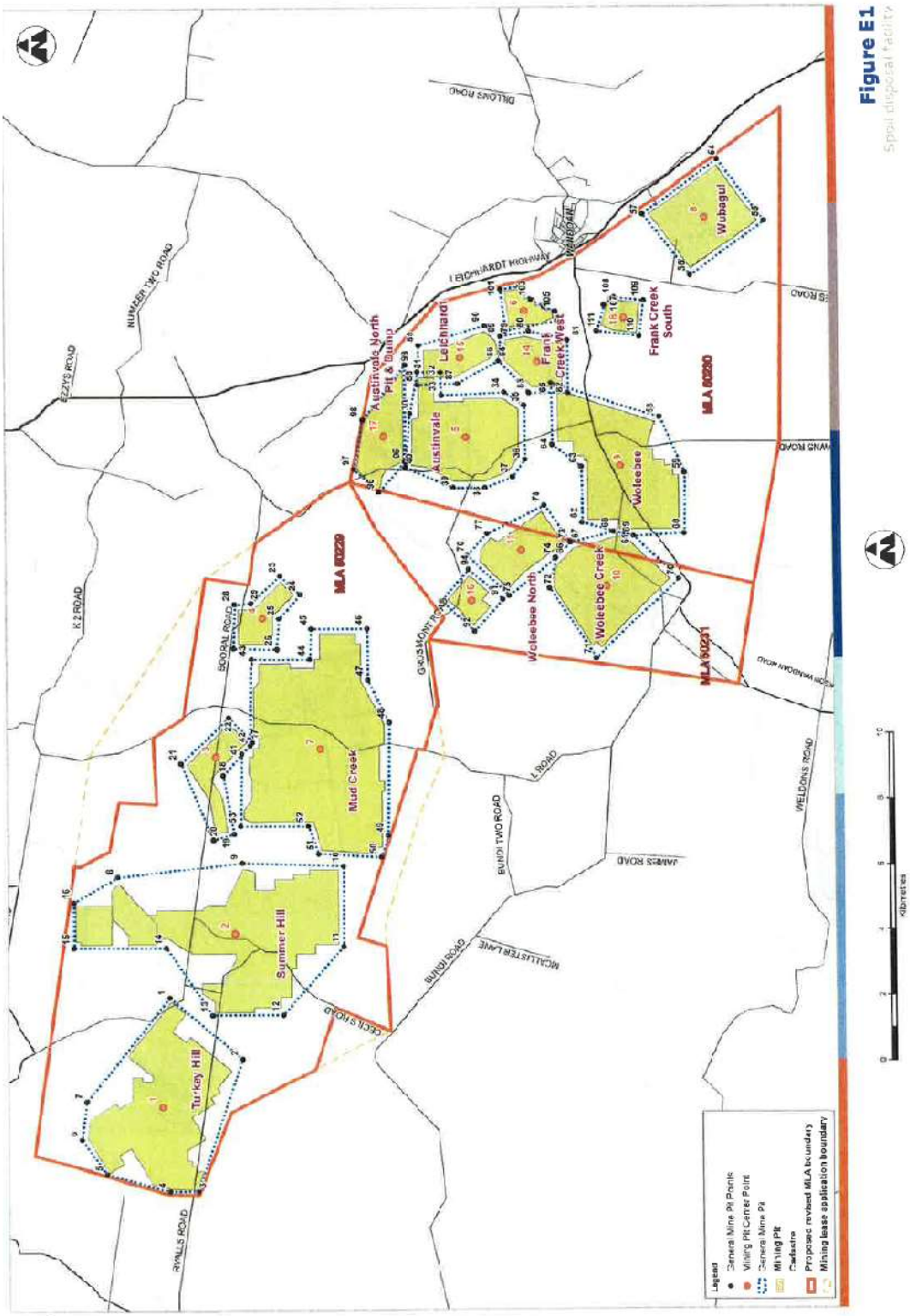


Figure F1 – Pre-requisite tenures

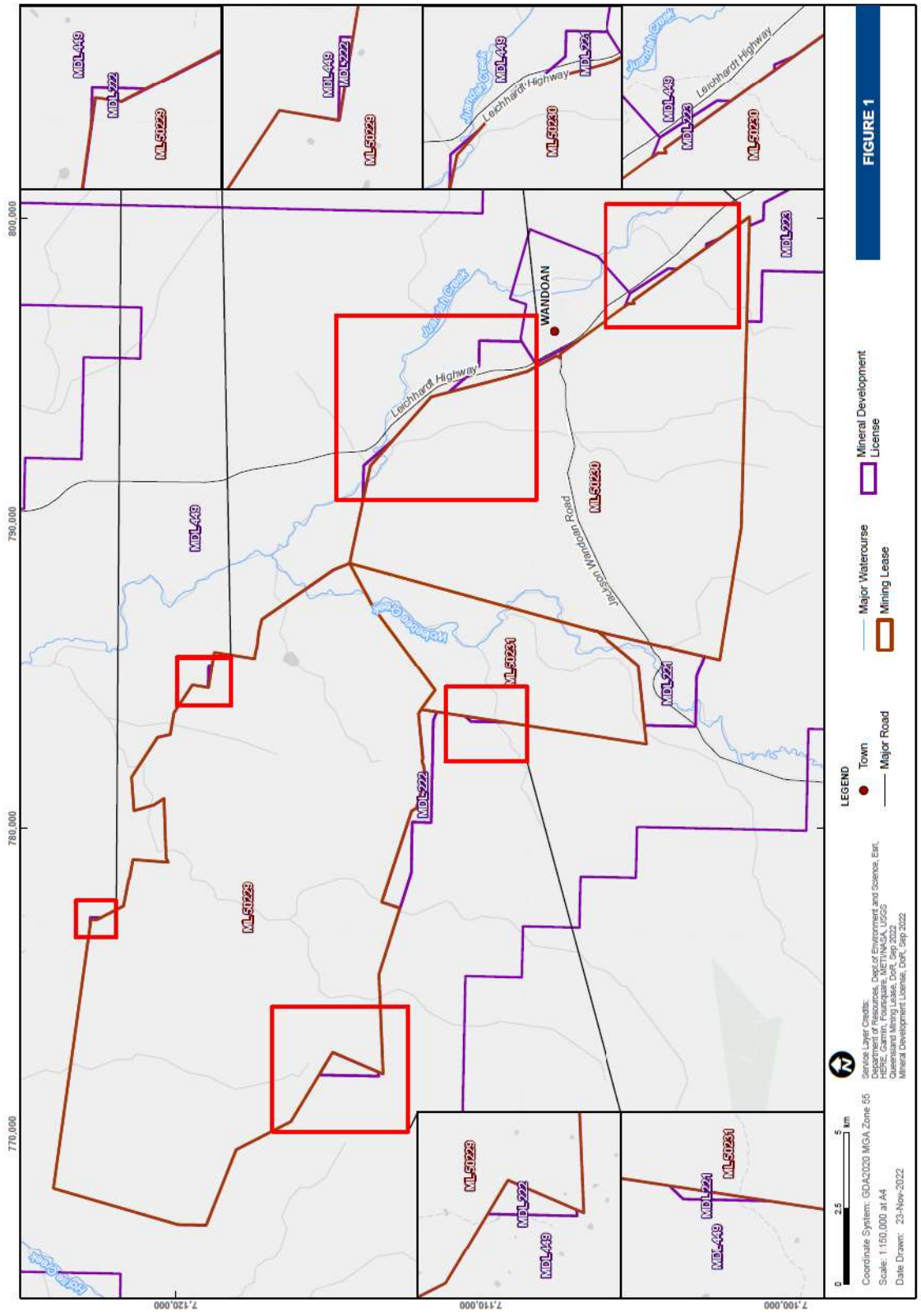
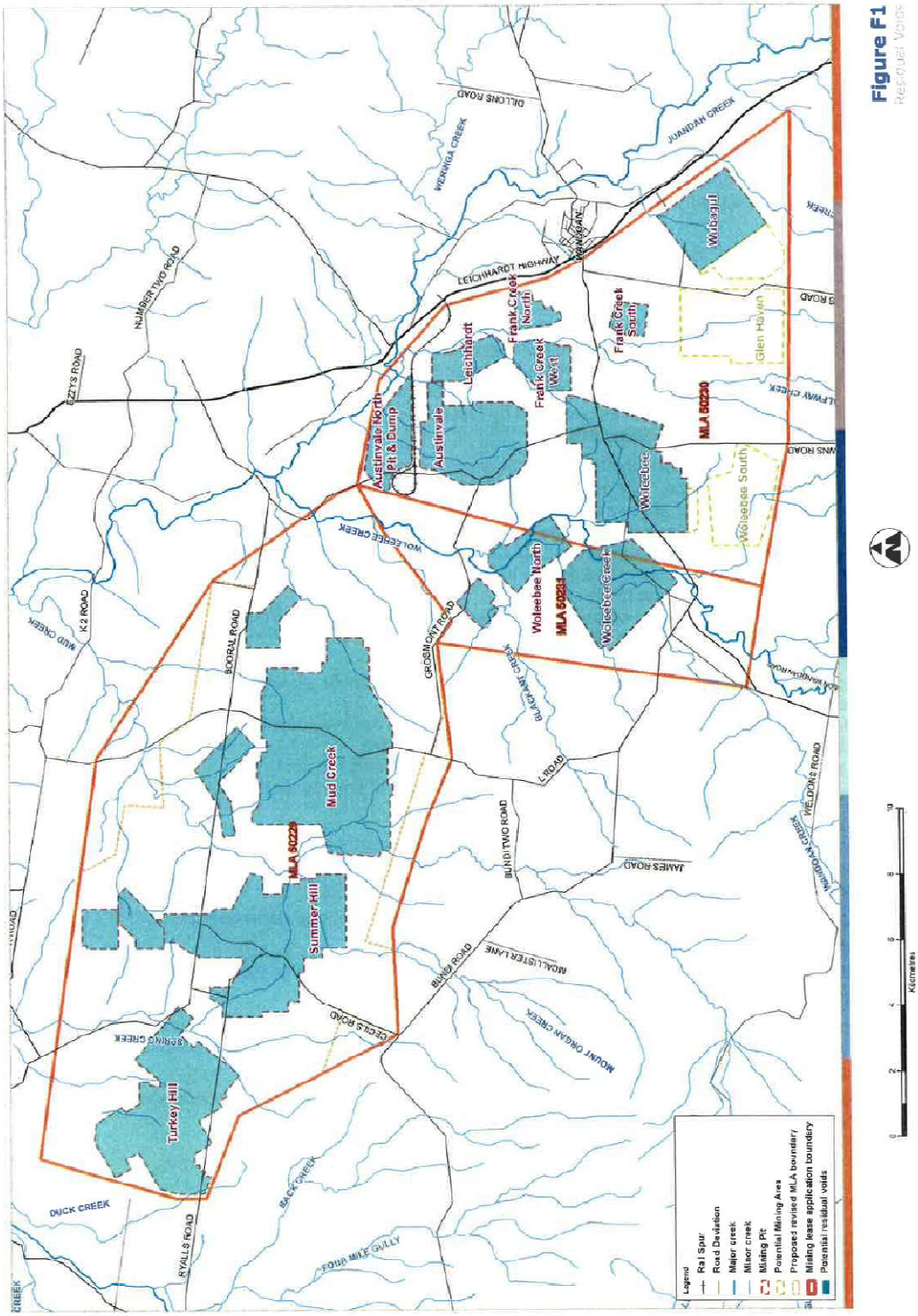


Figure F2 – Residual voids



END OF ENVIRONMENTAL AUTHORITY

TECHNICAL REPORT

Geochemical, physical, and spontaneous combustion assessment of mine materials

Wandoan Coal Project (WCP)

Prepared for: **Glencore Coal Assets Australia Pty Ltd**

MINE WASTE AND WATER MANAGEMENT

© RGS Environmental Consultants Pty Ltd. 3/30 Lensworth Street, Coopers Plains QLD 4108……...www.rgsenv.com

TECHNICAL REPORT

Geochemical, physical, and spontaneous combustion assessment of mine materials

Wandoan Coal Project (WCP)

Prepared for: **Glencore Coal Assets Australia Pty Ltd**

DOCUMENT CONTROL	
Document Number	**01**
Project Number	**2022005**
File Location	**01_2022005_Wandoan GPSC Report_Rev D_28082024.docx**

DOCUMENT DISTRIBUTION			
Document Name	**Revision**	**Distributed to**	**Date distributed**
01_2022005__Geochemical, physical, and spontaneous combustion assessment of mine materials_Rev D_26092024	**Rev D**	**Glencore Coal Assets Australia Pty Ltd**	**26.09.2024**

Limitations and disclaimer:

This report documents the work undertaken by RGS Environmental Consultants Pty Ltd (RGS).

This report should be read in full. While the findings presented in this report are based on information that RGS considers reliable unless stated otherwise, the accuracy and completeness of source information cannot be guaranteed, although RGS has taken reasonable steps to verify the accuracy of such source data. RGS has made no independent verification of this information beyond the agreed scope of works and RGS assumes no responsibility for any inaccuracies or omissions outside of RGS's direct control. Furthermore, the information compiled in this report addresses the specific needs of the Client, so may not address the needs of third parties using this report for their own purposes. Thus, RGS and their employees accept no liability for any losses or damage for any action taken or not taken on the basis of any part of the contents of this report. Those acting on information provided in this report do so entirely at their own risk.

This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Executive Summary

E.1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) was commissioned by Glencore Coal Assets Australia Pty Ltd (GCAA) to complete a geochemical, physical, and spontaneous combustion (GPSC) assessment of mine materials from the Wandoan Coal Project (WCP). The initial GPSC work program focussed on characterisation of bulk samples specifically obtained from the Wandoan Bulk Sample Pit (WBSP) (also known as the Trial Pit) located within the footprint of the planned Austinvale Pit. The subsequent GPSC work program encompassed a more widespread distribution of drill core samples across the WCP, including eight drill holes representing materials likely to be generated from the Wolleebee, Leichhardt, and Austinvale Pits.

Priority has been placed on assessing materials likely to be mined early in the mine life. Samples were obtained from three of the proposed fifteen pits that may potentially be mined by the WCP. Coal quality data supports the likelihood that mine material characteristics will be consistent over the project area. This includes the remaining twelve pits whose mine materials will be tested when mining has sufficiently progressed.

The scope of work for the GPSC assessment included:

- A desktop assessment of existing project information;
- Development of a GPSC Sampling and Analysis Plan (GPSC-SAP);
- Implementation of the GPAC-SAP and completion of GPSC tests on relevant mine materials;
- Provision of a stand-alone technical report that contributes to fulfillment of the relevant regulatory guideline and project approval requirements in Queensland including those associated with the development of a Progressive Rehabilitation and Closure Plan (PRCP) (this report).

RGS completed the initial GPSC assessment of mine materials from the WBSP in mid-2023. This updated technical report includes the results from that assessment as well as the available results from the subsequent GPSC assessment up to April 2024.

In order to present the GPSC results in context, materials from the WCP were classified into three groups:

- Spoil (soil, overburden, interburden, and basement materials)
- Potential coal rejects (roof, floor, and parting materials)
- Coal and coal rejects (coal, coarse reject, and tailing materials)

E.2 Methodology

A total of 18 bulk samples of mine materials from the WBSP were collected from a single test pit by GCAA and supplied to RGS. An additional 2 samples of coarse reject (1 sample) and tailings (1 sample) materials were subsequently supplied to RSG by GCAA for inclusion in the GPSC assessment program. A total of 122 drill hole samples of mine materials from the broader WCP were sourced from 8 drill holes, located in the planned Leichhardt, Austinvale, and Wolleebee open pit footprint areas and also supplied to RGS for inclusion in the GPSC assessment program.

Selected samples of mine materials were subjected to a program of GPSC tests and the results are reported and interpreted herein.

E.3 Geochemical classification

The results of the static and kinetic geochemical test program demonstrate that the acid, metalliferous, and saline drainage (AMD) potential of the mine materials represented by the samples tested is low. Typically, mine materials are classified as non-acid forming (NAF) or NAF-Barren, and generally have low oxidisable sulfur content and excess acid neutralising capacity (ANC). Materials represented by the samples have a low risk of acid generation and a high factor of safety with respect to potential AMD.

The concentration of trace metals/metalloids in mine material solids are low compared to applied guideline criteria for soils and median crustal abundance in un-mineralised soils and are not expected to present any environmental issues associated with revegetation and rehabilitation.

The concentration of major ions expected in surface runoff and seepage from mine materials is likely to be dominated by sodium, chloride, sulfate and bicarbonate; with lower concentrations of other major ions. The concentration of fluoride in leachate from soil materials may be slightly elevated compared to applied water quality guideline criteria (ANZG, 2018).

Trace metals/metalloids were sparingly soluble at the circumneutral to slightly alkaline pH of the leachate produced by most mine materials. Dissolved metal/metalloid concentrations in surface runoff and seepage from bulk NAF materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at the WCP.

E.4 Soil quality

Subsoil has moderate cation exchange capacity (CEC) and is sodic with low salinity. Nutrients such as organic matter and plant-available phosphorus (P) and potassium (K) are low but are sufficient to support native vegetation. The subsoils are rich in clay and highly plastic, which can likely be attributed to the proportion of swelling clay minerals. Soil texture ranges from clays to sandy loams, with more gravelly soils prevalent in the Leichhardt Pit. Clays and silty clays from the Austinvale Pit have a good water retention capability.

Subsoil and overburden materials are classified as Emerson Class 1 and 2, indicating some potential for partial or complete dispersion. Exchangeable sodium percentage (ESP) values are elevated and suggested that these materials are typically sodic and are classified as Class 2B potentially dispersive soils based on Rengasamy et.al. (1984). Notwithstanding, sodic soils are common and naturally occurring in Queensland and soil materials from the WCP should be amenable to revegetation as part of rehabilitation activities.

E.5 Physical characteristics

The particle size distribution of subsoil in the Austinvale and Wolleebee Pits is predominantly clay and silt, whereas Leichhardt soils are predominantly gravel. Overburden, interburden, and parting rocks have poor durability and disintegrate readily with weathering into mostly clay and silt sized particles with some sand.

In materials from the Austinvale Pit, upper subsoil has the highest proportion of clay, and the lowest permeability and overburden has the highest permeability due to its relatively high density and proportion of sand. Coal and interburden materials have moderate permeability. When impacted by water, subsoil and overburden are potentially dispersive and have elevated turbidity, as demonstrated by their long column settlement times.

The point load strength of overburden, interburden, and partings is variable from very low to high and is the equivalent of stiff clay to sandstone.

E.6 Spontaneous combustion assessment

Spontaneous combustion testing results demonstrate that the Macalister Upper, Macalister Lower, and Wambo coal samples have a low relative ignition temperature (RIT) values and therefore have a high spontaneous combustion propensity. Coal reject and tailings from the Macalister Upper seam, as well as potential rejects, in contrast, have a high RIT and are much less likely to spontaneously combust.

Incubation testing on the coal samples demonstrates that the coal can achieve thermal runaway in both a loose pile and highly fractured in-situ state under ideal conditions. Due to their high R_{70} values (5-7 (°C/h)) coal thicknesses of >1 m represent an increased risk for spontaneous combustion, particularly if the coal is exposed to oxygen and is kept dry from moisture.

It is recommended that an appropriate Spontaneous Combustion Management Plan (SCMP) be developed and implemented to limit the risk of spontaneous combustion from coal materials. While the SCMP should also address the management of coal reject and tailing materials, no specific management measures are expected to be required to minimise the risk of for spontaneous combustion from these materials.

Table of Contents

1 Introduction 1
1.1 Project description 1
1.2 Geology 4
1.3 Target coal seams 6
1.4 Purpose of assessment 9
1.5 Scope of work 9
1.6 PRCP requirements 9
1.7 Desktop study 10
2 Methodology 12
2.1 Phase 1 sample collection 12
2.1.1 WBSP test pit samples 12
2.1.2 Coal rejects and tailings 13
2.1.3 WBSP individual samples 14
2.1.4 WBSP composite samples 14
2.2 Phase 2 Drill hole samples 15
2.2.1 Drill hole locations 15
2.2.2 Drill hole individual samples 17
2.2.3 Drill hole composite samples 17
2.3 Summary of Phase 1 and Phase 2 sampling program 18
2.4 Analytical Test Program 19
2.4.1 Static geochemical testing 19
2.4.2 Kinetic geochemical testing 20
2.4.3 Soil quality 22
2.4.4 Physical testing 23
2.4.5 Mineralogy 26
2.4.6 Spontaneous combustion testing 26
2.5 Analysis program 27
3 Results and interpretation 29
3.1 Static geochemistry 29
3.1.1 pH 29
3.1.2 Electrical Conductivity 30
3.1.3 Potential acidity 32
3.1.4 Maximum Potential Acidity and Acid Neutralising Capacity 34
3.1.5 Net Acid Producing Potential 35
3.1.6 Geochemical classification 36
3.1.7 Coal quality data 39
3.2 Multi-element testing 42
3.2.1 Multi-element concentration in solids 42
3.2.2 Multi-element concentration in water extracts 43
3.3 Kinetic testing 44
3.4 Soil quality 47
3.4.1 Soil characterisation 47

3.4.2 Soil nutrients 48
3.4.3 Soil class characterisation 49
3.4.4 Emerson class testing 50
3.5 Physical testing 51
3.5.1 Particle size distribution 51
3.5.2 Soil texture classification 52
3.5.3 Permeability testing and density 53
3.5.4 Column settlement 55
3.5.5 California Bearing Ratio 55
3.5.6 Aggregate soundness (sodium sulfate) 56
3.5.7 Point load testing 59
3.5.8 Atterberg limits 62
3.5.9 Soil water characteristic curves 63
3.6 Mineralogy 64
3.7 Spontaneous combustion testing 67
4 Discussion 69
4.1 Acid forming potential 69
4.2 Multi-element composition and enrichment 69
4.3 Water quality 69
4.4 Soil characteristics 69
4.4.1 Upper and lower subsoil 69
4.4.2 Overburden 69
4.5 Physical characteristics 70
4.6 Spontaneous combustion 70
5 Conclusions 71
5.1 Conclusions 71
6 References 72
Attachments A-1
Attachment A: Acid and Metalliferous Drainage – an overview A-1
Attachment B: Geochemical characterisation tables B-1
Attachment C: KLC data and trends C-1
Attachment D: Sample catalogue D-1
Attachment E: Spontaneous combustion test report E-1
Attachment F: Desktop study F-1
Attachment G: ALS laboratory certificates of analysis G-1
Attachment H: Trilab laboratory certificates of analysis H-1
Attachment I: Column settlement results I-1
Attachment J: Levay and Co laboratory results J-1
Attachment K: Soil Water Group laboratory certificates of analysis K-1
Attachment L: X-Ray Vision laboratory certificates of analysis L-1

List of Figures

Figure 1-1: Project location 2
Figure 1-2: Mining lease areas 3
Figure 1-3: Surface geology 5
Figure 1-4: Typical stratigraphic column at the Wandoan Coal Project 7
Figure 1-5: Wandoan Walloon Coal Measures, target seams and local seam geology 8
Figure 2-1: WBSP location 12
Figure 2-2: Phase 2 drill hole locations 16
Figure 2-3: AMIRA Phase 1 KLC test photographs after 7 months 21
Figure 2-4: AMIRA Phase 2 KLC test photographs after 2 months 21
Figure 2-5: Emerson Class classifications 23
Figure 3-1: pH results for spoil 29
Figure 3-2: pH results for potential coal reject 29
Figure 3-3: pH results for coal and coal reject 30
Figure 3-4: EC results for spoil 30
Figure 3-5: EC results for potential coal reject 31
Figure 3-6: EC results for coal and coal reject 31
Figure 3-7: Total sulfur results for spoil 32
Figure 3-8: Total sulfur results for potential coal reject 32
Figure 3-9: Total sulfur results for coal and coal reject 33
Figure 3-10: Sulfur speciation comparison for coal and coal reject 34
Figure 3-11: ANC versus MPA for coal and coal reject 35
Figure 3-12: NAPP values for spoil 35
Figure 3-13: NAPP values for potential coal reject 36
Figure 3-14: NAPP values for coal and coal reject 36
Figure 3-15: Geochemical classification by material type - spoil 37
Figure 3-16: Geochemical classification material type – potential coal reject 38
Figure 3-17: Geochemical classification by material type – coal and coal rejects 38
Figure 3-18: Total sulfur distribution for raw coal samples 39
Figure 3-19: Total sulfur content in coal float sink fractions 40
Figure 3-20: Median total sulfur distribution for coal across the exploration area and mining lease tenements 41
Figure 3-21: Secondary mineral formation on low quality/grade coal (WS1A) and tailings 46
Figure 3-22: Results for organic matter and organic carbon 48
Figure 3-23: Results for Total N, Total P, and Bicarbonate Extractable K 49
Figure 3-24: Soil salinity classes for subsoil and overburden 49

Figure 3-25: Particle size distribution curves for soil 51
Figure 3-26: Particle size distribution curves for disintegrated sample of mine materials 51
Figure 3-27: Soil texture classifications 53
Figure 3-28: Permeability results for mine materials 54
Figure 3-29: Axial and diametral point load strength directions 59
Figure 3-30: Point load strength material comparison 61
Figure 3-31: AASHTO classifications for subsoil 62
Figure 3-32: Soil water characteristic curves for subsoil, and overburden 63
Figure 3-33: Mineralogy (XRD) results mine materials 66

List of Tables

Table 1-1: Surat Basin stratigraphy - north eastern area 4
Table 2-1: Individual soil, coal and overburden/interburden samples 13
Table 2-2: Individual coal reject and tailing samples 13
Table 2-3: Wandoan Phase 1 individual samples 14
Table 2-4: Wandoan Phase 1 composites 15
Table 2-5: Phase 2 drill holes 15
Table 2-6: Drill hole sampling frequency/distribution 17
Table 2-7: Drill hole ME and KLC composites 18
Table 2-8: WBSP and drill hole sampling summary 18
Table 2-9 : WBSP and drill core KLC set up 20
Table 2-10: Analysis program 28
Table 3-1: Geochemical classification criteria for WCP 37
Table 3-2: Geochemical Abundance Index enrichment factors 42
Table 3-3: Sulfate generation and sulfide oxidation rates for KLC test materials 45
Table 3-4: Summary of soil characterisation results 47
Table 3-5: Soil characterisation guidelines 47
Table 3-6: Summary of soil classifications 50
Table 3-7: Emerson Class results – Austinvale Pit 50
Table 3-8: Emerson Class results – Leichhardt and Wolleebee Pits 50
Table 3-9: PSD and soil texture results for subsoil, overburden, interburden and parting 52
Table 3-10: Permeability and maximum dry density results 54
Table 3-11: Summary of column settlement test results 55
Table 3-12: CBR compaction results for soil and overburden 55
Table 3-13: Results for aggregate soundness testing – Phase 1 56
Table 3-14: Results for aggregate soundness testing – Phase 2 57
Table 3-15: Point load summary table 59
Table 3-16: Atterberg Limits for subsoil 62
Table 3-17: Summary of soil water characteristic curve data 63
Table 3-18: Mineralogy results for mine materials 65
Table 3-19: Intrinsic spontaneous combustion test results 67
Table 3-20: Spontaneous combustion propensity rating 67

Glossary of terms and acronyms

Acidity	A measure of hydrogen ion (H+) concentration and certain dissolved metals in a solution when titrated to a set pH value; generally expressed as mg/L $CaCO_3$ equivalent.
ABA	Acid Base Account. Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
ALS	Australian Laboratory Services.
AMD	Acid and metalliferous drainage from mine waste materials generally characterised by low pH, and elevated concentrations of major ions and dissolved metals/metalloids.
ANC	Acid Neutralising Capacity expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's potential ability to neutralise acid.
ANC:MPA	The ratio of the ANC to the Maximum Potential Acidity of a sample. Used to assess the risk of a sample generating acid conditions.
AS	Australian Standards
AASHTO	American Association of Highway and Transportation Officials.
CBR	California bearing ratio
CEC	Cation Exchange Capacity
CHPP	Coal Handling and Processing Plant
CPT	Crossing Point Temperature
Dispersive	Dispersive soil and rock materials are structurally unstable and disperse into basic particles such as sand, silt and clay in water. When a dispersive soil is wet, the basic structure has a tendency to collapse, whereas when it is dry it is prone to surface sealing and crusting.
DTPA	Diethylene Triamine Penta-acetic Acid. A chelating agent used to detect levels of micronutrients available to plants, such as Cu, Fe, Mn, and Zn.
EC	Electrical Conductivity, expressed as µS/cm.
eCEC	Effective CEC provides a measure of the mass of exchangeable cations (Ca, Mg, Na and K) in a sample.
EIS	Environmental Impact Statement.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
FIMS	Flow Injection Mercury System.
GAI	Geochemical Abundance Index
GPSC-SAP	Geochemical, Physical and Spontaneous Combustion Sampling and Analysis Plan
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry.
INAP	International Network on Acid Prevention
Interburden	The material found in between coal seams and considered to be of low economic value (i.e., a type of waste material).
ISCP	Intrinsic spontaneous combustion propensity

KLC	Kinetic Leach Column. Leaching setup that generates time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions)
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
ML	Mining Lease
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (Scr) content of a sample by 30.625 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAF - Barren	NAF and barren of sulfur (i.e., less than or equal to 0.1 % sulfur).
NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.
NEPC	National Environmental Protection Council
Overburden	The waste rock material found overlying the first ore horizon within the stratigraphic profile.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PC Titrator	Potentiometric Compact Titrator. PC Titrators are specially designed for routine applications and simple operation, allowing basic titration analysis from a single device.
PFS	Pre-Feasibility Study
pH	A measure of hydrogen ion (H^+) concentration.
PLMU	Post Mining Land Use
PRCP	Progressive Rehabilitation and Closure Plan
PSD	Particle Size Distribution.
R_{70}	The adiabatic self-heating rate.
RGS	RGS Environmental Consultants Pty Ltd
RIT	Relative ignition temperature
ROM	Run-of-Mine
S	Sulfur.
S_{CR}	Chromium reducible sulfur. Analysis technique for measuring the proportion (%) of reactive sulfide sulfur in a mine waste material.
SHT	Self-heating temperature.
Slaking	Disintegration of unconfined soil or rock after exposure to air and subsequent immersion in water.
Sodic	Sodic soil and rock materials are characterized by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SO_4^{2-}	Sulfate.

Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
SWCC	Soil water characteristic curves
TCC	Total cation concentration.
TSF	Tailings Storage Facility
TSS	Total Suspended Solids is a measurement of the suspended solids concentration in a water sample.
Turbidity	The cloudiness of a fluid, often measured in water quality analyses by TSS.
WBSP	Wandoan Bulk Sample Pit located within a trial pit in the proposed Austinvale Pit area
WCP	Wandoan Coal Project
WS1A	Coal from working section 1A (Upper Macalister MU10A to MU32).
WS1B	Coal from working section 1B (Upper Macalister MU41A to MU50).
w:v	Weight to volume ratio.
XRD	X-Ray Diffraction. Instrumental method for analysing material mineralogy.

1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) was commissioned by the Glencore Coal Assets Australia Pty Ltd (GCAA) to complete a geochemical, physical and spontaneous combustion (GPSC) assessment of mine materials from the Wandoan Coal Project (WCP). The initial GPSC work program focussed on characterisation of samples specifically obtained from the Wandoan Bulk Sample Pit (WBSP) (also known as the Trial Pit) located within the planned footprint of the Austinvale Pit. The subsequent GPSC work program encompassed a more widespread distribution of samples across the WCP, including eight drill holes representing materials likely to be generated from the Wolleebee, Leichhardt, and Austinvale Pits, being the three pits proposed to be mined first over a period of approximately 15 years..

The aim of the GPSC assessment was to select and characterise representative samples of mine materials (including coal, coarse reject and tailings and overburden/interburden materials) from the Wolleebee, Leichhardt, and Austinvale Pits to effectively assess the geochemical, physical and spontaneous combustion properties of these materials.

The overall objective of the RGS work program was to produce a stand-alone technical report that contributes to fulfillment of the relevant regulatory guideline for the development of a Progressive Rehabilitation and Closure Plan (PRCP).

1.1 Project description

The WCP is located approximately 350 km northwest of Brisbane and 60 km south of Taroom, to the west of the Wandoan township (**Figure 1-1**). The proposed open cut mine is located within three Mining Leases (MLs) 50229, 50230 and 50231 (**Figure 1-2**). The MLs make up approximately 32 000 hectares (ha).

Thermal coal resources will be mined using dragline, truck, excavator and shovel equipment. This ROM coal will be washed on-site at a coal handling and processing plant (CHPP).

During the initial stages of construction for each pit, spoil will be placed into an out-of-pit overburden emplacement until sufficient void space is available to back fill the void and commence in-pit filling. The Plate and Frame Filter tailings dewatering method is being considered to remove the need for a tailings storage facility (TSF) at the mine, and instead return the dewatered tailings to overburden emplacements, co-disposed with the coarse coal reject waste stream (GCAA, 2022).

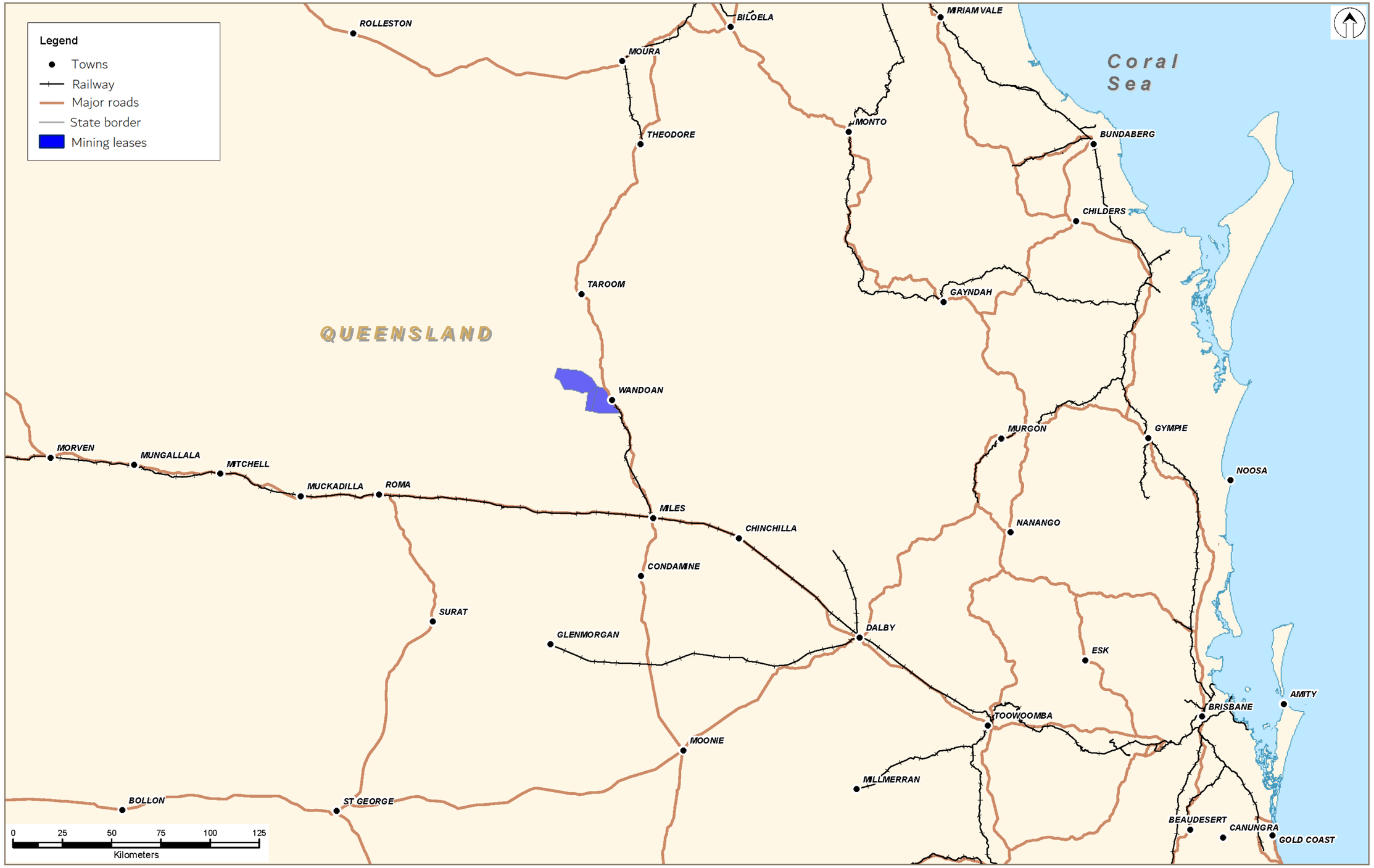


Figure 1-1: Project location

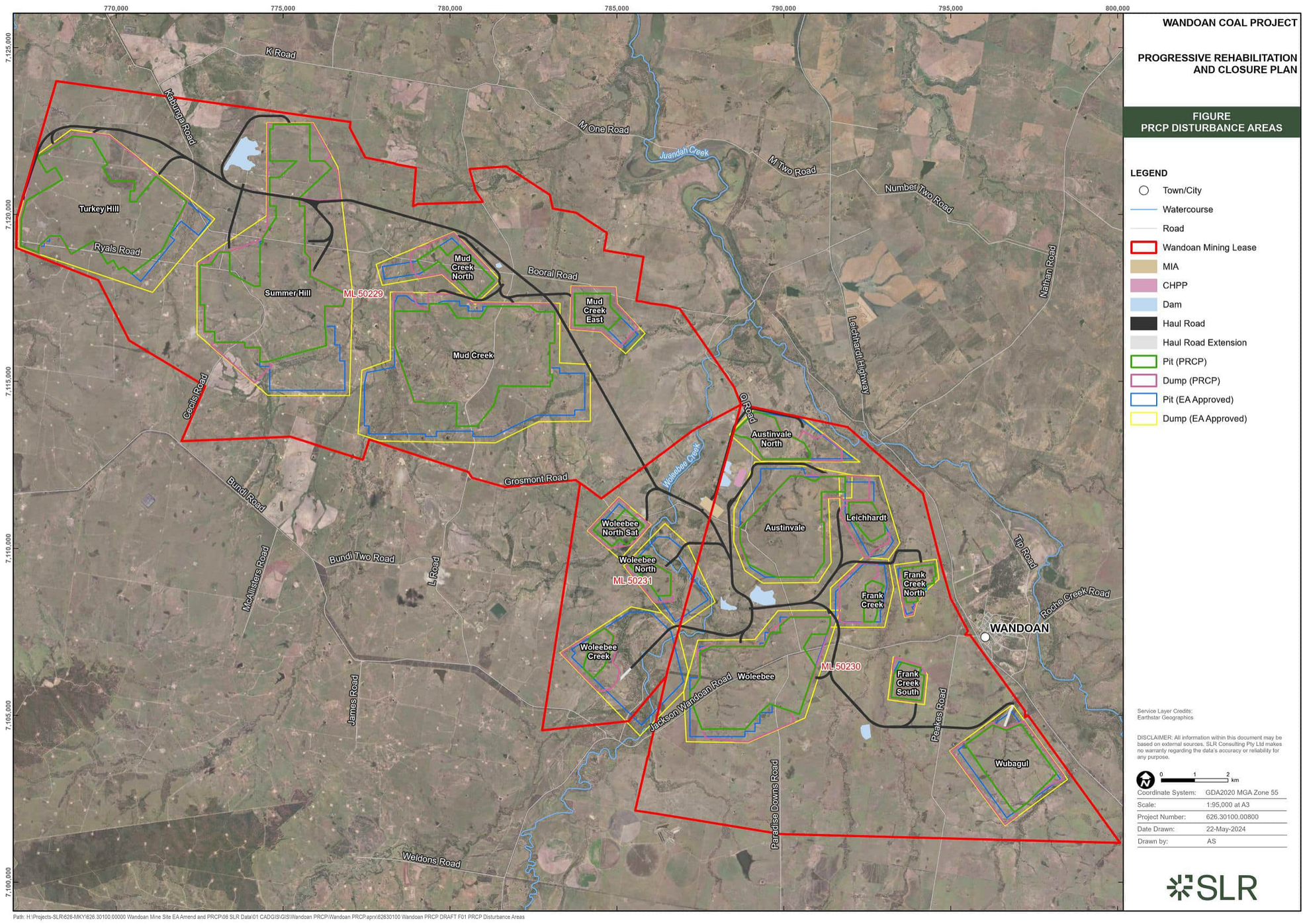


Figure 1-2: Mining lease areas

1.2 Geology

A desktop study of historical studies completed for the regional and local geology of the WCP is included in **Attachment F** and summarised here.

The geological sequence present within the WCP mining leases consist of early Jurassic through to Middle/Late Jurassic sedimentary rocks, which are overlain by Quaternary alluvium (Qa). A description of the surface geological units and their ages is included in **Table 1-1** and mapped in **Figure 1-3**. The Injune Creek Group consists of:

- Westbourne Formation (Jsw) (sandstone and mudstone with coal, about 140 m thick), not found in the Project area
- Springbok Sandstone (Jsw) (friable sandstone with beds of mudstone and thin coal seams near its base, about 90 m thick), located in the eastern portion of the Project area
- Walloon Subgroup (variable sandstone/siltstone/mudstone/coal lithology with thick banded coal seams, up to 510 m thick). This unit consists of the Juandah Coal Measures (Jtj), Tangalooma Sandstone (Jtj) and Taroom Coal Measures (Jet)
- Eurombah Formation (Jet) (quartzose sandstone with some silt, mudstone and fine coal fragments).

Table 1-1: Surat Basin stratigraphy - north eastern area

Age			Formation	Description
Late Jurassic			Gubberamunda Sandstone (Jg)	Fine to coarse and pebbly, poorly sorted, friable, cross-bedded, quartzose to sub-labile sandstone. Minor interbedded siltstone and mudstone. Upper fluvial depositional environment.
Middle to Late Jurassic	Injune Creek Group		Westbourne Formation (Jsw)	Finely interbedded lithic sandstone, mudstone and coal in lower part. Interbedded siltstone and lithic sandstone in upper part. Lacustrine deposition grading to point bar at the top.
			Springbok Sandstone (Jsw)	Litho-feldspathic sandstone, medium to coarse, porous and friable, some calcareous and cemented beds, minor siltstone, mudstone and coal seams. Lower part trough cross-stratified with authigenic matrix, upper part poorly cemented, exhibiting point bar depositional features.
Middle Jurassic		Walloon Sub-Group	Juandah Coal Measures (Jtj)	Lithic, labile sandstone, interbedded with siltstone, mudstone and coal, with coal deposition more frequent towards top. Argillaceous component of sandstone is mainly authigenic.
			Tangalooma Sandstone (Jtj)	Lithic, labile sandstone, medium grained with argillaceous matrix. Numerous intraformational conglomerate beds. Sedimentary structures suggest channel deposition grading to point bar deposition.
			Taroom Coal Measures (Jet)	Sub-labile, medium grained sandstone grading upwards to interbedded sandstone, siltstone, mudstone and coal.
			Eurombah Formation (Jet)	Lithic to sub-labile, poorly sorted, medium grained sandstone with argillaceous matrix. Minor siltstone and mudstone in basal section, more argillaceous towards top.
Early Jurassic			Hutton Sandstone	Interbedded labile to quartzose sandstone, siltstone and mudstone and intraformational conglomerate.

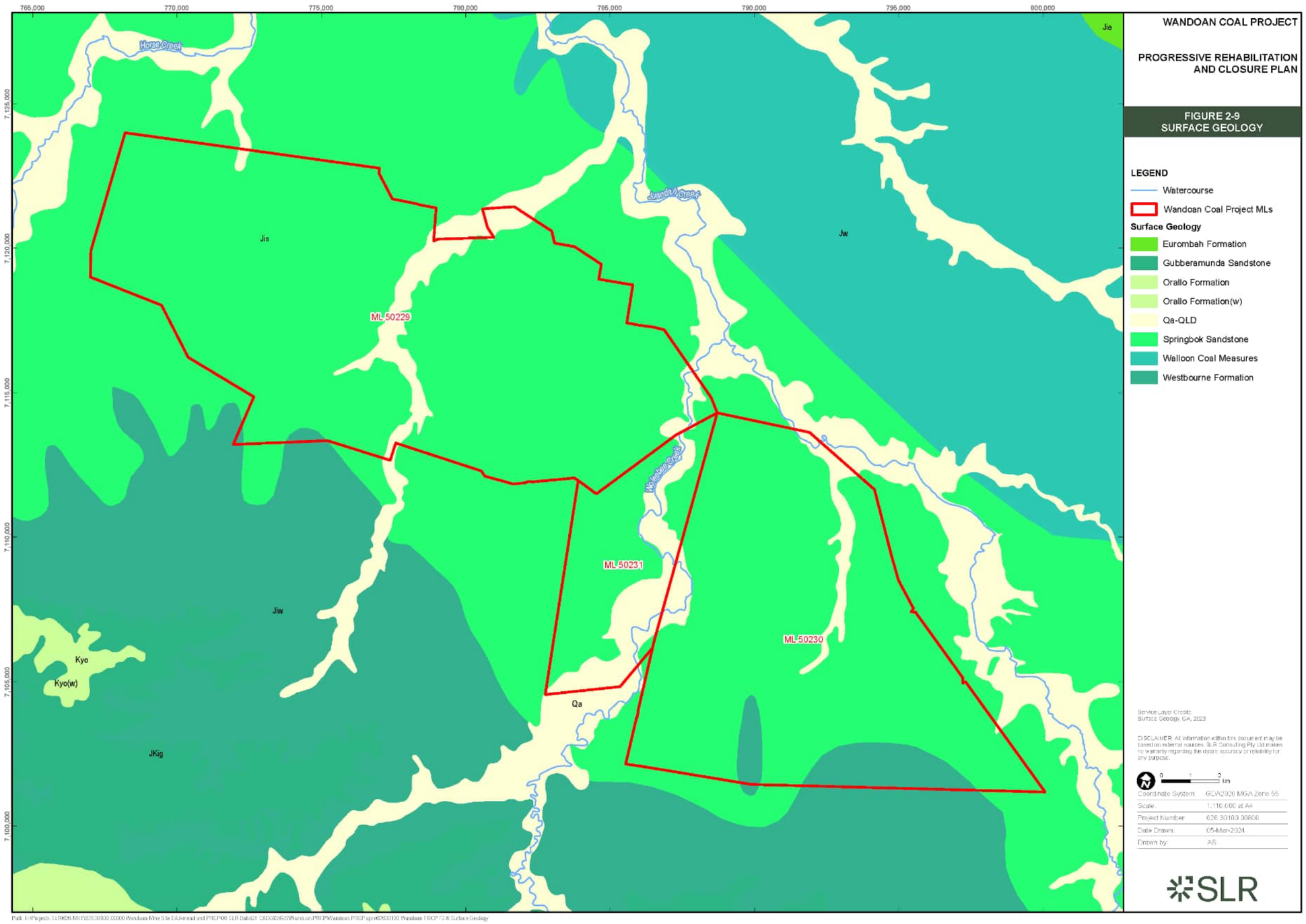


Figure 1-3: Surface geology

The Juandah Coal Measures contain the economic coal reserves of the WCP, and comprise medium to coarse grained lithic sandstone, siltstone, mudstone and coal seams. The particle size generally increases with depth. The coal seams are relatively flat, with a regional dip of approximately zero to two degrees to the south-west, with localised steeper dips.

The following seam groups occur within the stratigraphic profile at the WCP (**Figure 1-4** and **Figure 1-5**):

Kogan

The Kogan coal seams generally occur in the southern portion of the mining leases and at shallower depths. The group consists of approximately seven seams, each of which generally vary in thickness between 0.1 m and 5.0 m.

Macalister Upper

The Macalister Upper coal seams occur below the Kogan seams. The group consists of approximately five seams, each of which generally vary in thickness between 0.05 m and 4 m.

Macalister Lower

The Macalister Lower coal seams occur below the Macalister Upper seams. The group consists of approximately six seams, each of which generally vary in thickness between 0.01 m and 3.0 m.

Wambo

The Wambo coal seams occur at shallower depths in the northern portion of the MLs and below the Macalister Lower seams in the rest of the MLs. The seam consists of approximately seven seams, each of which generally vary in thickness between 0.1 m and 3.0 m.

1.3 Target coal seams

The target coal seams at the WCP include the Kogan, Macalister Upper/Lower and Wambo seams described above, which are relatively shallow seams at the WCP location, and are part of the Juandah Coal Measures which in turn for part of the broader Walloon Coal Measures as shown in **Figure 1-5**.

The local stratigraphy at the WBSP area is also illustrated in **Figure 1-5** and the target coal seams are overlain with weathered Tangalooma siltstone/mudstone materials with defined sandstone lenses. Carbonaceous shale can also be present between the Macalister Upper and Lower seams.

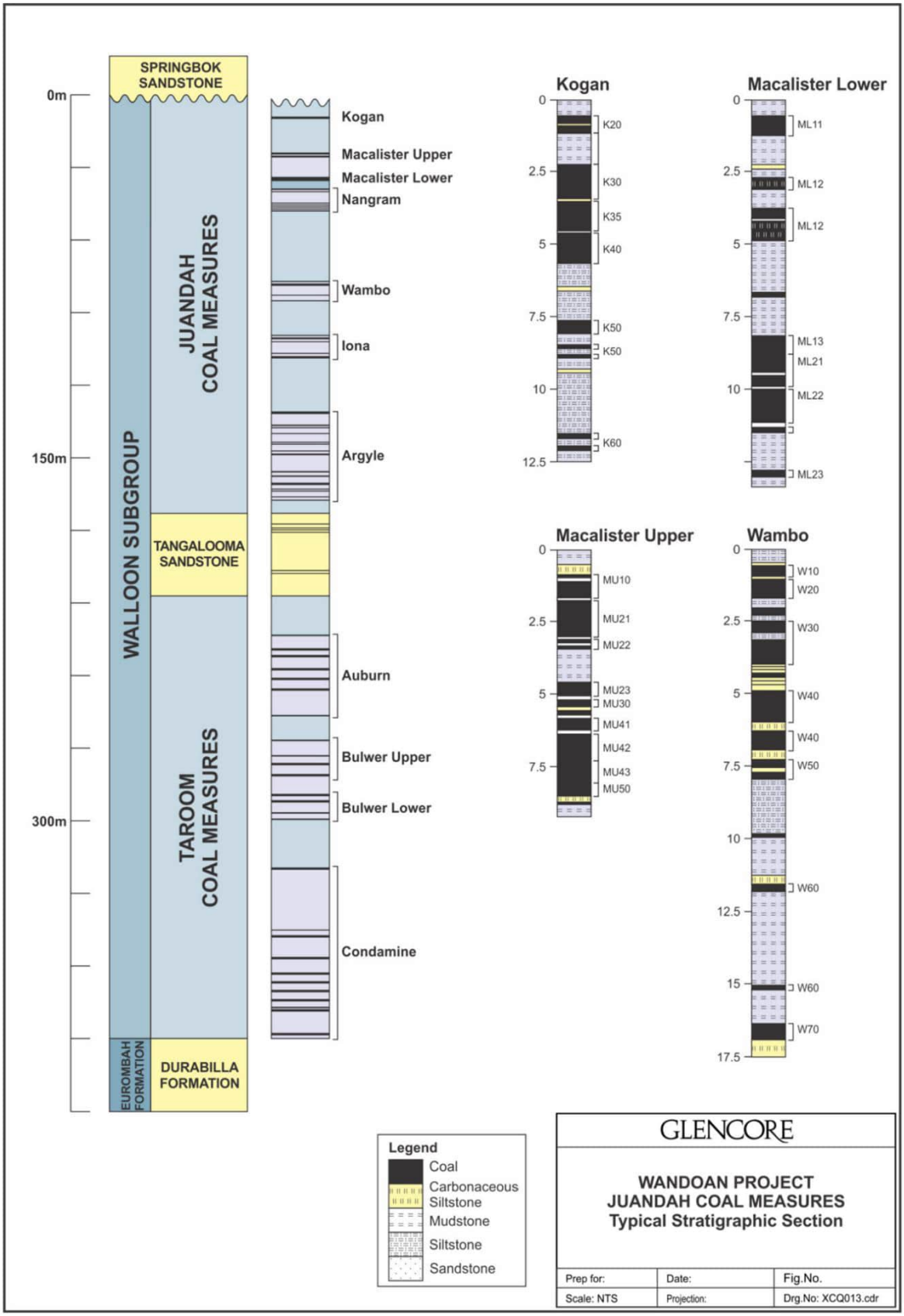
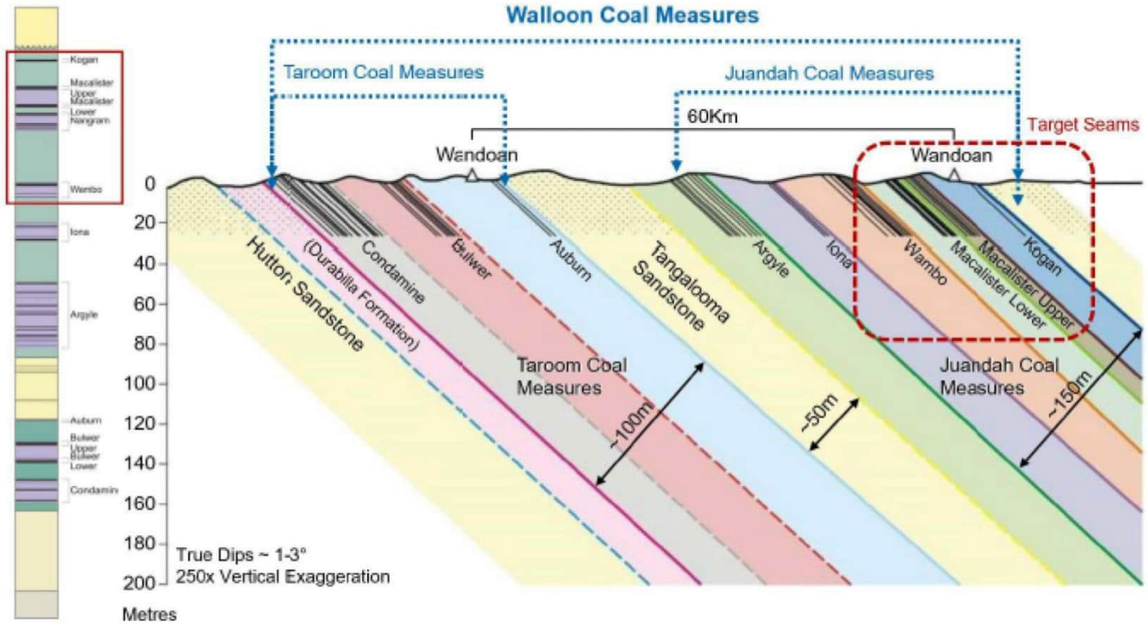


Figure 1-4: Typical stratigraphic column at the Wandoan Coal Project

Geology and Target Seams

Target Seams



Seam Average	Total Coal Thk	Total Parting Thk	Coal Ply Thk	Parting Thk	Raw Ash	% of Tonnage
Kogan	1.9	2.8	0.13	0.21	13.4	15%
Macalister Upper	5.4	2.3	0.27	0.14	17.1	57%
Macalister Lower	3.3	4.1	0.25	0.33	19.6	22%
Wambo	1.3	1.3	0.15	0.16	13.4	6%

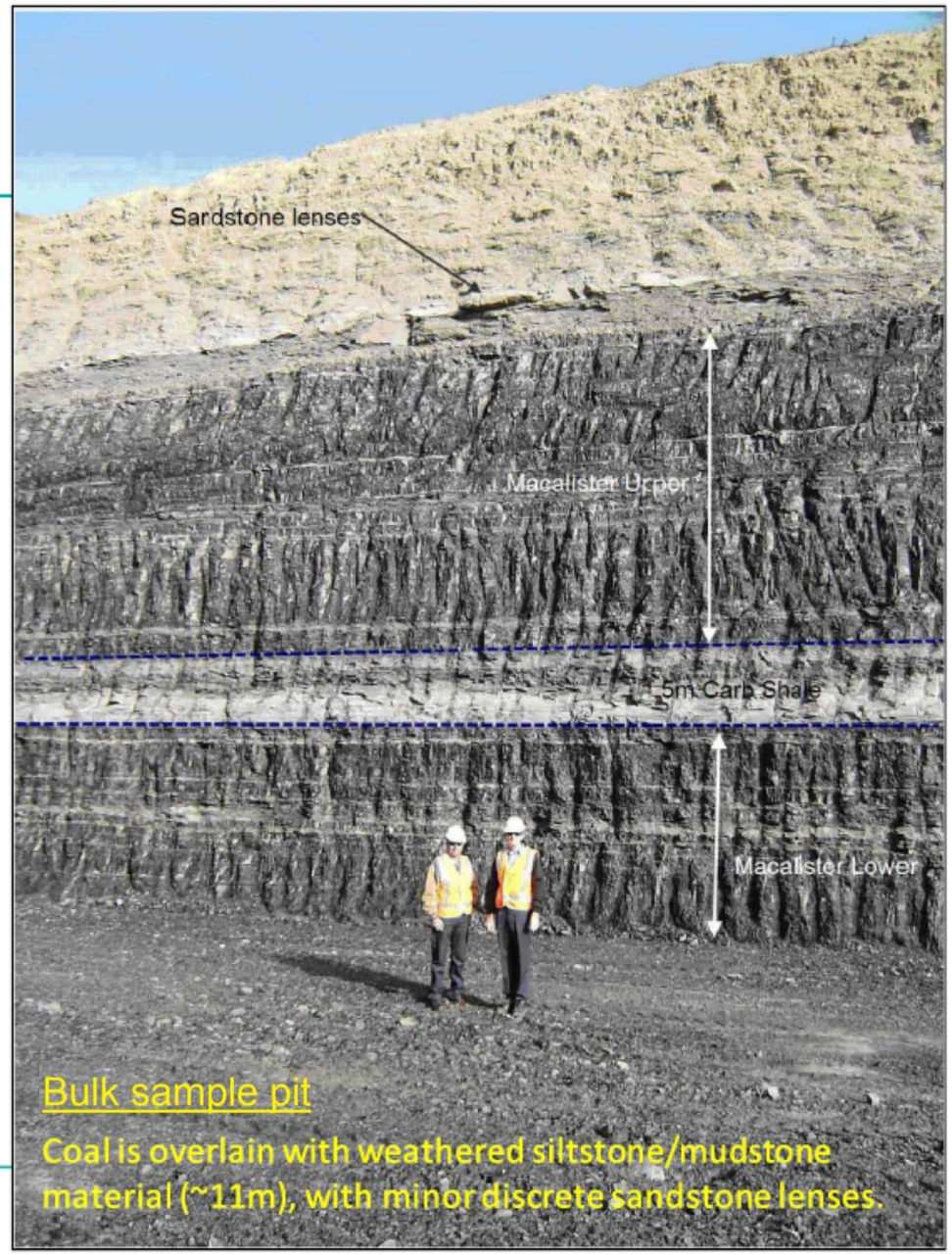


Figure 1-5: Wandoan Walloon Coal Measures, target seams and local seam geology

1.4 Purpose of assessment

The purpose of this GPSC assessment was primarily to characterise mine materials including soil, overburden, interburden, coal, coarse reject, and tailing materials that will be mined or subsequently generated from processing coal from the WCP open pits using a variety of geochemical and, where appropriate, selected physical and spontaneous combustion testing methods. Based on the characterisation results, the materials have been classified as beneficial (e.g., non-acid forming (NAF)) or deleterious (e.g., potentially acid forming (PAF)) in order to assign a suitable use for each unit. For example, overburden material could be used for embankments or as fill to lift infrastructure above flood plains. Highly weathered material could potentially be used as part of a growth medium for rehabilitation. It is expected that the program of work will assist in the development of a financially viable and environmentally robust management strategy for mine materials.

1.5 Scope of work

The scope of work for the GPSC assessment included:

- A desktop assessment of existing project information;
- Development of a GPSC Sampling and Analysis Plan (GPSC-SAP).
- Implementation of the GPSC-SAP
- Completion of GPSC tests of on relevant materials.
- Provision of a stand-alone technical report

The initial GPSC sampling program included a total of 18 bulk samples of mine materials from the WBSP, which were collected by GCAA personnel as detailed in **Section 2.1**. In addition, a further two bulk samples of coarse reject and tailing materials were provided by GCAA following processing of coal at ALS laboratory (ALS). A laboratory testing program on the representative samples of mine materials was completed by mid-2023 as described in **Section 2.3**.

The subsequent GPSC sampling and analysis program included an additional 122 samples from eight drill holes and focussed on collecting representative samples of overburden, interburden, coal, and potential reject materials from the GCAA exploration and groundwater borehole drilling program. The samples were received from November 2023 to February 2024 and analysis occurred concurrently until April 2024.

RGS has provided this stand-alone Technical Report

1.6 PRCP requirements

The need to comply with the PRCP guideline (DES, 2023) has influenced the program of work recommended to be completed for the WCP.

In the PRCP guideline, geochemical and chemical analysis is referenced on pages 20, 29, 30, 31, 33 and 70 and physical analysis is referenced on pages 29, 30 and 70.

For the PRCP, the number of samples needed to inform life of mine planning decisions varies, and is (in part) a subjective process that considers:

- Volume of mine waste being produced;
- Number of open pits being mined;
- Depth of open pits;
- Variation in soil types and regolith properties;
- Variability of the geochemical and physical properties of each rock type within and between open pits;
- Number of major rock types; and
- Mining method.

In order to address PRCP Guideline requirements, RGS developed and implemented a GPSC-SAP to ensure there was adequate coverage within the WBSP and broader project area to characterise and classify representative samples of the various mine materials.

The need for comprehensive geochemical and selected physical testing is clearly defined in the PRCP Guideline i.e., the waste characterisation report should achieve the following outcomes:

- Sampling regime meets best practice standards, is spatially representative of all material being mined (i.e., the coal seams, exposed pit walls and overburden) and representative of all lithologies;
- Be capable of confidently classifying mine and processing waste streams (e.g., coal rejects) based on environmental risk and management requirements;
- Be capable of generating block models or equivalent models and estimating the volume of mine waste based on waste type (i.e., level of environmental risk); and,
- Provide recommendations for the management and mitigation of mine and processing waste streams to manage environmental risk and achieve proposed rehabilitation methods and objectives.

The GPSC-SAP developed by RGS for the WBSP and the broader planned open cut pits at WCP addressed the following:

- Potential for acid, neutral and alkaline pH drainage and saline and metalliferous drainage (AMD);
- The fact that not all NAF materials are the same:
  - NAF material can, in some cases, range in its physical properties from being sand or clay to fresh volcanic rock that will resist weathering for millennia, and it is this aspect of material characterisation that becomes critical when stable constructed mine landforms are being designed;
  - NAF material may contain elevated sodium chloride and metal/metalloid content and have the potential to leach saline and metalliferous drainage;
- Physicochemical properties of all the materials from the topsoil to the deepest mined surface to address:
  - sodic potential; porosity and permeability; erosion; and water holding potential.
- The potential for co-disposal of processing waste materials within overburden at storage facilities or as part of pit backfilling activities; and,
- The impact of backfilling mine waste into mined voids and the effect this can have on the porewater quality that accumulates in the backfilled material as the water level recovers.

1.7 Desktop study

A desktop study of previous relevant information on the WCP is included in **Attachment F**. Completed work includes:

- Environmental Impact Assessment (2010);
- Groundwater studies, including existing groundwater use and quality, and potential impacts from mining and mitigation (2008);
- Soil and land suitability surveys including soil classification and fertility studies (2008);
- Overburden fertility studies and geochemical assessment (2008);
- Washability studies on coal rejects (2022); and,
- Tailings dewatering studies (2022).

Groundwater characterisation summary from previous studies (circa. 2008)

- pH is neutral to slightly alkaline (7.0 - 8.1)
- Salinity is elevated (11,300 to 23,100 µS/cm)
- Major cations and anions are sodium (Na) and chloride (Cl)
- May contain minor concentrations of dissolved arsenic (As)
- Turbidity is elevated (7,113 to 15,816 mg/L)
- Total hardness as $CaCO_3$ is elevated

Soil characterisation summary from previous studies (circa. 2008)

- Soils were classified as brown dermosol, vertosols, and chromosols
- May be dispersive or non-dispersive
- Soils are typically heavy clays that have strong plasticity
- Slightly to strongly alkaline pH, low to elevated salinity
- Low organic carbon content (2% - 4%)
- Low to medium N and P availability

Overburden characterisation from previous studies (circa. 2008)

- Alkaline pH (9.2 - 10.4)
- Salinity is low to moderate (280 – 1,080 μS/cm)
- Low Cation Exchange Capacity (CEC), exchangeable cations dominated by Na and calcium (Ca)
- Low organic matter
- Can be dispersive, especially sandstone
- Some overburden is non-dispersive, especially siltstone/coal
- Total sulfur (S) is low (0.01 to 0.14 %S)
- Acid Neutralising Capacity (ANC) is low to moderate (6 to 50 kg H_2SO_4/t)
- All samples have negative Net Acid Producing Potential (NAPP)
- Levels of total trace metals in solids are low

No coarse rejects or tailings characterisation studies were undertaken previously.

2 Methodology

2.1 Phase 1 sample collection

2.1.1 WBSP test pit samples

RGS received 18 representative bulk samples of soil, overburden, coal, and interburden that were collected by GCAA personnel from a test pit adjacent to the WBSP, which is located in the proposed Austinvale Pit footprint (**Figure 2-1**). Upper subsoil (0.0 to 0.6 m) included some topsoil as well as subsoil material. Lower subsoil was collected from a depth of 0.6 to 1.7 m. The soil units were classified as Quaternary alluvium (Qa) and were underlain by soft, highly weathered Springbrok Sandstone (Jsw) to 2.2 m. Underneath these soil materials lay the Juandah Coal Measures (Jtj), which contained a variety of low grade and higher-grade Macalister Upper coal plies.

The lithology and depth of the samples of mine materials are summarised in **Table 2-1**.

Complete test pit soil logs with photographs are provided in **Attachment D**.

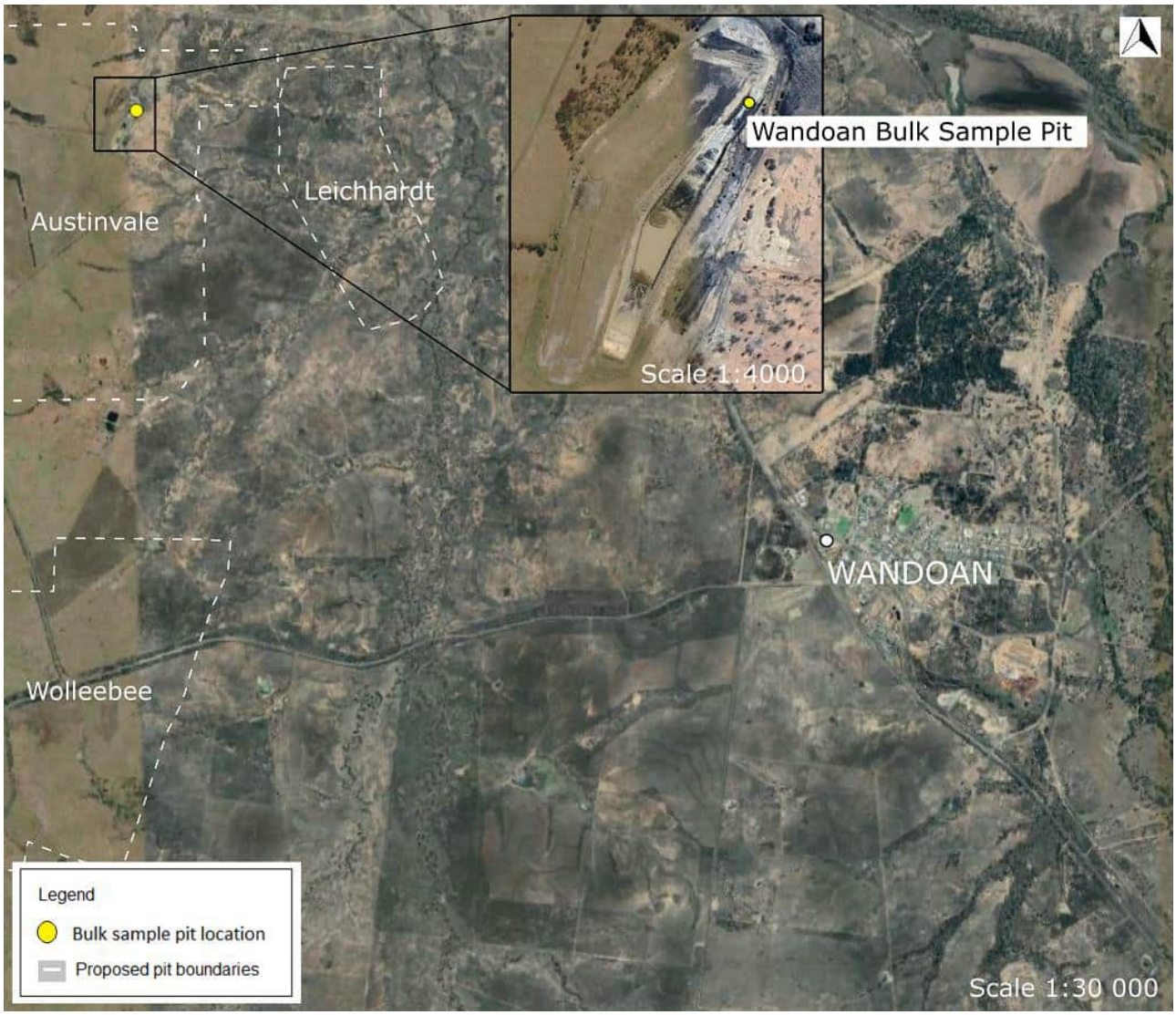


Figure 2-1: WBSP location

Table 2-1: Individual soil, coal and overburden/interburden samples

RGS ID	Description	Geology	Depth From (m)	Depth To (m)	Mass (kg)
2022005_0001	Upper subsoil	Quaternary alluvium (Qa)	0.0	0.6	20.76
2022005_0002	Upper subsoil		0.0	0.6	18.16
2022005_0003	Lower subsoil		0.6	1.7	17.52
2022005_0004	Lower subsoil		0.6	1.7	19.31
2022005_0005	Overburden	Springbok Sandstone (Jsw)	1.7	2.2	27.95
2022005_0006	Overburden		1.7	2.2	15.64
2022005_0008	WS1A	Juandah Coal Measures (Jtj)	2.2	4.0	19.49
2022005_0009	WS1A		2.2	4.0	19.39
2022005_0010	WS1A		2.2	4.0	20.32
2022005_0011	WS1A		2.2	4.0	20.4
2022005_0012	WS1A		2.2	4.0	19.91
2022005_0007	Interburden WS1B		4.0	4.4	21.08
2022005_0013	WS1B		4.4	7.0	16.95
2022005_0014	WS1B		4.4	7.0	17.2
2022005_0015	WS1B		4.4	7.0	15.62
2022005_0016	WS1B		4.4	7.0	17.77
2022005_0017	MU/ML IB		7.0	7.5	20.07
2022005_0018	MU/ML IB		7.0	7.5	18.66

2.1.2 Coal rejects and tailings

A sample catalogue for the coal reject (one coarse reject and one tailings sample) provided by GCAA is included in **Attachment D** and summarised in **Table 2-2**.

Table 2-2: Individual coal reject and tailing samples

RGS ID	Description	Material type	Date	Mass (kg)
2022005_0019	Rejects	Coarse coal rejects	1/04/2022	11.05
2022005_0020	Tailings filter cake	Tailings	16/08/2022	6.5

Coal rejects are comprised of coarse reject and fine (tailings) materials and are a specific type of waste generated from processing coal at the CHPP. These materials may be stored individually at storage facilities or may be co-disposed to provide texture and stability to the weaker tailing materials. Alternatively, these materials can be placed within overburden emplacements along with typically a much larger volume of overburden and interburden materials. Coal rejects generally require some form of encapsulation if they are geochemically classified as PAF.

RGS received a single 11 kg **coarse reject** sample from ALS which had been subjected to float sink analysis at nine different density ratios, ranging from 1.30 to 2.20. The raw coal had been separated into four fractions: feed, product, middlings, and reject. The reject contained a higher proportion of ash compared to product coal and is lower in fixed carbon and fuel ratio. The inorganic (ash) component is comprised of minerals, such as pyrite, quartz, calcite, siderite, and clays.

Tailings are a fine coal waste material produced during processing as a watery slurry. Tailings are usually piped to a tailings storage facility (TSF) for ease of transportation but can instead be thickened or dewatered to recover water and reduce runoff and seepage. Tailings slurry and thickened tailings are usually soft and wet

and difficult to rehabilitate; however, dewatered tailings are generally soil-like, relatively stable, and rehabilitation of these materials is relatively straightforward, if managed effectively. The WCP will not have a TSF.

RGS received a 6.5 kg bucket of **tailings filter cake** from ALS which had been dewatered from a 25-35 % solids tailings slurry using a Plate and Frame Filter. The tailings slurry was processed in an off-site pilot plant from coal samples (n=17) from the Macalister Upper coal seam and is representative of typical underflow conditions (i.e., clay and silt particles <0.06 mm) from working section #1 (WS1). These seams were 2.2 to 7.0 m in depth.

2.1.3 WBSP individual samples

Table 2-3 summarises the total number of individual samples of mine materials included in the initial sampling program at the WBSP. In total there were 20 individual samples, which are comprised of soil, overburden, interburden, coal, coal rejects, and tailings.

Table 2-3: Wandoan Phase 1 individual samples

Material type	Number of samples
Soil	4
Overburden	2
Interburden	3
Coal	9
Coal reject	1
Tailings	1
Total	**20**

2.1.4 WBSP composite samples

The 20 individual samples from the WBSP were subjected to initial static geochemical screening tests to determine the variability within each material type. Based on these results (**Section 3.1**), individual samples were selected to group together to make composite sample materials with similar properties, increase the available mass for each composite sample, and make the most efficient use of the analytical testing budget. In this assessment, there were three types of composites, which are summarised in **Table 2-4**:

Multi-element (ME) composites: One or two individual samples of similar material type were combined into composite samples for multi-element testing to optimise the analytical test program (n=10).

Bulk composites: A bulk composite sample comprising 4 to 6 individual samples of similar material types (e.g. low grade coal, C011 and coal, C012) was created to provide increased mass and optimise the analytical test program (n=2) including for physical testing, such as permeability.

Kinetic Leach Column (KLC) composites: Individual samples of selected mine material types that may have potential to influence surface water runoff and seepage water quality were prepared as composite samples (n=6). Soil materials were specifically excluded from the KLC test program.

Table 2-4: Wandoan Phase 1 composites

RGS ID	Description	ME Composite ID	Bulk Composite ID	KLC Composite
2022005_001	Upper subsoil	2022005_C01		
2022005_002	Upper subsoil			
2022005_003	Lower subsoil	2022005_C02		
2022005_004	Lower subsoil			
2022005_005	Overburden	2022005_C03		KLC 1
2022005_006	Overburden			
2022005_007	Interburden WS1B	2022005_C04	2022005_C011	KLC 2
2022005_008	WS1A			
2022005_009	WS1A	2022005_C05		
2022005_010	WS1A			
2022005_011	WS1A	2022005_C06		
2022005_012	WS1A			
2022005_013	WS1B	2022005_C07	2022005_C012	KLC 3
2022005_014	WS1B			
2022005_015	WS1B	2022005_C08		
2022005_016	WS1B			
2022005_017	Interburden MU/ML	2022005_C09		KLC 4
2022005_018	Interburden MU/ML			
2022005_0019	RGS FGX Rejects	2022005_C10		KLC 5
2022005_0020	Tailings filter cake			KLC 6

2.2 Phase 2 Drill hole samples

2.2.1 Drill hole locations

A total of 122 drill hole samples of mine materials from the WCP were sourced from 8 drill holes, located in the planned Leichhardt, Austinvale, and Wolleebee open pit footprint areas (**Table 2-6**). Drill holes R9595P and R9608P (circled in red in **Figure 2-2**) are monitoring boreholes that produced chip samples. The remaining 6 holes are exploration drill holes (circled in blue in **Figure 2-2**) and produced regular or large diameter core samples. All drill holes are contained within the proposed pit shells except for R9595P, which is located slightly to the northeast of the Leichhardt Pit.

Table 2-5: Phase 2 drill holes

#	Drill hole ID	Client ID	Pit	Drill hole type	Description
1	R9595P	2023MB01	Leichhardt	Monitoring borehole	Chip
2	R9608P	2023MB02	Leichhardt	Monitoring borehole	Chip
3	C9610GP		Leichhardt	Exploration	Core
4	C9606GP	LD2023_3	Austinvale	Exploration	Core
5	L9612	LD2023_1	Austinvale	Exploration	Core
6	L9611	LD2023_2	Austinvale	Exploration	Core
7	L9614	LD2023_4	Wolleebee	Exploration	Core
8	C9605GP	Geochem #2	Wolleebee	Exploration	Core

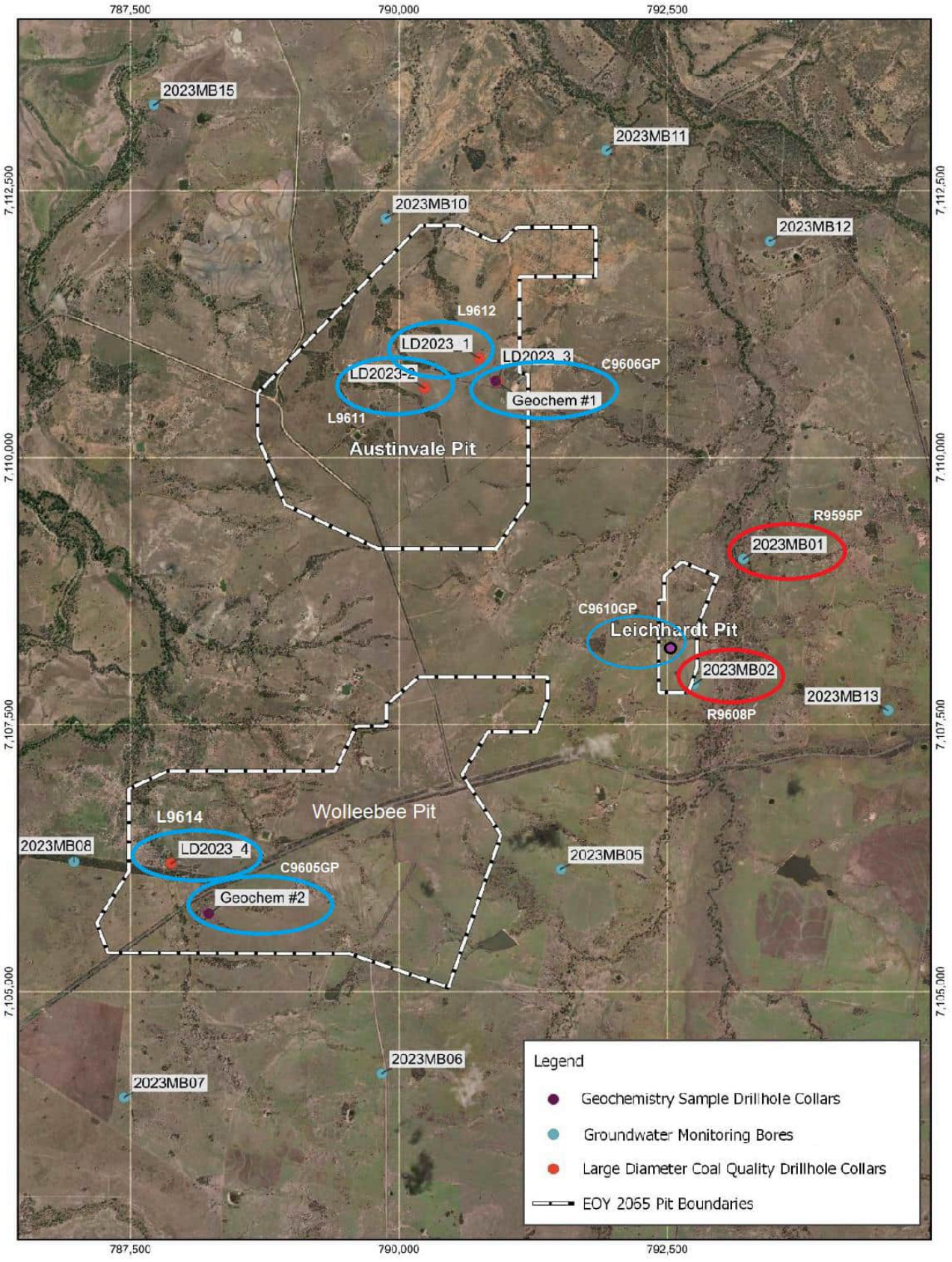


Figure 2-2: Phase 2 drill hole locations

2.2.2 Drill hole individual samples

The sampling frequency and types of mine materials collected from within each of the 8 drill holes is provided in **Table 2-6**. Each drill hole contained between 5 and 24 samples and supplied a range of mine materials from the surface to the base of the proposed mining operation, including overburden, interburden, coal, potential reject, parting, and basement. Parting refers to non-coal material in between coal plies. The target coal seams covered were the Kogan (K), Macalister Upper (MU), Macalister Lower (ML), and Wambo (WA). Thin coal plies that were split by sediments were classified as potential reject, whereas parting materials were between well-separated plies and did not contain coal. In total, 122 individual drill hole samples were collected.

Table 2-6: Drill hole sampling frequency/distribution

Drill hole ID	Overburden	Interburden	Coal / Potential reject	Parting / roof / floor	Basement	Seams	Total
R9595P	4	1	3	2		MU	**10**
R9608P	2	4	9	2	3	MU, ML, WA	**20**
C9610GP	4	3	5	12		MU, ML, WA	**24**
C9606GP	6		11	6		K, MU, ML, WA	**23**
L9612	1			10		MU, ML, WA	**11**
L9611				5		MU, ML, WA	**5**
L9614	1	1	3	8		MU, ML, WA	**13**
C9605GP	7	2		7		K, MU, ML	**16**
Total	**25**	**11**	**31**	**52**	**3**		**122**

2.2.3 Drill hole composite samples

After the initial screening process (**Section 3.1**), the individual drill hole samples of mine materials from the broader WCP were grouped together on the basis of their material type and geochemical properties (**Table 2-7**). The composite samples were then subjected to more detailed geochemical analyses, such as soluble metal(loid) concentrations (**Section 3.2.2**). The composites (C13 to C28) were designed to represent different:

- Material types (e.g., coal, overburden, interburden)
- Pit locations (Leichhardt, Austinvale, or Wolleebee)
- Coal seams (Kogan, Macalister Upper, Macalister Lower, or Wambo)

RGS sought to represent each of these variables in the composite samples, however this was not always possible due to the available individual sample mass. Particular care was taken with regards to representing carbonaceous materials (e.g., coal and potential reject), as these materials can contain slightly elevated total sulfur concentrations compared to non-carbonaceous materials. The composites (C13 to C16, C27, and C28) contained between 1 and 3 samples and generally had low sample mass (<1 kg).

Low risk materials (e.g., overburden and parting) that had been tested generally contained low levels of total sulfur (**Section 3.1.3.1**) and were grouped into larger composites (C17 to C26) of between 10 and 21 samples and had a relatively high sample mass (>1 kg).

Composite samples representing the Macalister Lower and Wambo coal seams (KLC 7 to KLC 10) were selected for the drill hole KLC program (**Table 2-7**). Samples from the previous KLC test program (sourced from the WBSP (KLC 1 to KLC 6), which encountered only the Macalister Upper coal seams. Additional KLC samples representing overburden and interburden from Leichhardt and Wolleebee Pits (KLC 11 and KLC 12) were also selected for KLC testing.

Table 2-7: Drill hole ME and KLC composites

ME Composite ID	Description	Pit	Number of samples	KLC Composite
2022005_C13	Coal – ML	Austinvale	3	KLC 7
		Leichhardt	1	
2022005_C14	Potential reject - ML	Austinvale	2	KLC 8
2022005_C15	Coal - WA	Austinvale	1	KLC 9
		Leichhardt	2	
2022005_C16	Potential reject - WA	Leichhardt	7	KLC 10
2022005_C17	Overburden	Austinvale	6	KLC 11
2022005_C18		Leichhardt	8	
2022005_C19		Wolleebee	6	
2022005_C20	Interburden	Leichhardt	8	KLC 12
2022005_C21		Wolleebee	2	
2022005_C22	Parting / roof / floor - MU	Austinvale	3	Excluded
		Leichhardt	4	
		Wolleebee	3	
2022005_C23	Parting / roof / floor - ML	Austinvale	7	
		Leichhardt	2	
		Wolleebee	3	
2022005_C24	Parting / roof / floor - WA	Austinvale	11	
		Leichhardt	10	
2022005_C25	Basement	Leichhardt	3	
2022005_C26	Parting / roof / floor - WA	Wolleebee	2	
2022005_C27	Coal – ML	Wolleebee	1	
2022005_C28	Coal - WA	Wolleebee	1	

2.3 Summary of Phase 1 and Phase 2 sampling program

A summary of individual samples collected in **the WBSP** and **drill hole sampling programs** is provided in **Table 2-8**. For this table, overburden collected from drill holes at a depth of less than 4 m was classified as soil. In total, 142 samples were collected in the WCP sample collection program.

Table 2-8: WBSP and drill hole sampling summary

Material type	WBSP	Drill hole	Total
Soil	4	7	**11**
Overburden	2	18	**20**
Interburden	3	11	**14**
Coal / potential reject	9	31	**40**
Partings / roof / floor		52	**52**
Basement		3	**3**
Coal reject	1		**1**
Tailings	1		**1**
Total	**20**	**122**	**142**

2.4 Analytical Test Program

2.4.1 Static geochemical testing

A series of static geochemical tests were completed on the mine materials summarised in **Section 2.3**. The test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, as well as the generation and the presence/leaching of soluble metals/metalloids and salts. The assessment also included characterisation of standard soil parameters including salinity, sodicity, cation exchange capacity, exchangeable sodium percentage and major metal/ metalloid concentrations. A summary of the parameters involved in completing a geochemical characterisation and assessment of mine materials is provided in **Attachment A**.

Static geochemical tests provide a 'snapshot' of the characteristics of a sample material at a single point in time. These tests were completed to screen individual samples before selecting either individual and/or composite samples for more detailed static test work.

The Acid Base Account method was used as a screening procedure whereby the acid-neutralising and acid-generating characteristics of the samples were assessed. All 142 individual samples were screened using the Acid Base Account method, which involved static geochemical testing for the following parameters:

- pH [1:5 w:v. sample:deionised water];
- Electrical conductivity (EC) [1:5 w:v. sample:deionised water];
- Total sulfur [LECO analyser]; and
- Acid Neutralising Capacity (ANC) [AMIRA, 2002 method].

The results of the Acid Base Account screening tests are discussed in **Section 3.1.** After the results of the screening tests were received and interpreted, selected samples with a total sulfur content greater than the median crustal abundance for sulfur (0.1 %S) were also tested for sulfide sulfur, using the chromium reducible sulfur (Scr), Australian Standard (AS 4969.7, 2008) method.

From the total sulfur value (or Scr value, where available), Maximum Potential Acidity (MPA) values were calculated by multiplying by the standard stoichiometric factor of 30.625 for pyrite/marcasite oxidation. Scr data was preferentially used where available, to provide a more accurate representation of the potential MPA, as acid generation primarily forms from the oxidation of reactive sulfide measured by this method.

After the results of the initial static geochemical tests were received and reviewed composite samples were created as described in **Section 2.1.4** and **Section 2.2.3** and 29 individual and composite samples were sent for whole rock multi-element testing at ALS Stafford laboratory.

The composite samples were tested for:

- pH and EC [1:5 w:v. sample:deionised water];
- Total major cations (Ca, Mg, K, Na) [HCl and HNO_3 acid digest followed by ICP-AES/MS];
- Acidity and alkalinity as $CaCO_3$ mg/L [PC Titrator (1:5 w:v water extracts)];
- Total metals/metalloids (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, and Zn) [HCl and HNO_3 acid digest followed by FIMS and/or ICP-AES/MS]; and
- Soluble major cations (Ca, Mg, K, Na) [ICP-AES/MS (1:5 w:v water extracts)];
- Soluble major anions (Cl, SO_4, F, P, Si) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)];
- Soluble metals (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, and Zn) [ICPAES/MS (1:5 w:v water extracts)].

Five selected samples of mine materials (soil and overburden) from the WBSP were also tested for exchangeable cations (Ca, Mg, Na and K) [ICP-AES], and results were used to calculate the cation exchange capacity and exchangeable sodium percentage. Summary geochemical results tables for the static geochemical test program are provided in **Attachment B**. The certified ALS laboratory certificates of analysis are provided in **Attachment G**.

2.4.2 Kinetic geochemical testing

The KLC tests simulated the weathering process that can lead to acid and base generation and reaction under laboratory-controlled conditions. The KLC tests allowed an assessment of the acid-forming and acid neutralising characteristics of a sample material and indicated the rate of acid/base generation, the period over which it occurred, and the management controls that may be required.

A total of twelve AMIRA (2002) style free-draining KLC tests were completed on selected composite samples of the various material types included in this assessment (**Table 2-9**). The mass of material in each KLC ranged from 1.0 to 2.0 kg and was generally dependent on material density (e.g., coal samples are less dense than overburden samples). The KLC test program associated with the WBSP samples are named KLC 1 to KLC 6 and the KLC tests associated with the drill core sampling program are KLC 7 to KLC 12.

Each KLC sample was leached with one litre of de-ionised water on a monthly basis for seven leaching events over a period of six months. Collected KLC leachate was subjected to testing using a standard water quality analysis suite after each leach event, as described in **Table 2-10**. Photographs of the KLC tests after seven monthly leach events are provided in **Figure 2-3** and **Figure 2-4**.

Analyses:

- pH and EC;
- Alkalinity and Acidity (as $CaCO_3$) [Automatic titrator];
- Major cations (Ca, Mg, Na and K) [ICP-MS];
- Major anions (Cl, F and SO_4) [Discreet Analyser and PC Titrator]; and
- Soluble metals/metalloids (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [ICP-MS/ICP-AES].

Table 2-9 : WBSP and drill core KLC set up

KLC Number	Column type	Material type	Number of samples in composite	Mass of material (kg)
KLC 1	AMIRA	Overburden	2	2.0
KLC 2	AMIRA	Low grade coal	6	1.5
KLC 3	AMIRA	Coal	4	1.2
KLC 4	AMIRA	Interburden	2	2.0
KLC 5	AMIRA	Coarse reject	1	2.0
KLC 6	AMIRA	Tailings	1	2.0
KLC 7	AMIRA	Coal	4	0.7
KLC 8	AMIRA	Potential reject	2	1.5
KLC 9	AMIRA	Coal	3	1.0
KLC 10	AMIRA	Potential reject	7	1.4
KLC 11	AMIRA	Overburden	20	2.0
KLC 12	AMIRA	Interburden	10	1.9

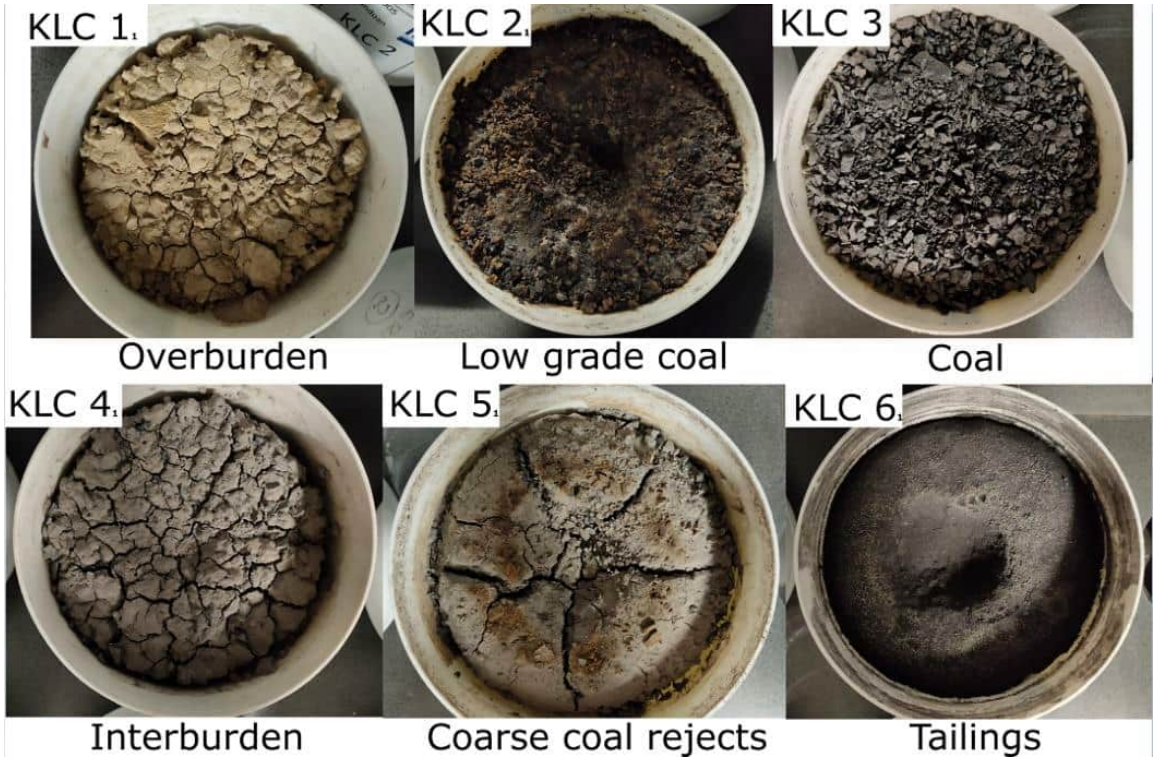


Figure 2-3: AMIRA Phase 1 KLC test photographs after 7 months

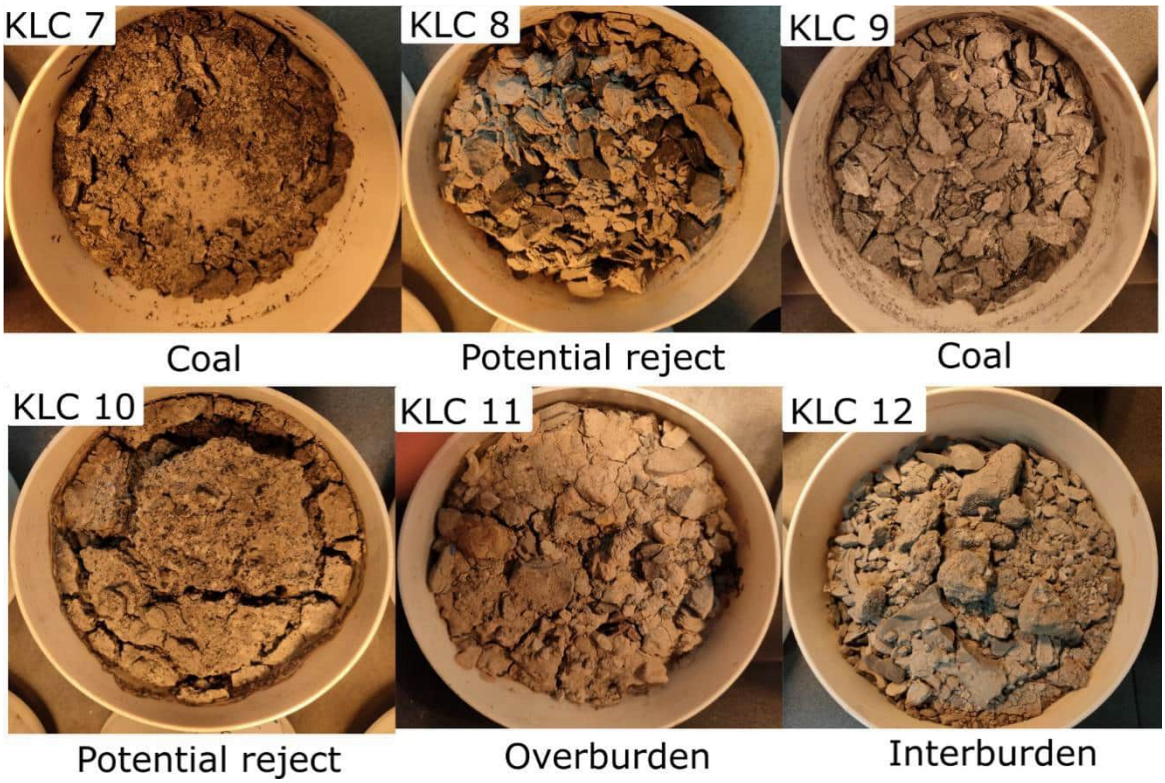


Figure 2-4: AMIRA Phase 2 KLC test photographs after 2 months

2.4.3 Soil quality

Soil quality testing was completed on four soil samples from the WBSP according to the range of analyses described in this section. The results are presented in **Table B2** and **Table B5** (**Attachment B).**

2.4.3.1 Soil nutrients

Soil quality describes the capability of the soil to maintain healthy plant growth under any given climatic regime. It is usually a function of the physical, chemical, and biological characteristics of the soil. To assess the available soil nutrients, soil samples are subjected to an agricultural suite.

Mining soils are typically not agricultural soils, and therefore the expectation that rehabilitation materials will meet cropping guidelines is unrealistic. Nutrient levels available for plants are usually low, but most mining soils can provide adequately for native vegetation without amelioration, as evidenced in undisturbed areas.

Soil nutrient analyses are generally completed on representative soil samples to provide baseline data to assess any impact on the soil caused by mining disturbance. Soils that have been stored during the mining process with the intent they are to be used later for rehabilitation can be expected to be less fertile.

Soil analyses:

- AG-3 Agricultural Suite:
  - pH ($CaCl_2$ method) [Rayment and Lyons, 2011];
  - Total organic carbon (TOC) in soil samples [APHA 5310 B]
  - Total organic matter (TOM) in soil samples [Walkley Black, AS 1289. 4.1.1-1997];
  - DTPA* extractable metals (Cu, Fe, Mn, and Zn) [Rayment and Lyons, 2011];
  - Nitrogen (N) nutrients (TN, TKN, NO_2, NO_3, NH_3 and NO_x) [APHA 4500];
  - Total and bicarbonate extractable phosphorous (P) (Colwell) [Rayment and Lyons, 2011];
  - Bicarbonate extractable potassium (K) (Colwell) [Rayment and Lyons, 2011];
  - Exchangeable cations [ICP-AES] [Rayment and Lyons, 2011].
  - Exchangeable Sodium Percentage (ESP).

*DTPA is an acronym for diethylene triamine penta-acetic acid.

2.4.3.2 Soil Salinity Class characterisation

ESP can be used in the classification of saline and alkaline soils or to determine if a sodium hazard exists. Under agricultural conditions, samples with ESP values less than 6 % are considered non-sodic, and greater than 14 % are considered strongly sodic and may be susceptible to dispersion and erosion (Isbell, 2016; and Northcote and Skene, 1972).

Rengasamy et. al. (1984) derived relationships between sodium adsorption ratio (SAR) and total cation concentration (TCC) (and by calculation ESP and EC) values to classify soils into Class 1, Class 2A, Class 2B (dispersive soils) and Class 3A and Class 3B (flocculated soils).

Analysis:

- Soil salinity class [Rengasamy et. al., 1984]

2.4.3.3 Emerson Class testing

The Emerson Class method is a physical analytical method used to qualify if a clay or soil ped will disperse or will flocculate in solution (**Figure 2-5**). The Emerson Class test can be used as a general guide to sodicity and potential for slaking and dispersion. The aggregate test can be used only as a general guide because of the large number of factors that determine whether slaking and dispersion occurs, such as sodicity, salinity, clay type, history of working and speed of wetting (Hazelton and Murphy, 2016).

Dispersion describes the behaviour of clay particles separating from one other in a moist soil: dispersion can cause soil aggregates to breakdown and the dispersed clay to clog soil pores: structural decline and erosion usually result (Baxter and Williamson, 2001).

Flocculated soils are favourable soils for rehabilitation because they contain particles which, when dispersed in a solution, remain in contact and adhere to each other forming clumps of a larger size (Baxter and Williamson, 2001). The flocculated clays tend to be stable hence are more likely to result in a resilient soil structure. Flocculated clays encourage soils to aggregate, and soils with stable aggregates allow water infiltration and drainage, provide pore spaces for air and water storage, enhance soil flora and fauna, and are more resistant to erosion.

Analysis:

- Emerson Class number (on aggregates) [AS 1289.3.8.1]

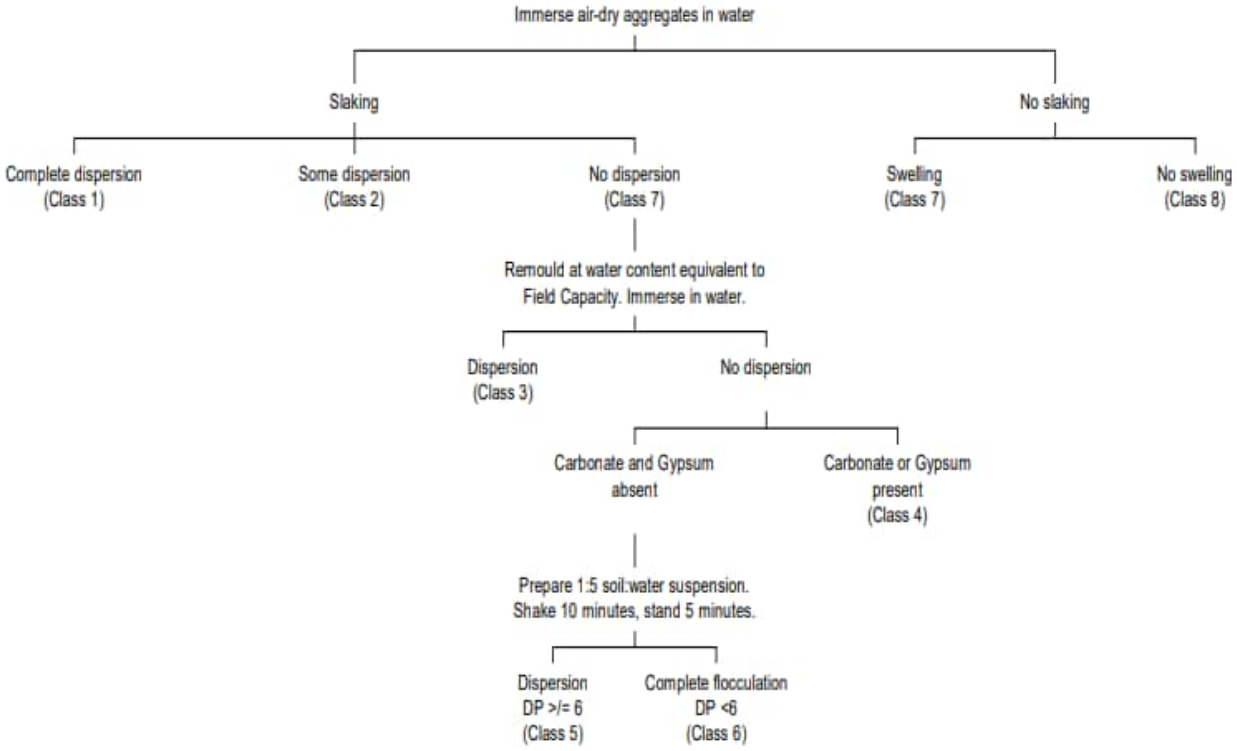


Figure 2-5: Emerson Class classifications

2.4.4 Physical testing

Physical testing of mine materials helps to determine their engineering properties from a geotechnical perspective. In many instances, an analysis of the physical properties can be used to interpret changes in geochemical behaviour over time, e.g., changes in permeability due to weathering. Material type (i.e., rock or soil) must be considered when selecting an appropriate physical test. Particle size distribution (grading), Emerson Class, column settlement, and Soil Water Characteristic Curves (SWCC) are suited for soil samples or weathered rock samples that have been crushed. Sodium soundness and point load testing can be completed on whole rock. Physical test results from Trilab laboratory are included in **Attachment H**. Column settlement results are provided in **Attachment I**. Soil-Water Characteristic Curve (SWCC) results from Soil Water Group are provided in **Attachment K**.

2.4.4.1 Particle Size Distribution

The objective of the particle size distribution (PSD) analysis is to group an assembly of particles of various shapes into separate ranges of sizes to determine the relative proportion by weight of each size range.

The PSD method employs sieving and sedimentation of a soil/water/dispersant suspension to separate the particles. The sedimentation technique is based on an application of Stokes' law to a soil/water suspension and periodic measurement of the density of the suspension (Gee et al., 2002).

Analysis:

- Grading with Hydrometer (includes Particle Density) [AS 1289.3.6.1]

2.4.4.2 Soil texture classification

Soil is a highly diverse material that can come in a variety of forms based on the composition of its particles. Soil particles range from clay (<0.002 mm) to silt (0.06 to 0.002 mm) and sand (0.06 and 2.0 mm in diameter). Soil can be 100% clay, silt, or sand, or it can be a combination of all three particle size classifications. The composition of these particles influences many important soil properties, such as its water retention and permeability. Twelve different soil texture categories have been accepted based on the percentages of these particles, which are determined by plotting each proportion on a soil texture triangle.

Analysis:

- Soil Texture Classification [ATSM-2017]

2.4.4.3 Permeability testing

Permeability (k) measures the flow of water through a substrate with an optimum moisture content of 20% ($k_{(20)}$), which varies with soil type. Low permeability materials (such as clays) may have application as liners to prevent infiltration into overburden emplacements, or from water storage dams into underlying sediments. Permeability is generally expected to increase as the soil compaction decreases (i.e., from k saturated 95 % to k saturated 90 %) due to an increase in void space between particles.

In the constant head permeability method, the top of the water column (head pressure) remains above the sample throughout the test and is commonly used for soils with a high flow rate, such as sands and gravels. In the falling head method, the head decreases as water infiltrates the sample, gradually decreasing pressure over the course of the test. This method is more suitable for fine grained soils and Permeability (k) is generally expressed in m/s.

Analysis:

- Permeability (falling or constant head method) [AS 1289.6.7.2-2001]

2.4.4.4 Column settlement

The column settlement experiment is performed by the RGS in-house laboratory. It is designed to measure the settling velocity of particles as they flocculate or become larger over time. Turbidity is used as an indicator of settling performance. The procedure is described below.

1. 100 g of soil or rock sample (sieved to -2 mm) was placed into a 1 L glass measuring cylinder and topped with DI water to a combined volume of 1 L.
2. A lid was placed over the top of the cylinder and the contents shaken thoroughly to ensure there were no sediments at the base of the cylinder.
3. The cylinder was placed on a stable surface and the contents were allowed to settle over time. Photographs were taken at 0, 8, 24, and 48 hours to show settlement progression.

Analysis:

- Column settlement [RGS in-house method number 105_RGSLM]

2.4.4.5 California Bearing Ratio

The compaction of soil can be expressed using the California Bearing Ratio (CBR). It is the pressure required to penetrate a soil sample with a standard 50 mm sized plunger. Compaction provides an indication of how much the material will increase in density over time. Compacted soils have a higher bearing ratio and provide

a more stable foundation for a cover design system. Consolidation is the additional compaction caused by the mass over overlying material e.g., cover system.

- California Bearing Ratio (CBR) [AS 1289.6.1.1 & AS 1289.2.1.1]

2.4.4.6 Aggregate Soundness (sodium sulfate)

Fresh rock fragments from the WBSP test pit were subjected to sodium soundness analysis at the RGS in-house laboratory to evaluate their rate of degradation over time. This test determines the resistance of aggregate particles to disintegration or drying, after soaking in a saturated salt solution. The sample is first submerged in a solution of sodium sulfate, sodium carbonate, and sodium chloride for 3 weeks. The sample is then removed from the solution and left to dry for 3 weeks, and the cycle repeated 5 times. If the sample disintegrates, the experiment is stopped and particle size distribution analysis is performed.

This process causes salt crystals to form in the aggregate pores, simulating accelerated weathering. Aggregate soundness is a long-term weathering test that may require months or years to reach completion.

Analysis:

- Aggregate soundness [RGS in-house method number 052RGSSLM, sodium sulfate solution]

2.4.4.7 Point load testing

Point load testing is an index which measures the strength characteristics of intact rocks. After determining sample dimensions, the sample is loaded with uniformly increasing force so that a break occurs between 10 – 60 seconds. The strength index (Is) is usually carried out on core samples of 50 mm diameter for which no correction is required (Is(50)). However, if the sample has different dimensions, it is termed an 'irregular lump' and must be corrected. The application of such a correction factor introduces possible inaccuracy (Broch and Franklin, 1972).

Analysis:

- Point load testing, irregular sample core/lump (Trilab laboratory method AS 4133.4.1-2007)

2.4.4.8 Atterberg limits

Atterberg Limits, also known as consistency limits, are used to classify the behaviour of soil as either: solid, semi-solid, plastic, or liquid depending on moisture content. For soils, the Atterberg limits have crucial implications to their agricultural, engineering, and mining use. Atterberg limits verify the nature of soil solids, which are affected by the thickness and dynamics of the diffused double layer within the clay mineral structure.

Atterberg Limits define the boundaries of the states in which a fine-grained soil can exist, and consist of:

- The **Liquid Limit**, also known as the upper plastic limit, which is the water content at which soil changes from the liquid state to a plastic state.
- The **Plastic Limit**, also known as the lower plastic limit, which is the water content at which a soil changes from the plastic state to a semisolid state; and
- The **Shrinkage Limit** is the maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass.

Each stage exhibits significant differences in strength, consistency, and behaviour. The behaviour of soil as water is added often gives an indication of whether the soil is plastic (predominantly clay) or non-plastic (predominantly silt); in our case, this behaviour should have some effect on erosional stability of the material (soil) under investigation.

Analysis:

- Atterberg limits [AS 1289.3.1.1]

2.4.4.9 Soil water characteristic curves

The SWCC, also known as a retention curve, shows the relationship between matric suction and water content. It is used to determine the hydraulic and mechanical behaviour of unsaturated soils and to help predict water

storage. SWCC are also used in geotechnical engineering to evaluate and predict the failure of slopes during heavy rainfall events. Matric suction refers to the height at which water can be drawn up (i.e., capillary rise) into an unsaturated soil.

SWCC are typically sigmoidal in shape and include a sharp transition zone that precedes residual conditions. Volumetric moisture content can be plotted against the pressure head (soil matrix potential) using van Genuchten parameters to generate water retention curves for different soil textures.

Analysis:

- Water Retention (Lourebco et al., 2011) including derived Van Genuchten parameters.

2.4.5 Mineralogy

The mineralogy of mine materials can be determined through x-ray diffraction (XRD) analysis by studying the crystallographic structure. The sample material is irradiated with incident x-rays and the intensities, and the scattering angles of x-rays that leave the material are measured.

The angle between the crystal facies is unique to each mineral, and thus leads to qualitative identification. With specialised techniques, modal amounts of minerals (semi-quantitative analysis) can also be determined, including the identification of fine-grained minerals, such as single and mixed-layer clays, which can be difficult to classify by optical methods. XRD spectra from the analysed material are matched to known mineral databases and can be mounted under different treatments to provide greater certainty to the classification.

The six KLC composite samples from the WBSP were sent to Levay and Co. Pty Ltd in South Australia for semi-quantitative mineralogical testing using X-Ray Diffraction (XRD) and the results from the test program are provided in **Attachment J**.

Four selected individual samples representing coal and potential reject materials sourced from drill core samples in the stratigraphically deeper coal seams were sent to X-Ray Vision in Australian Capital Territory and the results from the analyses are provided in **Attachment L**.

Analysis:

- Mineralogy by semi-quantitative XRD with clay speciation

2.4.6 Spontaneous combustion testing

The presence of carbonaceous material in coal, carbonaceous spoil, coarse rejects or tailings under certain circumstances may lead to spontaneous combustion. Spontaneous combustion is caused by the oxidation of coal and related carbonaceous materials, causing self-heating. One potential source of heat for this to occur is provided by sulfide oxidation, which is an exothermic process. In the presence of rapidly oxidising pyrite/marcasite, elevated temperatures and spontaneous combustion can occur without an external ignition source. Whilst spontaneous combustion is more likely to occur in materials characterised with a high propensity for this to occur, less reactive materials can also spontaneously combust if exposed to triggering environmental conditions and can be exacerbated by small amounts of water/rainfall.

Spontaneous combustion is a risk to people, facilities and the environment. Burning coal can release smoke and carbon monoxide, and fires in coal stockpiles and coal seams can be difficult to extinguish. The likelihood of spontaneous combustion varies with material type/characteristics as well as the method of storage/location.

The most common spontaneous combustion tests used in the Australia coal industry are the R_{70} adiabatic self-heating rate, crossing point temperature (CPT) and the relative ignition temperature (RIT). These tests can provide an indication of the intrinsic spontaneous combustion propensity (ISCP) of a particular sample material, which in Australia is generally based on a simple classification scheme that utilises the adiabatic self-heating (R_{70}) value (Beamish and Beamish, 2011; and Industry and Investment NSW, 2011).

The adiabatic self-heating (R_{70}) classification scheme does not provide an indication of the timeframe taken for spontaneous combustion issues to occur (incubation period). It also ignores the effects of moderating extrinsic factors such as in-mine ambient temperature and moisture and in general, the entire coal self-heating behaviour from low ambient temperature to thermal runaway can only be assessed by replicating in-mine conditions (such as the amount of fracturing for unmined coal in an exposed high wall situation) (Beamish and Theiler, 2017).

It is now well established that a spontaneous combustion hazard assessment can be improved by benchmarking against known coal self-heating experience from operating mines and built stockpiles using an incubation test method (Beamish and Thieler, 2015). The improved method used in this assessment can also quantify any accelerating effects from the presence of reactive pyrite/marcasite in coal and non-coal strata.

Incubation to Thermal Runaway can only occur if the following physical boundary conditions are met:

- There is a critical thickness present. For coals with an R_{70} value less than 2, the critical thickness required is generally greater than 2 m. For coals with an R_{70} value between 2 to 4 the thickness needs to be greater than 1.5 m. For coals with an R_{70} value between 4 to 8, the thickness needs to be greater than 1 m.
- There is a sufficient continuous supply of oxygen due to airflow. In a loose pile this is normally created by ventilation flow underground or wind flow in a surface environment. For fractured material in-situ there needs to be a considerable pressure differential present to enable the air to penetrate through the fracture system.
- In a surface environment there is no moisture accumulation from surface ponding or groundwater penetration that either excludes ingress of oxygen or creates a large evaporative heat loss mechanism.

It should also be noted that in a surface environment the material will oxidise over time to a point of deactivation if no heat is accumulated (Beamish, 2012).

Four carbonaceous samples from the WBSP (top and base of MU coal, coal rejects, and tailings) and four samples of drill core materials (coal from ML and WA, and potential reject from ML and WA) were subjected to spontaneous combustion testing and assessment.

Analysis:

- Spontaneous combustion testing [SponComSIM™, B3 Mining Services Pty Ltd]

2.5 Analysis program

The geochemical, physical, and spontaneous combustion analysis program for the soil, overburden, interburden, coal, coal reject and tailings samples (n=142) in the WBSP and drill core from the broader WCP area is described in **Table 2-10**.

Table 2-10: Analysis program

	PHASE 1	Soil, rock, and coal individual samples from WBSP	Coal reject sample	Tailings filter cake sample	ME and bulk composite samples	KLC composite samples	PHASE 2	Soil, rock, and coal individual samples	ME and bulk composite samples	KLC composite samples	Total
		18	**1**	**1**	**12**	**6**		**122**	**16**	**6**	**182**
Static geochemical analyses	**ALS Code**	**Method Code**	001-018	019	020	C01 - C12	KLC1-KLC6	021-142	C13 - C28	KLC7-KLC12	
Moisture Content			4		1	8					**13**
pH and EC (1:5)	IN-4S	APHA 4500 H+ - B and APHA 2510 B	18	1	1	8		122	16		**166**
NAPP (includes ANC, Total S)	ASS1	III. Coastech Research (Canada)	18	1	1			122			**142**
Chromium Reducible Sulfur (22B)	EA026	Ahern et al (2004)	5					23			**28**
Total cations (Ca, Mg, K, Na)	ED093T	APHA 3120B, APHA 3125B	4			8			16		**29**
Total metals by ICP-MS (As, Sb, Ba, Be, Cd, Cr, Co, Cu, Mn, Mo, Ni, Pb, Se, Th, U, V, Zn)	EG020T	USEPA 6020 ICP/MS	4		1	8			16		**29**
Total Metals by ICP-AES (Al, B, Fe)	EG005T	USEPA 6010 ICP/AES	4		1	8			16		**29**
Mercury (Total)	EG035T	APHA 3112 Hg-B CV/FIMS	4		1	8			16		**29**
Soil fertility analyses	**ALS Code**	**Method Code**									
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC >300µm) NOTE: If pH < 6.0 ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1				1					**1**
ED008+EN34+EA02 and EA010 + NT8S Nutrients (TN, TP, TKN, NO_2, NO_3, NH_3 and NO_x)	AG-2	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,									
AG2 + Chloride (1:5), pH ($CaCl_2$) Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and Organic Carbon by Walkley Black	AG-3	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D,				4					**4**
Shale Flask Extraction 1:3 and 16 hr leach for water soluble elements	**ALS Code**	**Method Code**									
Acidity as CaCO3 only	ED038P $CaCO_3$	APHA 2310 B	4		1	8			16		**29**
Cations - Dissolved: Calcium, Magnesium, Sodium, Potassium	NT-01	APHA 3120B, APHA 3125B	4		1	8			16		**29**
Anions: Major (Cl, SO_4, Alkalinity), Fluoride	NT-02A	APHA 3120B, APHA 3125B	4		1	8			16		**29**
Dissolved trace metals by ICP-MS/AES (including digestion) (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn)	EG020F (ME-02)	USEPA 6020 ICP/MS	4		1	8			16		**29**
Mercury (dissolved)	EG035F	APHA 3112 Hg-B CV/FIMS			1				16		**17**
Kinetic Leach Column testing	**ALS Code**	**Method Code**									
pH and EC	EA005P + EA010P	APHA 4500 H+ - B and APHA 2510 B					6			6	**12**
Acidity as CaCO3 only	ED038P $CaCO_3$	APHA 2310 B					6			6	**12**
Cations - Dissolved: Calcium, Magnesium, Sodium, Potassium	NT-01	APHA 3120B, APHA 3125B					6			6	**12**
Anions: Major (Cl, SO_4, Alkalinity), Fluoride	NT-02A	APHA 3120B, APHA 3125B					6			6	**12**
Trace metals by ICP-MS/AES (including digestion) (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn)	EG020F (ME-02)	USEPA 6020 ICP/MS					6			6	**12**
Mercury (dissolved)	EG035F	APHA 3112 Hg-B CV/FIMS					6			6	**12**
Fluoride (dissolved)	EK040-P						6			6	**12**
Physical Parameters (Trilab Brisbane)	**Code**	**Method Code**									
Grading with Hydrometer (includes Particle Density)	Based on method	AS 1289.3.6.1 , AS 1289.3.6.3	9								**9**
Atterberg Limits - Standard Oven Preparation	Based on method		4								**4**
Maximum Dry Density - A Mould Standard - 1 litre	Based on method					6					**6**
Soaked California Bearing Ratio (CBR) - includes Standard MDD	Based on method					3					**3**
Permeability (falling head) - includes MDD Standard 90%	Based on method					6					**6**
Emerson Class No.	Based on method	AS1289.3.8.1	6					3			**9**
Point Load testing	Based on method							10			**10**
Physical Parameters (RGS In-House)	**Code**	**Method Code**									
Dry grading (sieving) to 0.075 mm	RGS In-House							3			**3**
Column Settlement	RGS In-House					3					**3**
Aggregate soundness (sodium sulfate)	RGS In-House					3		10			**13**
X-Ray Diffraction (XRD) (Levay & Co)	Code	Method Code									
XRD Analysis - sample containing clay	Based on method		6		1			4			**11**
SWCC Testing (Soil Water Group)	**Code**	**Method Code**									
Soil Water Characteristic Curve (10 Point)	Based on method					3					**3**
Spontaneous Combustion (B3 Mining)	**Code**	**Method Code**									
Spontaneous Combustion analysis			2	1	1			4			**8**

3 Results and interpretation

3.1 Static geochemistry

Acid Base Account results for the 142 individual samples of coal and mine materials are presented in **Table B1** (**Attachment B)** and summarised in this section. The ABA results are presented by material type i.e., **spoil** (soil, overburden, interburden, basement); **potential coal reject** (roof, floor, parting) **coal and coal reject** (coal, coarse reject and tailings) to facilitate interpretation.

3.1.1 pH

Spoil: The $pH_{1:5}$ values for the soil, overburden, interburden, and basement samples are variable and range from 5.0 to 10.1 (**Figure 3-1**). One soil sample ($pH_{1:5}$ 5.0) from Austinvale Pit has a naturally slightly acidic pH compared to the other samples, although this value is similar to the pH of the deionised water used in the test program (pH 5.7). The pH values for all of the remaining samples are more alkaline for the interburden and basement samples and are expected to add some alkalinity to contact water.

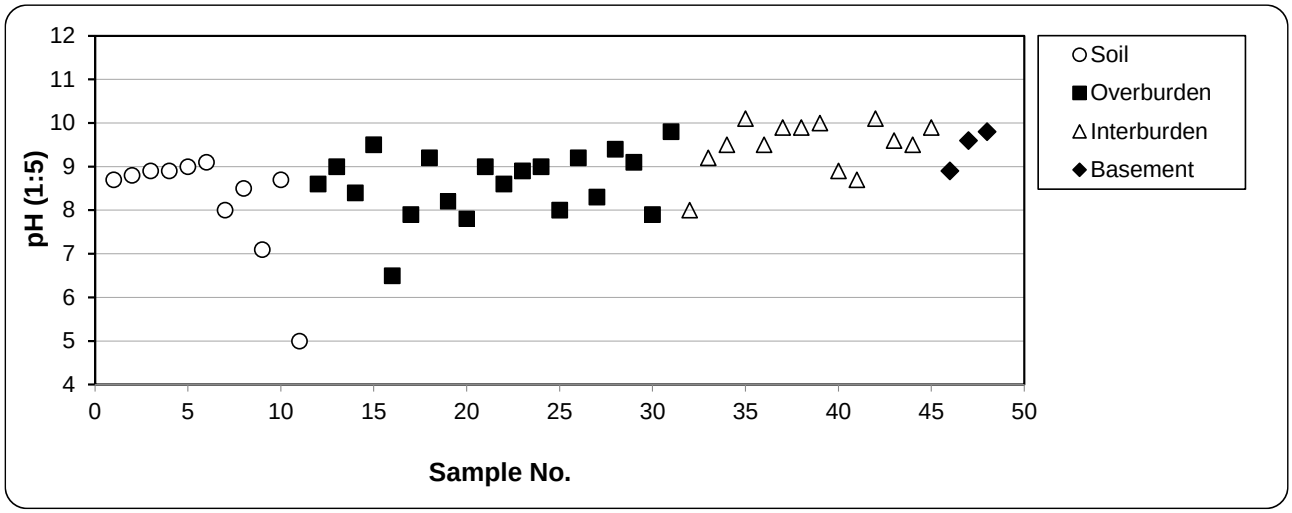


Figure 3-1: pH results for spoil

Potential coal reject: The $pH_{1:5}$ values for materials from the roof, floor and partings range from 7.9 to 10.7 (**Figure 3-2**). Partings are marginally more alkaline (median $pH_{1:5}$ 9.6) than roof (median $pH_{1:5}$ 9.3) and floor (median $pH_{1:5}$ 9.1). These materials are also expected to add some alkalinity to contact water.

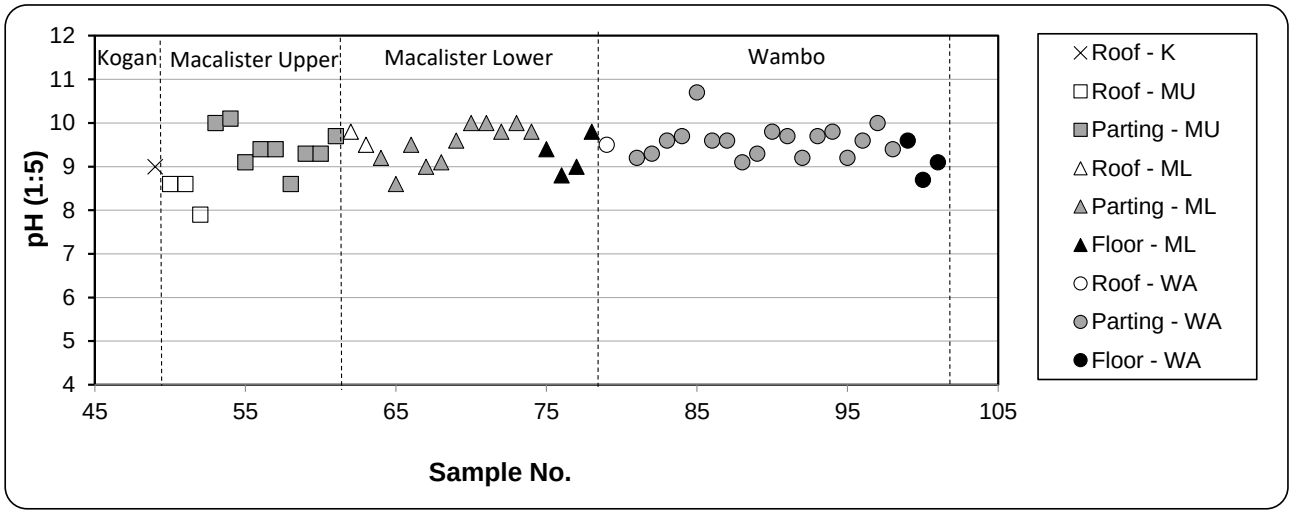


Figure 3-2: pH results for potential coal reject

Coal and coal reject: The $pH_{1:5}$ values for the coal, coarse reject and tailing samples range from 5.5 to 9.8 (**Figure 3-3**). The median pH values for each coal seam are Kogan ($pH_{1:5}$ 8.1), Macalister Upper ($pH_{1:5}$ 7.7), Macalister Lower ($pH_{1:5}$ 8.4) and Wambo ($pH_{1:5}$ 8.7), indicating a slight increase in alkalinity with depth. Four of the Macalister Upper samples had a pH value between 5 and 6, which is similar to the pH of the deionised water used in the test program (pH 5.7). Coarse reject and tailings produced from the Macalister Upper seam were slightly alkaline and pH neutral ($pH_{1:5}$ 8.6 and 7.0, respectively).

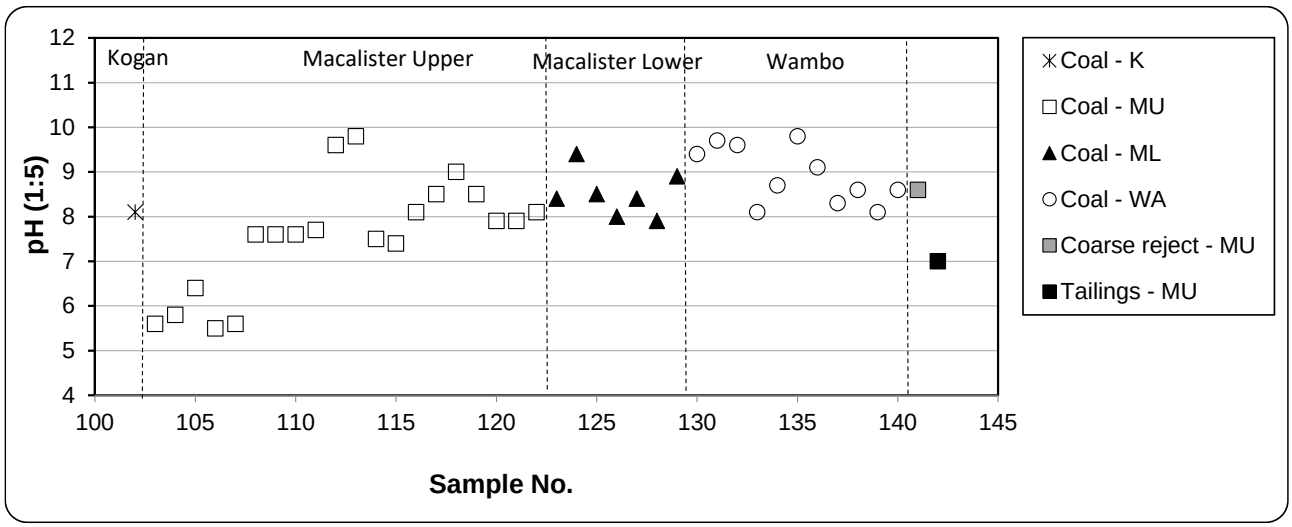


Figure 3-3: pH results for coal and coal reject

3.1.2 Electrical Conductivity

Spoil: The $EC_{1:5}$ values for the soil, overburden, interburden, and basement samples are variable, range from 67 to 1,430 µS/cm and are typically low (median 592 µS/cm) (**Figure 3-4**). Slightly elevated EC values (>1,000 µS/cm) are associated with one sample in each of the material types and are not consistent. Upper subsoil has a lower EC value than lower subsoil.

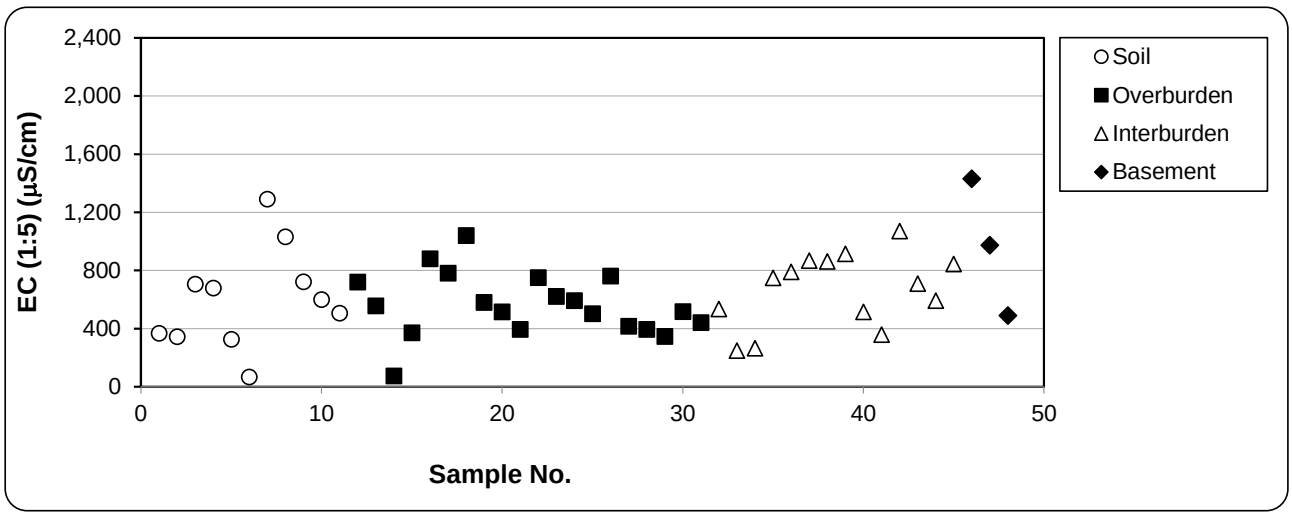


Figure 3-4: EC results for spoil

Potential coal reject: The $EC_{1:5}$ values for the roof, floor and parting samples are variable, range from 245 to 1,820 µS/cm and are typically low (median 545 µS/cm) (**Figure 3-5**). One parting sample from between plies of the Wambo coal seam had an elevated EC (1,820 µS/cm), whereas all other samples had EC values below 1,100 µS/cm.

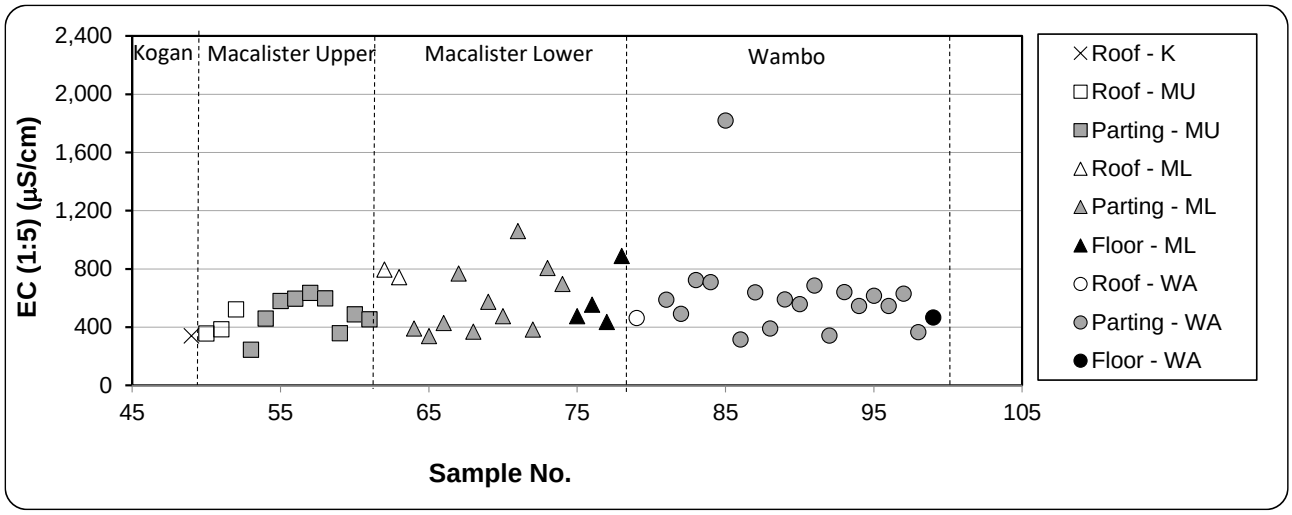


Figure 3-5: EC results for potential coal reject

Coal and coal reject: The $EC_{1:5}$ values for coal, coal reject, and tailing samples are variable, range from 206 to 1,800 µS/cm and are typically low (median 564 µS/cm) (**Figure 3-6**). Only one coal sample from the Macalister Upper seam (1,800 µS/cm) was greater than 1,000 µS/cm. Median $EC_{1:5}$ values for each seam are Kogan ($EC_{1:5}$ 345 µS/cm), Macalister Upper ($EC_{1:5}$ 573 µS/cm), Macalister Lower ($EC_{1:5}$ 439 µS/cm), and Wambo ($EC_{1:5}$ 692 µS/cm). The $EC_{1:5}$ values of coal reject and tailings are very low (367 and 67 µS/cm, respectively).

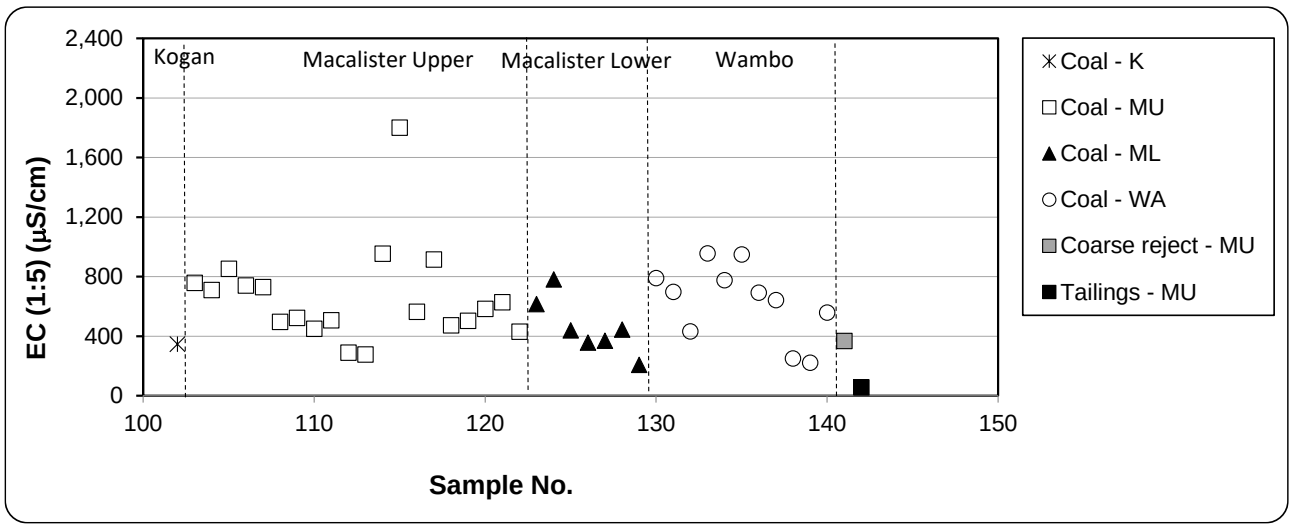


Figure 3-6: EC results for coal and coal reject

The pH and EC tests were completed on pulverised samples (≤ 75 µm) with a large surface area in contact with the leaching solution, thereby providing greater potential for dissolution and reaction (including acid neutralising capacity). It is also expected that the salinity of leachate from low sulfur mine materials will diminish with time as salts are flushed from the material matrix and a state of equilibrium develops. At that point, the salinity of any seepage/surface runoff should stabilise at a lower asymptotic concentration relative to the salinity caused by natural weathering/erosion of the materials.

3.1.3 Potential acidity

3.1.3.1 Total sulfur

Spoil: The total sulfur content of soil, overburden, interburden, and basement samples ranges from <0.01 to 0.18 %S (median 0.02 %S) and is generally very low as shown in **Figure 3-7.** Materials with a total sulfur content less than or equal to 0.1 %S are essentially barren of sulfur[1] and have negligible capacity to generate acidity through sulfide oxidation when exposed to oxidising conditions.

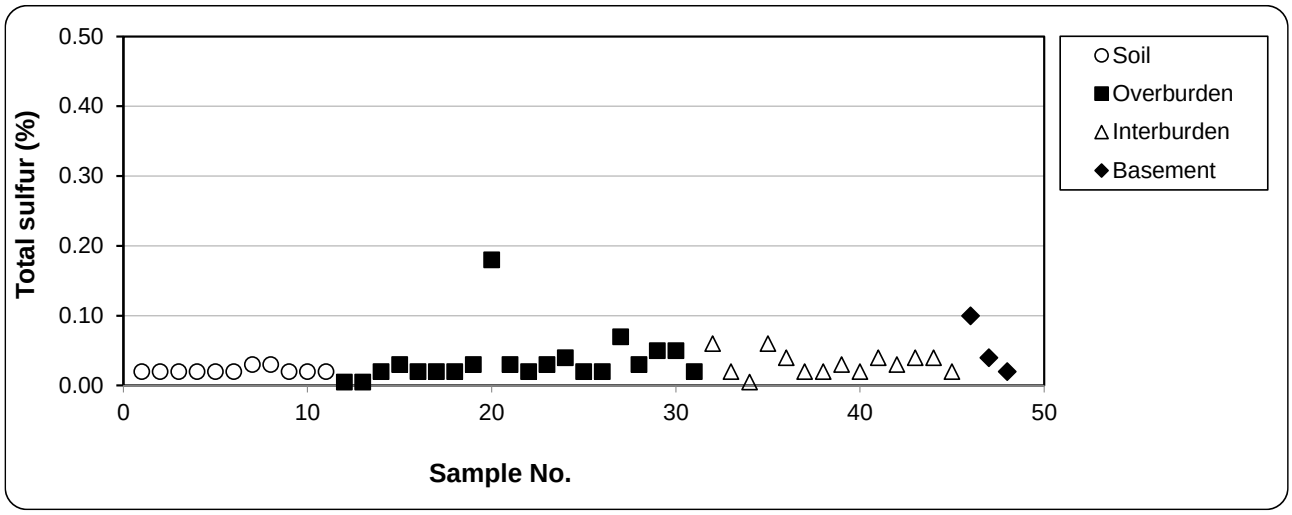


Figure 3-7: Total sulfur results for spoil

Potential coal reject: The total sulfur content of samples representing roof, floor and parting materials is also low (0.01 to 0.13 %S) and has a median 0.04 %S (**Figure 3-8**). Over 96% of these samples contain ≤0.1 %S and are essentially barren of sulfur.

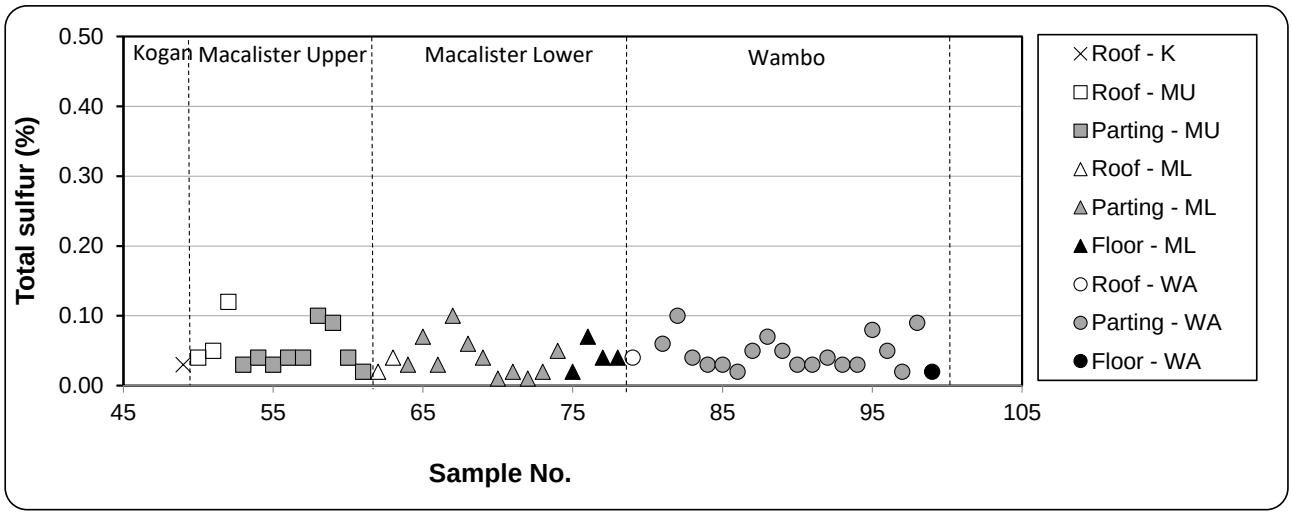


Figure 3-8: Total sulfur results for potential coal reject

[1] The median crustal abundance of sulfur is 0.07 %S (Bowen 1979; INAP, 2023), which has been rounded.to 0.1 % S.

Coal and coal reject: The total sulfur content of coal, coal reject, and tailing samples ranges from 0.03 to 0.32 %S (median 0.14 %S) and is generally low as shown in **Figure 3-9**. Coal samples tend to have a higher total sulfur content than spoil and potential coal reject materials. The median total sulfur content by coal seam is relatively low [(Kogan (0.18 %S), Macalister (0.12 %S), Macalister Lower (0.17 %S), and Wambo (0.14 %S)].

While the total sulfur content of some of the coal and tailings samples from the WCP is greater than 0.1%S the total sulfur concentrations are relatively low and may not be present in a sulfide form. Sulfides such as pyrite/marcasite have the potential to generate acidity. The chromium reducible sulfur (S_{CR}) method measures the sulfide sulfur content or un-oxidised portion of sulfur that may be reactive (**Section 3.1.3.2**).

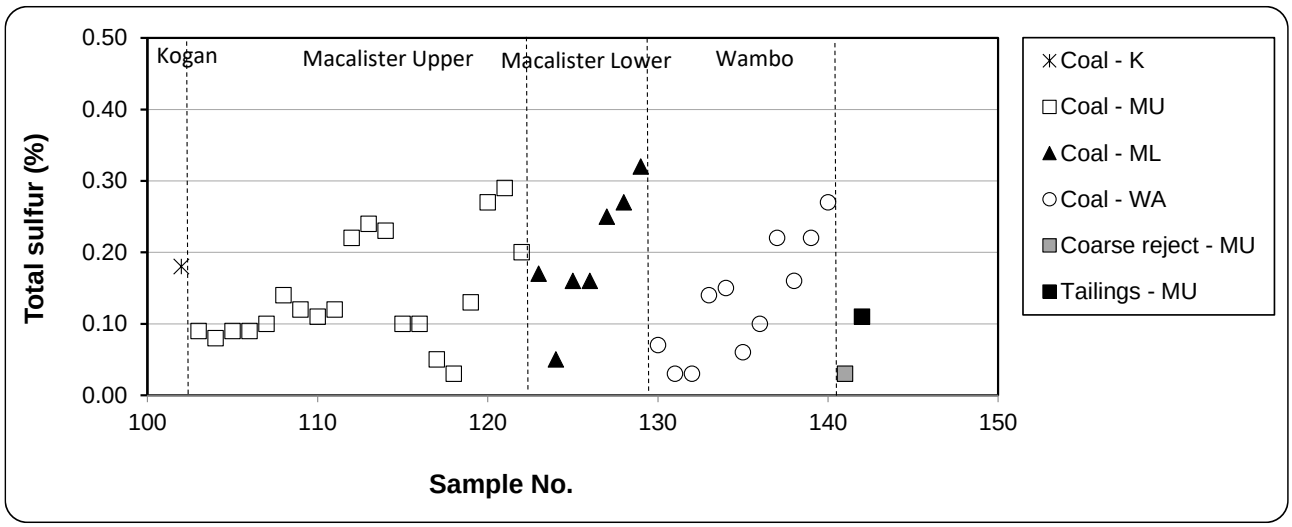


Figure 3-9: Total sulfur results for coal and coal reject

3.1.3.2 Sulfide sulfur

The sulfide sulfur content of selected coal and coal reject samples was verified using the chromium reducible sulfur (S_{CR}) test as described in **Section 3.1.3.1**. Samples with a total sulfur content greater than or equal to 0.1 %S (n=28) were selected for further testing using the S_{CR} method.

The S_{CR} content of the 28 selected samples has been plotted against total sulfur in **Figure 3-10**. The two dotted lines represent situations where all of the total sulfur, or half (50 %) of the total sulfur, respectively, is present in sulfide form. Some of the coal samples from the Macalister Upper seam plot along the first dotted line, indicating that the majority of total sulfur is present as sulfide. By comparison, tailings, as well as coal from the Kogan, Macalister Lower, and Wambo seams plot along or below the second dotted line, showing that more than half of the total sulfur is likely to be present as non-acid generating forms of sulfur, such as sulfate or organic sulfur.

Three samples tested for S_{CR} were not coal samples (excluded from **Figure 3-10**). One overburden sample from the Wolleebee Pit, and a Macalister Upper roof and a Wambo floor sample, both from Austinvale Pit, contained >0.1 %S. The S_{CR} results for these samples were all <0.1 %S_{CR}, indicating that these samples contain non-acid generating forms of sulfur.

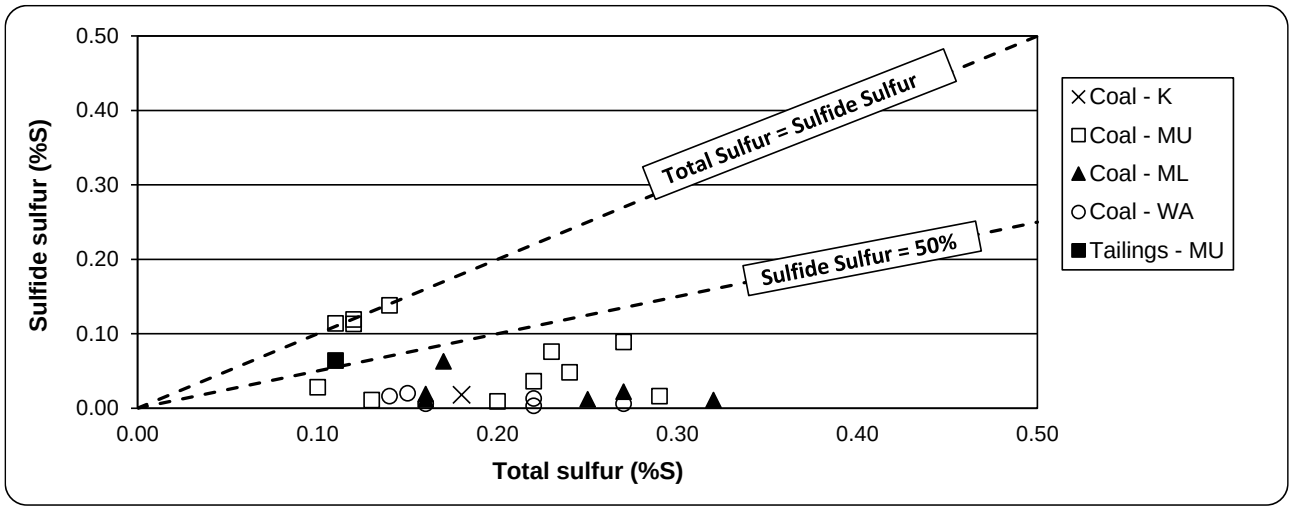


Figure 3-10: Sulfur speciation comparison for coal and coal reject

3.1.4 Maximum Potential Acidity and Acid Neutralising Capacity

Based on the total sulfur content, the Maximum Potential Acidity (MPA) that could be generated by each of the 142 samples of coal and mine materials from the WCP has been calculated. The MPA ranges from 0.15 to 8.9 kg H_2SO_4/t; and has a low median value of 0.9 kg H_2SO_4/t. This indicates that the majority of samples have a low theoretical potential to produce acidity.

The ANC measures the amount of acid (as kg H_2SO_4 /t) that could be neutralised by acid neutralising minerals present in the sample materials. The ANC for the samples ranges from 0.5 to 281 kg H_2SO_4/t and has a median value of 14 kg H_2SO_4/t.

The ANC:MPA ratio measures the proportion of ANC present in the sample compared to the MPA. If the ANC:MPA = 3 or greater, there is an excess of ANC which is likely to buffer any acid produced and there is generally negligible risk of acid generation (INAP, 2024[2]; COA, 2016). If the ANC:MPA ratio is less than 1, there are equal or lesser proportions of ANC compared to MPA, and there may be insufficient ANC to neutralise the MPA, and therefore materials represented by the samples may have some overall risk of generating acid.

The ANC:MPA ratio for the 142 coal and mine material samples ranges from 0.3 to 459 and has a median value of 13. **Figure 3-11** shows a plot of ANC versus MPA for coal and coal reject samples. Spoil and potential coal reject samples (n=101) are essentially barren of sulfur and plot behind the sulfur = 0.1% dotted line and have not been shown on this graph.

ANC:MPA ratio lines have been plotted on the figure to illustrate the factor of safety associated with the samples. The results indicate that most (95 %) of the coal and coal reject samples tested plot in the 'negligible' risk domain and/or have negligible sulfide content. Two samples from the Leichhardt Pit, one from the Macalister Upper seam and one from the Wambo seam, plot in the 'possible' risk domain.

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

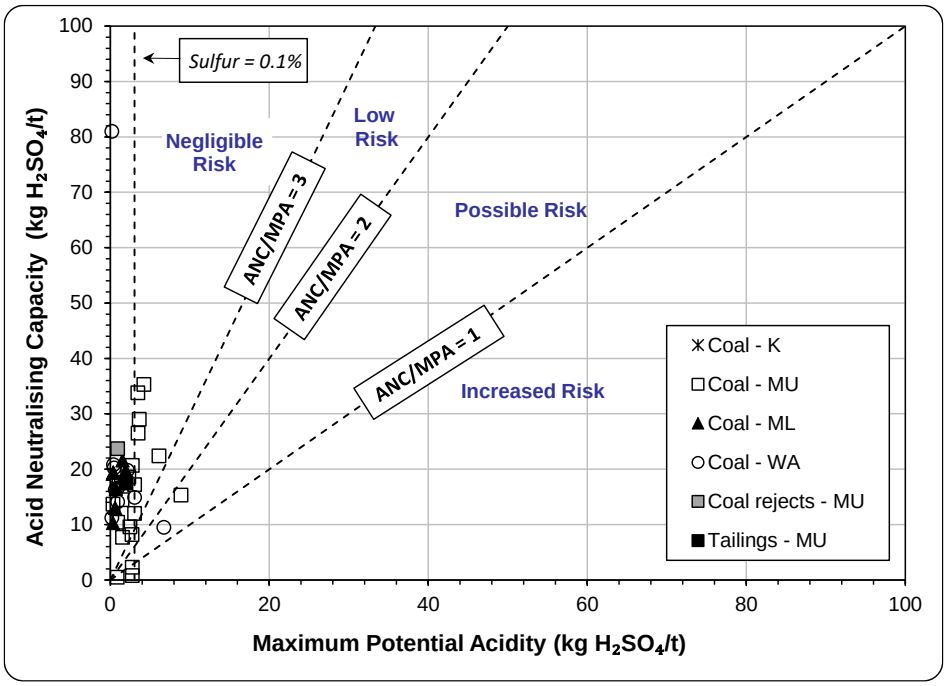


Figure 3-11: ANC versus MPA for coal and coal reject

3.1.5 Net Acid Producing Potential

The NAPP for the 142 samples has been calculated by subtracting the ANC from the MPA. Strongly positive NAPP values generally indicate some risk of acid production and that a material is classified as PAF. Strongly negative NAPP values generally indicate that a material is NAF or Acid Consuming (AC). NAPP values close to zero (i.e., between -5 and +5 kg H_2SO_4/t) have some inherent uncertainty in terms of material classification, although materials represented by these samples are expected to have a low risk and elevated factor of safety with respect to potential capacity to generate acid.

Spoil: The NAPP value for the soil, overburden, interburden, and basement samples ranges from -178 to -2.1 kg H_2SO_4/t (median -13.5 H_2SO_4/t) and is negative for all samples as shown in **Figure 3-12**. NAPP values are variable and soil samples generally have the most negative NAPP values, along with occasional samples of overburden and interburden.

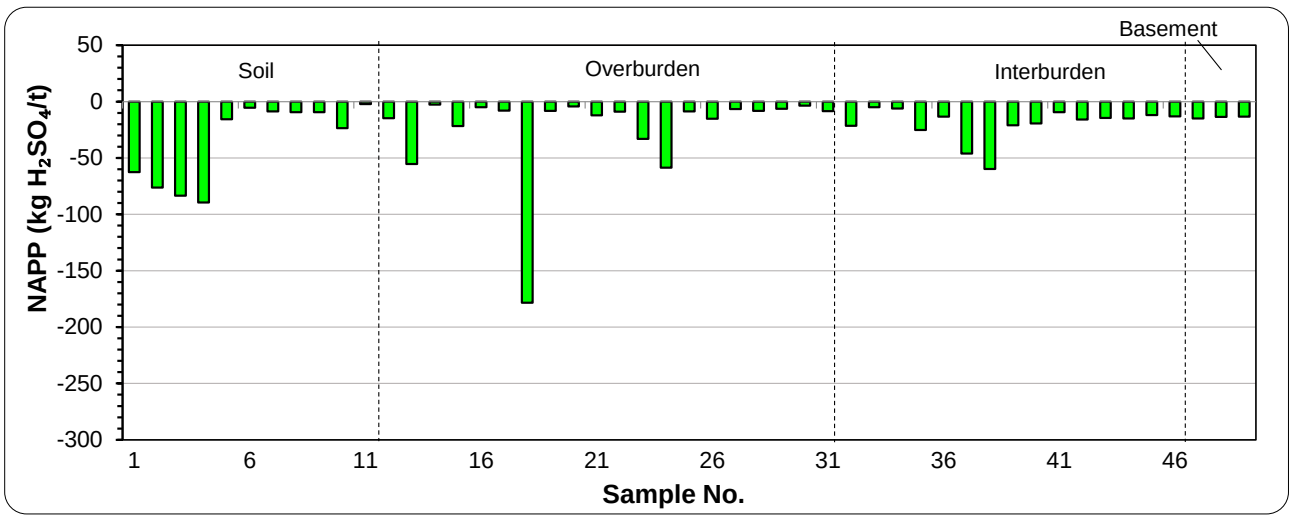


Figure 3-12: NAPP values for spoil

Potential coal reject: The NAPP values for materials representing roof, floor and parting samples ranges from -280 to -1.7 kg H_2SO_4/t and is negative for all samples as shown in **Figure 3-13**. The median NAPP value is -9.0 H_2SO_4/t and samples with strongly negative NAPP values are occasionally associated with the Macalister Lower and Wambo seams.

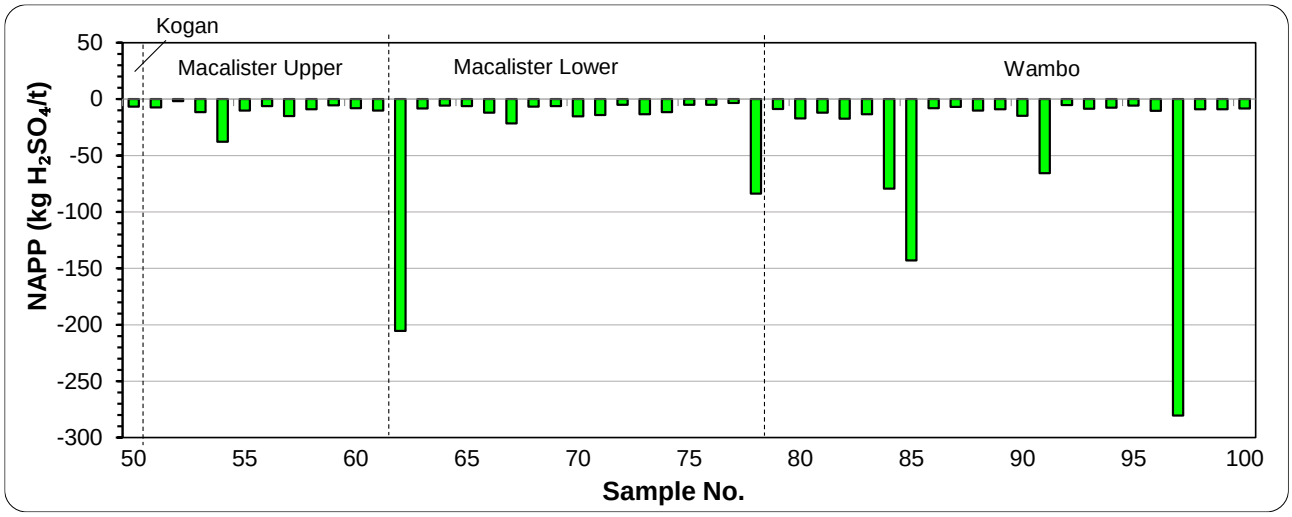


Figure 3-13: NAPP values for potential coal reject

Coal and coal reject: The NAPP value for coal, coarse reject and tailing samples ranges from -81 to +2.0 kg H_2SO_4/t and is typically negative or close to zero as shown in **Figure 3-14**. The coal materials have generally consistent slightly negative NAPP values and most (90%) values are in the range -30 to 0 H_2SO_4/t. Three samples have slightly positive NAPP values (≤ 2 kg H_2SO_4/t), and these samples are all from the low grade coal in the Macalister Upper seam in the Austinvale Pit.

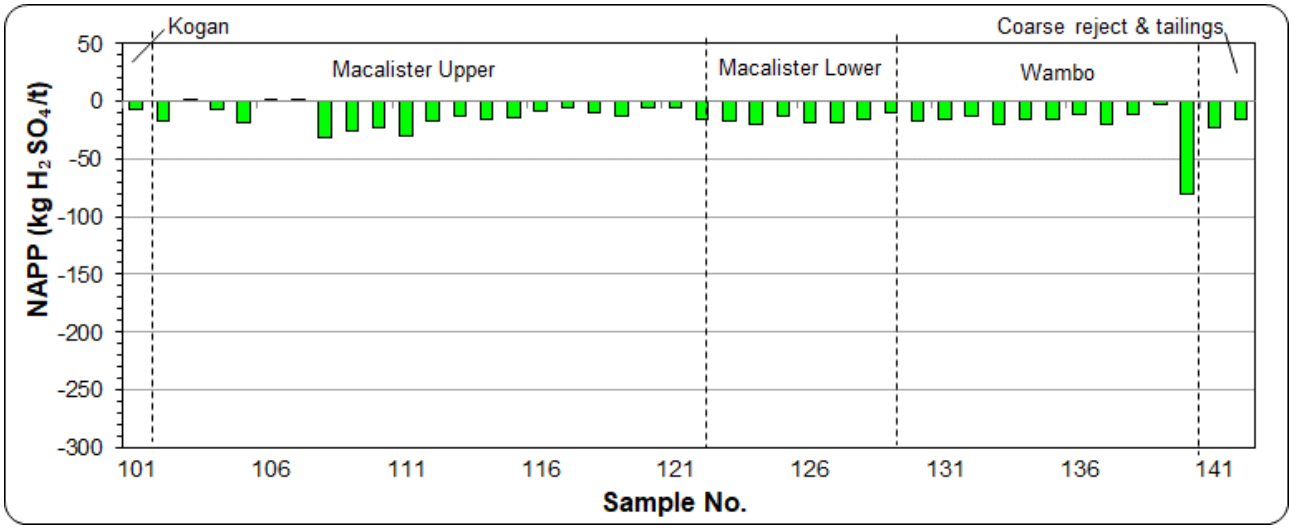


Figure 3-14: NAPP values for coal and coal reject

3.1.6 Geochemical classification

Table 3-1 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the 142 samples from the WCP subjected to static geochemical testing.

Table 3-1: Geochemical classification criteria for WCP

Geochemical Classification	Total Sulfur[1] (%)	ANC: MPA Ratio	NAPP (kg H_2SO_4/t)	Number of Samples (n=142)	% Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	138	97 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	4	3 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	0	0 %
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

Notes:

1. Sulfide sulfur (using the S_{CR} test) has been measured for selected samples and where available, sulfide sulfur has been used in place of total sulfur for sample classification and to calculate the MPA value.

The results in **Table 3-1** demonstrate that that 138 of the 142 samples (97 %) are classified as NAF (Barren) as they have a low sulfide sulfur content (≤ 0.1 %S). A few samples (4 out of 142 or 3 %) have marginally elevated sulfide content (compared to background concentrations) but also have sufficient ANC to be classified as NAF. No samples are classified as Uncertain or PAF.

Overall, most materials represented by the samples tested are expected to have a very low risk and increased factor of safety with respect to potential acid generation.

Based on the static ABA data, all of the spoil and potential coal reject samples are classified NAF (Barren) **(Figure 3-15** and **Figure 3-16**). The majority of the coal and coal reject samples are also classified NAF (Barren) and only four coal samples obtained from the Macalister Upper seam at the Austinvale WBSP are classified as NAF (**Figure 3-17**).

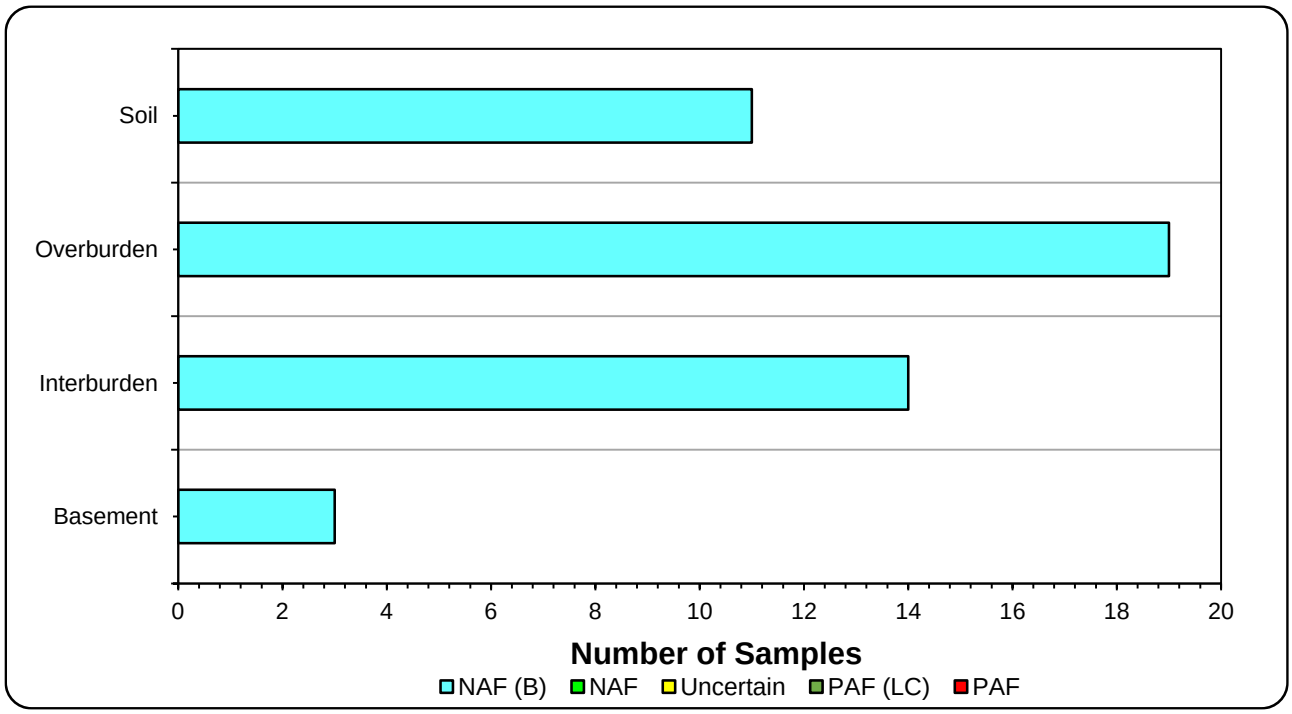


Figure 3-15: Geochemical classification by material type - spoil

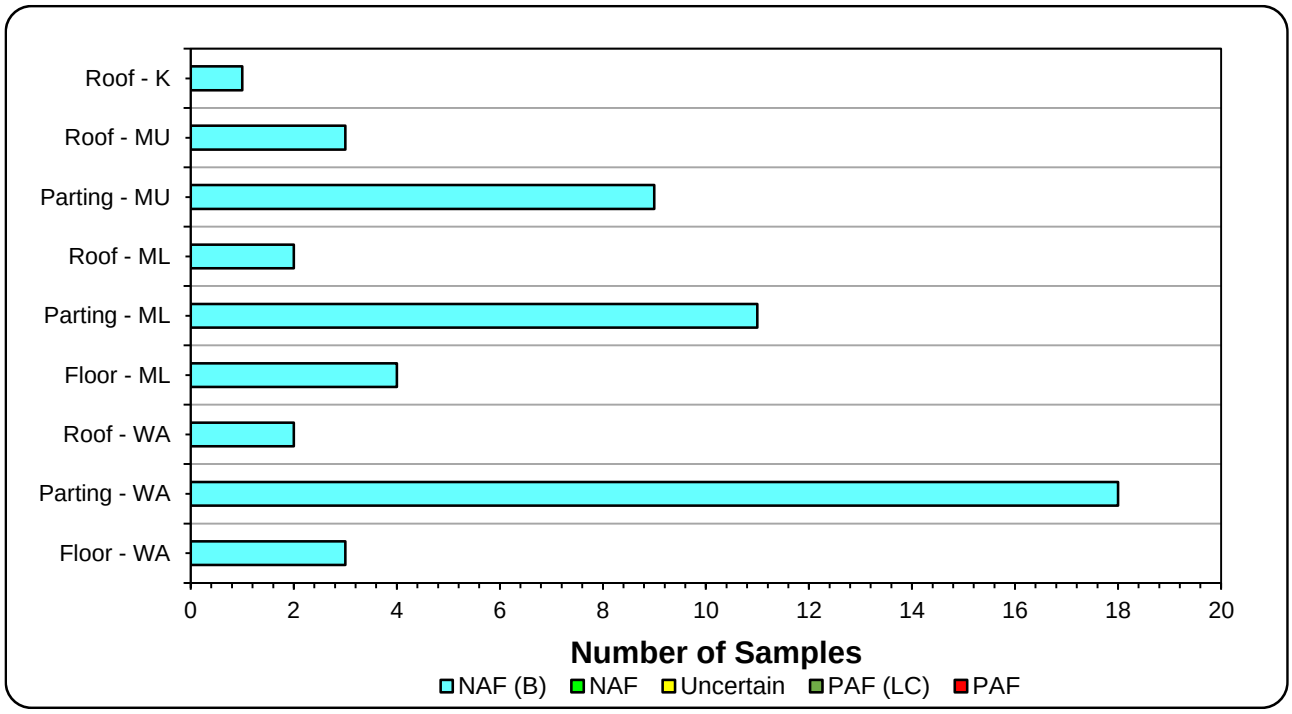


Figure 3-16: Geochemical classification material type – potential coal reject

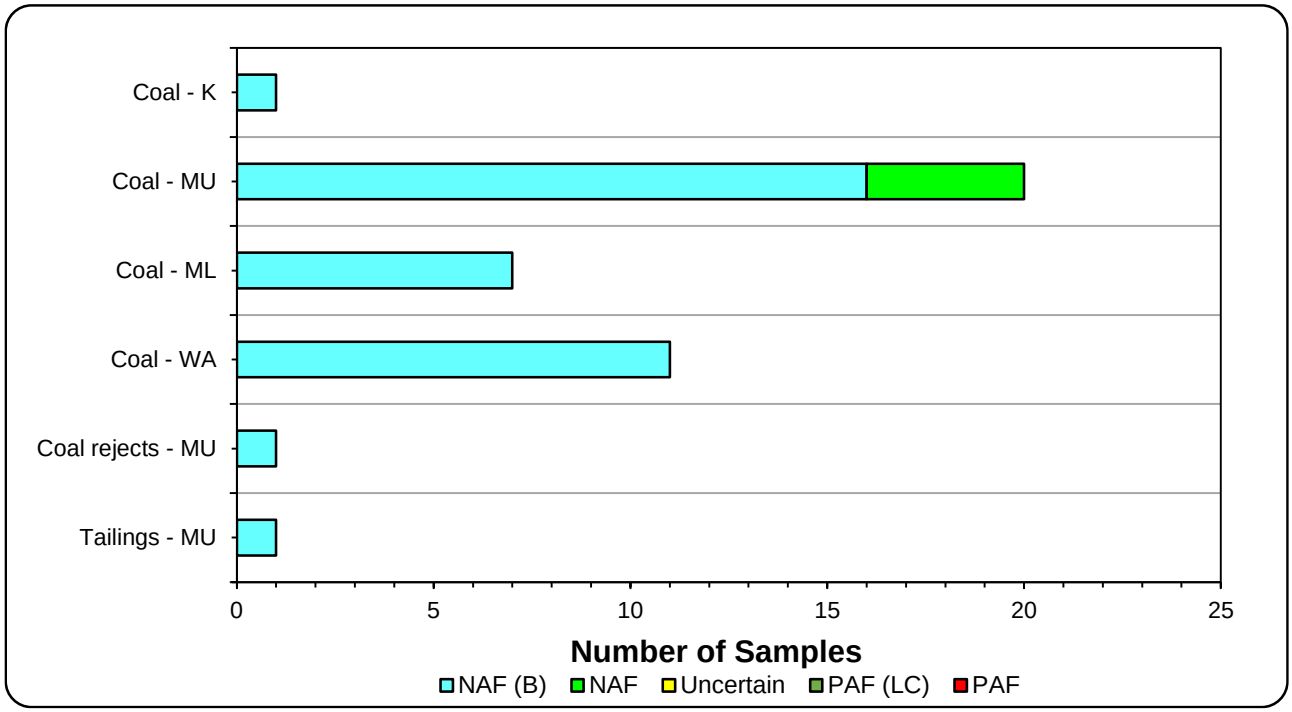


Figure 3-17: Geochemical classification by material type – coal and coal rejects

3.1.7 Coal quality data

3.1.7.1 Total sulfur results

Mined coal will be temporarily stockpiled at the run-of-mine (ROM) area prior to washing at the CHPP. Any sulfide sulfur present in these stockpiles could impact surface runoff and potentially produce AMD. Exploration drillholes located around the mine tenements provided samples of raw coal that were subjected to coal quality testing. The coal quality data was used to map the distribution of sulfur across the WCP area.

The total sulfur distribution in raw coal materials for the target coal seams (Macalister Upper, Macalister Lower, and Wambo) are illustrated in **Figure 3-18.** The results demonstrate that approximately 83 % of the raw coal material represented by the samples tested has a total sulfur content <0.5 %S.

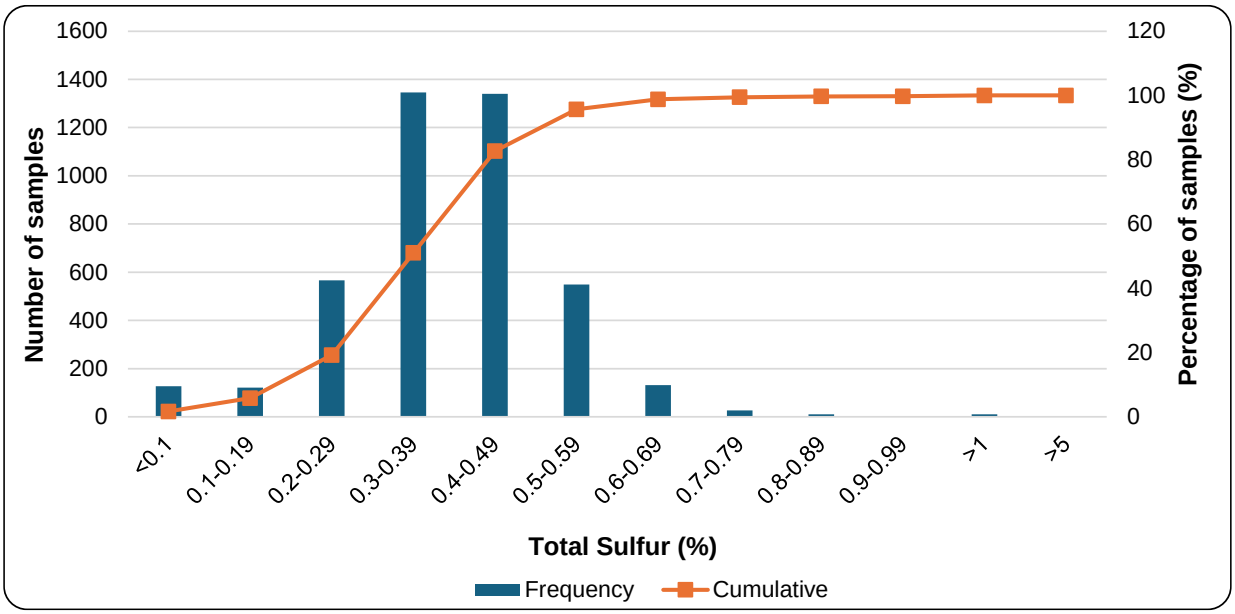


Figure 3-18: Total sulfur distribution for raw coal samples

The results in **Figure 3-18** are based on coal quality testing conducted by ALS Coal and laboratory certificates provided by GCAA. The total sulfur content is measured by proximate analysis. A data set of 4,232 total sulfur results were available from 203 exploration drillholes drilled between August 2018 and September 2021.

It should also be noted that based on the total sulfur and sulfide sulfur results previously shown in **Figure 3-10** and a much larger database of potential coal reject results and existing coal quality results in the northeastern Surat Basin, most of the total sulfur present in the coal reject materials is likely to be present in a non-acid generating form such as organic sulfur, which has negligible capacity to generate acid. This finding is entirely consistent with the non-marine environment in which the Walloon coal deposits were formed in this region.

In terms of potential impacts from the ROM coal stockpile, it is expected that the quality of any leachate will be similar to that of coal and coal reject materials described in **Section 3.1.6**. As is standard practice at coal mining operations in Queensland, any surface runoff and seepage from the ROM coal stockpile will be monitored for quality and managed in the mine water management system.

3.1.7.2 Total sulfur in float sink samples

At the ALS coal quality laboratory, coal is processed into different size fractions (F1.30 to F2.00) by float sink analysis. The total sulfur contents for coal float sink fractions for 650 samples from selected drill holes (n=19) is presented in **Figure 3-19**. Results demonstrate that fine coal particles (F1.30 to F1.40) have the highest median total sulfur content (0.46%). While coarser particles contained in the F1.90 to F2.00 fraction have relatively low median total sulfur (0.16%), occasional outliers of higher total sulfur content can occur in coarser grains.

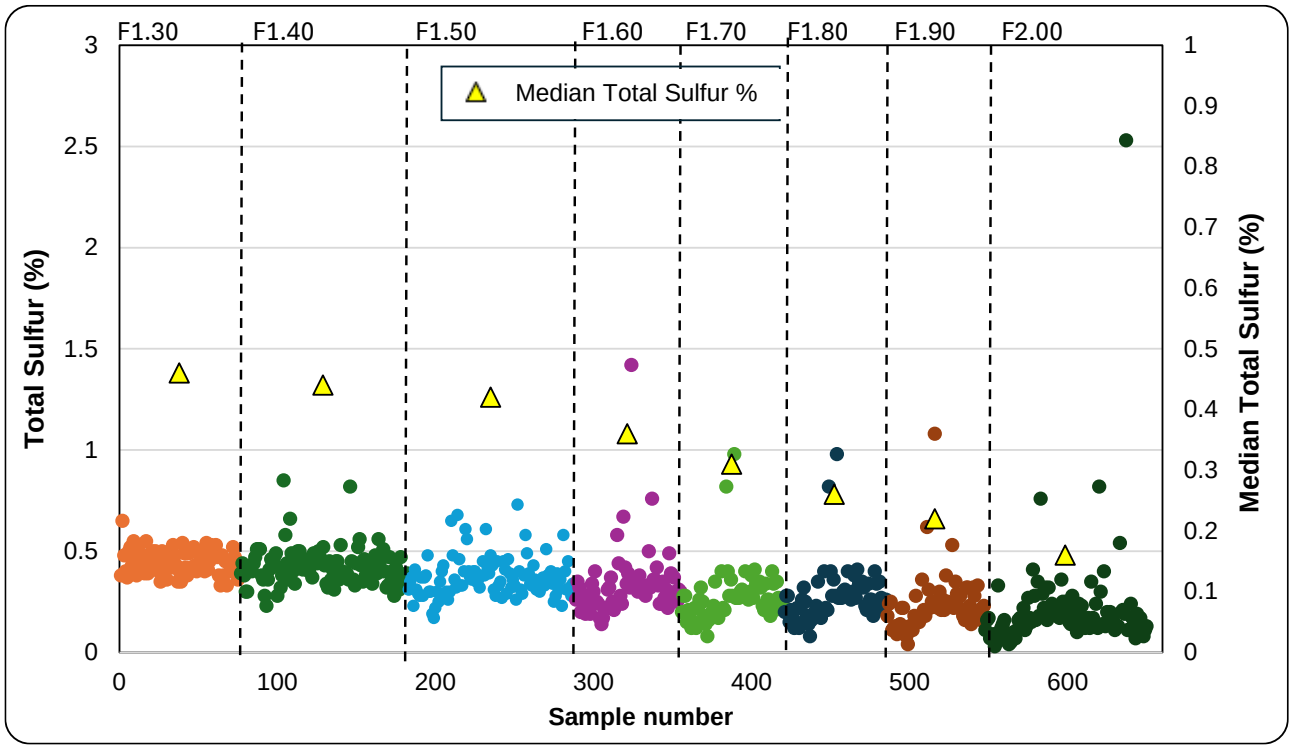


Figure 3-19: Total sulfur content in coal float sink fractions

3.1.7.3 Total sulfur spatial distribution

The number of coal samples in each of the exploration drill holes located around the mine tenements ranged from 1 to 51. The median total sulfur of each drill hole was calculated (0.21 to 0.55 %S).

The location of the 203 exploration drill holes has been plotted in **Figure 3-20**. To aid interpretation, data from drill holes in close proximity have been grouped together to form clusters (n=2 to n=41).

The median total sulfur content of each cluster of drill holes was then calculated. These results have been plotted in **Figure 3-20** to show the distribution of total sulfur across the exploration area, which is approximately 100 km^2 in area.

Coal with the highest median total sulfur content (0.46%) is located in the northwestern area, whereas coal with the lowest median total sulfur values (0.31%) is generally found in the southeast. In addition, the distribution of total sulfur tends to be relatively low near the mining tenements and higher towards the perimeter. All of the clusters of drill holes contain <0.5% median total sulfur content and are typically low, demonstrating the widespread high factor of safety in terms of potential acid generation for the distribution of these materials. This low concentration of total sulfur is expected to be consistent over the general WCP project area.

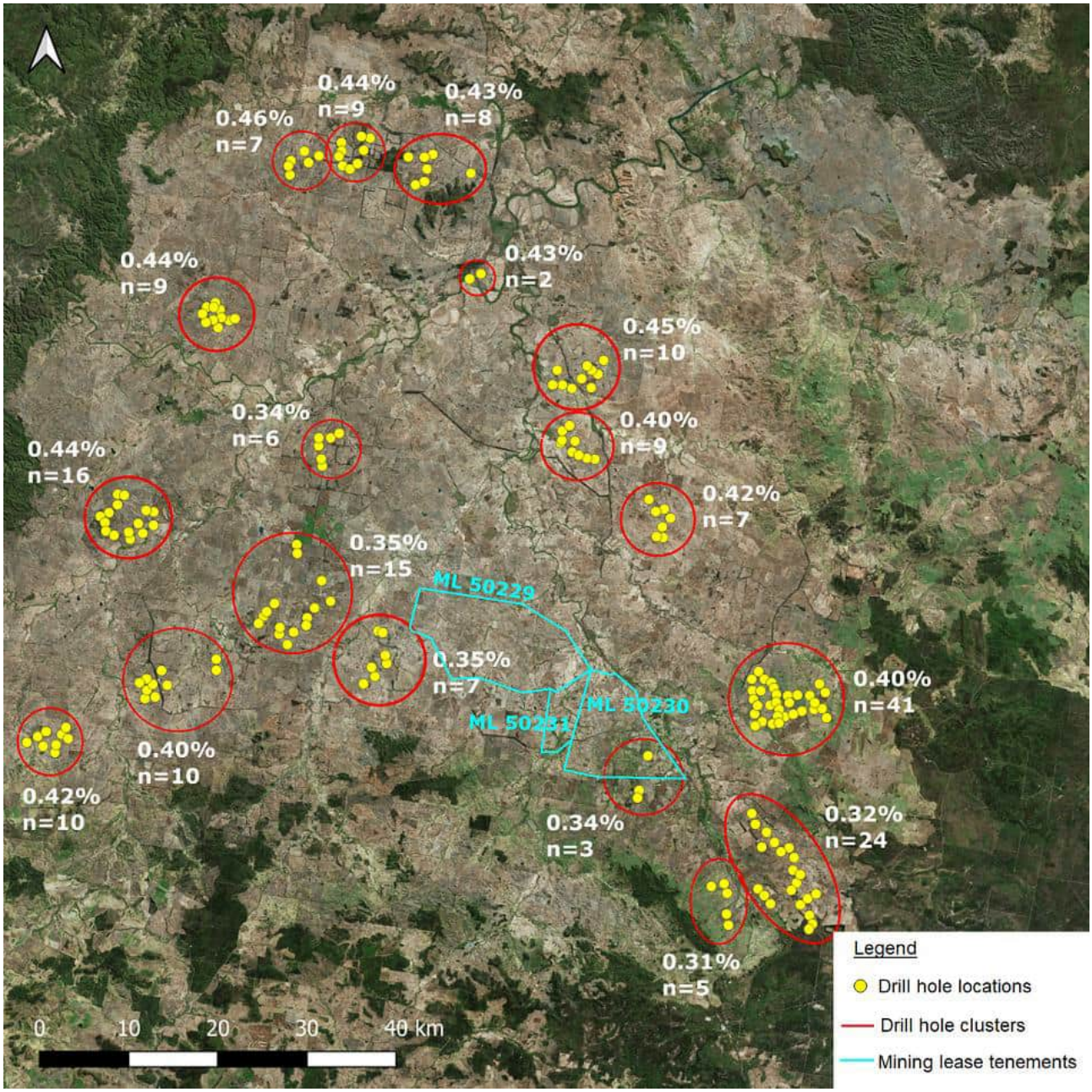


Figure 3-20: Median total sulfur distribution for coal across the exploration area and mining lease tenements

3.2 Multi-element testing

3.2.1 Multi-element concentration in solids

Multi-element analyses were completed on 29 selected individual and composite samples of mine materials as described in **Sections 2.1.4** and **Section 2.2.3**. The program of work was completed to identify any elements that present at concentrations of environmental concern with respect to materials handling, storage, revegetation and water quality. The results of the analyses are presented in **Table B2** (**Attachment B)** and summarised here.

To provide relevant context, the total metal/metalloid concentration in samples are compared to National Environmental Protection Council (NEPC) Health-based Investigation Levels (HIL(C)) applied to humans for soils in public open spaces (NEPC, 2013). The results indicate that the sample materials typically have low total metal and metalloid concentrations in solids, some below the laboratory limit of reporting (LoR) and all below the applied NEPC (HIL(C)) guideline for soils.

To provide additional context, the multi-element results are compared to the median background concentration (median crustal abundance) of those elements in unmineralised soils (Bowen, 1979, CRC, 2000 and INAP, 2024). From this comparison, a geochemical abundance index (GAI) is calculated. The GAI quantifies an assay result for a particular element in terms of the median crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times median crustal abundance, as shown in **Table 3-2**.

Table 3-2: Geochemical Abundance Index enrichment factors

GAI	Enrichment Factor	GAI	Enrichment Factor
0	Less than 3-fold enrichment	**4**	24 – 48 fold enrichment
1	3 – 6 fold enrichment	**5**	48 – 96 fold enrichment
2	6 – 12 fold enrichment	**6**	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important 'trace' elements more so than with major rock-forming elements. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. The GAI provides an indication of metals/metalloids that may be enriched relative to the median crustal abundance, however the following points should also be considered:

- The median crustal abundance varies between different literature sources, therefore affecting the calculated GAI values.
- If a sample is shown to be enriched relative to the median crustal abundance, there is no direct correlation that that particular sample will also leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the environment in which it occurs.
- Whilst some element concentrations can be elevated relative to the median crustal abundance, the nature of a coal deposit means the background levels may also be elevated.

Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g., low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

Table B2 (**Attachment B**) provides total metal/metalloid concentrations for the 29 selected individual and composite samples of mine materials. The relative enrichment of metals/metalloids in these samples compared to median crustal abundance (GAI) is presented in **Table B3** (**Attachment B**).

The GAI results indicate that most of the metals and metalloids tested in the samples have GAI values less than 3 and are therefore not enriched compared to unmineralised soils (Bowen, 1979; CRC, 2000; INAP,

2024). The only minor exception is beryllium (Be), which has a GAI value of 4 in the Macalister Lower seam coal sample from the Wolleebee Pit, albeit that the concentration in the sample is still relatively low (6 mg/kg) as background concentrations of beryllium in unmineralised soils can range up to 40 mg/kg (Bowen, 1979).

The initial solubility and potential mobility of metals or metalloids in static water extract tests is investigated in **Section 3.2.2**.

3.2.2 Multi-element concentration in water extracts

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from mine materials on mine sites in Queensland. As such, RGS has compared the multi-element results in water extracts from 29 selected individual and composite samples of mine materials from the WCP with Australian guideline values for freshwater aquatic ecosystems (95 % species protection level) and livestock drinking water (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge.

It should also be recognised that direct comparison of geochemical data with water quality guideline values can be misleading. For the purpose of this study, guideline values are only provided for broad context and should not be interpreted as arbitrary "maximum" or "trigger" values. Using sample pulps (ground to passing 75 µm) provides a high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. The results from screening tests on water extract solutions are assumed to represent a "worst case" scenario for pore water and potentially initial surface runoff and seepage from mine materials.

The results from multi-element testing of water extracts (1:5 solid:water) from the 29 selected individual and composite samples of mine materials are presented in **Table B4** (**Attachment B**).

The pH of the water extracts from the samples ranges from 5.6 to 9.8 and is typically alkaline (median 8.8). Most samples, at least initially, add some alkalinity to contact water as the pH of the deionised water used in the test program was pH 5.7. The pH values are more alkaline for some of the materials represented by the overburden, interburden, parting and basement samples.

Acidity in the water extracts from the samples ranges from <1 to 2,760 mg/L (as $CaCO_3$ equivalent) and is highest in the low grade Macalister Upper coal (WS1A) samples from shallower depth in the stratigraphic profile. The total alkalinity in the water extracts is variable and ranges from 482 to 9,940 mg $CaCO_3$/L. The majority of the alkalinity in the samples is in the form of bicarbonate (HCO_3), although some materials also contain carbonate. The net alkalinity values for the samples are all positive apart from one composite sample of low grade coal (WS1A_3). This indicates that most sample materials have excess acid buffering capacity in the unlikely event that any acidity is generated by a mine material.

The EC for the water extract from the samples ranges from 65 to 992 µS/cm and have a relatively low median value of 649 µS/cm). The concentration of major ions in the water extracts is relatively low and typically dominated by sodium (Na^+), chloride (Cl^-), and sulfate (SO_4^{2-}). The concentration of sulfate in the water extracts ranges from <2 mg/L to 170 mg/L (median 12 mg/L) and is well below the livestock drinking water guideline criterion of 1,000 mg/L (ANZG, 2018). The concentration of fluoride ranges from 0.2 to 7.6 mg/L and is generally less than the livestock drinking water guideline criterion of 2 mg/L (ANZG, 2018). The exceptions are the water extracts from the soil and overburden samples at the WBSP area, which have fluoride concentrations greater than the applied guideline value.

The concentrations of dissolved trace metals/metalloids tested in water extracts from the samples of mine materials are typically low and predominantly below the laboratory limit of reporting. Most dissolved metal/metalloid concentrations are below the applied water quality guideline criteria. The exceptions are aluminium (12 samples), arsenic (4 samples), boron (4 samples), copper (13 samples), selenium (1 sample) and zinc (1 sample), which can have concentrations marginally greater than the applied freshwater aquatic ecosystem water quality guideline values for 95% species protection. Notwithstanding, the concentration of these dissolved elements in the water extracts is at least one, and generally several, orders of magnitude lower than the applied guideline values for livestock drinking water (ANZG, 2018).

As previously stated, the sample materials in contact with the water extracts are pulverised to <0.075 mm and have a relatively large surface area. However, this condition is offset by the low rock:water dilution (1:5) that is unlikely to represent the true ratio between spoil and rainfall. The laboratory data should be considered as indicative for pore water and initial contact water for mine materials but cannot be directly scaled to the field.

3.3 Kinetic testing

The dynamic quality of contact water (if the mine materials are left unmanaged and exposed to oxidising conditions) and the potential risk to water resources over time at the WCP was investigated using a KLC test program. Twelve KLC composite samples (KLC 1 to KLC 12) underwent KLC testing. The KLC leaching regime is described in **Section 2.4.2**. The KLC test results and trends are provided in **Attachment C**.

The leachate results from the KLC test program are presented alongside Australian water quality guideline values for freshwater aquatic ecosystems (95 % species protection) and livestock drinking water quality (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge. It should be noted that the KLC samples were crushed to pass a 10 mm sieve size, where required, and therefore have a high surface area for potential geochemical reaction. The ratio of sample to water in the KLC tests was approximately 2:1 to 3:1 (w/v) (i.e., concentrated), whereas the ratio of sample to water used in the water extract tests (**Section 3.2.2**) where results were arbitrarily compared against water quality guideline values to provide some context is an order of magnitude more dilute at 1:5 (w/v). Whilst arbitrary comparisons against guideline concentrations can be helpful in some situations to provide context, such comparisons cannot be directly extrapolated to the field situation at the WCP.

The KLC test results and trends provided in **Attachment C** indicate that:

- Leachate collected from the KLC tests on most of the mine materials has a pH value that is typically in the slightly alkaline or in the pH neutral range. The lowest pH values were obtained from KLC 2, which represents the low grade Macalister Upper coal (WS1A) material. The pH results from KLC 2 trend towards a value similar to the deionised water used in the KLC test. These results indicate that pH values in pore water within mine materials represented by the samples tested, if exposed to weathering conditions, are likely to remain within the pH neutral to slightly alkaline range.
- The EC value in leachate collected from the 12 KLC test samples is generally low and shows a decreasing trend. Most sample materials generate a leachate with an EC value less than 1,000 µS/cm. The only exception is the leachate collected from the low quality/grade coal sample (KLC 2), which initially increase towards 2,000 µS/cm before reducing to less than 500 µS/cm towards the end of the test period. These results indicate that the salinity of initial pore water from these materials that may interact with surface runoff and seepage at storage facilities is likely to be slightly brackish.
- Acidity levels in leachate from most of the KLC tests over the test period are typically low (≤ 11 mg/L, as $CaCO_3$ equivalent). The main exception is leachate from the low quality/grade coal (KLC 2), which can have a slightly higher acidity value (up to 46 mg/L, as $CaCO_3$ equivalent).
- The alkalinity values in leachate collected from the KLC tests are typically higher than the acidity levels leading to a positive net alkalinity value (i.e., the alkalinity is greater than the acidity) in most leachate collected over the test period. The only exception is for the second and third leachate collected from KLC 2 in weeks 4 and 8, which had slightly negative net alkalinity values.
- The concentrations of major ions in leachate from the KLC tests is relatively low and typically dominated by sodium, chloride and sulfate (and bicarbonate).
- The concentration of sulfate in leachate is relatively low and generally less than 200 mg/L from most KLC samples. The highest sulfate concentration in leachate (509 mg/L) was collected from the low quality/grade coal sample (KLC 2) after 8 weeks, although the sulfate concentration decreased towards the end of the test period and approached 100 mg/L.
- The sulfate concentration in the KLC leachate collected from the sample materials is less than the applied livestock water quality guideline criterion for this anion (1,000 mg/L) over the entire test period.
- The sulfate generation rate results obtained for the KLC samples have been used to determine the rate of sulfide oxidation in these materials. Most sulfate salts generated from sulfide reaction involving materials with a relatively low sulfide sulfur concentration are highly soluble, and therefore will be collected in column leachate. The dissolved sulfate (and calcium) concentrations in the KLC leachate are typically much less than the solubility limit of gypsum ($CaSO_4$), for example, which indicates that sulfate generation is not controlled by gypsum dissolution in the KLC test materials. Therefore, the sulfate concentrations and oxidation rate calculations provide reasonable estimates of these parameters and the results align

well with existing static and dynamic geochemical data derived from a wide range of mine waste materials (AMIRA, 1995). The sulfate generation rate and associated sulfide oxidation rate for the KLC test materials are shown in **Table 3-3**.

Table 3-3: Sulfate generation and sulfide oxidation rates for KLC test materials

KLC Sample Number	Sample Description	Sulfate Generation Rate (mg/kg/week)	Oxidation Rate (kg $O_2/m^3/s$)
KLC 1	Overburden	0.2	1.0×10^{-10}
KLC 2	Low quality/grade coal (WS1A) - MU	16.2	6.6×10^{-9}
KLC 3	Coal (WS1B) - MU	13.7	4.6×10^{-9}
KLC 4	Interburden	2.2	9.6×10^{-10}
KLC 5	Coal reject - MU	6.4	2.6×10^{-9}
KLC 6	Tailings - MU	6.5	2.2×10^{-9}
KLC 7	Coal - ML	0.7	2.4×10^{-10}
KLC 8	Potential reject - ML	0.2	7.2×10^{-11}
KLC 9	Coal - ML	0.6	2.1×10^{-10}
KLC 10	Potential reject - ML	0.2	6.7×10^{-11}
KLC 11	Overburden	1.2	5.0×10^{-10}
KLC 12	Interburden	0.1	4.2×10^{-11}

The sulfate generation rate from the KLC samples ranges from 0.1 to 16.2 mg/kg/week indicating that the rate of sulfide oxidation is low in materials represented by these samples. The equivalent oxidation rate ranges from 4.2×10^{-11} to 6.6×10^{-9} kg $O_2/m^3/s$. Mine materials with an oxidation rate in the low range (i.e., less than 1×10^{-8} kg $O_2/m^3/s$) and a moderate ANC level typically have an increased factor of safety and are likely to generate leachate that is pH neutral or alkaline and/or has a low level of acidity (AMIRA, 1995; Bennett *et al*., 2000). Hence, all of the materials represented by the KLC composite samples tested fall into this category.

Overall, the KLC results generally reflect the range of material characteristics predicted from the static geochemical test results presented in **Section 3.1**.

- The concentrations of dissolved trace metals/metalloids in leachate from the composite samples are typically below the laboratory Limit of Reporting (LoR). Some precipitation of secondary minerals was observed forming on the surface of the low quality/grade coal (WS1A) (KLC 2) and also the tailing sample (KLC 6) (**Figure 3-21**). These are likely to be sulfate minerals, such as jarosite, which was detected in the mineralogical analysis (**Section 3.6**).
- The concentrations of dissolved aluminium (Al), boron (B), chromium (Cr), copper (Cu), lead (Pb), selenium (Se and zinc (Zn) in leachate can be greater than the applied freshwater ecosystem (95 % species protection level) although the Al concentration is potentially due to the transfer of colloidal material through the laboratory filtration stage and reporting to the dissolved fraction reported.
- The KLC test results to date agree with those observed in the static multi-element testing (**Section 3.2.2**). Most trace metals/metalloids are sparingly soluble while the pH of the leachate is generally circumneutral to slightly alkaline.
- The KLC test results demonstrate that materials represented by the 12 composite samples from the WCP are likely to present a relatively low level of risk with respect to potential to impact upon the quality of surface water and groundwater resources.

Figure 3-21: Secondary mineral formation on low quality/grade coal (WS1A) and tailings

3.4 Soil quality

3.4.1 Soil characterisation

Soil characterisation results for the five selected individual samples of mine materials (upper subsoil, lower subsoil, and shallow overburden) are presented in **Table B2 (Attachment B)** and summarised in **Table 3-4**. Guidelines for classifying soils by agricultural standards are provided in **Table** 3-5 (Hazelton and Murphy, 2016). While mine soils are not required to meet these standards to be suitable for rehabilitation, deficiencies can be used to predict the types of rehabilitation issues that may occur and can be incorporated into plans for future rehabilitation field trials.

CEC results range from 11.2 to 18.0 meq/100g (median 14.9 meq/100g) and infer that effective cation exchange capacity (eCEC) is typically moderate. The ESP results range from 12.7 to 33.8 % (median 26.1 %) and indicate that materials represented by these samples are typically sodic and may be prone to dispersion.

The exchangeable cation concentrations for Ca, Mg, K, and Na show that the composite samples have high concentrations of exchangeable Na and Mg (**Table 3-5**). The exchangeable Ca concentration is moderate and the exchangeable K concentration is very low. The Ca:Mg ratio for the samples ranges from 0.5 to 2.8 and shows that most materials are relatively low in Ca and some may not be structurally stable (Hazelton and Murphy, 2016). Soils with poor structural stability are more likely to have erosion issues.

Sodic soils with elevated ESP are common and naturally occurring in Queensland. Sodicity is not the same as salinity, although both can be dependent on Na. A high proportion of exchangeable Na compared to other cations (sodicity) weakens the bond between soil particles and can lead to:

- Reduced flow of water (i.e., poor infiltration) through soil, causing drainage issues;
- Increased accumulation of salt over time through waterlogging;
- Dispersion in the soil surface, leading to crusting and sealing;
- Increased susceptibility to erosion, including gullies and tunnels;
- Poor soil stability due to loss of particle aggregation; and
- Dense, impenetrable soils with shallow rooting depth.

Table 3-4: Summary of soil characterisation results

Parameter	Analysis	Min	Max	Average	Median
pH	Acidity/alkalinity	9.3	9.5	9.4	9.4
Electrical Conductivity (EC) (mS/cm) (1:5)	Salinity	207	658	467	571
Exchangeable Ca (meq/100g)	Exchangeable Cations	2.5	9.8	6.7	7.0
Exchangeable Mg (meq/100g)	Exchangeable Cations	3.5	6.0	4.7	5.0
Exchangeable K (meq/100g)	Exchangeable Cations	<0.2	<0.2	<0.2	<0.2
Exchangeable Na (meq/100g)	Exchangeable Cations	1.9	4.7	3.3	3.2
Cation exchange capacity (CEC) (meq/100g)	Soil fertility	11.2	18.0	14.7	14.9
Exchangeable Sodium Percentage (ESP) (%)	Sodicity	12.7	33.8	23.4	26.1
Calcium/Magnesium Ratio	Soil stability	0.5	2.8	1.5	1.2
Magnesium/Potassium Ratio	Soil stability	35	60	47	50

Table 3-5: Soil characterisation guidelines

Parameter	Very low	Low	Moderate	High	Very high
Exchangeable Ca	0-2	2-5	5-10	10-20	>20
Exchangeable Mg	0-0.3	0.3-1.0	1-3	3-8	>8
Exchangeable K	0-0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2
Exchangeable Na	0-0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2
Cation Exchange Capacity (CEC) (meq/100g)	<6	6-12	12-25	25-40	>40
	Non-sodic		Sodic	Strongly sodic	
Exchangeable Sodium Percentage (ESP) (%)	0-6		6-14	>14	
	Ca deficient	Ca (low)	Balanced	Mg (low)	Mg deficient
Ca/Mg ratio	<1	1-4	4-6	6-10	>10
	Mg deficient	Mg (low)	Balanced	K (low)	K deficient
Mg/K ratio	<0.6	0.6-1.2	1.2-1.8	1.8-2.4	>2.4

3.4.2 Soil nutrients

Based on results for the four selected individual soil samples, the soils have reasonable fertility. Organic matter (OM) has a concentration of 1.0 to 1.6 % with a median of 1.4 % (**Figure 3-22**). Total Nitrogen (N) is 530 to 800 mg/kg (median 658 mg/kg), although much of this will be held in organic matter and may not be available to plants. Total Phosphorous (P) ranges from 127 to 161 mg/kg and has a median value of 142 mg/kg (**Figure 3-23**). Bicarbonate extractable P is below the limit of reporting (LoR), and bicarbonate extractable potassium (K) is within 117 to 130 mg/kg (median 124 mg/kg) and is above the critical value of 80 mg/kg that begins to limit plant growth (Hazelton and Murphy, 2016).

These results are consistent with previous soil studies (**Section 1.8** and **Attachment F**). Fertiliser addition should therefore not be required as the nutritional content of the soil is sufficient to support grazing and native vegetation as a Post Mining Land Uses (PLMU) as evidenced in non-disturbed areas.

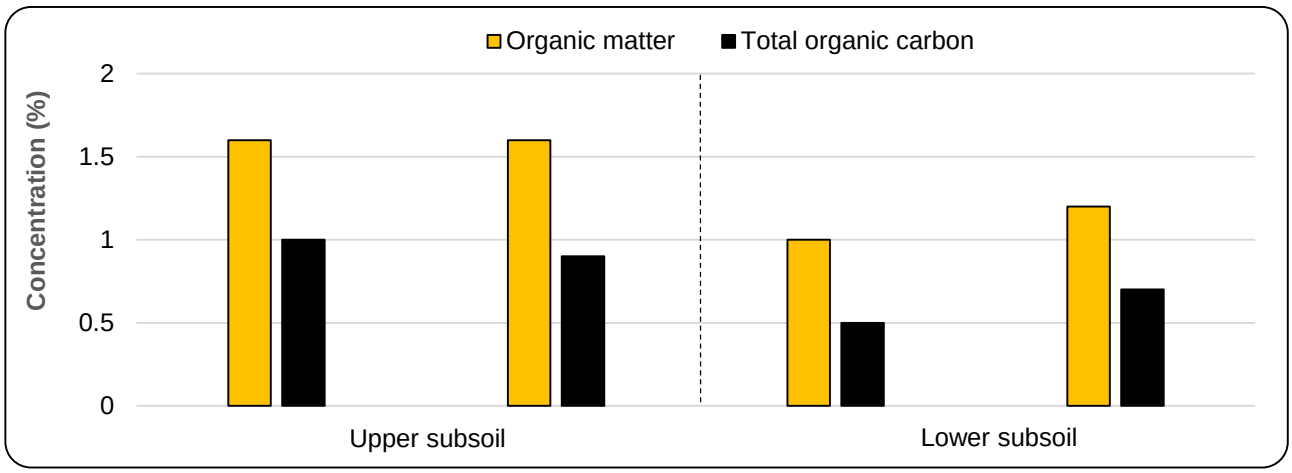


Figure 3-22: Results for organic matter and organic carbon

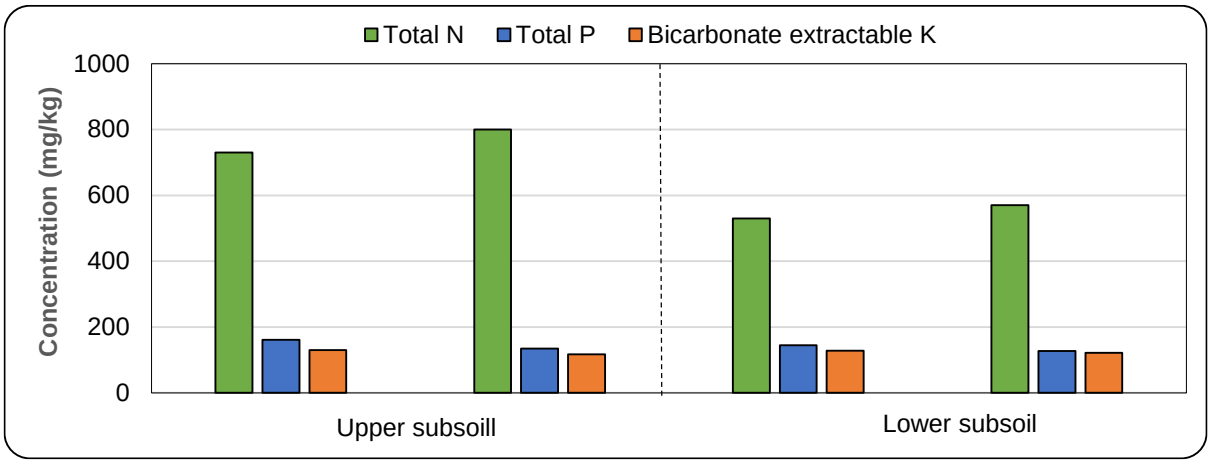


Figure 3-23: Results for Total N, Total P, and Bicarbonate Extractable K

3.4.3 Soil class characterisation

A quantitative method of for classification of soil slaking/dispersion/flocculation is the method developed by Rengasamy et al. (1984). Using this method, the $EC_{1:5}$ and ESP results for the five selected soil and overburden samples were plotted to qualify the soil dispersion and assign a soil classification (**Figure 3-24**). All of the samples classify as Class 2B soils which are potentially dispersive but have low salinity. The highest $EC_{1:5}$ value is 658 µS/cm from a subsoil sample, but this value is below the dotted line (in the figure) at which point salinity begins to affect productivity. **Table 3-6** shows a summary of soil classifications, for which all five samples classify as sodic but not saline.

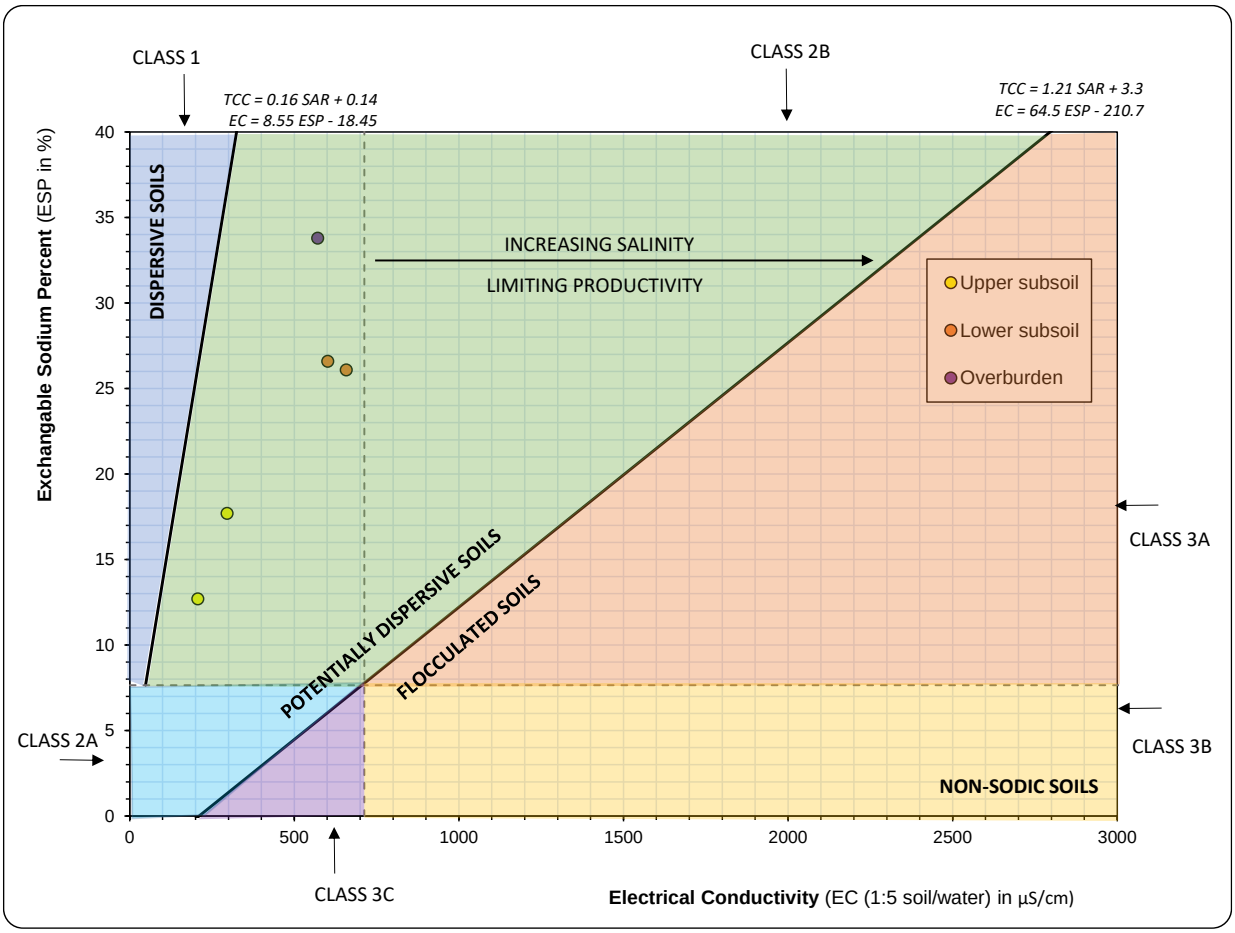


Figure 3-24: Soil salinity classes for subsoil and overburden

Table 3-6: Summary of soil classifications

ESP % ↓ EC (mS/cm) →	0-1,200	1,200-4,0000	4,000-6,000	6,000+
0-10	Normal soil (Class 2A or 3C)	Saline soil (Class 3B)	Saline soil (Class 3B)	Saline soil (Class 3B)
10-30	Sodic soil (80%) (Class 1 or 2B)	Saline-sodic soil (Class 2B or 3A)	Saline-sodic soil (Class 3A	Saline-sodic soil (Class 3A
30-45	Sodic soil (20%) (Class 1 or 2B)	Saline-sodic soil (Class 2B or 3A)	Saline-sodic soil (Class 3A)	Saline-sodic soil (Class 3A)
45-60	Sodic soil (Class 1)	Saline-sodic soil (Class 2B or 3A)	Saline-sodic soil (Class 3A)	Saline-sodic soil (Class 3A)
60+	Sodic soil (Class 1)	Saline-sodic soil (Class 2B or 3A)	Saline-sodic soil (Class 3A)	Saline-sodic soil (Class 3A)

3.4.4 Emerson class testing

Nine selected individual samples of upper and lower subsoil and overburden from the WBSP and subsequent drill hole sampling programs underwent aggregate stability (Emerson Class) analysis. Six samples were from the Austinvale Pit, two samples were from the Leichhardt Pit, and one sample was from the Wolleebee Pit. Emerson Class results are qualitative, not quantitative and exclude the effect of chemical parameters such as EC and individual ion chemistry. A lithological sample description is outlined for each test result in **Table 3-7** and **Table 3-8**. All of the soils are brown in colour. The Emerson classifications for each material verify that they are all dispersive or show some dispersion.

- 44 % are Emerson Class 1: Complete dispersion.
- 56 % are Emerson Class 2: Some dispersion.

Explanatory information regarding Emerson class classifications, their relationship to dispersibility, and their applications are provided in **Section 2.4.3.3.**

Table 3-7: Emerson Class results – Austinvale Pit

Composite No.	001	002	003	004	005	006
Lithological unit	Upper Subsoil	Upper Subsoil	Lower Subsoil	Lower Subsoil	Overburden	Overburden
Description	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY trace gravel - brown	Silty CLAY trace gravel - brown
Emerson Class Number	**2**	**2**	**2**	**2**	**1**	**2**
Dispersion	Some dispersion	Some dispersion	Some dispersion	Some dispersion	Complete dispersion	Some dispersion

Table 3-8: Emerson Class results – Leichhardt and Wolleebee Pits

Sample No.	021	031	051
Lithological unit	Upper Subsoil	Lower Subsoil	Lower Subsoil
Pit	Leichhardt	Leichhardt	Wolleebee
Emerson Class Number	**1**	**1**	**1**
Dispersion	Complete dispersion	Complete dispersion	Complete dispersion

3.5 Physical testing

3.5.1 Particle size distribution

Figure 3-25 and **Figure 3-26** show particle size distribution (PSD) results for eight selected individual soil samples and fourteen overburden, interburden and parting samples from the WBSP and subsequent drill hole sampling programs. The subsoil samples are unconsolidated sediments. The overburden, interburden and parting samples were originally weathered rock samples that were subjected to aggregate soundness testing (detailed in **Section 3.5.5**) and have since disintegrated into finer particles.

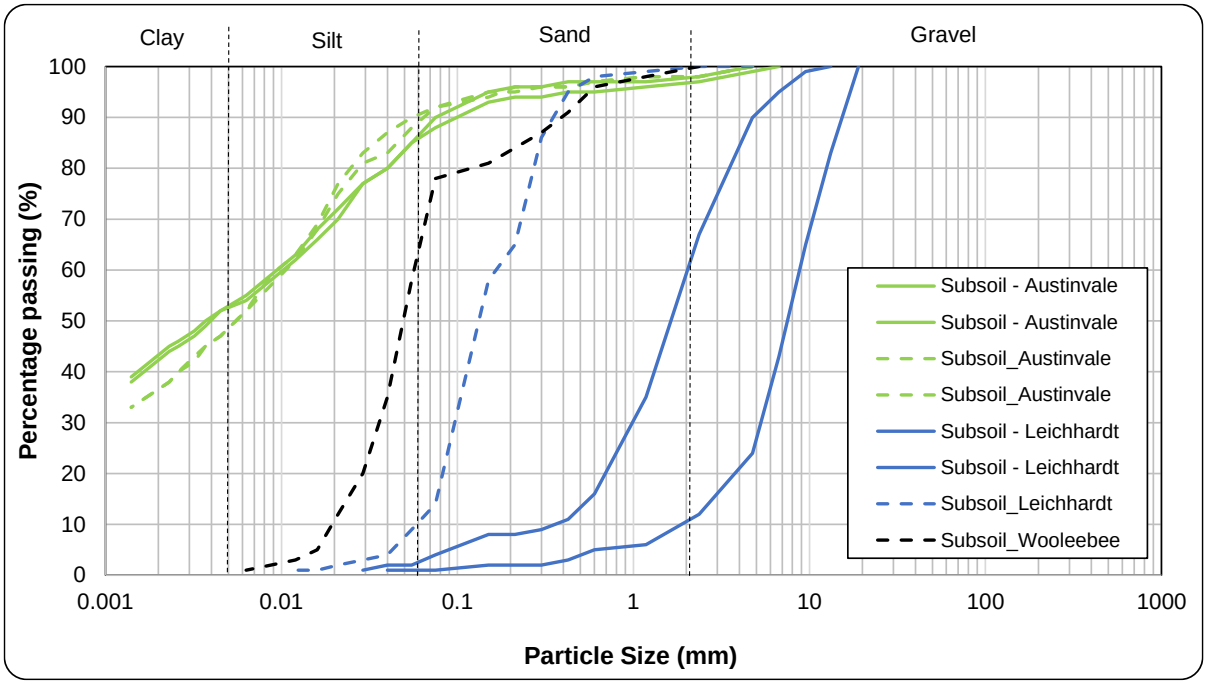


Figure 3-25: Particle size distribution curves for soil

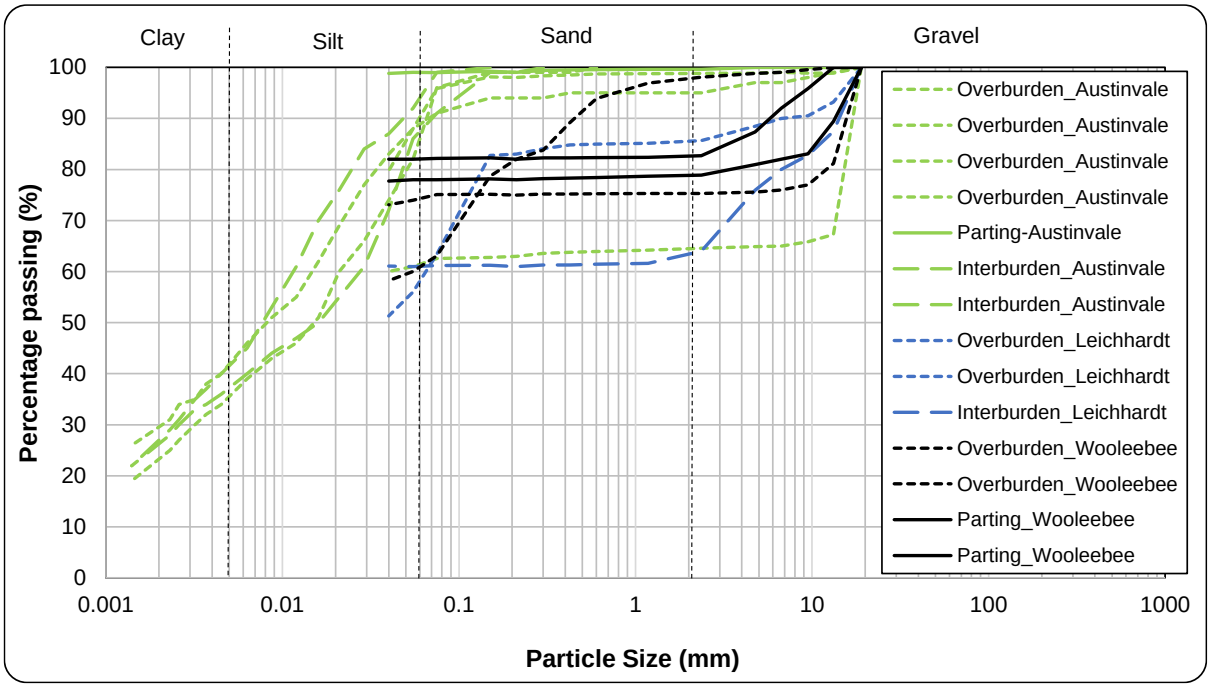


Figure 3-26: Particle size distribution curves for disintegrated sample of mine materials

The mine materials have been sorted according to the pit area – Austinvale, Leichhardt, or Wolleebee. Subsoil from the Austinvale Pit has a relatively high proportion of clay and silt (85 to 90%), whereas subsoil from the Leichhardt Pit contains only 10% clay and silt and 90% gravel.

Disintegrated overburden, interburden and parting materials from the Austinvale Pit are also typically fine materials containing mostly clay and silt (90 to 95%) and less than 5% gravel. Wolleebee samples contain between 60 to 80% clay and silt, whereas Leichhardt samples are typically coarser. For all three pits, overburden contains more sand than interburden and parting, which have a higher proportion of gravel. This result is to be expected as overburden is more weathered.

In the Austinvale Pit, clay content decreases with depth (**Table 3-9**). Upper subsoil contains the most clay (<0.004 mm), followed by lower subsoil, then overburden and interburden. The opposite is true for silt particles (0.004-0.06 mm), the proportion of which appear to increase with depth. Sand particles range from 8 % to 18 % and are generally highest in overburden and interburden samples. Most samples contain a minor proportion of gravel (0 to 5 %).

In the Wolleebee and Leichhardt Pits, there is an increase in clay and silt particles with depth. However, sand and gravel proportions are variable.

Table 3-9: PSD and soil texture results for subsoil, overburden, interburden and parting

Lithological unit	Clay (<0.004 mm)	Silt (0.004 – 0.06 mm)	Sand (0.06 – 2.4 mm)	Gravel (> 2.4 mm)	Soil texture classification (excl. gravel)
Austinvale					
Upper Subsoil	49 – 50%	35 – 36%	12 – 13%	2 - 3%	Clay
Lower Subsoil	45%	43 – 45%	8 – 10%	2%	Silty Clay
Overburden	32 – 38%	50%	7 – 18%	0 – 5%	Silty Clay Loam
Interburden	34 – 37%	52 – 55%	8 – 14%	0%	Clay Loam
Leichhardt					
Upper Subsoil	1 – 2%		1 – 6%	92 – 98%	~ Sandy Clay Loam
Lower Subsoil	9%		54%	37%	~ Loamy Sand
Overburden	46 – 56%		17 – 29%	11 – 35%	~ Clay loam
Interburden	61%		3%	24%	~ Silty clay
Wolleebee					
Subsoil	58%		26%	16%	~ Clay Loam
Overburden	60 – 74%		1 – 38%	1 – 24%	~ Clay loam
Parting	78 – 82%		0 –1%	13 – 19%	~ Silty clay

Notes:
1. Leichhardt and Wolleebee materials tested by dry sieving PSD methods only, which cannot differentiate between clay and silt particles.
2. For the purposes of soil texture classification, it is assumed that half of the clay and silt particles are clay, and the other half are silt.

3.5.2 Soil texture classification

Subsoil, overburden, interburden and parting have been tabulated to show their respective proportions (**Table 3-9)**. Using only the fine (excluding gravel) proportions of clay (< 0.004 mm), silt (> 0.004 to < 0.06 mm), and sand (> 0.06 to < 2.4 mm) the PSD results were then plotted on a soil texture classification triangle **(Figure 3-27**). Soil texture classifications range from clay for upper subsoil, to loamy sand for lower subsoil and most samples have a high proportion of clay. As noted above, the overburden, interburden and parting samples are weathered rock samples that have undergone aggregate soundness testing (**Section 3.5.5**) and have disintegrated.

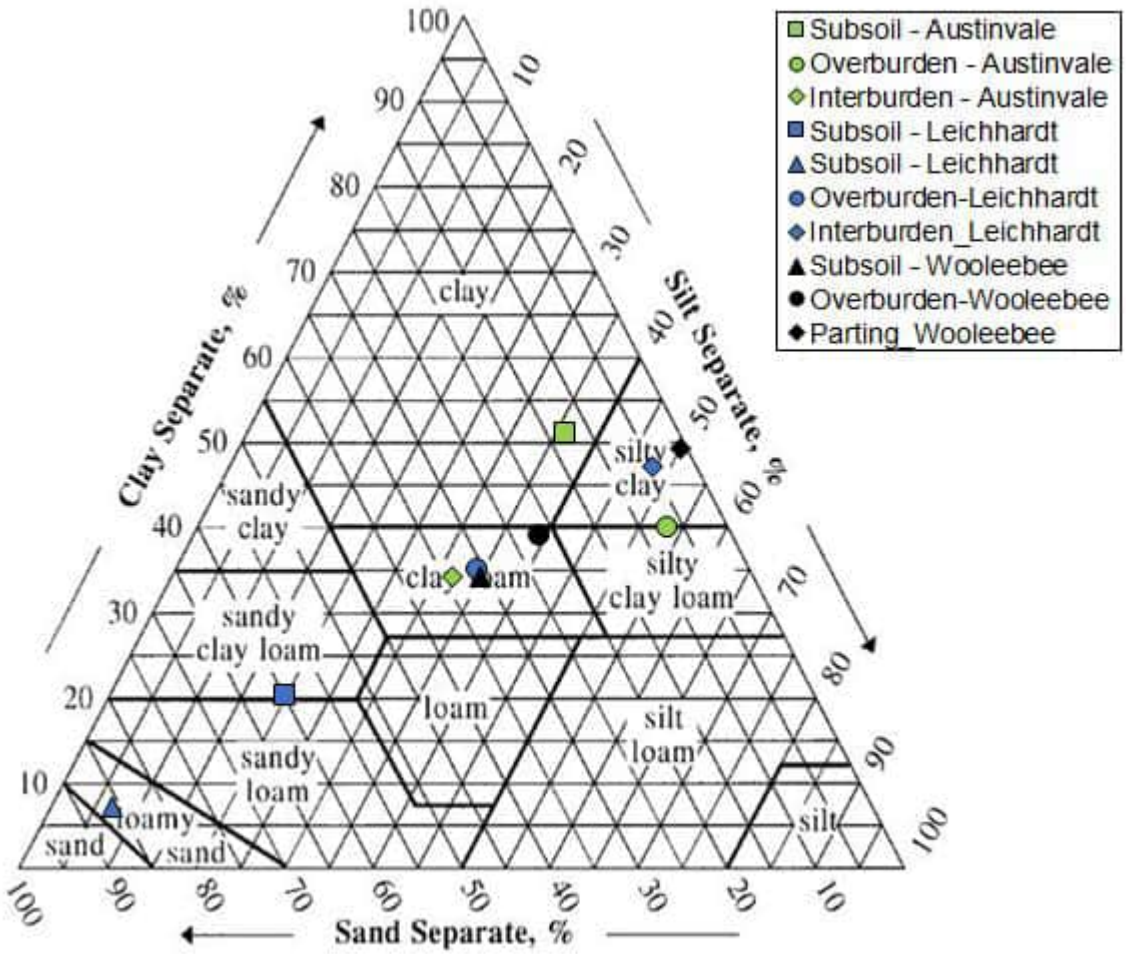


Figure 3-27: Soil texture classifications

3.5.3 Permeability testing and density

Six selected composite samples of subsoil, overburden, interburden, and coal were subjected to permeability (K_{sat}) analysis by either the falling head method (for fine samples), or the constant head method (for coarser samples) (**Section 2.4.4.3**). All samples had a standard compaction ratio of 90 %. Results are summarised in **Figure 3-28** as well as **Table 3-9**, including maximum dry density results.

Upper subsoil has the lowest permeability (3.4 x 10^{-9} m/s), which is consistent with PSD results (**Table 3-9**) verifying that upper subsoil has the highest proportion of clay. Overburden has the highest permeability (5.4 x 10^{-6} m/s) which is consistent with overburden having a high proportion of sand. This sample is likely to be less permeable (and contain more clay) than deeper overburden and interburden materials. Low grade coal (WS1A) and coal (WS1B) have low to moderate permeabilities ranging from 1.8 x 10^{-8} to 2.5 x 10^{-8} m/s.

Maximum dry density results range from 1.00 to 1.91 t/m^3 and verify that overburden has the highest density, whereas coal has a relatively low density.

Table 3-10: Permeability and maximum dry density results

Lithology	#	Description	Maximum Dry Density (t/m³)	PERMEABILITY: FALLING HEAD: kSat 90% StdCom. m/s	PERMEABILITY: CONSTANT HEAD: kSat 90% StdCom. m/s
Upper subsoil	C01	CLAY- brown	1.69	3.40E-09	
Lower subsoil	C02	CLAY- brown	1.71	4.60E-09	
Overburden	C03	Silty CLAY with gravel - brown	1.91		5.40E-06
Interburden	C09	Silty GRAVEL - Black	1.77		1.70E-07
Low grade coal (WS1A)	C11	Silty GRAVEL - Black	1.00		2.50E-08
Coal (WS1B)	C12	Silty GRAVEL - Black	1.12		1.80E-08

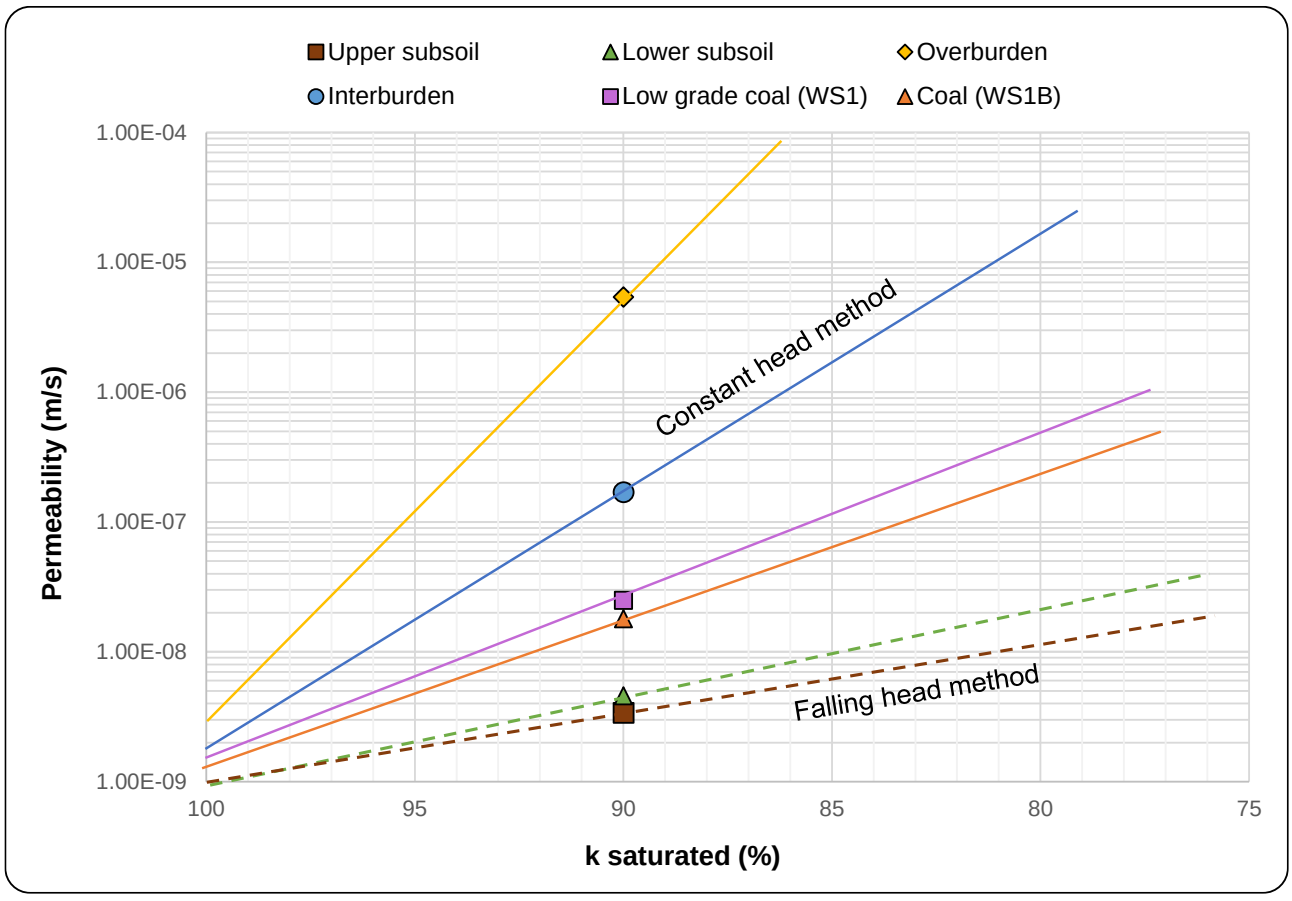


Figure 3-28: Permeability results for mine materials

3.5.4 Column settlement

The column settlement test measures how quickly particles flocculate and settle from a turbid mixture. Three selected composites for subsoil, and overburden underwent column settlement testing. Photographs of the samples at hourly intervals are included in **Attachment I**.

Results are summarised in **Table 3-11** and verify that the samples have poor settlement and elevated turbidity. After 8 hours, the three composite sample solutions are still turbid. After 24 hours, the lower subsoil composite has started to flocculate, creating clear layer of water in the upper 20 mL of solution, which increases to 100 mL after 48 hours. Upper subsoil also begins to settle after 24 hours, but it does not flocculate as well as lower subsoil and the supernatant liquid is still cloudy. Overburden particles do not appear to settle even after 120 hours, which may be related to its sodicity and potential for dispersion (**Table 3-7** and **Figure 3-24**).

This result is consistent with previous groundwater studies (**Section** □ and **Attachment F**) that verify that turbidity in groundwater is greater than Australian freshwater aquatic ecosystem guidelines (ANZG 2018).

Table 3-11: Summary of column settlement test results

	C01	C02	C03
Duration	Upper subsoil	Lower subsoil	Overburden
0 Hours	E	E	E
1 Hour	E	E	E
3 Hours	E	E	E
4 Hours	E	E	E
5 Hours	E	E	E
6 Hours	E	E	E
7 Hours	E	E	E
8 Hours	E	E	E
24 Hours	H	H	E
48 Hours	H	H	E
72 Hours	H	H	E
96 Hours	H	H	E
120 Hours	H	H	E
Hours to settle	**120+**	**120+**	**120+**

Turbidity: E = Extreme, H = High, M = Moderate, S = Slight, N = Negligible

3.5.5 California Bearing Ratio

California Bearing Ratio (CBR) results verify that the three composite samples representing subsoil and overburden have low to moderate CBR Values (1.0 – 2.5%) (**Table 3-12**). This demonstrates that the materials have weak resistance to penetration under controlled moisture and density conditions, a low bearing capacity and are highly susceptible to compaction and shearing. The swell and shrink mechanism (wetting and drying) will help to reduce compaction over time for these material types.

Table 3-12: CBR compaction results for soil and overburden

		Max Force	Max Penetration	CBR Penetration	CBR Value	Equivalent to	Comments
Sample	Material	(kN)	(mm)	(mm)	(%)		
C01	Upper subsoil	0.22	12.5	5.0	1	Clay	Low
C02	Lower subsoil	0.52	12.5	2.5	2.5	Clay-silt	Low-mod
C03	Overburden	0.55	12.5	5.0	1.5	Clay	Low

3.5.6 Aggregate soundness (sodium sulfate)

Aggregate soundness testing was completed for 13 selected individual samples of consolidated waste rock (overburden, interburden, and parting) at the RGS in-house laboratory. The samples were soaked in a sodium sulfate solution and then dried as described in **Section 2.4.4.6**. Results are summarised in **Table 3-13** and **Table 3-14**.

The 13 samples have weak rock durability and disintegrated after the first wet and dry cycle. The experiment was discontinued at this point. The samples were then collected and oven dried before PSD analysis was performed either by Trilab or at the RGS in-house laboratory (**Section 3.5.1**). Due to their poor durability, overburden, interburden and parting materials tested to date are unlikely to be suitable as competent material for rock armouring, if required in final landforms.

Table 3-13: Results for aggregate soundness testing – Phase 1

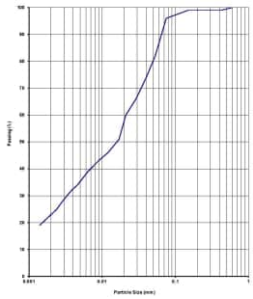
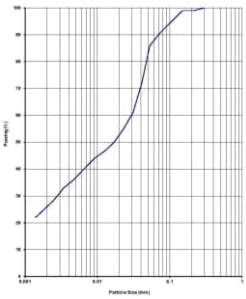
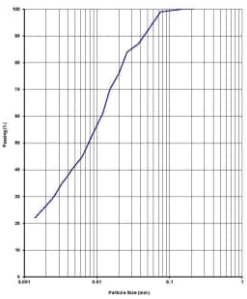
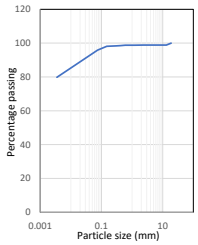
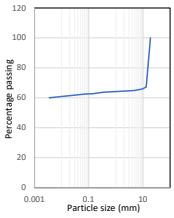
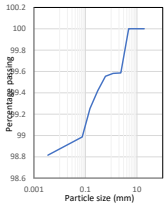
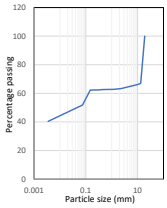
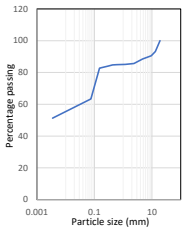
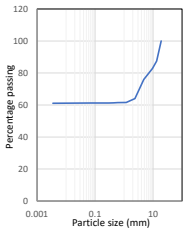
Date	5/07/2022	27/07/2022	17/08/2022
Sample	Samples were immersed in the salt solution for 3 weeks.	After 3 weeks, samples were drained, and oven dried until the samples reach a constant mass.	Samples fully disintegrated and sent to Trilab for PSD analysis (hydrometer only)
2022005_006	Overburden - SS		
2022005_017	Interburden - ST		
2022005_018	Interburden - ST		

Table 3-14: Results for aggregate soundness testing – Phase 2

Date	25/01/2024	29/01/2024	13/02/2024
Sample	Samples were oven dried and then immersed in the salt solution	Samples fully disintegrated after 4 days	Samples underwent wet sieving PSD
2022005_054	Overburden - SS		
2022005_057	Overburden – SS/ST		
2022005_059	Parting – MS		
2022005_064	Parting – SS/MS		

2022005_070	Overburden- SS/ST		
2022005_071	Overburden – ST/SS		
2022005_078	Parting – ST		
2022005_090	Overburden – SS		
2022005_092	Overburden – SS/ST		

2022005_100	Interburden – MS		

3.5.7 Point load testing

The point load strength of 10 selected core samples were analysed by Trilab laboratory. A summary of the sample depths and their lithologies is provided in **Table 3-15**. The axial load strengths (Is(50)) of the samples ranges from 0.12 to 1.24 MN/m^2 (median 0.49 MN/m^2) (or MPa), noting that a correction factor is applied to standardise the samples to have a 50 mm diameter. The diametral load strengths (Is(50)) are 0.06 to 1.03 MN/m^2 (median 0.33 MN/m^2), indicating that the rocks are weaker parallel to bedding planes (**Figure 3-29**).

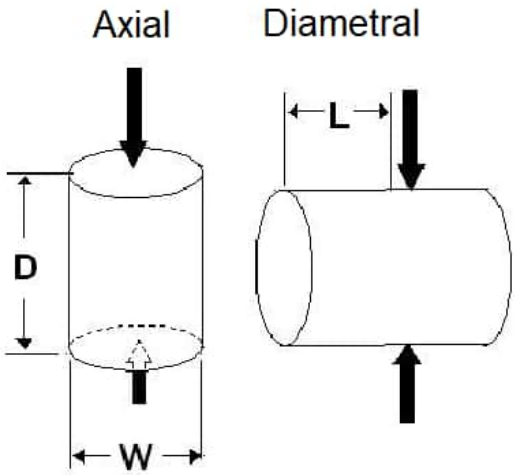


Figure 3-29: Axial and diametral point load strength directions

Table 3-15: Point load summary table

Drillhole ID	Pit	Depth (from)	Depth (to)	Lithology	Is (50) (Mpa) - Axial	Is(50) (Mpa) - Diametral
C9605GP_GC_02	Wolleebee	2	2.4	ST	0.12	0.13
C9605GP_GC_10	Wolleebee	26.7	27	MS	1.24	1.03
C9605GP_GC_12	Wolleebee	28.46	28.6	MS	0.47	0.06
C9605GP_GC_13	Wolleebee	34.79	35.2	SS/MS	1.15	0.64
C6906GP_GC_06	Austinvale	14.4	14.6	SS	1.02	0.58
C6906GP_GC_10	Austinvale	23.99	24.5	SS/ST	1.27	0.44
C6906GP_GC_15	Austinvale	34.06	34.4	ST/SS	0.43	0.32
C9610GP_GC_02	Leichhardt	11.29	11.6	SS/ST	0.51	0.34
C9610GP_GC_04	Leichhardt	16.5	16.8	ST/SS	0.47	0.12
C9610GP_GC_12	Leichhardt	35.6	35.9	MS	0.46	0.29

The axial Is(50) values have been plotted in **Figure 3-30** along with typical strength ranges for common rock materials. The point load strengths of the samples range from low to high. Uniaxial compressive strengths vary from weak to moderately strong. The weakest rock is a shallow, weathered siltstone from 2.4 m depth. The strongest rock is a sandstone/siltstone from 24.5 m depth. One sample is equivalent to a stiff clay. The remaining nine samples are equivalent to standard mudstone and sandstone.

Competent rocks with high or very high point load are suitable to supply strength and structure for engineered waterways and drains. They can also be used on slopes to provide erosion resistance. Soft rocks with low point load strength can be used to supplement soil as a growth medium, due to their highly weathered material properties. The latter is more appropriate for the WCP mine materials.

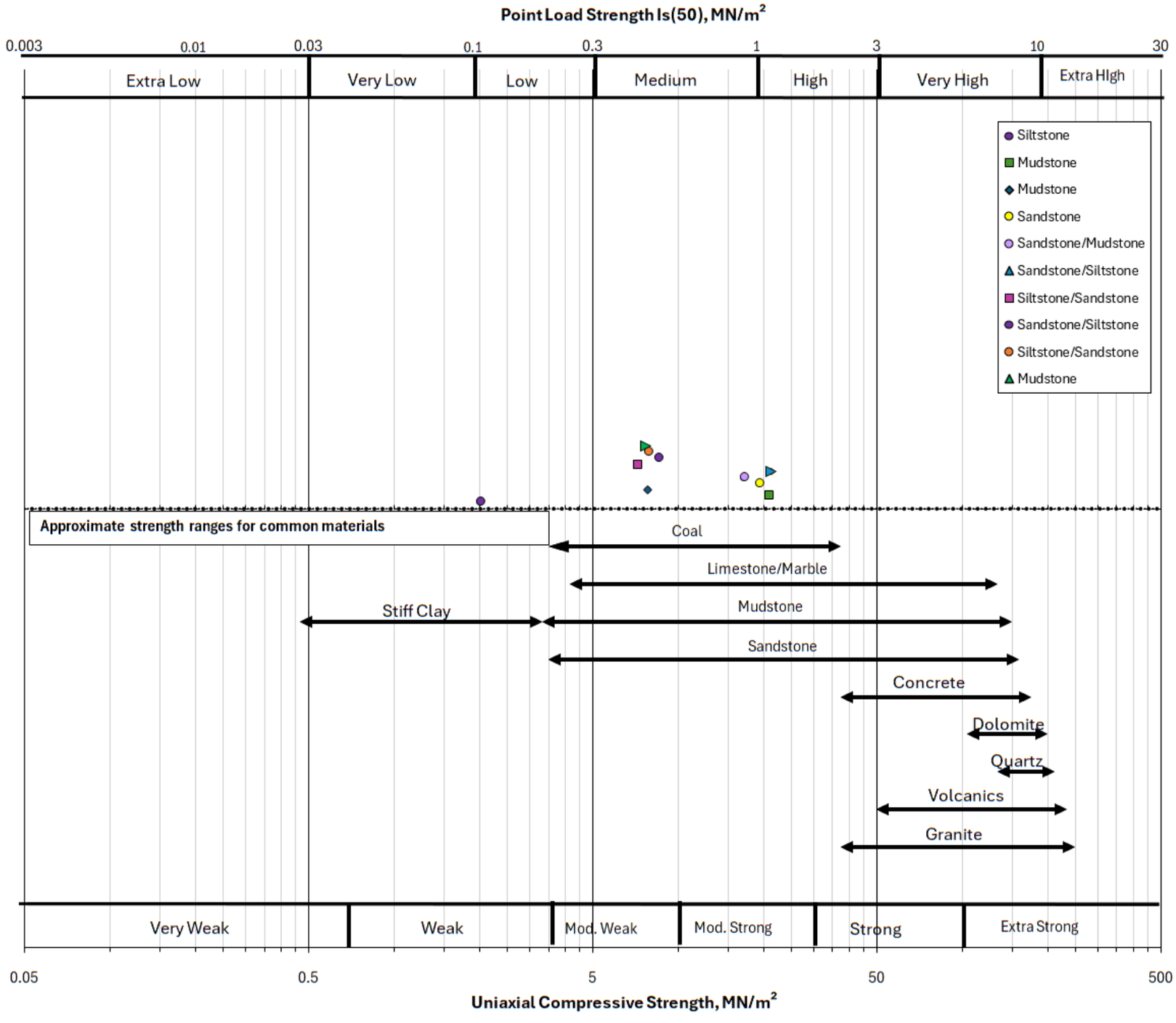


Figure 3-30: Point load strength material comparison

3.5.8 Atterberg limits

The clay fraction of subsoil samples (<0.004 mm) underwent analysis for Atterberg Limits. The Plasticity index (PI) % is the water content at which the soil begins to display plastic properties. It can be non-plastic (0%), slightly plastic (1-6%), medium plastic (7-17%), or highly plastic (18-100%) (Sowers, 1979). Silt and sand have very low or no plasticity. Complete physical results from Trilab are included in **Attachment H.**

The results verify that subsoil has high liquid limits and linear shrinkage values (**Table 3-16**). This confirms that the soils are high in shrinking and swelling clay mineral types and is consistent with CBR results (**Section 3.5.5**), previous soil studies (**Section** □ and **Attachment F**) and mineralogy results discussed in **Section 3.6**.

The American Association of Highway and Transportation Officials (AASHTO) soil classifications based on WAQTC (2020) are presented in **Figure 3-31**. Upper and lower subsoils classify as highly plastic by their Plasticity Index % (48-49 %) and are a high plasticity clay according to AASHTO soil classifications. This result verifies that the soils are suitable to perform as a reduced or low permeability layer for rehabilitation activities.

Table 3-16: Atterberg Limits for subsoil

	Upper subsoil	Upper subsoil	Lower subsoil	Lower subsoil
	001	002	003	004
Liquid Limit (%)	48	48	49	48
Plastic Limit (%)	17	17	19	19
Plasticity Index (%)	31	31	30	29
Linear Shrinkage (%)	15+	14.5+	14.5+	14

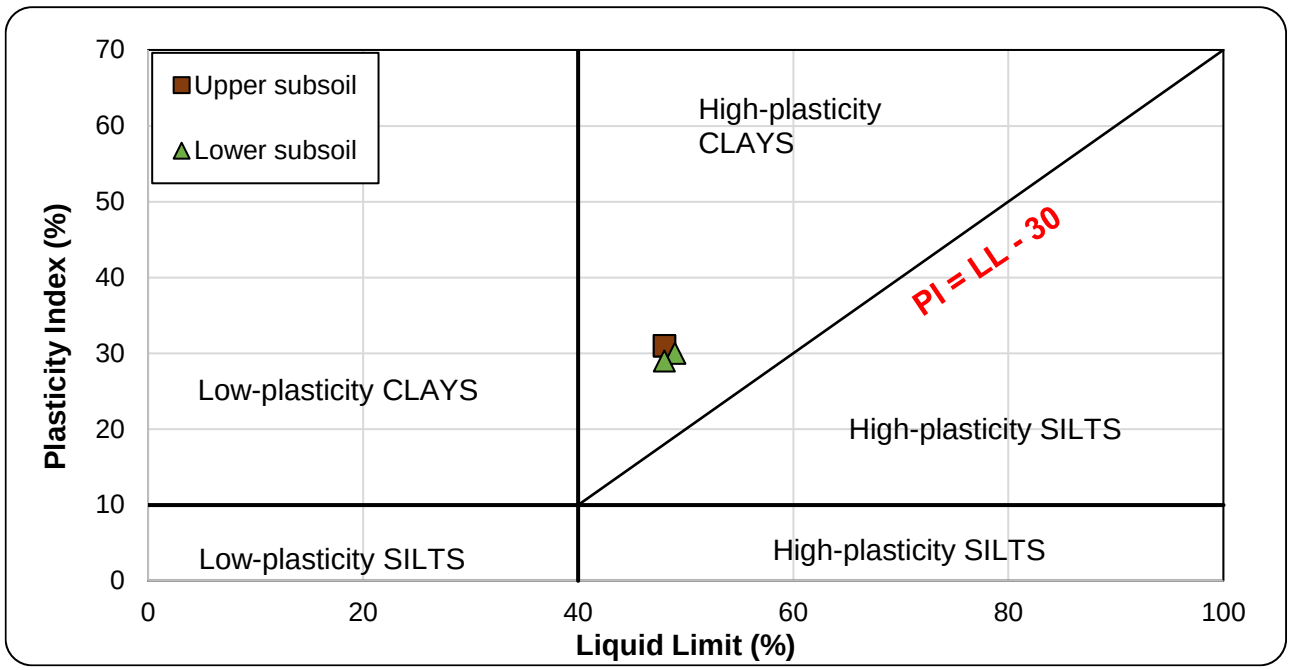


Figure 3-31: AASHTO classifications for subsoil

3.5.9 Soil water characteristic curves

A complete set of soil water characteristic curve results from Soil Water Group are provided in **Attachment K.**

Water retention data was collected for three composite samples of subsoil and overburden (**Figure 3-32**). Soil water characteristic curves can be used to determine van Genuchten parameters, i.e., residual water content (θ_r) and the saturated water content (θ_s). The inflexion point of the curve indicates the field capacity of the soil, and upper and lower transition zones infer the wilting point and saturation, respectively.

The data obtained from the water retention curves has been summarised in **Table 3-17** and confirm there is only a slight variation between material types.

The data bars and graph show that upper subsoil behaves most similarly to a clay and has the highest amount of water retention, whereas overburden has the least amount of water retention and behaves more like a silt or sand. Overall, the water retention curves display the shape and soil moisture content that is typical of a silty clay. This confirms that these soils are likely to have high water retention and to drain slowly after a rain event. These soils will provide an ideal growth medium for plants, for uses such as in material covers.

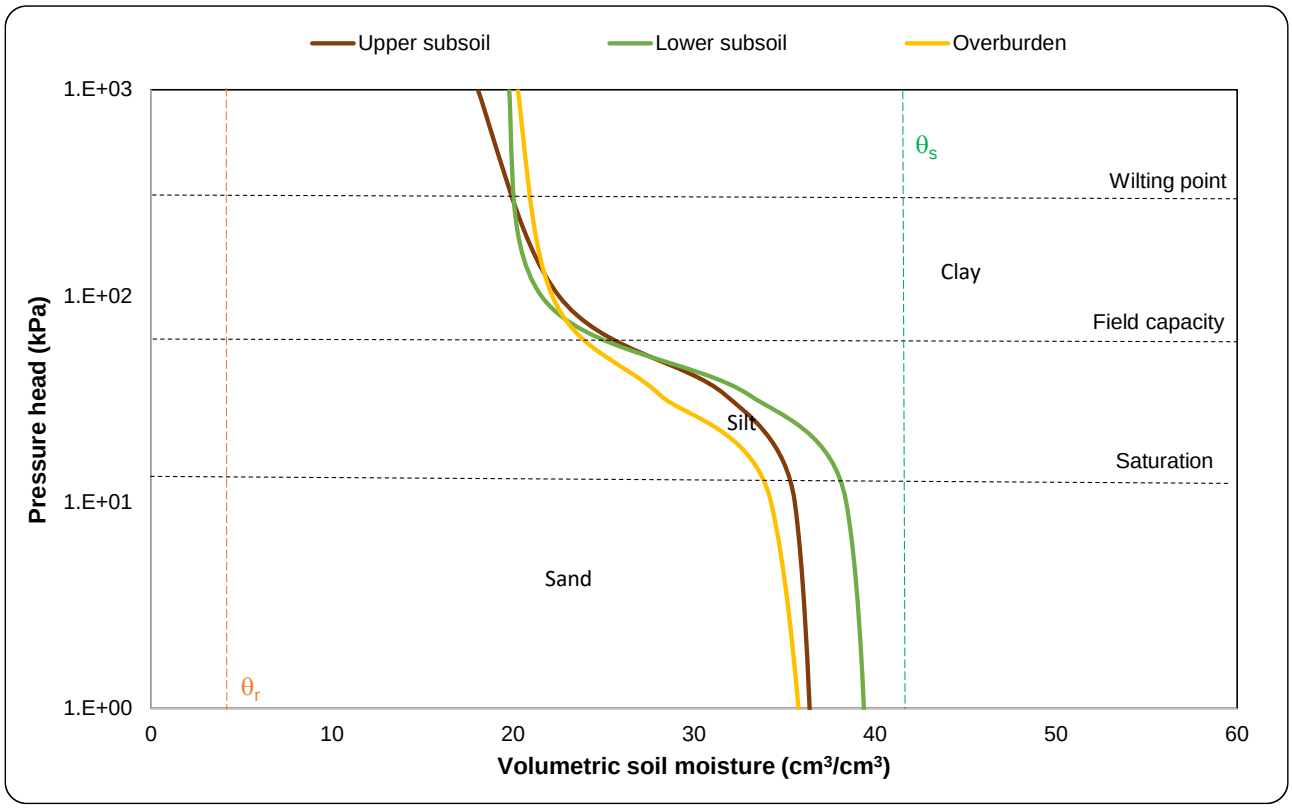


Figure 3-32: Soil water characteristic curves for subsoil, and overburden

Table 3-17: Summary of soil water characteristic curve data

Sample	Lithology	Residual water content (θ_r) (cm^3/cm^3)	Saturated water content (θ_s) (cm^3/cm^3)	Wilting point (cm^3/cm^3)	Field capacity (cm^3/cm^3)	Saturation (cm^3/cm^3)
2022005_001	Upper subsoil	0.1709	0.3674	17.34	31.74	37.27
2022005_002	Lower subsoil	0.1948	0.3949	19.59	33.06	40.26
2022005_003	Overburden	0.1949	0.3743	19.98	28.13	37.62

3.6 Mineralogy

Five selected individual and six composite samples of mine materials underwent mineralogical analysis by semi-quantitative x-ray diffraction (XRD). The samples contain a mixture of single and mixed-layer clays, quartz, feldspar, and calcite as well as iron sulfide and iron oxide minerals (**Table 3-18** and **Figure 3-33**). The proportion of potentially acid generating minerals (predominantly pyrite, pyrrhotite, and marcasite) range from <0.1 to 0.7 % across all of the individual and composite samples and is generally low.

- Pyrite ranges from <0.1 % to 0.6 % (median 0.4 %)
- Pyrrhotite was only found in tailings at 0.7 %
- Marcasite was only found in tailings at 0.1 %

Pyrite was not detected in the coal (WS1B) sample from the Macalister Upper seam, indicating some sample heterogeneity given that total sulfur and sulfide sulfur were detected using the Leco high temperature method. It is likely that the higher proportion of calcite (2.4 %) in coal (WS1B) compared to the calcite (2.1 %) in low grade coal (WS1A), is contributing towards its higher ANC, but other minerals contained in the amorphous fraction may also have an influence. Amorphous materials are crystalline solids that lacks crystalline structure, shape or form, and therefore have not been clearly identified through XRD.

Upper and lower subsoil are relatively high in calcite (3.7 to 4.5 %) compared to a median value of 2.1 % for calcite across all samples. As calcite is an important acid consuming mineral, this verifies the high ANC values and negative NAPP values for upper and lower subsoil observed in **Figure 3-12**.

A comparative interpretation with the total metal and metalloid results (**Section 3.2.1**) indicates that the Low grade coal (WS1A) is relatively low in Ca, Al, and Ba which may otherwise be providing secondary neutralising capacity, and it may be this lack of acid consuming minerals, rather than the presence of minor amounts of acid generating minerals (e.g., pyrite) that results in the slightly lower pH values for these (WS1A) samples.

The proportion of albite (Na-feldspar) increases with depth from 9.9 % in upper subsoil to 17.0 % in overburden. This trend correlates to increasing sodicity (**Figure 3-24**) and may therefore be the dominant mineral influencing this material characteristic.

Coal from the Macalister Upper seam (WS1A and WS1B) in the Austinvale Pit has a lower amorphous content (29.9 to 47 %) than coal from Macalister Lower (ML) in the Austinvale Pit (87 %) and Wambo (WA) from the Leichhardt Pit (79 %). The non-amorphous content (e.g., quartz, clay, and calcite) indicates the mineral matter in the coal, which produces ash when the coal is combusted. The lack of pyrite and other sulfide minerals (e.g., pyrrhotite and marcasite), as well as low mineral matter in the ML and WA coals suggest that deeper coal seams are higher in quality.

Potential reject materials have no amorphous content and are rich in quartz (27 to 33 %) and clay, consisting of kaolinite (15 to 20 %) and smectite (34 to 40 %). The mineralogical composition of these samples is similar to overburden (C03), verifying that potential rejects can be safely co-disposed within spoil and do not present any significant risk in terms of AMD.

Table 3-18: Mineralogy results for mine materials

	Upper subsoil	Lower subsoil	Overburden	Low grade coal (WS1A)	Coal (WS1B)	Coal reject	Tailings	Coal (ML)	Coal (WA)	Potential reject (ML)	Potential reject (WA)
	C01	C02	C03	C11	C12	C10	020	087	0113	077	039
Quartz	38.2	36	36.9	22.3	11.1	21.5	7.3	2	6	33	27
Kaolinite	25.6	24.6	21.6	33.0	36.0	35.5	11.1	8	11	20	15
Albite	9.9	13.6	17.0	7.0	ND	3.2	2.4	ND	<1	6	10
Microcline	0.9	1.4	1.8	0.8	ND	0.9	ND			2	2
Smectite	10.4	9.3	10.3	2.6	3.3	10.8	1.0	<1	<1	34	40
Calcite	3.7	4.5	1.6	2.1	2.4	0.8	ND	3	<1	2	1
Muscovite-illite	0.4	1.9	2.6	1.8	0.2	1.7	4.3	ND	4	3	3
Pyrite	0.5	0.6	0.5	0.4	ND	0.4	0.1				
Gypsum	0.1	ND	ND	0.1	ND	0.2	ND				
Jarosite	ND	0.1	0.2	0.1	ND	0.1	ND				
Ankerite	ND	ND	ND	ND	ND	0.1	ND				
Siderite	ND	ND	0.2	ND	ND	0.2	ND				
Amorphous - coal	10.3	8.0	7.3	29.9	47.0	24.6	ND	87	79		
Magnetite	ND	ND	ND	ND	ND	ND	71.6				
Pyrrhotite	ND	ND	ND	ND	ND	ND	0.7				
Marcasite	ND	ND	ND	ND	ND	ND	0.1				
Chlorite										<1	2
Anatase											<1

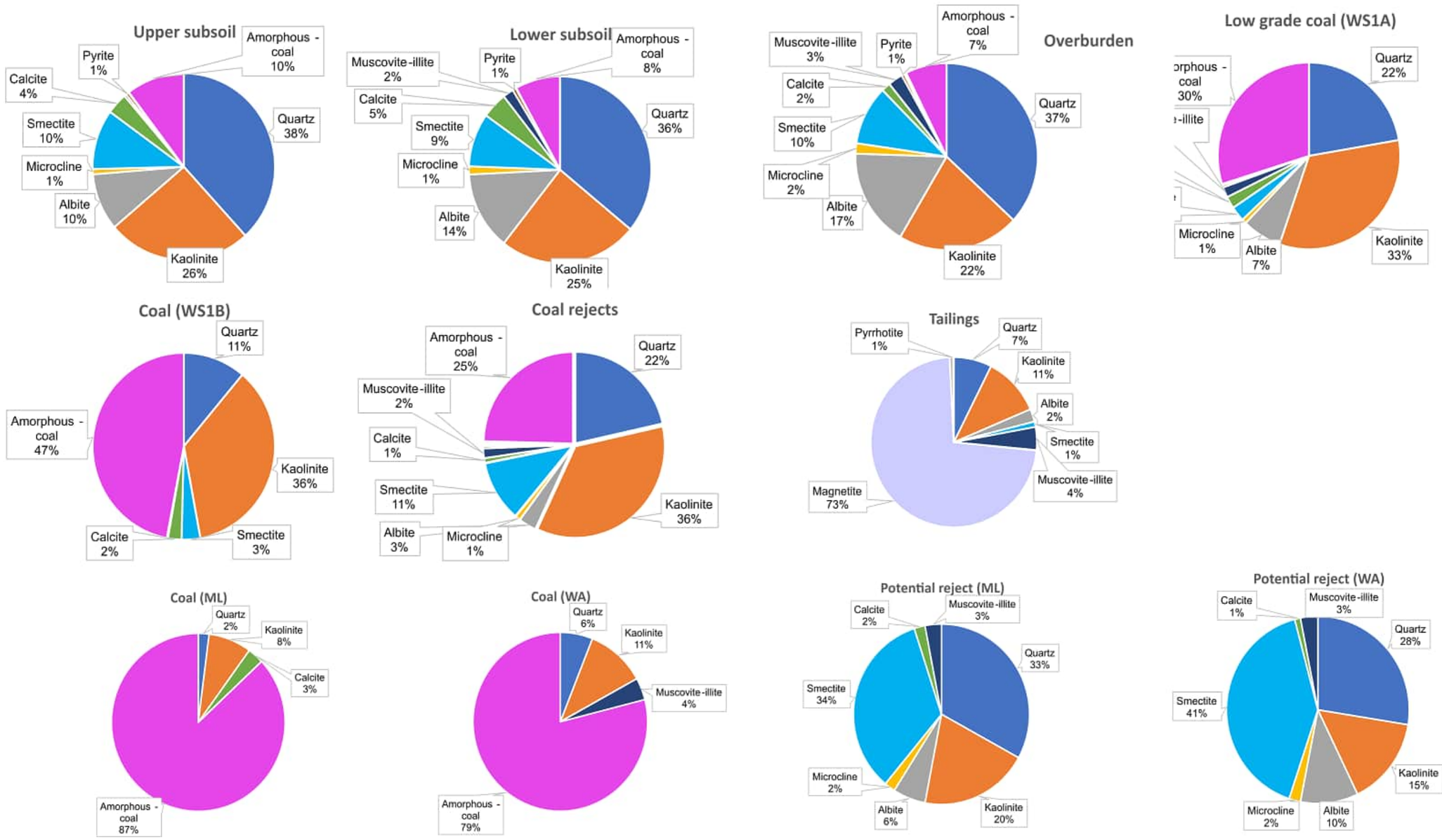


Figure 3-33: Mineralogy (XRD) results mine materials

3.7 Spontaneous combustion testing

For the WBSP, two coal samples, one coal reject, and one tailings sample from the Macalister Upper (WS1B) seam were subjected to spontaneous combustion testing at B3 Mining Services laboratory as described in **Section 2.4.6**. For the subsequent drill hole sampling program, the spontaneous combustion testing program was expanded to include two composite coal samples and two composite potential coal reject samples from the Macalister Lower and Wambo seams (C13 to C16, as described in **Table 2-7**). The relevant technical reports supplied by B3 Mining Service laboratory are provided in **Attachment E**.

The samples were characterised by R_{70} testing and coal quality analysis, the results of which are summarised in **Table 3-19**. The R_{70} values calculated for the eight samples range from 0.07 °C/h to 8.82 °C/h. These test results indicate that the sample materials have classifications ranging from low to ultra-high in terms of intrinsic spontaneous combustion propensity (ISPC), consistent with the rank of coal (high volatile C bituminous). Of the sample materials tested, coal has the highest ISPC rating. The relative ignition temperature (RIT) values for the samples are consistent with the R_{70} values and are indicative of a range of reactivities towards oxygen.

Table 3-19: Intrinsic spontaneous combustion test results

Sample No.	Sample Description	Sample Type	Ash Content (%, db)[1]	R_{70} (°C/h)	RIT (°C)	ISCP NSW Rating
1	2022005_013 (WS1B)	Coal	32.8	4.91	129.2	Very High
2	2022005_016 (WS1B)	Coal	21.6	6.84	120.3	Very High
3	FGX Coal Reject	Coal reject	67.5	0.72	183.5	Low-Medium
4	Tailings Filter Cake	Tailings	77.3	0.07	250.4	Low
5	2022005_C13 (ML)	Coal	27.7	6.62	122.9	Very High
6	2022005_C14 (ML)	Potential reject	74.2	1.44	178.3	Medium
7	2022005_C15 (WA)	Coal	26.4	8.82	115.7	Ultra-High
8	2022005_C16 (WA)	Potential reject	80.4	0.44	197.0	Low

%, db = percent dry basis

Calculated spontaneous combustion index values for the minimum self-heating temperature (SHT) indicate a high spontaneous combustion propensity rating for coal and medium propensity rating for coal reject (**Table 3-20**). The calculated crossing point temperature (CPT) values indicate a medium to high spontaneous combustion propensity rating for coal and low rating for coal reject, tailings, and potential reject.

Table 3-20: Spontaneous combustion propensity rating

Sample No.	Sample Description	Sample Type	SHT (°C)	Propensity rating	CPT (°C)	Propensity rating
1	2022005_013 (WS1B)	Coal	70	High	136	Medium
2	2022005_016 (WS1B)	Coal	67	High	128	High
3	FGX Coal Reject	Coal reject	88	Medium	171	Low
4	Tailings Filter Cake	Tailings	Invalid	Invalid	210	Low
5	2022005_C13 (ML)	Coal	31	High	133	Medium
6	2022005_C14 (ML)	Potential reject	Invalid	Invalid	175	Low
7	2022005_C15 (WA)	Coal	35	High	133	Medium
8	2022005_C16 (WA)	Potential reject	Invalid	Invalid	207	Low

Incubation testing on the selected coal samples from the MU, ML, and WA seams (which have a NAF geochemical classification and can have a relatively low sulfide sulfur value (<0.005 to 0.138 % as Scr)) indicates the coal can achieve thermal runaway in both a loose pile and highly fractured in-situ state under ideal conditions. However, for ideal conditions there are several criticalities that need to be present, including:

- For a remnant high wall coal seam occurrence, there is critical coal seam thickness present[3];
- There is a sufficient and continuous supply of oxygen due to airflow, such as underground ventilation flow or wind flow in a surface environment; and
- In a surface environment, no moisture accumulation from surface ponding or groundwater penetration that either excludes ingress of oxygen or creates a large evaporative heat loss mechanism.

It should also be noted that in a surface environment the material will oxidise over time to a point of deactivation if no heat is accumulated.

[3] For coals with an R_{70} < 2, thickness required is generally > 2 m. For coals with an R_{70} between 2-4, the thickness needs to be > 1.5 m. For coals with an R_{70} value between 4-8, the thickness needs to be > 1 m.

4 Discussion

4.1 Acid forming potential

The results of the ABA tests presented in **Section 3.1** and the water extract and KLC test results discussed in **Sections 3.2.2** and **Section 3.3**, respectively, demonstrate that the AMD potential of the mine materials represented by the samples tested is low. Typically, mine materials are classified as NAF or NAF-Barren, and generally have low oxidisable sulfur content and excess ANC. Materials represented by the samples have a low risk of acid generation and a high factor of safety with respect to potential AMD.

4.2 Multi-element composition and enrichment

The concentration of trace metals/metalloids in mine materials is expected to be low compared to the median crustal abundance in un-mineralised soils and is not expected to present any environmental issues associated with revegetation and rehabilitation.

4.3 Water quality

The static and kinetic geochemical test results presented in this report demonstrate that surface runoff and seepage from NAF materials is likely to have a pH that is circumneutral to slightly alkaline and will have a relatively low salinity based on EC values.

The concentrations of major ions in leachate from coal and mine waste materials are relatively low and are dominated by sodium, chloride, sulfate and bicarbonate, with lower concentrations of other major ions. The concentration of fluoride in leachate from soil materials may be slightly elevated compared to applied water quality guideline criteria (ANZG, 2018).

The concentration of most dissolved trace metals and metalloids in water in contact with the mine materials is low, predominantly below the laboratory LoR, and below the applied livestock water quality guideline criteria. The only exception is selenium, which can have a concentration greater than the livestock drinking water value (ANZG, 2018) under ideal oxidising conditions.

Overall, dissolved metal/metalloid concentrations in surface runoff and seepage from the mine materials are unlikely to present a significant risk to surface and groundwater resources with the expectation that the material will be handled according to standard industry mine waste management practices.

4.4 Soil characteristics

4.4.1 Upper and lower subsoil

Soil characterisation results for upper and lower subsoil demonstrate that the soils have moderate CEC and are likely to be sodic (measured by ESP) with low salinity. The soils are rich in clay and highly plastic, which can likely be attributed to the proportion of swelling clay minerals, such as smectite/montmorillonite. Soil texture ranges from clays to sandy loams and soils have a good water retention capability. Nutrients such as organic matter and plant-available P and K are low but are sufficient to support native vegetation. The subsoils provide reasonable fertility for a vegetation growth medium, with the provision that they are not used on steep slopes in final landforms, due to their sodicity and potential for dispersion (Emerson Class 1 and 2) and erosion.

4.4.2 Overburden

Exchangeable cation and sodicity results (measured by ESP) for the overburden sample indicates that the material has a low CEC value and is considered low in potassium, moderate in calcium and high in sodium and magnesium. Overburden may be sodic; and consequently, susceptible to dispersion and erosion, and for this reason should be managed appropriately during planned rehabilitation activities. For example, overburden materials could be managed by placement of a revegetated soil layer over final landforms as part of rehabilitation.

4.5 Physical characteristics

The particle size distribution of upper and lower subsoil in the Austinvale and Wolleebee Pits is predominantly clay and silt, whereas Leichhardt soils are predominantly gravel. Overburden, interburden, and parting rocks have poor durability and disintegrate readily with weathering into mostly clay and silt sized particles with some sand.

In materials from the Austinvale Pit, upper subsoil has the highest proportion of clay, and the lowest permeability and overburden has the highest permeability due to its relatively high density and proportion of sand. Coal and interburden materials have moderate permeability. When impacted by water, subsoil and overburden are potentially dispersive and have elevated turbidity, as demonstrated by their long column settlement times.

The point load strength of overburden, interburden, and partings is variable from very low to high and is the equivalent of stiff clay to sandstone. The rocks are unsuitable for rock armouring on steep slopes but could be used as bulk fill and as a parent material for re-creating the soil profile.

If competent rock is required as part of the rehabilitation design, fresh Permian rock from below the weathering profile would need to be sampled and analysed for suitability.

4.6 Spontaneous combustion

Spontaneous combustion testing results presented in **Section 3.7** demonstrate that the good quality Macalister Upper coal (WS1B), Macalister Lower, and Wambo coal samples have a low RIT values and therefore have a very high to ultra-high spontaneous combustion propensity. Coal reject and tailings from the Macalister Upper seam, as well as potential rejects, in contrast, have a high RIT and are much less likely to spontaneously combust.

Incubation testing on the coal samples demonstrates that the coal can achieve thermal runaway in both a loose pile and highly fractured in-situ state under ideal conditions. Due to their high R_{70} values (5-7 (°C/h)) coal thicknesses of >1 m represent an increased risk for spontaneous combustion, particularly if the coal is exposed to oxygen and is kept dry from moisture.

5 Conclusions

5.1 Conclusions

The results obtained in this assessment are consistent with previous studies completed on the WCP. The main findings of the GPSC assessment are:

- Mine materials typically have low oxidisable sulfur content, excess ANC, and are typically classified as NAF or NAF-Barren. These materials have a low risk of acid generation and a high factor of safety with respect to potential for AMD.
- Initial and ongoing surface runoff and seepage from most mine materials is expected to be pH neutral to slightly alkaline and be slightly brackish. Low grade coal materials from the Macalister Upper seam may generate contact water quality that has a lower pH and is slightly more brackish than the other mine materials tested.
- The concentration of major ions in surface runoff and seepage from mine materials is expected to be low and generally dominated by sodium, chloride, sulfate and bicarbonate. The concentration of fluoride in leachate from soil materials may be slightly elevated compared to applied water quality guideline criteria (ANZG, 2018).
- The concentration of trace metals/metalloids in mine material solids are expected to be low compared to applied guideline criteria for soils and median crustal abundance in un-mineralised soils and are not expected to present any environmental issues associated with revegetation and rehabilitation.
- Trace metals/metalloids are sparingly soluble at the neutral to slightly alkaline pH of the leachate expected from most mine materials. Dissolved metal/metalloid concentrations in surface runoff and seepage from bulk NAF materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at the WCP.
- Subsoil should be amenable to revegetation as part of rehabilitation activities and could be used as a cover for sodic overburden materials to limit the potential for dispersion and erosion.
- Coal materials from the Macalister Upper, Macalister Lower, and Wambo seams have a high risk of spontaneous combustion. Coarse reject and tailings materials generated from processing the Macalister Upper seam have a lower risk of spontaneous combustion.

6 References

AMIRA (1995). Mine Waste Management: *Project P387 Prediction and Identification of Acid Forming Mine Waste*. Australian Minerals Industry Research Association, Report prepared by EGi Pty Ltd, August 1995.

AMIRA (2002). *ARD Test Handbook: Project 387A Prediction and Kinetic Control of Acid Mine Drainage*. Australian Minerals Industry Research Association, Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd, May 2002.

ANZG (2018). *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 Governments and Australian state and territory governments, Canberra, ACT (2018).

AS 1289.2.1.1. (2005). *Methods of testing soils for engineering purposes – Soil; moisture content tests – Determination of the moisture content of a soil – Oven drying method (standard method).* Standards Australia.

AS 1289.3.6.1 (1995). *Methods of testing soils for engineering purposes – Soil classification tests – Determination of the particle size distribution of a soil – Standard method by sieving.* Standards Australia.

AS 1289.3.1.1 (2009). Methods of testing soils for engineering purposes – Soil classification tests – Determination of the liquid limit of a soil – Four point Casagrande method. Standards Australia.

AS 1289.3.8.1. (2017). *Methods of testing soils for engineering purposes – Soil classification tests – Dispersion – Determination of Emerson class number of a soil.* Standards Australia.

AS 1289.4.1.1 (2019). *Methods of testing soils for engineering purposes – Soil chemical tests – Determination of the organic matter content of a soil – Normal method.* Standards Australia.

AS 1289.6.1.1. (2014). Methods of testing soils for engineering purposes. Soil strength and consolidation tests – Determination of the California Bearing Ratio of a soil – Standard laboratory method for a remoulded specimen. Standards Australia.

AS 1289.6.7.2 (2001). Methods of testing soils for engineering purposes. Soil strength and consolidation tests – Determination of permeability of a soil. Standards Australia.

AS 4133.4.1. (2007). Methods of testing rocks for engineering purposes – Rock Strength Tests – Determination of point load strength index (Reconfirmed 2016). Standards Australia.

AS 4969.7. (2008). *Analysis of Acid Sulfate soil – Dried samples – Methods of Test. Method 7: Determination of Chromium Reducible Sulfur (Scr)*. Standards Australia, June.

ASTM Committee D-18 on Soil and Rock. (2017). Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 1. ASTM international.

Baxter and Williamson (2001). *Know your soils.* Part 1 – Introduction to soils. Technical bulletin produced by Department of Natural Resources and Environment, State of Victoria, 2001.

Beamish, B. B. and Beamish, R. (2011). Testing and sampling requirements for input to spontaneous combustion risk assessment, in Proceedings of the Australian Mine Ventilation Conference (eds: B Beamish and D Chalmers), pp 15-21 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B and Beamish, R, (2012). Benchmarking coal self-heating using a moist adiabatic oven test, in *Proceedings of the 14th US/North American Mine Ventilation Symposium* (eds F Calizaya and M.G. Nelson), pp423-427 (university of Utah, Department of Mining Engineering, Utah, USA).

Beamish, B. B. and Theiler, J.(2015). Contrast in self-heating behaviour for coals of similar rank, in Proceedings of the 15th Coal Operators' Conference (ed: N Aziz), pp 300-304, (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B. B. and Theiler, J. (2017). Recognising the deficiencies of current spontaneous combustion propensity index parameters, in Proceedings of the Australian Mine Ventilation Conference, pp 113-117 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B. B. and Theiler, J. (2019). Coal spontaneous combustion: Examples of the self-heating incubation process, *International Journal of Coal Geology*, 215:103297.

Bennett, J.W., Comarmond, M.J. and Jeffery, J.J. (2000). *Comparison of Oxidation Rates of Sulfidic Mine Wastes Measured in the Laboratory and Field*. Australian Centre for Mining Environmental Research, Brisbane.

Bowen, H.J.M. (1979). *Environmental Chemistry of the Elements,* Academic Press, New York, p36-37

Broch, E., & Franklin, J. A. (1972, November). The point-load strength test. In *International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts* (Vol. 9, No. 6, pp. 669-676). Pergamon.

COA (2016). Leading Practice Sustainable Development Program for the Mining Industry - Managing Acid and Metalliferous Drainage. Commonwealth of Australia, Canberra.

CRC (2000). *Handbook of Chemistry and Physics. 103rd Edition*. Ed. John Rumble.

DES (2023). *Guideline. Progressive rehabilitation and closure plans (PRC plans). Version 3* Document ESR/2019/4964. Last Reviewed 04 APR 2023. Queensland Government Department of Environment and Science.

Accessed from: https://environment.des.qld.gov.au/__data/assets/pdf_file/0026/95444/rs-gl-prc-plan.pdf

GCAA (2022). Surat Hydrogen Project: Plate and Frame Pilot Plant Report. Technical report produced for Glencore Coal Assets Australia, July 2022. 33pp.

Gee, Glendon W., and Dani Or. (2002). "2.4 Particle-size analysis." *Methods of soil analysis: Part 4 physical methods* 5: 255-293.

Hazelton, P. and Murphy, B. (2016). Crouch, R., Reynolds, K.C., Hicks, R.W., and Greentree, D.A. (2007). Soils and their use of earthworks. In '*Interpreting soil test results: What do all the numbers mean?'* pp. 24-27. CSIRO publishing.

INAP (2024). *Global Acid Rock Drainage Guide (GARD Guide)*. Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP) (http://www.inap.com.au/).

Industry and Investment NSW (2011). Guidelines. MDG 1006 - Technical Reference. Technical Reference for Spontaneous Combustion Management Guideline. Document produced by Mine Safety Operations Branch of Industry and Investment NSW, May.

Isbell, R.F. (2002). *The Australian Soil Classification (revised edition)*. CSIRO Publishing. Victoria.

Lourenço, S.D.N. et. al., (2011). A new procedure for the determination of the soil water retention curves by continuous drying using high-suction tensiometers. Canadian Geotechnical Journal, 48(2): 327-335.

MEND (2009). Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials, MEND Report 1.20.1, December 2009.

National Environment Protection Assessment of Site Contamination) (NEPC) (2013). *Guideline on Investigation Levels for Soil and Groundwater.* Schedule B1. Legislative document.

Northcote, K.H. and Skene, J.K.M. (1972). *Australian Soils with Saline and Sodic Properties.* CSIRO Australia, Soil Publication No. 27, Canberra.

Parsons Brinckerhoff (2009). Addendum to the Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment. Technical document produced by Parsons Brinckerhoff Australia Pty. 2133006K-RPT00X-B:ow. September 2009.

Rayment, G. E., & Lyons, D. J. (2011). *Soil chemical methods: Australasia* (Vol. 3). CSIRO publishing.

Rengasamy, P., et al. (1984). "Identification of dispersive behaviour and the management of red-brown earths." *Soil Research* 22.4: 413-431.

RGS (2024a) Test method for Sodium Sulfate Soundness Test. Document number 052RGSSLM_MLS_Sodium_Sulfate Soundness Test. Dated 17 January 2024.

RGS (2024b) Test method for REM Geochemistry Sampling (incl. Method for Sample Settlement Columns). 105_RGSLM_REM Geochemistry Sampling. Dated 22 November 2022.

Sowers, G. F. (1979). Introductory Soil Mechanics & Foundations. *Geotechnical engineering*, *92*, 114-117.

WAQTC (2020). *Determining the plastic limit and plasticity index of soils for AASHTO T 90 (17).* Standard Procedure. Published October 2020.

Attachments

Attachment A: Acid and Metalliferous Drainage – an overview

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

Mine materials may include soil, overburden, interburden, tailings, coarse rejects, economic and non-economic coal. Some of these materials can belong to the following material subsets, depending on their proposed use.

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

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

Standard industry terms used to classify the Net Acid Producing Potential (NAPP**)** of mine materials include the following.

- **AF (Acid Forming)** – highly reactive material that can produce acid rapidly (days to weeks).
- **PAF (Potentially Acid Forming)** - has some potential to produce acidity.
- **PAF- LC (Potentially Acid Forming - Low Capacity)** - has the potential to produce lower amounts of acidity.
- **NAF (Non-Acid Forming)** - will not produce acidity but may leach salts and some metals/metalloids due to the presence of low sulfide bearing material.
- **NAF-Barren)** - will not produce acid or leach salts due to the absence of sulfide minerals (typically < 0.1 %S).
- **AC (Acid Consuming)** – has some Acid Neutralising Capacity (ANC) that will contribute to ongoing acid neutralisation e.g., calcite in basalt.

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

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

- Seepage from overburden emplacements or low-grade ore stockpiles (in-pit or ex-pit);
- Operating pits;
- Decommissioned pits; and
- Back-filled pits.

Mine impacted water can be classified as having:

- Acid, neutral or alkaline pH;
- Variable concentrations of major ions (salts e.g. calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride); and

- Variable concentrations of metals (e.g. Al, Fe, Mn and Zn) or metalloids (e.g. Mo, Se and V) with the concentrations often linked to pH.

Potential sources of acidity in mine impacted water at mine sites can include the following.

- Oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2024).
- Rainfall and leaching of cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}) and sodium (Na^{+}) that reduce soil pH by atmospheric carbonic, nitric or sulfuric acid.
- Organic matter decay.

Potential sources of salts in mine impacted water at mine sites that can include the following.

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

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

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

Pathways by which AMD is mobilised

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

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

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

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

Attachment B: Geochemical characterisation tables

Table B1: Acid Base Account Results for mine materials from the Wandoan Coal Project

Sample No.	RGS Sample ID	ALS Lab ID	Client Sample ID	Sample Type	From	To	Interval	Depth	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)					(µS/cm)	(%)		(kg H_2SO_4/t)				
1	2022005_001	EB2208963001	Topsoil WANTP 0-0.6	Topsoil	0.0	0.6	0.6	0.6	8.70	366	0.02		63.1	0.6	-62.5	103.0	Non-Acid Forming (barren)
2	2022005_002	EB2208963002	Soil WANTP 0-0.6	Topsoil	0.0	0.6	0.6	0.6	8.80	343	0.02		76.9	0.6	-76.3	125.6	Non-Acid Forming (barren)
3	2022005_003	EB2208963003	Subsoil 600mm WANTP 0-0.6	Subsoil	0.0	0.6	0.6	0.6	8.90	706	0.02		84.1	0.6	-83.5	137.3	Non-Acid Forming (barren)
4	2022005_004	EB2208963004	Subsoil 600mm WANTP 0-0.6	Subsoil	0.0	0.6	0.6	0.6	8.90	678	0.02		90.2	0.6	-89.6	147.3	Non-Acid Forming (barren)
5	2022005_005	EB2208963005	Overburden 1700mm WANTP 0.6-2.2	Overburden	0.6	2.2	1.6	1.6	8.60	720	<0.01		14.9	0.2	-14.7	97.3	Non-Acid Forming (barren)
6	2022005_006	EB2208963006	Overburden 1700mm WANTP 0.6-2.2	Overburden	0.6	2.2	1.6	1.6	9.00	555	<0.01		55.4	0.2	-55.2	361.8	Non-Acid Forming (barren)
7	2022005_008	EB2208963008	WS1A WANTP 2.2-4	Poor quality coal	2.2	4.0	1.8	1.8	5.60	758	0.09		2.3	2.8	0.5	0.8	Non-Acid Forming (barren)
8	2022005_009	EB2208963009	WS1A WANTP 2.2-4	Poor quality coal	2.2	4.0	1.8	1.8	5.80	710	0.08		9.6	2.5	-7.2	3.9	Non-Acid Forming (barren)
9	2022005_010	EB2208963010	WS1A WANTP 2.2-4	Poor quality coal	2.2	4.0	1.8	1.8	6.40	852	0.09		20.7	2.8	-17.9	7.5	Non-Acid Forming (barren)
10	2022005_011	EB2208963011	WS1A WANTP 2.2-4	Poor quality coal	2.2	4.0	1.8	1.8	5.50	740	0.09		0.8	2.8	2.0	0.3	Non-Acid Forming (barren)
11	2022005_012	EB2208963012	WS1A WANTP 2.2-4	Poor quality coal	2.2	4.0	1.8	1.8	5.60	729	0.10	0.028	0.5	0.9	0.4	0.6	Non-Acid Forming (barren)
12	2022005_013	EB2208963013	WS1B WANTP 4.4-7	Coal	4.4	7.0	2.6	2.6	7.60	496	0.14	0.138	35.3	4.2	-31.1	8.4	Non-Acid Forming
13	2022005_014	EB2208963014	WS1B WANTP 4.4-7	Coal	4.4	7.0	2.6	2.6	7.60	522	0.12	0.119	29.0	3.6	-25.4	8.0	Non-Acid Forming
14	2022005_015	EB2208963015	WS1B WANTP 4.4-7	Coal	4.4	7.0	2.6	2.6	7.60	450	0.11	0.114	26.5	3.5	-23.0	7.6	Non-Acid Forming
15	2022005_016	EB2208963016	WS1B WANTP 4.4-7	Coal	4.4	7.0	2.6	2.6	7.70	506	0.12	0.113	33.8	3.5	-30.3	9.8	Non-Acid Forming
16	2022005_007	EB2208963007	Interburden WS1B WANTP 4-4.4	Interburden	4.0	4.4	0.4	0.4	8.00	534	0.06		23.3	1.8	-21.5	12.7	Non-Acid Forming (barren)
17	2022005_017	EB2208963017	MU/ML IB WANTP 7-7.5	Interburden	7.0	7.5	0.5	0.5	9.20	248	0.02		5.7	0.6	-5.1	9.3	Non-Acid Forming (barren)
18	2022005_018	EB2208963018	MU/ML IB WANTP 7-75	Interburden	7.0	7.5	0.5	0.5	9.50	264	<0.01		6.3	0.2	-6.1	41.1	Non-Acid Forming (barren)
19	2022005_019	EB2209260001	Coarse Reject	Coal reject	-	-	-	-	8.60	367	0.03		23.7	0.9	-22.8	25.8	Non-Acid Forming (barren)
20	2022005_020	EB2224327001	Tailings Filter Cake	Tailings	-	-	-	-	7.00	56	0.11	0.064	17.5	2.0	-15.5	8.9	Non-Acid Forming (barren)
21	2022005_021	EB2336599001	R9595P_GO_01	Overbudern	0.0	1.0	1.0	1.0	9.00	325	0.02		16.2	0.6	-15.6	26.4	Non-Acid Forming (barren)
22	2022005_022	EB2336599002	R9595P_GO_02	Overburden	3.0	4.0	1.0	1.0	9.10	67	0.02		6.1	0.6	-5.5	10.0	Non-Acid Forming (barren)
23	2022005_023	EB2336599003	R9595P_GO_03	Overbudern	7.0	8.0	1.0	1.0	8.40	74	0.02		3.2	0.6	-2.6	5.2	Non-Acid Forming (barren)
24	2022005_024	EB2336599004	R9595P_GO_04	Overburden	10.0	11.0	1.0	1.0	9.50	371	0.03		22.6	0.9	-21.7	24.6	Non-Acid Forming (barren)
25	2022005_025	EB2336599005	R9595P_GO_05	Coal	13.0	14.0	1.0	1.0	9.60	289	0.22	0.036	17.6	1.1	-16.5	16.0	Non-Acid Forming (barren)
26	2022005_026	EB2336599006	R9595P_GO_06	Parting	17.0	18.0	1.0	1.0	10.00	245	0.03		12.5	0.9	-11.6	13.6	Non-Acid Forming (barren)
27	2022005_027	EB2336599007	R9595P_GO_07	Coal	18.0	19.0	1.0	1.0	9.80	276	0.24	0.048	14.5	1.5	-13.0	9.9	Non-Acid Forming (barren)
28	2022005_028	EB2336599008	R9595P_GO_08	Interburden	21.0	22.0	1.0	1.0	10.10	460	0.04		39.0	1.2	-37.8	31.8	Non-Acid Forming (barren)
29	2022005_029	EB2336599009	R9595P_GO_09	Coal	23.0	24.0	1.0	1.0	7.50	954	0.23	0.076	18.6	2.3	-16.3	8.0	Non-Acid Forming (barren)
30	2022005_030	EB2336599010	R9595P_GO_10	Interburden	29.0	30.0	1.0	1.0	10.10	748	0.06		27.0	1.8	-25.2	14.7	Non-Acid Forming (barren)
31	2022005_0031	EB2340155001	R9608P_GO_01	Overburden	0.0	1.0	1.0	1.0	8.00	1,290	0.03		9.5	0.9	-8.6	10.3	Non-Acid Forming (barren)
33	2022005_0032	EB2340155002	R9608P_GO_02	Overburden	5.0	6.0	1.0	1.0	6.50	879	0.02		5.5	0.6	-4.9	9.0	Non-Acid Forming (barren)
34	2022005_0033	EB2340155003	R9608P_GO_03	Coal	8.0	9.0	1.0	1.0	7.40	1,800	0.10		17.2	3.1	-14.1	5.6	Non-Acid Forming (barren)
35	2022005_0034	EB2340155004	R9608P_GO_04	Coal	15.1	16.1	1.0	1.0	8.40	615	0.17	0.063	19.8	1.9	-17.9	10.3	Non-Acid Forming (barren)
36	2022005_0035	EB2340155005	R9608P_GO_05	Interburden	18.0	19.0	1.0	1.0	9.50	789	0.04		14.6	1.2	-13.4	11.9	Non-Acid Forming (barren)
37	2022005_0036	EB2340155006	R9608P_GO_06	Interburden	21.0	22.0	1.0	1.0	9.90	867	0.02		46.8	0.6	-46.2	76.4	Non-Acid Forming (barren)
38	2022005_0037	EB2340155007	R9608P_GO_07	Interburden	26.0	27.0	1.0	1.0	9.90	862	0.02		60.4	0.6	-59.8	98.6	Non-Acid Forming (barren)
39	2022005_0038	EB2340155008	R9608P_GO_08	Interburden	32.0	33.0	1.0	1.0	10.00	913	0.03		22.0	0.9	-21.1	23.9	Non-Acid Forming (barren)
40	2022005_0039	EB2340155009	R9608P_GO_09	Coal	35.5	36.5	1.0	1.0	9.40	790	0.07		19.8	2.1	-17.7	9.2	Non-Acid Forming (barren)
41	2022005_0040	EB2340155010	R9608P_GO_10	Parting	37.0	38.0	1.0	1.0	9.20	589	0.06		13.8	1.8	-12.0	7.5	Non-Acid Forming (barren)
42	2022005_0042	EB2340155011	R9608P_GO_12	Coal	38.5	39.5	1.0	1.0	9.70	697	0.03		16.6	0.9	-15.7	18.1	Non-Acid Forming (barren)
43	2022005_0043	EB2340155012	R9608P_GO_13	Parting	40.8	41.8	1.0	1.0	9.30	492	0.10		20.4	3.1	-17.3	6.7	Non-Acid Forming (barren)
44	2022005_0044	EB2340155013	R9608P_GO_14	Coal	42.5	43.5	1.0	1.0	9.60	432	0.03		14.1	0.9	-13.2	15.3	Non-Acid Forming (barren)
45	2022005_0045	EB2340155014	R9608P_GO_15	Coal	44.4	45.4	1.0	1.0	8.10	956	0.14	0.016	20.2	0.5	-19.7	41.2	Non-Acid Forming (barren)
46	2022005_0046	EB2340155015	R9608P_GO_16	Coal	46.3	47.3	1.0	1.0	8.70	775	0.15	0.020	16.3	0.6	-15.7	26.6	Non-Acid Forming (barren)

Table B1: Acid Base Account Results for mine materials from the Wandoan Coal Project

Sample No.	RGS Sample ID	ALS Lab ID	Client Sample ID	Sample Type	From	To	Interval	Depth	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)					(µS/cm)	(%)		(kg H_2SO_4/t)				
47	2022005_0047	EB2340155016	R9608P_GO_17	Coal	47.3	48.3	1.0	1.0	9.80	949	0.06		17.9	1.8	-16.1	9.7	Non-Acid Forming (barren)
48	2022005_0048	EB2340155017	R9608P_GO_18	Coal	48.3	49.3	1.0	1.0	9.10	692	0.10		14.9	3.1	-11.8	4.9	Non-Acid Forming (barren)
49	2022005_0041	EB2340155018	R9608P_GO_11	Basement	52.3	53.3	1.0	1.0	8.90	1,430	0.10		16.1	3.1	-13.0	5.3	Non-Acid Forming (barren)
50	2022005_0049	EB2340155019	R9608P_GO_19	Basement	55.3	56.3	1.0	1.0	9.60	973	0.04		16.1	1.2	-14.9	13.1	Non-Acid Forming (barren)
51	2022005_0050	EB2340155020	R9608P_GO_20	Basement	58.3	59.3	1.0	1.0	9.80	489	0.02		14.2	0.6	-13.6	23.2	Non-Acid Forming (barren)
52	2022005_0051	EB2340155021	C9605GP_GC_01	Overburden	0.8	1.3	0.5	0.5	8.50	1,030	0.03		10.3	0.9	-9.4	11.2	Non-Acid Forming (barren)
53	2022005_0052	EB2340155022	C9605GP_GC_02	Overburden	2.0	2.4	0.4	0.4	7.10	722	0.02		10.0	0.6	-9.4	16.3	Non-Acid Forming (barren)
54	2022005_0053	EB2340155023	C9605GP_GC_03	Overburden	7.0	7.3	0.4	0.4	7.90	781	0.02		8.6	0.6	-8.0	14.0	Non-Acid Forming (barren)
55	2022005_0054	EB2340155024	C9605GP_GC_04	Overburden	11.0	11.4	0.4	0.4	9.20	1,040	0.02		179.0	0.6	-178.4	292.2	Non-Acid Forming (barren)
56	2022005_0055	EB2340155025	C9605GP_GC_05	Overburden	14.0	14.3	0.3	0.3	8.20	580	0.03		8.5	0.9	-7.6	9.3	Non-Acid Forming (barren)
57	2022005_0057	EB2340155027	C9605GP_GC_07	Overburden	20.0	20.4	0.4	0.4	9.00	393	0.03		13.0	0.9	-12.1	14.1	Non-Acid Forming (barren)
58	2022005_0058	EB2340155028	C9605GP_GC_08	Roof	21.9	22.4	0.5	0.5	9.00	341	0.03		14.2	0.9	-13.3	15.5	Non-Acid Forming (barren)
59	2022005_0059	EB2340155029	C9605GP_GC_09	Interburden	26.0	26.4	0.4	0.4	8.90	515	0.02		19.9	0.6	-19.3	32.5	Non-Acid Forming (barren)
60	2022005_0060	EB2340155030	C9605GP_GC_10	Interburden	26.7	27.0	0.3	0.3	8.70	358	0.04		10.6	1.2	-9.4	8.7	Non-Acid Forming (barren)
61	2022005_0061	EB2340155031	C9605GP_GC_11	Roof	27.0	27.4	0.4	0.4	8.60	357	0.04		7.8	1.2	-6.6	6.4	Non-Acid Forming (barren)
62	2022005_0062	EB2340155032	C9605GP_GC_12	Parting	28.5	28.6	0.2	0.2	9.10	580	0.03		11.2	0.9	-10.3	12.2	Non-Acid Forming (barren)
63	2022005_0063	EB2340155033	C9605GP_GC_13	Parting	34.8	35.2	0.4	0.4	9.40	596	0.04		7.5	1.2	-6.3	6.1	Non-Acid Forming (barren)
64	2022005_0064	EB2340155034	C9605GP_GC_14	Roof	36.4	37.0	0.6	0.6	9.80	795	0.02		206.0	0.6	-205.4	336.3	Non-Acid Forming (barren)
65	2022005_0065	EB2340155035	C9605GP_GC_15	Parting	40.6	41.0	0.4	0.4	9.20	391	0.03		6.7	0.9	-5.8	7.3	Non-Acid Forming (barren)
66	2022005_0066	EB2340155036	C9605GP_GC_16	Parting	41.0	41.3	0.3	0.3	8.60	338	0.07		8.3	2.1	-6.2	3.9	Non-Acid Forming (barren)
67	2022005_0067	EB2340155037	C6906GP_GC_01	Overburden	0.3	0.6	0.3	0.3	8.70	599	0.02		24.2	0.6	-23.6	39.5	Non-Acid Forming (barren)
68	2022005_0068	EB2340155038	C6906GP_GC_02	Overburden	3.2	3.5	0.3	0.3	5.00	506	0.02		2.7	0.6	-2.1	4.4	Non-Acid Forming (barren)
69	2022005_0069	EB2340155039	C6906GP_GC_03	Overburden	8.0	8.4	0.5	0.5	8.60	751	0.02		9.6	0.6	-9.0	15.7	Non-Acid Forming (barren)
70	2022005_0070	EB2340155040	C6906GP_GC_04	Overburden	11.3	11.6	0.3	0.3	8.90	620	0.03		34.1	0.9	-33.2	37.1	Non-Acid Forming (barren)
71	2022005_0071	EB2340155041	C6906GP_GC_05	Overburden	13.0	13.3	0.3	0.3	9.00	591	0.04		59.8	1.2	-58.6	48.8	Non-Acid Forming (barren)
72	2022005_0072	EB2340155042	C6906GP_GC_06	Overburden	14.4	14.6	0.2	0.2	8.00	502	0.02		9.3	0.6	-8.7	15.2	Non-Acid Forming (barren)
73	2022005_0073	EB2340155043	C6906GP_GC_07	Coal	15.9	16.1	0.2	0.2	8.10	564	0.10		12.0	3.1	-8.9	3.9	Non-Acid Forming (barren)
74	2022005_0074	EB2340155044	C6906GP_GC_08	Coal	20.5	20.6	0.1	0.1	8.50	914	0.05		7.7	1.5	-6.2	5.0	Non-Acid Forming (barren)
75	2022005_0075	EB2340155045	C6906GP_GC_09	Coal	23.0	23.1	0.1	0.1	9.00	472	0.03		10.4	0.9	-9.5	11.3	Non-Acid Forming (barren)
76	2022005_0076	EB2340155046	C6906GP_GC_10	Roof	24.0	24.5	0.6	0.6	9.50	744	0.04		9.5	1.2	-8.3	7.8	Non-Acid Forming (barren)
77	2022005_0077	EB2340155047	C6906GP_GC_11	Coal	28.0	28.7	0.7	0.7	9.40	780	0.05		21.6	1.5	-20.1	14.1	Non-Acid Forming (barren)
78	2022005_0078	EB2340155048	C6906GP_GC_12	Parting	29.5	29.8	0.3	0.3	9.50	429	0.03		13.0	0.9	-12.1	14.1	Non-Acid Forming (barren)
79	2022005_0079	EB2340155049	C6906GP_GC_13	Floor	30.7	31.0	0.3	0.3	9.40	475	0.02		5.6	0.6	-5.0	9.1	Non-Acid Forming (barren)
80	2022005_0080	EB2340155050	C6906GP_GC_14	Roof	32.1	32.5	0.5	0.5	9.50	463	0.04		9.9	1.2	-8.7	8.1	Non-Acid Forming (barren)
81	2022005_0081	EB2340155051	C6906GP_GC_15	Parting	34.1	34.4	0.4	0.4	9.60	723	0.04		14.6	1.2	-13.4	11.9	Non-Acid Forming (barren)
82	2022005_0082	EB2340155052	C6906GP_GC_16	Floor	35.7	36.0	0.3	0.3	9.60	466	0.02		9.6	0.6	-9.0	15.7	Non-Acid Forming (barren)
83	2022005_0083	EB2340155053	C9605GP_SP_01	Coal	22.4	22.6	0.2	0.2	8.10	345	0.18	0.018	17.1	0.6	-16.5	31.0	Non-Acid Forming (barren)
84	2022005_0084	EB2340155054	C9605GP_SP_02	Coal	34.6	34.8	0.2	0.2	8.50	502	0.13	0.011	13.7	0.3	-13.4	40.7	Non-Acid Forming (barren)
85	2022005_0085	EB2340155055	C9605GP_SP_03	Coal	35.2	35.4	0.2	0.2	8.50	439	0.16	0.019	13.0	0.6	-12.4	22.3	Non-Acid Forming (barren)
86	2022005_0086	EB2340155056	C9605GP_SP_04	Coal	38.3	38.5	0.2	0.2	8.00	357	0.16	0.012	19.4	0.4	-19.0	52.8	Non-Acid Forming (barren)
87	2022005_0087	EB2340155057	C9605GP_SP_05	Coal	41.9	42.2	0.3	0.3	8.40	369	0.25	0.012	19.4	0.4	-19.0	52.8	Non-Acid Forming (barren)
88	2022005_0088	EB2340155058	C9606GP_SP_01	Coal	30.1	30.3	0.2	0.2	7.90	444	0.27	0.022	16.5	0.7	-15.8	24.5	Non-Acid Forming (barren)
89	2022005_0089	EB2340155059	C9606GP_SP_04	Coal	35.3	35.5	0.1	0.1	8.30	641	0.22	0.013	20.8	0.4	-20.4	52.2	Non-Acid Forming (barren)
90	2022005_0090	EB2402727001		Overburden	6.1	6.3	0.3	0.3	9.20	761	0.02		15.9	0.6	-15.3	26.0	Non-Acid Forming (barren)
91	2022005_0091	EB2402727002	C9610GP_GC_01	Overburden	11.3	11.6	0.3	0.3	8.30	416	0.07		8.7	2.1	-6.6	4.1	Non-Acid Forming (barren)

Table B1: Acid Base Account Results for mine materials from the Wandoan Coal Project

Sample No.	RGS Sample ID	ALS Lab ID	Client Sample ID	Sample Type	From	To	Interval	Depth	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)					(µS/cm)	(%)		(kg H_2SO_4/t)				
92	2022005_0092	EB2402727003	C9610GP_GC_02	Overburden	14.1	14.5	0.4	0.4	9.40	394	0.03		9.1	0.9	-8.2	9.9	Non-Acid Forming (barren)
93	2022005_0093	EB2402727004		Overburden	16.5	16.8	0.3	0.3	9.10	346	0.05		8.0	1.5	-6.5	5.2	Non-Acid Forming (barren)
94	2022005_0094	EB2402727005	C9610GP_GC_03	Coal	17.5	17.6	0.1	0.1	7.90	582	0.27	0.089	8.2	2.7	-5.5	3.0	Non-Acid Forming (barren)
95	2022005_0095	EB2402727006	C9610GP_GC_04	Parting	18.0	19.3	1.3	1.3	9.40	636	0.04		16.2	1.2	-15.0	13.2	Non-Acid Forming (barren)
96	2022005_0096	EB2402727007	C9610GP_GC_05	Parting	21.5	21.8	0.3	0.3	8.60	598	0.10		12.1	3.1	-9.0	4.0	Non-Acid Forming (barren)
97	2022005_0097	EB2402727008	C9610GP_GC_06	Parting	24.4	24.6	0.2	0.2	9.00	769	0.10		24.6	3.1	-21.5	8.0	Non-Acid Forming (barren)
98	2022005_0098	EB2402727009	C9610GP_GC_07	Floor	28.1	28.5	0.4	0.4	8.80	555	0.07		7.2	2.1	-5.1	3.4	Non-Acid Forming (barren)
99	2022005_0099	EB2402727010	C9610GP_GC_08	Interburden	29.5	29.9	0.3	0.3	10.10	1,070	0.03		16.9	0.9	-16.0	18.4	Non-Acid Forming (barren)
100	2022005_0100	EB2402727011	C9610GP_GC_09	Interburden	32.1	32.5	0.4	0.4	9.60	708	0.04		15.8	1.2	-14.6	12.9	Non-Acid Forming (barren)
101	2022005_0101	EB2402727012	C9610GP_GC_10	Interburden	35.6	35.9	0.3	0.3	9.50	592	0.04		16.3	1.2	-15.1	13.3	Non-Acid Forming (barren)
102	2022005_0102	EB2402727013	C9610GP_GC_11	Roof	36.3	36.7	0.4	0.4	9.80	755	0.04		18.4	1.2	-17.2	15.0	Non-Acid Forming (barren)
103	2022005_0103	EB2402727014	C9610GP_GC_12	Parting	38.6	38.9	0.3	0.3	9.70	710	0.03		80.2	0.9	-79.3	87.3	Non-Acid Forming (barren)
104	2022005_0104	EB2402727015	C9610GP_GC_13	Parting	39.6	39.8	0.2	0.2	10.70	1,820	0.03		144.0	0.9	-143.1	156.7	Non-Acid Forming (barren)
105	2022005_0105	EB2402727016	C9610GP_GC_14	Parting	41.2	41.8	0.6	0.6	9.60	315	0.02		8.6	0.6	-8.0	14.0	Non-Acid Forming (barren)
106	2022005_0106	EB2402727017	C9610GP_GC_15	Parting	42.6	43.0	0.4	0.4	9.60	639	0.05		8.5	1.5	-7.0	5.6	Non-Acid Forming (barren)
107	2022005_0107	EB2402727018	C9610GP_GC_16	Parting	44.3	44.5	0.2	0.2	9.10	390	0.07		12.2	2.1	-10.1	5.7	Non-Acid Forming (barren)
108	2022005_0108	EB2402727019	C9610GP_GC_17	Parting	45.0	45.3	0.3	0.3	9.30	590	0.05		10.6	1.5	-9.1	6.9	Non-Acid Forming (barren)
109	2022005_0109	EB2402727020	C9610GP_GC_18	Parting	45.6	45.9	0.3	0.3	9.80	558	0.03		15.8	0.9	-14.9	17.2	Non-Acid Forming (barren)
110	2022005_0110	EB2402727021	C9610GP_GC_19	Coal	46.1	46.5	0.4	0.4	8.60	249	0.16	0.006	11.2	0.2	-11.0	61.0	Non-Acid Forming (barren)
111	2022005_0114	EB2402727025	C9610GP_GC_20	Roof	23.1	23.3	0.2	0.2	8.60	386	0.05		8.8	1.5	-7.3	5.7	Non-Acid Forming (barren)
112	2022005_0115	EB2402727026	C9610GP_GC_21	Floor	37.6	37.7	0.2	0.2	9.00	436	0.04		4.7	1.2	-3.5	3.8	Non-Acid Forming (barren)
113	2022005_0116	EB2402727027	L9611_GC_01	Parting	40.2	40.2	0.0	0.0	9.70	685	0.03		66.5	0.9	-65.6	72.4	Non-Acid Forming (barren)
114	2022005_0117	EB2402727028	L9611_GC_02	Parting	43.6	43.8	0.2	0.2	9.20	342	0.04		6.5	1.2	-5.3	5.3	Non-Acid Forming (barren)
115	2022005_0118	EB2402727029	L9611_GC_03	Floor	45.2	45.3	0.1	0.1	8.70	368	0.13	0.006	8.5	0.2	-8.3	46.3	Non-Acid Forming (barren)
116	2022005_0119	EB2402727030	L9611_GC_04	Overburden	6.8	7.0	0.3	0.3	7.90	517	0.05		5.2	1.5	-3.7	3.4	Non-Acid Forming (barren)
117	2022005_0120	EB2402727031	L9611_GC_05	Roof	8.3	8.5	0.3	0.3	7.90	522	0.12	0.053	5.4	1.6	-3.8	3.3	Non-Acid Forming (barren)
118	2022005_0121	EB2402727032	L9612_GC_01	Parting	10.5	10.7	0.2	0.2	9.30	359	0.09		8.3	2.8	-5.5	3.0	Non-Acid Forming (barren)
119	2022005_0122	EB2402727033	L9612_GC_02	Parting	21.8	22.0	0.2	0.2	9.10	369	0.06		8.6	1.8	-6.8	4.7	Non-Acid Forming (barren)
120	2022005_0123	EB2402727034	L9612_GC_03	Parting	23.6	23.8	0.2	0.2	9.60	574	0.04		7.4	1.2	-6.2	6.0	Non-Acid Forming (barren)
121	2022005_0124	EB2402727035	L9612_GC_04	Floor	24.1	24.3	0.1	0.1	9.80	890	0.04		84.9	1.2	-83.7	69.3	Non-Acid Forming (barren)
122	2022005_0125	EB2402727036	L9612_GC_05	Parting	27.9	28.1	0.2	0.2	9.70	641	0.03		9.5	0.9	-8.6	10.3	Non-Acid Forming (barren)
123	2022005_0126	EB2402727037	L9612_GC_06	Parting	29.4	29.6	0.2	0.2	9.80	545	0.03		8.5	0.9	-7.6	9.3	Non-Acid Forming (barren)
124	2022005_0127	EB2402727038	L9612_GC_07	Parting	31.6	31.8	0.2	0.2	9.20	616	0.08		8.2	2.5	-5.8	3.3	Non-Acid Forming (barren)
125	2022005_0128	EB2402727039	L9612_GC_08	Parting	34.3	34.5	0.2	0.2	9.60	546	0.05		12.0	1.5	-10.5	7.8	Non-Acid Forming (barren)
126	2022005_0129	EB2402727040	L9612_GC_09	Floor	36.1	36.3	0.2	0.2	9.10	290	0.09		10.5	2.8	-7.7	3.8	Non-Acid Forming (barren)
127	2022005_0111	EB2402727042	L9612_GC_10	Coal	20.1	20.3	0.2	0.2	7.90	627	0.29	0.016	15.3	8.9	-6.4	31.2	Non-Acid Forming (barren)
128	2022005_0112	EB2402727043	L9612_GC_11	Coal	23.2	23.4	0.2	0.2	8.10	429	0.20	0.009	22.4	6.1	-16.3	81.3	Non-Acid Forming (barren)
129	2022005_0113	EB2402727044	C9610GP_SP_01	Coal	38.6	38.6	0.0	0.0	8.10	221	0.22	<0.005	9.5	0.1	-9.4	124.1	Non-Acid Forming (barren)
130	2022005_0130	EB2403811001	C9610GP_SP_02	Overburden	18.0	19.6	1.6	1.6	9.80	441	0.02		9.0	0.6	-8.4	14.7	Non-Acid Forming (barren)
131	2022005_0131	EB2403811002	L9614_GC_02	Parting	19.6	21.0	1.4	1.4	9.30	488	0.04		9.4	1.2	-8.2	7.7	Non-Acid Forming (barren)
132	2022005_0132	EB2403811003	L9614_GC_03	Parting/Coal	21.0	23.9	2.9	2.9	9.70	453	0.02		10.7	0.6	-10.1	17.5	Non-Acid Forming (barren)
133	2022005_0133	EB2403811004	L9614_GC_04	Parting	23.9	26.2	2.3	2.3	9.90	843	0.02		12.6	0.6	-12.0	20.6	Non-Acid Forming (barren)
134	2022005_0134	EB2403811005	L9614_GC_05	Parting	26.2	27.0	0.8	0.8	10.00	475	0.01		15.7	0.3	-15.4	51.3	Non-Acid Forming (barren)
135	2022005_0135	EB2403811006	L9614_GC_06	Parting	27.0	30.0	3.0	3.0	10.00	1,060	0.02		14.7	0.6	-14.1	24.0	Non-Acid Forming (barren)
136	2022005_0136	EB2403811007	L9614_GC_07	Parting	30.0	33.0	3.0	3.0	9.80	383	0.01		5.4	0.3	-5.1	17.6	Non-Acid Forming (barren)

Table B1: Acid Base Account Results for mine materials from the Wandoan Coal Project

Sample No.	RGS Sample ID	ALS Lab ID	Client Sample ID	Sample Type	From	To	Interval	Depth	pH (1:5)	EC (1:5)	Total S	Scr	ANC[2]	MPA[2]	NAPP[2]	ANC: MPA Ratio	Sample Classification[3]
					(m)					(µS/cm)	(%)		(kg H_2SO_4/t)				
137	2022005_0137	EB2403811008	L9614_GC_08	Parting	33.0	36.0	3.0	3.0	10.00	807	0.02		14.0	0.6	-13.4	22.9	Non-Acid Forming (barren)
138	2022005_0138	EB2404828001	L9614_GC_09	Parting	48.0	48.4	0.4	0.4	9.80	697	0.05		13.1	1.5	-11.6	8.6	Non-Acid Forming (barren)
139	2022005_0139	EB2404828002	L9614_GC_10	Coal	48.4	48.5	0.1	0.1	8.90	206	0.32	0.011	10.3	0.3	-10.0	30.6	Non-Acid Forming (barren)
140	2022005_0140	EB2404828003	L9614_GC_12	Parting	51.7	51.9	0.2	0.2	10.00	630	0.02		281.0	0.6	-280.4	458.8	Non-Acid Forming (barren)
141	2022005_0141	EB2404828004	L9614_GC_13	Parting	54.9	55.2	0.2	0.2	9.40	366	0.09		11.8	2.8	-9.0	4.3	Non-Acid Forming (barren)
142	2022005_0142	EB2404828005	L9614_GC_14	Coal	65.9	66.1	0.2	0.2	8.60	558	0.27	0.006	81.0	0.2	-80.8	440.8	Non-Acid Forming (barren)

Notes:

1. Current pH and EC results provided for 1:5 sample:water extracts
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential
3. Sample classification criteria detail provided in report text.

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

Table B2: Multi-element results for mine materials from the Wandoan Coal Project

	RGS Sample Number →		2022005_001	2022005_002	2022005_003	2022005_004	2022005_C03	2022005_C04	2022005_C05	2022005_C06	2022005_C07	2022005_C08
	Sampling Date →		27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022
	ALS Laboratory ID →		EB2215308001	EB2215308002	EB2215308003	EB2215308004	EB2215308005	EB2215308006	EB2215308007	EB2215308008	EB2215308009	EB2215308010
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Topsoil (0-0.6 m)_1	Topsoil (0-0.6 m)_2	Subsoil (0.6-1.6 m)_1	Subsoil (0.6-1.6 m)_2	Overburden (1.6-2.2 m)	Poor Quality Coal (WS1A)_1	Poor Quality Coal (WS1A)_2	Poor Quality Coal (WS1A)_3	Coal (WS1B)_1	Coal (WS1B)_2
pH	0.1	-	8.80	8.80	8.90	9.00	9.10	6.20	6.20	5.60	7.60	7.60
Electrical Conductivity	1	-	374	349	743	674	605	703	775	747	538	479
Major Cations	All units mg/kg		All units mg/kg									
Calcium (Ca)	50	-	17,700	25,500	26,400	31,800	9,600	10,700	12,400	10,900	10,600	10,600
Magnesium (Mg)	50	-	4,320	4,800	5,200	5,780	3,620	2,000	1,860	2,120	1,420	1,390
Potassium (K)	50	-	890	860	790	910	940	440	590	480	190	200
Sodium (Na)	50	-	1,100	1,180	1,910	2,050	1,610	2,610	1,990	3,030	1,250	1,270
Aluminium (Al)	50	-	10,800	10,600	8,910	10,500	6,570	3,530	2,630	4,040	1,170	1,200
Iron (Fe)	50	-	24,300	24,000	26,400	28,500	16,200	3,030	2,190	3,010	2,460	2,180
Minor and Trace Elements	All units mg/kg		All units mg/kg									
Arsenic (As)	5	300	2.8	2.6	2.6	2.8	2.2	1.4	1.4	1.6	1.5	1.4
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium (Ba)	10	-	225	231	211	213	120	145	166	166	181	181
Beryllium (Be)	1	90	0.8	0.8	0.9	0.9	0.5	0.4	0.4	0.5	0.4	0.4
Cadmium (Cd)	1	90	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt (Co)	2	300	9	8	15	15	10	3	2	4	2	2
Chromium (Cr) **	2	300	10	10	9	10	8	2	2	2	1	2
Copper (Cu)	5	17,000	17	17	19	21	19	13	14	12	9	9
Mercury (Hg)	0.1	80	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese (Mn)	5	19,000	434	423	481	531	427	68	60	58	26	27
Molybdenum (Mo)	2	-	0.2	0.2	0.3	0.3	0.2	0.4	0.4	0.4	0.3	0.4
Nickel (Ni)	2	1,200	11	12	12	13	12	2	2	2	2	2
Lead (Pb)	5	600	12	12	13	15	12	9	9	9	8	8
Antimony (Sb)	5	-	0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	0.2	<0.1	<0.1
Selenium (Se)	5	700	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thorium (Th)	0.1	-	2.4	2.4	3.1	3.2	3.9	1.8	1.9	1.9	1.1	1.0
Uranium (U)	0.1	-	0.3	0.3	0.5	0.5	1.1	0.5	0.5	0.6	0.4	0.5
Vanadium (V)	5	-	41	40	35	39	23	22	31	26	19	19
Zinc (Zn)	5	30,000	39	40	47	50	58	11	7	12	5	4
Exchangeable Cations		-	All units meq/100g (except Exchangable Sodium Percentage (%))									
Exchangeable Calcium	0.2	-	9.8	9.6	4.5	7.0	2.5					
Exchangeable Magnesium	0.2	-	5.0	3.5	4.2	6.0	5.0					
Exchangeable Potassium	0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2					
Exchangeable Sodium	0.2	-	3.2	1.9	3.1	4.7	3.8					
Cation Exchange Capacity	0.2	-	18	14.9	11.8	17.7	11.2					
Exchangeable Sodium Percent	0.2%	-	17.7	12.7	26.1	26.6	33.8					
Calcium/Magnesium Ratio	0.2	-	1.9	2.8	1.1	1.2	0.5					
	All units mg/kg		All units mg/kg									
Bicarbonate Extractable K (Colwell)	100	-	130	117	128	122						
Bicarbonate Ext. P (Colwell)	5	-	<5	<5	<5	<5						
Chloride	10	-	150	20	680	570						
DTPA Extractable Metals	All units mg/kg		All units mg/kg									
Copper	1.00	-	<1.00	<1.00	<1.00	<1.00						
Iron	1.00	-	9.10	8.37	6.70	6.48						
Manganese	1.00	-	3.24	3.70	4.06	4.46						
Zinc	1.00	-	<1.00	<1.00	<1.00	<1.00						
Soil Nutrients	All units mg/kg		All units mg/kg									
Ammonia as N	20	-	<20	<20	<20	<20						
Nitrite as N (Sol.)	0.1	-	<0.1	0.2	<0.1	<0.1						
Nitrate as N (Sol.)	0.1	-	2.1	1.3	2.1	0.5						
Nitrite + Nitrate as N (Sol.)	0.1	-	2.1	1.5	2.1	0.5						
Total Kjeldahl Nitrogen as N	20	-	730	800	530	570						
Total Nitrogen as N	20	-	730	800	530	570						
Total Phosphorus as P	2	-	161	135	145	127						
Organic Matter	Units as shown		Units as shown									
Organic Matter	0.5%	-	1.6	1.6	1.0	1.2						
Total Organic Carbon	0.5%	-	1.0	0.9	0.5	0.7						
Emerson Class	-	-										
Emerson Class	-	-	2	2	2	2	1	2				

Notes:

< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). See main report for detailed reference.

Table B2: Multi-element results for mine materials from the Wandoan Coal Project

	RGS Sample Number →		2022005_C09	2022005_C10	2022005_020	2022005_C13	2022005_C14	2022005_C15	2022005_C16	2022005_C17	2022005_C18	2022005_C19
	Sampling Date →		27/05/2022	27/05/2022	18/08/2022	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024
	ALS Laboratory ID →		EB2215308011	EB2215308012	EB2225688001	EB2405781008	EB2405781009	EB2405781010	EB2405781011	EB2405781012	EB2405781013	EB2405781014
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Interburden_1	Coal Reject	Tailings	Coal Macalister Lower	Potential Coal Reject Macalister Lower	Coal Wambo	Potential Reject Wambo	Overburden Austinvale	Overburden Leichhardt	Overburden Wooleebee
pH	0.1	-	9.30	7.30	6.80	8.00	8.30	8.40	8.80	8.20	8.80	8.90
Electrical Conductivity	1	-	245	821	65	503	656	442	992	710	576	926
Major Cations	All units mg/kg		All units mg/kg									
Calcium (Ca)	50	-	960	8,060	5,260	4,010	4,560	2,660	3,410	4,130	3,790	20,000
Magnesium (Mg)	50	-	1,480	1,990	850	560	780	1,290	2,530	3,430	2,930	2,190
Potassium (K)	50	-	840	710	200	150	580	440	800	860	480	720
Sodium (Na)	50	-	1,560	1,390	80	2,040	2,160	2,120	3,600	1,210	3,200	2,870
Aluminium (Al)	50	-	2,140	2,790	1,490	1,090	2,200	3,550	6,910	7,020	5,840	5,450
Iron (Fe)	50	-	1,590	2,420	97,400	1,990	1,070	4,500	11,400	22,000	7,340	9,230
Minor and Trace Elements	All units mg/kg		All units mg/kg									
Arsenic (As)	5	300	1.9	1.2	2.9	1.2	1.7	1.1	2.7	2.8	1.6	4.6
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium (Ba)	10	-	18	54	141	136	116	126	130	25.5	19.8	51.1
Beryllium (Be)	1	90	<0.1	0.2	1.8	1	1.6	1.4	0.8	0.4	0.5	0.7
Cadmium (Cd)	1	90	0.3	0.1	0.3	<0.1	0.2	<0.1	0.1	<0.1	<0.1	<0.1
Cobalt (Co)	2	300	4	1	7	2.6	4.3	3.1	11.3	7.7	3.3	15.6
Chromium (Cr) **	2	300	1	1	22	6.2	3.4	6.4	5.4	6.7	3.1	3.7
Copper (Cu)	5	17,000	38	22	18	8.7	15.3	18.3	24.3	19.6	8.3	18.2
Mercury (Hg)	0.1	80	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese (Mn)	5	19,000	12	53	689	36.7	5.6	56	137	242	78	784
Molybdenum (Mo)	2	-	0.6	0.4	1.4	0.5	1.8	0.3	0.5	0.4	<0.1	0.2
Nickel (Ni)	2	1,200	4	1	16	1.8	4.3	3.2	9.2	9.4	5.6	10.5
Lead (Pb)	5	600	18	9	17	10.4	11.2	12.3	11.6	10.1	9.2	12.8
Antimony (Sb)	5	-	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium (Se)	5	700	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thorium (Th)	0.1	-	3.2	3.0	1.2	1.5	1.8	2.8	2.6	3.4	2.1	3.1
Uranium (U)	0.1	-	0.5	0.5	0.8	0.4	0.4	0.7	0.4	0.4	0.3	0.4
Vanadium (V)	5	-	7	12	40	88	24	91	29	22	13	40
Zinc (Zn)	5	30,000	45	14	147	46.7	34.1	20.8	63	59.7	49.2	45
Exchangeable Cations		-	All units meq/100g (except Exchangable Sodium Percentage (%))									
Exchangeable Calcium	0.2	-										
Exchangeable Magnesium	0.2	-										
Exchangeable Potassium	0.2	-										
Exchangeable Sodium	0.2	-										
Cation Exchange Capacity	0.2	-										
Exchangeable Sodium Percent	0.2%	-										
Calcium/Magnesium Ratio	0.2	-										
	All units mg/kg		All units mg/kg									
Bicarbonate Extractable K (Colwell)	100	-										
Bicarbonate Ext. P (Colwell)	5	-										
Chloride	10	-										
DTPA Extractable Metals	All units mg/kg											
Copper	1.00	-										
Iron	1.00	-										
Manganese	1.00	-										
Zinc	1.00	-										
Soil Nutrients	All units mg/kg		All units mg/kg									
Ammonia as N	20	-										
Nitrite as N (Sol.)	0.1	-										
Nitrate as N (Sol.)	0.1	-										
Nitrite + Nitrate as N (Sol.)	0.1	-										
Total Kjeldahl Nitrogen as N	20	-										
Total Nitrogen as N	20	-										
Total Phosphorus as P	2	-										
Organic Matter	Units as shown		Units as shown									
Organic Matter	0.5%	-										
Total Organic Carbon	0.5%	-										
Emerson Class	-	-										
Emerson Class	-	-										

Notes:

< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). See main report for detailed reference.

Table B2: Multi-element results for mine materials from the Wandoan Coal Project

	RGS Sample Number →		2022005_C20	2022005_C21	2022005_C22	2022005_C23	2022005_C24	2022005_C25	2022005_C26	2022005_C27	2022005_C28
	Sampling Date →		16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	13/03/2024	13/03/2024	13/03/2024
	ALS Laboratory ID →		EB2405781015	EB2405781016	EB2405781017	EB2405781018	EB2405781019	EB2405781020	EB2408546001	EB2408546002	EB2408546003
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Interburden Leichhardt	Interburden Wooleebee	Parting Mcalister Upper	Parting Mcalister Lower	Parting Wambo	Basement	Parting Wambo	Coal Macalister Lower	Coal Wambo
pH	0.1	-	9.70	8.80	9.00	9.40	9.60	9.80	9.70	8.50	8.50
Electrical Conductivity	1	-	936	419	478	773	752	668	649	185	440
Major Cations	All units mg/kg		All units mg/kg								
Calcium (Ca)	50	-	5,440	1,730	1,570	1,390	2,480	2,490	53,700	2,340	28,800
Magnesium (Mg)	50	-	3,030	3,360	1,650	990	2,260	3,430	5,350	780	690
Potassium (K)	50	-	880	880	940	930	800	1,110	800	180	120
Sodium (Na)	50	-	4,650	1,500	2,540	2,790	3,390	3,120	2,160	2,580	1,840
Aluminium (Al)	50	-	7,550	7,260	4,360	3,390	5,860	9,080	6,690	1,510	830
Iron (Fe)	50	-	16,800	26,100	4,660	2,190	8,030	16,600	18,600	1,290	1,850
Minor and Trace Elements	All units mg/kg		All units mg/kg								
Arsenic (As)	5	300	4.1	2.2	1.8	1.3	2	3.6	<5	<5	<5
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium (Ba)	10	-	118	58.2	81.3	116	116	120	120	180	140
Beryllium (Be)	1	90	0.5	0.5	0.3	0.3	0.3	0.4	<1	6	2
Cadmium (Cd)	1	90	0.1	0.2	0.2	0.2	0.2	0.1	<1	<1	<1
Cobalt (Co)	2	300	7.6	11.1	2.9	2.3	5.1	5.2	4	14	5
Chromium (Cr) **	2	300	5.8	7.2	3.8	2.8	3.9	6.7	7	12	2
Copper (Cu)	5	17,000	20.4	25.4	27.2	28.9	28.5	26	31	23	10
Mercury (Hg)	0.1	80	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.20	<0.1
Manganese (Mn)	5	19,000	344	400	49	15	71.4	162	584	15	48
Molybdenum (Mo)	2	-	0.3	0.5	0.2	0.2	0.2	0.2	<2	<2	<2
Nickel (Ni)	2	1,200	9.9	13.1	4.3	2.9	5.4	6	5	9	6
Lead (Pb)	5	600	10.9	12.8	14.4	15.9	13.7	11.8	15	9	6
Antimony (Sb)	5	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	<5	<5
Selenium (Se)	5	700	<1	<1	<1	<1	<1	<1	<5	<5	<5
Thorium (Th)	0.1	-	2.9	3.7	3.9	3.9	3.4	3.2	3.6	0.9	0.6
Uranium (U)	0.1	-	0.4	0.4	0.5	0.6	0.5	0.4	0.4	0.5	0.7
Vanadium (V)	5	-	18	23	17	28	14	20	39	198	48
Zinc (Zn)	5	30,000	81.3	80.2	37.4	38.9	62.8	78.9	37	116	13
Exchangeable Cations		-	All units meq/100g (except Exchangable Sodium Percentage (%))								
Exchangeable Calcium	0.2	-									
Exchangeable Magnesium	0.2	-									
Exchangeable Potassium	0.2	-									
Exchangeable Sodium	0.2	-									
Cation Exchange Capacity	0.2	-									
Exchangeable Sodium Percent	0.2%	-									
Calcium/Magnesium Ratio	0.2	-									
	All units mg/kg		All units mg/kg								
Bicarbonate Extractable K (Colwell)	100	-									
Bicarbonate Ext. P (Colwell)	5	-									
Chloride	10	-									
DTPA Extractable Metals	All units mg/kg										
Copper	1.00	-									
Iron	1.00	-									
Manganese	1.00	-									
Zinc	1.00	-									
Soil Nutrients	All units mg/kg		All units mg/kg								
Ammonia as N	20	-									
Nitrite as N (Sol.)	0.1	-									
Nitrate as N (Sol.)	0.1	-									
Nitrite + Nitrate as N (Sol.)	0.1	-									
Total Kjeldahl Nitrogen as N	20	-									
Total Nitrogen as N	20	-									
Total Phosphorus as P	2	-									
Organic Matter	Units as shown										
Organic Matter	0.5%	-	Units as shown								
Total Organic Carbon	0.5%	-									
Emerson Class	-	-									
Emerson Class	-	-									

Notes:

< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.

1. NEPC (2013). See main report for detailed reference.

Table B3: Geochemical Abundance Index results for mine materials from the Wandoan Coal Project

Parameters	RGS Sample Number →		2022005_001	2022005_002	2022005_003	2022005_004	2022005_C03	2022005_C04	2022005_C05	2022005_C06	2022005_C07	2022005_C08
	Sampling Date →		27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022
	ALS Laboratory ID →		EB2215308001	EB2215308002	EB2215308003	EB2215308004	EB2215308005	EB2215308006	EB2215308007	EB2215308008	EB2215308009	EB2215308010
	Limit of Reporting	Median Crustal Abundance[1,2,3]	Topsoil (0-0.6 m)_1	Topsoil (0-0.6 m)_2	Subsoil (0.6-1.6 m)_1	Subsoil (0.6-1.6 m)_2	Overburden (1.6-2.2 m)	Poor Quality Coal (WS1A)_1	Poor Quality Coal (WS1A)_2	Poor Quality Coal (WS1A)_3	Coal (WS1B)_1	Coal (WS1B)_2
Major Cations	(All units in mg/kg)		Geochemical Abundance Index									
Calcium (Ca)	50	15,000	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index									
Arsenic (As)	5	6	0	0	0	0	0	0	0	0	0	0
Boron (B)	50	20	0	0	0	0	0	0	0	0	0	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3	1	1	1	1	0	0	0	0	0	0
Cadmium (Cd)	1	0.35	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	2	8	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	2	70	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	30	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	2	1.2	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	2	50	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	5	35	0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	5	1	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	5	0.4	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.1	9	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	5	90	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	5	90	0	0	0	0	0	0	0	0	0	0

Notes: GAI's greater than or equal to 3 are highlighted.

1. Median Crustal Abundance values from INAP, 2024.
2. Bowen (1979)
3. CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index results for mine materials from the Wandoan Coal Project

Parameters	RGS Sample Number →		2022005_C09	2022005_C10	2022005_020	2022005_C13	2022005_C14	2022005_C15	2022005_C16	2022005_C17	2022005_C18	2022005_C19
	Sampling Date →		27/05/2022	27/05/2022	18/08/2022	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024
	ALS Laboratory ID →		EB2215308011	EB2215308012	EB2225688001	EB2405781008	EB2405781009	EB2405781010	EB2405781011	EB2405781012	EB2405781013	EB2405781014
	Limit of Reporting	Median Crustal Abundance[1,2,3]	Interburden_1	Coal Reject	Tailings	Coal Macalister Lower	Potential Coal Reject Macalister Lower	Coal Wambo	Potential Reject Wambo	Overburden Austinvale	Overburden Leichhardt	Overburden Wooleebee
Major Cations	(All units in mg/kg)		Geochemical Abundance Index									
Calcium (Ca)	50	15,000	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	1	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index									
Arsenic (As)	5	6	0	0	0	0	0	0	0	0	0	0
Boron (B)	50	20	0	0	0	0	0	0	0	0	0	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3	0	0	2	1	2	2	1	0	0	1
Cadmium (Cd)	1	0.35	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	2	8	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	2	70	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	30	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	2	1.2	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	2	50	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	5	35	0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	5	1	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	5	0.4	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.1	9	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	5	90	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	5	90	0	0	0	0	0	0	0	0	0	0

Notes: GAI's greater than or equal to 3 are highlighted.

1. Median Crustal Abundance values from INAP, 2024.
2. Bowen (1979)
3. CRC Handbook of Chemistry and Physics (2000).

Table B3: Geochemical Abundance Index results for mine materials from the Wandoan Coal Project

Parameters	RGS Sample Number →		2022005_C20	2022005_C21	2022005_C22	2022005_C23	2022005_C24	2022005_C25	2022005_C26	2022005_C27	2022005_C28
	Sampling Date →		16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	13/03/2024	13/03/2024	13/03/2024
	ALS Laboratory ID →		EB2405781015	EB2405781016	EB2405781017	EB2405781018	EB2405781019	EB2405781020	EB2408546001	EB2408546002	EB2408546003
	Limit of Reporting	Median Crustal Abundance[1,2,3]	Interburden Leichhardt	Interburden Wooleebee	Parting Mcalister Upper	Parting Mcalister Lower	Parting Wambo	Basement	Parting Wambo	Coal Macalister Lower	Coal Wambo
Major Cations	(All units in mg/kg)		Geochemical Abundance Index								
Calcium (Ca)	50	15,000	0	0	0	0	0	0	1	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0
Minor and Trace Elements	(All units in mg/kg)		Geochemical Abundance Index								
Arsenic (As)	5	6	0	0	0	0	0	0	0	0	0
Boron (B)	50	20	0	0	0	0	0	0	0	0	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	0.3	0	0	0	0	0	0	0	4	2
Cadmium (Cd)	1	0.35	0	0	0	0	0	0	0	0	0
Cobalt (Co)	2	8	0	0	0	0	0	0	0	0	0
Chromium (Cr)	2	70	0	0	0	0	0	0	0	0	0
Copper (Cu)	5	30	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	1	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	2	1.2	0	0	0	0	0	0	0	0	0
Nickel (Ni)	2	50	0	0	0	0	0	0	0	0	0
Lead (Pb)	5	35	0	0	0	0	0	0	0	0	0
Antimony (Sb)	5	1	0	0	0	0	0	0	1	1	1
Selenium (Se)	5	0.4	0	0	0	0	0	0	2	2	2
Thorium (Th)	0.1	9	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0
Vanadium (V)	5	90	0	0	0	0	0	0	0	1	0
Zinc (Zn)	5	90	0	0	0	0	0	0	0	0	0

Notes: GAI's greater than or equal to 3 are highlighted.

1. Median Crustal Abundance values from INAP, 2024.
2. Bowen (1979)
3. CRC Handbook of Chemistry and Physics (2000).

Table B4: Multi-element test results for water extracts from mine materials from the Wandoan Coal Project

		RGS Sample Number →		2022005_001	2022005_002	2022005_003	2022005_004	2022005_C03	2022005_C04	2022005_C05	2022005_C06	2022005_C07	2022005_C08
		Sample Date →		27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022
		ALS Laboratory ID →		EB2215308001	EB2215308002	EB2215308003	EB2215308004	EB2215308005	EB2215308006	EB2215308007	EB2215308008	EB2215308009	EB2215308010
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Topsoil (0-0.6 m)_1	Topsoil (0-0.6 m)_2	Subsoil (0.6-1.6 m)_1	Subsoil (0.6-1.6 m)_2	Overburden (1.6-2.2 m)	Poor Quality Coal (WS1A)_1	Poor Quality Coal (WS1A)_2	Poor Quality Coal (WS1A)_3	Coal (WS1B)_1	Coal (WS1B)_2
pH	0.01 pH unit	6 to 9	-	8.8	8.8	8.9	9.0	9.1	6.2	6.2	5.6	7.6	7.6
Electrical Conductivity	1 µS/cm	<1,000#	-	374	349	743	674	605	703	775	747	538	479
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	64	43	160	220	125	<0.2	<0.2	<0.2	<0.2	<0.2
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,594	2,180	10,420	5,060	2,720	1,160	1,382	892	2,780	2,660
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,658	2,220	10,580	5,280	2,840	1,160	1,382	892	2,780	2,660
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	990	1,040	2,760	99	82
Net Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,658	2,220	10,580	5,280	2,840	170	342	-1,868	2,681	2,578
Major Ions		All units mg/L		All units mg/L									
Calcium (Ca)	2	-	1,000	4	4	4	4	<2	6	8	4	26	22
Magnesium (Mg)	2	-	-	<2	<2	2	<2	<2	2	4	2	14	12
Potassium (K)	2	-	-	<2	<2	<2	<2	<2	4	6	4	4	2
Sodium (Na)	2	-	-	84	80	142	134	124	164	172	160	110	106
Chloride (Cl)	2	-	-	16	6	126	100	76	34	50	62	2	2
Fluoride (F)	0.2	-	2	3.6	3.4	7.6	7.2	6.0	0.5	0.5	0.5	0.2	0.2
Sulfate (SO_4^{2-})	2	-	1,000	10	8	24	24	6	96	116	170	36	28
Silica (Si)	0.2	-	-	8	8	7	8	7	25	22	27	7	7
Reactive Phosphorus (P)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	0.05	<0.02	<0.02	<0.02
Trace Metals/Metalloids		All units mg/L		All units mg/L									
Aluminium (Al)	0.02	0.055	5	0.06	0.08	0.04	0.04	0.04	0.16	0.18	0.7	0.01	0.01
Arsenic (As)(III)	0.002	0.024	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.004	0.008	<0.002	<0.002
Boron (B)	0.2	0.37	5	0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.4	0.2	0.1
Barium (Ba)	0.002	-	-	0.008	0.008	0.012	0.008	0.002	0.006	0.01	0.008	0.092	0.11
Beryllium (Be)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
Chromium (Cr)	0.002	0.001 (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.002	0.0014	1	0.008	0.01	0.004	0.004	0.004	0.004	0.004	0.008	<0.002	<0.002
Iron (Fe)	0.02	-	-	0.2	0.2	<0.02	<0.02	<0.02	<0.02	<0.02	0.4	<0.02	<0.02
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese (Mn)	0.002	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.018	0.024	0.026	0.008	0.006
Molybdenum (Mo)	0.002	-	0.15	0.004	0.004	0.004	0.004	0.002	0.008	0.008	0.004	0.008	0.008
Nickel (Ni)	0.002	0.011	1	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002
Lead (Pb)	0.002	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.002	-	-	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.02	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Uranium (U)	0.002	-	0.1	<0.002	<0.002	<0.002	<0.002	0.012	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Zinc (Zn)	0.01	0.008	20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent.

for still water bodies only, moving rivers at low flow rates should not exceed 2,200 µS/cm.

ANZG (2018). 1. Trigger values for freshwater aquatic ecosystems (95% species protection level).

2. Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-element test results for water extracts from mine materials from the Wandoan Coal Project

		RGS Sample Number →		2022005_C09	2022005_C10	2022005_020	2022005_C13	2022005_C14	2022005_C15	2022005_C16	2022005_C17	2022005_C18	2022005_C19
		Sample Date →		27/05/2022	27/05/2022	18/08/2022	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024
		ALS Laboratory ID →		EB2215308011	EB2215308012	EB2225688001	EB2405781008	EB2405781009	EB2405781010	EB2405781011	EB2405781012	EB2405781013	EB2405781014
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Interburden_1	Coal Reject	Tailings	Coal Macalister Lower	Potential Coal Reject Macalister Lower	Coal Wambo	Potential Reject Wambo	Overburden Austinvale	Overburden Leichhardt	Overburden Wooleebee
pH	0.01 pH unit	6 to 9	-	9.3	7.3	6.8	8.0	8.3	8.4	8.8	8.2	8.8	8.9
Electrical Conductivity	1 µS/cm	<1,000#	-	245	821	65	503	656	442	992	710	576	926
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	71	<0.2	<0.2	<0.2	<0.2	<0.2	93	<0.2	16	47
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	410	2,040	702	1,012	2,080	708	1,090	1,106	530	6,840
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	482	2,040	702	1,012	2,080	708	1,184	1,106	544	6,900
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<0.2	82	50	37	12	11	<0.2	5	<0.2	<0.2
Net Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	482	1,958	652	975	2,068	697	1,184	1,101	544	6,900
Major Ions		All units mg/L		All units mg/L									
Calcium (Ca)	2	-	1,000	<2	28	6	2	4	<2	<2	6	<2	<2
Magnesium (Mg)	2	-	-	<2	16	<2	<2	<2	<2	<2	4	<2	<2
Potassium (K)	2	-	-	<2	12	<2	2	6	<2	4	8	<2	2
Sodium (Na)	2	-	-	48	156	6	162	182	126	204	140	96	182
Chloride (Cl)	2	-	-	6	24	<2	42	66	24	114	126	112	158
Fluoride (F)	0.2	-	2	1.4	0.2	0.8	0.4	0.6	0.6	0.8	0.4	0.8	1.6
Sulfate (SO_4^{2-})	2	-	1,000	24	42	12	2	4	<2	12	36	10	20
Silica (Si)	0.2	-	-	13	13	5	7	11	8	10	9	12	15
Reactive Phosphorus (P)	0.02	-	-	0.08	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trace Metals/Metalloids		All units mg/L		All units mg/L									
Aluminium (Al)	0.02	0.055	5	0.08	0.01	0.04	<0.02	<0.02	0.04	0.04	<0.02	0.02	<0.02
Arsenic (As)(III)	0.002	0.024	-	0.094	<0.002	<0.002	0.002	0.016	0.002	0.032	<0.002	0.024	0.016
Boron (B)	0.2	0.37	5	0.1	0.1	<0.2	0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.002	-	-	<0.002	0.024	0.018	0.026	0.04	0.008	0.012	0.004	<0.002	0.004
Beryllium (Be)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.002	0.001 (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.002	0.0014	1	<0.002	0.004	0.01	<0.002	<0.002	<0.002	<0.002	0.004	0.002	0.002
Iron (Fe)	0.02	-	-	<0.02	<0.02	0.4	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese (Mn)	0.002	1.9	-	<0.002	0.032	0.028	<0.002	<0.002	<0.002	<0.002	0.008	<0.002	0.004
Molybdenum (Mo)	0.002	-	0.15	0.108	0.05	<0.002	0.02	0.04	0.008	0.11	0.016	0.012	0.012
Nickel (Ni)	0.002	0.011	1	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
Lead (Pb)	0.002	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.02	0.011	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Uranium (U)	0.002	-	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.002	<0.002	0.004
Vanadium (V)	0.02	-	-	0.12	<0.02	<0.02	0.06	0.08	0.2	0.08	<0.02	0.06	0.24
Zinc (Zn)	0.01	0.008	20	<0.01	<0.01	0.022	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent.

for still water bodies only, moving rivers at low flow rates should not exceed 2,200 µS/cm.

ANZG (2018). 1. Trigger values for freshwater aquatic ecosystems (95% species protection level).

2. Recommended guideline limits for Livestock Drinking Water.

Table B4: Multi-element test results for water extracts from mine materials from the Wandoan Coal Project

		RGS Sample Number →		2022005_C20	2022005_C21	2022005_C22	2022005_C23	2022005_C24	2022005_C25	2022005_C26	2022005_C27	2022005_C28
		Sample Date →		16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	16/02/2024	13/03/2024	13/03/2024	13/03/2024
		ALS Laboratory ID →		EB2405781015	EB2405781016	EB2405781017	EB2405781018	EB2405781019	EB2405781020	EB2408546001	EB2408546002	EB2408546003
Parameters	**Limit of Reporting**	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Interburden Leichhardt	Interburden Wooleebee	Parting Mcalister Upper	Parting Mcalister Lower	Parting Wambo	Basement	Parting Wambo	Coal Macalister Lower	Coal Wambo
pH	0.01 pH unit	6 to 9	-	9.7	8.8	9.0	9.4	9.6	9.8	9.7	8.5	8.5
Electrical Conductivity	1 µS/cm	<1,000#	-	936	419	478	773	752	668	649	185	440
Carbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	436	31	31	187	296	156	506	16	34
Bicarbonate Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,416	670	622	1,962	1,806	840	7,580	654	9,920
Total Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,852	700	654	2,140	2,100	996	8,080	670	9,940
Acidity (mg $CaCO_3$/L)	1 mg/L	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Net Alkalinity (mg $CaCO_3$/L)	1 mg/L	-	-	1,852	700	654	2,140	2,100	996	8,080	670	9,940
Major Ions		All units mg/L										
Calcium (Ca)	2	-	1,000	<2	<2	<2	<2	<2	<2	<2	<2	<2
Magnesium (Mg)	2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2
Potassium (K)	2	-	-	2	2	2	4	2	2	<2	<2	2
Sodium (Na)	2	-	-	138	88	86	158	142	110	<2	<2	<2
Chloride (Cl)	2	-	-	28	78	72	60	40	38	30	30	52
Fluoride (F)	0.2	-	2	0.8	1.2	1.0	1.4	1.4	0.8	<0.2	<0.2	<0.2
Sulfate (SO_4^{2-})	2	-	1,000	12	10	18	6	6	8	<2	<2	<2
Silica (Si)	0.2	-	-	16	6	11	60	66	66	-	-	-
Reactive Phosphorus (P)	0.02	-	-	0	<0.02	0.04	0.3	0.4	0.5	0.2	<0.02	<0.02
Trace Metals/Metalloids		All units mg/L										
Aluminium (Al)	0.02	0.055	5	0.06	0.06	0.06	0.08	0.12	0.12	<0.02	<0.02	<0.02
Arsenic (As)(III)	0.002	0.024	-	0.27	0.034	0.05	0.054	0.086	0.186	0.04	0.04	<0.002
Boron (B)	0.2	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	0.2
Barium (Ba)	0.002	-	-	0.004	0.002	<0.002	0.01	0.008	0.004	<0.002	<0.002	<0.002
Beryllium (Be)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.002	0.001 (hex)*	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.002	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese (Mn)	0.002	1.9	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	0.002	-	0.15	0.054	0.068	0.036	0.032	0.04	0.03	<0.002	<0.002	<0.002
Nickel (Ni)	0.002	0.011	1	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	0.002	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	0.002	-	-	0.004	0.002	<0.002	<0.002	0.01	0.02	<0.002	<0.002	<0.002
Selenium (Se)	0.02	0.011	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Uranium (U)	0.002	-	0.1	0.004	<0.002	<0.002	0.02	0.02	0.01	<0.002	<0.002	<0.002
Vanadium (V)	0.02	-	-	0.14	0.04	0.16	0.26	0.24	0.16	0.42	0.32	0.04
Zinc (Zn)	0.01	0.008	20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: Shaded cells exceed applied guideline values. * Cr (VI) = hexavalent.

for still water bodies only, moving rivers at low flow rates should not exceed 2,200 µS/cm.

ANZG (2018). 1. Trigger values for freshwater aquatic ecosystems (95% species protection level).

2. Recommended guideline limits for Livestock Drinking Water.

Attachment C: KLC data and trends

KLC 1 Overburden

		Weight (kg)	2.00	Total S (%)	0.010	ANC	35.2		
		pH (1:5)	8.80	Scr (%)	0.010	NAPP	-34.9		
		EC (µS/cm)	638	MPA	0.31	ANC:MPA	114.9		
Date			02-Jun-22	30-Jun-22	28-Jul-22	26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22
Number of Weeks			0	4	8	12	16	20	24	28
Leach Number			1	2	3	4	5	6	7	8
ALS Laboratory Number			EB2215727001	EB2218970001	EB2222089001	EB2225164001	EB2227924001	EB2231031001	EB2234415001	EB2237794001
Volume On (L)			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)			0.394	0.682	0.781	0.741	0.739	0.815	0.781	0.817
Cum. Volume (L)			0.4	1.076	1.857	2.598	3.337	4.152	4.933	5.750
Pore Volumes	Water Quality Guidelines		0.292	0.797	1.376	1.924	2.472	3.076	3.654	4.259
pH (RGS Measurement)	6 to 9	-	9.31	8.82	8.78	7.46	8.20	8.51	7.81	7.63
pH (ALS Measurement)			8.42	7.97	7.45	7.27	7.48	7.48	7.33	7.72
pH (deionised water used in test)		-	5.61	5.98	5.30	7.01	6.13	5.78	5.82	5.41
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	158	151	121	79	77	100	105	112
EC (ALS Measurement) (µS/cm)			171	184	139	87	80	99	104	90
Acidity (mg/L as $CaCO_3$)*	-	-	<1	1.0	2.0	2.0	2.0	5.0	3.0	<1
Alkalinity (mg/L as $CaCO_3$)*	-	-	45.0	20.0	19.0	28.0	23.0	18.0	17.0	21.0
Net Alkalinity (mg/L as $CaCO_3$)*			44.5	19.0	17.0	26.0	21.0	13.0	14.0	20.5
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	<1	<1	<1	1	<1	<1	<1	<1
Potassium	K	1	-	-	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium	Mg	1	-	-	<1	<1	<1	1	<1	<1	<1	<1
Sodium	Na	1	-	-	35	27	27	18	17	19	22	19
Chloride	Cl	1	-	-	24	28	26	13	12	18	21	14
Fluoride	F	0.1	-	2	1.1	0.8	0.7	0.5	0.5	0.6	0.7	0.6
Sulfate	SO_4	1	-	1,000	3	5	3	2	2	3	1	2
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	0.12	0.47	0.41	0.07	0.07	0.45	0.24	0.08
Arsenic	As	0.001	0.024	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	Ba	0.001	-	-	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.001
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.003	0.002	0.001	0.001	0.002	0.001	0.001	0.001
Iron	Fe	0.05	-	-	0.06	0.14	0.14	<0.05	<0.05	0.14	0.09	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.002	0.001	0.001	0.001	<0.001	0.001	0.001	0.002
Molybdenum	Mo	0.001	-	0.15	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002	0.001
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	Zn	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				0.6	1.7	1.2	0.7	0.7	1.2	0.4	0.8
Cumulative SO_4 Release	Cum SO_4				0.6	2.3	3.5	4.2	4.9	6.2	6.6	7.4
Ca Release Rate	Ca				0.1	0.2	0.2	0.4	0.2	0.2	0.2	0.2
Cumulative Ca Release	Cum Ca				0.1	0.3	0.5	0.8	1.0	1.2	1.4	1.6
Mg Release Rate	Mg				0.1	0.2	0.2	0.4	0.2	0.2	0.2	0.2
Cumulative Mg Release	Cum Mg				0.1	0.3	0.5	0.8	1.0	1.2	1.4	1.6
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				0.9	1.6	0.9	0.3	0.6	0.9	0.3	0.6

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 2 Poor Quality Coal - MU

				Weight (kg)	1.50	Total S (%)	0.100	ANC	11.5				
				pH (1:5)	6.08	Scr (%)	0.100	NAPP	-8.4				
				EC (µS/cm)	714	MPA	3.06	ANC:MPA	3.8				
Date					02-Jun-22	30-Jun-22	28-Jul-22	26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22
Number of Weeks					0	4	8	12	16	20	24	28
Leach Number					1	2	3	4	5	6	7	8
ALS Laboratory Number					EB2215727002	EB2218970002	EB2222089002	EB2225164002	EB2227924002	EB2231031002	EB2234415002	EB2237794002
Volume On (L)					1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)					0.356	0.380	0.349	0.300	0.377	0.435	0.386	0.462
Cum. Volume (L)					0.4	0.736	1.085	1.385	1.762	2.197	2.583	3.045
Pore Volumes	Water Quality Guidelines				0.264	0.545	5.000	1.026	1.305	1.627	1.913	2.256
pH (RGS Measurement)	6 to 9	-			6.78	5.64	5.33	5.48	5.76	5.62	5.63	5.62
pH (ALS Measurement)					6.81	5.68	5.19	5.44	5.71	5.80	5.81	5.81
pH (deionised water used in test)		-			5.61	5.98	5.30	7.01	6.13	5.78	5.82	5.41
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^			805	1,422	1,758	1,279	763	565	581	452
EC (ALS Measurement) (µS/cm)					822	1,490	1,900	1,290	772	550	538	428
Acidity (mg/L as $CaCO_3$)*	-	-			5.0	20.0	46.0	40.0	26.0	15.0	28.0	20.0
Alkalinity (mg/L as $CaCO_3$)*	-	-			15.0	12.0	28.0	40.0	28.0	25.0	30.0	22.0
Net Alkalinity (mg/L as $CaCO_3$)*					10.0	-8.0	-18.0	0.0	2.0	10.0	2.0	2.0
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**								
Calcium	Ca	1	-	1,000	7	16	28	16	8	8	8	7
Potassium	K	1	-	-	2	3	4	4	2	2	3	2
Magnesium	Mg	1	-	-	4	8	16	10	3	3	3	2
Sodium	Na	1	-	-	158	239	373	280	164	113	117	92
Chloride	Cl	1	-	-	113	122	174	99	55	38	36	24
Fluoride	F	0.1	-	2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	SO_4	1	-	1,000	171	396	509	388	233	158	147	125
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**								
Aluminium	Al	0.01	0.055	5	0.09	0.58	0.93	2.58	0.69	1.2	0.8	0.65
Arsenic	As	0.001	0.024	0.5	0.006	0.006	0.006	<0.005	0.004	0.003	0.003	0.002
Barium	Ba	0.001	-	-	0.035	0.036	0.054	0.044	0.035	0.038	0.033	0.026
Beryllium	Be	0.001	-	-	<0.001	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	0.19	0.35	0.48	0.53	0.27	0.24	0.23	0.2
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0005	0.0002	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	0.001	<0.005	0.005	0.005	0.003	0.003	0.003	0.003
Chromium	Cr	0.001	0.001	1	<0.001	<0.005	<0.001	<0.005	0.003	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.014	0.032	0.053	0.063	0.031	0.021	0.02	0.017
Iron	Fe	0.05	-	-	0.06	0.40	0.58	1.47	1.06	0.59	0.49	0.43
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.019	0.05	0.109	0.069	0.028	0.028	0.029	0.023
Molybdenum	Mo	0.001	-	0.15	0.016	<0.005	0.003	<0.005	0.003	0.001	0.002	0.002
Nickel	Ni	0.001	0.011	1	0.001	<0.005	0.004	<0.005	0.003	0.002	0.002	0.003
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.005	0.004	<0.005	0.002	0.002	0.002	0.002
Antimony	Sb	0.001	-	-	<0.001	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	0.02	<0.05	0.04	<0.05	<0.01	<0.01	<0.01	<0.01
Thorium	Th	0.001	-	-	<0.001	<0.005	0.001	<0.005	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	0.01	<0.05	0.03	<0.05	0.02	0.02	0.02	0.02
Zinc	Zn	0.005	0.008	-	0.007	0.025	0.005	<0.025	0.005	<0.005	0.006	0.006
Calculations**	**Elements**											
SO_4 Release Rate	SO_4				40.6	100.3	118.4	77.6	58.6	45.8	37.8	38.5
Cumulative SO_4 Release	Cum SO_4				40.6	140.9	259.3	336.9	395.5	441.3	479.1	517.6
Ca Release Rate	Ca				1.7	4.1	6.5	3.2	2.0	2.3	2.1	2.2
Cumulative Ca Release	Cum Ca				1.7	5.7	12.2	15.4	17.4	19.8	21.8	24.0
Mg Release Rate	Mg				0.9	2.0	3.7	2.0	0.8	0.9	0.8	0.6
Cumulative Mg Release	Cum Mg				0.9	3.0	6.7	8.7	9.5	10.3	11.1	11.7
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				5.2	5.7	3.9	5.0	7.5	5.1	4.7	5.1

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 3 Coal - MU

			Weight (kg)	1.20	Total S (%)	0.100	ANC	28.2		
			pH (1:5)	7.73	Scr (%)	0.180	NAPP	-22.7		
			EC (µS/cm)	503	MPA	5.51	ANC:MPA	5.1		
Date				02-Jun-22	30-Jun-22	28-Jul-22	26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22
Number of Weeks				0	4	8	12	16	20	24	28
Leach Number				1	2	3	4	5	6	7	8
ALS Laboratory Number				EB2215727003	EB2218970003	EB2222089003	EB2225164003	EB2227924003	EB2231031003	EB2234415003	EB2237794003
Volume On (L)				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)				0.660	0.616	0.626	0.626	0.567	0.631	0.610	0.622
Cum. Volume (L)				0.7	1.276	1.902	2.528	3.095	3.726	4.336	4.958
Pore Volumes	Water Quality Guidelines			0.489	0.945	1.409	1.873	2.293	2.760	3.212	3.673
pH (RGS Measurement)	6 to 9	-		7.74	6.88	6.92	6.86	6.77	6.67	6.82	6.96
pH (ALS Measurement)				7.51	7.11	6.81	7.05	7.13	7.13	6.93	7.26
pH (deionised water used in test)		-		5.61	5.98	5.30	7.01	6.13	5.78	5.82	5.41
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^		151	251	256	321	327	330	324	358
EC (ALS Measurement) (µS/cm)				161	272	295	343	337	334	309	337
Acidity (mg/L as $CaCO_3$)*	-	-		3.0	2.0	3.0	2.0	4.0	4.0	4.0	4.0
Alkalinity (mg/L as $CaCO_3$)*	-	-		34.0	14.0	9.0	10.0	11.0	12.0	12.0	14.0
Net Alkalinity (mg/L as $CaCO_3$)*				31.0	12.0	6.0	8.0	7.0	8.0	8.0	10.0
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**							
Calcium	Ca	1	-	1,000	4	2	4	4	2	4	4	4
Potassium	K	1	-	-	<1	<1	1	2	2	2	2	2
Magnesium	Mg	1	-	-	<1	<1	2	2	2	2	2	2
Sodium	Na	1	-	-	28	42	53	63	68	60	59	65
Chloride	Cl	1	-	-	2	2	1	<1	<1	<1	<1	<1
Fluoride	F	0.1	-	2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Sulfate	SO_4	1	-	1,000	38	84	105	123	132	120	112	142
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**							
Aluminium	Al	0.01	0.055	5	0.05	0.4	0.24	0.06	0.08	0.12	0.05	0.11
Arsenic	As	0.001	0.024	0.5	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	Ba	0.001	-	-	0.078	0.021	0.019	0.019	0.017	0.019	0.02	0.018
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	<0.05	0.07	0.06	0.09	0.07	0.11	0.13	0.14
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
Iron	Fe	0.05	-	-	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.003	0.001	0.001	0.002	<0.001	0.001	0.002	0.002
Molybdenum	Mo	0.001	-	0.15	0.008	0.003	0.003	<0.001	0.005	0.001	0.002	0.002
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	Zn	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calculations**	**Elements**											
SO_4 Release Rate	SO_4				20.9	43.1	54.8	64.2	62.4	63.1	56.9	73.6
Cumulative SO_4 Release	Cum SO_4				20.9	64.0	118.8	183.0	245.3	308.4	365.4	439.0
Ca Release Rate	Ca				2.2	1.0	2.1	2.1	0.9	2.1	2.0	2.1
Cumulative Ca Release	Cum Ca				2.2	3.2	5.3	7.4	8.3	10.4	12.5	14.6
Mg Release Rate	Mg				0.3	0.3	1.0	1.0	0.9	1.1	1.0	1.0
Cumulative Mg Release	Cum Mg				0.3	0.5	1.6	2.6	3.6	4.6	5.6	6.7
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				3.3	12.4	6.0	7.0	10.4	6.9	6.4	8.1

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 4 Interburden

			Weight (kg)	2.00	Total S (%)	0.010	ANC	6.0	
			pH (1:5)	9.35	Scr (%)	0.117	NAPP	-2.4	
			EC (µS/cm)	256	MPA	3.58	ANC:MPA	1.7	
Date				02-Jun-22	30-Jun-22	28-Jul-22	26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22
Number of Weeks				0	4	8	12	16	20	24	28
Leach Number				1	2	3	4	5	6	7	8
ALS Laboratory Number				EB2215727004	EB2218970004	EB2222089004	EB2225164004	EB2227924004	EB2231031004	EB2234415004	EB2237794004
Volume On (L)				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)				0.452	0.518	0.627	0.615	0.591	0.586	0.660	0.667
Cum. Volume (L)				0.5	0.970	1.597	2.212	2.803	3.389	4.049	4.716
Pore Volumes	Water Quality Guidelines			0.335	0.719	1.183	1.639	2.076	2.510	2.999	3.493
pH (RGS Measurement)	6 to 9	-		10.02	9.02	8.35	7.10	6.80	6.95	7.47	7.02
pH (ALS Measurement)				9.01	8.10	7.24	6.98	7.17	7.24	6.89	7.11
pH (deionised water used in test)		-		5.61	5.98	5.30	7.01	6.13	5.78	5.82	6.41
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^		128	147	101	114	112	106	69	84
EC (ALS Measurement) (µS/cm)				126	175	114	123	117	104	67	81
Acidity (mg/L as $CaCO_3$)*	-	-		<1	<1	1.0	2.0	2.0	2.0	3.0	1.0
Alkalinity (mg/L as $CaCO_3$)*	-	-		45.0	21.0	12.0	11.0	8.0	10.0	8.0	8.0
Net Alkalinity (mg/L as $CaCO_3$)*				44.5	20.5	11.0	9.0	6.0	8.0	5.0	7.0
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**							
Calcium	Ca	1	-	1,000	<1	<1	<1	<1	<1	<1	<1	<1
Potassium	K	1	-	-	<1	<1	<1	1	1	<1	<1	1
Magnesium	Mg	1	-	-	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	Na	1	-	-	25	26	23	24	22	21	22	16
Chloride	Cl	1	-	-	4	5	3	3	3	2	2	1
Fluoride	F	0.1	-	2	0.6	0.4	0.2	0.1	0.1	0.1	0.1	0.1
Sulfate	SO_4	1	-	1,000	17	44	35	27	37	33	20	26
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**							
Aluminium	Al	0.01	0.055	5	0.17	2.12	0.41	0.08	0.04	0.36	0.07	0.19
Arsenic	As	0.001	0.024	0.5	0.018	0.011	0.006	0.005	0.003	0.004	0.003	0.003
Barium	Ba	0.001	-	-	<0.001	0.005	0.002	<0.001	0.001	0.002	<0.001	0.001
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.004	0.002	0.002	0.002	0.003	0.002	0.002	0.002
Iron	Fe	0.05	-	-	<0.05	0.28	0.06	<0.05	0.08	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	Mo	0.001	-	0.15	0.035	0.082	0.065	0.07	0.079	0.051	0.026	0.026
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	0.01	0.04	0.03	0.04	0.04	0.04	0.02	0.02
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	0.04	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	Zn	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calculations**	**Elements**											
SO_4 Release Rate	SO_4				3.8	11.4	11.0	8.3	10.9	9.7	6.6	8.7
Cumulative SO_4 Release	Cum SO_4				3.8	15.2	26.2	34.5	45.4	55.1	61.7	70.4
Ca Release Rate	Ca				0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
Cumulative Ca Release	Cum Ca				0.1	0.2	0.4	0.6	0.7	0.8	1.0	1.2
Mg Release Rate	Mg				0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
Cumulative Mg Release	Cum Mg				0.1	0.2	0.4	0.6	0.7	0.8	1.0	1.2
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				5.4	13.9	11.0	8.5	11.7	10.4	6.3	8.2

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 5 Coal Rejects - MU

				Weight (kg)	2.00	Total S (%)	0.030	ANC	23.7				
				pH (1:5)	8.60	Scr (%)	0.030	NAPP	-22.8				
				EC (µS/cm)	367	MPA	0.92	ANC:MPA	25.8				
Date					02-Jun-22	30-Jun-22	28-Jul-22	26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22
Number of Weeks					0	4	8	12	16	20	24	28
Leach Number					1	2	3	4	5	6	7	8
ALS Laboratory Number					EB2215727005	EB2218970005	EB2222089005	EB2225164005	EB2227924005	EB2231031005	EB2234415005	EB2237794005
Volume On (L)					1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0
Volume Off (L)					0.359	0.344	0.318	0.365	0.348	0.380	0.345	0.505
Cum. Volume (L)					0.4	0.703	1.021	1.386	1.734	2.114	2.459	2.964
Pore Volumes			Water Quality Guidelines		0.266	0.521	0.756	1.027	1.284	1.566	1.821	2.196
pH (RGS Measurement)			6 to 9	-	7.94	7.06	7.25	7.13	7.44	6.78	7.01	6.93
pH (ALS Measurement)					7.68	7.23	7.11	7.20	7.77	7.17	7.20	7.31
pH (deionised water used in test)				-	5.61	5.98	5.30	7.01	6.13	5.78	5.82	5.41
EC (RGS Measurement) (µS/cm)			<1,000 #	3,580^	503	815	749	535	544	379	343	162
EC (ALS Measurement) (µS/cm)					549	878	872	556	554	382	328	154
Acidity (mg/L as $CaCO_3$)*			-	-	2.0	3.0	3.0	2.0	3.0	11.0	6.0	3.0
Alkalinity (mg/L as $CaCO_3$)*			-	-	66.0	26.0	28.0	30.0	67.0	29.0	32.0	13.0
Net Alkalinity (mg/L as $CaCO_3$)*					64.0	23.0	25.0	28.0	64.0	18.0	26.0	10.0
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**								
Calcium	Ca	1	-	1,000	3	5	8	4	4	5	4	2
Potassium	K	1	-	-	2	2	3	2	3	2	2	2
Magnesium	Mg	1	-	-	2	4	5	3	4	3	2	1
Sodium	Na	1	-	-	115	135	167	107	123	69	63	29
Chloride	Cl	1	-	-	54	69	70	31	29	23	18	6
Fluoride	F	0.1	-	2	0.8	0.5	0.4	0.4	0.5	0.2	0.3	0.1
Sulfate	SO_4	1	-	1,000	82	242	274	152	162	101	98	47
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**								
Aluminium	Al	0.01	0.055	5	0.03	0.13	0.08	0.05	0.34	0.06	0.06	0.24
Arsenic	As	0.001	0.024	0.5	0.004	0.003	0.002	0.001	0.002	<0.001	0.002	<0.001
Barium	Ba	0.001	-	-	0.018	0.02	0.023	0.014	0.015	0.013	0.009	0.004
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	0.05	0.08	0.08	0.06	0.09	0.07	0.08	<0.05
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.008	0.028	0.041	0.034	0.048	0.028	0.033	0.014
Iron	Fe	0.05	-	-	<0.05	0.10	0.10	0.06	0.12	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.005	0.005	0.005	0.004	0.002	0.004	0.003	0.001
Molybdenum	Mo	0.001	-	0.15	0.060	0.043	0.044	0.028	0.053	0.026	0.027	0.009
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	0.001	0.001	0.002	<0.001	<0.001	<0.001
Lead	Pb	0.001	0.0034	0.1	<0.001	0.001	0.002	0.002	0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	0.04	0.07	0.07	0.04	0.02	0.02	0.01	<0.01
Thorium	Th	0.001	-	-	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	V	0.01	-	-	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01
Zinc	Zn	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calculations**	**Elements**											
SO_4 Release Rate	SO_4				14.7	41.6	43.6	27.7	28.2	19.2	16.9	11.9
Cumulative SO_4 Release	Cum SO_4				14.7	56.3	99.9	127.6	155.8	175.0	191.9	203.8
Ca Release Rate	Ca				0.5	0.9	1.3	0.7	0.7	1.0	0.7	0.5
Cumulative Ca Release	Cum Ca				0.5	1.4	2.7	3.4	4.1	5.0	5.7	6.2
Mg Release Rate	Mg				0.4	0.7	0.8	0.5	0.7	0.6	0.3	0.3
Cumulative Mg Release	Cum Mg				0.4	1.0	1.8	2.4	3.1	3.7	4.0	4.3
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				5.4	8.7	7.0	7.1	6.4	4.2	5.6	5.4

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 6 Tailings - MU

Weight (kg)	2.00	Total S (%)	0.110	ANC	17.5	
pH (1:5)	7.00	Scr (%)	0.064	NAPP	-15.5	
EC (µS/cm)	56	MPA	1.96	ANC:MPA	8.9	

	Water Quality Guidelines								
Date			26-Aug-22	21-Sep-22	20-Oct-22	17-Nov-22	15-Dec-22	12-Jan-23	09-Feb-23	10-Mar-23
Number of Weeks			0	4	8	12	16	20	24	28
Leach Number			1	2	3	4	5	6	7	8
ALS Laboratory Number			EB2225164006	EB2227924006	EB2231031006	EB2234415006	EB2237794006	EB2300796001	EB2303737001	EB2307278001
Volume On (L)			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)			0.523	0.307	0.349	0.368	0.370	0.405	0.423	0.457
Cum. Volume (L)			0.5	0.830	1.179	1.547	1.917	2.322	2.745	3.202
Pore Volumes			0.387	0.615	0.873	1.146	1.420	1.720	2.033	2.372
pH (RGS Measurement)	6 to 9	-	7.21	6.31	6.49	6.56	6.50	6.19	5.81	6.18
pH (ALS Measurement)			7.42	6.81	6.80	6.68	6.59	6.54	6.20	6.65
pH (deionised water used in test)		-	7.01	6.13	5.78	5.82	5.41	5.47	5.07	5.93
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	503	124	323	524	453	335	243	233
EC (ALS Measurement) (µS/cm)			532	128	322	529	448	338	271	234
Acidity (mg/L as $CaCO_3$)*	-	-	3.0	3.0	4.0	8.0	9.0	7.0	4.0	3.0
Alkalinity (mg/L as $CaCO_3$)*	-	-	47.0	5.0	10.0	16.0	13.0	9.0	12.0	6.0
Net Alkalinity (mg/L as $CaCO_3$)*			44.0	2.0	6.0	8.0	4.0	2.0	8.0	3.0

Major Ions (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]							
Calcium	Ca	1	-	1,000	62	11	45	66	57	42	35	25
Potassium	K	1	-	-	6	2	4	5	4	3	3	2
Magnesium	Mg	1	-	-	12	2	7	12	11	9	7	6
Sodium	Na	1	-	-	31	8	13	20	20	14	12	10
Chloride	Cl	1	-	-	20	1	3	6	4	<5	3	1
Fluoride	F	0.1	-	2	0.6	0.4	0.5	0.5	0.4	0.4	0.5	0.4
Sulfate	SO_4	1	-	1,000	148	45	134	220	174	137	94	91
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**							
Aluminium	Al	0.01	0.055	5	0.03	0.03	0.03	0.02	0.04	0.03	0.04	0.03
Arsenic	As	0.001	0.024	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Barium	Ba	0.001	-	-	0.12	0.038	0.089	0.098	0.083	0.072	0.068	0.053
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	B	0.05	0.37	5	0.15	<0.05	0.16	0.25	0.24	0.19	0.21	0.15
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001
Chromium	Cr	0.001	0.001	1	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	Cu	0.001	0.0014	1	0.018	0.006	0.009	0.010	0.011	0.008	0.009	0.006
Iron	Fe	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	Mn	0.001	1.9	-	0.171	0.054	0.185	0.350	0.358	0.277	0.209	0.167
Molybdenum	Mo	0.001	-	0.15	0.002	0.002	0.002	0.001	0.002	0.001	0.001	<0.001
Nickel	Ni	0.001	0.011	1	0.008	0.003	0.005	0.007	0.008	0.006	0.006	0.004
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.001	-	-	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	Zn	0.005	0.008	-	0.027	0.01	0.018	0.028	0.031	0.03	0.02	0.018
Calculations**	**Elements**											
SO_4 Release Rate	SO_4				38.7	6.9	23.4	40.5	32.2	27.7	19.9	19.9
Cumulative SO_4 Release	Cum SO_4				38.7	45.6	69.0	109.5	141.7	169.4	189.3	189.3
Ca Release Rate	Ca				16.2	1.7	7.9	12.1	10.5	8.5	7.4	7.4
Cumulative Ca Release	Cum Ca				16.2	17.9	25.8	37.9	48.4	56.9	64.4	64.4
Mg Release Rate	Mg				3.1	0.3	1.2	2.2	2.0	1.8	1.5	1.5
Cumulative Mg Release	Cum Mg				3.1	3.4	4.7	6.9	8.9	10.7	12.2	12.2
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				0.8	1.3	1.0	1.1	1.0	1.0	0.8	0.8

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 7 Coal - ML

		Weight (kg)	0.70	Total S (%)	0.19	ANC	17.9			
		pH (1:5)	8.40	Scr (%)	0.03	NAPP	-17.1			
		EC (µS/cm)	445	MPA	0.81	ANC:MPA	22.1			
Date			16-Feb-24	13-Mar-24	11-Apr-24					
Number of Weeks			0	4	8					
Leach Number			1	2	3	4	5	6	7	
ALS Laboratory Number			EB2405382001	EB2408509001	EB2412068001					
Volume On (L)			1.0	1.0	1.0					
Volume Off (L)			0.734	0.759	0.726					
Cum. Volume (L)			0.7	0.8	1.485					
Pore Volumes	Water Quality Guidelines		0.544	0.562	1.100					
pH (RGS Measurement)	6 to 9	-	6.20	7.59	7.22					
pH (ALS Measurement)			7.13	7.66	7.75					
pH (deionised water used in test)		-	6.06	5.70	5.84					
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	52	188	269					
EC (ALS Measurement) (µS/cm)			57	190	284					
Acidity (mg/L as $CaCO_3$)*	-	-	2.0	2.0	3.0					
Alkalinity (mg/L as $CaCO_3$)*	-	-	16.0	40.0	56.0					
Net Alkalinity (mg/L as $CaCO_3$)*			14.0	38.0	53.0					
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	2	<1	<1				
Potassium	K	1	-	-	<1	1	1				
Magnesium	Mg	1	-	-	<1	<1	<1				
Sodium	Na	1	-	-	10	40	64				
Chloride	Cl	1	-	-	7	34	46				
Fluoride	F	0.1	-	2	<0.1	0.1	0.1				
Sulfate	SO_4	1	-	1,000	1	2	4				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	0.12	0.12	0.29				
Arsenic	As	0.001	0.024	0.5	<0.001	0.003	0.003				
Barium	Ba	0.001	-	-	0.409	0.156	0.012				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	<0.05	0.23	0.21				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	<0.001	0.002	0.002				
Iron	Fe	0.05	-	-	<0.05	0.05	0.21				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.003	<0.001	0.001				
Molybdenum	Mo	0.001	-	0.15	0.002	0.007	0.005				
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	<0.01	0.02	0.02				
Zinc	Zn	0.005	0.008	-	0.008	0.014	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				1.0	2.2	4.1				
Cumulative SO_4 Release	Cum SO_4				1.0	3.2	7.4				
Ca Release Rate	Ca				2.10	0.54	0.52				
Cumulative Ca Release	Cum Ca				2.10	2.64	3.16				
Mg Release Rate	Mg				0.52	0.54	0.52				
Cumulative Mg Release	Cum Mg				0.52	1.07	1.59				
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				0.1	0.6	1.3				

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 8 Potential Rejects - ML

		Weight (kg)	1.50	Total S (%)	0.16	ANC	19.1			
		pH (1:5)	8.65	Scr (%)	0.04	NAPP	-18.0			
		EC (µS/cm)	612	MPA	1.10	ANC:MPA	17.3			
Date			16-Feb-24	13-Mar-24	11-Apr-24					
Number of Weeks			0	4	8					
Leach Number			1	2	3	4	5	6	7	
ALS Laboratory Number			EB2405382002	EB2408509002	EB2412068001					
Volume On (L)			1.0	1.0	1.0					
Volume Off (L)			0.329	0.647	0.693					
Cum. Volume (L)			0.3	0.976	1.669					
Pore Volumes	Water Quality Guidelines		0.244	0.723	1.236					
pH (RGS Measurement)	6 to 9	-	9.13	8.58	6.78					
pH (ALS Measurement)			9.26	8.71	7.91					
pH (deionised water used in test)		-	6.06	5.70	5.84					
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	185	119	74					
EC (ALS Measurement) (µS/cm)			187	122	86					
Acidity (mg/L as $CaCO_3$)*	-	-	<1	<1	1.0					
Alkalinity (mg/L as $CaCO_3$)*	-	-	54.0	34.0	21.0					
Net Alkalinity (mg/L as $CaCO_3$)*			53.5	33.5	20.0					
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	<1	<1	<1				
Potassium	K	1	-	-	<1	<1	<1				
Magnesium	Mg	1	-	-	<1	<1	<1				
Sodium	Na	1	-	-	41	28	17				
Chloride	Cl	1	-	-	22	19	13				
Fluoride	F	0.1	-	2	0.4	0.2	0.1				
Sulfate	SO_4	1	-	1,000	2	2	2				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	1.73	0.09	0.15				
Arsenic	As	0.001	0.024	0.5	0.01	0.006	0.003				
Barium	Ba	0.001	-	-	0.079	0.13	0.007				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	0.08	0.18	0.05				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	0.002	0.002	0.002				
Iron	Fe	0.05	-	-	0.31	<0.05	<0.05				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.001	<0.001	<0.001				
Molybdenum	Mo	0.001	-	0.15	0.004	0.006	0.004				
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	0.001	<0.001	<0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	0.05	0.03	0.02				
Zinc	Zn	0.005	0.008	-	<0.005	0.01	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				0.4	0.9	0.9				
Cumulative SO_4 Release	Cum SO_4				0.4	1.3	2.2				
Ca Release Rate	Ca				0.11	0.22	0.23				
Cumulative Ca Release	Cum Ca				0.11	0.33	0.56				
Mg Release Rate	Mg				0.11	0.22	0.23				
Cumulative Mg Release	Cum Mg				0.11	0.33	0.56				
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				0.6	0.6	0.6				

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 9 Coal - WA

		Weight (kg)	1.00	Total S (%)	0.20	ANC	13.8			
		pH (1:5)	8.30	Scr (%)	0.01	NAPP	-13.5			
		EC (µS/cm)	370	MPA	0.29	ANC:MPA	47.4			
Date			16-Feb-24	13-Mar-24	11-Apr-24					
Number of Weeks			0	4	8					
Leach Number			1	2	3	4	5	6	7	
ALS Laboratory Number			EB2405382003	EB2408509003	EB2412068003					
Volume On (L)			1.0	1.0	1.0					
Volume Off (L)			0.751	0.703	0.724					
Cum. Volume (L)			0.8	1.454	2.178					
Pore Volumes	Water Quality Guidelines		0.556	1.077	1.613					
pH (RGS Measurement)	6 to 9	-	6.74	7.64	7.05					
pH (ALS Measurement)			7.82	7.46	7.77					
pH (deionised water used in test)		-	6.06	5.70	5.84					
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	77	99	107					
EC (ALS Measurement) (µS/cm)			84	101	126					
Acidity (mg/L as $CaCO_3$)*	-	-	2.0	2.0	2.0					
Alkalinity (mg/L as $CaCO_3$)*	-	-	28.0	29.0	37.0					
Net Alkalinity (mg/L as $CaCO_3$)*			26.0	27.0	35.0					

Major Ions (mg/L)	Elements	LoR	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]						
Calcium	Ca	1	-	1,000	<1	<1	<1				
Potassium	K	1	-	-	<1	<1	<1				
Magnesium	Mg	1	-	-	<!	<1	<1				
Sodium	Na	1	-	-	18	22	28				
Chloride	Cl	1	-	-	10	15	14				
Fluoride	F	0.1	-	2	0.2	0.2	0.2				
Sulfate	SO_4	1	-	1,000	2	2	4				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	0.26	0.09	0.26				
Arsenic	As	0.001	0.024	0.5	0.001	0.001	0.002				
Barium	Ba	0.001	-	-	0.194	0.082	0.018				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	0.08	0.18	0.1				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	<0.001	0.002	0.004				
Iron	Fe	0.05	-	-	<0.05	<0.05	0.24				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.001	<0.001	0.004				
Molybdenum	Mo	0.001	-	0.15	0.001	0.004	0.005				
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	0.08	0.12	0.22				
Zinc	Zn	0.005	0.008	-	<0.005	0.006	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				1.5	1.4	2.9				
Cumulative SO_4 Release	Cum SO_4				1.5	2.9	5.8				
Ca Release Rate	Ca				0.38	0.35	0.36				
Cumulative Ca Release	Cum Ca				0.38	0.73	1.09				
Mg Release Rate	Mg					0.35	0.36				
Cumulative Mg Release	Cum Mg										
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)					0.6	1.3				

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.

Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.

for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 10 Potential Rejects - WA

			Weight (kg)	1.40	Total S (%)	0.08	ANC	17.1		
			pH (1:5)	9.40	Scr (%)	0.05	NAPP	-15.7		
			EC (µS/cm)	756	MPA	1.44	ANC:MPA	11.9		
Date				16-Feb-24	13-Mar-24	11-Apr-24				
Number of Weeks				0	4	8				
Leach Number				1	2	3	4	5	6	7
ALS Laboratory Number				EB2405382004	EB2408509004	EB2412068004				
Volume On (L)				1.0	1.0	1.0				
Volume Off (L)				0.463	0.752	0.741				
Cum. Volume (L)				0.5	1.215	1.956				
Pore Volumes	Water Quality Guidelines			0.343	0.900	1.449				
pH (RGS Measurement)	6 to 9	-		6.77	7.11	6.57				
pH (ALS Measurement)				8.14	7.39	6.89				
pH (deionised water used in test)		-		6.06	5.70	5.84				
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^		285	63	39				
EC (ALS Measurement) (µS/cm)				291	67	44				
Acidity (mg/L as $CaCO_3$)*	-	-		2.0	2.0	2.0				
Alkalinity (mg/L as $CaCO_3$)*	-	-		46.0	16.0	10.0				
Net Alkalinity (mg/L as $CaCO_3$)*				44.0	14.0	8.0				
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	<1	<1	<1				
Potassium	K	1	-	-	<1	<1	<1				
Magnesium	Mg	1	-	-	<1	<1	<1				
Sodium	Na	1	-	-	62	18	10				
Chloride	Cl	1	-	-	57	11	8				
Fluoride	F	0.1	-	2	0.2	<0.1	<0.1				
Sulfate	SO_4	1	-	1,000	5	2	1				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	1.65	0.12	0.17				
Arsenic	As	0.001	0.024	0.5	0.01	0.002	<0.001				
Barium	Ba	0.001	-	-	0.071	0.055	0.009				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	0.12	0.22	<0.05				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	0.002	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	0.002	0.001	<0.001				
Iron	Fe	0.05	-	-	0.43	0.05	0.08				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.004	<0.001	0.001				
Molybdenum	Mo	0.001	-	0.15	0.017	0.004	0.001				
Nickel	Ni	0.001	0.011	1	0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	0.002	<0.001	<0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	0.03	<0.01	<0.01				
Zinc	Zn	0.005	0.008	-	0.008	0.007	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				1.7	1.1	0.5				
Cumulative SO_4 Release	Cum SO_4				1.7	2.7	3.3				
Ca Release Rate	Ca				0.17	0.27	0.26				
Cumulative Ca Release	Cum Ca				0.17	0.43	0.70				
Mg Release Rate	Mg				0.17	0.27	0.26				
Cumulative Mg Release	Cum Mg				0.17	0.43	0.70				
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				1.6	0.6	0.3				

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

KLC 11 Overburden

		Weight (kg)	2.00	Total S (%)	0.04	ANC	23.3			
		pH (1:5)	8.30	Scr (%)	0.04	NAPP	-22.1			
		EC (µS/cm)	607	MPA	1.16	ANC:MPA	20.0			
Date			16-Feb-24	13-Mar-24	11-Apr-24					
Number of Weeks			0	4	8					
Leach Number			1	2	3	4	5	6	7	
ALS Laboratory Number			EB2405382005	EB2408509005	EB2412068005					
Volume On (L)			1.0	1.0	1.0					
Volume Off (L)			0.407	0.637	0.663					
Cum. Volume (L)			0.4	1.307	1.970					
Pore Volumes	Water Quality Guidelines		0.301	0.968	1.459					
pH (RGS Measurement)	6 to 9	-	6.60	6.70	6.53					
pH (ALS Measurement)			7.9	7.22	7.14					
pH (deionised water used in test)		-	6.06	5.70	5.84					
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^	170	230	171					
EC (ALS Measurement) (µS/cm)			185	241	214					
Acidity (mg/L as $CaCO_3$)*	-	-	2.0	2.0	3.0					
Alkalinity (mg/L as $CaCO_3$)*	-	-	32.0	18.0	18.0					
Net Alkalinity (mg/L as $CaCO_3$)*			30.0	16.0	15.0					
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	<1	<1	<1				
Potassium	K	1	-	-	<1	1	<1				
Magnesium	Mg	1	-	-	<1	<1	<1				
Sodium	Na	1	-	-	38	46	38				
Chloride	Cl	1	-	-	30	54	38				
Fluoride	F	0.1	-	2	0.2	0.1	<0.1				
Sulfate	SO_4	1	-	1,000	6	17	17				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	1.21	0.11	0.2				
Arsenic	As	0.001	0.024	0.5	0.001	<0.001	<0.001				
Barium	Ba	0.001	-	-	0.068	0.135	0.002				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	0.11	0.16	0.05				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	0.003	0.002	0.001				
Iron	Fe	0.05	-	-	0.49	0.06	0.1				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.004	0.002	0.004				
Molybdenum	Mo	0.001	-	0.15	0.001	<0.001	<0.001				
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	<0.01	<0.01	<0.01				
Zinc	Zn	0.005	0.008	-	0.008	0.008	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				1.2	5.4	5.6				
Cumulative SO_4 Release	Cum SO_4				1.2	6.6	12.3				
Ca Release Rate	Ca				0.10	0.16	0.17				
Cumulative Ca Release	Cum Ca				0.10	0.26	0.43				
Mg Release Rate	Mg				0.10	0.16	0.17				
Cumulative Mg Release	Cum Mg				0.10	0.26	0.43				
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				1.9	5.4	5.4				

Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

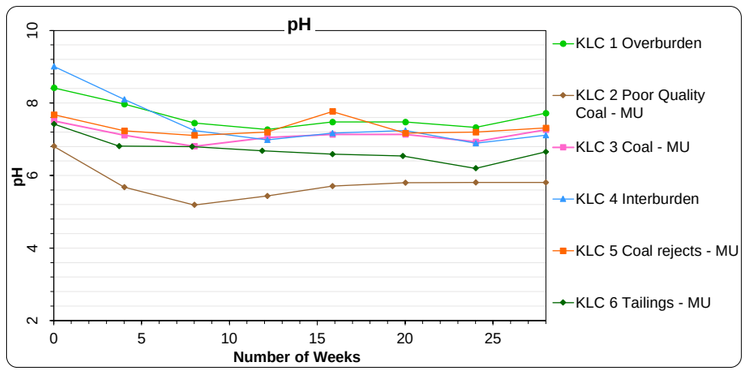
KLC 12 Interburden

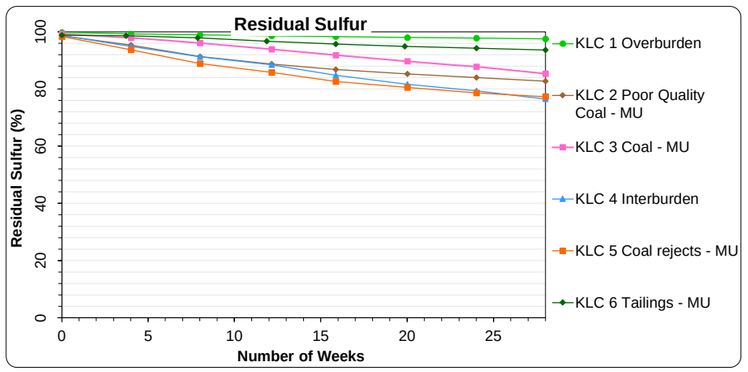
			Weight (kg)	1.90	Total S (%)	0.03	ANC	24.8		
			pH (1:5)	9.60	Scr (%)	0.03	NAPP	-23.9		
			EC (µS/cm)	742	MPA	0.92	ANC:MPA	27.0		
Date				16-Feb-24	13-Mar-24	11-Apr-24				
Number of Weeks				0	4	8				
Leach Number				1	2	3	4	5	6	7
ALS Laboratory Number				EB2405382006	EB2408509006	EB2412068006				
Volume On (L)				1.0	1.0	1.0				
Volume Off (L)				0.670	0.737	0.667				
Cum. Volume (L)				0.7	0.7	1.404				
Pore Volumes	Water Quality Guidelines			0.496	0.546	1.040				
pH (RGS Measurement)	6 to 9	-		9.65	7.85	6.85				
pH (ALS Measurement)				9.68	7.6	7.24				
pH (deionised water used in test)		-		6.06	5.70	5.84				
EC (RGS Measurement) (µS/cm)	<1,000 #	3,580^		106	55	45				
EC (ALS Measurement) (µS/cm)				112	60	56				
Acidity (mg/L as $CaCO_3$)*	-	-		<1	1.0	2.0				
Alkalinity (mg/L as $CaCO_3$)*	-	-		48.0	21.0	17.0				
Net Alkalinity (mg/L as $CaCO_3$)*				47.5	20.0	15.0				
Major Ions (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Calcium	Ca	1	-	1,000	<1	<1	<1				
Potassium	K	1	-	-	<1	<1	<1				
Magnesium	Mg	1	-	-	<1	<1	<1				
Sodium	Na	1	-	-	26	16	10				
Chloride	Cl	1	-	-	7	7	8				
Fluoride	F	0.1	-	2	<0.1	<0.1	<01				
Sulfate	SO_4	1	-	1,000	2	1	<1				
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**Aquatic Ecosystems (Freshwater)[1]**	**Livestock Drinking Water[2]**						
Aluminium	Al	0.01	0.055	5	0.94	0.1	0.13				
Arsenic	As	0.001	0.024	0.5	0.008	0.002	0.002				
Barium	Ba	0.001	-	-	0.063	0.132	0.005				
Beryllium	Be	0.001	-	-	<0.001	<0.001	<0.001				
Boron	B	0.05	0.37	5	0.11	0.18	<0.05				
Cadmium	Cd	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001				
Cobalt	Co	0.001	-	1	<0.001	<0.001	<0.001				
Chromium	Cr	0.001	0.001	1	<0.001	<0.001	<0.001				
Copper	Cu	0.001	0.0014	1	0.001	0.001	<0.001				
Iron	Fe	0.05	-	-	0.24	<0.05	0.09				
Mercury	Hg	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001				
Manganese	Mn	0.001	1.9	-	0.003	0.001	0.002				
Molybdenum	Mo	0.001	-	0.15	0.002	0.002	0.002				
Nickel	Ni	0.001	0.011	1	<0.001	<0.001	<0.001				
Lead	Pb	0.001	0.0034	0.1	<0.001	<0.001	<0.001				
Antimony	Sb	0.001	-	-	<0.001	<0.001	<0.001				
Selenium	Se	0.01	0.011	0.02	<0.01	<0.01	<0.01				
Thorium	Th	0.001	-	-	<0.001	<0.001	<0.001				
Uranium	U	0.001	-	-	<0.001	<0.001	<0.001				
Vanadium	V	0.01	-	-	0.02	<0.01	<0.01				
Zinc	Zn	0.005	0.008	-	0.006	0.006	<0.005				
Calculations**	**Elements**									
SO_4 Release Rate	SO_4				0.7	0.4	0.2				
Cumulative SO_4 Release	Cum SO_4				0.7	1.1	1.3				
Ca Release Rate	Ca				0.18	0.19	0.18				
Cumulative Ca Release	Cum Ca				0.18	0.37	0.55				
Mg Release Rate	Mg				0.18	0.19	0.18				
Cumulative Mg Release	Cum Mg				0.18	0.37	0.55				
SO_4/(Ca+Mg) molar ratio	SO_4/(Ca+Mg)				0.6	0.3	0.2				

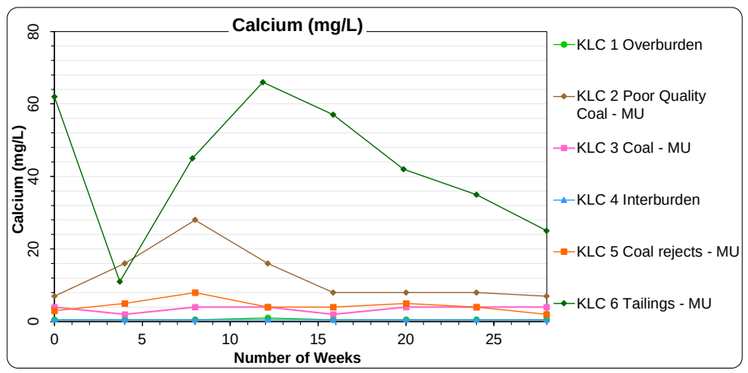
Notes: ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

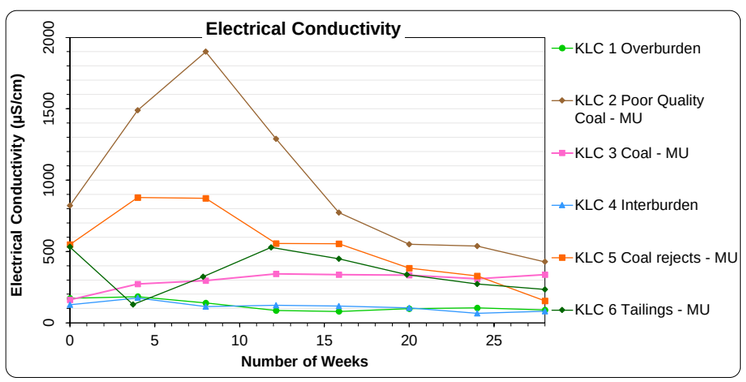
< indicates less than the analytical detection limit. * Acidity and alkalinity data calculated in mg $CaCO_3$/L.
Shaded cells exceed applied guideline values. (tri)* 0.024 g/L for trivalent Arsenic (III). (hex)* Cr (VI) = hexavalent.
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm.
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.
** SO4, Ca and Mg release rates calculated in mg/kg/flush. Residual ANC assumes that all leached Mg and Ca is due to dissolution of calcite or dolomite.
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity. MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

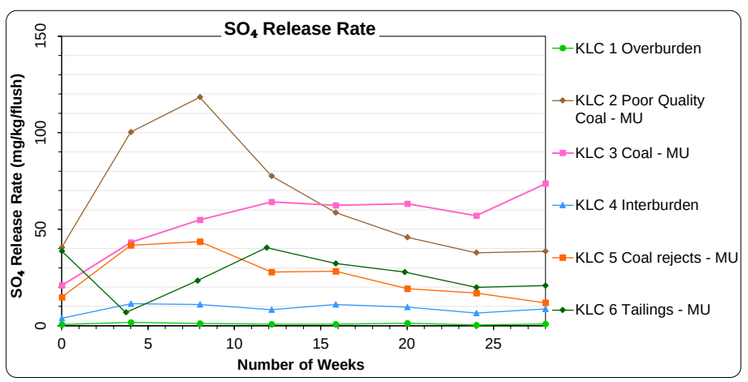
KLC Plots

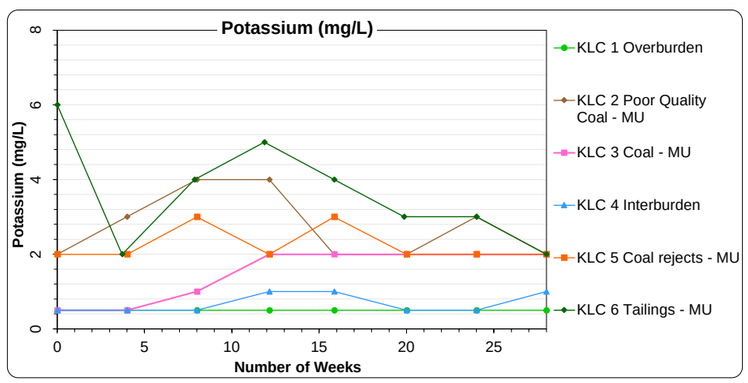

pH
pH
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

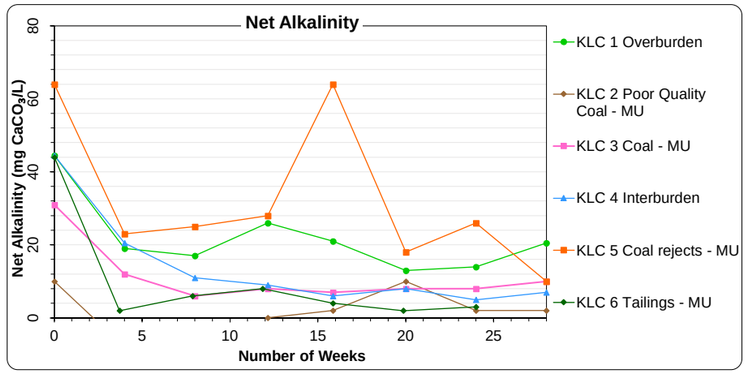

Residual Sulfur
Residual Sulfur (%)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

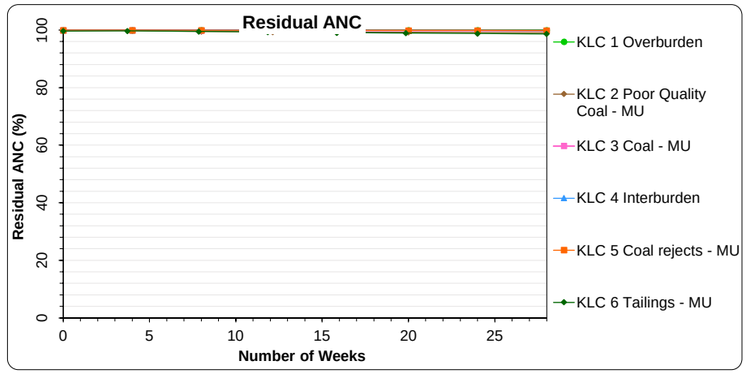

Calcium (mg/L)
Calcium (mg/L)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

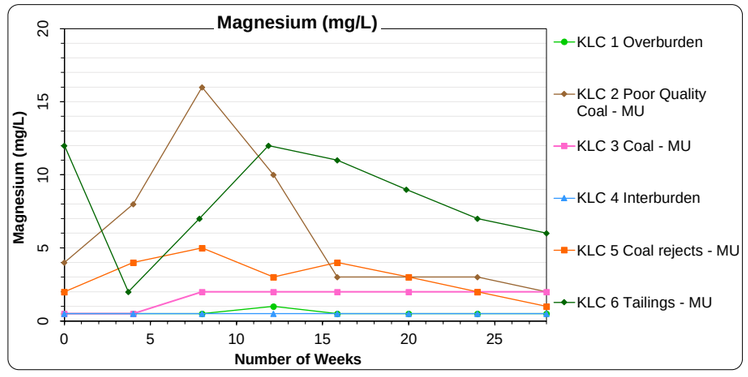

Electrical Conductivity
Electrical Conductivity (µS/cm)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU


SO4 Release Rate
SO4 Release Rate (mg/kg/flush)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

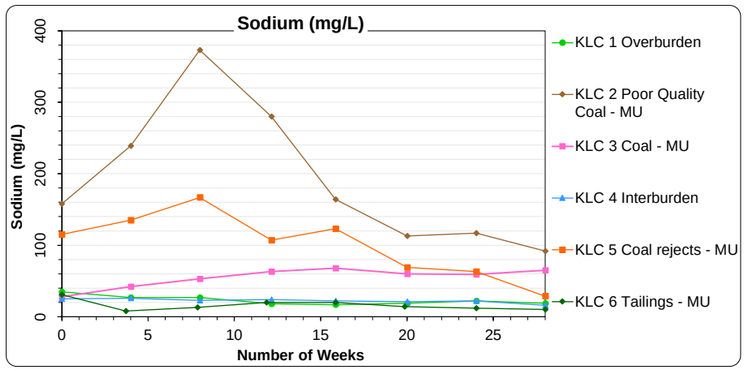

Potassium (mg/L)
Potassium (mg/L)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

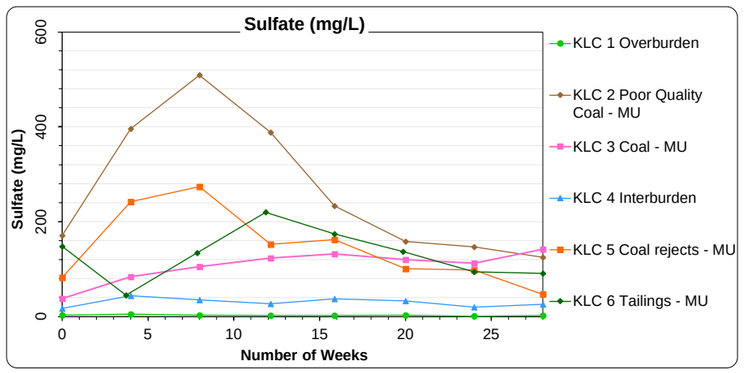

Net Alkalinity
Net Alkalinity (mg CaCO3/L)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

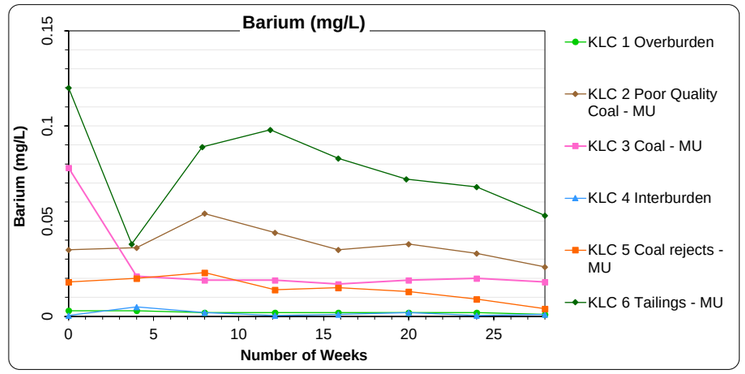

Residual ANC
Residual ANC (%)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

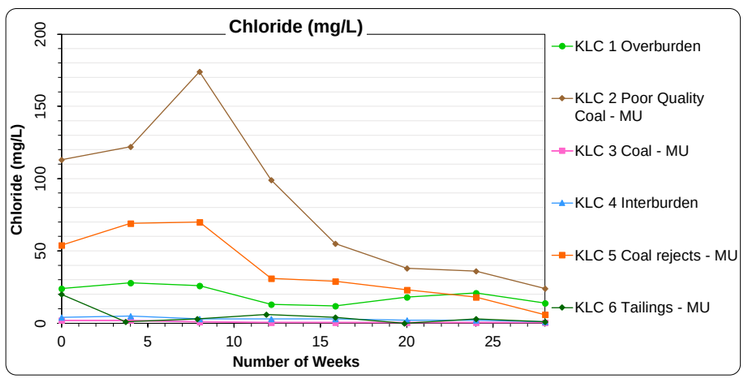

Magnesium (mg/L)
Magnesium (mg/L)
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

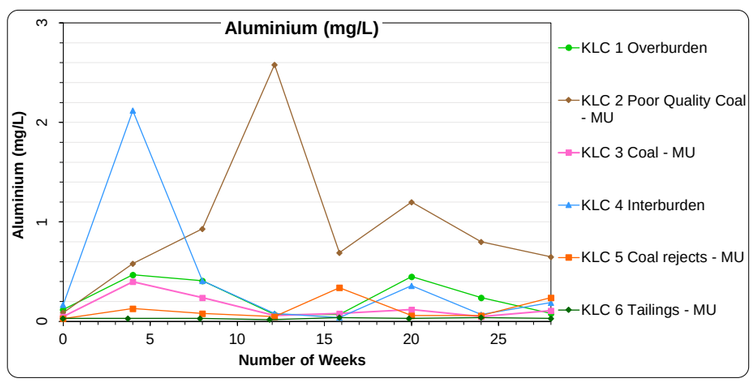
KLC Plots

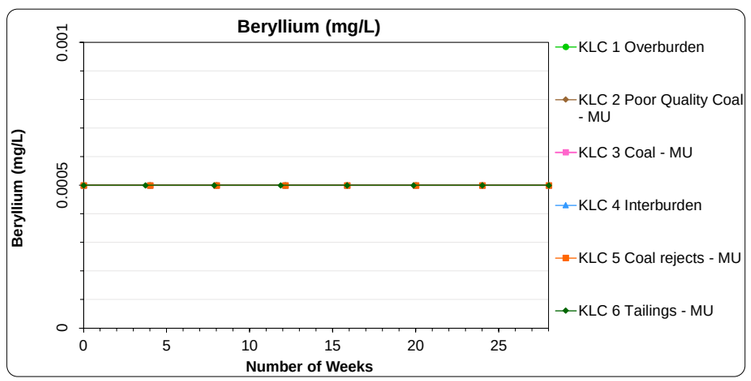

Sodium (mg/L)
Sodium (mg/L)
0
100
200
300
400
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

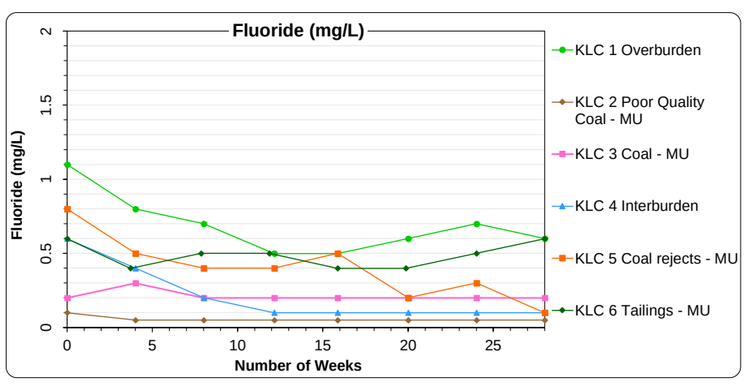

Sulfate (mg/L)
Sulfate (mg/L)
0
200
400
600
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

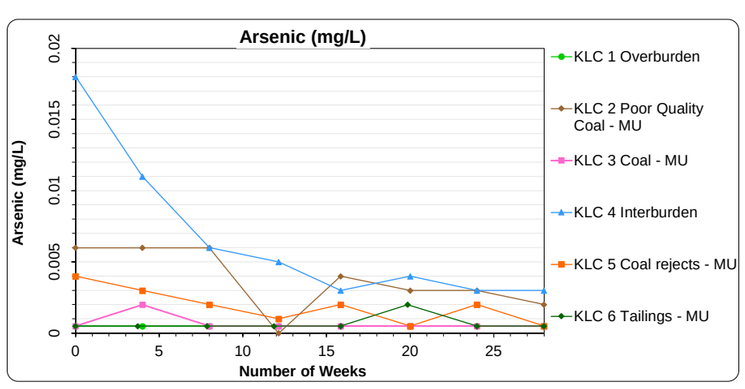

Barium (mg/L)
Barium (mg/L)
0
0.05
0.1
0.15
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

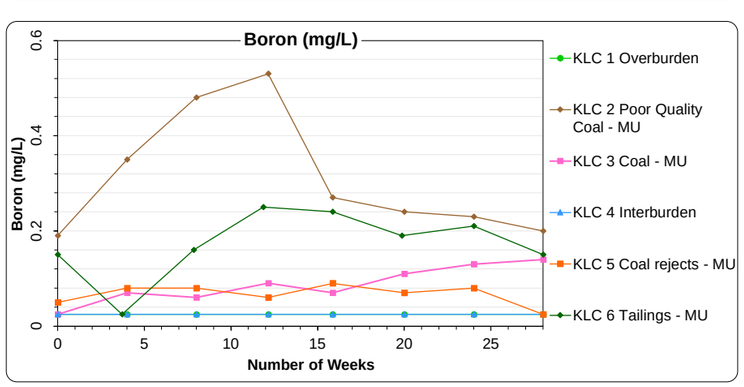

Chloride (mg/L)
Chloride (mg/L)
0
50
100
150
200
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU


Aluminium (mg/L)
Aluminium (mg/L)
0
1
2
3
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

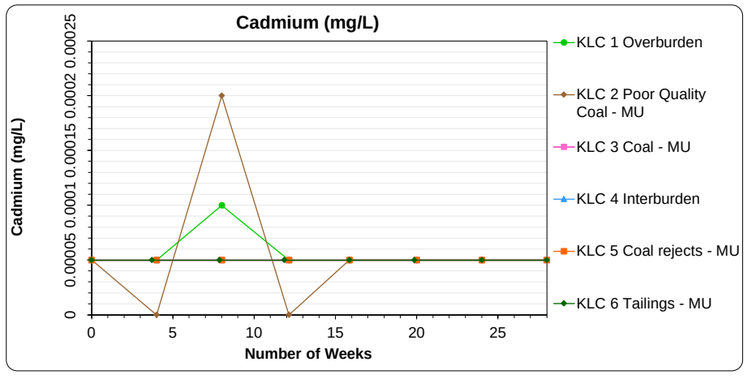

Beryllium (mg/L)
Beryllium (mg/L)
0
0.0005
0.001
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

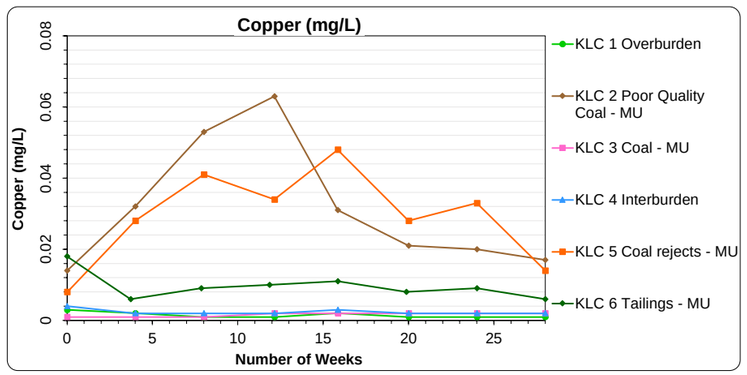

Fluoride (mg/L)
Fluoride (mg/L)
0
0.5
1
1.5
2
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

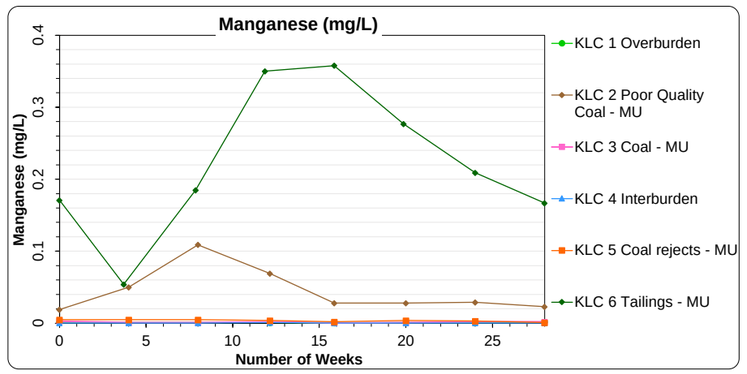

Arsenic (mg/L)
Arsenic (mg/L)
0
0.005
0.01
0.015
0.02
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

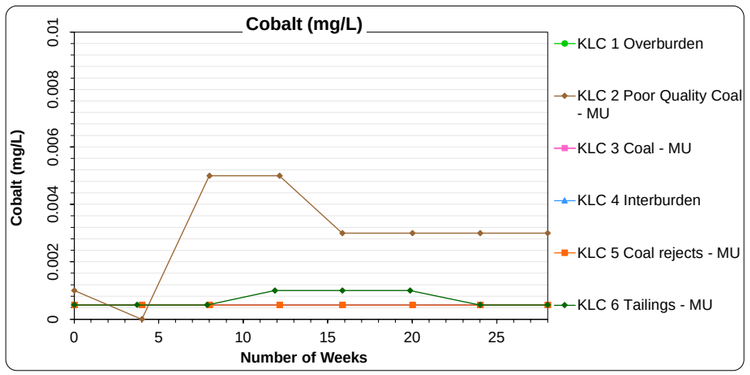

Boron (mg/L)
Boron (mg/L)
0
0.2
0.4
0.6
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

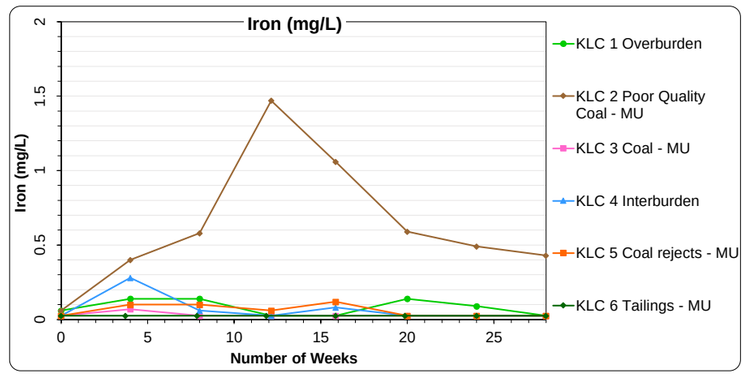
KLC Plots

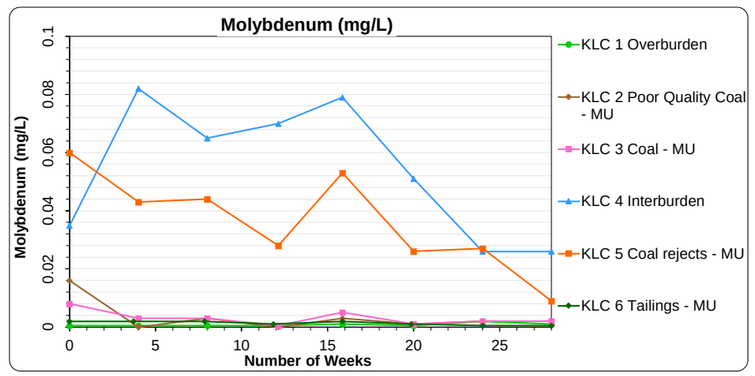

Cadmium (mg/L)
Cadmium (mg/L)
0
0.00005
0.0001
0.00015
0.0002
0.00025
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

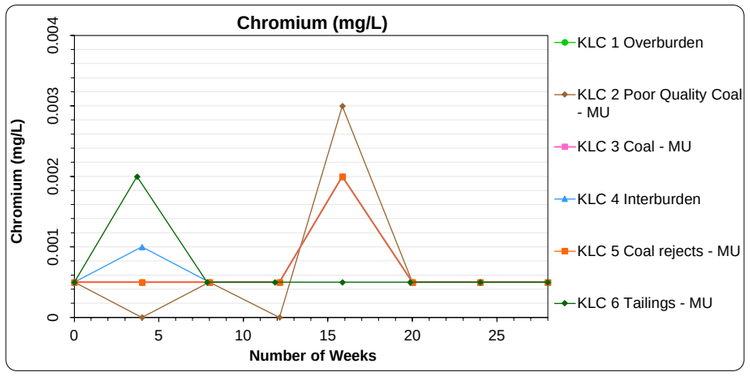

Copper (mg/L)
Copper (mg/L)
0
0.02
0.04
0.06
0.08
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

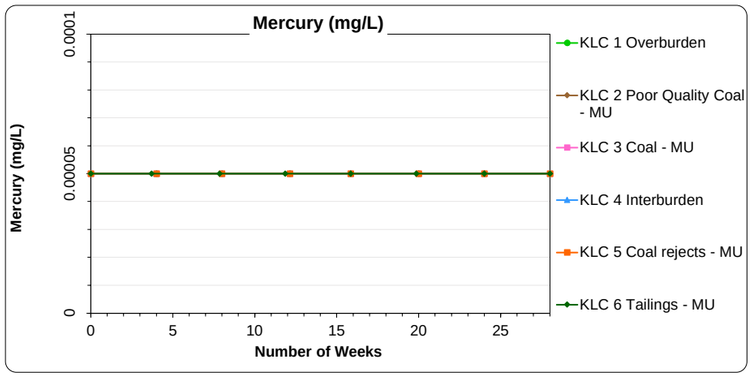

Manganese (mg/L)
Manganese (mg/L)
0
0.1
0.2
0.3
0.4
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

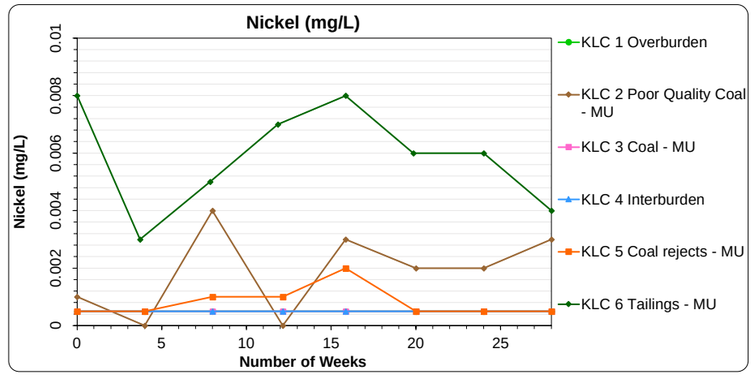

Cobalt (mg/L)
Cobalt (mg/L)
0
0.002
0.004
0.006
0.008
0.01
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU


Iron (mg/L)
Iron (mg/L)
0
0.5
1
1.5
2
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

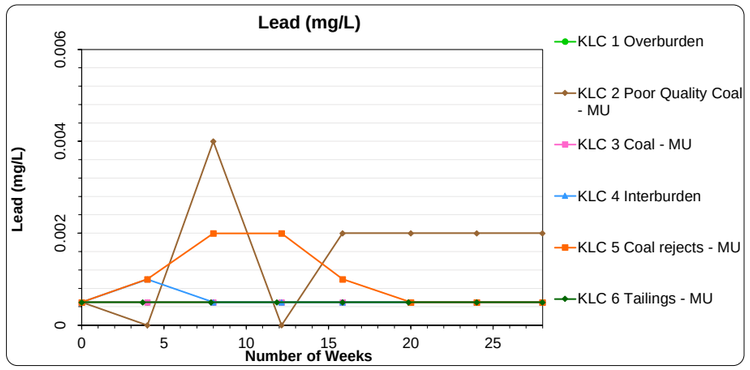

Molybdenum (mg/L)
Molybdenum (mg/L)
0
0.02
0.04
0.06
0.08
0.1
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

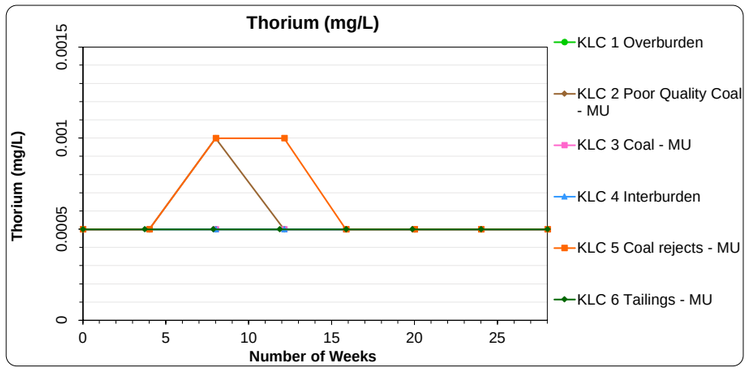

Chromium (mg/L)
Chromium (mg/L)
0
0.001
0.002
0.003
0.004
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

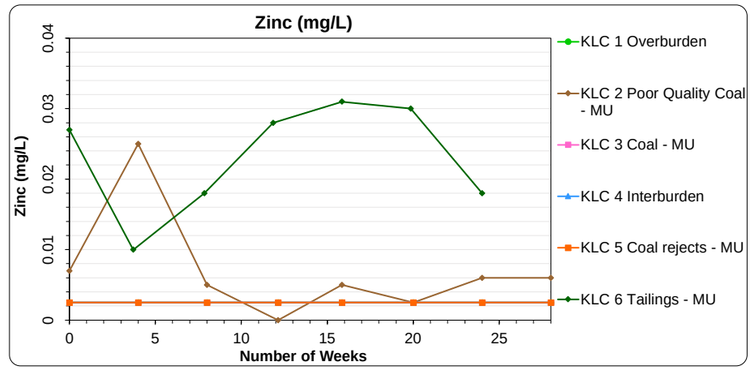

Mercury (mg/L)
Mercury (mg/L)
0
0.00005
0.0001
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

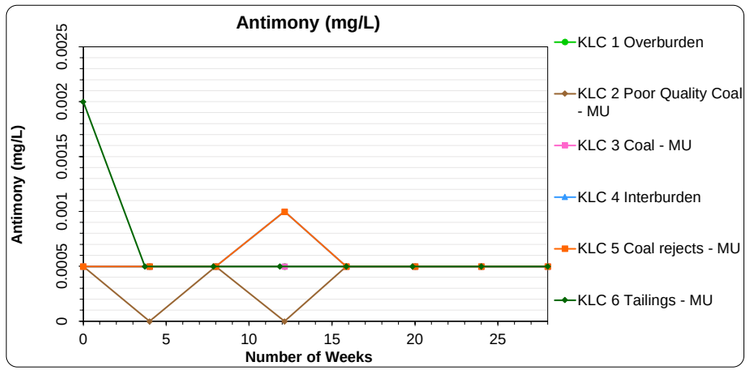

Nickel (mg/L)
Nickel (mg/L)
0
0.002
0.004
0.006
0.008
0.01
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

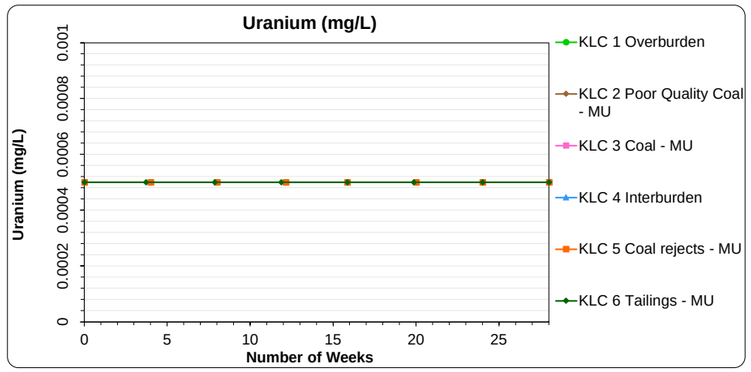
KLC Plots

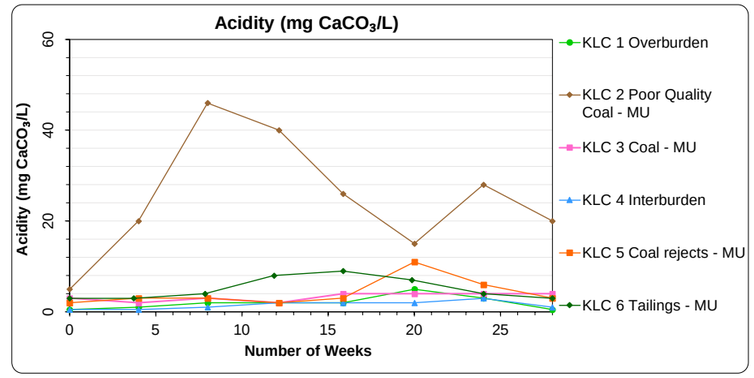

Lead (mg/L)
Lead (mg/L)
0
0.002
0.004
0.006
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

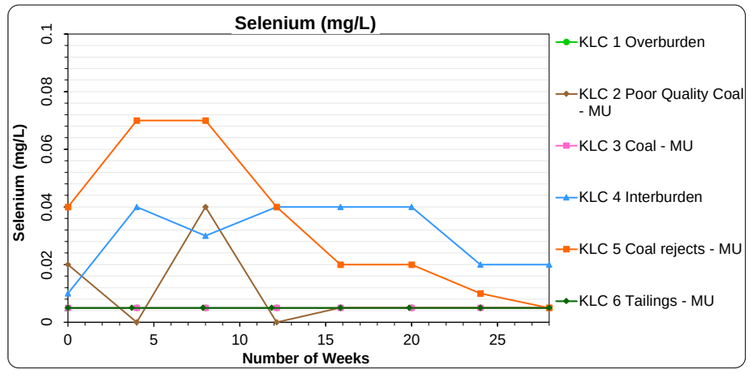

Thorium (mg/L)
Thorium (mg/L)
0
0.0005
0.001
0.0015
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

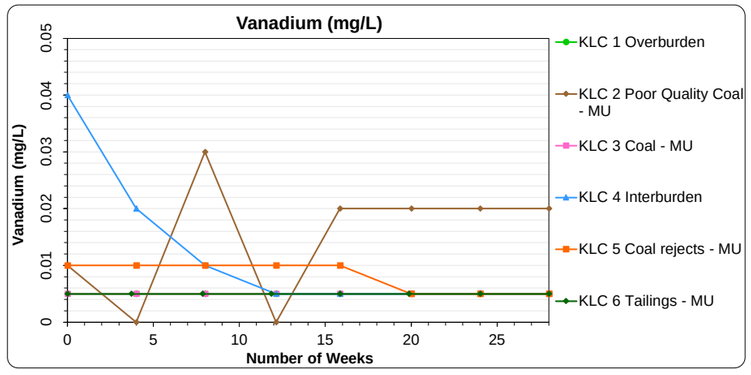

Zinc (mg/L)
Zinc (mg/L)
0
0.01
0.02
0.03
0.04
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

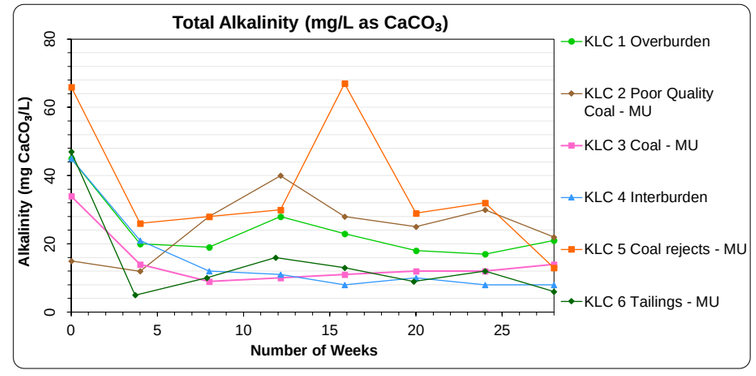

Antimony (mg/L)
Antimony (mg/L)
0
0.0005
0.001
0.0015
0.002
0.0025
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU


Uranium (mg/L)
Uranium (mg/L)
0
0.0002
0.0004
0.0006
0.0008
0.001
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

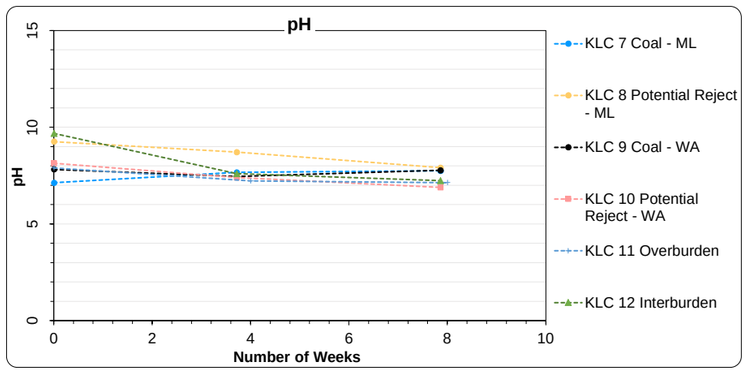

Acidity (mg CaCO3/L)
Acidity (mg CaCO3/L)
0
20
40
60
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

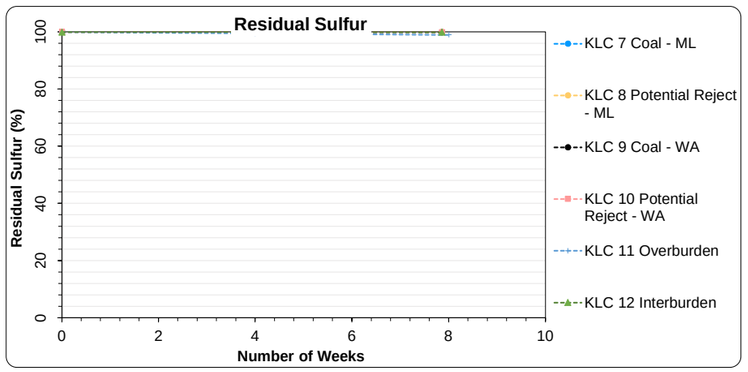

Selenium (mg/L)
Selenium (mg/L)
0
0.02
0.04
0.06
0.08
0.1
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

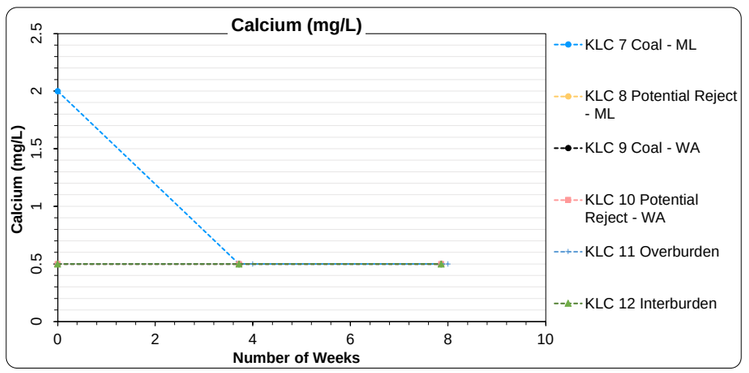

Vanadium (mg/L)
Vanadium (mg/L)
0
0.01
0.02
0.03
0.04
0.05
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

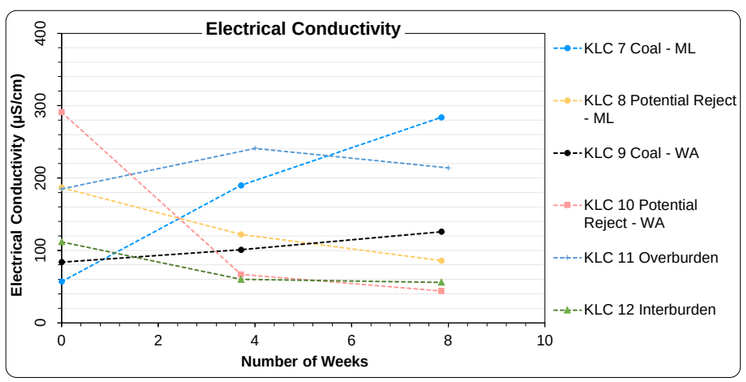

Total Alkalinity (mg/L as CaCO3)
Alkalinity (mg CaCO3/L)
0
20
40
60
80
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Poor Quality Coal - MU
KLC 3 Coal - MU
KLC 4 Interburden
KLC 5 Coal rejects - MU
KLC 6 Tailings - MU

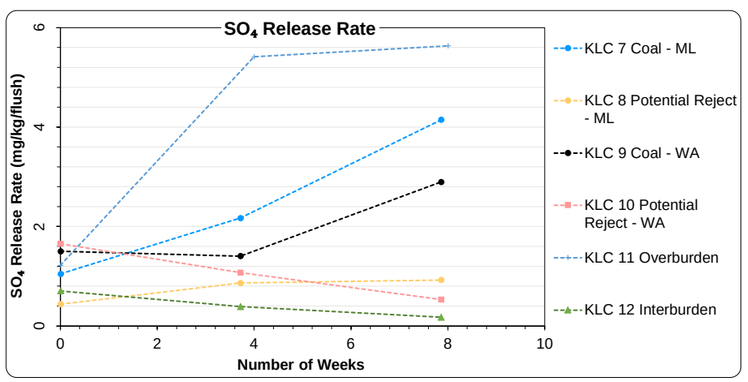
KLC Plots

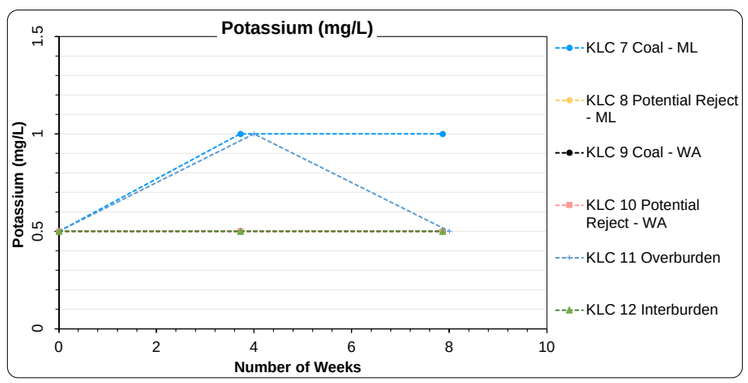

pH
pH
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

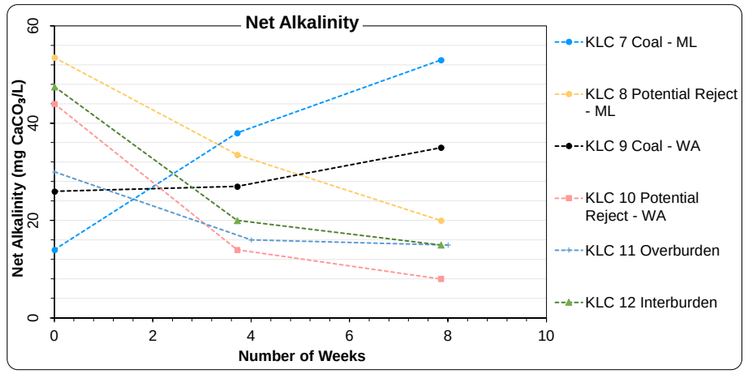

Residual Sulfur
Residual Sulfur (%)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

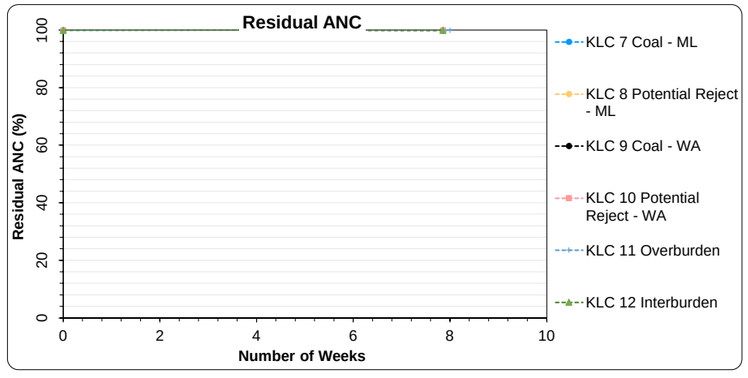

Calcium (mg/L)
Calcium (mg/L)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

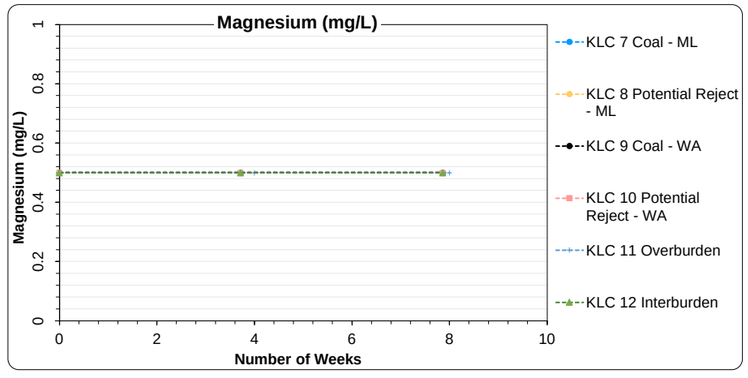

Electrical Conductivity
Electrical Conductivity (µS/cm)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


SO4 Release Rate
SO4 Release Rate (mg/kg/flush)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

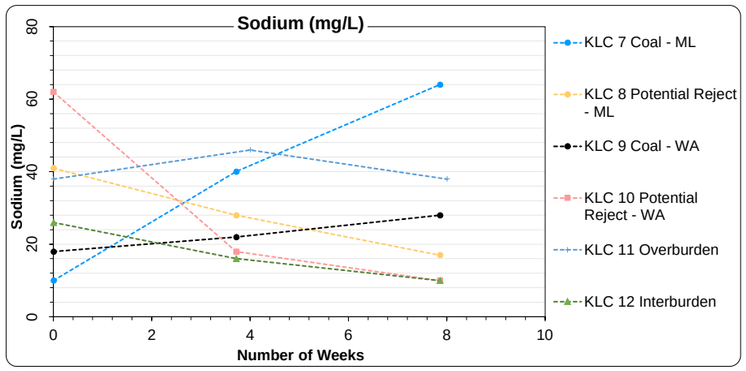

Potassium (mg/L)
Potassium (mg/L)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

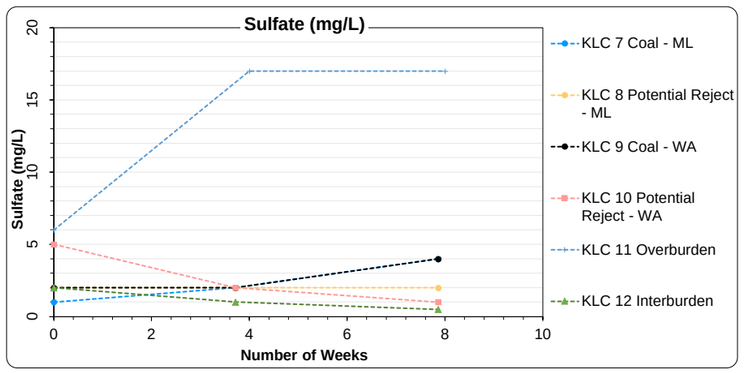

Net Alkalinity
Net Alkalinity (mg CaCO3/L)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

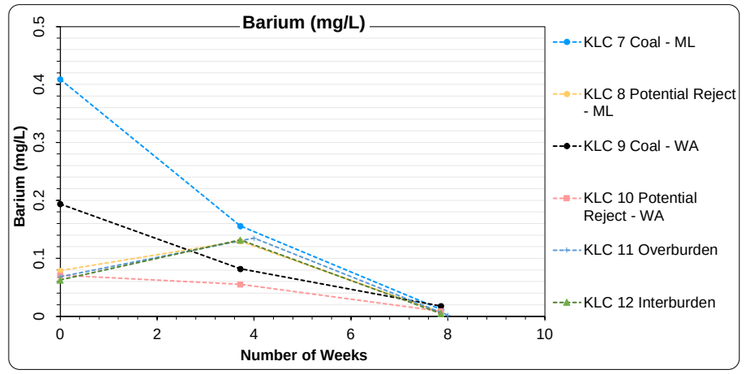

Residual ANC
Residual ANC (%)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

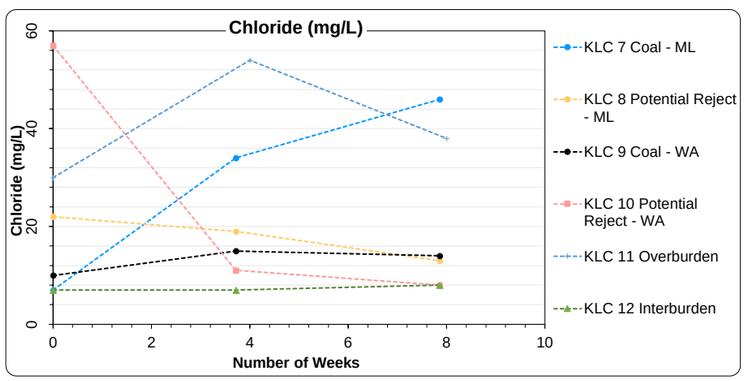

Magnesium (mg/L)
Magnesium (mg/L)
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

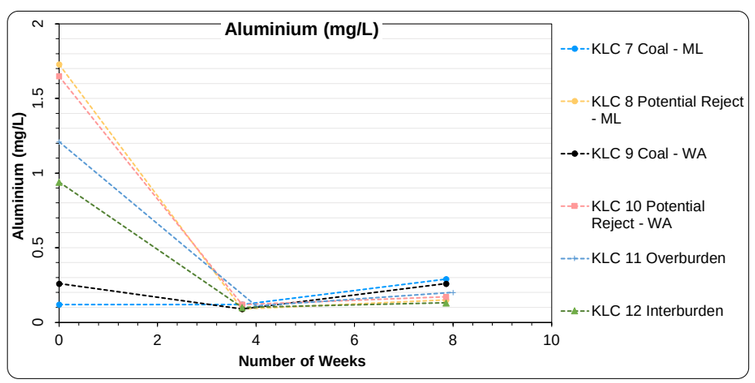
KLC Plots

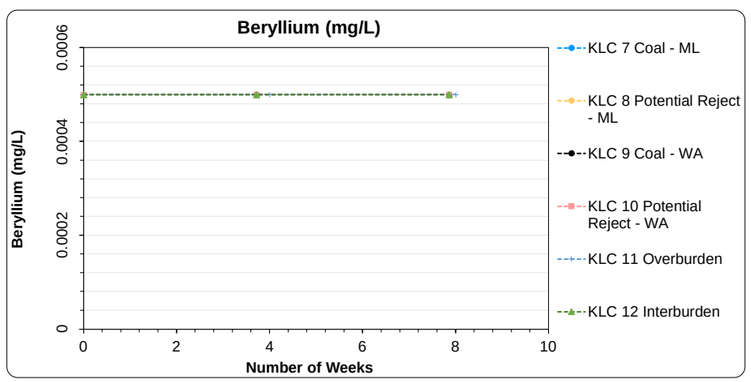

Sodium (mg/L)
Sodium (mg/L)
0
20
40
60
80
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

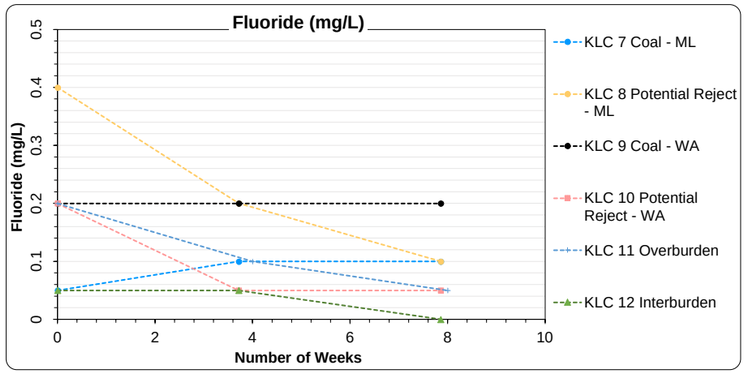

Sulfate (mg/L)
Sulfate (mg/L)
0
5
10
15
20
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

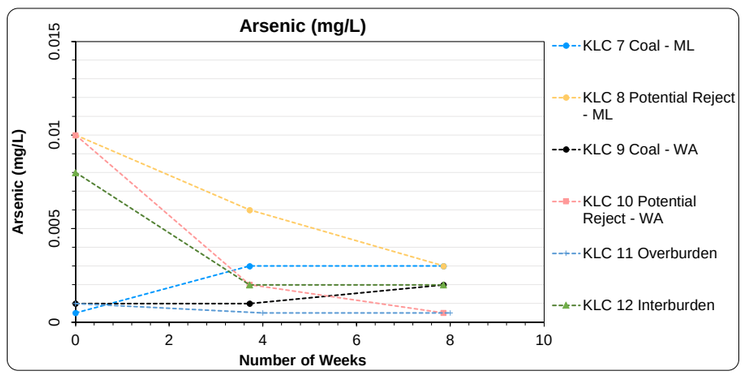

Barium (mg/L)
Barium (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

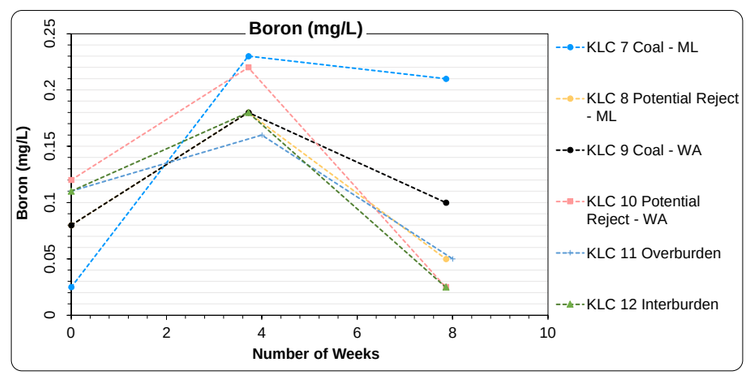

Chloride (mg/L)
Chloride (mg/L)
0
20
40
60
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Aluminium (mg/L)
Aluminium (mg/L)
0
0.5
1
1.5
2
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

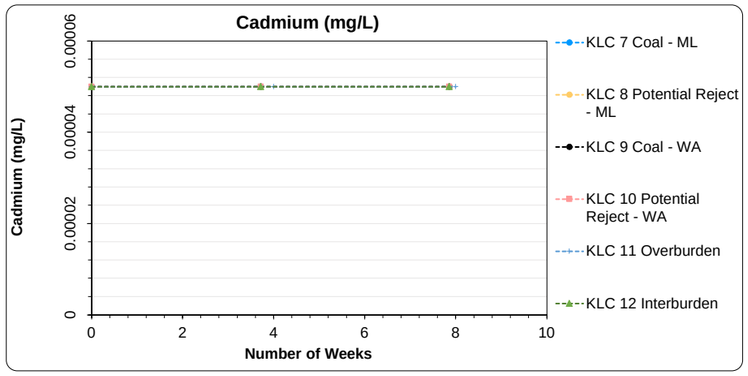

Beryllium (mg/L)
Beryllium (mg/L)
0
0.0002
0.0004
0.0006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

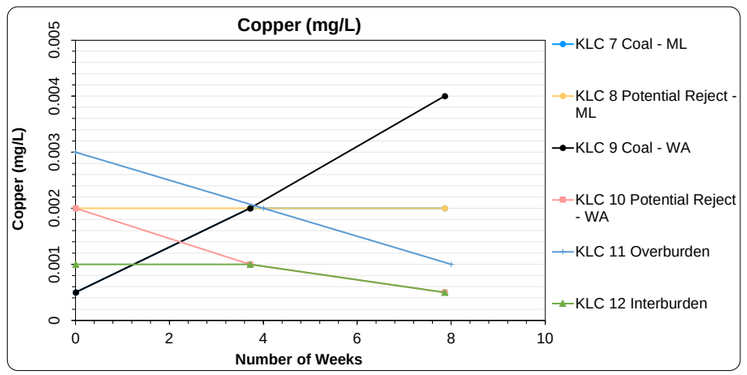

Fluoride (mg/L)
Fluoride (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

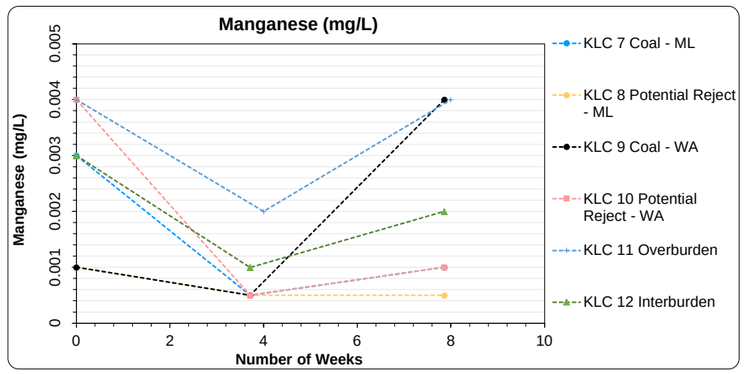

Arsenic (mg/L)
Arsenic (mg/L)
0
0.005
0.01
0.015
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

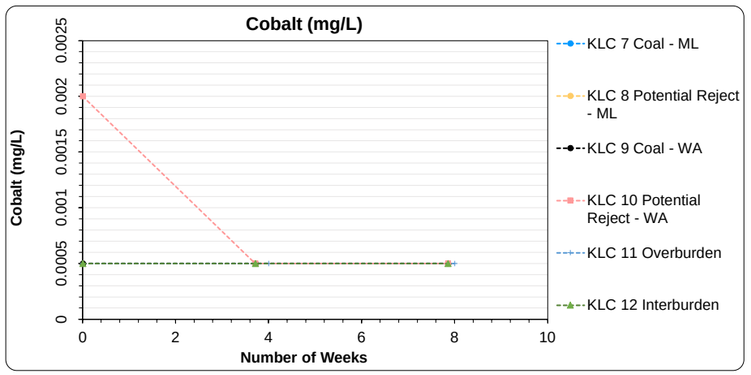

Boron (mg/L)
Boron (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

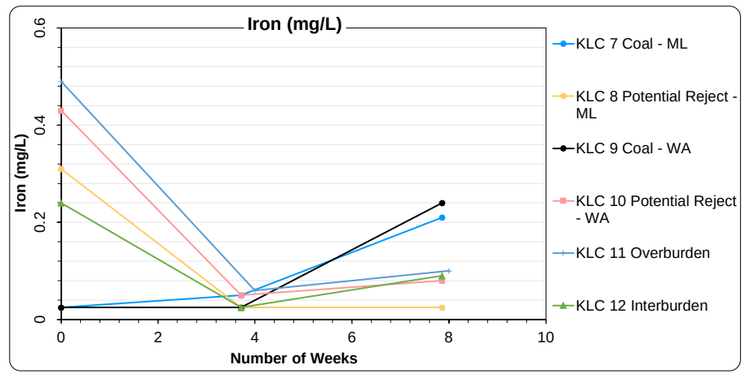
KLC Plots

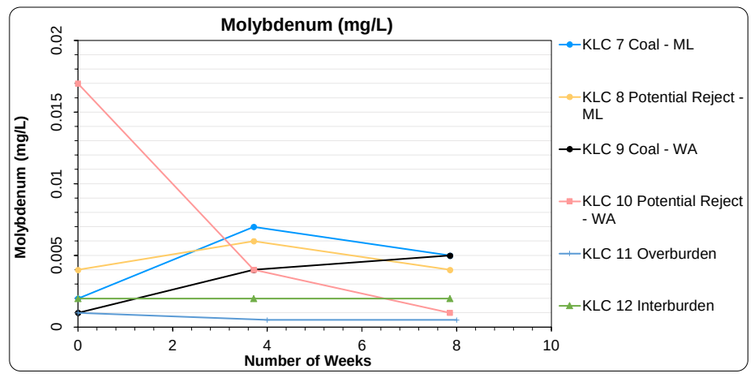

Cadmium (mg/L)
Cadmium (mg/L)
0
0.00002
0.00004
0.00006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

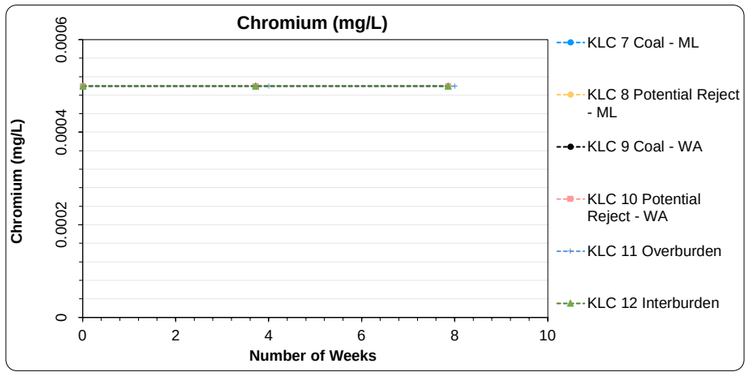

Copper (mg/L)
Copper (mg/L)
0
0.001
0.002
0.003
0.004
0.005
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

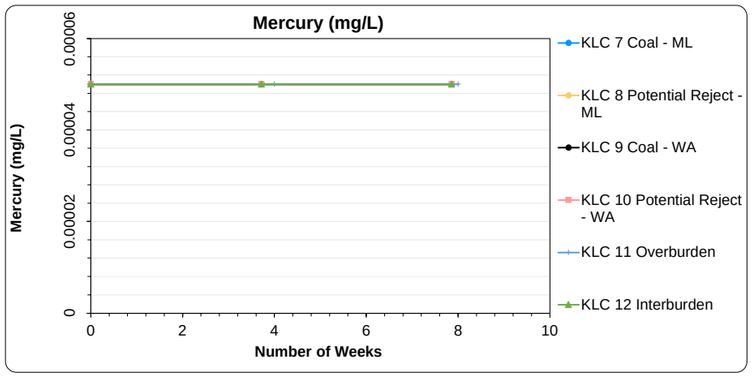

Manganese (mg/L)
Manganese (mg/L)
0
0.001
0.002
0.003
0.004
0.005
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

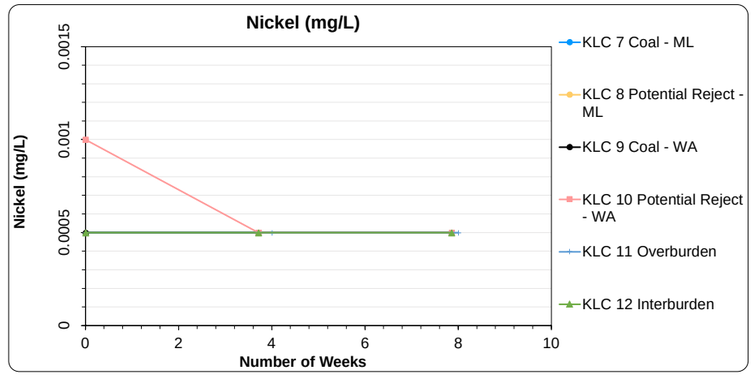

Cobalt (mg/L)
Cobalt (mg/L)
0
0.0005
0.001
0.0015
0.002
0.0025
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Iron (mg/L)
Iron (mg/L)
0
0.2
0.4
0.6
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

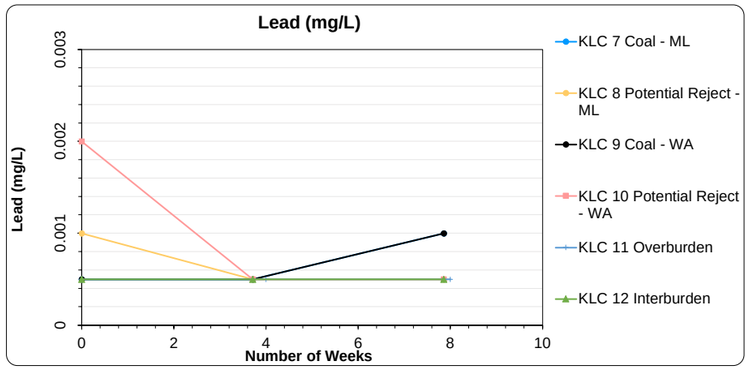

Molybdenum (mg/L)
Molybdenum (mg/L)
0
0.005
0.01
0.015
0.02
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

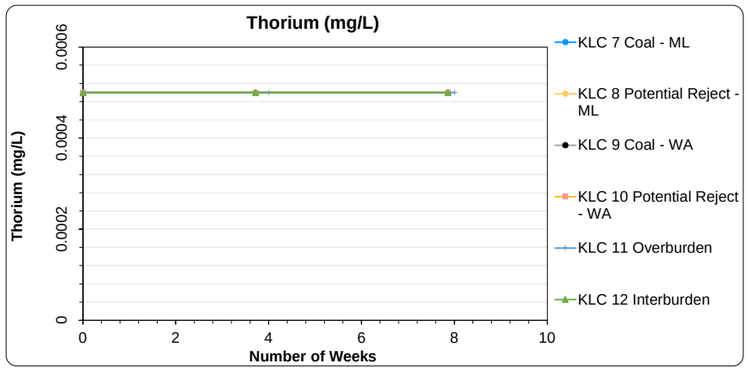

Chromium (mg/L)
Chromium (mg/L)
0
0.0002
0.0004
0.0006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

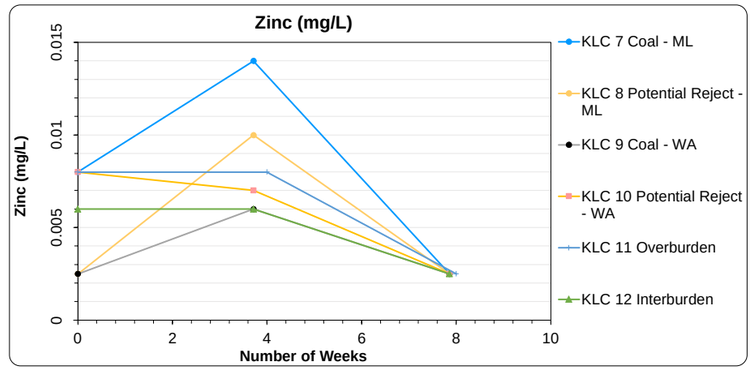

Mercury (mg/L)
Mercury (mg/L)
0
0.00002
0.00004
0.00006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

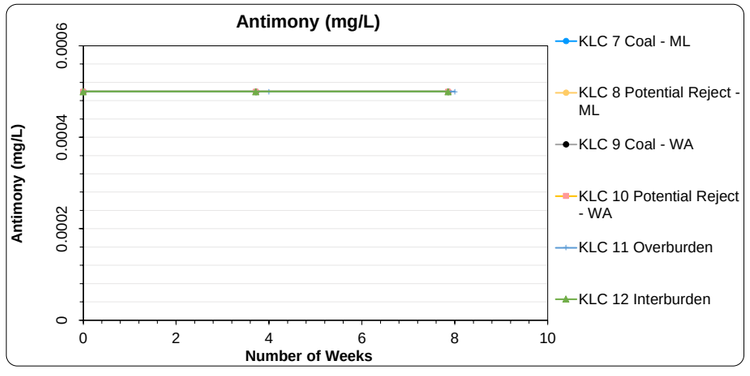

Nickel (mg/L)
Nickel (mg/L)
0
0.0005
0.001
0.0015
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

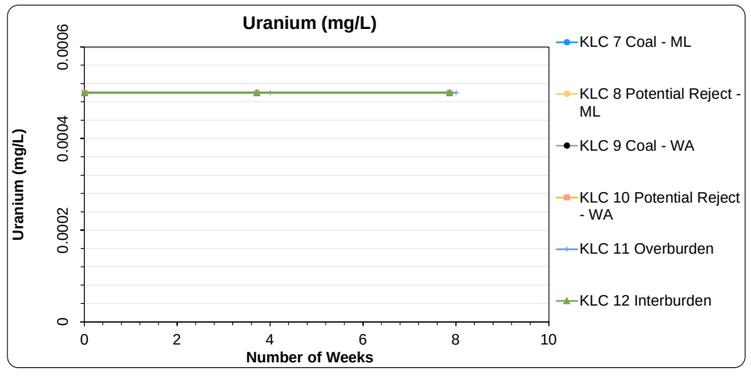
KLC Plots

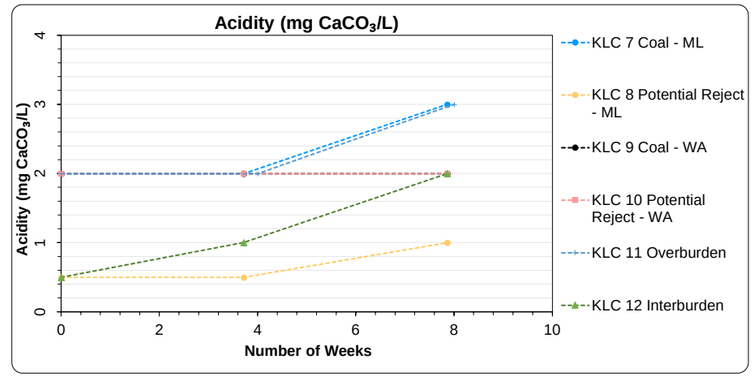

Lead (mg/L)
Lead (mg/L)
0
0.001
0.002
0.003
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

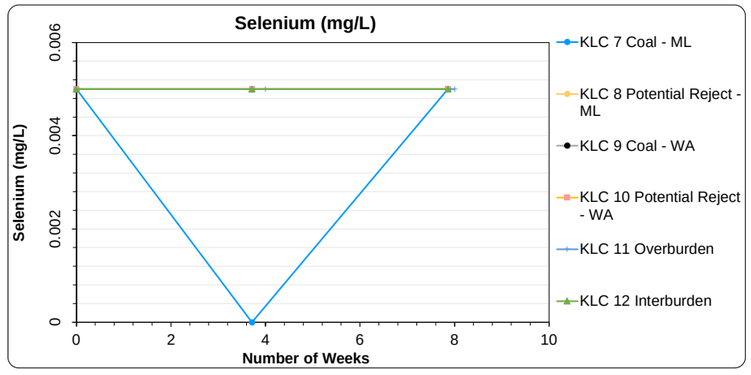

Thorium (mg/L)
Thorium (mg/L)
0
0.0002
0.0004
0.0006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

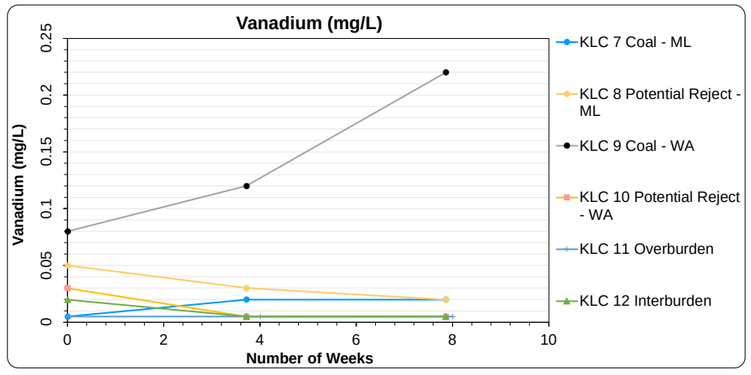

Zinc (mg/L)
Zinc (mg/L)
0
0.005
0.01
0.015
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

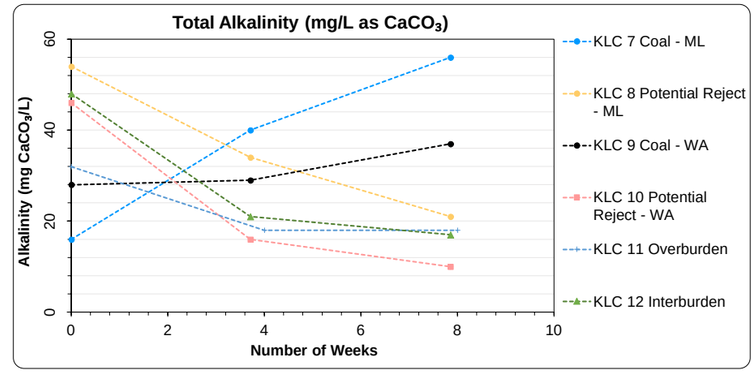

Antimony (mg/L)
Antimony (mg/L)
0
0.0002
0.0004
0.0006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Uranium (mg/L)
Uranium (mg/L)
0
0.0002
0.0004
0.0006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Acidity (mg CaCO3/L)
Acidity (mg CaCO3/L)
0
1
2
3
4
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Selenium (mg/L)
Selenium (mg/L)
0
0.002
0.004
0.006
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Vanadium (mg/L)
Vanadium (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden


Total Alkalinity (mg/L as CaCO3)
Alkalinity (mg CaCO3/L)
0
20
40
60
0
2
4
6
8
10
Number of Weeks
KLC 7 Coal - ML
KLC 8 Potential Reject - ML
KLC 9 Coal - WA
KLC 10 Potential Reject - WA
KLC 11 Overburden
KLC 12 Interburden

Attachment D: Sample catalogue

TEST PIT LOG

TEST PIT: Hole ID: **WANTP**
Top of Hole: **0.0 m**
End of Hole: **7.5 m**

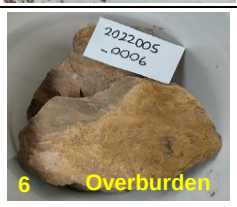
Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Client: Glencore
Project: 2022005_Glencore Wandoan
Site:
Method:
Contractor:
Log Date: 02/03/2022

Coordinates: -26.092648 North
149.911176 East
GCS:
Logged by:
Datum:
Page: 1 of 1

Depth	Unit	Graphic	Material	Moisture	Strength	Density
			Topsoil/Soil 0 - 0.6 m (60 cm thickness) "The top soil was skimmed, and the soil taken immediately beneath. The grader then cam through for a second pass, ripping to ~600mm and the subsoil sample was then taken." 2022005_0001 to 2022005_0002	D to M	S	VL
1.0			Subsoil 600 mm 0.6 - 1.7 m 2022005_0003 to 2022005_0004	D to M	S	VL
2.0			Overburden 1700 mm 1.7 - 2.2 m "Taken from same location as soil samples at 1700mm depth." 2022005_0005 to 2022005_0006 Total thickness 0.5 m	D	S to F	VL to MD
3.0			WS1A - Poor Quality Coal (MU) "Coal from working section 1A (MU10A to MU32)." 2022005_0008 to 2022005_0012 WS1A is 2.2 - 4.0 m (1.8 m thickness)	D	F	L
4.0			Interburden WS1B - Carbonaceous siltstone "Sample of the interburden between working section 1a (McAlister Upper MU32) and working section 1b (McAlister upper MU41A)." 2022005_0007 (4.0 - 4.4 m, 40 cm thickness)	D	F	L
5.0			WS1B - Coal (Macalister Upper) "Coal from working section 1B (MU41A to MU50)." 20220005_0013 to 2022005_0016 WS1B is 4.4 to 7.0 m (2.6 m thickness)	D	F	L
6.0						
7.0			MU/ML Interburden - Siltstone "Sample of the interburden between working section 1 (McAlister Upper MU50) and working section 2 (McAlister lower ML11A)." 2022005_0017 to 2022005_0018 (Depth to ML11A is 8.3 m)	D	F	MD
8.0						

Sample photographs



Field photographs

SOIL

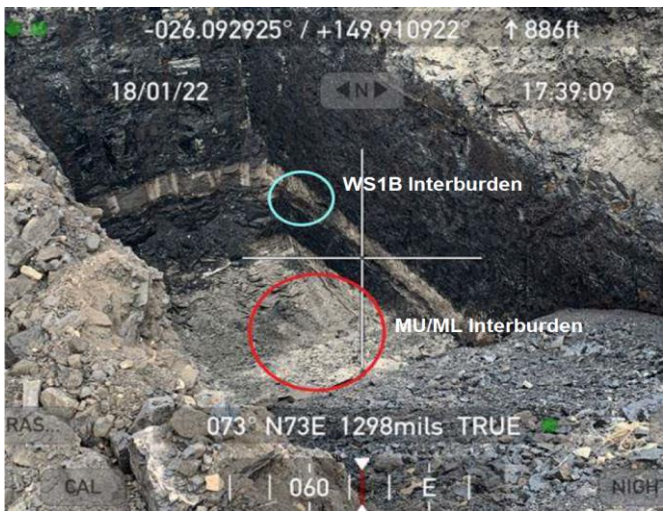
OVERBURDEN

No photo

WS1A

WS1B

WS1B Interburden and MU/ML Interburden



Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **C9605GP**
Top of Hole: **0.0 m**
End of Hole: **41.32 m**

Client:	Glencore
Project:	2022005_Glencore Wandoan
Site:	
Method:	Diamond drill - core (FC)
Contractor:	
Log Date:	03/12/2023

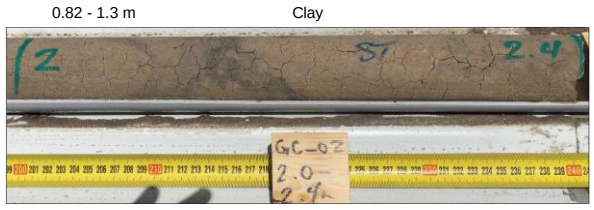
Coordinates: 7105731 North ML50230
788224 East
GCS:
Logged by:
Datum: GDA z55
Page: 1 of 2

- Soil (Clay)
- Saprolite (Silt, Claystone)
- Mudstone
- Sandstone
- Sandstone, Mudstone
- Sandstone, Siltstone
- Siltstone
- Siltstone, Sandstone
- Siltstone ± Carbonaceous
- Carbonaceous Siltstone
- Coal

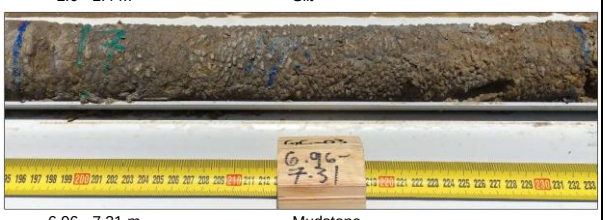
Depth	Unit	Graphic	Material	Moisture	Strength	Density
			2022005_051	M	VS	MD
			Clay, greyish speckled brown, silty rare (<1%) disseminated granules residual soil, soft, broken core, high plasticity, gradational basal contact			
			2022005_052	D	VS	MD
			Silt, greyish medium brown, clayey rare (<1%) disseminated sandy residual soil, soft, solid core, high plasticity, gradational basal contact			
3.0						
				M	VS	MD
6.0						
			2022005_053			
			Mudstone, greyish mottled brown, silty in part distinctly weathered, extremely low strength rock, thickly laminated (6-20 mm) solid core, gradational basal contact			
9.0				D	S	MD
			2022005_054			
			Sandstone, fine grained, light brown, lithic rare (<1%) claystone bands, distinctly weathered, low strength rock, very thinly bedded (20-60 mm), solid core, erosional basal contact, rare (<1%) carbonaceous remains on bedding planes			
12.0				D	S	MD
			2022005_055			
			Siltstone, light grey, slightly sandy in part slightly weathered, very low strength rock, thickly laminated (6-20 mm), solid core, basal contact open or readily parts, rare (<1%) iron oxide on joints			
15.0			2022005_056			
			Carbonaceous siltstone, dark grey, rare (<1%) coaly stringer fresh, low strength rock, thickly laimated (6-20 mm), solid core, sharp and irregular basal contact, abundant (30-60%) carbonaceous remains on bedding planes			
				?	?	?
18.0						
			2022005_057	D	F	VD
			50% siltstone, medium grey, rare (<1%) carbonaceous wisps, fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact, rare (1%) carbonaceous remains on bedding planes. Irregularly interbedded with 50% sandstone, fine grained, light grey, silty slightly calcareous in part fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact			
21.0			2022005_058			
			Siltstone, medium grey, slightly carbonaceous near base of unit, fresh, low strength rock, thinly bedded (60-200 mm) solid core, gradational basal contact, rare (<1%) carbonaceous remains on bedding planes			
24.0				D	St	MD
			2022005_059			
			Mudstone, medium grey, minor (1-15%) sideritic clasts near base of unit, fresh, low strength rock, massive/absent bedding, solid core	D	St	MD
27.0						

Sample photographs

0.82 - 1.3 m Clay



2.0 - 2.4 m Silt



6.96 - 7.31 m Mudstone

11.0 - 11.4 m Sandstone

14.0 - 14.24 m Siltstone ± Carbonaceous

PHOTO MISSING

15.48 - 15.63 m Carbonaceous Siltstone

20.0 - 20.37 m Siltstone, Sandstone

21.9 - 22.4 m Siltstone

26.01 - 26.4 m Mudstone

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)	
C9605GP_GC_01	0.82	1.3	CL	2.329	
C9605GP_GC_02	2	2.4	SI	2.415	
C9605GP_GC_03	6.96	7.31	MS	1.91	
C9605GP_GC_04	11	11.4	SS	2.348	
C9605GP_GC_05	14	14.25	ST,XT	1.368	
C9605GP_GC_06	15.48	15.63	XT	0.718	Photo missing
C9605GP_GC_07	20	20.37	ST,SS	2.577	
C9605GP_GC_08	21.9	22.4	ST	3.483	
C9605GP_GC_09	26.01	26.4	MS	2.648	
C9605GP_GC_10	26.7	26.97	MS	1.906	
C9605GP_GC_11	26.97	27.38	ST,SS	2.829	
C9605GP_GC_12	28.46	28.63	MS	1.018	
C9605GP_GC_13	34.79	35.22	SS,MS	2.873	
C9605GP_GC_14	36.38	36.99	SS,MS	4.161	
C9605GP_GC_15	40.64	41	ST	2.472	
C9605GP_GC_16	41	41.32	XM,CO,KL	1.6454	

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **C9605GP**
Top of Hole: **0.0 m**
End of Hole: **41.32 m**

Client:	Glencore	Coordinates:	7105731 North ML50230
Project:	2022005_Glencore Wandoan		788224 East
Site:		GCS:	
Method:	Diamond drill - core (FC)	Logged by:	
Contractor:		Datum:	GDA z55
Log Date:	03/12/2023	Page:	2 of 2

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Unit	Graphic	Material	Moisture	Strength	Density
26.0			2022005_060	D	St	MD
			Mudstone, medium grey, slightly silty in part fresh, low strength rock, massive/absent bedding, solid core, gradational basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_061			
			50% siltstone, medium grey, rare (<1%) carbonaceous wisps, fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact, rare (1%) carbonaceous remains on bedding planes interlaminated with 50% sandstone, fine grained, light grey, slity slightly calcareous in part fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact	D	St	MD
28.0			2022005_062			
			Mudstone, medium grey, tends to carbonaceous fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and planar basal contact	D	F	MD
30.0						
32.0						
34.0			2022005_063	D	F	MD
			Sandstone, fine grained, light grey, fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and planar basal contact. Mudstone, medium grey, rare (<1%) carbonaceous wisps near base of unit fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and planar basal conatct			
36.0			2022005_064	D	St	MD
			Sandstone, fine grained, light grey, lithic rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20 mm), solid core, gradational basal contact. Mudstone, light grey, silty carbonaceous near base of unit fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and irregular basal contact			
38.0				D	F	MD
40.0			2022005_065	D	F	MD
			Siltstone, medium grey, clayey rare (<1%) carbonaceous wisps fresh, very low strength rock, thickly laminated (6-20 mm) broken core, micro faulted, sharp and irregular basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_066			
42.0			Carbonaceous mudstone, dark grey, common (15-30%) coaly laminae (2-20 mm) fresh, low strength rock, thickly laminated (6-20 mm), solid core, basal contact open or readily parts, abundant (30-60%) carbonaceous remains on bedding planes. Coal, mainly dull with frequent bright bands (10-40%) bright coal), black, fresh, very low strength rock, thickly laminated (6-20 mm), very broken core, friable, basal contact.			

Sample photographs

26.7 - 26.97 m (or 26.87 - 27.1 m?) Mudstone

26.97 - 27.38 m (or 27.1 - 27.5 m?) Siltstone, Sandstone

28.46 - 28.63 m Mudstone

34.79 - 35.22 m Sandstone, Mudstone

36.38 - 36.99 m Sandstone, Mudstone

40.64 - 41.0 m Siltstone

41.0 - 41.32 m Carbonaceous Mudstone ± Coal

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)	
C9605GP_GC_01	0.82	1.3	CL	2.329	
C9605GP_GC_02	2	2.4	SI	2.415	
C9605GP_GC_03	6.96	7.31	MS	1.91	
C9605GP_GC_04	11	11.4	SS	2.348	
C9605GP_GC_05	14	14.25	ST,XT	1.368	
C9605GP_GC_06	15.48	15.63	XT	0.718	Photo missing
C9605GP_GC_07	20	20.37	ST,SS	2.577	
C9605GP_GC_08	21.9	22.4	ST	3.483	
C9605GP_GC_09	26.01	26.4	MS	2.648	
C9605GP_GC_10	26.7	26.97	MS	1.906	
C9605GP_GC_11	26.97	27.38	ST,SS	2.829	
C9605GP_GC_12	28.46	28.63	MS	1.018	
C9605GP_GC_13	34.79	35.22	SS,MS	2.873	
C9605GP_GC_14	36.38	36.99	SS,MS	4.161	
C9605GP_GC_15	40.64	41	ST	2.472	
C9605GP_GC_16	41	41.32	XM,CO,KL	1.6454	

Note: Spontaneous combustion coal samples not shown

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **C9606GP**
Top of Hole: **0.0 m**
End of Hole: **35.5 m**

Client:	Glencore	Coordinates:	7110731 North ML50230
Project:	2022005_Glencore Wandoan		790893 East
Site:		GCS:	
Method:	Diamond drill - core (FC)	Logged by:	
Contractor:		Datum:	GDA z55
Log Date:	06/12/2023	Page:	1 of 3

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Unit	Graphic	Material	Moisture	Strength	Density
			2022005_067	W	VS	L
			Soil, greyish dark brown, clayey slightly sandy residual soil, soft, very broken core, gradational basal contact			
2.0				M	VS	VL
			2022005_068			
			Claystone, creamy mottled brown, silty in part extremely weathered, extremely low strength rock, thinly bedded (60-200 mm), very broken core, puggy, gradational basal contact			
4.0				M	S	MD
6.0						
			2022005_069	D	F	MD
8.0			60% Siltstone, creamy mottled brown, clayey extremely weathered, extremely low strength rock, thinly bedded (60-200 mm), broken core, sharp and irregular basal contact, interbedded with 40% Sandstone, fine grained, creamy light to medium brown, silty clayey matrix extremely weathered, extremely low strength rock, thinly bedded (60 - 200 mm) broken core, core, sharp and irregular basal contact			
10.0			2022005_070	D	St	MD
			90% Sandstone, fine grained, light grey, lithic rare (<1%) coarser grains fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact, interlaminated with 10% Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact			
12.0			2022005_071	D	St	MD
			90% Siltstone, medium grey, rare (<1%) carbonaceous wisps, fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and irregular basal contact, rare (<1%) carbonaceous remains on bedding planes. Irregularly interbedded with 10% Sandstone, fine grained, grey lithic silty fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and irregular basal contact			
14.0			2022005_072			
			Sandstone, fine grained, light grey, lithic slightly iron stained near top of unit, fresh, low strength rock, thickly laminated (6-20 mm), solid core, erosional basal contact			
16.0						
18.0						

Sample photographs

0.3 - 0.63 m Soil

3.2 - 3.5 m Clayey sand

7.95 - 8.4 m Siltstone, Sandstone

11.3 - 11.62 m Sandstone, Siltstone

12.99 - 13.3 m Siltstone, Sandstone

14.4 - 14.59 m Sandstone

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C6906GP_GC_01	0.3	0.63	SO	1.689
C6906GP_GC_02	3.2	3.5	CS	2.248
C6906GP_GC_03	7.95	8.4	ST,SS	3.131
C6906GP_GC_04	11.3	11.62	SS,ST	2.178
C6906GP_GC_05	12.99	13.3	ST,SS	2.249
C6906GP_GC_06	14.4	14.59	SS	1.362
C6906GP_GC_07	15.91	16.14	ST,XT	1.449
C6906GP_GC_08	20.5	20.58	XM	0.525
C6906GP_GC_09	23	23.11	MS	0.645
C6906GP_GC_10	23.99	24.54	SS,ST	3.705
C6906GP_GC_11	28	28.66	CO,ST,ZM	3.991
C6906GP_GC_12	29.49	29.79	ST	2.051
C9606GP_SP_01	30.07	30.27	CO,TF	0.85
C6906GP_GC_13	30.67	31	ST,SS	2.185
C6906GP_GC_14	32.07	32.53	ST	2.987
C6906GP_GC_15	34.06	34.42	ST,SS	2.41
C6906GP_GC_16	35.69	36.02	ST	2.299
C9606GP_SP_04	35.31	35.46	CO	0.581

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **C9606GP**
Top of Hole: **0.0 m**
End of Hole: **35.5 m**

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Client: Glencore
Project: 2022005_Glencore Wandoan
Site:
Method: Diamond drill - core (FC)
Contractor:
Log Date: 06/12/2023

Coordinates: 7110731 North ML50230
790893 East
GCS:
Logged by:
Datum: GDA z55
Page: 2 of 3

Depth | Unit | Graphic | Material | Moisture | Strength | Density

16.0
2022005_073
Carbonaceous siltstone, dark grey, rare (<1%) coaly mudstone bands, fresh, low strength rock, thickly laminated (6-20 mm) solid core, basal contact open or readily parts, abundant (30-60%) carbonaceous remains on bedding planes

18.0
20.0
2022005_074
Carbonaceous mudstone, dark grey, fresh, low strength rock, thickly laminated (6-20 mm) solid core, gradational basal contact

22.0
2022005_075
Tuff, silt sized, brownish dark grey, fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and planar basal contact

24.0
2022005_076
Sandstone, fine grained, light grey, rare (<1%) siltstone laminae (2-20 mm) fresh, low strength rock, thickly laminated (6-20 mm), solid core, sharp and planar basal contact

26.0
2022005_077
Siltstone, medium grey, rare (<1%) coaly laminae (2-20 mm) fresh, low strength rock, thickly laminated (6-20 mm), solid core, sheared at basal contact, rare (<1%) carbonaceous remains on bedding planes. Coaly Mudstone, dark grey, fresh, very low strength rock, thickly laminated (6-20 mm), very broken core, sheared, sheared at basal contact

28.0
Macalister Lower
2022005_078
Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20 mm), solid core, basal contact open or readily parts, rare (<1%) carbonaceous remains on bedding planes

30.0
2022005_088
Coal, dull (<1% bright coal, black, fresh, low strength rock, thickly laminated (6-20 mm) solid core, gradational basal contact
Macalister Lower

32.0

Sample photographs

15.91 - 16.14 m Siltstone ± Carbonaceous

20.5 - 20.58 m Carbonaceous Mudstone

23.0 - 23.11 m Tuff

23.99 - 24.54 m Sandstone, Siltstone

28.0 - 28.66 m Coal, Siltstone

29.49 - 29.79 m Siltstone

30.07 - 30.27 m (~30.31 - 30.51 m) Coal

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C6906GP_GC_01	0.3	0.63	SO	1.689
C6906GP_GC_02	3.2	3.5	CS	2.248
C6906GP_GC_03	7.95	8.4	ST,SS	3.131
C6906GP_GC_04	11.3	11.62	SS,ST	2.178
C6906GP_GC_05	12.99	13.3	ST,SS	2.249
C6906GP_GC_06	14.4	14.59	SS	1.362
C6906GP_GC_07	15.91	16.14	ST,XT	1.449
C6906GP_GC_08	20.5	20.58	XM	0.525
C6906GP_GC_09	23	23.11	MS	0.645
C6906GP_GC_10	23.99	24.54	SS,ST	3.705
C6906GP_GC_11	28	28.66	CO,ST,ZM	3.991
C6906GP_GC_12	29.49	29.79	ST	2.051
C9606GP_SP_01	30.07	30.27	CO,TF	0.85
C6906GP_GC_13	30.67	31	ST,SS	2.185
C6906GP_GC_14	32.07	32.53	ST	2.987
C6906GP_GC_15	34.06	34.42	ST,SS	2.41
C6906GP_GC_16	35.69	36.02	ST	2.299
C9606GP_SP_04	35.31	35.46	CO	0.581

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

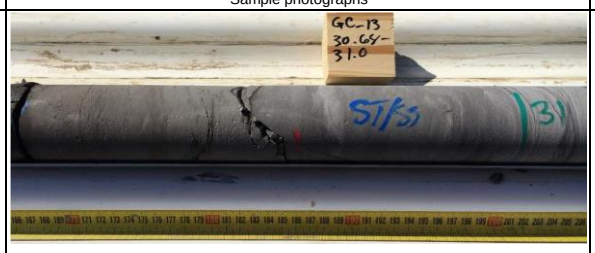
Hole ID: **C9606GP**
Top of Hole: **0.0 m**
End of Hole: **35.5 m**

Client:	Glencore	Coordinates:	7110731 North ML50230
Project:	2022005_Glencore Wandoan		790893 East
Site:		GCS:	
Method:	Diamond drill - core (FC)	Logged by:	
Contractor:		Datum:	GDA z55
Log Date:	06/12/2023	Page:	3 of 3

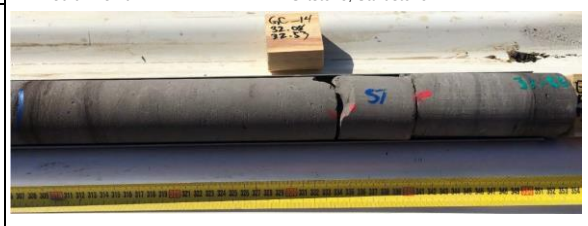
Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Unit	Graphic	Material	Moisture	Strength	Density
30.0				D	F	VD
			2022005_079	D	St	VD
31.0			90% Siltstone, light grey, fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes. Irregularly interbedded with 10% Sandstone, fine grained, medium grey, lithic silty, fresh, low strength rock, thickly laminated (6-20 mm) solid core, sharp and planar basal contact			
			2022005_080	D	St	MD
32.0			Siltstone, medium grey, rare (<1%) slightly carbonaceous bands fresh, low strength rock, thinly bedded (60-200 mm) solid core, gradational basal contact, minor (1-15%) carbonaceous remains on bedding planes			
				D	F	MD
33.0						
34.0						
			2022005_081	D	F	MD
35.0			Coal, dull with minor bright bands (1-10% bright coal) black, fresh, very low strength rock, thickly laminated (6-20 mm), broken core, basal contact open or readily parts			
			Wambo			
			2022005_089			
36.0			Siltstone, medium grey, slightly carbonaceous near top of unit, fresh, low strength rock, thickly laminated (6-20 mm), broken core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
37.0						
38.0						

Sample photographs



30.67 - 31.0 m Siltstone, Sandstone



32.07 - 32.53 m Siltstone

34.06 - 34.42 m Siltstone, Sandstone

35.31 - 35.46 m (~35.54 - 35.69 m) Coal

35.69 - 36.02 m Siltstone

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C6906GP_GC_01	0.3	0.63	SO	1.689
C6906GP_GC_02	3.2	3.5	CS	2.248
C6906GP_GC_03	7.95	8.4	ST,SS	3.131
C6906GP_GC_04	11.3	11.62	SS,ST	2.178
C6906GP_GC_05	12.99	13.3	ST,SS	2.249
C6906GP_GC_06	14.4	14.59	SS	1.362
C6906GP_GC_07	15.91	16.14	ST,XT	1.449
C6906GP_GC_08	20.5	20.58	XM	0.525
C6906GP_GC_09	23	23.11	MS	0.645
C6906GP_GC_10	23.99	24.54	SS,ST	3.705
C6906GP_GC_11	28	28.66	CO,ST,ZM	3.991
C6906GP_GC_12	29.49	29.79	ST	2.051
C9606GP_SP_01	30.07	30.27	CO,TF	0.85
C6906GP_GC_13	30.67	31	ST,SS	2.185
C6906GP_GC_14	32.07	32.53	ST	2.987
C6906GP_GC_15	34.06	34.42	ST,SS	2.41
C6906GP_GC_16	35.69	36.02	ST	2.299
C9606GP_SP_04	35.31	35.46	CO	0.581

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **C9610GP**
Top of Hole: **0.0 m**
End of Hole: **46.5 m**

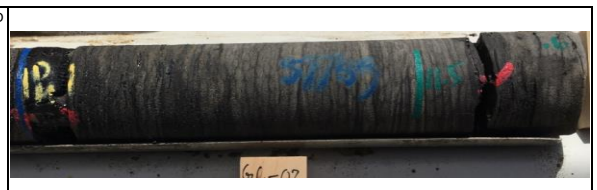
Client:	Glencore	Coordinates:	7108342 North ML50230
Project:	2022005_Glencore Wandoan		792609 East
Site:		GCS:	
Method:	Diamond drill - core (FC)	Logged by:	
Contractor:		Datum:	GDA z55
Log Date:	07/01/2024	Page:	1 of 3

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

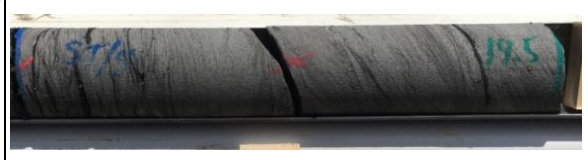
Depth	Unit	Graphic	Material	Moisture	Strength	Density
			2022005_0090	D	F	MD
6.0			Sandstone, fine to medium grained , light grey, lithic kaolinitic matrix slightly weathered, very low strength rock, very thinly bedded (20-60mm), solid core, high slaking, erosional basal contact			
8.0			2022005_0091	D	F	MD
10.0			50% Siltstone, medium grey, slightly carbonaceous in part fresh, very low strength rock, thickly laminated (6-20mm), solid core, sharp and irregular basal contact, interlaminated with 50% Sandstone, medium grained , light grey, lithic kaolinitic matrix fresh, very low strength rock, thickly laminated (6-20mm), solid core, high slaking, erosional basal contact	D	F	MD
12.0			2022005_0092	D	F	MD
14.0			90% Sandstone, fine to medium grained , light grey, lithic rare (<1%) coaly clasts fresh, low strength rock, very thinly bedded (20-60mm), solid core, erosional basal contact, Irregularly interbedded with 10% Siltstone, medium grey, slightly carbonaceous in part fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_0093	D	F	L
16.0			80% Siltstone, medium grey, slightly carbonaceous in part fresh, very low strength rock, thickly laminated (6-20mm), solid core, sharp and irregular basal contact, rare (<1%) carbonaceous remains on bedding planes interlaminated with 20% Sandstone, fine to medium grained, light grey, lithic rare (<1%) coaly clasts fresh, very low strength rock, thickly laminated (6-20mm), solid core, high slaking, erosional basal contact			
			2022005_0094			
18.0			Coal, stony, black, tends to highly coaly mudstone fresh, very low strength rock, thickly laminated (6-20mm), very broken core, basal contact open or readily parts			
			Macalister Upper	D	F	MD
			2022005_0095			
			Siltstone, medium grey, slightly clayey fresh, very low strength rock, thickly laminated (6-20mm), shear zone, broken core, sheared, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_0111			
20.0			Coal, mainly dull with frequent bright bands (10-40% bright coal), black, fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact , MU40	D	F	L
			Macalister Upper			

Sample photographs

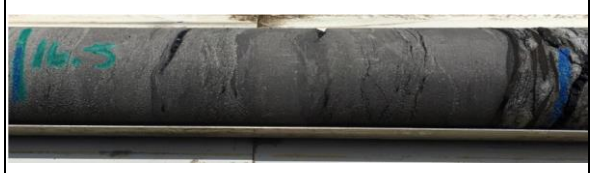
6.06 - 6.32 m Sandstone



11.29 - 11.6 m Sandstone, Siltstone



14.12 - 14.5 m Sandstone, Siltstone



16.5 - 16.76 m Siltstone, Sandstone

20.13 - 20.3 m Coal

18 - 19.31m Siltstone

20.13 - 20.3 m Coal

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C9610GP_GC_01	6.06	6.32	SS	1.629
C9610GP_GC_02	11.29	11.6	SS, ST	2.099
C9610GP_GC_03	14.12	14.5	SS, ST	2.489
C9610GP_GC_04	16.5	16.76	ST, SS	1.72
C9610GP_GC_05	17.47	17.6	CO	0.569
C9610GP_GC_06	18	19.31	ST	1.926
C9610GP_SP_01	20.13	20.3	CO	0.777
C9610GP_GC_07	21.48	21.75	XM	1.244
C9610GP_SP_02	23.2	23.4	CO	0.791
C9610GP_GC_08	24.41	24.63	ST	1.318
C9610GP_GC_09	28.11	28.52	ST, XM, CO	2.056
C9610GP_GC_10	29.53	29.85	SS	1.962
C9610GP_GC_11	32.1	32.48	MS	2.507
C9610GP_GC_12	35.6	35.9	MS	2.003
C9610GP_GC_13	36.34	36.74	MS	2.491
C9610GP_SP_03	38.57	38.6	CO	0.529
C9610GP_GC_14	38.64	38.9	SS, ST	1.757
C9610GP_GC_15	39.58	39.79	TF	1.166
C9610GP_GC_16	41.2	41.81	ST, SS	4.314
C9610GP_GC_17	42.59	42.98	ST	2.605
C9610GP_GC_18	44.27	44.5	XM	1.472
C9610GP_GC_19	44.98	45.26	XM	1.127
C9610GP_GC_20	45.6	45.92	SS, ST	2.2
C9610GP_GC_21	46.06	46.5	XM, CO	2.104

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

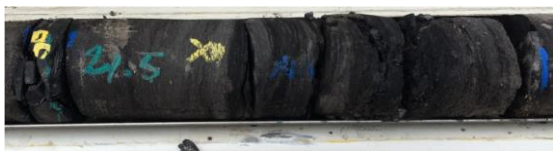
Hole ID: **C9610GP**
Top of Hole: **0.0 m**
End of Hole: **46.5 m**

Client:	Glencore	Coordinates:	7108342 North, 792609 East, ML50230
Project:	2022005_Glencore Wandoan	GCS:	
Site:		Logged by:	
Method:	Diamond drill - core (FC)	Datum:	GDA z55
Contractor:		Page:	2 of 3
Log Date:	07/01/2024		

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Unit	Graphic	Material	Moisture	Strength	Density
			2022005_0096	D	F	MD
22.0			Carbonaceous Mudstone, dark grey, rare (<1%) coaly stringers fresh, very low strength rock, thickly laminated (6-20mm), broken core, basal contact open or readily parts, abundant (30-60%) carbonaceous remains on bedding planes			
			2022005_0112	D	F	MD
			Coal, mainly dull with frequent bright bands (10-40% bright coal), black, fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact			
			Macalister Upper			
24.0			2022005_0097			
			Siltstone, medium grey, carbonaceous near base of unit fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact	D	F	MD
26.0						
			2022005_0098	D	F	L
28.0			Siltstone, medium grey, slightly carbonaceous near base of unit fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact. Coal, bright with dull bands (60-90% bright coal), black, fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact			
			2022005_0099	D	St	VD
30.0			Sandstone, fine to medium grained , light grey, lithic rare (<1%) siltstone laminae (2-20mm) fresh, low strength rock, thickly laminated (6-20mm), solid core, erosional basal contact			
			2022005_0100	D	F	MD
32.0			Mudstone, medium grey, slightly silty fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_0101	D	F	MD
34.0			Mudstone, medium grey, slightly silty fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
36.0			2022005_0102			
			Mudstone, medium grey, slightly silty fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_0113	D	F	L
38.0			Coal, mainly dull with frequent bright bands (10-40% bright coal), black, fresh, very low strength rock, thickly laminated (6-20mm), crushed core, sharp and planar basal contact			
			Wambo			

Sample photographs


21.48 - 21.75 m Carbonaceous mudstone

23.2 - 23.4 m Coal

24.41 - 24.63 m Siltstone

28.11 - 28.52 m Siltstone, Carbonaceous Mudstone, and Coal

29.53 - 29.85 m Sandstone

32.1 - 32.48 m Mudstone

35.6 - 35.9 m Mudstone

36.34 - 36.74 m Mudstone

38.57 - 38.6 m Coal

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C9610GP_GC_01	6.06	6.32	SS	1.629
C9610GP_GC_02	11.29	11.6	SS, ST	2.099
C9610GP_GC_03	14.12	14.5	SS, ST	2.489
C9610GP_GC_04	16.5	16.76	ST, SS	1.72
C9610GP_GC_05	17.47	17.6	CO	0.569
C9610GP_GC_06	18	19.31	ST	1.926
C9610GP_SP_01	20.13	20.3	CO	0.777
C9610GP_GC_07	21.48	21.75	XM	1.244
C9610GP_SP_02	23.2	23.4	CO	0.791
C9610GP_GC_08	24.41	24.63	ST	1.318
C9610GP_GC_09	28.11	28.52	ST, XM, CO	2.056
C9610GP_GC_10	29.53	29.85	SS	1.962
C9610GP_GC_11	32.1	32.48	MS	2.507
C9610GP_GC_12	35.6	35.9	MS	2.003
C9610GP_GC_13	36.34	36.74	MS	2.491
C9610GP_SP_03	38.57	38.6	CO	0.529
C9610GP_GC_14	38.64	38.9	SS, ST	1.757
C9610GP_GC_15	39.58	39.79	TF	1.166
C9610GP_GC_16	41.2	41.81	ST, SS	4.314
C9610GP_GC_17	42.59	42.98	ST	2.605
C9610GP_GC_18	44.27	44.5	XM	1.472
C9610GP_GC_19	44.98	45.26	XM	1.127
C9610GP_GC_20	45.6	45.92	SS, ST	2.2
C9610GP_GC_21	46.06	46.5	XM, CO	2.104

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE: Hole ID: **C9610GP** | Top of Hole: **0.0 m** | End of Hole: **46.5 m**

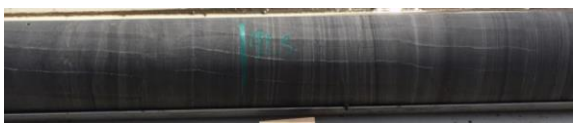
Client:	Glencore	Coordinates:	7108342 North	ML50230
Project:	2022005_Glencore Wandoan		792609 East	
Site:		GCS:		
Method:	Diamond drill - core (FC)	Logged by:		
Contractor:		Datum:	GDA z55	
Log Date:	07/01/2024	Page:	3 of 3	

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Unit	Graphic	Material	Moisture	Strength	Density
			2022005_0103	D	F	MD
			80% Sandstone, fine grained , light grey, lithic fresh, low strength rock, thickly laminated (6-20mm), solid core, erosional basal contact, interlaminated with 20% Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
39.0			2022005_0104	D	F	MD
			Tuff, silt sized, creamy light brown, fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact			
40.0			2022005_0105	D	St	VD
41.0			90% Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes interlaminated with 10%. Sandstone, fine grained , light grey, silty fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact	D	F	MD
42.0			2022005_0106			
			Siltstone, light to medium grey, sandy common (15-30%) sandstone laminae (2-20mm) fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes	D	S	L
43.0			2022005_0107	D	F	MD
44.0			Carbonaceous Mudstone, brownish dark grey, rare (<1%) coaly stringers fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact			
45.0			2022005_0108			
			Carbonaceous Mudstone, dark grey, rare (<1%) coaly wisps fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact	D	St	VD
			2022005_0109			
46.0			70% Sandstone, fine grained , light grey, lithic fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, interlaminated with 30% Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes			
			2022005_0110			
			Coal, dull with minor bright bands (1-10% bright coal), black, fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact	D	F	MD
47.0			Wambo			

38.64 - 38.9 m Sandstone, Siltstone

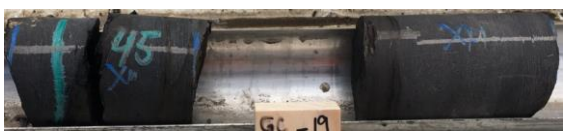
39.58 - 39.79 m Tuff



41.2 - 41.81 m Siltstone, Sandstone

42.59 - 42.98 m Siltstone

44.27 - 44.5 m Carbonaceous Mudstone



44.98 - 45.26 m Carbonaceous Mudstone

45.6 - 45.92 m Siltstone, Sandstone

46.06 - 46.5 m Carbonaceous Mudstone, Coal

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
C9610GP_GC_01	6.06	6.32	SS	1.629
C9610GP_GC_02	11.29	11.6	SS, ST	2.099
C9610GP_GC_03	14.12	14.5	SS, ST	2.489
C9610GP_GC_04	16.5	16.76	ST, SS	1.72
C9610GP_GC_05	17.47	17.6	CO	0.569
C9610GP_GC_06	18	19.31	ST	1.926
C9610GP_SP_01	20.13	20.3	CO	0.777
C9610GP_GC_07	21.48	21.75	XM	1.244
C9610GP_SP_02	23.2	23.4	CO	0.791
C9610GP_GC_08	24.41	24.63	ST	1.318
C9610GP_GC_09	28.11	28.52	ST, XM, CO	2.056
C9610GP_GC_10	29.53	29.85	SS	1.962
C9610GP_GC_11	32.1	32.48	MS	2.507
C9610GP_GC_12	35.6	35.9	MS	2.003
C9610GP_GC_13	36.34	36.74	MS	2.491
C9610GP_SP_03	38.57	38.6	CO	0.529
C9610GP_GC_14	38.64	38.9	SS, ST	1.757
C9610GP_GC_15	39.58	39.79	TF	1.166
C9610GP_GC_16	41.2	41.81	ST, SS	4.314
C9610GP_GC_17	42.59	42.98	ST	2.605
C9610GP_GC_18	44.27	44.5	XM	1.472
C9610GP_GC_19	44.98	45.26	XM	1.127
C9610GP_GC_20	45.6	45.92	SS, ST	2.2
C9610GP_GC_21	46.06	46.5	XM, CO	2.104

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **L9611**
Top of Hole: **0.0 m**
End of Hole: **51.5 m**

Client:	Glencore
Project:	2022005_Glencore Wandoan
Site:	
Method:	Large diameter- core (LD)
Contractor:	
Log Date:	10/01/2024

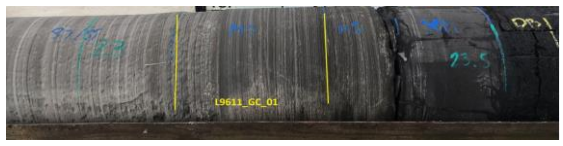
Coordinates: 7110646 North ML50230
790236 East
GCS:
Logged by:
Datum: GDA z55
Page: 1 of 1

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth | Unit | Graphic | Material | Moisture | Strength | Density | Sample photographs | Summary

20.0

D F MD



2022005__0114

Mudstone, medium grey, slightly silty fresh, medium strength rock, thickly laminated (6-20mm), solid core, sharp and planar basal contact, rare (<1%) carbonaceous remains on bedding planes

23.1 - 23.3 m Mudstone

24.0

28.0

32.0

D F MD

37.55 - 37.7 m Mudstone, Coal

36.0

D St VD

2022005__0115

Carbonaceous Mudstone, brownish dark grey, tends to coaly fresh, low strength rock, thickly laminated (6-20mm), solid core, basal contact open or readily parts. Coal, stony, black, tends to highly coaly mudstone fresh, low strength rock, thickly laminated (6-20mm), solid core, basal contact open or readily parts

Macalister Lower

2022005__0116

40.17- 40.2 m Siltstone, Sandstone

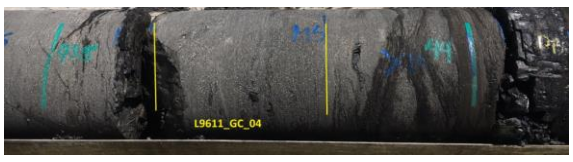
40.0

70% Siltstone, medium grey, rare (<1%) carbonaceous wisps fresh, medium strength rock, thickly laminated (6-20mm), solid core, sharp and irregular basal contact, rare (<1%) carbonaceous remains on bedding planes interlaminated with 30% Sandstone, fine grained , light grey, lithic fresh, low strength rock, thickly laminated (6-20mm), solid core, sharp and irregular basal contact

D F MD

2022005__0117

Mudstone, medium grey, rare (<1%) coaly wisps near base of unit fresh, low strength rock, thickly laminated (6-20mm), solid core, basal contact open or readily parts



43.6 - 43.84 m Mudstone

44.0

2022005__0118

Carbonaceous Mudstone, brownish dark grey, tends to tuffaceous fresh, medium strength rock, thickly laminated (6-20mm), solid core, gradational basal contact, abundant (30-60%) carbonaceous remains on bedding planes. Coal, dull (<1% bright coal), black, fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact

Wambo

D F MD

45.18 - 45.33 m Mudstone, Coal

48.0

52.0

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)
L9611_GC_01	23.1	23.3	MS	15.036
L9611_GC_02	37.55	37.7	MS, CO	9.799
L9611_GC_03	40.17	40.2	ST, SS	19.791
L9611_GC_04	43.6	43.84	MS	16.765
L9611_GC_05	45.18	45.33	MS, CO	9.426

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE: Hole ID: **L9612** | Top of Hole: **0.0 m** | End of Hole: **41.3 m**

Client:	Glencore	Coordinates:	7111668 North	ML50230
Project:	2022005_Glencore Wandoan		790893 East	
Site:		GCS:		
Method:	Large diameter- core (LD)	Logged by:		
Contractor:		Datum:	GDA z55	
Log Date:	12/01/2024	Page:	1 of 2	

Soil (Clay)
Saprolite (Silt, Claystone)
Mudstone
Sandstone
Sandstone, Mudstone
Sandstone, Siltstone
Siltstone
Siltstone, Sandstone
Siltstone ± Carbonaceous
Carbonaceous Siltstone
Coal

Depth	Material	Moisture	Strength	Density
	2022005__0119	D	St	VD
	Sandstone, fine grained , light grey, lithic minor (1-15%) siltstone laminae (2-20mm) slightly weathered, low strength rock, medium bedded (200-600mm), solid core, gradational basal contact			
8.0	2022005__0120			
	Siltstone, light to medium grey, slightly weathered, very low strength rock, thinly laminated (<6mm), solid core, gradational basal contact	D	F	MD
10.0	2022005__0121			
	Sandstone, fine grained , light grey, lithic siltstone in part fresh, medium strength rock, medium bedded (200-600mm), solid core, gradational basal contact	D	F	MD
12.0				
14.0				
16.0				
18.0				
20.0		D	F	MD
	2022005__0122			
22.0	Siltstone, light to medium grey, fresh, medium strength rock, thinly laminated (<6mm), solid core, sharp and planar basal contact. Coal, stony, black, fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact	D	F	MD
	Macalister Lower			
	2022005__0123			
	Siltstone, light to medium grey, fresh, medium 244.50 244.36 strength rock, thinly laminated (<6mm), solid core, gradational basal contact			
24.0				

Sample photographs

6.75 - 7 m Sandstone

8.25 - 8.5 m Siltstone

10.45- 10.65 m Sandstone

21.76 - 22 m Siltstone, Coal

23.6 - 23.8 m Siltstone

Summary

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)	
L9612_GC_01	6.75	7	SS	19.191	
L9612_GC_02	8.25	8.5	ST	12.854	
L9612_GC_03	10.45	10.65	SS	11.758	
L9612_GC_05	21.76	22	MS, CO	9.066	
L9612_GC_06	23.6	23.8	ST	15.801	**Not shown**
L9612_GC_07	24.12	24.26	SS	11.734	
L9612_GC_08	27.9	28.1	SS, ST	12.481	
L9612_GC_09	29.4	29.62	SS	18.068	
L9612_GC_10	31.55	31.77	SS, ST	12.657	
L9612_GC_11	34.3	34.5	ST	13.894	
L9612_GC_12	36.1	36.31	XT, SS	10.481	

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

DRILL HOLE LOG

DRILL HOLE:

Hole ID: **L9612**
Top of Hole: **0.0 m**
End of Hole: **41.3 m**

Client:	Glencore
Project:	2022005_Glencore Wandoan
Site:	
Method:	Large diameter- core (LD)
Contractor:	
Log Date:	12/01/2024

Coordinates:	7111668	North	ML50230
	790893	East	
GCS:			
Logged by:			
Datum:	GDA z55		
Page:	2 of 2		

- Soil (Clay)
- Saprolite (Silt, Claystone)
- Mudstone
- Sandstone
- Sandstone, Mudstone
- Sandstone, Siltstone
- Siltstone
- Siltstone, Sandstone
- Siltstone ± Carbonaceous
- Carbonaceous Siltstone
- Coal

Depth | Unit | Graphic | Material | Moisture | Strength | Density | Sample photographs | Summary

24.0

2022005__0124
Sandstone, fine grained , light grey, lithic minor (1-15%) siltstone laminae (2-20mm) fresh, medium strength rock, medium bedded (200-600mm), solid core, gradational basal contact

D St VD

24.12 - 24.26 m Sandstone

26.0

28.0

2022005__0125
50% Sandstone, fine grained , light grey, lithic fresh, medium strength rock, medium bedded (200-600mm), solid core, gradational basal contact 50% Siltstone, light to medium grey, fresh, medium strength rock, thinly laminated (<6mm), solid core, gradational basal contact

D St VD

27.9 - 28.1 m Sandstone, Siltstone

2022005__0126
Sandstone, fine grained , light grey, lithic minor (1-15%) siltstone laminae (2-20mm) fresh, medium strength rock, medium bedded (200-600mm), solid core, gradational basal contact

30.0

D St VD

29.4 -29.62 m Sandstone

32.0

2022005__0127
50% Sandstone, fine grained , light grey, lithic fresh, medium strength rock, medium bedded (200-600mm), broken core, gradational basal contact 50% Siltstone, light to medium grey, fresh, medium strength rock, thinly laminated (<6mm), broken core, gradational basal contact

D F MD

31.55- 31.77 m Sandstone, Siltstone

34.0

2022005__0128
Siltstone, light to medium grey, fresh, medium strength rock, thinly laminated (<6mm), solid core, gradational basal contact

D F MD

34.3 - 34.5 m Siltstone

36.0

2022005__0129
Carbonaceous Siltstone, dark grey, coarser laminae (2-20mm) throughout fresh, low strength rock, thickly laminated (6-20mm), solid core, gradational basal contact

D F MD

36.1 -36.31 m Carbonaceous Siltstone, Sandstone

38.0

40.0

Sample ID	Depth from (m)	Depth to (m)	Lithology	Mass (kg)	
L9612_GC_01	6.75	7	SS	19.191	
L9612_GC_02	8.25	8.5	ST	12.854	
L9612_GC_03	10.45	10.65	SS	11.758	
L9612_GC_05	21.76	22	MS, CO	9.066	
L9612_GC_06	23.6	23.8	ST	15.801	Not shown
L9612_GC_07	24.12	24.26	SS	11.734	
L9612_GC_08	27.9	28.1	SS, ST	12.481	
L9612_GC_09	29.4	29.62	SS	18.068	
L9612_GC_10	31.55	31.77	SS, ST	12.657	
L9612_GC_11	34.3	34.5	ST	13.894	
L9612_GC_12	36.1	36.31	XT, SS	10.481	

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Attachment E: Spontaneous combustion test report

MINING SERVICES
AUSTRALIA'S LEADER IN SPONCOM RISK ASSESSMENT AND MANAGEMENT PLANNING

SPONTANEOUS COMBUSTION TECHNICAL REPORT

SPONTANEOUS COMBUSTION HAZARD ASSESSMENT OF COAL AND REJECTS SAMPLES FROM WANDOAN MINE

B3 MINING SERVICES TECHNICAL REPORT – 2022/TR030

PREPARED FOR RGS ENVIRONMENTAL PTY LTD

JUNE, 2022

Prepared by Dr B Basil Beamish MAusIMM CP(Min) RPEQ No.12621
and
Jan Theiler AAusIMM

B3 Mining Services Pty Ltd
PO Box 1565
Toowong BC QLD 4066
Telephone: 0488 708 949
basil@b3miningservices.com

ABN 36 122 684 584

Declaration

This report and the data on which it is based are prepared solely for the use of the person or corporation to whom it is addressed. It may not be used or relied upon by any other person or entity. No warranty is given to any other person as to the accuracy of any of the information, data or opinions expressed herein. B3 Mining Services Pty Ltd expressly disclaims all liability and responsibility whatsoever to the maximum extent possible by law in relation to any unauthorised use of this report.

COMMERCIAL IN CONFIDENCE

EXECUTIVE SUMMARY

This report contains the results and analysis of spontaneous combustion testing of Wandoan coal and rejects samples.

Previous spontaneous combustion studies using an adiabatic oven have measured the self-heating rate index (R_{70}) of coals being mined around the world, including many New South Wales mining operations. Therefore, comparisons between this study and the previous studies can be used to obtain a relative indication of the intrinsic spontaneous combustion propensity of the coal and rejects samples. In addition, spontaneous combustion indices (minimum self-heating temperature and crossing point temperature) have been derived from coal quality data of the samples. These derived indices are also used to obtain a relative indication of the intrinsic propensity of the coal and rejects for spontaneous combustion.

The R_{70} self-heating rate values measured for Wandoan coal samples range from 4.91 °C/h to 6.84 °C/h, which rates the samples as having a Very High intrinsic spontaneous combustion propensity. The R_{70} self-heating rate values measured for the Wandoan rejects samples range from 0.07 °C/h to 0.72 °C/h which rates the samples as having a Low to Low-Medium intrinsic spontaneous combustion propensity. These values are consistent with the rank, type and ash contents of the samples. It should be noted that the R_{70} test is performed on a dry basis and as such it does not provide any indication of the time taken to reach thermal runaway. Calculated spontaneous combustion index values for minimum self-heating temperature and crossing point temperature generally indicate the coal samples have a Medium to High spontaneous combustion propensity rating and the rejects samples have a Low to Medium rating. The measured relative ignition temperatures for the samples are in agreement with the R_{70} results.

Adiabatic oven incubation testing shows that **under ideal conditions of critical thickness, ample continuous supply of oxygen and minimal heat dissipation**, the 2022005_013 and 2022005_016 coal samples reach thermal runaway in a minimum time period of 10 to 13 days and 7.6 to 10 days respectively. The incubation period is also modified by various coal physical properties and site-specific factors, which are discussed in this report.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
LIST OF FIGURES iii
LIST OF TABLES iv
1.0 INTRODUCTION 1
1.1 Spontaneous combustion testing 1
1.2 Scope of the work 2
2.0 METHODOLOGY 3
2.1 Samples 3
2.2 Adiabatic oven R_{70} test procedure 3
2.3 Adiabatic oven incubation test procedure 4
2.4 Coal rank analysis procedure 5
2.5 Intrinsic spontaneous combustion propensity analysis procedure 5
2.6 Minimum self-heating temperature analysis procedure 6
2.7 Crossing point temperature and relative ignition temperature analysis procedure 7
3.0 ANALYSIS OF RESULTS AND INTERPRETATION 9
3.1 Coal quality analysis and rank 9
3.2 Intrinsic spontaneous combustion propensity analysis 11
3.3 Minimum self-heating temperature and crossing point temperature analysis 12
3.4 Incubation period analysis 13
4.0 EVALUATION OF SPONTANEOUS COMBUSTION HAZARD LIKELIHOOD 14
4.1 Introduction 14
4.2 Coal physical properties and site factors 15
4.3 Preliminary hazard assessment of site-specific factors 18
4.3.1 General hazard assessment methodology 18
4.3.2 Spontaneous combustion hazard likelihood 18
5.0 CONCLUSIONS 23
REFERENCES 24
APPENDIX 1 Adiabatic testing results for Wandoan samples 29

LIST OF FIGURES

Figure 1 Suggate rank plot for Wandoan samples 9

Figure 2 R_{70} self-heating rate relationship with ash content for Wandoan samples, showing intrinsic spontaneous combustion propensity classes based on Queensland conditions 12

Figure 3 Enclosed stockpile storage of Kideco coal 14

Figure 4 Coal heating developed in uncompacted stockpile 15

Figure 5 Relationship between oxygen concentration in air and oxygen absorption rate 17

Figure 6 Partial spontaneous combustion fault tree showing possible causes leading to an unwanted event 18

Figure 7 Incubation test results for 2022005_013 sample with incubation period shown for a loosely piled state under ideal conditions .. 20

Figure 8 Incubation test results for 2022005_013 sample with incubation period shown for a highly fractured in-situ state under ideal conditions 20

Figure 9 Incubation test results for 2022005_016 sample with incubation period shown for a loosely piled state under ideal conditions .. 21

Figure 10 Incubation test results for 2022005_016 sample with incubation period shown for a highly fractured in-situ state under ideal conditions 21

LIST OF TABLES

Table 1 Wandoan samples supplied for spontaneous combustion testing 3
Table 2 Intrinsic spontaneous combustion propensity classification 6
Table 3 Analytical and rank data for Wandoan coal samples..... 10
Table 4 R_{70} and RIT values for Wandoan samples with their corresponding Intrinsic Spontaneous Combustion Propensity (ISCP) rating 11
Table 5 SHT and CPT values for Wandoan samples with their corresponding Spontaneous Combustion Propensity rating 12
Table 6 Incubation test conditions and minimum incubation period for coal samples from Wandoan Mine 13

1.0 INTRODUCTION

1.1 Spontaneous combustion testing

There are a number of spontaneous combustion tests documented in the literature that produce indices for rating the propensity of coal to spontaneously combust (Nelson and Chen, 2007). The more common ones that have gained wider use in the Australian and New Zealand coal industries are R_{70} self-heating rate, crossing point temperature (CPT), relative ignition temperature (RIT) and minimum self-heating temperature (SHT). The first three of these are available from laboratory testing that is offered in Australia. However, SHT is a calculated value from coal quality data using the original equation developed by Smith and Lazzara (1987) based on US coals, as this test is no longer offered by any laboratory.

All of the existing index parameters provide an indication of the intrinsic spontaneous combustion propensity of a particular coal using a classification scheme, but they do not provide any indication of the timeframe taken for coal spontaneous combustion issues to occur (incubation period). They also do not provide a proper hazard evaluation of coal self-heating that takes into consideration the effects of extrinsic factors (Beamish and Theiler, 2017a). The moderating influences of extrinsic factors such as in-mine ambient temperature and moisture (both in the coal and the surrounding environment) have been recognised and studied by Hodges and Hinsley (1964), Guney (1971) and Smith and Lazzara (1987) using adiabatic oven testing. From these early studies it is clear that the entire coal self-heating behaviour from low ambient temperature to thermal runaway can only be fully assessed by replicating in-mine conditions.

Recent investigations by Beamish and Beamish (2011a, 2012) have shown how spontaneous combustion hazard assessment can be improved by benchmarking against known coal self-heating experience from operating mines and built stockpiles using an Incubation test method. Beamish *et al* (2012) and Beamish and Theiler (2015) provide working examples of the success of this new technique. In addition, earlier efforts to identify and quantify any accelerating effects from the presence of reactive pyrite in coal and non-coal strata were not successful (Miron, Lazzara and Smith, 1992), but the new incubation test method has overcome this problem (Beamish and Theiler, 2017b).

1.2 Scope of the work

RGS Environmental Pty Ltd sought to establish the spontaneous combustion hazard likelihood of coal and rejects samples from the Wandoan Mine. To achieve the spontaneous combustion hazard assessment of these samples the following scope of testing was developed and performed:

1. R_{70} testing of each sample to establish their Intrinsic Spontaneous Combustion Propensity rating. In addition, this test also produced a value for the Relative Ignition Temperature of the sample.
2. Incubation testing of the coal samples to establish the minimum incubation period (time to thermal runaway if it occurred) and to compare against previous results for benchmark coals under ambient mine conditions. In the event that no thermal runaway was recorded for ambient mine conditions step-heating incubation testing was to be conducted to replicate exposure of the coal to an additional heat source.
3. Coal quality analysis (proximate, ultimate and calorific value) of the samples to be used to assist with interpretation of testing results and to calculate values for minimum self-heating temperature (SHT) and crossing point temperature (CPT), where applicable.

2.0 METHODOLOGY

2.1 Samples

The sample reference numbers and corresponding sample details supplied are contained in Table 1. As soon as possible after receiving the samples, they were prepared for spontaneous combustion testing.

Table 1
Wandoan samples supplied for spontaneous combustion testing

Mine/ Location	Sample Name	Sample Type	Test Reference Number
Wandoan	2022005_013	Coal	RGSWAN1R RGSWAN1INAL
Wandoan	2022005_016	Coal	RGSWAN2R RGSWAN2INAL
Wandoan	2022005_019	Rejects (coarse)	RGSWAN3R
Wandoan	2022005_020	Rejects (tailings)	RGSWAN4R

R = R_{70} self-heating rate test;
INAL = Incubation testing conducted under natural air leakage flow rate conditions

2.2 Adiabatic oven R_{70} test procedure

Full details of the adiabatic oven are given in Beamish, Barakat and St George (2000). Prior to each R_{70} test, the sample to be tested is removed from the freezer, crushed and sieved to <212 μm in as short a time as possible to minimise the effects of oxidation on fresh surfaces created by the grinding of the coal. A 150 g sample is placed in a 750 mL volumetric flask and a unidirectional flow of nitrogen at 250 mL/min applied to the flask inside a drying oven. Precautions are taken to ensure the exclusion of oxygen from the vessel prior to heating the coal for drying. Hence, the air is flushed from the system at room temperature for a period of one hour. After one hour, the oven is ramped up to 110 °C and the coal is dried under nitrogen for at least 16 h to ensure complete drying of the sample. All R_{70} tests are performed on a dry basis to standardise the test results.

At the completion of drying, the coal is transferred into the reaction vessel and left to stabilise at 40 °C in the adiabatic oven with nitrogen passing through it. The reaction vessel is a 450 mL

thermos flask inner. When the sample temperature has stabilised, the oven is switched to remote monitoring mode. This enables the oven to track and match the coal temperature rise due to oxidation. The gas selection switch is turned to oxygen with a constant flow rate of 50 mL/min. The temperature change of the coal with time is recorded by a datalogging system for later analysis. The oven limit switch is set at 160 °C to cut off the power to the oven, and stop the oxygen flowing when the sample reaches this temperature. When the oven cools down, the sample is removed from the reaction vessel, which is then cleaned in preparation for the next test.

For coals with a low self-heating rate, a step-heat procedure is used, since these coals can take over 100 hours to reach test completion. The decision to step-heat the sample is based on the sample temperature not reaching 90 ºC after approximately 20 hours. For these samples the coal temperature is step-heated to between 100 ºC to 130 ºC (depending on the temperature the coal has reached in the first 20 hours) using the oven heaters and then returned to adiabatic tracking mode to allow the coal to continue to thermal runaway adiabatically. This enables a value for the relative ignition temperature of the coal to be determined and the test to be completed in two days, inclusive of drying.

2.3 Adiabatic oven incubation test procedure

This test is designed to replicate the true coal self-heating behaviour from low ambient temperature. As such, the normal in-mine temperature is used as the starting point for the test. The nature of the test also assumes that in the real operational situation there is a critical coal pile thickness present that minimises any heat dissipation (represented by the adiabatic oven testing environment) and there is a sufficient supply of oxygen present to maintain the oxidation reaction. A larger sample mass and lower oxygen flow rate is used, compared to the R_{70} test method, to produce conditions that more closely match reality. The coal sample either reaches thermal runaway, or begins to lose heat due to insufficient coal intrinsic reactivity to overcome heat loss from moisture release/evaporation and/or heat sink effects from non-reactive mineral matter. As the coal is tested with its as-received moisture content, for some coals this may produce a prolonged temperature shoulder on the way to thermal runaway. This feature of the coal self-heating is not identified by the older R_{70} test, which only measures the coal intrinsic spontaneous combustion propensity on a dry basis. For coals with a low self-heating rate, a proprietary step-heat procedure is used to establish the self-heating behaviour of the coal from low ambient mine temperature through to thermal runaway or to record the coal self-heating behaviour when exposed to an additional heat source.

2.4 Coal rank analysis procedure

Suggate (2000, 1998) demonstrated the applicability of the Suggate rank parameter to both New Zealand and Australian coals. This parameter is determined from either the calorific value and volatile matter of the coal expressed on a dry mineral matter and sulphur free basis (dmmsf), or the atomic O/C and H/C of the coal expressed on a mineral matter free basis. The simpler of these two approaches is to use the calorific value and volatile matter data. This has been done in this report using a purpose-built spreadsheet to generate the Suggate rank plots. In addition, the ASTM rank has been calculated using equations contained in the COALAP computer program developed by Sykes and Suggate (1990).

2.5 Intrinsic spontaneous combustion propensity analysis procedure

The R_{70} self-heating rate value was first reported by Humphreys, Rowlands and Cudmore (1981), who used an adiabatic oven to assess the propensity of Queensland coals for spontaneous combustion. They defined a self-heating rate value R_{70}, which equated to the time taken for dry, crushed coal to increase in temperature from 40 ºC to 70 ºC due to oxidation under adiabatic conditions. For coals with a low self-heating rate, which are tested using a step-heat procedure, the R_{70} is calculated based on the non-Arrhenius kinetics theory proposed by Beamish and Arisoy (2008a) and Arisoy and Beamish (2015). This kinetic model is applicable to all coals and enables interpolation of the missing data between the initial self-heating up to 20 hours and the higher temperature self-heating rate data after the step-heating to the oven trip temperature.

Moreby (1997) reports that a coal with an R_{70} value below 0.5 ºC/h is considered to be low propensity, 0.5-0.8 ºC/h medium propensity, while coals with an R_{70} value higher than 0.8 ºC/h are considered to be highly prone to spontaneous combustion. Beamish, Barakat and St George (2001), Beamish (2005) and Beamish *et al* (2005) and Beamish and Arisoy (2008) have published R_{70} values for New Zealand, Australian, Indonesian and American coals using the same adiabatic oven at The University of Auckland and The University of Queensland, which clearly shows a distinct rank relationship. High rank bituminous coals have R_{70} values less than 0.8 ºC/h, whereas low rank subbituminous coals have R_{70} values in excess of 16 ºC/h.

More recent testing has recorded values in excess of 32°C/h for sub-bituminous C coals and a value of 99°C/h has been recorded for a lignite sample. Consequently, the majority of coals currently being mined around the World would fit the high propensity category based on the three tier rating system, which suggests there is a need to review the way in which the R_{70} value is used in hazard assessment.

As the R_{70} test procedure is performed on a dry basis, the value obtained is actually a true measure of the intrinsic coal reactivity to oxygen. Hence, Beamish and Beamish (2011a) proposed an appropriate intrinsic spontaneous combustion propensity rating classification based on R_{70} values for Queensland and New South Wales conditions (Table 2), which takes into consideration the different start temperatures that exist in both settings. Also, the boundary for each class takes into account that the rank relationship with R_{70} values is non-linear.

Table 2
Intrinsic spontaneous combustion propensity classification (ISCP)
(based on Queensland and New South Wales coal conditions)

ISCP Class	Propensity rating	Queensland R_{70} value (°C/h)	New South Wales R_{70} value (°C/h)
I	Low (L)	$R_{70} < 0.5$	$R_{70} < 1$
II	Low-Medium (LM)	$0.5 \leq R_{70} < 1$	$1 \leq R_{70} < 2$
III	Medium (M)	$1 \leq R_{70} < 2$	$2 \leq R_{70} < 4$
IV	High (H)	$2 \leq R_{70} < 4$	$4 \leq R_{70} < 8$
V	Very High (VH)	$4 \leq R_{70} < 8$	$8 \leq R_{70} < 16$
VI	Ultra-High (UH)	$8 \leq R_{70} < 16$	$16 \leq R_{70} < 32$
VII	Extremely High (EH)	$R_{70} \geq 16$	$R_{70} \geq 32$

Beamish and Beamish (2011a)

2.6 Minimum self-heating temperature analysis procedure

In the 1980s the US Bureau of Mines had an active research team working on coal spontaneous combustion issues. A test method was developed that produced an index parameter for spontaneous combustion propensity called Minimum Self-heating Temperature (SHT). This index parameter was found to be related to the coal oxygen content (O, % dry, ash-free basis) according to the following equation (Smith and Lazzara, 1987):

$$SHT\ (^oC) = 139.74 - 6.57 \times O$$

To account for the increased (or decreased) reactivity of a coal due to ambient in-mine temperatures, the value for the minimum SHT determined from the equation can be adjusted based on the ambient in-mine temperature of the coal. A value of 12.8 ºC (55 ºF) is used as the baseline in-mine temperature (Smith, Rumancik and Lazzara, 1996):

$$SHT_{adj}\ (^oC) = [SHT - (T_{ambient} - 12.8)]$$

According to Smith, Rumancik and Lazzara (1996) coals with adjusted SHT's <70 ºC are rated as having a high spontaneous combustion propensity, while those with adjusted SHT's > 100 ºC are rated as having a low spontaneous combustion propensity. Coals with adjusted SHT's between 70 and 100 ºC are rated as having a medium spontaneous combustion propensity.

Beamish and Beamish (2011a) found that for a range of Australian coals the high intrinsic spontaneous combustion propensity boundary should be increased to 80 ºC using the original Smith and Lazzara equation for SHT. Therefore, the Smith and Lazzara (1987) equation and the modified boundary are applied to the samples in this report.

2.7 Crossing point temperature and relative ignition temperature analysis procedure

The determination of crossing point and relative ignition temperatures (CPT and RIT) follows a similar methodology (Banerjee, 1985). Both tests use an oven heated at a fixed rate (usually 2 ºC/min) to drive the temperature of the coal to a point where the coal crosses over the oven temperature and rapidly progresses towards thermal runaway. This is substantially different to the adiabatic oven testing where the oven tracks the coal temperature as it reacts with oxygen. The lower the CPT or RIT value the higher the spontaneous combustion propensity of the coal.

Barve and Mahadevan (1994) established that CPT values can be calculated from coal quality data based on the moisture content (M, air-dried basis) and the ash content (A, dry basis) of the coal. They proposed a separate equation for bituminous coals in general and a more specific equation for high volatile bituminous coals:

General CPT equation for bituminous coals

$$CPT\ (^{o}C) = 168.8 - 10.3 \times M + 0.12 \times A + 0.69 \times M^2 - 0.06 \times M \times A + 0.01 \times A^2$$

CPT equation for high volatile bituminous coals

$$CPT\ (^{o}C) = 170 - 5.16 \times M - 2.8 \times A - 0.005 \times M^2 + 0.28 \times M \times A + 0.02 \times A^2$$

Banerjee *et al* (1972) determined that coals with CPT values less than 140 ºC are generally considered to have a high intrinsic spontaneous combustion propensity, those within the range of 140 ºC to 160 ºC have a medium intrinsic spontaneous combustion propensity, and coals with CPT values greater than 160 ºC have a low intrinsic spontaneous combustion propensity. However, more recent checks of each of the CPT equations for a range of Australian coals suggests that the boundaries should be set at 130 ºC for high propensity and 150 ºC for low propensity.

The adiabatic R_{70} self-heating rate test also provides a value for RIT, which is defined as the temperature where the rate of coal self-heating reaches 2 ºC/min. Subsequently, the coal temperature rapidly rises beyond this point on its way to thermal runaway. This value is obtained from the R_{70} self-heating rate data and can be compared against the R_{70} value to provide a confirmation of the relative intrinsic spontaneous combustion propensity of the coal. The lower the RIT value the higher the intrinsic propensity of the coal for spontaneous combustion.

3.0 ANALYSIS OF RESULTS AND INTERPRETATION

3.1 Coal quality analysis and rank

Proximate analysis, ultimate analysis and calorific value determination was performed on duplicates of the test samples. A summary of the results obtained for each sample are contained in Table 3. The ASTM rank classification of the samples is high volatile C bituminous, based on their volatile matter content and calorific value. The coal samples plot above the high vitrinite coal band on a Suggate rank plot (Figure 1), which indicates they are liptinite-rich. The Wandoan rejects samples are omitted from the plot due to distortions in the mineral matter content correction, which often produce unreliable results for very high ash content samples. The sulphur content of the coal and rejects samples is low indicating the presence of pyrite is negligible.

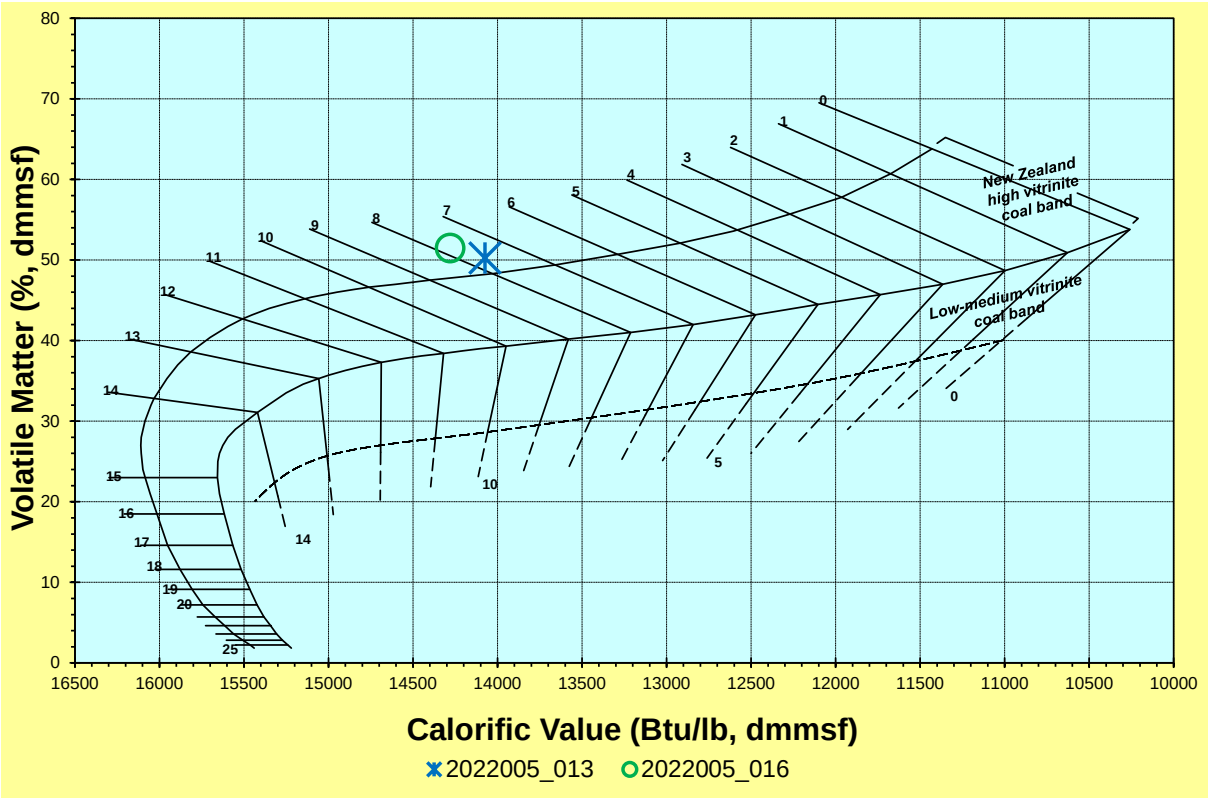


Figure 1. Suggate rank plot for Wandoan samples.

Table 3
Analytical and rank data for Wandoan samples

	2022005013	2022005016	2022005019	2022005020
PROXIMATE ANALYSIS (air-dried basis)				
Moisture (%)	8.4	9.2	6.6	2.3
Ash (%)	32.8	21.6	67.5	77.3
Volatile Matter (%)	31.3	36.8	16.5	18.8
Fixed Carbon (%)	27.5	32.4	9.4	1.60
Total Sulphur (%)	0.24	0.28	0.06	0.11
Calorific Value (MJ/kg, raw)	18.12	22.20	6.56	6.63
ULTIMATE ANALYSIS (dry ash-free basis)				
Carbon (%)	81.8	81.6	82.0	80.4
Hydrogen (%)	5.39	5.10	5.85	6.03
Nitrogen (%)	1.88	1.84	2.22	1.62
Sulphur (%)	1.02	0.72	0.85	0.54
Oxygen (%)	9.9	10.7	9.1	11.4
COAL RANK PARAMETERS				
VM (%, dmmsf)	50.3	51.5	50.8	na
CV (Btu/lb, dmmsf)	14074	14279	14760	na
Suggate rank	7.6	7.7	9.0	na
VM (%, dmmf)	51.0	51.9	54.1	na
CV (Btu/lb, mmmf)	11847	12241	10063	na
ASTM rank	hvCb	hvCb	hvCb	na

3.2 Intrinsic spontaneous combustion propensity analysis

A copy of the temperature data recorded for the R_{70} self-heating rate tests, which were conducted on the samples is contained in Appendix 1. A summary of the results is contained in Table 4, and shows the R_{70} values range from 0.07 °C/h to 6.84 °C/h. The RIT values are consistent with the R_{70} values and are indicative of a high reactivity towards oxygen for the lower ash content coal samples.

Table 4
R_{70} and RIT values for Wandoan samples with their corresponding Intrinsic Spontaneous Combustion Propensity (ISCP) rating

Sample	Ash content (%, db)	R_{70} (°C/h)	RIT (°C)	ISCP QLD rating
2022005_013	35.8	4.91	129.2	Very High
2022005_016	23.8	6.84	120.3	Very High
2022005_019	72.3	0.72	183.5	Low-Medium
2022005_020	79.1	0.07	250.4	Low

When interpreting R_{70} values it is important to realise that the value is not only rank dependent (Beamish, 2005; Beamish and Arisoy, 2008b), it is also affected by coal type (Beamish and Clarkson, 2006; Beamish and Arisoy, 2008b) and mineral matter constituents (Beamish and Blazak, 2005; Beamish and Arisoy, 2008b; Beamish and Sainsbury, 2008). As such, a true comparison between samples can be obtained by plotting R_{70} against the ash content (acting as an indicator parameter of mineral matter content) of the coal on a dry basis as shown in Figure 2. An ash content trend is apparent for the samples.

The intrinsic spontaneous combustion propensity rating based on Queensland conditions for the Wandoan coal and rejects samples is Very High and Low to Low-Medium respectively. These ratings are consistent with the rank, type and ash content of the samples.

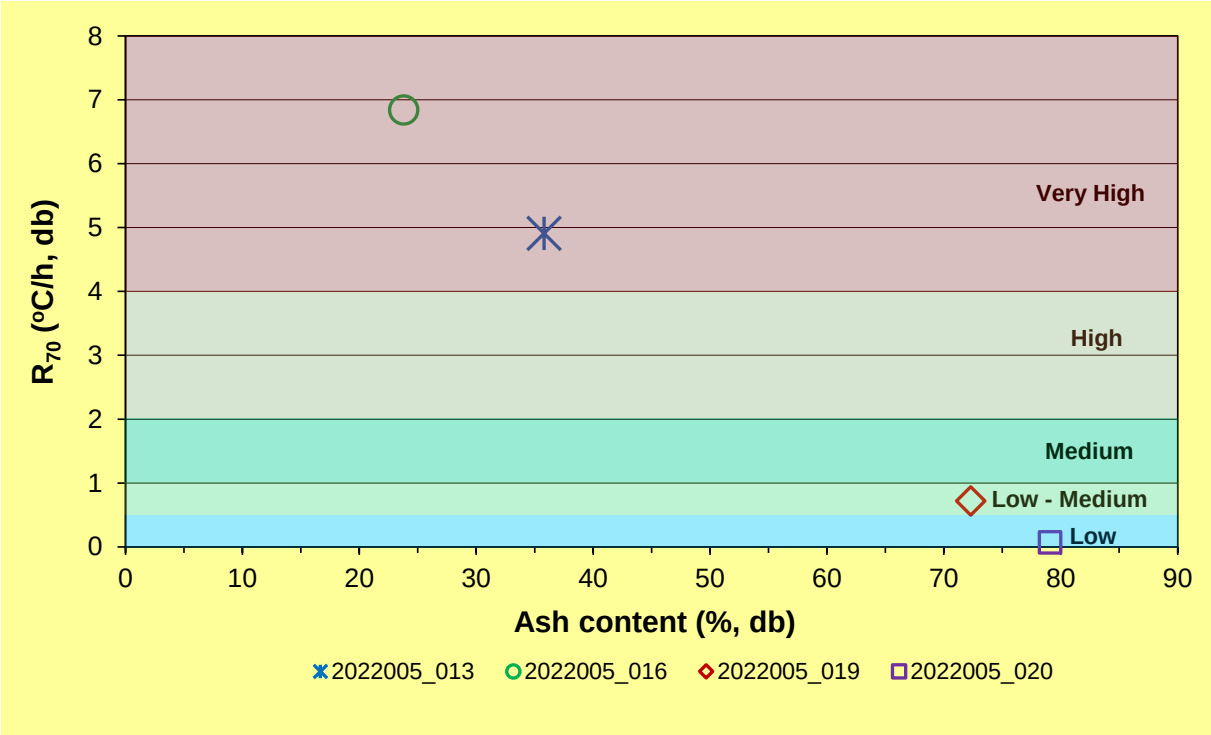


Figure 2. R_{70} self-heating rate relationship with ash content for Wandoan samples, showing intrinsic spontaneous combustion propensity classes based on Queensland conditions.

3.3 Minimum self-heating temperature and crossing point temperature analysis

The calculated minimum self-heating temperature and crossing point temperature values for the Wandoan coal and rejects samples are contained in Table 5 with their respective propensity ratings. The SHT values indicate a High spontaneous combustion propensity rating for the coal and Medium rating for the rejects. The CPT values for the samples generally indicate a Medium to High spontaneous combustion propensity rating for the coal and Low rating for the rejects.

Table 5
SHT and CPT values for Wandoan samples with their corresponding spontaneous combustion propensity rating

Sample	SHT (°C)	Propensity rating	CPT (°C)	Propensity rating
2022005_013	70	High	136	Medium
2022005_016	67	High	128	High
2022005_019	88	Medium	171	Low
2022005_020	Invalid	Invalid	210	Low

3.4 Incubation period analysis

Beamish and Beamish (2010, 2011a,b and 2012) showed that the time taken for coal to reach thermal runaway under loosely piled conditions (incubation period) can be determined using a laboratory adiabatic testing technique that is benchmarked against known coal performance on site. This analysis has been applied to the coal samples from Wandoan Mine. The initial conditions for the test and the inferred minimum incubation periods for both loosely piled coal and fractured in-situ coal are contained in Table 6. These results are consistent with the intrinsic reactivity of the samples and the moisture content in the coal that acts as a moderator of coal self-heating.

Table 6
Incubation test conditions and minimum incubation period for coal samples from Wandoan Mine

Sample	Moisture content (%)	Ash content (%)	Initial temperature (°C)	Minimum Incubation Period Loosely Piled Coal (days)	Minimum Incubation Period Highly Fractured In-situ Coal (years)
2022005_013	8.9	32.6	35.0	10 - 13	~ 2.0
2022005_016	9.8	21.5	35.0	7.6 – 10	~ 1.6

NTR – No Thermal Runaway in a practical timeframe without an additional heat source

It should be noted that the longer the coal is exposed to a cooler temperature, the longer it takes to reach thermal runaway (incubate) due to heat dissipation effects to the surroundings. Conversely, if the coal is exposed to an additional external heat source, this will reduce the time to reach thermal runaway due to the temperature dependence of the oxidation reaction rate. For coals with a low intrinsic reactivity an additional heat source (either internal such as the presence of reactive pyrite or external such as contact with PUR) can often be the root cause of developing a spontaneous combustion event (Theiler and Beamish, 2019). A delay in thermal runaway (longer incubation period) is also created by an oxygen deficient atmosphere.

4.0 EVALUATION OF SPONTANEOUS COMBUSTION HAZARD LIKELIHOOD

4.1 Introduction

The intrinsic spontaneous combustion propensity of Wandoan coal and rejects samples has been determined from laboratory testing to be Very High and Low-Medium respectively. However, to establish an overall site-specific hazard assessment of spontaneous combustion likelihood it is necessary to take into consideration the physical properties of the coal, as well as the mine site factors. This is emphasised by way of stockpile examples in Figures 3 and 4 that show loosely formed coal piles with steep sides and coarse coal near the base, which is a poor combination in terms of spontaneous combustion management where the surrounding environmental conditions favour heat gain over heat dissipation.

Figure 3. Enclosed stockpile storage of Kideco coal showing no compaction except from the weight of the stockpile and steep sides at angle of repose with coarse coal fraction accumulated at the base of the stockpile allowing pathways for air to enter the stockpile and create a chimney effect. Note the moisture condensation lines within the rectangular zone arising from hot spot development inside the pile. Thermal runaway reached in 10-13 days.

Figure 4. Coal heating developed in uncompacted stockpile with steep sides (angle of repose) and coarse coal fraction accumulated at the base of the stockpile allowing pathways for air to enter the stockpile and create a chimney effect. The hotspot has migrated from inside the stockpile to daylight on the surface and reach ignition.

4.2 Coal physical properties and site factors

Production of coal fines will enhance the reactivity of the coal through greater access of air to oxidation sites as a result of the increased surface area available for reaction to take place. The ease of fines production is a property of the coal, which is best measured by the Hardgrove Grindability Index (HGI) value. Also, care must be taken in identifying areas of crushed coal that may be associated with faulting or other geological features, as these will provide greater fines production and pathways for air access into the seam.

Moisture effects on coal self-heating in a pile of broken coal (whether naturally formed underground by roof falls, or as part of goaf formation or surface-built stockpiles) are two-fold. In the case of low-moisture content coals, the maximum temperature increases steadily with time. In the case of high-moisture coals, temperature increases rapidly initially before evaporation dominates and the temperature reaches a plateau value (generally around 80-90 °C). Once the coal becomes dry locally the temperature will increase rapidly towards

thermal runaway. However, if the coal pile has been in a prolonged drying phase that is interrupted by a wetting or rain event and the water penetrates into the coal pile then additional heat can be generated from the "heat of wetting" effect as the coal re-adsorbs the moisture available to it. A similar effect is created by an increase in humidity, which can also lead to premature thermal runaway in the coal pile.

The coal ambient temperature also plays a major role in determining the initial coal self-heating rate. The R_{70} test is performed at 40 °C to compare all coals on a standard basis. This temperature is more closely aligned with Queensland coals for which the test was originally developed (Humphreys, Rowlands and Cudmore, 1981) and is indicative of underground or summer temperatures in the Bowen Basin. For coal ambient temperatures at least 10 °C lower than this, the initial self-heating rate of the coal will be greatly diminished (approximately halved). This increases the timeframe for any hot spot to develop assuming ideal conditions exist to allow heat to accumulate in broken coal. The converse is also true.

Arisoy and Akgun (2000) showed that for different coal reactivities there was a critical pile thickness necessary for coal self-heating to develop to a stage where spontaneous combustion was inevitable after three months. This thickness varied between 0.85 and 1.8m for coals with high reactivities and medium reactivities respectively. More recent work by Akgun and Essenhigh (2001) also showed that where coal pile heights exceeded 2 m, given sufficient time and other favourable conditions, coal self-heating leading to thermal runaway was inevitable. This aspect of coal self-heating is often overlooked in underground mining and must be considered if coal is to be left in the goaf from using a coal roof, or falls into the goaf from adjacent seams, or significant floor coal is left in the goaf.

There are two very important parameters that determine the rate at which a hot spot will develop in a broken coal pile. These are pile porosity and slope angle of the pile sides. Compaction decreases the pile porosity and thus increases the resistance to the airflow into the pile, which results in suppressing the oxidation reaction due to air starvation (Akgun and Essenhigh, 2001). As the slope of the coal pile sides decreases, the time to thermal runaway increases. Akgun and Essenhigh (2001) found that reducing the coal pile slope from 63° to 34° increased the time to thermal runaway by 100%. Hence, steep-sided coal piles create the biggest problem for coal self-heating, which normally initiates about 2 m in from the sides.

Air supply to broken coal is also a pre-requisite for self-heating to generate. In a goaf environment, exclusion of air removes the issue. However, often some air leakage will occur.

As a standard risk mitigation strategy, gas monitoring of the goaf environment will normally provide confirmation of this, with any hot spot development showing as a change in goaf gas composition (for example abnormal increases in carbon monoxide or other spontaneous combustion indicators above the background trends).

Winmill (1915) performed a definitive study of the effect of varying the percentage of oxygen in air on the rate of oxygen absorption by crushed coal (<250 µm) at 30 °C and hence the rate at which reaction can take place. The results of this study (Figure 5) showed that the rate of oxygen absorption was proportional to the square-root of the oxygen percentage in the air. As such the rate of oxygen absorption dropped to just over half when the oxygen concentration decreased from 100% to 20.9% (normal air concentration) and when the oxygen concentration decreased to 5% the rate of oxygen absorption halved again. These findings emphasise the importance of keeping goaf areas airtight. Winmill (1915) also stated that "So long as the oxygen is below 2 per cent, it would seem that no coal has a sufficiently high rate of oxidation to cause any serious rise in temperature".

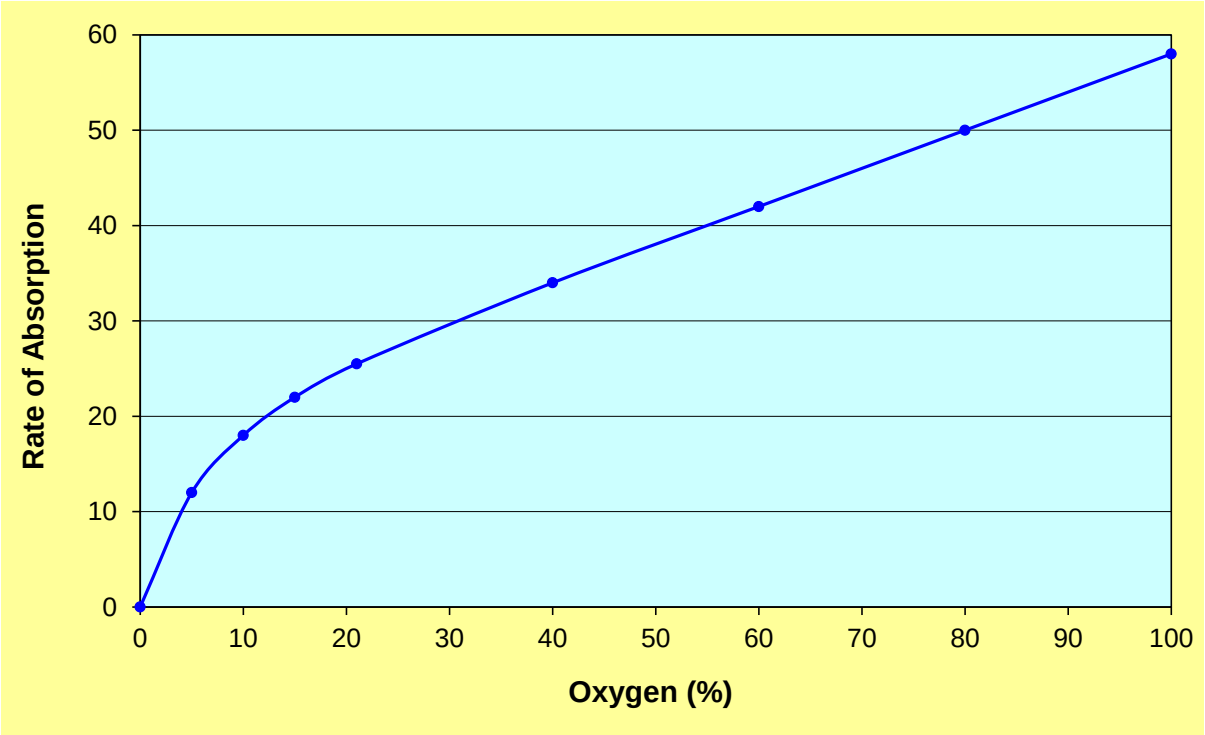


Figure 5. Relationship between oxygen concentration in air and oxygen absorption rate (note the rates of absorption are expressed in arbitrary units, since comparative figures only are required).

4.3 Preliminary hazard assessment of site-specific factors

4.3.1 General hazard assessment methodology

Risk assessment is routinely used in the coal industry to develop plans that are appropriate to the management of hazards. Leading practice at all coal mines requires the implementation of a Principal Hazard Management Plan for Spontaneous Combustion. The initial step in developing this plan should be to identify the root causes of an unwanted spontaneous combustion event. This can be achieved using the Fault Tree Analysis (FTA) risk assessment method. A generic example of the initial branches of a spontaneous combustion fault tree is shown in Figure 6. The self-heating behaviour of the coal can be assessed in the context of the Wandoan Mine to enable the likelihood of developing a spontaneous combustion event to be evaluated.

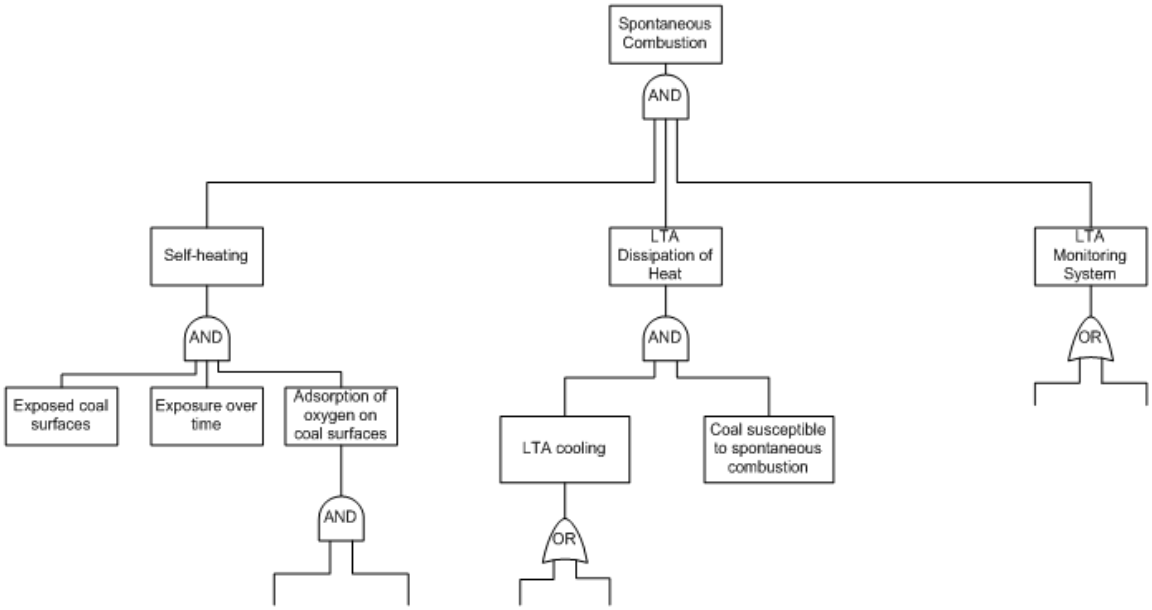


Figure 6. Partial spontaneous combustion fault tree showing possible causes leading to an unwanted event (modified from Beamish *et al*, 2010). Note: LTA = Less Than Adequate

4.3.2 Spontaneous combustion hazard likelihood

The data obtained to date from the Wandoan coal and rejects samples is insufficient to develop a database for establishing whether the intrinsic reactivity/moisture heat balance of the samples favours reaching Thermal Runaway (TR) or No Thermal Runaway (NTR). Consequently, a boundary line cannot be drawn between the two possible outcomes for the site-specific situation by plotting the total moisture content of each sample against the R_{70} self-heating rate value.

Incubation testing was conducted on the coal samples to measure the self-heating behaviour of the coal from an initial coal temperature of 35 °C in its as-received moisture state. The results of this testing shown in Figures 7-10 indicate the Wandoan coal can achieve thermal runaway in both a loose pile and highly fractured in-situ state under ideal conditions. However, for ideal conditions there are several criticalities that need to be present. These are:

- There is a critical thickness present. For coals with an R_{70} value less than 2 the critical thickness required is generally greater than 2m. For coals with an R_{70} value between 2-4 the thickness needs to be greater than 1.5m. For coals with an R_{70} value between 4-8 the thickness needs to be greater than 1m.
- There is a sufficient and continuous supply of oxygen due to airflow. In a loose pile this is normally created by ventilation flow underground or wind flow in a surface environment. For fractured material in-situ there needs to be a considerable pressure differential present to enable the air to penetrate through the fracture system. This often occurs around faulted ground in underground mines where there is a substantial pressure differential between intake and return airways. In a surface mine exposure, the air penetration is more difficult as it is controlled mainly by barometric pumping, which is minimal compared to an underground mine situation.
- In a surface environment there would need to be no moisture accumulation from surface ponding or groundwater penetration that either excludes ingress of oxygen or creates a large evaporative heat loss mechanism.

It should also be noted that in a surface environment the material will oxidise over time to a point of deactivation if no heat is accumulated.

The presence of reactive pyrite can initiate a spontaneous combustion event in a sample that may plot in the NTR category based on the moisture content and R_{70} self-heating rate value. This is because the R_{70} test does not identify the effects of reactive pyrite due to it being conducted on a dry basis. An initial indication of the presence of pyrite can be obtained by analysing the sample for sulphur content. If pyrite is indicated then the test sample should be subjected to an Incubation test with the coal moisture present to quantify any effects of accelerated self-heating if the pyrite proves to be reactive. The self-heating curves for the Wandoan samples in the low temperature region, showed no signs of accelerated heating.

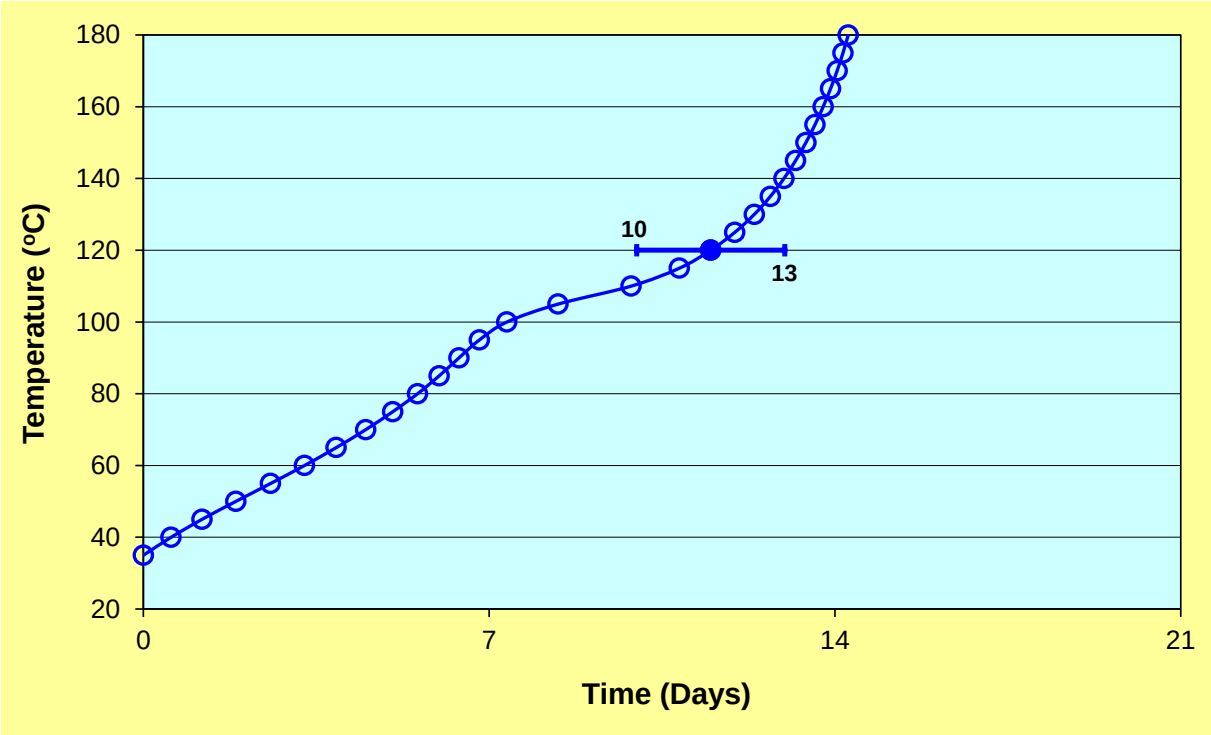


Figure 7. Incubation test results for 2022005_013 sample with incubation period shown for a loosely piled state under ideal conditions.

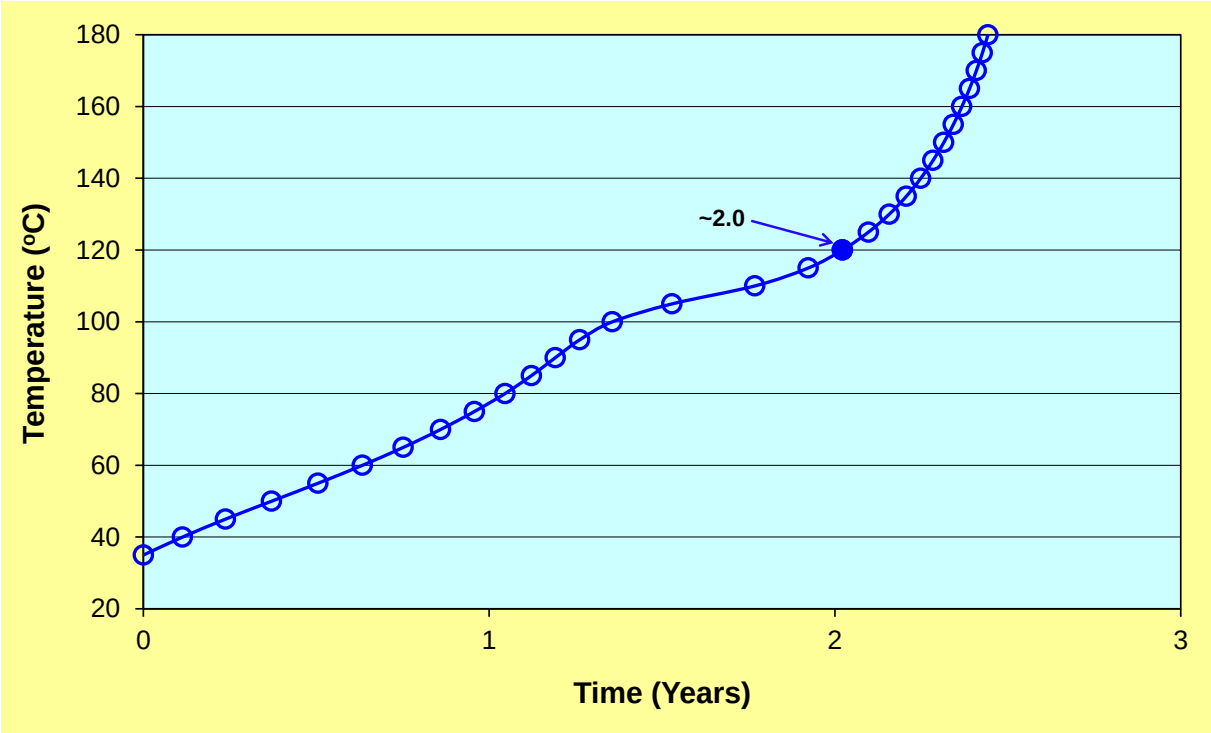


Figure 8. Incubation test results for 2022005_013 sample with incubation period shown for a highly fractured in-situ state under ideal conditions.

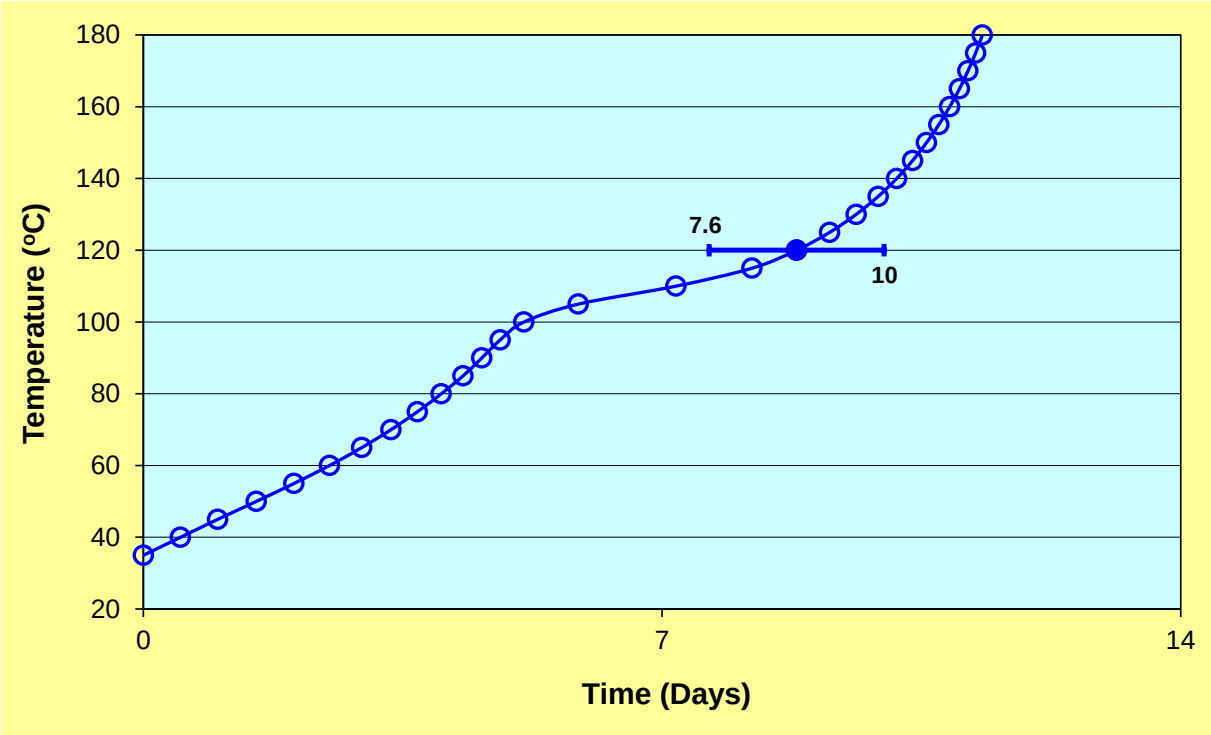


Figure 9. Incubation test results for 2022005_016 sample with incubation period shown for a loosely piled state under ideal conditions.

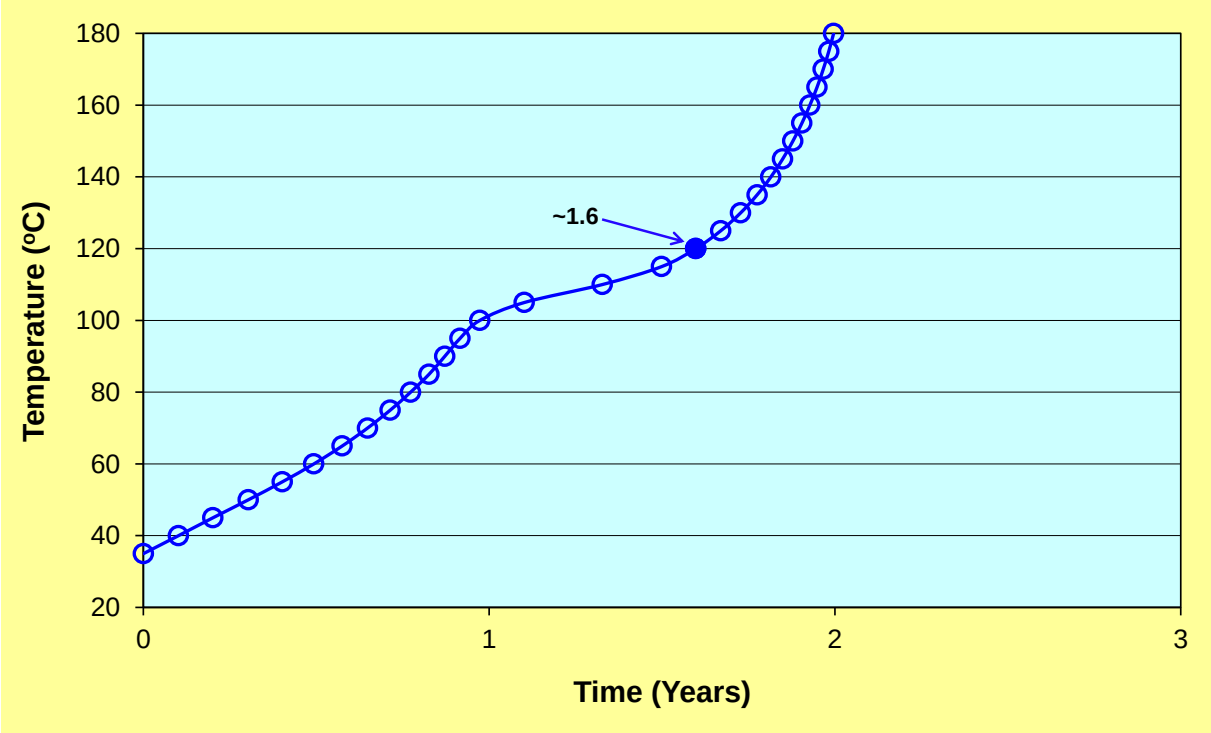


Figure 10. Incubation test results for 2022005_016 sample with incubation period shown for a highly fractured in-situ state under ideal conditions.

There is another possible situation that could lead to a spontaneous combustion event for a coal that plots in the NTR category. This is when the coal comes into contact with an external heat source, such as a curing compound used in an underground environment (for example PUR (Cliff, Beamish and Cuddihy, 2009) or other products that produce an exothermic reaction). Embers from a bushfire could also act as an external heat source in a surface environment. Under these circumstances the temperature of the coal may be artificially raised and a short incubation period ensues.

5.0 CONCLUSIONS

Adiabatic testing of Wandoan coal samples has resulted in R_{70} values ranging from 4.91 °C/h to 6.84 °C/h. These R_{70} values indicate that the intrinsic spontaneous combustion propensity rating for the coal samples is Very High based on Queensland conditions. The R_{70} self-heating rate value measured for the Wandoan rejects samples ranges from 0.07 °C/h to 0.72 °C/h which rates the samples as having a Low to Low-Medium intrinsic spontaneous combustion propensity. The R_{70} values are consistent with the rank, ash content and type of the samples. Calculated spontaneous combustion index values for minimum self-heating temperature indicate a High spontaneous combustion propensity rating for the coal samples and Medium rating for the reject samples. The calculated crossing point temperature values indicate Medium to High spontaneous combustion propensity ratings for the coal samples and Low ratings for the rejects samples. The relative ignition temperature values measured for the samples confirm the intrinsic spontaneous combustion propensity rating obtained from the R_{70} values.

Incubation testing has been applied to the coal samples from Wandoan Mine. The results obtained show that **under ideal conditions of critical thickness, ample continuous supply of oxygen and minimal heat dissipation to the surroundings** the 2022005_013 and 2022005_016 coal samples are able to reach thermal runaway in a minimum time period of 10 to 13 days and 7.6 to 10 days respectively from an initial coal temperature of 35 °C.

REFERENCES

Arisoy, A and Beamish, B, 2015. Reaction kinetics of coal oxidation at low temperatures, *Fuel*, 159:412-417.

Akgun, F and Essenhigh, R H, 2001. Self-ignition characteristics of coal stockpiles: theoretical prediction from a two-dimensional unsteady-state model, *Fuel*, 80:409-415.

Arisoy, A and Akgun, F, 2000. Effect of pile height on spontaneous heating of coal stockpiles, *Combustion Science and Technology*, 153:157-168.

Banerjee, S C, 1985. *Spontaneous Combustion of Coal and Mine Fires*, 168 p (Balkema:Rotterdam).

Banerjee, S C, Nandy D K, Banerjee, D D and Chakravorty, R N, 1972. Classification of coal with respect to their susceptibility to spontaneous combustion, *Trans. Min. Geol. & Met. Inst. of India*, 59(2):15-31.

Barve, S D and Mahadevan,V, 1994. Prediction of spontaneous heating liability of Indian coals based on proximate constituents. in *Proceedings 12th International Coal Preparation Congress*, pp 557-562 (Cracow, Poland).

Beamish, B B, 2005. Comparison of the R_{70} self-heating rate of New Zealand and Australian coals to Suggate rank parameter, *International Journal of Coal Geology*, 64(1-2):139-144.

Beamish, B B and Arisoy, A, 2008a. Effect of mineral matter on coal self-heating rate, *Fuel*, 87:125-130.

Beamish, B B and Arisoy, A, 2008b. Effect of intrinsic coal properties on self-heating rates, in *Proceedings 12th US/North American Mine Ventilation Symposium*, K G Wallace Jr (ed), pp 149-153 (The Society of Mining, Metallurgy and Exploration Inc., Littleton, USA).

Beamish, B and Beamish, R, 2012. Benchmarking coal self-heating using a moist adiabatic oven test, in *Proceedings of the 14th US/North American Mine Ventilation Symposium* (eds:F Calizaya and M G Nelson), pp 423-427 (University of Utah, Department of Mining Engineering, Utah, USA).

Beamish, B and Beamish, R, 2011a. Testing and sampling requirements for input to spontaneous combustion risk assessment, in *Proceedings of the Australian Mine Ventilation Conference* (eds: B Beamish and D Chalmers), pp 15-21 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B and Beamish, R, 2011b. Experience with using a moist coal adiabatic oven testing method for spontaneous combustion assessment, in *Proceedings 11th Coal Operators' Conference*, N Aziz (ed), pp 380-384 (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B and Beamish, R, 2010. Benchmarking moist coal adiabatic oven testing, in *Proceedings 10th Coal Operators' Conference*, N Aziz (ed), pp 264-268 (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B B and Blazak, D G, 2005. Relationship between ash content and R_{70} self-heating rate of Callide coal, *International Journal of Coal Geology*, 64(1-2):126-132.

Beamish, B B and Clarkson, F, 2006. Self-heating rates of Sydney Basin coals – The emerging picture, in *Proceedings of the 36th Sydney Basin Symposium*, pp 1-8 (University of Wollongong).

Beamish, B B and Sainsbury, W, 2008. Development of a site specific self-heating rate prediction equation for a high volatile bituminous coal, in *Proceedings 8th Coal Operators' Conference* (ed: N Aziz), pp 161-165, (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B B and Theiler, J, 2019. Coal spontaneous combustion: Examples of the self-heating incubation process, *International Journal of Coal Geology*, 215:103297.

Beamish, B B and Theiler, J, 2017a. Recognising the deficiencies of current spontaneous combustion propensity index parameters, in *Proceedings of the Australian Mine Ventilation Conference*, pp 113-117 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B B and Theiler, J, 2017b. Assessing the reactivity of pyrite, in *Proceedings 17th Coal Operators' Conference* (eds: N Aziz and B Kininmonth), pp 391-394, (University of Wollongong).

Beamish, B B and Theiler, J, 2015. Contrast in self-heating behaviour for coals of similar rank, in *Proceedings 15th Coal Operators' Conference* (ed: N Aziz), pp 300-304, (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B B, Barakat, M A and St George, J D, 2001. Spontaneous-combustion propensity of New Zealand coals under adiabatic conditions, in *Geotechnical and Environmental Issues Related to Coal Mining*, P. Lindsay and T.A. Moore (eds), Special Issue, *International Journal of Coal Geology*, 45(2-3):217-224.

Beamish, B B, Barakat, M A and St George, J D, 2000. Adiabatic testing procedures for determining the self-heating propensity of coal and sample ageing effects, *Thermochimica Acta*, 362 (1-2):79-87.

Beamish, B B, Blazak, D G, Hogarth, L C S and Jabouri, I, 2005. R_{70} relationships and their interpretation at a mine site, in *Proceedings COAL2005 Conference*, pp 183-185 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B, McLellan, P, Turunc, U, Raab, M and Beamish, R, 2012. Quantifying spontaneous combustion inhibition of reactive coals, in *Proceedings of the 14th US/North American Mine Ventilation Symposium* (eds:F Calizaya and M G Nelson), pp 435-440 (University of Utah, Department of Mining Engineering, Utah, USA).

Beamish, B, Sutherland, T, Coull, M, Walker, D, Day, G, Shales, C, Craker, R, Rowland J and Smith J, 2010. Application of fault tree analysis to coal spontaneous combustion, in *Proceedings 10th Coal Operators' Conference*, N Aziz (ed), pp 269-273 (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Cliff, D, Beamish, B and Cuddihy, P, 2009. Explosions, fires and spontaneous combustion, in *Monograph 12, Australasian Coal Mining Practice – Third Edition*, pp 800-814 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Guney, M, 1971. An adiabatic study of the influence of moisture on the spontaneous heating of coal, *CIM Bulletin*, 64:138-146.

Hodges, D J and Hinsley, F B, 1964. The influence of moisture on the spontaneous heating of coal, *The Mining Engineer*, 123:211-224.

Humphreys, D, Rowlands, D and Cudmore, J F, 1981. Spontaneous combustion of some Queensland coals, in *Proceedings of Ignitions, Explosions and Fires in Coal Mines Symposium*, pp 5-1 - 5-19 (The AusIMM Illawarra Branch).

Miron, Y, Lazzara, C P and Smith, A C, 1992. Cause of floor self-heatings in an underground coal mine, United States Bureau of Mines Report of Investigation RI9415.

Moreby, R, 1997. Dartbrook coal - Case study, in *Proceedings 6th International Mine Ventilation Congress*, pp 39-45 (The Society of Mining, Metallurgy and Exploration Inc., Littleton, USA).

Nelson, M I and Chen, X D, 2007. Survey of experimental work on the self-heating and spontaneous combustion of coal, *The Geological Society of America Reviews in Engineering Geology*, 18:31-83.

Smith, A C and Lazzara, C P, 1987. Spontaneous combustion studies of US coals, US Bureau of Mines Report of Investigations RI 9079.

Smith, A C, Rumancik, W P and Lazzara, C P. SPONCOM – A computer program for the prediction of the spontaneous combustion potential of an underground coal mine, in *Proceedings Fifth Conference on the Use of Computers in the Coal Industry*, pp 134-143 (West Virginia University, Morgantown, USA).

Suggate, R P, 2000. The Rank (Sr) scale: its basis and its application as a maturity index for all coals, *New Zealand Journal of Geology and Geophysics*, 43:521-553.

Suggate, R P, 1998. Analytical variation in Australian coals related to coal type and rank, *International Journal of Coal Geology*, 37:179-206.

Sykes, R and Suggate, R P, 1990. Coalap – A computer programme for coal analysis calculations and determination of ASTM rank, New Zealand Geological Survey Record 39.

Theiler, J and Beamish, B B, 2019. Mechanisms for spontaneous combustion events in low intrinsic reactivity coals and carbonaceous shales, in Proceedings of The Australian Mine Ventilation Conference, (ed: B Belle), pp 160-164 (The Australasian Institute of Mining and Metallurgy: Melbourne).

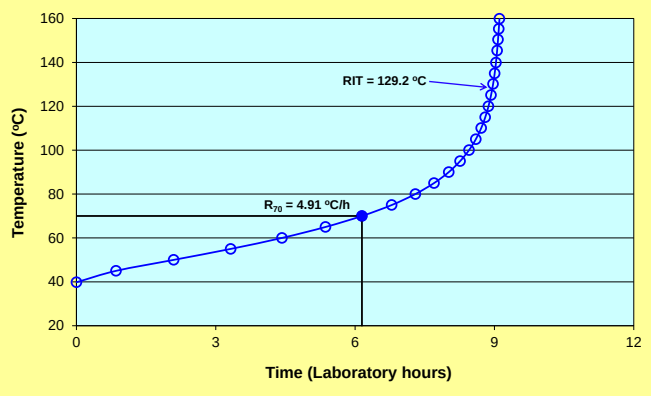
Winmill, T F, 1915. The absorption of oxygen by coal – Part VIII The effect on the absorption of the size of the coal particles and the percentage of oxygen in the air, *Transactions of the Institute of Mining Engineers*, 51:493-499.

APPENDIX 1
ADIABATIC TESTING RESULTS FOR WANDOAN COAL SAMPLES

Wandoan Mine

RGSWAN1R	2022005_013	
Date prepared	1/04/2022	
Date on test	4/04/2022	
Adiabatic self-heating test R_{70}	4.91	°C/h
Relative ignition temperature (RIT)	129.2	°C
Moisture content	8.9	%

Coal Temp (°C)	Time (min)	Time (h)
39.8	0	0.000
45.0	51.17	0.853
50.0	125.67	2.094
55.0	199.33	3.322
60.0	265.50	4.425
65.0	321.83	5.364
70.0	368.83	6.147
75.0	407.33	6.789
80.0	437.83	7.297
85.0	462.00	7.700
90.0	481.00	8.017
95.0	495.67	8.261
100.0	507.17	8.453
105.0	516.00	8.600
110.1	523.00	8.717
115.0	528.17	8.803
120.0	532.33	8.872
125.1	535.67	8.928
130.2	538.33	8.972
135.0	540.33	9.006
139.9	542.00	9.033
145.4	543.50	9.058
150.4	544.67	9.078
155.3	545.67	9.094
159.9	546.50	9.108



Wandoan Mine

RGSWAN1INAL	2022005_013	
Date prepared	1/04/2022	
Date on test	1/04/2022	
Moisture content	8.9	%

Time to thermal runaway (t_{TR})

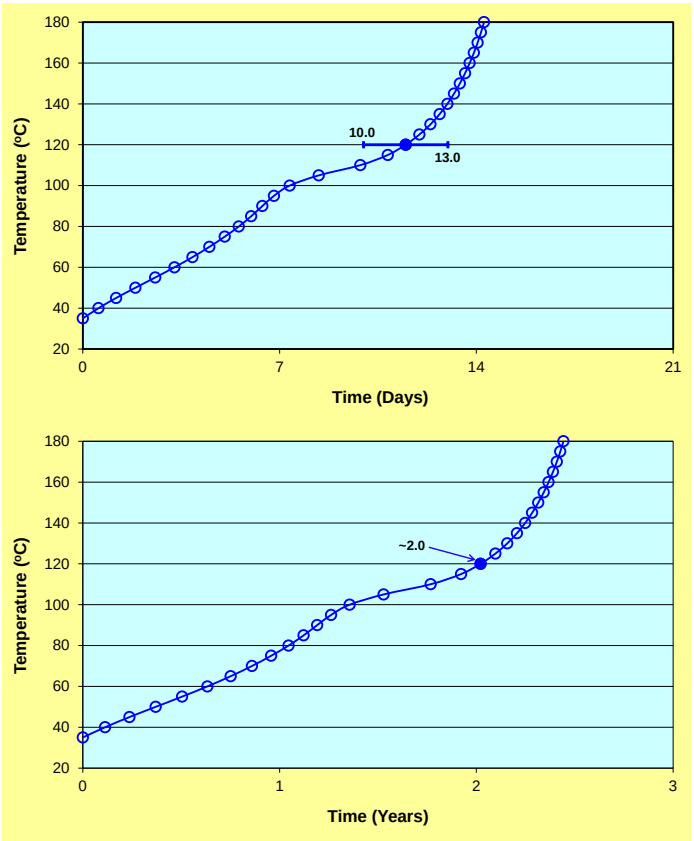
Loosely Piled Coal

Minimum incubation period lower limit	10	days
Minimum incubation period upper limit	13	days

Highly Fractured In-situ State

Minimum incubation period	~2.0	years

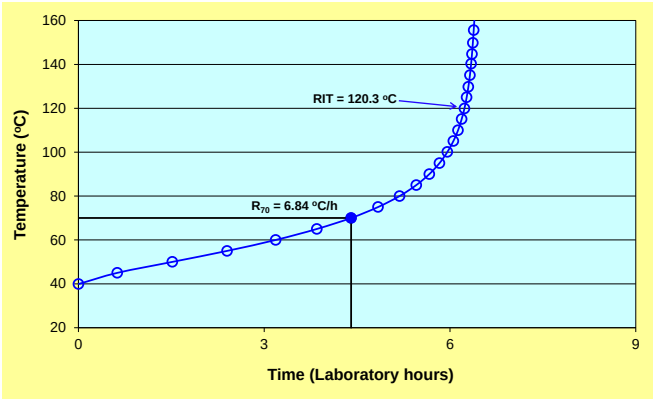
Coal Temp (°C)	Loose Time (days)	In-situ Time (years)
35.0	0.00	0.00
40.0	0.56	0.11
45.0	1.19	0.24
50.0	1.87	0.37
55.0	2.57	0.50
60.0	3.26	0.63
65.0	3.90	0.75
70.0	4.50	0.86
75.0	5.05	0.96
80.0	5.55	1.05
85.0	5.99	1.12
90.0	6.39	1.19
95.0	6.80	1.26
100.0	7.36	1.36
105.0	8.40	1.53
110.0	9.87	1.77
115.0	10.85	1.92
120.0	11.49	2.02
125.0	11.97	2.10
130.0	12.37	2.16
135.0	12.69	2.21
140.0	12.97	2.25
145.0	13.21	2.28
150.0	13.41	2.31
155.0	13.60	2.34
160.0	13.76	2.37
165.0	13.91	2.39
170.0	14.05	2.41
175.0	14.16	2.43
180.0	14.27	2.44



Wandoan Mine

RGSWAN2R	2022005_016	
Date prepared	4/04/2022	
Date on test	5/04/2022	
Adiabatic self-heating test R_{70}	6.84	°C/h
Relative ignition temperature (RIT)	120.3	°C
Moisture content	9.8	%

Coal Temp (°C)	Time (min)	Time (h)
39.9	0	0.000
45.0	37.67	0.628
50.0	91.00	1.517
55.0	144.00	2.400
60.0	191.17	3.186
65.0	231.00	3.850
70.0	264.17	4.403
75.0	290.33	4.839
80.0	311.17	5.186
85.0	327.33	5.456
90.0	340.00	5.667
95.0	349.83	5.831
100.1	357.50	5.958
105.1	363.33	6.056
110.0	367.83	6.131
115.1	371.33	6.189
119.9	374.00	6.233
125.0	376.17	6.269
129.8	377.83	6.297
135.1	379.33	6.322
140.3	380.50	6.342
144.7	381.33	6.356
149.8	382.17	6.369
155.6	383.00	6.383
160.5	383.67	6.394



Wandoan Mine

RGSWAN2INAL	2022005_016	
Date prepared	4/04/2022	
Date on test	4/04/2022	
Moisture content	9.8	%

Time to thermal runaway (t_{TR})

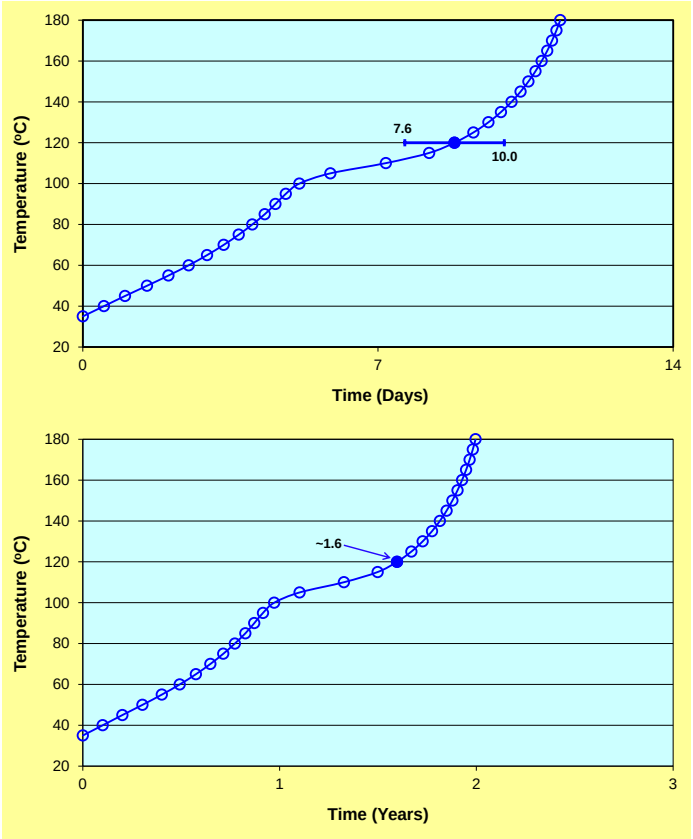
Loosely Piled Coal

Minimum incubation period lower limit	7.6	days
Minimum incubation period upper limit	10	days

Highly Fractured In-situ State

Minimum incubation period	~1.6	years

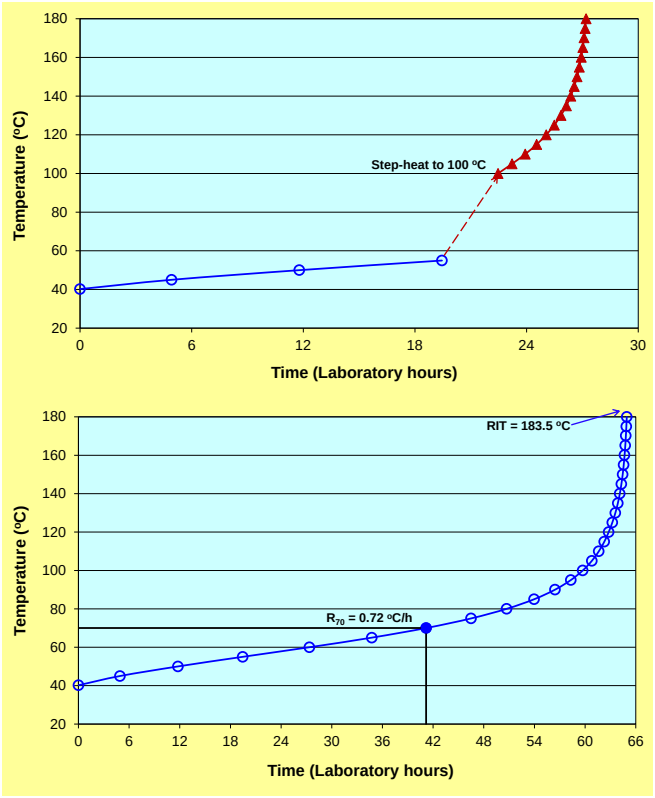
Coal Temp (°C)	Loose Time (days)	In-situ Time (years)
35.0	0.00	0.00
40.0	0.50	0.10
45.0	1.00	0.20
50.0	1.52	0.30
55.0	2.03	0.40
60.0	2.51	0.49
65.0	2.95	0.57
70.0	3.34	0.65
75.0	3.70	0.71
80.0	4.02	0.77
85.0	4.31	0.83
90.0	4.57	0.87
95.0	4.82	0.92
100.0	5.14	0.97
105.0	5.87	1.10
110.0	7.19	1.33
115.0	8.21	1.50
120.0	8.82	1.60
125.0	9.26	1.67
130.0	9.62	1.73
135.0	9.92	1.77
140.0	10.17	1.81
145.0	10.38	1.85
150.0	10.57	1.88
155.0	10.74	1.90
160.0	10.88	1.93
165.0	11.02	1.95
170.0	11.13	1.97
175.0	11.23	1.98
180.0	11.32	2.00



Wandoan Mine

RGSWAN3R	2022005_019	
Date prepared	6/04/2022	
Date on test	7/04/2022	
Adiabatic self-heating test R_{70}	0.72	°C/h
Relative ignition temperature (RIT)	183.5	°C
Moisture content	7.4	%

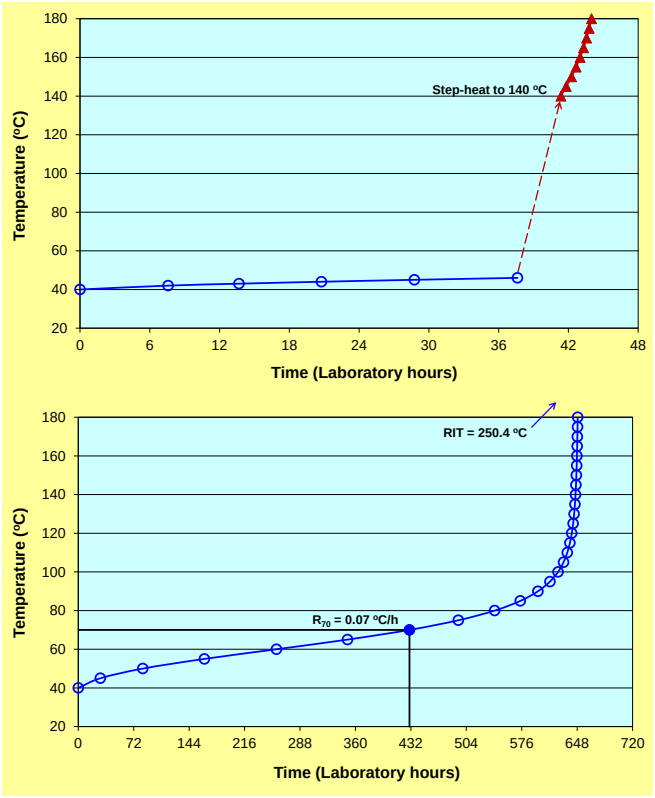
Coal Temp (°C)	Time (min)	Time (h)
40.2	0	0.000
45.0	295.17	4.919
50.0	707.17	11.786
55.0	1167.17	19.453
60.0	1641.50	27.358
65.0	2084.75	34.746
70.0	2470.82	41.180
75.0	2789.53	46.492
80.0	3042.49	50.708
85.0	3237.94	53.966
90.0	3386.51	56.442
95.0	3498.65	58.311
100.0	3583.34	59.722
105.0	3647.77	60.796
110.0	3697.42	61.624
115.0	3736.36	62.273
120.0	3767.36	62.789
125.0	3793.36	63.223
130.0	3814.86	63.581
135.0	3832.36	63.873
140.0	3846.53	64.109
145.0	3857.69	64.295
150.0	3866.86	64.448
155.0	3874.19	64.570
160.1	3880.36	64.673
165.1	3885.36	64.756
170.2	3889.53	64.825
175.0	3892.86	64.881
180.0	3895.86	64.931



Wandoan Mine

RGSWAN4R	2022005_020	
Date prepared	19/08/2022	
Date on test	22/08/2022	
Adiabatic self-heating test R_{70}	0.07	°C/h
Relative ignition temperature (RIT)	250.4	°C
Moisture content	2.0	%

Coal Temp (°C)	Time (min)	Time (h)
40.0	0	0.000
45.0	1725.39	28.756
50.0	5027.00	83.783
55.0	9831.61	163.860
60.0	15442.87	257.381
65.0	20985.47	349.758
70.0	25806.91	430.115
75.0	29624.64	493.744
80.0	32451.19	540.853
85.0	34450.86	574.181
90.0	35826.36	597.106
95.0	36759.08	612.651
100.0	37389.37	623.156
105.0	37817.37	630.290
110.0	38111.27	635.188
115.0	38316.29	638.605
120.0	38462.06	641.034
125.0	38567.90	642.798
130.0	38646.48	644.108
135.0	38706.16	645.103
140.0	38752.52	645.875
145.0	38789.32	646.489
150.0	38819.15	646.986
155.0	38843.80	647.397
160.0	38864.39	647.740
165.0	38882.36	648.039
170.0	38897.72	648.295
175.0	38911.11	648.519
180.0	38923.21	648.720



MINING SERVICES
AUSTRALIA'S LEADER IN SPONCOM RISK ASSESSMENT AND MANAGEMENT PLANNING

SPONTANEOUS COMBUSTION TECHNICAL REPORT

SPONTANEOUS COMBUSTION HAZARD ASSESSMENT OF COAL AND REJECTS SAMPLES FROM WANDOAN MINE

B3 MINING SERVICES TECHNICAL REPORT – 2024/TR021

PREPARED FOR RGS ENVIRONMENTAL PTY LTD

MARCH, 2024

Prepared by Dr B Basil Beamish MAusIMM CP(Min) RPEQ No.12621
and
Jan Theiler AAusIMM

B3 Mining Services Pty Ltd
PO Box 1089
Mount Ommaney QLD 4074
Telephone: 0488 708 949
basil@b3miningservices.com

ABN 36 122 684 584

Declaration

This report and the data on which it is based are prepared solely for the use of the person or corporation to whom it is addressed. It may not be used or relied upon by any other person or entity. No warranty is given to any other person as to the accuracy of any of the information, data or opinions expressed herein. B3 Mining Services Pty Ltd expressly disclaims all liability and responsibility whatsoever to the maximum extent possible by law in relation to any unauthorised use of this report.

COMMERCIAL IN CONFIDENCE

EXECUTIVE SUMMARY

This report contains the results and analysis of coal spontaneous combustion testing of coal and rejects samples from Wandoan Mine, Queensland.

Previous spontaneous combustion studies using an adiabatic oven have measured the self-heating rate index (R_{70}) of coals being mined around the world, including many Queensland mining operations. Therefore, comparisons between this study and the previous studies can be used to obtain a relative indication of the intrinsic spontaneous combustion propensity of the coal and reject samples. In addition, spontaneous combustion indices (minimum self-heating temperature and crossing point temperature) have been derived from coal quality data of the samples. These derived indices are also used to obtain a relative indication of the intrinsic propensity of the coal for spontaneous combustion.

The R_{70} self-heating rate values measured for coal and rejects samples from Wandoan Mine range from 0.44 °C/h to 8.82 °C/h. The rejects samples have the lowest values and the coal samples have the highest values. Based on Queensland conditions the rejects gave a Low to Medium intrinsic spontaneous combustion propensity rating and the coal has a Very High to Ultra-High rating. These values are consistent with the rank and type of coal. It should be noted that the R_{70} test is performed on a dry basis and as such it does not provide any indication of the time taken to reach thermal runaway. Calculated spontaneous combustion index values for crossing point temperature indicate the samples have a Low to Medium spontaneous combustion propensity rating. The measured relative ignition temperatures for the samples are in agreement with the R_{70} results.

A spontaneous combustion hazard likelihood chart has been developed from these test results, which shows that the coal samples are classified as TR (Thermal Runaway is possible under ideal conditions) whereas the rejects are classified as NTR (No Thermal Runaway without an additional heat source).

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
LIST OF FIGURES iii
LIST OF TABLES iv
1.0 INTRODUCTION 1
1.1 Spontaneous combustion testing 1
1.2 Scope of the work 2
2.0 METHODOLOGY 3
2.1 Samples 3
2.2 Adiabatic oven R_{70} test procedure 3
2.3 Coal rank analysis procedure 4
2.4 Intrinsic spontaneous combustion propensity analysis procedure 4
2.5 Minimum self-heating temperature analysis procedure 6
2.6 Crossing point temperature and relative ignition temperature analysis procedure 7
3.0 ANALYSIS OF RESULTS AND INTERPRETATION 9
3.1 Coal quality analysis and rank 9
3.2 Intrinsic spontaneous combustion propensity analysis 11
3.3 Minimum self-heating temperature and crossing point temperature analysis 12
4.0 EVALUATION OF SPONTANEOUS COMBUSTION HAZARD LIKELIHOOD 14
4.1 Introduction 14
4.2 Coal physical properties and site factors 15
4.3 Spontaneous combustion hazard likelihood 18
4.3.1 General hazard assessment methodology 18
4.3.2 Spontaneous combustion hazard likelihood chart 18
5.0 CONCLUSIONS 21
REFERENCES 22
APPENDIX 1 Adiabatic testing results for coal and rejects samples from Wandoan Mine 26

LIST OF FIGURES

Figure 1 Suggate rank plot for coal samples from Wandoan Mine 9

Figure 2 R_{70} self-heating rate relationship with ash content for Wandoan coal and rejects showing intrinsic spontaneous combustion propensity classes based on Queensland conditions 12

Figure 3 Enclosed stockpile storage of Kideco coal 14

Figure 4 Coal heating developed in uncompacted stockpile 15

Figure 5 Relationship between oxygen concentration in air and oxygen absorption rate 17

Figure 6 Partial spontaneous combustion fault tree showing possible causes leading to an unwanted event 18

Figure 7 Spontaneous combustion hazard likelihood chart based on total moisture content and R_{70} self-heating rate value under ideal conditions 19

LIST OF TABLES

Table 1 Coal and rejects samples supplied for spontaneous combustion testing 3

Table 2 Intrinsic spontaneous combustion propensity classification 6

Table 3 Analytical and rank data for coal and rejects samples from Wandoan Mine 10

Table 4 R_{70} and RIT values for coal and rejects samples from Wandoan Mine with their corresponding Intrinsic Spontaneous Combustion Propensity (ISCP) rating 11

Table 5 SHT and CPT values for coal and rejects samples from Wandoan Mine with their corresponding Spontaneous Combustion Propensity rating 13

1.0 INTRODUCTION

1.1 Spontaneous combustion testing

There are a number of spontaneous combustion tests documented in the literature that produce indices for rating the propensity of coal to spontaneously combust (Nelson and Chen, 2007). The more common ones that have gained wider use in the Australian and New Zealand coal industries are R_{70} self-heating rate, crossing point temperature (CPT), relative ignition temperature (RIT) and minimum self-heating temperature (SHT). The first three of these are available from laboratory testing that is offered in Australia. However, SHT is a calculated value from coal quality data using the original equation developed by Smith and Lazzara (1987) based on US coals, as this test is no longer offered by any laboratory.

All of the existing index parameters provide an indication of the intrinsic spontaneous combustion propensity of a particular coal using a classification scheme, but they do not provide any indication of the timeframe taken for coal spontaneous combustion issues to occur (incubation period). They also do not provide a proper hazard evaluation of coal self-heating that takes into consideration the effects of extrinsic factors (Beamish and Theiler, 2017a). The moderating influences of extrinsic factors such as in-mine ambient temperature and moisture (both in the coal and the surrounding environment) have been recognised and studied by Hodges and Hinsley (1964), Guney (1971) and Smith and Lazzara (1987) using adiabatic oven testing. From these early studies it is clear that the entire coal self-heating behaviour from low ambient temperature to thermal runaway can only be fully assessed by replicating in-mine conditions.

Investigations by Beamish and Beamish (2011, 2012) have shown how spontaneous combustion hazard assessment can be improved by benchmarking against known coal self-heating experience from operating mines and built stockpiles using an Incubation test method. Beamish *et al* (2012) and Beamish and Theiler (2015) provide working examples of the success of this new technique. In addition, earlier efforts to identify and quantify any accelerating effects from the presence of reactive pyrite in coal and non-coal strata were not successful (Miron, Lazzara and Smith, 1992), but the new incubation test method has overcome this problem (Beamish and Theiler, 2019, 2017b).

1.2 Scope of the work

RGS Environmental Pty Ltd sought to establish the spontaneous combustion hazard likelihood of coal and rejects samples from Wandoan Mine. To achieve the spontaneous combustion hazard assessment of these samples the following scope of testing was developed and performed:

1. R_{70} testing of each sample to establish their Intrinsic Spontaneous Combustion Propensity rating. In addition, this test also produced a value for the Relative Ignition Temperature of the sample.
2. Coal quality analysis (proximate, total sulphur and calorific value) of the samples to be used to assist with interpretation of testing results and to calculate values for minimum self-heating temperature (SHT) and crossing point temperature (CPT), where applicable.
3. Development of a spontaneous combustion hazard likelihood chart for the samples tested.

2.0 METHODOLOGY

2.1 Samples

The sample reference numbers and corresponding sample details supplied are contained in Table 1. As soon as possible after receiving the samples, they were prepared for spontaneous combustion testing.

Table 1
Coal and rejects samples supplied for spontaneous combustion testing

Mine/ Location	Sample ID	Sample Type	Test Reference Number
Wandoan	2022005_SP4, C13	Coal	RGSWAN5R
Wandoan	2022005_SP5, C14	Rejects	RGSWAN6R
Wandoan	2022005_SP6, C15	Coal	RGSWAN7R
Wandoan	2022005_SP7, C16	Rejects	RGSWAN8R

R = R_{70} self-heating rate test

2.2 Adiabatic oven R_{70} test procedure

Full details of the adiabatic oven are given in Beamish, Barakat and St George (2000). Prior to each R_{70} test, the sample to be tested is removed from the freezer, crushed and sieved to <212 μm in as short a time as possible to minimise the effects of oxidation on fresh surfaces created by the grinding of the coal. A 150 g sample is placed in a 750 mL volumetric flask and a unidirectional flow of nitrogen at 250 mL/min applied to the flask inside a drying oven. Precautions are taken to ensure the exclusion of oxygen from the vessel prior to heating the coal for drying. Hence, the air is flushed from the system at room temperature for a period of one hour. After one hour, the oven is ramped up to 110 °C and the coal is dried under nitrogen for at least 16 h to ensure complete drying of the sample. All R_{70} tests are performed on a dry basis to standardise the test results.

At the completion of drying, the coal is transferred into the reaction vessel and left to stabilise at 40 °C in the adiabatic oven with nitrogen passing through it. The reaction vessel is a

450 mL thermos flask inner. When the sample temperature has stabilised, the oven is switched to remote monitoring mode. This enables the oven to track and match the coal temperature rise due to oxidation. The gas selection switch is turned to oxygen with a constant flow rate of 50 mL/min. The temperature change of the coal with time is recorded by a datalogging system for later analysis. The oven limit switch is set at 160 °C to cut off the power to the oven, and stop the oxygen flowing when the sample reaches this temperature. When the oven cools down, the sample is removed from the reaction vessel, which is then cleaned in preparation for the next test.

For coals with a low self-heating rate, a step-heat procedure is used, since these coals can take over 100 hours to reach test completion. The decision to step-heat the sample is based on the sample temperature not reaching 90 ºC after approximately 20 hours. For these samples the coal temperature is step-heated to between 100 ºC to 130 ºC (depending on the temperature the coal has reached in the first 20 hours) using the oven heaters and then returned to adiabatic tracking mode to allow the coal to continue to thermal runaway adiabatically. This enables a value for the relative ignition temperature of the coal to be determined and the test to be completed in two days, inclusive of drying.

2.3 Coal rank analysis procedure

Suggate (2000, 1998) demonstrated the applicability of the Suggate rank parameter to both New Zealand and Australian coals. This parameter is determined from either the calorific value and volatile matter of the coal expressed on a dry mineral matter and sulphur free basis (dmmsf), or the atomic O/C and H/C of the coal expressed on a mineral matter free basis. The simpler of these two approaches is to use the calorific value and volatile matter data. This is normally done using a purpose-built spreadsheet to generate the Suggate rank plots. In addition, the ASTM rank is calculated using equations contained in the COALAP computer program developed by Sykes and Suggate (1990).

2.4 Intrinsic spontaneous combustion propensity analysis procedure

The R_{70} self-heating rate value was first reported by Humphreys, Rowlands and Cudmore (1981), who used an adiabatic oven to assess the propensity of Queensland coals for spontaneous combustion. They defined a self-heating rate value R_{70}, which equated to the time taken for dry, crushed coal to increase in temperature from 40 ºC to 70 ºC due to

oxidation under adiabatic conditions. For coals with a low self-heating rate, which are tested using a step-heat procedure, the R_{70} is calculated based on the non-Arrhenius kinetics theory proposed by Beamish and Arisoy (2008a) and Arisoy and Beamish (2015). This kinetic model is applicable to all coals and enables interpolation of the missing data between the initial self-heating up to 20 hours and the higher temperature self-heating rate data after the step-heating to the oven trip temperature.

Moreby (1997) reports that a coal with an R_{70} value below 0.5 ºC/h is considered to be low propensity, 0.5-0.8 ºC/h medium propensity, while coals with an R_{70} value higher than 0.8 ºC/h are considered to be highly prone to spontaneous combustion. Beamish, Barakat and St George (2001), Beamish (2005) and Beamish *et al* (2005) and Beamish and Arisoy (2008b) have published R_{70} values for New Zealand, Australian, Indonesian and American coals using the same adiabatic oven at The University of Auckland and The University of Queensland, which clearly shows a distinct rank relationship. High rank bituminous coals have R_{70} values less than 0.8 ºC/h, whereas low rank subbituminous coals have R_{70} values in excess of 16 ºC/h.

More recent testing has recorded values in excess of 32°C/h for sub-bituminous C coals and a value of 99°C/h has been recorded for a lignite sample. Consequently, the majority of coals currently being mined around the World would fit the high propensity category based on the three tier rating system, which suggests there is a need to review the way in which the R_{70} value is used in hazard assessment.

As the R_{70} test procedure is performed on a dry basis, the value obtained is actually a true measure of the intrinsic coal reactivity to oxygen. Hence, Beamish and Beamish (2011a) proposed an appropriate intrinsic spontaneous combustion propensity rating classification based on R_{70} values for Queensland and New South Wales conditions (Table 2), which takes into consideration the different start temperatures that exist in both settings. Also, the boundary for each class takes into account that the rank relationship with R_{70} values is non-linear.

Table 2
Intrinsic spontaneous combustion propensity classification (ISCP)
(based on Queensland and New South Wales coal conditions)

ISCP Class	Propensity rating	Queensland R_{70} value (°C/h)	New South Wales R_{70} value (°C/h)
I	Low (L)	$R_{70} < 0.5$	$R_{70} < 1$
II	Low-Medium (LM)	$0.5 \leq R_{70} < 1$	$1 \leq R_{70} < 2$
III	Medium (M)	$1 \leq R_{70} < 2$	$2 \leq R_{70} < 4$
IV	High (H)	$2 \leq R_{70} < 4$	$4 \leq R_{70} < 8$
V	Very High (VH)	$4 \leq R_{70} < 8$	$8 \leq R_{70} < 16$
VI	Ultra-High (UH)	$8 \leq R_{70} < 16$	$16 \leq R_{70} < 32$
VII	Extremely High (EH)	$R_{70} \geq 16$	$R_{70} \geq 32$

Beamish and Beamish (2011a)

2.5 Minimum self-heating temperature analysis procedure

In the 1980s the US Bureau of Mines had an active research team working on coal spontaneous combustion issues. A test method was developed that produced an index parameter for spontaneous combustion propensity called Minimum Self-heating Temperature (SHT). This index parameter was found to be related to the coal oxygen content (O, % dry, ash-free basis) according to the following equation (Smith and Lazzara, 1987):

$$SHT\ (^oC) = 139.74 - 6.57 \times O$$

To account for the increased (or decreased) reactivity of a coal due to ambient in-mine temperatures, the value for the minimum SHT determined from the equation can be adjusted based on the ambient in-mine temperature of the coal. A value of 12.8 ºC (55 ºF) is used as the baseline in-mine temperature (Smith, Rumancik and Lazzara, 1996):

$$SHT_{adj}\ (^oC) = [SHT - (T_{ambient} - 12.8)]$$

According to Smith, Rumancik and Lazzara (1996) coals with adjusted SHT's <70 ºC are rated as having a high spontaneous combustion propensity, while those with adjusted SHT's > 100 ºC are rated as having a low spontaneous combustion propensity. Coals with adjusted

SHT's between 70 and 100 ºC are rated as having a medium spontaneous combustion propensity.

Beamish and Beamish (2011a) found that for a range of Australian coals the high intrinsic spontaneous combustion propensity boundary should be increased to 80 ºC using the original Smith and Lazzara equation for SHT. Therefore, the Smith and Lazzara (1987) equation and the modified boundary are applied to the samples in this report.

2.6 Crossing point temperature and relative ignition temperature analysis procedure

The determination of crossing point and relative ignition temperatures (CPT and RIT) follows a similar methodology (Banerjee, 1985). Both tests use an oven heated at a fixed rate (usually 2 ºC/min) to drive the temperature of the coal to a point where the coal crosses over the oven temperature and rapidly progresses towards thermal runaway. This is substantially different to the adiabatic oven testing where the oven tracks the coal temperature as it reacts with oxygen. The lower the CPT or RIT value the higher the spontaneous combustion propensity of the coal.

Barve and Mahadevan (1994) established that CPT values can be calculated from coal quality data based on the moisture content (M, air-dried basis) and the ash content (A, dry basis) of the coal. They proposed a separate equation for bituminous coals in general and a more specific equation for high volatile bituminous coals:

General CPT equation for bituminous coals

$$CPT\ (^{o}C) = 168.8 - 10.3 \times M + 0.12 \times A + 0.69 \times M^2 - 0.06 \times M \times A + 0.01 \times A^2$$

CPT equation for high volatile bituminous coals

$$CPT\ (^{o}C) = 170 - 5.16 \times M - 2.8 \times A - 0.005 \times M^2 + 0.28 \times M \times A + 0.02 \times A^2$$

Banerjee *et al* (1972) determined that coals with CPT values less than 140 ºC are generally considered to have a high intrinsic spontaneous combustion propensity, those within the range of 140 ºC to 160 ºC have a medium intrinsic spontaneous combustion propensity, and coals with CPT values greater than 160 ºC have a low intrinsic spontaneous combustion propensity. However, more recent checks of each of the CPT equations for a range of

Australian coals suggests that the boundaries should be set at 130 ºC for high propensity and 150 ºC for low propensity.

The adiabatic R_{70} self-heating rate test also provides a value for RIT, which is defined as the temperature where the rate of coal self-heating reaches 2 ºC/min. Subsequently, the coal temperature rapidly rises beyond this point on its way to thermal runaway. This value is obtained from the R_{70} self-heating rate data and can be compared against the R_{70} value to provide a confirmation of the relative intrinsic spontaneous combustion propensity of the coal. The lower the RIT value the higher the intrinsic propensity of the coal for spontaneous combustion.

3.0 ANALYSIS OF RESULTS AND INTERPRETATION

3.1 Coal quality analysis and rank

Proximate analysis, ultimate analysis and calorific value determination was performed on duplicates of the test samples. A summary of the results obtained for each sample are contained in Table 3. The ASTM rank classification of the coal samples is high volatile C bituminous, based on the volatile matter content and calorific value. For the high ash content coal rejects samples, it is difficult to obtain a valid mineral matter correction. The coal samples plot above the high vitrinite coal band as seen on a Suggate rank plot (Figure 1). This indicates that they are liptinite-rich. All samples have a low sulphur content, which indicates the presence of pyrite is minimal. The coal rejects samples have a very high oxygen content, which is most likely due to the presence of carbonate mineral matter.

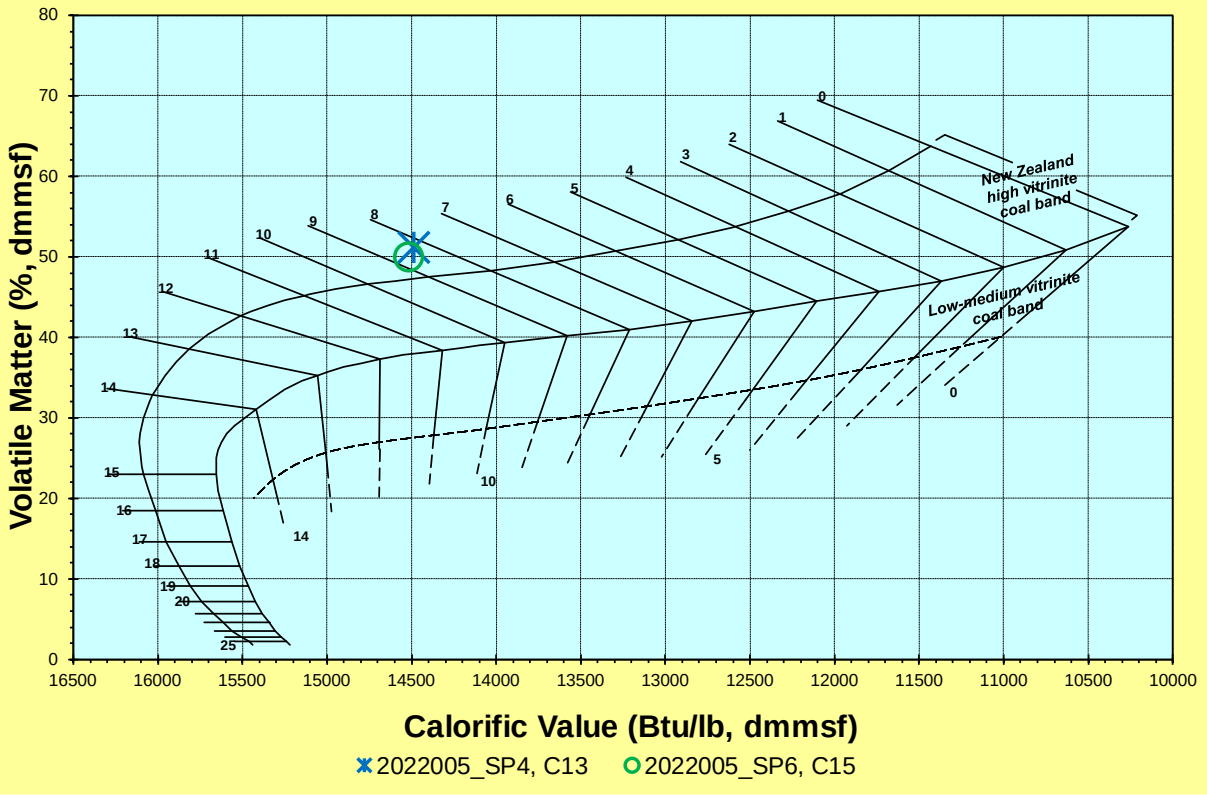


Figure 1. Suggate rank plot for coal samples from Wandoan Mine.

Table 3
Analytical and rank data for coal and rejects samples from Wandoan Mine

	2022005 SP4	2022005 SP5	2022005 SP6	2022005 SC7
PROXIMATE ANALYSIS (air-dried basis)				
Moisture (%)	10.1	6.6	10.7	7.7
Ash (%)	24.9	69.3	23.6	74.2
Volatile Matter (%)	34.6	14.4	34.2	11.6
Fixed Carbon (%)	30.4	9.7	31.5	6.5
Total Sulphur (%)	0.23	0.08	0.34	0.06
Calorific Value (MJ/kg, raw)	21.01	6.03	21.31	4.37
ULTIMATE ANALYSIS (dry ash-free basis)				
Carbon (%)	76.0	66.8	76.3	65.7
Hydrogen (%)	5.97	7.43	6.10	7.40
Nitrogen (%)	1.03	1.04	1.17	1.05
Sulphur (%)	0.35	0.33	0.52	0.33
Oxygen (%)	16.6	24.4	15.9	25.5
COAL RANK PARAMETERS				
VM (%, dmmsf)	51.2	43.2	50.0	38.8
CV (Btu/lb, dmmsf)	14488	15150	14520	17667
Suggate rank	8.3	na	8.6	na
VM (%, dmmf)	51.7	47.7	50.6	46.5
CV (Btu/lb, mmmf)	12114	9940	12046	8963
ASTM rank	hvCb	na	hvCb	na

3.2 Intrinsic spontaneous combustion propensity analysis

A copy of the temperature data recorded for the R_{70} self-heating rate tests that were conducted on the samples from Wandoan Mine is contained in Appendix 1. A summary of the results is contained in Table 4, and shows the R_{70} values range from 0.44 °C/h to 8.82 °C/h. The RIT values for the samples are consistent with the R_{70} values and are indicative of a low to ultra-high reactivity towards oxygen.

Table 4
R_{70} and RIT values for coal and rejects samples from Wandoan Mine with their corresponding Intrinsic Spontaneous Combustion Propensity (ISCP) rating

Sample	Ash content (%, db)	R_{70} (°C/h)	RIT (°C)	ISCP QLD rating
2022005_SP4, C13	27.7	6.62	122.9	Very High
2022005_SP5, C14	74.2	1.44	178.3	Medium
2022005_SP6, C15	26.4	8.82	115.7	Ultra-High
2022005_SP7, C16	80.4	0.44	197.0	Low

When interpreting R_{70} values it is important to realise that the value is not only rank dependent (Beamish, 2005; Beamish and Arisoy, 2008b), it is also affected by coal type (Beamish and Clarkson, 2006; Beamish and Arisoy, 2008b) and mineral matter constituents (Beamish and Blazak, 2005; Beamish and Arisoy, 2008b; Beamish and Sainsbury, 2008). As such, a true comparison between samples can be obtained by plotting R_{70} against the ash content (acting as an indicator parameter of mineral matter content) of the coal on a dry basis as shown in Figure 2. An ash content trend is apparent for the samples from Wandoan Mine and this could be used for extrapolation to other samples where the ash content has been determined.

The intrinsic spontaneous combustion propensity rating based on Queensland conditions for the coal and rejects samples from Wandoan Mine is Low to Medium for the rejects and Very High to Ultra-High for the coal. This rating is consistent with the rank and type of coal.

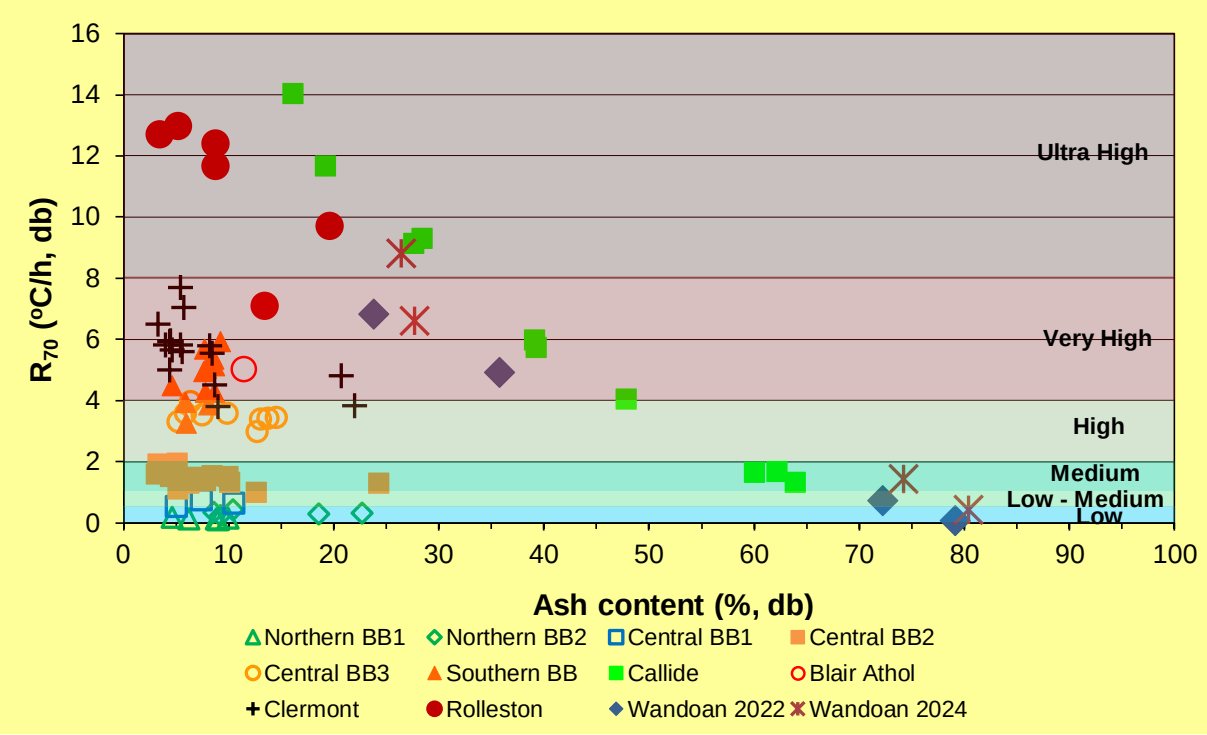


Figure 2. R_{70} self-heating rate relationship with ash content for Wandoan coal and rejects, showing intrinsic spontaneous combustion propensity classes based on Queensland conditions.

3.3 Minimum self-heating temperature and crossing point temperature analysis

The calculated minimum self-heating temperature and crossing point temperature values for the coal and rejects samples from Wandoan Mine are contained in Table 5 with their respective propensity ratings. The SHT values of the high ash content rejects samples is strongly affected the presence of carbonate mineral matter, which results in an elevated oxygen content and therefore invalidates the use of this index for the rejects. The CPT values for the samples generally indicate a Low to Medium spontaneous combustion propensity rating that correlates with decreasing ash content of each sample. The SHT values for the coal samples produce a High spontaneous combustion propensity rating.

Table 5
SHT and CPT values for coal and rejects samples from Wandoan Mine with their corresponding spontaneous combustion propensity rating

Sample	SHT (°C)	Propensity rating	CPT (°C)	Propensity rating
2022005_SP4, C13	31	High	133	Medium
2022005_SP5, C14	Invalid	Invalid	175	Low
2022005_SP6, C15	35	High	133	Medium
2022005_SP7, C16	Invalid	Invalid	207	Low

4.0 EVALUATION OF SPONTANEOUS COMBUSTION HAZARD LIKELIHOOD

4.1 Introduction

The intrinsic spontaneous combustion propensity of coal and rejects samples from Wandoan Mine has been determined from laboratory testing to be Low to Medium for the rejects and Very High to Ultra-High for the coal. However, to establish an overall site-specific hazard assessment of spontaneous combustion likelihood it is necessary to take into consideration the physical properties of the coal, as well as the mine site factors. This is emphasised by way of stockpile examples in Figures 3 and 4 that show loosely formed coal piles with steep sides and coarse coal near the base, which is a poor combination in terms of spontaneous combustion management where the surrounding environmental conditions favour heat gain over heat dissipation.

Figure 3. Enclosed stockpile storage of Kideco coal showing no compaction except from the weight of the stockpile and steep sides at angle of repose with coarse coal fraction accumulated at the base of the stockpile allowing pathways for air to enter the stockpile and create a chimney effect. Note the moisture condensation lines within the rectangular zone arising from hot spot development inside the pile. Thermal runaway reached in 10-13 days.

Figure 4. Coal heating developed in uncompacted stockpile with steep sides (angle of repose) and coarse coal fraction accumulated at the base of the stockpile allowing pathways for air to enter the stockpile and create a chimney effect. The hotspot has migrated from inside the stockpile to daylight on the surface and reach ignition.

4.2 Coal physical properties and site factors

Production of coal fines will enhance the reactivity of the coal through greater access of air to oxidation sites as a result of the increased surface area available for reaction to take place. The ease of fines production is a property of the coal, which is best measured by the Hardgrove Grindability Index (HGI) value. Also, care must be taken in identifying areas of crushed coal that may be associated with faulting or other geological features, as these will provide greater fines production and pathways for air access into the seam.

Moisture effects on coal self-heating in a pile of broken coal (whether naturally formed underground by roof falls, or as part of goaf formation or surface built stockpiles) are two-fold. In the case of low-moisture content coals, the maximum temperature increases steadily with time. In the case of high-moisture coals, temperature increases rapidly initially before evaporation dominates and the temperature reaches a plateau value (generally around 80-

90 °C). Once the coal becomes dry locally the temperature will increase rapidly towards thermal runaway. However, if the coal pile has been in a prolonged drying phase that is interrupted by a wetting or rain event and the water penetrates into the coal pile then additional heat can be generated from the "heat of wetting" effect as the coal re-adsorbs the moisture available to it. A similar effect is created by an increase in humidity, which can also lead to premature thermal runaway in the coal pile.

The coal ambient temperature also plays a major role in determining the initial coal self-heating rate. The R_{70} test is performed at 40 °C to compare all coals on a standard basis. This temperature is more closely aligned with Queensland coals for which the test was originally developed (Humphreys, Rowlands and Cudmore, 1981) and is indicative of underground or summer temperatures in the Bowen Basin. For coal ambient temperatures at least 10 °C lower than this, the initial self-heating rate of the coal will be greatly diminished (approximately halved). This increases the timeframe for any hot spot to develop assuming ideal conditions exist to allow heat to accumulate in broken coal. The converse is also true.

Arisoy and Akgun (2000) showed that for different coal reactivities there was a critical pile thickness necessary for coal self-heating to develop to a stage where spontaneous combustion was inevitable after three months. This thickness varied between 0.85 and 1.8m for coals with high reactivities and medium reactivities respectively. More recent work by Akgun and Essenhigh (2001) also showed that where coal pile heights exceeded 2 m, given sufficient time and other favourable conditions, coal self-heating leading to thermal runaway was inevitable. This aspect of coal self-heating is often overlooked in underground mining and must be considered if coal is to be left in the goaf from using a coal roof, or falls into the goaf from adjacent seams, or significant floor coal is left in the goaf.

There are two very important parameters that determine the rate at which a hot spot will develop in a broken coal pile. These are pile porosity and slope angle of the pile sides. Compaction decreases the pile porosity and thus increases the resistance to the airflow into the pile, which results in suppressing the oxidation reaction due to air starvation (Akgun and Essenhigh, 2001). As the slope of the coal pile sides decreases, the time to thermal runaway increases. Akgun and Essenhigh (2001) found that reducing the coal pile slope from 63° to 34° increased the time to thermal runaway by 100%. Hence, steep-sided coal piles create the biggest problem for coal self-heating, which normally initiates about 2 m in from the sides.

Air supply to broken coal is also a pre-requisite for self-heating to generate. In a goaf environment, exclusion of air removes the issue. However, often some air leakage will occur. As a standard risk mitigation strategy, gas monitoring of the goaf environment will normally provide confirmation of this, with any hot spot development showing as a change in goaf gas composition (for example abnormal increases in carbon monoxide or other spontaneous combustion indicators above the background trends).

Winmill (1915) performed a definitive study of the effect of varying the percentage of oxygen in air on the rate of oxygen absorption by crushed coal (<250 µm) at 30 °C and hence the rate at which reaction can take place. The results of this study (Figure 5) showed that the rate of oxygen absorption was proportional to the square-root of the oxygen percentage in the air. As such the rate of oxygen absorption dropped to just over half when the oxygen concentration decreased from 100% to 20.9% (normal air concentration) and when the oxygen concentration decreased to 5% the rate of oxygen absorption halved again. These findings emphasise the importance of keeping goaf areas airtight. Winmill (1915) also stated that "So long as the oxygen is below 2 per cent, it would seem that no coal has a sufficiently high rate of oxidation to cause any serious rise in temperature".

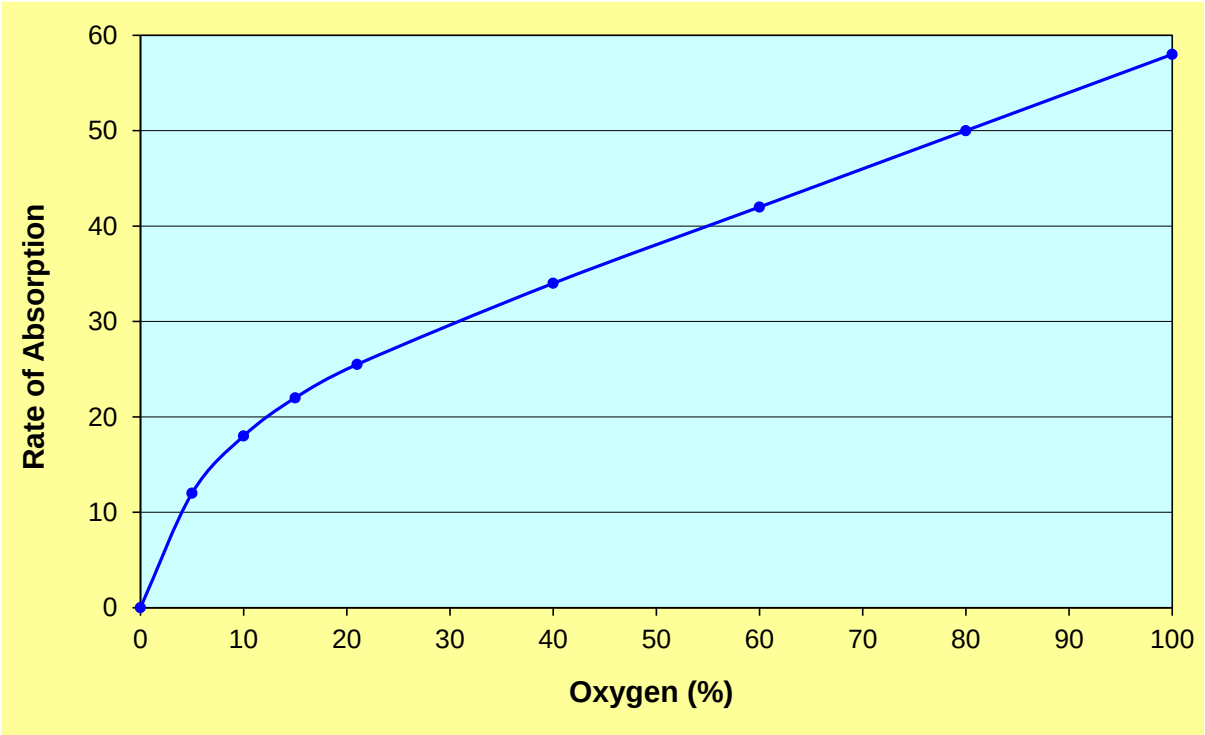


Figure 5. Relationship between oxygen concentration in air and oxygen absorption rate (note the rates of absorption are expressed in arbitrary units, since comparative figures only are required).

4.3 Spontaneous combustion hazard likelihood

4.3.1 General hazard assessment methodology

Risk assessment is routinely used in the coal industry to develop plans that are appropriate to the management of hazards. Leading practice at all coal mines requires the implementation of a Principal Hazard Management Plan for Spontaneous Combustion. The initial step in developing this plan should be to identify the root causes of an unwanted spontaneous combustion event. This can be achieved using the Fault Tree Analysis (FTA) risk assessment method. A generic example of the initial branches of a spontaneous combustion fault tree is shown in Figure 6. The self-heating behaviour of the coal and rejects can be assessed in the context of the Wandoan Mine to enable the likelihood of developing a spontaneous combustion event to be evaluated.

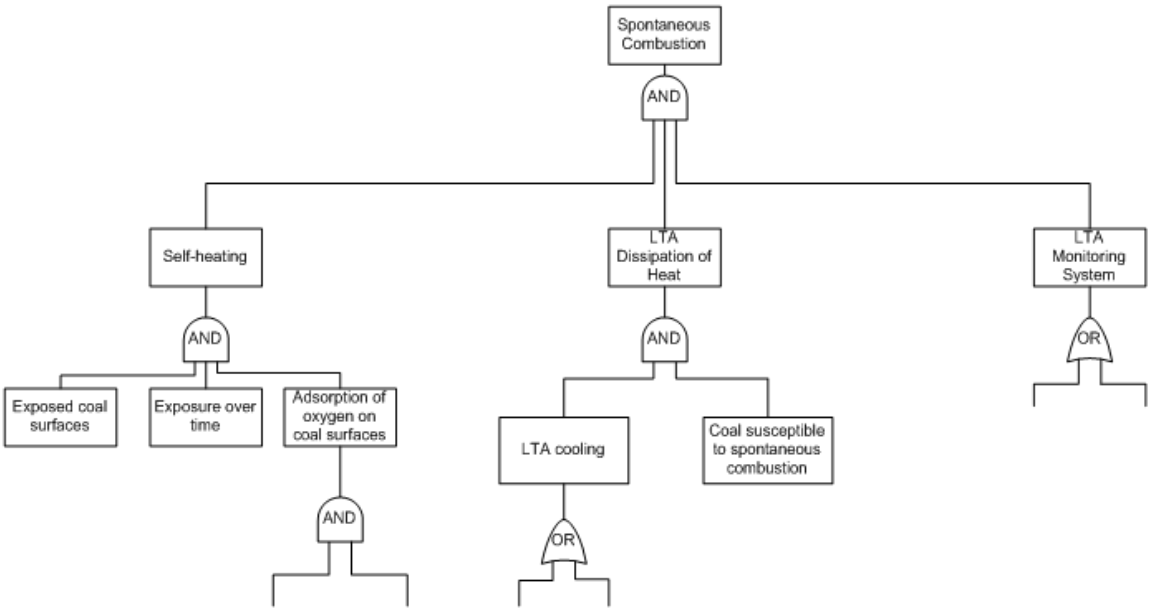


Figure 6. Partial spontaneous combustion fault tree showing possible causes leading to an unwanted event (modified from Beamish *et al*, 2010). Note: LTA = Less Than Adequate

4.3.2 Spontaneous combustion hazard likelihood chart

The data obtained to date for Wandoan Mine coal and rejects samples provides a solid database for establishing whether the intrinsic reactivity/moisture heat balance of the samples favours reaching Thermal Runaway (TR) or No Thermal Runaway (NTR). Consequently, a boundary line can be drawn between the two possible outcomes for the site-

specific situation. This is shown in Figure 7 by plotting the total moisture content of each sample from Wandoan Mine against the R_{70} self-heating rate value. The importance of the moisture state of the coal and rejects is emphasised by the red arrow. Based on Figure 7, all the coal samples are classified as TR due their high intrinsic reactivity being able to overcome the heat loss from moisture liberation and evaporation. Conversely, all the rejects samples are classified as NTR due to their low intrinsic reactivity being unable to overcome the heat loss from moisture liberation and evaporation.

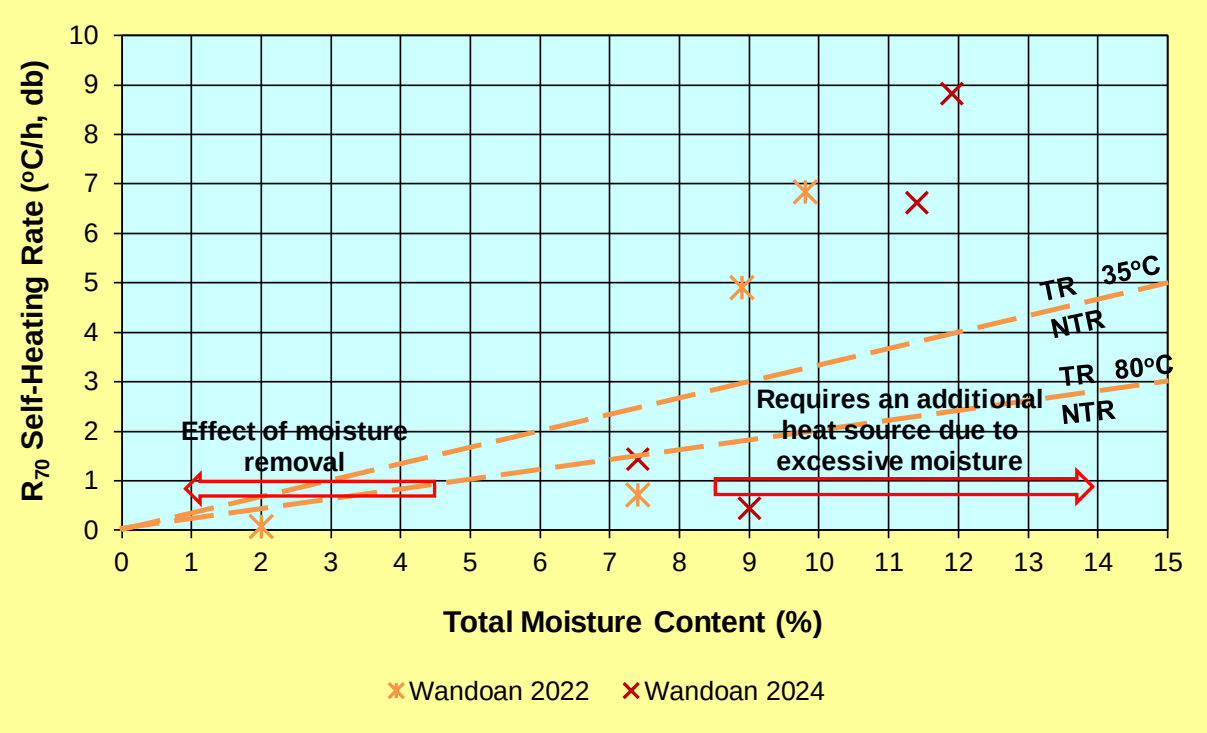


Figure 7. Spontaneous combustion hazard likelihood chart based on total moisture content and R_{70} self-heating rate value under ideal conditions. TR – Thermal Runaway; NTR – No Thermal Runaway in a practical timeframe without the presence of an additional heat source.

For ideal conditions there are several criticalities that need to be present. These are:

- There is a critical thickness present. For coals with an R_{70} value less than 2 the critical thickness required is generally greater than 1.5 m. For coals with an R_{70} value between 2-4 the thickness needs to be greater than 1.0 m. For coals with an R_{70} value between 4-8 the thickness needs to be greater than 0.5 m. For coals with a higher reactivity a thickness less than 0.5 m can be sufficient depending on the moisture state of the coal.
- There is a sufficient and continuous supply of oxygen due to airflow. In a loose pile this is normally created by ventilation flow underground or wind flow in a surface

environment, particularly during high wind conditions. For fractured material in-situ there needs to be a considerable pressure differential present to enable the air to penetrate through the fracture system. This often occurs around faulted ground in underground mines where there is a substantial pressure differential between intake and return airways. In a surface mine exposure, the air penetration is more difficult as it is controlled mainly by barometric pumping, which is minimal compared to an underground mine situation.

- In a surface environment there would need to be no moisture accumulation from surface ponding or groundwater penetration that either excludes ingress of oxygen or creates a large evaporative heat loss mechanism.

It should also be noted that in a surface environment the material will oxidise over time to a point of deactivation if no heat is accumulated.

The presence of reactive pyrite can also initiate a spontaneous combustion event in a sample that may plot in the NTR category. This is because the R_{70} test does not identify the effects of reactive pyrite due to it being conducted on a dry basis. An initial indication of the presence of pyrite can be obtained by analysing the sample for sulphur content. If pyrite is indicated then the test sample should be subjected to an Incubation test with the coal moisture present to quantify any effects of accelerated self-heating if the pyrite proves to be reactive.

There is another possible situation that could lead to a spontaneous combustion event for a coal that plots in the NTR category. This is when the coal comes into contact with an external heat source, such as a curing compound used in an underground environment (for example PUR (Cliff, Beamish and Cuddihy, 2009) or other products that produce an exothermic reaction). Embers from a bushfire could also act as an external heat source in a surface environment. Under these circumstances the temperature of the coal may be artificially raised and a short incubation period ensues.

5.0 CONCLUSIONS

Adiabatic testing of coal and rejects samples from Wandoan Mine has resulted in R_{70} values ranging from 0.44 °C/h to 8.82 °C/h. These R_{70} values indicate that the intrinsic spontaneous combustion propensity rating for the samples is Low to Medium for the rejects and Very High to Ultra-High for the coal based on Queensland conditions. The R_{70} values are consistent with the rank and type of coal. Calculated spontaneous combustion index values for crossing point temperature indicate a Low to Medium spontaneous combustion propensity rating. The relative ignition temperature values measured for the samples confirm the intrinsic spontaneous combustion propensity rating obtained from the R_{70} values.

The likelihood of self-heating generating a hot spot that leads to a spontaneous ignition event is moderated by various coal physical properties and mine site-specific factors. Under ideal conditions incubation to thermal runaway is possible for the coal samples from Wandoan Mine due to the intrinsic reactivity being sufficient to overcome heat loss from moisture liberation and evaporation. The opposite applies to the rejects samples. A spontaneous combustion hazard likelihood chart has been developed from these results for use in future classification.

REFERENCES

Akgun, F and Essenhigh, R H, 2001. Self-ignition characteristics of coal stockpiles: theoretical prediction from a two-dimensional unsteady-state model, *Fuel*, 80:409-415.

Arisoy, A and Akgun, F, 2000. Effect of pile height on spontaneous heating of coal stockpiles, *Combustion Science and Technology*, 153:157-168.

Arisoy, A and Beamish, B, 2015. Reaction kinetics of coal oxidation at low temperatures, *Fuel*, 159:412-417.

Banerjee, S C, 1985. *Spontaneous Combustion of Coal and Mine Fires*, 168 p (Balkema:Rotterdam).

Banerjee, S C, Nandy D K, Banerjee, D D and Chakravorty, R N, 1972. Classification of coal with respect to their susceptibility to spontaneous combustion, *Trans. Min. Geol. & Met. Inst. of India*, 59(2):15-31.

Barve, S D and Mahadevan,V, 1994. Prediction of spontaneous heating liability of Indian coals based on proximate constituents. in *Proceedings 12th International Coal Preparation Congress*, pp 557-562 (Cracow, Poland).

Beamish, B B, 2005. Comparison of the R_{70} self-heating rate of New Zealand and Australian coals to Suggate rank parameter, *International Journal of Coal Geology*, 64(1-2):139-144.

Beamish, B B and Arisoy, A, 2008a. Effect of mineral matter on coal self-heating rate, *Fuel*, 87:125-130.

Beamish, B B and Arisoy, A, 2008b. Effect of intrinsic coal properties on self-heating rates, in *Proceedings 12th US/North American Mine Ventilation Symposium*, K G Wallace Jr (ed), pp 149-153 (The Society of Mining, Metallurgy and Exploration Inc., Littleton, USA).

Beamish, B and Beamish, R, 2012. Benchmarking coal self-heating using a moist adiabatic oven test, in *Proceedings of the 14th US/North American Mine Ventilation Symposium* (eds:F Calizaya and M G Nelson), pp 423-427 (University of Utah, Department of Mining Engineering, Utah, USA).

Beamish, B and Beamish, R, 2011. Testing and sampling requirements for input to spontaneous combustion risk assessment, in *Proceedings of the Australian Mine Ventilation Conference* (eds: B Beamish and D Chalmers), pp 15-21 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B B and Blazak, D G, 2005. Relationship between ash content and R_{70} self-heating rate of Callide coal, *International Journal of Coal Geology*, 64(1-2):126-132.

Beamish, B B and Clarkson, F, 2006. Self-heating rates of Sydney Basin coals – The emerging picture, in *Proceedings of the 36th Sydney Basin Symposium*, pp 1-8 (University of Wollongong).

Beamish, B B and Sainsbury, W, 2008. Development of a site specific self-heating rate prediction equation for a high volatile bituminous coal, in *Proceedings 8th Coal Operators' Conference* (ed: N Aziz), pp 161-165, (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B B and Theiler, J, 2019. Coal spontaneous combustion: Examples of the self-heating incubation process, *International Journal of Coal Geology*, 215:103297.

Beamish, B B and Theiler, J, 2017a. Recognising the deficiencies of current spontaneous combustion propensity index parameters, in *Proceedings of the Australian Mine Ventilation Conference*, pp 113-117 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B B and Theiler, J, 2017b. Assessing the reactivity of pyrite, in *Proceedings 17th Coal Operators' Conference* (eds: N Aziz and B Kininmonth), pp 391-394, (University of Wollongong).

Beamish, B B and Theiler, J, 2015. Contrast in self-heating behaviour for coals of similar rank, in *Proceedings 15th Coal Operators' Conference* (ed: N Aziz), pp 300-304, (University of Wollongong and The Australasian Institute of Mining and Metallurgy).

Beamish, B B, Barakat, M A and St George, J D, 2001. Spontaneous-combustion propensity of New Zealand coals under adiabatic conditions, in *Geotechnical and Environmental Issues*

Related to Coal Mining, P. Lindsay and T.A. Moore (eds), Special Issue, *International Journal of Coal Geology*, 45(2-3):217-224.

Beamish, B B, Barakat, M A and St George, J D, 2000. Adiabatic testing procedures for determining the self-heating propensity of coal and sample ageing effects, *Thermochimica Acta*, 362 (1-2):79-87.

Beamish, B, Edwards, D and Theiler, J, 2018. Implementation of interactive spontaneous combustion hazard assessment and management at Meandu Mine, in *Proceedings 18th Coal Operators' Conference* (eds: N Aziz and B Kininmonth), pp 329-335, (University of Wollongong).

Beamish, B B, Blazak, D G, Hogarth, L C S and Jabouri, I, 2005. R_{70} relationships and their interpretation at a mine site, in *Proceedings COAL2005 Conference*, pp 183-185 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Beamish, B, McLellan, P, Turunc, U, Raab, M and Beamish, R, 2012. Quantifying spontaneous combustion inhibition of reactive coals, in *Proceedings of the 14th US/North American Mine Ventilation Symposium* (eds:F Calizaya and M G Nelson), pp 435-440 (University of Utah, Department of Mining Engineering, Utah, USA).

Cliff, D, Beamish, B and Cuddihy, P, 2009. Explosions, fires and spontaneous combustion, in *Monograph 12, Australasian Coal Mining Practice – Third Edition*, pp 800-814 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Guney, M, 1971. An adiabatic study of the influence of moisture on the spontaneous heating of coal, *CIM Bulletin*, 64:138-146.

Hodges, D J and Hinsley, F B, 1964. The influence of moisture on the spontaneous heating of coal, *The Mining Engineer*, 123:211-224.

Humphreys, D, Rowlands, D and Cudmore, J F, 1981. Spontaneous combustion of some Queensland coals, in *Proceedings of Ignitions, Explosions and Fires in Coal Mines Symposium*, pp 5-1 - 5-19 (The AusIMM Illawarra Branch).

Miron, Y, Lazzara, C P and Smith, A C, 1992. Cause of floor self-heatings in an underground coal mine, United States Bureau of Mines Report of Investigation RI9415.

Moreby, R, 1997. Dartbrook coal - Case study, in *Proceedings 6th International Mine Ventilation Congress*, pp 39-45 (The Society of Mining, Metallurgy and Exploration Inc., Littleton, USA).

Nelson, M I and Chen, X D, 2007. Survey of experimental work on the self-heating and spontaneous combustion of coal, *The Geological Society of America Reviews in Engineering Geology*, 18:31-83.

Smith, A C and Lazzara, C P, 1987. Spontaneous combustion studies of US coals, US Bureau of Mines Report of Investigations RI 9079.

Smith, A C, Rumancik, W P and Lazzara, C P, 1996. SPONCOM – A computer program for the prediction of the spontaneous combustion potential of an underground coal mine, in *Proceedings Fifth Conference on the Use of Computers in the Coal Industry*, pp 134-143 (West Virginia University, Morgantown, USA).

Suggate, R P, 2000. The Rank (Sr) scale: its basis and its application as a maturity index for all coals, *New Zealand Journal of Geology and Geophysics*, 43:521-553.

Suggate, R P, 1998. Analytical variation in Australian coals related to coal type and rank, *International Journal of Coal Geology*, 37:179-206.

Sykes, R and Suggate, R P, 1990. Coalap – A computer programme for coal analysis calculations and determination of ASTM rank, New Zealand Geological Survey Record 39.

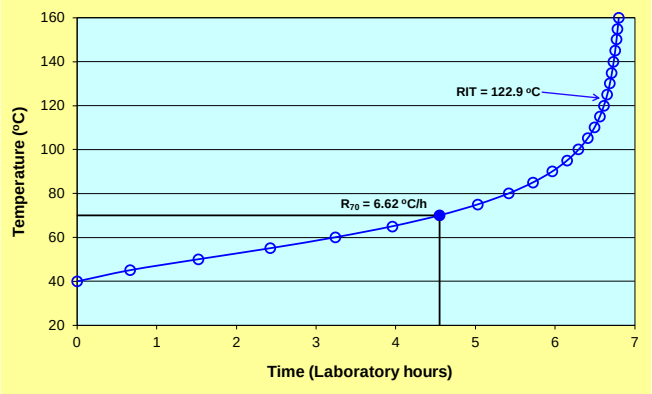
Winmill, T F, 1915. The absorption of oxygen by coal – Part VIII The effect on the absorption of the size of the coal particles and the percentage of oxygen in the air, *Transactions of the Institute of Mining Engineers*, 51:493-499.

APPENDIX 1
ADIABATIC TESTING RESULTS FOR COAL AND REJECTS SAMPLES FROM WANDOAN MINE

Wandoan Mine

	Coal	
RGSWAN5R	2022005_SP4, C13	
Date prepared	12/02/2024	
Date on test	13/02/2024	
Adiabatic self-heating test R_{70}	6.62	^{o}C/h
Relative ignition temperature (RIT)	122.9	^{o}C
Moisture content (as-received)	11.4	%

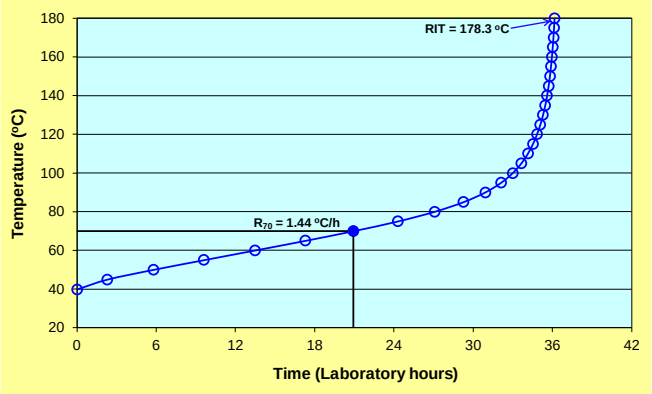
Coal Temp (^{o}C)	Time (min)	Time (h)
39.9	0	0.000
45.0	39.83	0.664
50.0	91.50	1.525
55.0	145.33	2.422
60.0	194.50	3.242
65.0	237.33	3.956
70.0	273.00	4.550
75.0	301.83	5.031
80.0	325.00	5.417
85.0	343.33	5.722
90.0	357.83	5.964
95.0	369.00	6.150
100.0	377.67	6.294
105.1	384.50	6.408
110.1	389.67	6.494
115.1	393.67	6.561
120.0	396.67	6.611
125.0	399.17	6.653
130.1	401.17	6.686
134.8	402.67	6.711
139.9	404.00	6.733
145.1	405.17	6.753
150.2	406.17	6.769
154.9	407.00	6.783
159.9	407.83	6.797



Wandoan Mine

	Rejects	
RGSWAN6R	2022005_SP5, C14	
Date prepared	13/02/2024	
Date on test	14/02/2024	
Adiabatic self-heating test R_{70}	1.44	^{o}C/h
Relative ignition temperature (RIT)	178.3	^{o}C
Moisture content (as-received)	7.4	%

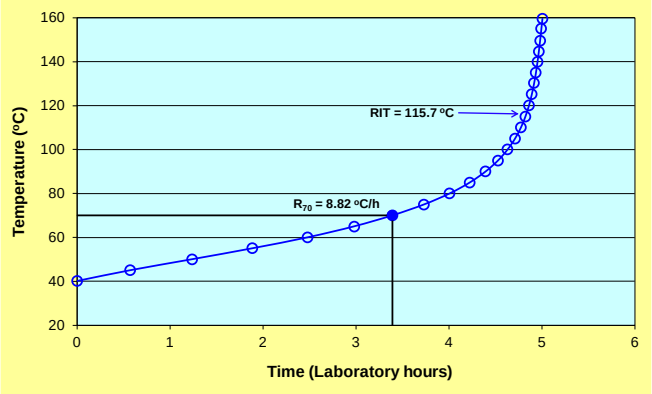
Coal Temp (^{o}C)	Time (min)	Time (h)
39.9	0	0.000
45.0	138.49	2.308
50.0	346.94	5.782
55.0	575.97	9.600
60.0	807.88	13.465
65.0	1037.74	17.296
70.0	1256.68	20.945
75.0	1457.11	24.285
80.0	1624.62	27.077
85.0	1756.44	29.274
90.0	1855.16	30.919
95.0	1927.36	32.123
100.0	1980.08	33.001
105.0	2019.14	33.652
110.0	2048.78	34.146
115.0	2071.86	34.531
120.0	2090.18	34.836
125.0	2105.40	35.090
130.0	2117.75	35.296
135.0	2127.83	35.464
140.0	2136.27	35.605
145.0	2143.06	35.718
150.1	2149.03	35.817
155.2	2153.97	35.899
160.0	2158.08	35.968
165.0	2161.75	36.029
170.0	2164.91	36.082
175.0	2167.66	36.128
180.0	2170.04	36.167



Wandoan Mine

	Coal	
RGSWAN7R	2022005_SP6, C15	
Date prepared	14/02/2024	
Date on test	15/02/2024	
Adiabatic self-heating test R_{70}	8.82	^{o}C/h
Relative ignition temperature (RIT)	115.7	^{o}C
Moisture content (as-received)	11.9	%

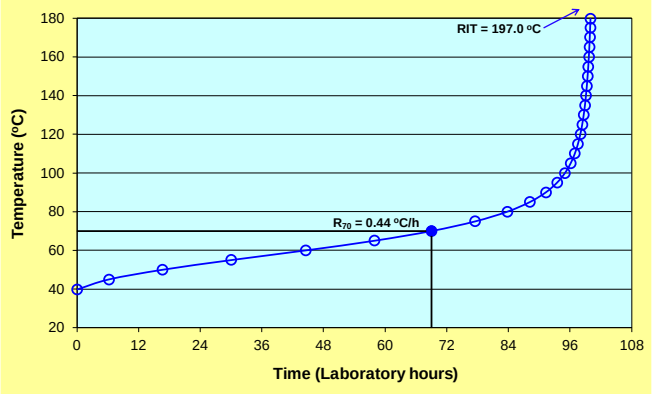
Coal Temp (^{o}C)	Time (min)	Time (h)
40.1	0	0.000
45.0	34.33	0.572
50.0	74.17	1.236
55.0	113.17	1.886
60.0	148.83	2.481
65.0	178.83	2.981
70.0	203.50	3.392
75.0	224.00	3.733
80.0	240.50	4.008
85.0	253.50	4.225
90.0	263.67	4.394
95.0	271.67	4.528
100.0	277.83	4.631
105.0	282.67	4.711
110.1	286.50	4.775
115.0	289.33	4.822
120.1	291.67	4.861
125.2	293.50	4.892
130.3	295.00	4.917
135.1	296.17	4.936
140.0	297.17	4.953
144.6	298.00	4.967
149.6	298.83	4.981
155.1	299.67	4.994
159.6	300.33	5.006



Wandoan Mine

	Rejects	
RGSWAN8R	2022005_SP7, C16	
Date prepared	19/02/2024	
Date on test	20/02/2024	
Adiabatic self-heating test R_{70}	0.44	^{o}C/h
Relative ignition temperature (RIT)	197.0	^{o}C
Moisture content (as-received)	9.0	%

Coal Temp (^{o}C)	Time (min)	Time (h)
39.8	0	0.000
45.0	372.09	6.201
50.0	1000.80	16.680
55.0	1803.22	30.054
60.0	2673.40	44.557
65.0	3476.87	57.948
70.0	4142.26	69.038
75.0	4653.24	77.554
80.0	5026.85	83.781
85.0	5292.37	88.206
90.0	5478.74	91.312
95.0	5609.53	93.492
100.0	5702.11	95.035
105.0	5768.64	96.144
110.0	5817.38	96.956
115.0	5853.89	97.565
120.0	5881.87	98.031
125.0	5903.81	98.397
130.0	5921.42	98.690
135.0	5935.98	98.933
140.0	5947.91	99.132
145.0	5958.23	99.304
150.1	5967.12	99.452
155.0	5974.81	99.580
160.0	5981.48	99.691
165.0	5987.55	99.792
170.1	5992.40	99.873
175.1	5997.05	99.951
179.8	6001.10	100.018



Attachment F: Desktop study

7 Desktop study

Prior to commencing the scope of work, RGS conducted a review of available information and previous studies to provide context and avoid repeating work that had already been completed.

7.1 Review of documents

RGS received several documents from previous studies that are listed in **Table 7-1**. Relevant extracts have been presented here in the desktop study and summarised with a gap analysis in the main body of the report in **Section 1.7**.

Table 7-1: Summary of background information documents

Document	Title	Source and date	File type
1	Wandoan to Miles Rail Line, April 2022	Glencore, 2022	Google Earth
2	Field site photos – Bulk Sample Pit, April 2022	Glencore, 2022	JPG
3	Field site photo locations	Glencore, 2022	Google Earth
4	Wandoan Coal Project – Preliminary Groundwater Assessment (V1_T10)	Parsons Brinckerhoff, 2008	PDF
5	Wandoan Coal project - Geology, mineral resources, overburden and soils impact assessment (V1_T09)	Parsons Brinckerhoff, 2008	PDF
6	Wandoan Coal project - Geology, mineral resources, overburden and soils impact assessment (V1_STR 09)	Parsons Brinckerhoff, 2009	PDF
7	EIS Nov 2010 Coordinator General report	QLD Govt, 2010	PDF
8	Environmental Authority EPML00297613	QLD Govt, 2019	PDF
9	EPBC 2008_4824 Approval	Aust Govt, 2011	PDF
10	Accelerated Degradation Index, PhD extract	Emmerton, 2021	Word
11	Wandoan FGX Program 2022 PR Template	ALS, 2022	Excel
12	Surat Hydrogen Project: Plate and Frame Pilot Plant Report, June 2022	GCAA, 2022	PDF
13	WAN Test Pit Sample Locations, 22 Feb 2022	GCAA, 2022	Excel
14	Interburden MU-ML 1B and Interburden WS1B	GCAA, 2022	PDF
15	WANTP Test pit sample photos	GCAA, 2022	JPG
16	Surat Hydrogen project summary schedule, 14 Sep 2022 + other updates	GCAA, 2022	Project Libre
17	Wandoan coal seams (Trial pit photo), 24 Dec 2021	GCAA, 2021	PDF
18	Wandoan coal project stratigraphic column (with seam codes), 23 Dec 2021	GCAA, 2021	Excel

7.2 Project information

7.2.1 Introduction

The proponent for the project, the Wandoan Joint Venture (WJV, the proponent), is proposing a new open-cut, thermal coal mine and supporting infrastructure located in the Surat Basin, to the west of Wandoan, approximately 350 kilometres (km) north-west of Brisbane and 60 km south of Taroom[11].

The thermal coal deposits for the project are estimated to be in excess of 1.2 billion tonnes located within three Mining Lease Applications (MLAs) 50229, 50230 and 50231. The MLAs make up approximately 32 000 hectares (ha) and approximately 11 000 ha would be used for mining operations. The remaining land is proposed to act as a buffer between mining operations and sensitive places.

[11] QLD Govt (2010). Wandoan Coal Project: Coordinator-General's evaluation report on the environmental impact statement. Under Part 4 of the State Development and Public Works Organisation Act 1971. Produced November 2010.

7.2.2 Mining operations

The proponent is seeking a 32-year mining lease (two years for construction and 30 years operational) for the extraction of the coal resource at a rate of approximately 30 million tonnes per annum (Mtpa) run-of-mine (ROM) coal from the three MLA areas. Ten pit areas, incorporating 16 individual pits in total, are scheduled for opening during the 30-year operation of the mine. Approximately 853 million tonnes ROM coal are proposed for mining during the 30-year period. This ROM coal will be washed on-site at a coal handling and processing plant (CHPP) and result in production of approximately 22 Mtpa of product coal[1].

Exploration drilling undertaken as part of project investigations indicated that the Juandah Coal Measures contain the economic coal reserves for the project in the Kogan, Macalister Upper, Macalister Lower and Wambo seam groups.

The project would be mined using dragline, truck, excavator and shovel equipment. It is proposed that the coal would be crushed, processed and blended if required on-site before being transported by rail to the Gladstone area for export. Export of coal from the mine is proposed via the proposed Surat Basin Rail to port facilities at Gladstone via a rail spur from the proposed Surat Basin Railway.

7.2.3 Water requirements

For raw water supply for mining operations, the proponent has concluded that supply of water from the Great Artesian Basin is not a sustainable option. Accordingly, the proponent is considering alternative options for raw water supply for mining operations. Preliminary investigations into the potential for connectivity between artesian groundwater and surface water have been undertaken[1].

As an alternative raw water supply source, SunWater proposes to increase the maximum storage capacity of the existing Glebe Weir from 17 700 ML to 30 100 ML by fitting four inflatable fabridams across the existing structure to raise the weir by 2.36 m full supply level (FSL). Construction will involve earth levees on both sides of the weir structure, construction of a control building and multi-level off take, with agreement to build a fishway on Tartrus Weir on the Mackenzie River or on the Glebe Weir, to offset potential impacts. Water will be transported via an underground pipeline 83 km in length and start at the pumping station built on the bank of Cockatoo Creek near its confluence with the Dawson River. While the initial 11 km will traverse private property, the majority of the remainder of the pipeline will follow the Nathan Road reserve, with a single balancing storage and re-lift pump stations constructed at high points approximately halfway along its length.

Given raw water demand for operation of the project is estimated to be up to approximately 9100 ML/y, and the raised weir will have the capacity to supply at least 6500 ML/y, the shortfall water supply of 2600 ML/y could be obtained by the proponent through a trading mechanism involving the purchase and conversion of existing medium priority water entitlements supplied for the Dawson Valley Water Supply Scheme to new high priority entitlements.

7.2.4 Surface water catchments

The project is located in the southern reach of the Fitzroy River drainage basin, in the upper catchment of the Dawson River. Approximately 83 per cent of the MLA areas drains to Juandah Creek, with the remainder draining to Horse Creek. Both Juandah and Horse Creeks flow north to the Dawson River. Mean annual flows from the MLA areas makes up about 1.4 per cent of the mean annual inflow to Glebe Weir on the Dawson River and less than 0.2 per cent of the total mean annual flow at the Fitzroy River mouth[1].

The mine proposal involves extensive open-cut mining of 11 000 ha of the MLA areas and the isolation of mined pits from the natural drainage flows by the diversion of some local drainage ways and levees.

The MLA catchments are included within the Water Resources (Fitzroy Basin) Plan (WRP) and related Resource Operation Plans (ROP) prepared by DERM under the *Water Act 2000*. During the EIS process, several nearby landholders, who rely upon seasonal waterholes for stock water, expressed concern that creek diversions and mine pits may impact on stock access to water and, by reducing flows, this may lead to shorter periods over which water is available for stock. Landholders also expressed concerns that potential increases in the salinity may make water unsuitable for livestock.

The containment of rainfall within mine excavation areas would reduce the available catchment and hence flows into local creeks following rainfalls.

7.2.5 Groundwater

The MLA area and surrounds are characterised by Quaternary sediments along the major creeklines of Frank Creek, Mud Creek, Woleebee Creek and their tributaries. This environment, containing shallow aquifers with a limited number of users, is underlain by the Surat Basin, which is further underlain by the sedimentary rocks of the Great Artesian Basin (GAB). The GAB supplies the majority of groundwater users in the region compared other aquifer types[1].

The proponent's monitoring program was comprised of sixteen monitoring bores, ten of which are open-holed (converted exploration boreholes intersecting various coal seams) and six specifically- designed monitoring or production bores. The proponent's groundwater monitoring program was intended to establish the baseline and ongoing groundwater levels within the MLA areas and surrounding areas.

The proponent committed to continued monitoring to determine longer term baseline monitoring for the duration of the project. The proponent also proposes to install additional monitoring bores progressively across the MLAs, which would further enable the recording of water levels to inform a regional groundwater contour map for the project as additional data is collected. At this time, seasonal variations within the aquifers have not been established. Longer term baseline monitoring for the duration of the project would allow for time series data to be collected and any season variations established.

7.2.6 Groundwater quality

The groundwater technical study was undertaken during the period December 2007 to July 2008. The technical study found that the cleats within the coal seams are the main water bearing structures. The deeper coal seams below 50 m are the more transmissive seams. Groundwater monitoring results show that the deeper coal seams of the Macalister and Wambo have a slightly lower salinity up to 17,000 µ/cm (brackish) compared with the upper coal seams of the Kogan, which are typically up to 23,000 µS/cm (brine). The alluvial sediments are considered to be a limited groundwater resource, located around Mud, Frank and Woleebee Creeks, and their tributaries[12].

Bores located in close proximity to the pits and extracting from above 75 m, are likely to be affected due to increased groundwater level drawdowns from pit dewatering activities. The offsite impacts should be limited to approximately 20 bores located in close proximity to the MLA boundary. The 20 bores potentially affected will be assessed in more detail to confirm the likely effects of the mining activities on the ongoing use of the bores.

Overall, the quality of groundwater within the bores is poor (Table 7-2), with major transgressions of guideline values for chloride, total hardness and sodium. The arsenic concentration for bore WPB1 is unsafe for human consumption.

[12] Parsons Brinckerhoff (2008). Wandoan Coal Project: Preliminary groundwater assessment. Technical document produced by Parsons Brinckerhoff Australia Pty. 2133006C-RPT013-B sb. November 2008.

Table 7-2: Groundwater bores water quality summary

Parameter	Units	LOR	WPB1		WMB1-D		WMB1-S		C4057	
			Start Test	End Test	Start Test	End Test	Start Test	End Test	Start Test	End Test
Date Sampled			25/05/2008	26/05/2008	25/05/2008	27/05/2008	25/05/2008	27/05/2008	25/05/2008	27/05/2008
pH Value	pH Unit	0.01	8.08	7.92	7.74	7.84	7.06	6.95	7.93	8.01
Electrical Conductivity @ 25°C	µS/cm	1	11700	15400	17500	17600	23100	23000	11600	11300
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1	<1	8
Bicarbonate Alkalinity as CaCO3	mg/L	1	465	351	300	298	525	610	358	346
Total Alkalinity as CaCO3	mg/L	1	465	351	300	298	525	610	358	354
Sulphate as SO4 2-	mg/L	1	11	4	4	6	133	132	2	<1
Chloride	mg/L	1	3990	5730	6410	6370	9480	9380	4090	4090
Calcium	mg/L	1	40	71	98	102	770	783	35	34
Magnesium	mg/L	1	17	31	41	43	334	332	16	15
Total Hardness as CaCO3	mg/L	1	170	305	413	431	3294	3319	153	147
Sodium	mg/L	1	2680	3640	3780	3740	4530	4510	2600	2630
Dissolved Arsenic	mg/L	0.001	0.006	0.007	0.005	0.004	0.002	<0.001	0.004	0.004
Dissolved Cadmium	mg/L	0.0001	0.0002	0.0002	0.0004	0.0002	0.0005	0.0003	0.0007	0.0001
Nitrite as N	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nitrate as N	mg/L	0.01	0.014	<0.010	<0.010	0.011	0.011	<0.010	<0.010	<0.010
Nitrite + Nitrate as N	mg/L	0.01	0.014	<0.010	<0.010	0.011	0.011	<0.010	<0.010	<0.010
Total Phosphorus	mg/L	0.01	<0.01	0.03	0.02	0.02	0.11	0.02	0.15	0.22
Potassium	mg/L	1	12	17	20	20	44	42	12	11
Benzene	µg/L	1	<5	<5	<5	<5	<5	<5	<5	<5
Total dissolved solids*	mg/L	-	7215	9844	10653	10579	15816	15789	7113	7134
Dissolved Oxygen	mg/L	0.1	2.8	3	3.1	2.9	3	2.2	3.9	2.9
Total Anions	meq/L	-	122	169	187	186	280	280	122	122
Total Cations	meq/L	-	120	165	173	172	264	264	116	118
Ionic Balance	%	-	0.77	1.15	3.86	3.87	3.01	2.96	2.55	2.01

Transgressed Australian Drinking Water Guidelines 2004 (NWQMS, 2004) Aesthetic Guideline Values

Exceeds Australian Drinking Water Guidelines 2004 (NWQMS, 2004) Health Guideline Values

7.2.7 Regional geology

The Project area is located within the Surat Basin, an eastern lobe of the Great Artesian Basin. The Surat Basin contains up to 2,500 m depth of sediments comprised mainly of Jurassic age clastic sedimentary rocks of inferred terrestrial origin and early Cretaceous age marine beds[13].

The geological history of the Wandoan region is based on deposition of sedimentary material, chemical and physical alteration, uplift and subsequent erosion. During the mid to late Triassic, freshwater streams deposited sand over much of the region. This was followed by a period of widespread erosion in the late Triassic, and then a cyclic period of fluvial sedimentation followed by erosion between the early Jurassic and early Cretaceous. Extensive coal deposits formed during middle Jurassic time.

Since the late Jurassic, the Surat Basin has been relatively stable. A marine transgression in the early Cretaceous was the last major sedimentary episode, after which the sea withdrew during the late Cretaceous.

Deep weathering of the land surface occurred during the Tertiary Period, however subsequent erosion has since stripped most of this profile from the northern areas of the Surat Basin (Slater 1986)[14]. South of Wandoan large areas of deeply weathered material form plateaus along the Great Dividing Range, and mesa topography elsewhere.

[13] Parsons Brinckerhoff (2009). Addendum to the Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment. Technical document produced by Parsons Brinckerhoff Australia Pty. 2133006C-RPT001-B:ow. November 2008.

[14] Slater, B 1986, Edaphic Properties of Soil and Overburden from a Potential Coal Mine near Wandoan, Queensland. University of Queensland Department of Agriculture.

7.2.8 Local geology

7.2.8.1 Quaternary alluvium

The source material of the Quaternary age alluvium along the drainage lines is anticipated to be the Injune Creek Group rocks for the shorter drainage lines, including Frank Creek, Spring Creek, Mud Creek and their associated tributaries. The alluvium of these creeks largely comprises sandy clay materials. The longer Woleebee Creek has a higher discharge and flows through the Orallo Formation and Gubberamunda Sandstone that is further upstream from the Project site. Floodplain sediments along Woleebee Creek are influenced by these geological units and the higher discharge in this creek and are mainly clayey sands[3].

7.2.8.2 Injune Creek Group

The Injune Creek Group includes the Westbourne Formation, Walloon Subgroup and Springbok Sandstone. The Walloon Subgroup incorporates the Juandah Coal Measures, Tangalooma Sandstone and the Taroom Coal Measures.

The Juandah Coal Measures contain the economic coal reserves of the Project, and comprise medium to coarse grained lithic sandstone, siltstone, mudstone and coal seams. The particle size generally increases with depth. The coal seams are relatively flat, with a regional dip of approximately zero to two degrees to the south-west, with localised steeper dips. Geotechnical drilling has identified the following seam groups within the Wandoan MLAs:

7.2.9 Overburden sampling

Locations of boreholes were selected based on existing exploration data and on location of proposed mining infrastructure and elements. Boreholes were drilled to between 39 m and 112 m in depth as a component of the mine geotechnical and exploration investigation program. Fifteen samples of overburden and interburden were obtained from selected depths from the four boreholes for material identification and laboratory testing purposes[3]. Geochemistry results for these samples are in **Section 7.2.14**.

Overburden in the Austinvale and Woleebee areas consist mostly of sandstone, siltstone, mudstone, claystone and coal, with minor ironstone. Upward fining sequences are common, and vertical and lateral changes of facies were observed[3].

The average depth of overburden is about 23.0 m in the Austinvale area, with about 1.2 m soil. In the Woleebee area the average depth of overburden is 26.0 m, with soil to about 3.2 m The depth of the weathering ranges from 10.0 m to 15.0 m in the eastern portion of the Project area, and from 8.0 m to 25.0 m in the western portion of the Project area.

Slater (1986)[4] concluded that the siltstones and the lithic or feldspathic sandstones would undergo rapid weathering to produce soil material high in clay content and possibly dispersive.

7.2.10 Land use survey

The majority of the land within the project site is highly disturbed, has a long history of vegetation clearing and has been primarily used for cattle grazing[1]. The study area is located in a landscape that has been highly modified by past land uses particularly agriculture (i.e. grazing and cropping). Vegetation in the local area is therefore highly fragmented and relictual (i.e. <10% retained)[15]. There is some small-scale dry land cropping, which is mainly used for cattle feed lots and fodder[1]. It has been recommended that land is progressively released at the completion of mining activities so that the land be rehabilitated to allow it to be released back to the land holder or on the market for primary production.

While some dry land cropping is presently undertaken within the MLA areas, the EIS outlined that most land within the post-mining landscape is proposed to be rehabilitated to the equivalent of land suitability classes

3, 4 and 5[16]. The proponent's current rehabilitation strategy makes a commitment to a partial return to productive grazing activities post-mine over most of the proposed mining area.

A further assessment was completed, which stated that it is expected that the Project will reduce areas of Class 3 dry land cropping and Class 2 beef cattle grazing. Large portions of the disturbed areas, including overburden stockpiles are recommended to be rehabilitated to Class 2 beef cattle grazing, and the final land use is suggested as a combination of cattle grazing and nature conservation[17].

Table 7-3: Land suitability classifications

Class	Suitability	Limitations	Description
1	Suitable	Negligible	Highly productive land requiring only simple management practices to maintain economic production.
2	Suitable	Minor	Land with limitations that either constrain production, or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable	Moderate	Land with limitations that either further constrain production, or require more than those management practices of class 2 land to maintain economic production.
4	Unsuitable	Severe	Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics or technology.
5	Unsuitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

It is also recommended that no open-cut coal mining shall occur during the life of this project at any point which is located within a 2 km 'high management zone' surrounding the Wandoan township. Air quality, noise and vibration studies outlined in the EIS indicated that operating a dragline at full capacity in Frank Creek Pit had the potential to adversely impact living conditions in the township of Wandoan.

The residual visual impacts of the project are considered to be minimal, although some impacts during the mine life have the potential to be high due to the open-cut nature of the mining operations and the large scale of the development. The mitigation measures proposed by the proponent, combined with progressive rehabilitation of mined and disturbed areas, will greatly minimise visual contrasts[1].

7.2.11 Topography and geomorphology

Low undulating hills, with an RL of between 250 m and 295 m AHD make up the majority of the Project area. Slopes are generally less than 4%, but up to 15% gradient for upper slopes in the western portion of the study area. The undulating hills are generally at a higher altitude to the south of the Project area than to the north (refer Figure 3-1). This is due to a regional slope away from the Great Dividing Range, in the south, towards the Dawson River Valley in the north[3].

The narrow floodplains, gentle slopes, bedrock-controlled channels and confined meanders of drainage lines suggest the landscape within the Project area is geologically young. The ephemeral creeks are slowly cutting into and eroding the undulating hills, with lateral erosion of the valleys being the main large-scale landscape altering activity, together with channel deepening. Temporary deposition of eroded material occurs on the

[16] QLD Govt (2015). Guidelines for Agricultural Land Evaluation in Queensland (Second Edition). Guideline prepared by Department of Science, Information Technology and Innovation (DSITI) and the Department of Natural Resources and Mines (DNRM). December 2015.

[17] Parsons Brinckerhoff (2009). Addendum to the Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment. Technical document produced by Parsons Brinckerhoff Australia Pty. 2133006K-RPT00X-B:ow. September 2009.

narrow floodplains. Erosion rates are anticipated to be low due to the relatively dry climate and low topographic gradient. Most erosion will occur during infrequent high rainfall events[3].

7.2.12 Soil classification and geochemistry

Locations of test pits were selected based on existing soil mapping, geological and topographic features of the landscape and proposed layout of the mining operations. The locations were selected to allow sampling of various soils within the landscape features and at multiple positions in the landscape. All test pits were excavated to between 0.4 m and 2.3 m in depth. Selected disturbed samples of surface and subsurface soils were obtained at regular intervals or at a change of strata for material identification and laboratory testing purposes[3] (**Figure 7-1**, **Figure 7-2** and **Table 7-4**)[7].

Classification of soils for the Project area was based on field observations, laboratory analytical data, aerial photography, the findings of geotechnical investigations. Eight different soils types, developed on various landforms and geology, were identified in the Project area. Abrupt boundaries between soils types generally do not occur in the Project area, except along drainage lines.

The soils of Cheshire and Kinnoul, which occur on the upper slopes, have been classified as Class 3 due to high erosion potential by surface runoff and the presence of alkaline subsoils that results in low nutrient availability. Alluvial soils are rated Class 3 due to the potential of flooding.

Downfall, Teviot and Rolleston soils, occurring on the lower slopes, were rated as Class 4 due to high alkalinity within 0.6 m of the soil surface resulting in nutrient deficiency. Some cropping currently occurs within this Class 4 land, however, long term sustainability is limited due to low nutrient and high alkalinity conditions, shallow rooting depth, and heavy application of fertilisers.

Small portions of land on the upper margins of the floodplains with alluvial soils, but impacted by flood to a lesser extent, are considered to be Class 2 land for dryland cropping.

7.2.13 Soil suitability for rehabilitation

Cheshire, Woleebee, Rolleston and Teviot soils have moderate to extreme alkalinity and sodicity within the subsoils and are strongly dispersive. All other subsoil within the Brigalow Uplands land resource areas (LRA) can be considered dispersive to a lesser extent[7].

Alkaline and sodic soils are generally dispersive and have high erosion potential if exposed. Sodic, alkaline soils are also poor plant growth mediums due to low nutrient availability and should not be used as such in rehabilitation of disturbed areas. The topsoil portion of these soils is suitable for use in rehabilitation.

Soils most susceptible to wind erosion are soils with sandy or loamy topsoils, which include the alluvial soils of Woleebee and Retro. Soils most susceptible to erosion by flowing water are those with dispersive (sodic) topsoil or upper subsoil. Soils on steep and moderate upper slopes, as occur on the undulating terrain and spoil piles, have higher risk from erosion by water than soils on gentle slopes and floodplain.

Exposure of dispersive subsoils has the potential to cause gully erosion problems, even if only small areas of subsoil are exposed e.g., gully formation on a gentle slope due to water runoff over dispersive soils. After initiation of erosion, for example after vegetation removal or ground disturbance, this erosion will continue to expand upslope and expose more dispersive soils.

Soil salinity in the Project area is of limited extent and is not considered a high risk. However, the subsoils of Cheshire, Teviot and Woleebee are moderately to highly saline and changes to the soil moisture regime due to vegetation removal or other impacts may increase near surface soil salinity. The topsoil of Teviot is saline and generally should not be used as a topsoil layer in rehabilitation. Should this soil be used in rehabilitation, it will require the use of salt tolerant vegetation species. The subsoils of Cheshire, Teviot and Woleebee are saline and should be buried within spoil stockpiles and covered with materials that are more stable. The subsoils of Cheshire and Woleebee should not be used in rehabilitation.

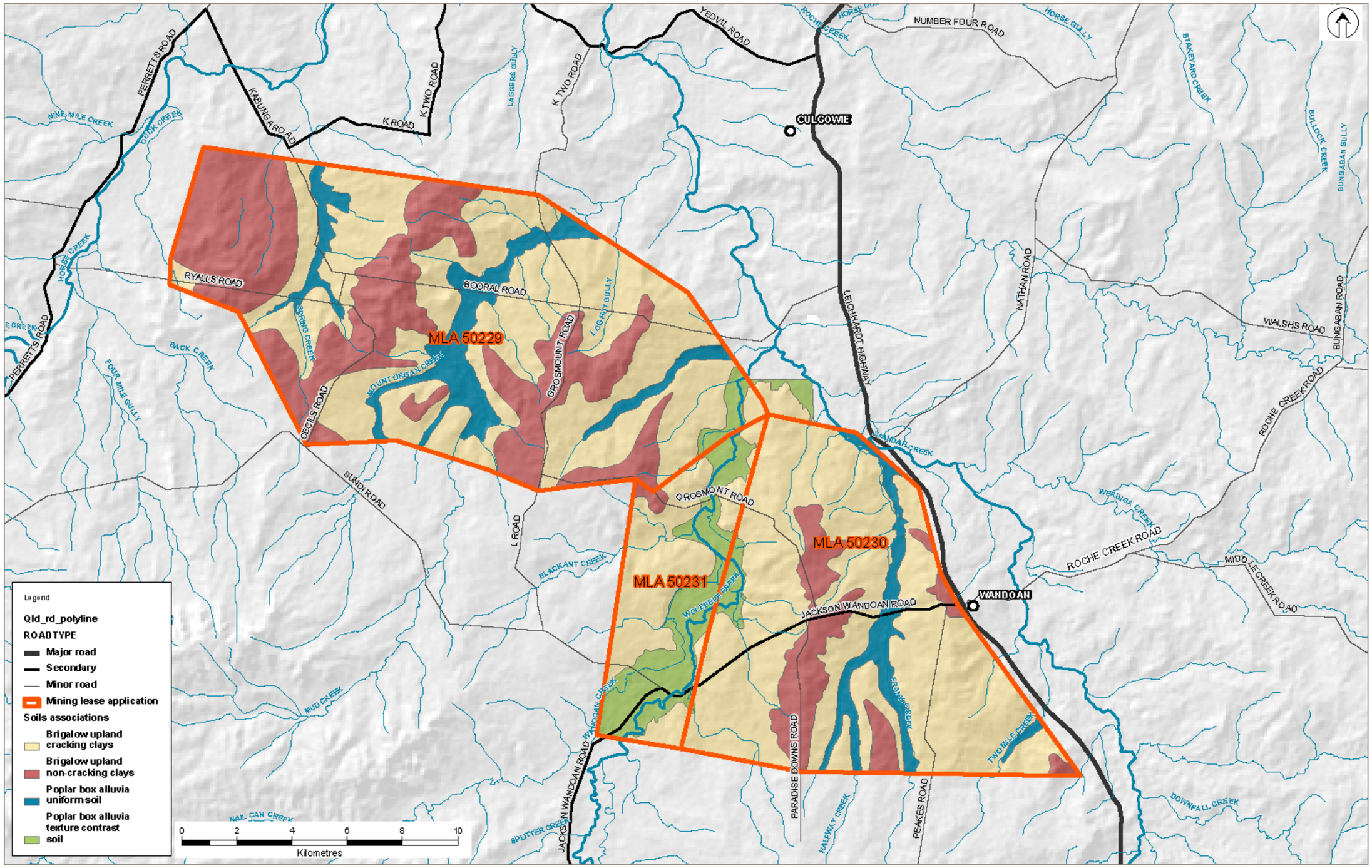


Figure 7-1: Soil associations within the Wandoan project area

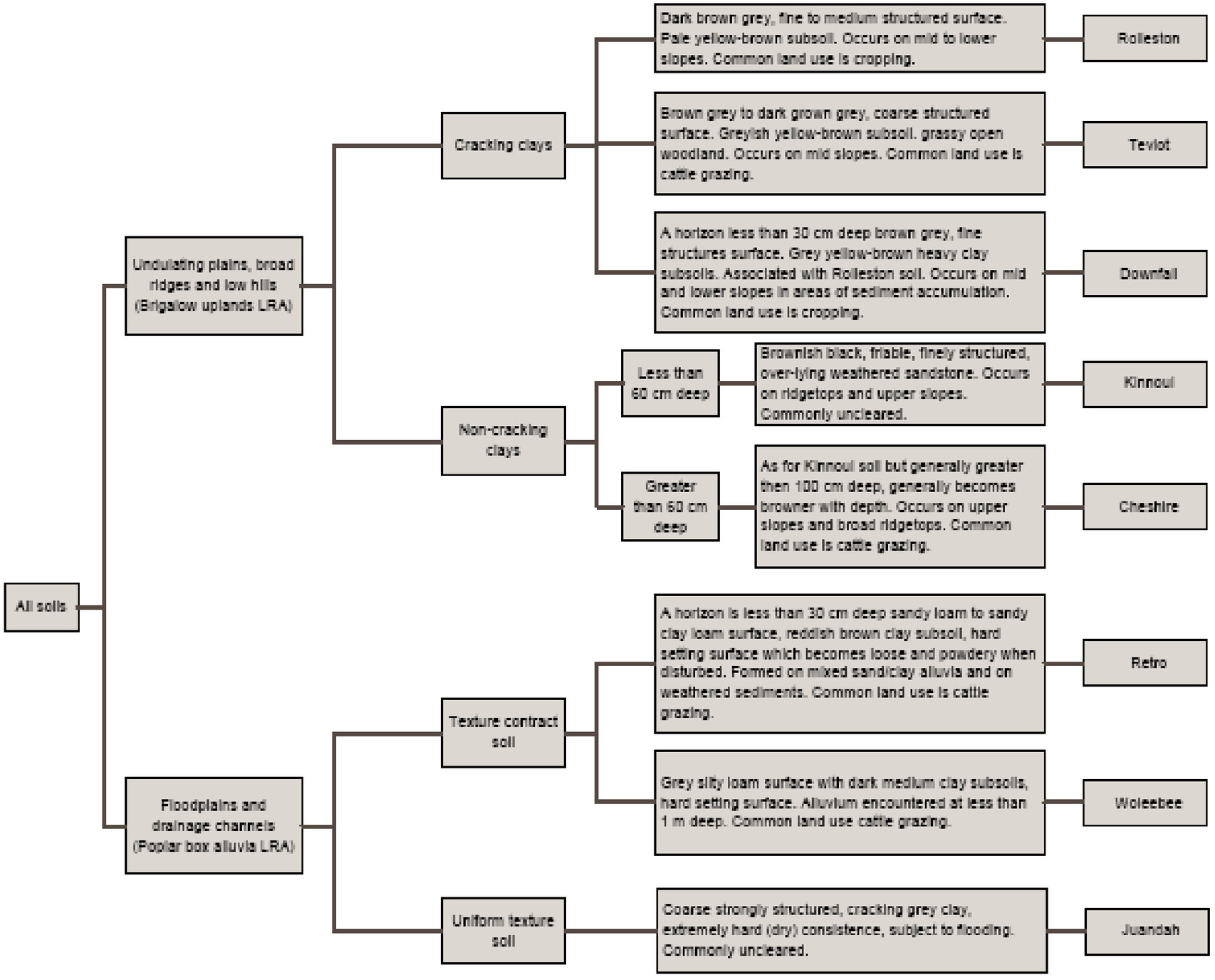


Figure 7-2: Key to soils in the Wandoan project area

Table 7-4: Soil classification summary table

Soil classification and description	Photograph	Soil classification and description	Photograph
Rolleston The Rolleston soil occurs on mid and lower slopes within the Brigalow Uplands — Cracking Clays association on land with a slope of approximately 1 to 4%. This soil is typically used for dryland grain cropping. Under the Australian Soil Classification this uniform cracking clay soil is classed as a **brown dermosol**. The topsoil is approximately 0.2 m deep and comprises non-dispersive to dispersive dark brown-grey heavy clay with blocky peds, slightly alkaline pH and low salinity. The topsoil has low to medium nitrogen and phosphorus availability and low organic carbon content. An A2 horizon may be absent. The B horizon consists of dispersive, high plasticity clay with strong blocky peds and calcareous concretions. The lower sub-soil is strongly acidic or strongly alkaline pale yellow- brown to yellow-orange and strongly dispersive, with weathered sandstone or siltstone encountered at depths greater than 1.5 m.		**Cheshire** Cheshire soils occur on steeper gradient upper slopes (up to 3%) within the Brigalow Uplands — Non Cracking Clays association. These soils have largely been cleared and are used for cattle grazing of native pastures. The soils are shallow, non-cracking uniform clays. Under the Australian Soil Classification, this soil is a **brown dermosol**. The topsoil is approximately 0.4 m to 0.6 m deep, and consists of dark, sandy clay to light clay, with a fine structure and a mildly alkaline pH. The topsoil has low to moderate salinity, and a non-dispersive A1 horizon, tending to a dispersive A2 horizon. The A1 horizon has medium nitrogen and phosphorus availability, and approximately 3% organic carbon. The B horizon consists of a brown to grey-brown medium clay, with calcareous concretions. This horizon tends yellow-brown at less than approximately 1.0 m depth and the sub-soil is strongly alkaline, highly saline and dispersive throughout the B and C horizons. Weathered sandstone or siltstone is typically encountered within 1.0 m to 1.5 m depth.	
Teviot Teviot soil occurs on gently inclined midslopes with a gradient of 1% to 3%, within the Brigalow Uplands — Cracking Clays association, and is typically used for cattle grazing of native pastures.Under the Australian Soil Classification this soil is a **brown vertosol**. The topsoil is approximately 0.2 m deep and consists of brown-grey to dark brown-grey clay with neutral to slightly alkaline pH, low salinity and non-dispersive. The topsoil has medium nitrogen and phosphorus availability and approximately 2-3% organic carbon. The B horizon comprises high plasticity clay with strong blocky peds and is dispersive. The lower sub-soil consists of strongly dispersive grey-yellow-brown clay, and appears highly susceptible to tunnel erosion if exposed. Weathered sandstone is typically encountered within 1.0 m to 1.5 m depth. Subsoils are moderately alkaline, with a consistent pH values throughout the B and C horizons. Salinity is moderate in the B horizon, and increases with depth.		**Retro** The Retro soils occur on gently undulating floodplains with slopes of less than 0.5% within Poplar Box Alluvia — Texture Contrast Soils and are typically uncleared, with grassy open woodland of poplar box and sandalwood. The soils are deep texture contrast soils, developed over weathered sedimentary rock or colluvium, but within the floodplain of the streams and under the Australian Soil Classification, it is classed as a **brown chromosol**. The A1 horizon is approximately 0.15 m deep and consists of a non-dispersive dark brown-grey clay-loam with neutral pH and low salinity. The topsoil has low to medium nutrient availability, with medium to high organic carbon content and is commonly underlain by a bleached, pale orange, A2 horizon. The B horizon consists of non-dispersive, high plasticity, dark brown heavy clay with medium sized blocky peds. Calcareous concretions may be present, and the soil has an alkaline pH. The lower sub-soil is dispersive, brown, heavy clay, grading to weathered sediments or colluvium at approximately 1.0 m depth.	Not available
Downfall Downfall soil occurs on mid to lower slopes of approximately 2% grade in areas of sediment/slopewash accumulation within the Brigalow Uplands — Cracking Clays association and is typically used for dryland grain farming. The soil is uniform cracking clay and under the Australian Soil Classification it is a **brown vertosol**. The topsoil (A1) is shallow, only about 0.05 m to 0.15 m depth, and consists of a neutral brown-grey clay of medium plasticity, with a fine granular structure, neutral to mildly alkaline pH, low salinity and dispersive. The topsoil has low nitrogen and phosphorus availability and approximately 2% organic carbon. The A2 horizon is generally absent. The upper B horizons consist of a medium to heavy clay with fine blocky peds, slightly alkaline pH, dispersive and traces of calcareous concretions. The lower subsoils are dispersive grey and/or yellow-brown heavy clays with strongly alkaline pH. Weathered sandstone or colluvium is typically encountered at greater than 1.5 m depth.	Not available	**Woleebee** Woleebee soil occurs on the floodplains of Woleebee and Juandah Creeks within Poplar Box Alluvia — Texture Contrast Soils. The soils are texture contrast soils developed on alluvium and are typically used for cattle grazing. Under the Australian Soil Classification this texture contrast soil is classed as a **brown sodosol**. The topsoil is approximately 0.15 m deep and comprises grey silt loam. It is dispersive, has a neutral pH, low to medium salinity, and low organic carbon content. The B horizon comprises strongly dispersive dark medium clay, with layered alluvium encountered at less than 1.0 m depth. The pH and salinity increase with depth to strongly alkaline and medium to high salinity from approximately 0.5 m depth.	
Kinnoul Kinnoul soil occurs on ridgetops and upper slopes within the Brigalow Uplands — Non Cracking Clays association and is commonly covered by regrowth brigalow softwood scrub. It is a shallower version of Cheshire, and often grades into Cheshire on upper slopes. Under the Australian Soil Classification, this soil is a **brown dermosol**. The topsoil is approximately 0.3 m to 0.4 m deep and consists of a dark, sandy clay or light clay, with a well developed blocky structure, neutral to mildly alkaline pH and low to moderate salinity and is considered non-dispersive. The topsoil has low to medium nitrogen and phosphorus availability, and approximately 3 to 3.5% organic carbon. The B horizons consist of brown and blocky light clay, with mild alkalinity, low to moderate salinity and low dispersivity, increasing to strongly dispersive with depth. Calcareous concretions are generally absent, but may be present on slopes where the soil grades into other soil types, or in areas of poorer drainage. Weathered sedimentary rock is generally encountered within 0.75 m depth.		**Juandah** Juandah soils occur on flat floodplains with less than 1% gradient within Poplar Box Alluvia—Uniform Soils. These soils are deep uniform clays developed on alluvium and are typically used for cattle grazing. Under the Australian Soil Classification this uniform cracking clay soil is classed as a **brown vertosol**. The topsoil is approximately 0.5 m deep and comprises high plasticity dark brown-grey clay with granular to blocky structure and a hardsetting surface where disturbed by agriculture. The topsoil has neutral pH and low salinity, with low to medium nitrogen and phosphorus availability. The A1 horizon is non-dispersive, with a dispersive A2 horizon. The B horizon consists of dispersive high plasticity dark brown-grey clay, with coarse blocky to massive structure, slight to moderately alkaline pH and low to medium salinity. Subsoils grade to yellow-brown massive, alkaline, clays. The soil profile is generally greater than 1.5 m deep, and underlain by alluvium.	

7.2.14 Mine waste geochemistry

7.2.14.1 Acid Base Accounting

The removal of spoil and mining of coal may allow oxidation of sulfidic material within the sediments that contain the coal reserves, to produce sulphuric acid. This process can be accelerated during mining operations, if large volumes of sulfidic material are exposed. The resulting sulphuric acid can make mine water drainage acidic and increase the levels of metal and sulphate concentrations in mine water. Increased acidity levels may also dissolve metals within overburden rock.

Spoil materials were assessed to determine whether potential acidic conditions may arise during operation, as well as reject material produced by coal washing. It was reported that spoil and reject samples results indicated that metal concentrations were low, although the solubility of most heavy metals could increase with elevated acidity. All samples tested showed that the spoil material had a negative net acid producing potential (NAPP). This indicates that the spoil and rejects have a large capacity to neutralise acidity compared to its capacity to generate acidity[1]. Geochemistry results for overburden and interburden (n=15) are shown in **Table 7-5**[7].

Further evidence of the non-acid forming nature of the overburden was provided by previous water quality testing undertaken in March 2006 and September 2008. The tests found water in the bulk sample pit, water management dam and seepage from rehabilitated overburden to have neutral to slightly alkaline pH.

The heavy metal analysis included arsenic, cadmium, copper, chromium, lead, nickel and zinc. Results showed that the concentrations of all heavy metals within the overburden tested were below the investigation level concentrations. Though the solubility of most heavy metals has a potential to increase with elevated acidity, due to the results of the low NAPP, overburden is not anticipated to generate significant acid mine drainage. Therefore, the stockpiling of overburden is unlikely to be a source of heavy metal contamination.

Proposed mitigation measures to monitor and manage acid producing potential in reject material, are sufficient to manage the low to negligible risk of acid mine drainage forming within the overburden and interburden.

Table 7-5: Wandoan overburden and interburden geochemistry results

Parameter	Range in values encountered	
	Weathered rock	Fresh rock
pH	9.2 – 9.9	9.7 – 10.4
Net Acid Production Potential (kg H_2SO_4/t)	-14.6 – -10.4	-48.8 – -4.1
Electrical conductivity (µS/cm)	763 – 1080	280 – 1020
Net acid generation (pH 4.5) (kg H_2SO_4/t)	<0.1	<0.1 – 11.7
Net acid generation (pH 7.0) (kg H_2SO_4/t)	<0.1	<0.1 – 62.2
pH after oxidation	8.3	3.7 – 8.5
Acid neutralising capacity (kg H_2SO_4/t)	10.7 – 15.6	6.0 – 50.0
Total Sulfur (%)	0.01 – 0.03	0.03 – 0.14

Borehole logs show some coal seams to be pyritic, and layers of overburden adjacent to coal seams could contain pyrite and have a total sulphur content higher than the bulk samples tested. These pyritic layers could produce some acid drainage if they were concentrated near the surface of the spoil[5].

Figure 7-3 shows overburden characteristics and resulting potential for acid production for samples tested as part of mine waste assessment. All samples have negative NAPP, and therefore plot in the left side of the

diagram. The samples with a pH(ox) less than 4.5 have low sulphur content, and therefore plot typical of organic acid effects on samples with minor or no acid rock drainage potential (Miller, 2008)[18].

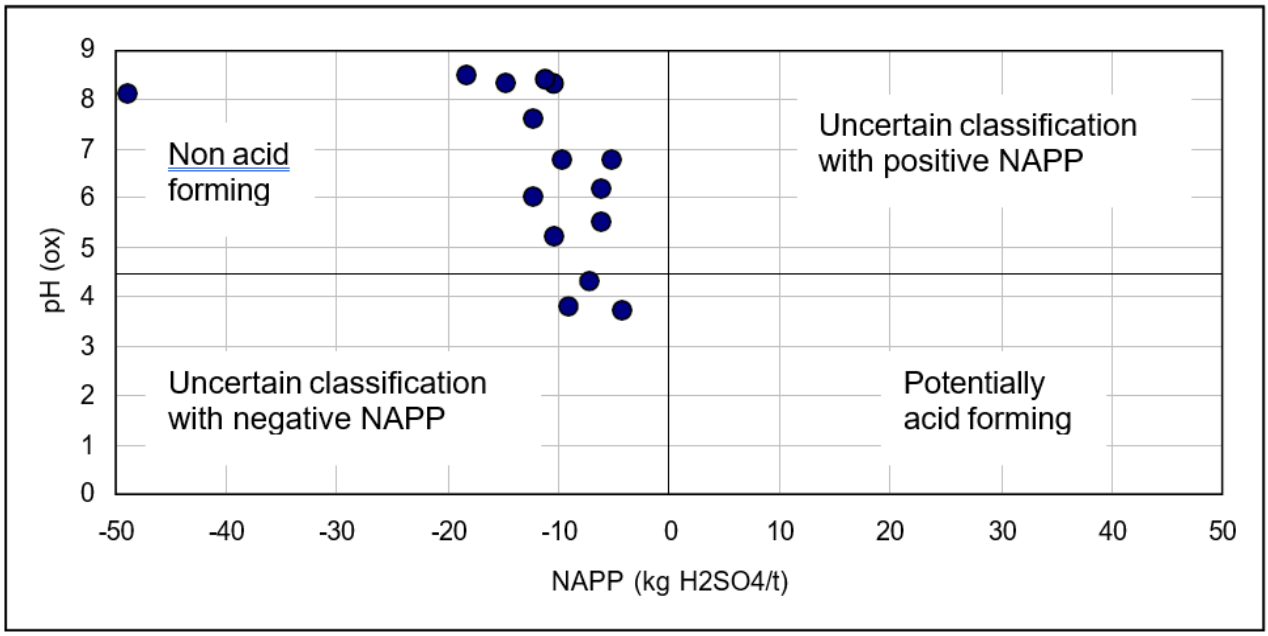


Figure 7-3: Classification of acid production potential

7.2.14.2 Multi-element testing

Heavy metal concentrations within the overburden and interburden (n=15) are below the concentrations requiring investigating under the National Environment Protection (Assessment of Site Contamination) Measure 1999 (National Environment Protection Council 1999) (**Table 7-6**). The studies suggest there is a low potential for overburden dumps to be a source of heavy metal contaminated leachate[7].

Table 7-6: Heavy metal concentrations in Wandoan overburden and interburden

Substance	Number of samples analysed	Minimum concentration (mg/kg)	Maximum concentration (mg/kg)	Samples exceeding environmental investigation level
Arsenic	15	<5	6	None
Cadmium	15	<1	<1	None
Copper	15	12	45	None
Total chromium	15	<2	10	None
Lead	15	8	24	None
Nickel	15	2	12	None
Zinc	15	5	133	None

[18] Miller, S, *Development of ARD Assessment for Coal Process Wastes*, ACARP Project C15034, Australian Coal Association Research Program, July 2008.

7.2.14.3 Mine waste soil quality

The overburden has very low organic matter and nitrogen content. The pH of overburden was found generally to be alkaline, with some siltstone and sandstone samples acidic. The concentration of exchangeable cations is low and is dominated by calcium and sodium. Electrical conductivity levels were medium to high, and trace elements (iron, manganese, copper, zinc) levels medium to high.

The potential for slaking and dispersion was assessed by Golders Associates (2008)[19]. This assessment found that clay rich, slake prone rocks are present throughout the overburden and interburden across the Project area, although some non-slaking materials were encountered. The results indicate that the slaking material is a high plasticity clay, with poor engineering properties.

Most overburden was found to be highly dispersive, with some siltstone/sandstone materials dispersive (overburden with more than 70% sandstone and siltstone, with more siltstone than sandstone) or non-dispersive (overburden with more than 70% siltstone/coal and sandstone, with more siltstone/coal than sandstone). Siltstone and mudstone dominated overburden should not be placed within the rooting depth of vegetation. All materials tested were found to be highly susceptible to tunnel erosion.

Dispersion is caused by chemically exchangeable sodium dominated clays that form weak bonds between individual clay particles and layers within the clay minerals, thus acting as a dispersing agent. Soils with an exchangeable sodium percent (ESP) of more than 15% are considered dispersive and soils with an ESP less than 5% are commonly considered as non- dispersive. The study found ESP values of 23 to 28 for weathered rock and 40 to 71 for fresh rock, indicating the overburden will be highly dispersive. These findings are in accordance with those by Slater (1986)[3], who found sodium as the dominant base cation, and ESP values of 14 to 34.

The dispersive nature of the overburden, combined with the low organic matter content, is anticipated to result in a hard setting surface crust. Untreated, this crust will limit seedling emergence and water infiltration and will increase overland surface runoff during rain events increasing the risk of sheet flow and gully erosion[5].

Glasshouse trials of buffel grass, wheat and siratro on various overburden substrate were conducted by Slater (1986)[3]. Slater found that generally, even when nutrient deficiencies were overcome by fertiliser addition, other overburden properties such as moisture holding capacity, pH, salinity and sodicity, remained hostile to plants[7].

7.2.15 Rejects and tailings processing

CHPP waste solids and process effluents comprise both coarse rejects and fine reject (tailings) material. Differentiation of the waste streams into coarse rejects and tailings is based on particle size and, for this project, tailings would consist of waste material less than 2 mm in particle size.

Data from the project bulk sample trials undertaken during early 2008, showed that coarse and fine reject material is very similar in nature, consisting of high ash clays and a small quantity of high ash inert and dull coal removed from the feed material during the trial washing process. The feed material from the deposit is very low in sulphur so the tailings will be low in sulphur and will not impose an acid risk on deposition.

7.2.16 Rejects and tailings disposal

The proponent has proposed to truck coarse rejects to nominated containment areas in various pits across the mine area so that coarse and fine rejects would be progressively disposed into the voids of mined pits. This would provide an effective long-term rejects storage option that does not sterilise future coal pit reserves and would reduce the environmental footprint by not disturbing areas in addition to the mine pits[1].

7.2.17 Mine water management

Three mine water management systems have been proposed (in order of cleanliness)[1].

[19] Golders Associates 2008, *Report of Geotechnical Evaluation for Open Pit Mining, Wandoan Coal Project, Wandoan*, *Queensland,* Golders Associates Pty Ltd, Brisbane.

The first mine water management system involves the pit water and process dirty water management system, which manages water captured in pits and running off dump stations and other areas with the potential to contribute high concentrations of dissolved salts, such as the CHPP and coal product stockpiles.

To maximise the opportunity for reusing the pit/process water across the site, a water pipeline is proposed to be constructed along the conveyor alignment between the CHPP and the dump stations in MLA 50229. During wet periods, the rate of return from the pits may exceed the capacity of the CHPP to use it and additional storage will be required to store this excess wastewater. Storage would only be required in later stages of the mine life and that storage of this water could occur in disused pits in either MLA 50229 prior to being pumped to the CHPP.

The second is the overburden runoff water management system, which treats water running off overburden dumps and other disturbed areas of the site with the potential to have elevated concentrations of suspended solids.

Runoff from active overburden dumps will have high turbidity and will require settlement in sedimentation dams. The first instance of these dams will be ‘dry basins’, with low level outlet pipes which would restrict the outflow from the sedimentation dams, but not permanently contain water. This will allow for coarse sediments to settle and, if necessary, allow a flocculant to be added to remove very fine sediment to meet allowable receiving water quality limits for turbidity associated with receiving watercourses.

Finally, the clean water management system, which manages water from undisturbed areas of the MLA areas and the catchments discharging through the site from upstream. The clean water management system would ensure that neither local runoff nor flood waters from the significant creek systems flowing through the project area enter the mine pits.

The system comprises:

- Diversions of streams around active mining areas where they cross creek channels
- Flood levees adjacent to pits and dumps to prevent flood waters entering the pits. Flood levees are sized to provide flood immunity during 0.1 per cent AEP (average exceedance probability, that is, a 1,000 year average recurrence interval (ARI) design flood event)
- High-wall bunds and clean water catch drains to divert catchments upslope of high-walls around the end-wall. Relatively few are required for the project due to the nature of the site topography and the pit layout. The proposed drains will largely follow existing contours to minimise the risk of erosive velocities.

Attachment G: ALS laboratory certificates of analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2208963**	Page	: 1 of 7
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 29-Mar-2022 13:00
Order number	: ----	Date Analysis Commenced	: 05-Apr-2022
C-O-C number	: ----	Issue Date	: 12-Apr-2022 08:37
Sampler	: LE XI NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 19		
No. of samples analysed	: 19		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- 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**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_001 Topsoil WANTP 0-0.6	2022005_002 Soil WANTP 0-0.6	2022005_003 Subsoil 600mm WANTP 0-0.6	2022005_004 Subsoil 600mm WANTP 0-0.6	2022005_005 Overburden 1700mm WANTP 0.6-2.2
				Sampling date / time	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00
					EB2208963-001	EB2208963-002	EB2208963-003	EB2208963-004	EB2208963-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**8.7**	**8.8**	**8.9**	**8.9**	**8.6**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-62.5**	**-76.3**	**-83.5**	**-89.6**	**-14.9**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**366**	**343**	**706**	**678**	**720**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**63.1**	**76.9**	**84.1**	**90.2**	**14.9**
ANC as CaCO3	----	0.1	% CaCO3		**6.4**	**7.8**	**8.6**	**9.2**	**1.5**
Fizz Rating	----	0	Fizz Unit		**2**	**2**	**2**	**2**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.02**	**0.02**	<0.01

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_006 Overburden 1700mm WANTP 0.6-2.2	2022005_007 Interburden WS1B WANTP 4-4.4	2022005_008 WS1A WANTP 2.2-4	2022005_009 WS1A WANTP 2.2-4	2022005_010 WS1A WANTP 2.2-4
				Sampling date / time	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00
					EB2208963-006	EB2208963-007	EB2208963-008	EB2208963-009	EB2208963-010
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.0**	**8.0**	**5.6**	**5.8**	**6.4**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-55.4**	**-21.5**	<0.5	**-7.2**	**-17.9**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**555**	**534**	**758**	**710**	**852**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**55.4**	**23.3**	**2.3**	**9.6**	**20.7**
ANC as CaCO3	----	0.1	% CaCO3		**5.6**	**2.4**	**0.2**	**1.0**	**2.1**
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**0**	**1**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	**0.06**	**0.09**	**0.08**	**0.09**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_011 WS1A WANTP 2.2-4	2022005_012 WS1B WANTP 2.2-4	2022005_013 WS1B WANTP 4.4-7	2022005_014 WS1B WANTP 4.4-7	2022005_015 WS1B WANTP 4.4-7
			Sampling date / time	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00
Compound	CAS Number	LOR	Unit	EB2208963-011	EB2208963-012	EB2208963-013	EB2208963-014	EB2208963-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	**5.6**	**7.6**	**7.6**	**7.6**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**2.0**	**2.6**	**-31.0**	**-25.3**	**-23.1**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**740**	**729**	**496**	**522**	**450**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**0.8**	**0.5**	**35.3**	**29.0**	**26.5**
ANC as CaCO3	----	0.1	% CaCO3	<0.1	<0.1	**3.6**	**3.0**	**2.7**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.09**	**0.10**	**0.14**	**0.12**	**0.11**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_016 WS1B WANTP 4.4-7	2022005_017 MU/ML IB WANTP 7-7.5	2022005_018 MU/ML IB WANTP 7-75	----	----
			Sampling date / time	29-Mar-2022 00:00	29-Mar-2022 00:00	29-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2208963-016	EB2208963-017	EB2208963-018	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.7**	**9.2**	**9.5**	**----**	**----**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-30.1**	**-5.1**	**-6.3**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**506**	**248**	**264**	**----**	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**33.8**	**5.7**	**6.3**	**----**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**3.4**	**0.6**	**0.6**	**----**	**----**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**0**	**----**	**----**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.12**	**0.02**	<0.01	**----**	**----**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**1:5 water used for solutions**	**----**	**----**	**----**	**----**
			Sampling date / time	[29-Mar-2022]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2208963-019**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.7**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2209260**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 01-Apr-2022 16:31
Order number	: ----	Date Analysis Commenced	: 05-Apr-2022
C-O-C number	: ----	Issue Date	: 12-Apr-2022 08:39
Sampler	: LE XI NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- 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)				Sample ID	2022005_019 RGS FGX Rejects	----	----	----	----
				Sampling date / time	01-Apr-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2209260-001	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**8.6**	----	----	----	----
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-22.8**	----	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**387**	----	----	----	----
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**23.7**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3		**2.4**	----	----	----	----
Fizz Rating	----	0	Fizz Unit		**1**	----	----	----	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.03**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**1:5 water used for solutions**	**----**	**----**	**----**	**----**
			Sampling date / time	01-Apr-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2209260-002**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.7**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2224327**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 18-Aug-2022 16:07
Order number	: ----	Date Analysis Commenced	: 23-Aug-2022
C-O-C number	: ----	Issue Date	: 26-Aug-2022 17:08
Sampler	: LE XI NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

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

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_020 Tailings Filter Cake	----	----	----	----
			Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2224327-001	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.0**	----	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-14.1**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**56**	----	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**17.5**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**1.8**	----	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	----	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.064**	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.11**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC of DI Water**	**----**	**----**	**----**	**----**
			Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2224327-002**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2336599**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 21-Nov-2023 14:30
Order number	: ----	Date Analysis Commenced	: 29-Nov-2023
C-O-C number	: ----	Issue Date	: 01-Dec-2023 13:44
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 11		
No. of samples analysed	: 11		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

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

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	R9595P_GO_01 R9595P	R9595P_GO_02 R9595P	R9595P_GO_03 R9595P	R9595P_GO_04 R9595P	R9595P_GO_05 R9595P
			Sampling date / time	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00
Compound	CAS Number	LOR	Unit	EB2336599-001	EB2336599-002	EB2336599-003	EB2336599-004	EB2336599-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.0	9.1	8.4	9.5	9.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-15.6	-5.5	-2.6	-21.7	-10.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	325	67	74	371	289
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	16.2	6.1	3.2	22.6	17.6
ANC as CaCO3	----	0.1	% CaCO3	1.6	0.6	0.3	2.3	1.8
Fizz Rating	----	0	Fizz Unit	1	0	0	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.03	0.22

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	R9595P_GO_06 R9595P	R9595P_GO_07 R9595P	R9595P_GO_08 R9595P	R9595P_GO_09 R9595P	R9595P_GO_10 R9595P
			Sampling date / time	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00	21-Nov-2023 00:00
Compound	CAS Number	LOR	Unit	EB2336599-006	EB2336599-007	EB2336599-008	EB2336599-009	EB2336599-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**10.0**	**9.8**	**10.1**	**7.5**	**10.1**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-11.6**	**-7.2**	**-37.8**	**-11.6**	**-25.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**245**	**276**	**460**	**954**	**748**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**12.5**	**14.5**	**39.0**	**18.6**	**27.0**
ANC as CaCO3	----	0.1	% CaCO3	**1.3**	**1.5**	**4.0**	**1.9**	**2.8**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**2**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.24**	**0.04**	**0.23**	**0.06**

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	DI Water 1:5	----	----	----	----
				Sampling date / time	21-Nov-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2336599-011	---------	---------	---------	---------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.6**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2340155**	Page	: 1 of 15
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 18-Dec-2023 17:07
Order number	: ----	Date Analysis Commenced	: 22-Dec-2023
C-O-C number	: ----	Issue Date	: 28-Dec-2023 16:25
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 60		
No. of samples analysed	: 60		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- 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)			Sample ID	2022005_0031 R9608P_GO_01	2022005_0032 R9608P_GO_02	2022005_0033 R9608P_GO_03	2022005_0034 R9608P_GO_04	2022005_0035 R9608P_GO_05
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-001	EB2340155-002	EB2340155-003	EB2340155-004	EB2340155-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.0**	**6.5**	**7.4**	**8.4**	**9.5**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-8.6**	**-4.9**	**-14.1**	**-14.6**	**-13.4**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1290**	**879**	**1800**	**615**	**789**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**9.5**	**5.5**	**17.2**	**19.8**	**14.6**
ANC as CaCO3	----	0.1	% CaCO3	**1.0**	**0.6**	**1.8**	**2.0**	**1.5**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.02**	**0.10**	**0.17**	**0.04**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0036 R9608P_GO_06	2022005_0037 R9608P_GO_07	2022005_0038 R9608P_GO_08	2022005_0039 R9608P_GO_09	2022005_0040 R9608P_GO_10
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-006	EB2340155-007	EB2340155-008	EB2340155-009	EB2340155-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.9	9.9	10.0	9.4	9.2
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-46.2	-59.8	-21.1	-17.6	-12.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	867	862	913	790	589
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	46.8	60.4	22.0	19.8	13.8
ANC as CaCO3	----	0.1	% CaCO3	4.8	6.2	2.2	2.0	1.4
Fizz Rating	----	0	Fizz Unit	2	2	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.03	0.07	0.06

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0041 R9608P_GO_11	2022005_0042 R9608P_GO_12	2022005_0043 R9608P_GO_13	2022005_0044 R9608P_GO_14	2022005_0045 R9608P_GO_15
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-011	EB2340155-012	EB2340155-013	EB2340155-014	EB2340155-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.7**	**9.3**	**9.6**	**8.1**	**8.7**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-15.7**	**-17.3**	**-13.2**	**-15.9**	**-11.7**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**697**	**492**	**432**	**956**	**775**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**16.6**	**20.4**	**14.1**	**20.2**	**16.3**
ANC as CaCO3	----	0.1	% CaCO3	**1.7**	**2.1**	**1.4**	**2.1**	**1.7**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.10**	**0.03**	**0.14**	**0.15**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0046 R9608P_GO_16	2022005_0047 R9608P_GO_17	2022005_0048 R9608P_GO_18	2022005_0049 R9608P_GO_19	2022005_0050 R9608P_GO_20
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-016	EB2340155-017	EB2340155-018	EB2340155-019	EB2340155-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.8	9.1	8.9	9.6	9.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-16.1	-11.8	-13.0	-14.9	-13.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	949	692	1430	973	489
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	17.9	14.9	16.1	16.1	14.2
ANC as CaCO3	----	0.1	% CaCO3	1.8	1.5	1.6	1.6	1.4
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.06	0.10	0.10	0.04	0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0051 C9605GP_GC_01	2022005_0052 C9605GP_GC_02	2022005_0053 C9605GP_GC_03	2022005_0054 C9605GP_GC_04	2022005_0055 C9605GP_GC_05
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-021	EB2340155-022	EB2340155-023	EB2340155-024	EB2340155-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.5**	**7.1**	**7.9**	**9.2**	**8.2**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-9.4**	**-9.4**	**-8.0**	**-178**	**-7.6**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1030**	**722**	**781**	**1040**	**580**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**10.3**	**10.0**	**8.6**	**179**	**8.5**
ANC as CaCO3	----	0.1	% CaCO3	**1.0**	**1.0**	**0.9**	**18.2**	**0.9**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**1**	**3**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.02**	**0.02**	**0.02**	**0.03**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0056 C9605GP_GC_06	2022005_0057 C9605GP_GC_07	2022005_0058 C9605GP_GC_08	2022005_0059 C9605GP_GC_09	2022005_0060 C9605GP_GC_10
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-026	EB2340155-027	EB2340155-028	EB2340155-029	EB2340155-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.8**	**9.0**	**9.0**	**8.9**	**8.7**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-4.2**	**-12.1**	**-13.3**	**-19.3**	**-9.4**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**515**	**393**	**341**	**515**	**358**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**9.7**	**13.0**	**14.2**	**19.9**	**10.6**
ANC as CaCO3	----	0.1	% CaCO3	**1.0**	**1.3**	**1.4**	**2.0**	**1.1**
Fizz Rating	----	0	Fizz Unit	**0**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.18**	**0.03**	**0.03**	**0.02**	**0.04**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0061 C9605GP_GC_11	2022005_0062 C9605GP_GC_12	2022005_0063 C9605GP_GC_13	2022005_0064 C9605GP_GC_14	2022005_0065 C9605GP_GC_15
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-031	EB2340155-032	EB2340155-033	EB2340155-034	EB2340155-035
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	9.1	9.4	9.8	9.2
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-6.6	-10.3	-6.3	-205	-5.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	357	580	596	795	391
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.8	11.2	7.5	206	6.7
ANC as CaCO3	----	0.1	% CaCO3	0.8	1.1	0.8	21.0	0.7
Fizz Rating	----	0	Fizz Unit	1	1	1	3	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.03	0.04	0.02	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0066 C9605GP_GC_16	2022005_0067 C6906GP_GC_01	2022005_0068 C6906GP_GC_02	2022005_0069 C6906GP_GC_03	2022005_0070 C6906GP_GC_04
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-036	EB2340155-037	EB2340155-038	EB2340155-039	EB2340155-040
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.7	5.0	8.6	8.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-6.2	-23.6	-2.1	-9.0	-33.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	338	599	506	751	620
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.3	24.2	2.7	9.6	34.1
ANC as CaCO3	----	0.1	% CaCO3	0.8	2.5	0.3	1.0	3.5
Fizz Rating	----	0	Fizz Unit	0	1	0	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.02	0.02	0.02	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0071 C6906GP_GC_05	2022005_0072 C6906GP_GC_06	2022005_0073 C6906GP_GC_07	2022005_0074 C6906GP_GC_08	2022005_0075 C6906GP_GC_09
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-041	EB2340155-042	EB2340155-043	EB2340155-044	EB2340155-045
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.0**	**8.0**	**8.1**	**8.5**	**9.0**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-58.6**	**-8.7**	**-8.9**	**-6.2**	**-9.5**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**591**	**502**	**564**	**914**	**472**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**59.8**	**9.3**	**12.0**	**7.7**	**10.4**
ANC as CaCO3	----	0.1	% CaCO3	**6.1**	**0.9**	**1.2**	**0.8**	**1.1**
Fizz Rating	----	0	Fizz Unit	**2**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.02**	**0.10**	**0.05**	**0.03**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0076 C6906GP_GC_10	2022005_0077 C6906GP_GC_11	2022005_0078 C6906GP_GC_12	2022005_0079 C6906GP_GC_13	2022005_0080 C6906GP_GC_14
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-046	EB2340155-047	EB2340155-048	EB2340155-049	EB2340155-050
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.5	9.4	9.5	9.4	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-8.3	-20.1	-12.1	-5.0	-8.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	744	780	429	475	463
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.5	21.6	13.0	5.6	9.9
ANC as CaCO3	----	0.1	% CaCO3	1.0	2.2	1.3	0.6	1.0
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.05	0.03	0.02	0.04

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0081 C6906GP_GC_15	2022005_0082 C6906GP_GC_16	2022005_0083 C9605GP_SP_01	2022005_0084 C9605GP_SP_02	2022005_0085 C9605GP_SP_03
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2340155-051	EB2340155-052	EB2340155-053	EB2340155-054	EB2340155-055
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.6	9.6	8.1	8.5	8.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.4	-9.0	-11.6	-9.7	-8.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	723	466	345	502	439
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	14.6	9.6	17.1	13.7	13.0
ANC as CaCO3	----	0.1	% CaCO3	1.5	1.0	1.7	1.4	1.3
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.02	0.18	0.13	0.16

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0086 C9605GP_SP_04	2022005_0087 C9605GP_SP_05	2022005_0088 C9606GP_SP_01	2022005_0089 C9606GP_SP_04	----
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	----
Compound	CAS Number	LOR	Unit	EB2340155-056	EB2340155-057	EB2340155-058	EB2340155-059	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.0**	**8.4**	**7.9**	**8.3**	**----**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-14.5**	**-11.8**	**-8.2**	**-14.1**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**357**	**369**	**444**	**641**	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**19.4**	**19.4**	**16.5**	**20.8**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**2.0**	**2.0**	**1.7**	**2.1**	**----**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**----**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.16**	**0.25**	**0.27**	**0.22**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	DI Water 1:5	----	----	----	----
				Sampling date / time	18-Dec-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2340155-060	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.4**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2402727**	Page	: 1 of 11
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 24-Jan-2024 15:10
Order number	: ----	Date Analysis Commenced	: 02-Feb-2024
C-O-C number	: ----	Issue Date	: 07-Feb-2024 09:49
Sampler	: Tyler Contour		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 41		
No. of samples analysed	: 41		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0090 C9610GP_GC_01 6.06-6.32m	2022005_0091 C9610GP_GC_02 11.29-11.6m	2022005_0092 C9610GP_GC_03 14.12-14.5m	2022005_0093 C9610GP_GC_04 16.5-16.76m	2022005_0094 C9610GP_GC_05 17.47-17.6m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-001	EB2402727-002	EB2402727-003	EB2402727-004	EB2402727-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.2**	**8.3**	**9.4**	**9.1**	**7.9**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-15.3**	**-6.6**	**-8.2**	**-6.5**	<0.5
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**761**	**416**	**394**	**346**	**582**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**15.9**	**8.7**	**9.1**	**8.0**	**8.2**
ANC as CaCO3	----	0.1	% CaCO3		**1.6**	**0.9**	**0.9**	**0.8**	**0.8**
Fizz Rating	----	0	Fizz Unit		**1**	**0**	**0**	**0**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.07**	**0.03**	**0.05**	**0.27**

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0095 C9610GP_GC_06 18-19.31m	2022005_0096 C9610GP_GC_07 21.48-21.75m	2022005_0097 C9610GP_GC_08 24.41-24.63m	2022005_0098 C9610GP_GC_09 28.11-28.52m	2022005_0099 C9610GP_GC_10 29.53-29.85m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
				EB2402727-006	EB2402727-007	EB2402727-008	EB2402727-009	EB2402727-010	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**9.4**	**8.6**	**9.0**	**8.8**	**10.1**	
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-15.0**	**-9.0**	**-21.5**	**-5.0**	**-16.0**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**636**	**598**	**769**	**555**	**1070**	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**16.2**	**12.1**	**24.6**	**7.2**	**16.9**	
ANC as CaCO3	----	0.1	% CaCO3	**1.6**	**1.2**	**2.5**	**0.7**	**1.7**	
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**1**	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.10**	**0.10**	**0.07**	**0.03**	

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0100 C9610GP_GC_11 32.1-32.48m	2022005_0101 C9610GP_GC_12 35-.6-35.9m	2022005_0102 C9610GP_GC_13 36.34-36.74m	2022005_0103 C9610GP_GC_14 38.64-38.9m	2022005_0104 C9610GP_GC_15 39.58-39.79m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-011	EB2402727-012	EB2402727-013	EB2402727-014	EB2402727-015
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.6	9.5	9.8	9.7	10.7
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-14.6	-15.1	-17.2	-79.3	-143
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		708	592	755	710	1820
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		15.8	16.3	18.4	80.2	144
ANC as CaCO3	----	0.1	% CaCO3		1.6	1.7	1.9	8.2	14.7
Fizz Rating	----	0	Fizz Unit		1	1	1	2	2
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.04	0.04	0.04	0.03	0.03

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0105 C9610GP_GC_16 41.2-41.81m	2022005_0106 C9610GP_GC_17 42.59-42.98m	2022005_0107 C9610GP_GC_18 44.27-44.5m	2022005_0108 C9610GP_GC_19 44.98-45.26m	2022005_0109 C9610GP_GC_20 45.6-45.92m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-016	EB2402727-017	EB2402727-018	EB2402727-019	EB2402727-020
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.6	9.6	9.1	9.3	9.8
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.0	-7.0	-10.0	-9.1	-14.9
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		315	639	390	590	558
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		8.6	8.5	12.2	10.6	15.8
ANC as CaCO3	----	0.1	% CaCO3		0.9	0.9	1.2	1.1	1.6
Fizz Rating	----	0	Fizz Unit		0	0	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.02	0.05	0.07	0.05	0.03

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0110 C9610GP_GC_21 46.06-46.5m	2022005_0114 L9611_GC_01 23.1-23.3m	2022005_0115 L9611_GC_02 37.55-37.7m	2022005_0116 L9611_GC_03 40.17-40.2m	2022005_0117 L9611_GC_04 43.6-43.84m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-021	EB2402727-025	EB2402727-026	EB2402727-027	EB2402727-028
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.6	8.6	9.0	9.7	9.2
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-6.3	-7.3	-3.5	-65.6	-5.3
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		249	386	436	685	342
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		11.2	8.8	4.7	66.5	6.5
ANC as CaCO3	----	0.1	% CaCO3		1.1	0.9	0.5	6.8	0.7
Fizz Rating	----	0	Fizz Unit		1	1	0	2	0
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.16	0.05	0.04	0.03	0.04

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0118 L9611_GC_05 45.18-45.33m	2022005_0119 L9612_GC_01 6.75-7m	2022005_0120 L9612_GC_02 8.25-8.5m	2022005_0121 L9612_GC_03 10.45-10.65m	2022005_0122 L9612_GC_05 21.76-22.0m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-029	EB2402727-030	EB2402727-031	EB2402727-032	EB2402727-033
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.7	7.9	7.9	9.3	9.1
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-4.5	-3.7	-1.7	-5.5	-6.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		368	517	522	359	369
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		8.5	5.2	5.4	8.3	8.6
ANC as CaCO3	----	0.1	% CaCO3		0.9	0.5	0.6	0.8	0.9
Fizz Rating	----	0	Fizz Unit		0	0	0	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.13	0.05	0.12	0.09	0.06

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)				Sample ID	2022005_0123 L9612_GC_06 23.6-23.8m	2022005_0124 L9612_GC_07 24.12-24.26m	2022005_0125 L9612_GC_08 27.9-28.1m	2022005_0126 L9612_GC_09 29.4-29.62m	2022005_0127 L9612_GC_10 31.55-31.77m
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
Compound	CAS Number	LOR	Unit		EB2402727-034	EB2402727-035	EB2402727-036	EB2402727-037	EB2402727-038
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.6	9.8	9.7	9.8	9.2
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-6.2	-83.7	-8.6	-7.6	-5.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		574	890	641	545	616
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		7.4	84.9	9.5	8.5	8.2
ANC as CaCO3	----	0.1	% CaCO3		0.8	8.7	1.0	0.9	0.8
Fizz Rating	----	0	Fizz Unit		0	2	0	0	0
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.04	0.04	0.03	0.03	0.08

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0128 L9612_GC_11 34.3-34.5m	2022005_0129 L9612_GC_12 36.1-36.31	2022005_0111 C9610GP_SP_01	2022005_0112 C9610GP_SP_02	2022005_0113 C9610GP_SP_03
				Sampling date / time	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00	24-Jan-2024 00:00
					EB2402727-039	EB2402727-040	EB2402727-042	EB2402727-043	EB2402727-044
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.6	9.1	7.9	8.1	8.1
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-10.5	-7.7	-6.4	-16.3	-2.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		546	290	627	429	221
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		12.0	10.5	15.3	22.4	9.5
ANC as CaCO3	----	0.1	% CaCO3		1.2	1.1	1.6	2.3	1.0
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.05	0.09	0.29	0.20	0.22

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	pH and EC of DI water	----	----	----	----
				Sampling date / time	24-Jan-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2402727-041	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**6.2**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2403811**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 05-Feb-2024 15:08
Order number	: ----	Date Analysis Commenced	: 08-Feb-2024
C-O-C number	: ----	Issue Date	: 13-Feb-2024 11:45
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 9		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: ROCK
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_0130 L9614_GC_01	2022005_0131 L9614_GC_02	2022005_0132 L9614_GC_03	2022005_0133 L9614_GC_04	2022005_0134 L9614_GC_05
				Sampling date / time	05-Feb-2024 00:00	05-Feb-2024 00:00	05-Feb-2024 00:00	05-Feb-2024 00:00	05-Feb-2024 00:00
					EB2403811-001	EB2403811-002	EB2403811-003	EB2403811-004	EB2403811-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.8	9.3	9.7	9.9	10.0
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.4	-8.2	-10.1	-12.0	-15.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		441	488	453	843	475
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		9.0	9.4	10.7	12.6	15.7
ANC as CaCO3	----	0.1	% CaCO3		0.9	1.0	1.1	1.3	1.6
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.02	0.04	0.02	0.02	0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2022005_0135 L9614_GC_06	2022005_0136 L9614_GC_07	2022005_0137 L9614_GC_08	----	----
			Sampling date / time	05-Feb-2024 00:00	05-Feb-2024 00:00	05-Feb-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2403811-006	EB2403811-007	EB2403811-008	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**10.0**	**9.8**	**10.0**	**----**	**----**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-14.1**	**-5.1**	**-13.4**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1060**	**383**	**807**	**----**	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**14.7**	**5.4**	**14.0**	**----**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**1.5**	**0.5**	**1.4**	**----**	**----**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**1**	**----**	**----**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.01**	**0.02**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	pH and EC of DI water	----	----	----	----
				Sampling date / time	05-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2403811-009	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**6.2**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2404828**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 12-Feb-2024 15:31
Order number	: ----	Date Analysis Commenced	: 20-Feb-2024
C-O-C number	: ----	Issue Date	: 23-Feb-2024 14:18
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- 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)			Sample ID	2022005_138 L9614_GC_09	2022005_139 L9614_GC_10	2022005_140 L9614_GC_12	2022005_141 L9614_GC_13	2022005_142 L9614_GC_14
			Sampling date / time	12-Feb-2024 00:00	12-Feb-2024 00:00	12-Feb-2024 00:00	12-Feb-2024 00:00	12-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	EB2404828-001	EB2404828-002	EB2404828-003	EB2404828-004	EB2404828-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.8	8.9	10.0	9.4	8.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-11.6	-0.5	-280	-9.0	-72.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	697	206	630	366	558
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	13.1	10.3	281	11.8	81.0
ANC as CaCO3	----	0.1	% CaCO3	1.3	1.0	28.6	1.2	8.3
Fizz Rating	----	0	Fizz Unit	1	1	4	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.05	0.32	0.02	0.09	0.27

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	pH and EC of DI water used for 1:5 solutions	----	----	----	----
				Sampling date / time	12-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2404828-006	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.3**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2210484**	Page	: 1 of 2
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 13-Apr-2022 14:41
Order number	: ----	Date Analysis Commenced	: 27-Apr-2022
C-O-C number	: ----	Issue Date	: 27-Apr-2022 11:35
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2022005_012	2022005_013	2022005_014	2022005_015	2022005_016
			Sampling date / time	13-Apr-2022 00:00	13-Apr-2022 00:00	13-Apr-2022 00:00	13-Apr-2022 00:00	13-Apr-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2210484-001**	**EB2210484-002**	**EB2210484-003**	**EB2210484-004**	**EB2210484-005**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.028**	**0.138**	**0.119**	**0.114**	**0.113**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2338568**	Page	: 1 of 2
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 04-Dec-2023 09:10
Order number	: ----	Date Analysis Commenced	: 12-Dec-2023
C-O-C number	: ----	Issue Date	: 12-Dec-2023 12:12
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	**2022005_025 R9595P_GO_05 13-14**	**2022005_027 R9595P_GO_07 18-19**	**2022005_029 R9595P_GO_09 23-24**	**----**	**----**
			Sampling date / time	04-Dec-2023 00:00	04-Dec-2023 00:00	04-Dec-2023 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2338568-001**	**EB2338568-002**	**EB2338568-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.036**	**0.048**	**0.076**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2400199**	Page	: 1 of 5
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 02-Jan-2024 11:59
Order number	: ----	Date Analysis Commenced	: 05-Jan-2024
C-O-C number	: ----	Issue Date	: 05-Jan-2024 11:04
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 11		
No. of samples analysed	: 11		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022005_0034 R9608P_GO_04R9608 P	2022005_0044 R9608P_GO_14R9608 P	2022005_0045 R9608P_GO_15R9608 P	2022005_0056 C9605GP_GC_06C960 5GP	2022005_0083 C9605GP_SP_01C960 5GP
				Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit		EB2400199-001	EB2400199-002	EB2400199-003	EB2400199-004	EB2400199-005
					Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.063**	**0.016**	**0.020**	**0.011**	**0.018**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0084 C9605GP_SP_02C960 5GP	2022005_0085 C9605GP_SP_03C960 5GP	2022005_0086 C9605GP_SP_04C960 5GP	2022005_0087 C9605GP_SP_05C960 5GP	2022005_0088 C9606GP_SP_01C960 6GP
			Sampling date / time	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00	18-Dec-2023 00:00
Compound	CAS Number	LOR	Unit	EB2400199-006	EB2400199-007	EB2400199-008	EB2400199-009	EB2400199-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.011**	**0.019**	**0.012**	**0.012**	**0.022**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0089 C9606GP_SP_04C960 6GP	----	----	----	----
			Sampling date / time	18-Dec-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2400199-011	--------	--------	--------	--------
				Result	----	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.013**	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2406579**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 12-Feb-2024 15:31
Order number	: ----	Date Analysis Commenced	: 01-Mar-2024
C-O-C number	: ----	Issue Date	: 05-Mar-2024 14:16
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 6		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_139 L9614_GC_10	2022005_142 L9614_GC_14	----	----	----
			Sampling date / time	26-Feb-2024 00:00	26-Feb-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2406579-002	EB2406579-005	--------	--------	--------
				Result	Result	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.011**	**0.006**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	pH and EC of DI water	----	----	----	----
				Sampling date / time	27-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2406579-006	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**6.0**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2215308**	Page	: 1 of 12
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 27-May-2022 14:18
Order number	: ----	Date Analysis Commenced	: 01-Jun-2022
C-O-C number	: ----	Issue Date	: 10-Jun-2022 13:07
Sampler	: LE XI NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 13		
No. of samples analysed	: 13		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- EK071G (Reactive Phosphorus): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- EK040S (Fluoride - Soluble) - Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.
- EG005T (Total Metals by ICP-AES): EB2215299-002 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_001 Topsoil WANTP 0-0.6	2022005_002 Soil WANTP 0-0.6	2022005_003 Subsoil 600mm WANTP 0-0.6	2022005_004 Subsoil 600mm WANTP 0-0.6	2022005_C03 Overburden_1
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-001	EB2215308-002	EB2215308-003	EB2215308-004	EB2215308-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**8.8**	**8.8**	**8.9**	**9.0**	**9.1**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**374**	**349**	**743**	**674**	**605**
ED037: Alkalinity									
ø **Total Alkalinity as CaCO3**	----	1	mg/kg		**8290**	**11100**	**52900**	**26400**	**14200**
ø **Bicarbonate Alkalinity as CaCO3**	71-52-3	1	mg/kg		**7970**	**10900**	**52100**	**25300**	**13600**
ø **Carbonate Alkalinity as CaCO3**	3812-32-6	1	mg/kg		**321**	**214**	**802**	**1100**	**624**
ED038A: Acidity									
Acidity	----	1	mg/kg		<5	<5	<5	<5	<5
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		**50**	**40**	**120**	**120**	**30**
Silica	7631-86-9	1	mg/kg		**39**	**40**	**35**	**38**	**35**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		**80**	**30**	**630**	**500**	**380**
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		**20**	**20**	**20**	**20**	<10
Magnesium	7439-95-4	10	mg/kg		<10	<10	**10**	<10	<10
Sodium	7440-23-5	10	mg/kg		**420**	**400**	**710**	**670**	**620**
Potassium	7440-09-7	10	mg/kg		<10	<10	<10	<10	<10
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg		**17700**	**25500**	**26400**	**31800**	**9600**
Magnesium	7439-95-4	50	mg/kg		**4320**	**4800**	**5200**	**5780**	**3620**
Sodium	7440-23-5	50	mg/kg		**1100**	**1180**	**1910**	**2050**	**1610**
Potassium	7440-09-7	50	mg/kg		**890**	**860**	**790**	**910**	**940**
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg		**1**	**1**	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**10800**	**10600**	**8910**	**10500**	**6570**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		**24300**	**24000**	**26400**	**28500**	**16200**
EG020S: Soluble Metals by ICPMS									

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_001 Topsoil WANTP 0-0.6	2022005_002 Soil WANTP 0-0.6	2022005_003 Subsoil 600mm WANTP 0-0.6	2022005_004 Subsoil 600mm WANTP 0-0.6	2022005_C03 Overburden_1
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-001	EB2215308-002	EB2215308-003	EB2215308-004	EB2215308-005
					Result	Result	Result	Result	Result
EG020S: Soluble Metals by ICPMS - Continued									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.01	mg/kg		**0.04**	**0.04**	**0.06**	**0.04**	**0.01**
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		**0.04**	**0.05**	**0.02**	**0.02**	**0.02**
Manganese	7439-96-5	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/kg		**0.02**	**0.02**	**0.02**	**0.02**	**0.01**
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	**0.02**	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		**0.01**	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	**0.06**
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg		**0.3**	**0.4**	**0.2**	**0.2**	**0.2**
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**2.8**	**2.6**	**2.6**	**2.8**	**2.2**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		**225**	**231**	**211**	**213**	**120**
Beryllium	7440-41-7	0.1	mg/kg		**0.8**	**0.8**	**0.9**	**0.9**	**0.5**
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	**0.1**
Cobalt	7440-48-4	0.1	mg/kg		**9.4**	**8.3**	**15.1**	**15.1**	**10.3**
Chromium	7440-47-3	0.1	mg/kg		**9.8**	**9.5**	**8.9**	**10.1**	**7.7**
Copper	7440-50-8	0.1	mg/kg		**16.9**	**17.2**	**19.3**	**20.6**	**19.3**
Thorium	7440-29-1	0.1	mg/kg		**2.4**	**2.4**	**3.1**	**3.2**	**3.9**
Manganese	7439-96-5	0.1	mg/kg		**434**	**423**	**481**	**531**	**427**
Molybdenum	7439-98-7	0.1	mg/kg		**0.2**	**0.2**	**0.3**	**0.3**	**0.2**
Nickel	7440-02-0	0.1	mg/kg		**11.2**	**12.2**	**12.3**	**13.4**	**12.1**
Lead	7439-92-1	0.1	mg/kg		**11.9**	**12.1**	**12.6**	**14.6**	**11.7**
Antimony	7440-36-0	0.1	mg/kg		**0.1**	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_001 Topsoil WANTP 0-0.6	2022005_002 Soil WANTP 0-0.6	2022005_003 Subsoil 600mm WANTP 0-0.6	2022005_004 Subsoil 600mm WANTP 0-0.6	2022005_C03 Overburden_1
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-001	EB2215308-002	EB2215308-003	EB2215308-004	EB2215308-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Uranium	7440-61-1	0.1	mg/kg		**0.3**	**0.3**	**0.5**	**0.5**	**1.1**
Zinc	7440-66-6	0.5	mg/kg		**39.3**	**40.1**	**46.8**	**50.4**	**58.3**
Vanadium	7440-62-2	1	mg/kg		**41**	**40**	**35**	**39**	**23**
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**18**	**17**	**38**	**36**	**30**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.2	<0.2	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C04 Low Grade Coal (LGC)_1	2022005_C05 Low Grade Coal (LGC)_2	2022005_C06 Low Grade Coal (LGC)_3	2022005_C07 Coal_1	2022005_C08 Coal_2
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-006	EB2215308-007	EB2215308-008	EB2215308-009	EB2215308-010
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.2	6.2	5.6	7.6	7.6
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		703	775	747	538	479
ED037: Alkalinity									
ø Total Alkalinity as CaCO3	----	1	mg/kg		5800	6910	4460	13900	13300
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg		5800	6910	4460	13900	13300
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg		<5	<5	<5	<5	<5
ED038A: Acidity									
Acidity	----	1	mg/kg		4950	5200	13800	495	412
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		480	580	850	180	140
Silica	7631-86-9	1	mg/kg		126	108	137	37	37
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		170	250	310	10	10
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		30	40	20	130	110
Magnesium	7439-95-4	10	mg/kg		10	20	10	70	60
Sodium	7440-23-5	10	mg/kg		820	860	800	550	530
Potassium	7440-09-7	10	mg/kg		20	30	20	20	10
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg		10700	12400	10900	10600	10600
Magnesium	7439-95-4	50	mg/kg		2000	1860	2120	1420	1390
Sodium	7440-23-5	50	mg/kg		2610	1990	3030	1250	1270
Potassium	7440-09-7	50	mg/kg		440	590	480	190	200
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		2	2	2	1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	2	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		3530	2630	4040	1170	1200
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		3030	2190	3010	2460	2180
EG020S: Soluble Metals by ICPMS									

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C04 Low Grade Coal (LGC)_1	2022005_C05 Low Grade Coal (LGC)_2	2022005_C06 Low Grade Coal (LGC)_3	2022005_C07 Coal_1	2022005_C08 Coal_2
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-006	EB2215308-007	EB2215308-008	EB2215308-009	EB2215308-010
					Result	Result	Result	Result	Result
EG020S: Soluble Metals by ICPMS - Continued									
Arsenic	7440-38-2	0.01	mg/kg		**0.02**	**0.02**	**0.04**	<0.01	<0.01
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.01	mg/kg		**0.03**	**0.05**	**0.04**	**0.46**	**0.55**
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	**0.01**	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		**0.02**	**0.02**	**0.04**	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/kg		**0.09**	**0.12**	**0.13**	**0.04**	**0.03**
Molybdenum	7439-98-7	0.01	mg/kg		**0.04**	**0.04**	**0.02**	**0.04**	**0.04**
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	**0.02**	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		<0.1	<0.1	**0.2**	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg		**0.8**	**0.9**	**3.5**	<0.1	<0.1
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**1.4**	**1.4**	**1.6**	**1.5**	**1.4**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		**145**	**166**	**166**	**181**	**181**
Beryllium	7440-41-7	0.1	mg/kg		**0.4**	**0.4**	**0.5**	**0.4**	**0.4**
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg		**3.3**	**2.1**	**4.0**	**1.7**	**1.9**
Chromium	7440-47-3	0.1	mg/kg		**1.9**	**2.1**	**2.1**	**1.4**	**1.5**
Copper	7440-50-8	0.1	mg/kg		**12.7**	**13.5**	**12.0**	**9.3**	**8.9**
Thorium	7440-29-1	0.1	mg/kg		**1.8**	**1.9**	**1.9**	**1.1**	**1.0**
Manganese	7439-96-5	0.1	mg/kg		**67.7**	**60.3**	**58.3**	**25.9**	**27.3**
Molybdenum	7439-98-7	0.1	mg/kg		**0.4**	**0.4**	**0.4**	**0.3**	**0.4**
Nickel	7440-02-0	0.1	mg/kg		**2.2**	**1.5**	**2.3**	**1.6**	**1.8**
Lead	7439-92-1	0.1	mg/kg		**8.7**	**9.4**	**9.1**	**7.7**	**8.4**
Antimony	7440-36-0	0.1	mg/kg		**0.2**	**0.1**	**0.2**	<0.1	<0.1

Analytical Results

Sub-Matrix: **PULP**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C04 Low Grade Coal (LGC)_1	2022005_C05 Low Grade Coal (LGC)_2	2022005_C06 Low Grade Coal (LGC)_3	2022005_C07 Coal_1	2022005_C08 Coal_2
				Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00	27-May-2022 00:00
					EB2215308-006	EB2215308-007	EB2215308-008	EB2215308-009	EB2215308-010
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Uranium	7440-61-1	0.1	mg/kg		**0.5**	**0.5**	**0.6**	**0.4**	**0.5**
Zinc	7440-66-6	0.5	mg/kg		**10.7**	**7.0**	**12.2**	**5.1**	**3.8**
Vanadium	7440-62-2	1	mg/kg		**22**	**31**	**26**	**19**	**19**
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		<5	<5	<5	**1**	**1**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.5	<0.5	<1.0	<0.1	<0.1

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C09 Interburden_1	2022005_C10 Coal Reject	----	----	----
			Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2215308-011	EB2215308-012	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.3**	**7.3**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**245**	**821**	----	----	----
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	**2410**	**10200**	----	----	----
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	**2050**	**10200**	----	----	----
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	**357**	<5	----	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	**412**	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**120**	**210**	----	----	----
Silica	7631-86-9	1	mg/kg	**66**	**64**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**30**	**120**	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	**140**	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	**80**	----	----	----
Sodium	7440-23-5	10	mg/kg	**240**	**780**	----	----	----
Potassium	7440-09-7	10	mg/kg	<10	**60**	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	**960**	**8060**	----	----	----
Magnesium	7439-95-4	50	mg/kg	**1480**	**1990**	----	----	----
Sodium	7440-23-5	50	mg/kg	**1560**	**1390**	----	----	----
Potassium	7440-09-7	50	mg/kg	**840**	**710**	----	----	----
EG005(ED093)S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	<1	----	----	----
Iron	7439-89-6	1	mg/kg	<1	<1	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2140**	**2790**	----	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	----
Iron	7439-89-6	50	mg/kg	**1590**	**2420**	----	----	----
EG020S: Soluble Metals by ICPMS								
Arsenic	7440-38-2	0.01	mg/kg	**0.47**	<0.01	----	----	----

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C09 Interburden_1	2022005_C10 Coal Reject	----	----	----
			Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2215308-011	EB2215308-012	--------	--------	--------
				Result	Result	----	----	----
EG020S: Soluble Metals by ICPMS - Continued								
Selenium	7782-49-2	0.1	mg/kg	**0.1**	<0.1	----	----	----
Barium	7440-39-3	0.01	mg/kg	<0.01	**0.12**	----	----	----
Beryllium	7440-41-7	0.01	mg/kg	<0.01	<0.01	----	----	----
Cadmium	7440-43-9	0.01	mg/kg	<0.01	<0.01	----	----	----
Cobalt	7440-48-4	0.01	mg/kg	<0.01	<0.01	----	----	----
Chromium	7440-47-3	0.01	mg/kg	<0.01	<0.01	----	----	----
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Copper	7440-50-8	0.01	mg/kg	<0.01	**0.02**	----	----	----
Manganese	7439-96-5	0.01	mg/kg	<0.01	**0.16**	----	----	----
Molybdenum	7439-98-7	0.01	mg/kg	**0.54**	**0.25**	----	----	----
Nickel	7440-02-0	0.01	mg/kg	<0.01	<0.01	----	----	----
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.01	mg/kg	<0.01	<0.01	----	----	----
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.05	mg/kg	<0.05	<0.05	----	----	----
Vanadium	7440-62-2	0.1	mg/kg	**0.6**	<0.1	----	----	----
Aluminium	7429-90-5	0.1	mg/kg	**0.4**	<0.1	----	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**1.9**	**1.2**	----	----	----
Selenium	7782-49-2	1	mg/kg	<1	<1	----	----	----
Barium	7440-39-3	0.1	mg/kg	**18.4**	**53.5**	----	----	----
Beryllium	7440-41-7	0.1	mg/kg	<0.1	**0.2**	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	**0.3**	**0.1**	----	----	----
Cobalt	7440-48-4	0.1	mg/kg	**4.3**	**1.0**	----	----	----
Chromium	7440-47-3	0.1	mg/kg	**1.0**	**1.1**	----	----	----
Copper	7440-50-8	0.1	mg/kg	**37.7**	**21.5**	----	----	----
Thorium	7440-29-1	0.1	mg/kg	**3.2**	**3.0**	----	----	----
Manganese	7439-96-5	0.1	mg/kg	**12.4**	**53.1**	----	----	----
Molybdenum	7439-98-7	0.1	mg/kg	**0.6**	**0.4**	----	----	----
Nickel	7440-02-0	0.1	mg/kg	**3.7**	**1.1**	----	----	----
Lead	7439-92-1	0.1	mg/kg	**18.2**	**8.8**	----	----	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	----	----	----
Uranium	7440-61-1	0.1	mg/kg	**0.5**	**0.5**	----	----	----
Zinc	7440-66-6	0.5	mg/kg	**44.9**	**14.1**	----	----	----

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C09 Interburden_1	2022005_C10 Coal Reject	----	----	----
			Sampling date / time	27-May-2022 00:00	27-May-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2215308-011	EB2215308-012	--------	--------	--------
				Result	Result	----	----	----
EG020T: Total Metals by ICP-MS - Continued								
Vanadium	7440-62-2	1	mg/kg	**7**	**12**	**----**	**----**	**----**
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	**----**	**----**	**----**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	**----**	**----**	**----**
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	**7**	**1**	**----**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	**0.4**	<0.1	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)				Sample ID	**pH and EC of DI water**	**----**	**----**	**----**	**----**
				Sampling date / time	27-May-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB2215308-013**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.4**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2225688**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 29-Aug-2022 14:37
Order number	: ----	Date Analysis Commenced	: 01-Sep-2022
C-O-C number	: ----	Issue Date	: 09-Sep-2022 09:59
Sampler	: LE XI K NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- ED040S (Soluble Major Anions by ICP-AES): EB2225342-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- ED093S (Soluble Major Cations by ICP): EB2225342-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- ED040S (Soluble Major Anions by ICP-AES): 2022005_020 (EB2225688-001) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG020-T (Total Metals by ICP-MS): Sample EB2225651-001 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_020 Tailings Filter Cake	----	----	----	----
			Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2225688-001	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**6.8**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**65**	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**1.1**	----	----	----	----
ED037: Alkalinity								
ø **Total Alkalinity as CaCO3**	----	1	mg/kg	**3510**	----	----	----	----
ø **Bicarbonate Alkalinity as CaCO3**	71-52-3	1	mg/kg	**3510**	----	----	----	----
ø **Carbonate Alkalinity as CaCO3**	3812-32-6	1	mg/kg	<5	----	----	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	**250**	----	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**60**	----	----	----	----
Silica	7631-86-9	1	mg/kg	**23**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	----	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**30**	----	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
Sodium	7440-23-5	10	mg/kg	**30**	----	----	----	----
Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
ED093T: Total Major Cations								
Sodium	7440-23-5	50	mg/kg	**80**	----	----	----	----
Potassium	7440-09-7	50	mg/kg	**200**	----	----	----	----
Calcium	7440-70-2	50	mg/kg	**5260**	----	----	----	----
Magnesium	7439-95-4	50	mg/kg	**850**	----	----	----	----
EG005(ED093)S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	----	----	----	----
Iron	7439-89-6	1	mg/kg	**2**	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1490**	----	----	----	----
Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
Iron	7439-89-6	50	mg/kg	**97400**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022005_020 Tailings Filter Cake	----	----	----	----
				Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2225688-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	----	----	----	----
Selenium	7782-49-2	0.1	mg/kg		<0.1	----	----	----	----
Barium	7440-39-3	0.01	mg/kg		**0.09**	----	----	----	----
Beryllium	7440-41-7	0.01	mg/kg		<0.01	----	----	----	----
Cadmium	7440-43-9	0.01	mg/kg		<0.01	----	----	----	----
Cobalt	7440-48-4	0.01	mg/kg		<0.01	----	----	----	----
Chromium	7440-47-3	0.01	mg/kg		<0.01	----	----	----	----
Thorium	7440-29-1	0.01	mg/kg		<0.01	----	----	----	----
Copper	7440-50-8	0.01	mg/kg		**0.05**	----	----	----	----
Manganese	7439-96-5	0.01	mg/kg		**0.14**	----	----	----	----
Molybdenum	7439-98-7	0.01	mg/kg		<0.01	----	----	----	----
Nickel	7440-02-0	0.01	mg/kg		**0.02**	----	----	----	----
Lead	7439-92-1	0.01	mg/kg		<0.01	----	----	----	----
Antimony	7440-36-0	0.01	mg/kg		<0.01	----	----	----	----
Uranium	7440-61-1	0.01	mg/kg		<0.01	----	----	----	----
Zinc	7440-66-6	0.05	mg/kg		**0.11**	----	----	----	----
Vanadium	7440-62-2	0.1	mg/kg		<0.1	----	----	----	----
Aluminium	7429-90-5	0.1	mg/kg		**0.2**	----	----	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**2.9**	----	----	----	----
Selenium	7782-49-2	1	mg/kg		<1	----	----	----	----
Barium	7440-39-3	0.1	mg/kg		**141**	----	----	----	----
Beryllium	7440-41-7	0.1	mg/kg		**1.8**	----	----	----	----
Cadmium	7440-43-9	0.1	mg/kg		**0.3**	----	----	----	----
Cobalt	7440-48-4	0.1	mg/kg		**6.7**	----	----	----	----
Chromium	7440-47-3	0.1	mg/kg		**21.9**	----	----	----	----
Copper	7440-50-8	0.1	mg/kg		**18.0**	----	----	----	----
Thorium	7440-29-1	0.1	mg/kg		**1.2**	----	----	----	----
Manganese	7439-96-5	0.1	mg/kg		**689**	----	----	----	----
Molybdenum	7439-98-7	0.1	mg/kg		**1.4**	----	----	----	----
Nickel	7440-02-0	0.1	mg/kg		**15.8**	----	----	----	----
Lead	7439-92-1	0.1	mg/kg		**17.1**	----	----	----	----
Antimony	7440-36-0	0.1	mg/kg		**0.5**	----	----	----	----
Uranium	7440-61-1	0.1	mg/kg		**0.8**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022005_020 Tailings Filter Cake	----	----	----	----
				Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2225688-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.5	mg/kg		**147**	----	----	----	----
Vanadium	7440-62-2	1	mg/kg		**40**	----	----	----	----
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	----	----	----	----
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**4**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.1	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC of DI Water**	**----**	**----**	**----**	**----**
			Sampling date / time	18-Aug-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2225688-002**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.4**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB2405781**	Page	: 1 of 14
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 16-Feb-2024 16:13
Order number	: ----	Date Analysis Commenced	: 21-Feb-2024
C-O-C number	: ----	Issue Date	: 28-Feb-2024 22:02
Sampler	: TYLER CONTOR		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 21		
No. of samples analysed	: 21		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Soil Preparation, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- EG020T (Total Metals by ICP-MS): 2022005_C23 (EB2405781-018) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): 2022005_C23 (EB2405781-018) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- It is recognised that EG005T (Total Metals by ICP-AES) is less than EG005S (Soluble Metals by ICP-AES) for some samples. However, the difference is within experimental variation of the methods.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C13 Macalister Lower Coal Composite Pulp	2022005_C14 ML Potential Reject Composite Pulp	2022005_C15 Wambo Coal Composite Pulp	2022005_C16 Wambo Potential Reject Composite Pulp	2022005_C17 Overburden_Austinval e Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
					EB2405781-008	EB2405781-009	EB2405781-010	EB2405781-011	EB2405781-012
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.0	8.3	8.4	8.8	8.2
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		503	656	442	992	710
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		2.9	2.2	<1.0	1.7	1.3
ED037: Alkalinity									
ø Total Alkalinity as CaCO3	----	5	mg/kg		5060	10400	3540	5920	5530
ø Bicarbonate Alkalinity as CaCO3	71-52-3	5	mg/kg		5060	10400	3540	5450	5530
ø Carbonate Alkalinity as CaCO3	3812-32-6	5	mg/kg		<5	<5	<5	467	<5
ED038A: Acidity									
Acidity	----	5	mg/kg		186	60	53	<5	26
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		10	20	<10	60	180
Silica	7631-86-9	1	mg/kg		37	54	42	50	43
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		210	330	120	570	630
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		10	20	<10	<10	30
Magnesium	7439-95-4	10	mg/kg		<10	<10	<10	<10	20
Sodium	7440-23-5	10	mg/kg		810	910	630	1020	700
Potassium	7440-09-7	10	mg/kg		10	30	<10	20	40
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg		4010	4560	2660	3410	4130
Magnesium	7439-95-4	50	mg/kg		560	780	1290	2530	3430
Sodium	7440-23-5	50	mg/kg		2040	2160	2120	3600	1210
Potassium	7440-09-7	50	mg/kg		150	580	440	800	860
EG005(ED093)S : Soluble Metals by ICPAES									

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C13 Macalister Lower Coal Composite Pulp	2022005_C14 ML Potential Reject Composite Pulp	2022005_C15 Wambo Coal Composite Pulp	2022005_C16 Wambo Potential Reject Composite Pulp	2022005_C17 Overburden_Austinvale Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
					EB2405781-008	EB2405781-009	EB2405781-010	EB2405781-011	EB2405781-012
					Result	Result	Result	Result	Result
EG005(ED093)S : Soluble Metals by ICPAES - Continued									
Boron	7440-42-8	1	mg/kg		**1**	**1**	<1	<1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**1090**	**2200**	**3550**	**6910**	**7020**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		**1990**	**1070**	**4500**	**11400**	**22000**
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		**0.01**	**0.08**	**0.01**	**0.16**	<0.01
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.01	mg/kg		**0.13**	**0.20**	**0.04**	**0.06**	**0.02**
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	**0.02**
Manganese	7439-96-5	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	**0.04**
Molybdenum	7439-98-7	0.01	mg/kg		**0.10**	**0.20**	**0.04**	**0.55**	**0.08**
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	**0.01**
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.01	mg/kg		<0.01	<0.01	<0.01	**0.02**	**0.01**
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		**0.3**	**0.4**	**1.0**	**0.4**	<0.1
Aluminium	7429-90-5	0.1	mg/kg		<0.1	<0.1	**0.2**	**0.2**	<0.1
EG020T: Total Metals by ICP-MS									

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C13 Macalister Lower Coal Composite Pulp	2022005_C14 ML Potential Reject Composite Pulp	2022005_C15 Wambo Coal Composite Pulp	2022005_C16 Wambo Potential Reject Composite Pulp	2022005_C17 Overburden_Austinval e Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
					EB2405781-008	EB2405781-009	EB2405781-010	EB2405781-011	EB2405781-012
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Arsenic	7440-38-2	0.1	mg/kg		**1.2**	**1.7**	**1.1**	**2.7**	**2.8**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		**136**	**116**	**126**	**130**	**25.5**
Beryllium	7440-41-7	0.1	mg/kg		**1.0**	**1.6**	**1.4**	**0.8**	**0.4**
Cadmium	7440-43-9	0.1	mg/kg		<0.1	**0.2**	<0.1	**0.1**	<0.1
Cobalt	7440-48-4	0.1	mg/kg		**2.6**	**4.3**	**3.1**	**11.3**	**7.7**
Chromium	7440-47-3	0.1	mg/kg		**6.2**	**3.4**	**6.4**	**5.4**	**6.7**
Copper	7440-50-8	0.1	mg/kg		**8.7**	**15.3**	**18.3**	**24.3**	**19.6**
Thorium	7440-29-1	0.1	mg/kg		**1.5**	**1.8**	**2.8**	**2.6**	**3.4**
Manganese	7439-96-5	0.1	mg/kg		**36.7**	**5.6**	**56.0**	**137**	**242**
Molybdenum	7439-98-7	0.1	mg/kg		**0.5**	**1.8**	**0.3**	**0.5**	**0.4**
Nickel	7440-02-0	0.1	mg/kg		**1.8**	**4.3**	**3.2**	**9.2**	**9.4**
Lead	7439-92-1	0.1	mg/kg		**10.4**	**11.2**	**12.3**	**11.6**	**10.1**
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		**0.4**	**0.4**	**0.7**	**0.4**	**0.4**
Zinc	7440-66-6	0.5	mg/kg		**46.7**	**34.1**	**20.8**	**63.0**	**59.7**
Vanadium	7440-62-2	1	mg/kg		**88**	**24**	**91**	**29**	**22**
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**2**	**3**	**3**	**4**	**2**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C18 Overburden Leichhardt Composite Pulp	2022005_C19 Overburden Wooleebee Composite Pulp	2022005_C20 Interburden_Leichhardt Composite Pulp	2022005_C21 Interburden_Wooleebee Composite Pulp	2022005_C22 Parting - MU Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
				EB2405781-013	EB2405781-014	EB2405781-015	EB2405781-016	EB2405781-017	
				Result	Result	Result	Result	Result	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**8.8**	**8.9**	**9.7**	**8.8**	**9.0**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	**576**	**926**	**936**	**419**	**478**	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	<1.0	**1.9**	**1.2**	<1.0	<1.0	
ED037: Alkalinity									
ø Total Alkalinity as CaCO3	----	5	mg/kg	**2720**	**34500**	**9260**	**3500**	**3270**	
ø Bicarbonate Alkalinity as CaCO3	71-52-3	5	mg/kg	**2650**	**34200**	**7080**	**3350**	**3110**	
ø Carbonate Alkalinity as CaCO3	3812-32-6	5	mg/kg	**78**	**234**	**2180**	**156**	**156**	
ED038A: Acidity									
Acidity	----	5	mg/kg	<5	<5	<5	<5	<5	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**50**	**100**	**60**	**50**	**90**	
Silica	7631-86-9	1	mg/kg	**62**	**73**	**78**	**30**	**54**	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	**560**	**790**	**140**	**390**	**360**	
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	**480**	**910**	**690**	**440**	**430**	
Potassium	7440-09-7	10	mg/kg	<10	**10**	**10**	**10**	**10**	
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg	**3790**	**20000**	**5440**	**1730**	**1570**	
Magnesium	7439-95-4	50	mg/kg	**2930**	**2190**	**3030**	**3360**	**1650**	
Sodium	7440-23-5	50	mg/kg	**3200**	**2870**	**4650**	**1500**	**2540**	
Potassium	7440-09-7	50	mg/kg	**480**	**720**	**880**	**880**	**940**	

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C18 Overburden Leichhardt Composite Pulp	2022005_C19 Overburden Wooleebee Composite Pulp	2022005_C20 Interburden_Leichhardt Composite Pulp	2022005_C21 Interburden_Wooleebee Composite Pulp	2022005_C22 Parting - MU Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
					EB2405781-013	EB2405781-014	EB2405781-015	EB2405781-016	EB2405781-017
					Result	Result	Result	Result	Result
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**5840**	**5450**	**7550**	**7260**	**4360**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		**7340**	**9230**	**16800**	**26100**	**4660**
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		**0.12**	**0.08**	**1.35**	**0.17**	**0.25**
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.01	mg/kg		<0.01	**0.02**	**0.02**	**0.01**	<0.01
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		**0.01**	**0.01**	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/kg		<0.01	**0.02**	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/kg		**0.06**	**0.06**	**0.27**	**0.34**	**0.18**
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	**0.01**	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	**0.02**	**0.01**	<0.01
Uranium	7440-61-1	0.01	mg/kg		<0.01	**0.02**	**0.02**	<0.01	<0.01
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		**0.3**	**1.2**	**0.7**	**0.2**	**0.8**
Aluminium	7429-90-5	0.1	mg/kg		**0.1**	<0.1	**0.3**	**0.3**	**0.3**

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C18 Overburden Leichhardt Composite Pulp	2022005_C19 Overburden Wooleebee Composite Pulp	2022005_C20 Interburden_Leichhardt Composite Pulp	2022005_C21 Interburden_Wooleebee Composite Pulp	2022005_C22 Parting - MU Composite Pulp
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
					EB2405781-013	EB2405781-014	EB2405781-015	EB2405781-016	EB2405781-017
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**1.6**	**4.6**	**4.1**	**2.2**	**1.8**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Barium	7440-39-3	0.1	mg/kg		**19.8**	**51.1**	**118**	**58.2**	**81.3**
Beryllium	7440-41-7	0.1	mg/kg		**0.5**	**0.7**	**0.5**	**0.5**	**0.3**
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	**0.1**	**0.2**	**0.2**
Cobalt	7440-48-4	0.1	mg/kg		**3.3**	**15.6**	**7.6**	**11.1**	**2.9**
Chromium	7440-47-3	0.1	mg/kg		**3.1**	**3.7**	**5.8**	**7.2**	**3.8**
Copper	7440-50-8	0.1	mg/kg		**8.3**	**18.2**	**20.4**	**25.4**	**27.2**
Thorium	7440-29-1	0.1	mg/kg		**2.1**	**3.1**	**2.9**	**3.7**	**3.9**
Manganese	7439-96-5	0.1	mg/kg		**78.0**	**784**	**344**	**400**	**49.0**
Molybdenum	7439-98-7	0.1	mg/kg		<0.1	**0.2**	**0.3**	**0.5**	**0.2**
Nickel	7440-02-0	0.1	mg/kg		**5.6**	**10.5**	**9.9**	**13.1**	**4.3**
Lead	7439-92-1	0.1	mg/kg		**9.2**	**12.8**	**10.9**	**12.8**	**14.4**
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		**0.3**	**0.4**	**0.4**	**0.4**	**0.5**
Zinc	7440-66-6	0.5	mg/kg		**49.2**	**45.0**	**81.3**	**80.2**	**37.4**
Vanadium	7440-62-2	1	mg/kg		**13**	**40**	**18**	**23**	**17**
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**4**	**8**	**4**	**6**	**5**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.1	<0.1	**0.6**	<0.1	**0.2**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C23 Parting - ML Composite Pulp	2022005_C24 Parting - Wambo Composite Pulp	2022005_C25 Basement Composite Pulp	----	----
			Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2405781-018	EB2405781-019	EB2405781-020	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.4**	**9.6**	**9.8**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**773**	**752**	**668**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	<1.0	<1.0	**----**	**----**
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	5	mg/kg	**10700**	**10500**	**4980**	**----**	**----**
ø Bicarbonate Alkalinity as CaCO3	71-52-3	5	mg/kg	**9810**	**9030**	**4200**	**----**	**----**
ø Carbonate Alkalinity as CaCO3	3812-32-6	5	mg/kg	**934**	**1480**	**778**	**----**	**----**
ED038A: Acidity								
Acidity	----	5	mg/kg	<5	<5	<5	**----**	**----**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**30**	**30**	**40**	**----**	**----**
Silica	7631-86-9	1	mg/kg	**60**	**66**	**66**	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**300**	**200**	**190**	**----**	**----**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	**----**	**----**
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	**----**	**----**
Sodium	7440-23-5	10	mg/kg	**790**	**710**	**550**	**----**	**----**
Potassium	7440-09-7	10	mg/kg	**20**	**10**	**10**	**----**	**----**
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	**1390**	**2480**	**2490**	**----**	**----**
Magnesium	7439-95-4	50	mg/kg	**990**	**2260**	**3430**	**----**	**----**
Sodium	7440-23-5	50	mg/kg	**2790**	**3390**	**3120**	**----**	**----**
Potassium	7440-09-7	50	mg/kg	**930**	**800**	**1110**	**----**	**----**
EG005(ED093)S : Soluble Metals by ICPAES								

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C23 Parting - ML Composite Pulp	2022005_C24 Parting - Wambo Composite Pulp	2022005_C25 Basement Composite Pulp	----	----
			Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2405781-018	EB2405781-019	EB2405781-020	--------	--------
				Result	Result	Result	----	----
EG005(ED093)S : Soluble Metals by ICPAES - Continued								
Boron	7440-42-8	1	mg/kg	<1	<1	<1	----	----
Iron	7439-89-6	1	mg/kg	<1	<1	<1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**3390**	**5860**	**9080**	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Iron	7439-89-6	50	mg/kg	**2190**	**8030**	**16600**	----	----
EG020S: Soluble Metals by ICPMS								
Arsenic	7440-38-2	0.01	mg/kg	**0.27**	**0.43**	**0.93**	----	----
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Barium	7440-39-3	0.01	mg/kg	**0.05**	**0.04**	**0.02**	----	----
Beryllium	7440-41-7	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Cadmium	7440-43-9	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Cobalt	7440-48-4	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Chromium	7440-47-3	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Copper	7440-50-8	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Manganese	7439-96-5	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Molybdenum	7439-98-7	0.01	mg/kg	**0.16**	**0.20**	**0.15**	----	----
Nickel	7440-02-0	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.01	mg/kg	<0.01	**0.01**	**0.02**	----	----
Uranium	7440-61-1	0.01	mg/kg	**0.02**	**0.02**	**0.01**	----	----
Zinc	7440-66-6	0.05	mg/kg	<0.05	<0.05	<0.05	----	----
Vanadium	7440-62-2	0.1	mg/kg	**1.3**	**1.2**	**0.8**	----	----
Aluminium	7429-90-5	0.1	mg/kg	**0.4**	**0.6**	**0.6**	----	----
EG020T: Total Metals by ICP-MS								

Analytical Results

Sub-Matrix: PULP
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C23 Parting - ML Composite Pulp	2022005_C24 Parting - Wambo Composite Pulp	2022005_C25 Basement Composite Pulp	----	----
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	----	----
					EB2405781-018	EB2405781-019	EB2405781-020	--------	--------
					Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS - Continued									
Arsenic	7440-38-2	0.1	mg/kg		**1.3**	**2.0**	**3.6**	**----**	**----**
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	**----**	**----**
Barium	7440-39-3	0.1	mg/kg		**116**	**116**	**120**	**----**	**----**
Beryllium	7440-41-7	0.1	mg/kg		**0.3**	**0.3**	**0.4**	**----**	**----**
Cadmium	7440-43-9	0.1	mg/kg		**0.2**	**0.2**	**0.1**	**----**	**----**
Cobalt	7440-48-4	0.1	mg/kg		**2.3**	**5.1**	**5.2**	**----**	**----**
Chromium	7440-47-3	0.1	mg/kg		**2.8**	**3.9**	**6.7**	**----**	**----**
Copper	7440-50-8	0.1	mg/kg		**28.9**	**28.5**	**26.0**	**----**	**----**
Thorium	7440-29-1	0.1	mg/kg		**3.9**	**3.4**	**3.2**	**----**	**----**
Manganese	7439-96-5	0.1	mg/kg		**15.0**	**71.4**	**162**	**----**	**----**
Molybdenum	7439-98-7	0.1	mg/kg		**0.2**	**0.2**	**0.2**	**----**	**----**
Nickel	7440-02-0	0.1	mg/kg		**2.9**	**5.4**	**6.0**	**----**	**----**
Lead	7439-92-1	0.1	mg/kg		**15.9**	**13.7**	**11.8**	**----**	**----**
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	**----**	**----**
Uranium	7440-61-1	0.1	mg/kg		**0.6**	**0.5**	**0.4**	**----**	**----**
Zinc	7440-66-6	0.5	mg/kg		**38.9**	**62.8**	**78.9**	**----**	**----**
Vanadium	7440-62-2	1	mg/kg		**28**	**14**	**20**	**----**	**----**
EG035S: Soluble Mercury by FIMS									
Mercury	7439-97-6	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	**----**	**----**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	**----**	**----**
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**7**	**7**	**4**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		**0.3**	**0.4**	**0.5**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0094 Coal - Macalister Upper C9610GP_GC_05 <20 mm	2022005_0110 Coal - Wambo C9610GP_GC_21 <20 mm	2022005_0111 Coal - Macalister Upper C9610GP_SP_01 <20 mm	2022005_0112 Coal - Macalister Upper C9610GP_SP_02 <20 mm	2022005_0113 Coal - Wambo C9610GP_SP_03 <20 mm
			Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	EB2405781-001	EB2405781-002	EB2405781-003	EB2405781-004	EB2405781-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.089**	**0.006**	**0.016**	**0.009**	<0.005

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2022005_0118 Floor - Wambo L9611_GC_05 <20 mm	2022005_0120 Roof - Macalister Upper L9612_GC_02 <20 mm	----	----	----
			Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2405781-006	EB2405781-007	--------	--------	--------
				Result	Result	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.006**	**0.053**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	Ph & EC of DI water in 1:5	----	----	----	----
				Sampling date / time	16-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2405781-021	--------	--------	--------	--------	
				Result	----	----	----	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	**5.6**	**----**	**----**	**----**	**----**	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**	

CERTIFICATE OF ANALYSIS

Work Order	: **EB2408546**	Page	: 1 of 6
Amendment	: **2**		
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 13-Mar-2024 17:03
Order number	: 2022005	Date Analysis Commenced	: 14-Mar-2024
C-O-C number	: ----	Issue Date	: 05-Apr-2024 18:11
Sampler	: TYLER CONTOR		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 4		
No. of samples analysed	: 4		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Acid Sulphate Soils, Stafford, QLD
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- EK040S (Fluoride - Soluble) - Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.
- Amendment (26/03/24): This report has been amended and re-released to allow the reporting of additional analytical data, specifically method EK040S, Soluble Fluoride.
- Amendment (05/04/2024): This report has been amended and re-released to allow the reporting of additional analytical data as listed in the COC, specifically method EK071G for sample IDs 2022005_C26, 2022005_C27, and 2022005_C28.
- ED040S (Soluble Major Anions by ICP-AES): EB2408536-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- ED093S (Soluble Major Cations by ICP): EB2408536-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C26	2022005_C27	2022005_C28	----	----
			Sampling date / time	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2408546-001	EB2408546-002	EB2408546-003	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.7**	**8.5**	**8.5**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**649**	**185**	**440**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	**5.2**	**5.9**	**----**	**----**
ED037: Alkalinity								
ø Hydroxide Alkalinity as CaCO3	DMO-210-001	5	mg/kg	<5	<5	<5	**----**	**----**
ø Carbonate Alkalinity as CaCO3	3812-32-6	5	mg/kg	**2530**	**78**	**168**	**----**	**----**
ø Bicarbonate Alkalinity as CaCO3	71-52-3	5	mg/kg	**37900**	**3270**	**49600**	**----**	**----**
ø Total Alkalinity as CaCO3	----	5	mg/kg	**40400**	**3350**	**49700**	**----**	**----**
ED038A: Acidity								
Acidity	----	5	mg/kg	<5	<5	<5	**----**	**----**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	<10	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**150**	**150**	**260**	**----**	**----**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	**10**	**----**	**----**
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	**----**	**----**
Sodium	7440-23-5	10	mg/kg	**520**	**170**	**510**	**----**	**----**
Potassium	7440-09-7	10	mg/kg	**20**	<10	<10	**----**	**----**
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	**53700**	**2340**	**28800**	**----**	**----**
Magnesium	7439-95-4	50	mg/kg	**5350**	**780**	**690**	**----**	**----**
Sodium	7440-23-5	50	mg/kg	**2160**	**2580**	**1840**	**----**	**----**
Potassium	7440-09-7	50	mg/kg	**800**	**180**	**120**	**----**	**----**
EG005(ED093)S : Soluble Metals by ICPAES								
Aluminium	7429-90-5	1	mg/kg	<1	<1	<1	**----**	**----**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Sample ID	2022005_C26	2022005_C27	2022005_C28	----	----
				Sampling date / time	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	----	----
Compound	CAS Number	LOR	Unit		EB2408546-001	EB2408546-002	EB2408546-003	--------	--------
					Result	Result	Result	----	----
EG005(ED093)S : Soluble Metals by ICPAES - Continued									
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Arsenic	7440-38-2	0.1	mg/kg		**0.2**	**0.2**	<0.1	----	----
Barium	7440-39-3	1	mg/kg		<1	<1	<1	----	----
Beryllium	7440-41-7	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Boron	7440-42-8	1	mg/kg		<1	**2**	**1**	----	----
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Chromium	7440-47-3	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Cobalt	7440-48-4	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Copper	7440-50-8	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Iron	7439-89-6	1	mg/kg		<1	<1	<1	----	----
Lead	7439-92-1	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Manganese	7439-96-5	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Molybdenum	7439-98-7	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Nickel	7440-02-0	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Vanadium	7440-62-2	0.1	mg/kg		**2.1**	**1.6**	**0.2**	----	----
Zinc	7440-66-6	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**6690**	**1510**	**830**	----	----
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	----	----
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	----	----
Barium	7440-39-3	10	mg/kg		**120**	**180**	**140**	----	----
Beryllium	7440-41-7	1	mg/kg		<1	**6**	**2**	----	----
Boron	7440-42-8	50	mg/kg		<50	<50	<50	----	----
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg		**7**	**12**	**2**	----	----
Cobalt	7440-48-4	2	mg/kg		**4**	**14**	**5**	----	----

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2022005_C26	2022005_C27	2022005_C28	----	----
			Sampling date / time	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2408546-001	EB2408546-002	EB2408546-003	--------	--------
				Result	Result	Result	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued								
Copper	7440-50-8	5	mg/kg	**31**	**23**	**10**	----	----
Iron	7439-89-6	50	mg/kg	**18600**	**1290**	**1850**	----	----
Lead	7439-92-1	5	mg/kg	**15**	**9**	**6**	----	----
Manganese	7439-96-5	5	mg/kg	**584**	**15**	**48**	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	----	----
Nickel	7440-02-0	2	mg/kg	**5**	**9**	**6**	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	----	----
Vanadium	7440-62-2	5	mg/kg	**39**	**198**	**48**	----	----
Zinc	7440-66-6	5	mg/kg	**37**	**116**	**13**	----	----
EG020S: Soluble Metals by ICPMS								
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
EG020T: Total Metals by ICP-MS								
Thorium	7440-29-1	0.1	mg/kg	**3.6**	**0.9**	**0.6**	----	----
Uranium	7440-61-1	0.1	mg/kg	**0.4**	**0.5**	**0.7**	----	----
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	**0.2**	<0.1	----	----
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	<5	<5	<2	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	**0.2**	<0.1	<0.1	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	pH and EC of DI Water	----	----	----	----
				Sampling date / time	13-Mar-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2408546-004	--------	--------	--------	--------
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**6.9**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2215658**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2022005 Wandoan	Date Samples Received	: 01-Jun-2022 16:40
Order number	: ----	Date Analysis Commenced	: 03-Jun-2022
C-O-C number	: ----	Issue Date	: 09-Jun-2022 15:50
Sampler	: LE XI NG		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- EK061G (TKN as N): Sample EB2215053_001 Shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.
- EK067G (Total Phosphorus): Sample EB2215579_013 Shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio results for some samples as required Exchangeable Potassium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): EB2215203-048 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_1 WANTP 0-0.6	2022005_2 WANTP 0-0.6	2022005_3 WANTP 0-0.6	2022005_4 WANTP 0-0.6	2022005_C03 WANTP 0-0.6
				Sampling date / time	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00
					EB2215658-001	EB2215658-002	EB2215658-003	EB2215658-004	EB2215658-005
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		8.2	8.1	8.4	8.3	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.4	9.3	9.4	9.5	9.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		296	207	658	602	571
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		9.5	10.0	9.6	10.0	----
ED006: Exchangeable Cations on Alkaline Soils									
ø Exchangeable Calcium	----	0.2	meq/100g		9.8	9.6	4.5	7.0	2.5
ø Exchangeable Magnesium	----	0.2	meq/100g		5.0	3.5	4.2	6.0	5.0
ø Exchangeable Potassium	----	0.2	meq/100g		<0.2	<0.2	<0.2	<0.2	<0.2
ø Exchangeable Sodium	----	0.2	meq/100g		3.2	1.9	3.1	4.7	3.8
ø Cation Exchange Capacity	----	0.2	meq/100g		18.0	14.9	11.8	17.7	11.2
ø Exchangeable Sodium Percent	----	0.2	%		17.7	12.7	26.1	26.6	33.8
ø Calcium/Magnesium Ratio	----	0.2	-		1.9	2.8	1.1	1.2	0.5
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	100	mg/kg		130	117	128	122	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		150	20	680	570	----
ED092: DTPA Extractable Metals									
ø Copper	7440-50-8	1.00	mg/kg		<1.00	<1.00	<1.00	<1.00	----
ø Iron	7439-89-6	1.00	mg/kg		9.10	8.37	6.70	6.48	----
ø Manganese	7439-96-5	1.00	mg/kg		3.24	3.70	4.06	4.46	----
ø Zinc	7440-66-6	1.00	mg/kg		<1.00	<1.00	<1.00	<1.00	----
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	<20	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	0.2	<0.1	<0.1	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		2.1	1.3	2.1	0.5	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		2.1	1.5	2.1	0.5	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022005_1 WANTP 0-0.6	2022005_2 WANTP 0-0.6	2022005_3 WANTP 0-0.6	2022005_4 WANTP 0-0.6	2022005_C03 WANTP 0-0.6
				Sampling date / time	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00	01-Jun-2022 00:00
Compound	CAS Number	LOR	Unit		EB2215658-001	EB2215658-002	EB2215658-003	EB2215658-004	EB2215658-005
					Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		730	800	530	570	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		730	800	530	570	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		161	135	145	127	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	<5	----
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.6	1.6	1.0	1.2	----
Total Organic Carbon	----	0.5	%		1.0	0.9	0.5	0.7	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2215727**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 02-Jun-2022 16:14
Order number	: ----	Date Analysis Commenced	: 03-Jun-2022
C-O-C number	: ----	Issue Date	: 13-Jun-2022 12:51
Sampler	: LE XI NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC1	2022005_C011 WKLC2	2022005_C012 WKLC3	2022005_C09 WKLC4	2022005_C10 WKLC5
				Sampling date / time	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00
					EB2215727-001	EB2215727-002	EB2215727-003	EB2215727-004	EB2215727-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**8.42**	**6.81**	**7.51**	**9.01**	**7.68**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**171**	**822**	**161**	**126**	**549**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	**9**	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**45**	**15**	**34**	**36**	**66**
Total Alkalinity as CaCO3	----	1	mg/L		**45**	**15**	**34**	**45**	**66**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	**5**	**3**	<1	**2**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**3**	**171**	**38**	**17**	**82**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**24**	**113**	**2**	**4**	**54**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**7**	**4**	<1	**3**
Magnesium	7439-95-4	1	mg/L		<1	**4**	<1	<1	**2**
Sodium	7440-23-5	1	mg/L		**35**	**158**	**28**	**25**	**115**
Potassium	7440-09-7	1	mg/L		<1	**2**	<1	<1	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.12**	**0.09**	**0.05**	**0.17**	**0.03**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.006**	<0.001	**0.018**	**0.004**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.003**	**0.035**	**0.078**	<0.001	**0.018**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.003**	**0.014**	**0.001**	**0.004**	**0.008**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.002**	**0.019**	**0.003**	<0.001	**0.005**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.016**	**0.008**	**0.035**	**0.060**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	**0.02**	<0.01	**0.01**	**0.04**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC1	2022005_C011 WKLC2	2022005_C012 WKLC3	2022005_C09 WKLC4	2022005_C10 WKLC5
				Sampling date / time	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00	02-Jun-2022 00:00
					EB2215727-001	EB2215727-002	EB2215727-003	EB2215727-004	EB2215727-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.01**	<0.01	**0.04**	**0.01**
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.007**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.19**	<0.05	<0.05	**0.05**
Iron	7439-89-6	0.05	mg/L		**0.06**	**0.06**	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**1.1**	**0.1**	**0.2**	**0.6**	**0.8**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**1.64**	**7.05**	**1.53**	**1.36**	**4.55**
ø Total Cations	----	0.01	meq/L		**1.52**	**7.60**	**1.42**	**1.09**	**5.37**
ø Ionic Balance	----	0.01	%		**----**	**3.79**	**----**	**----**	**8.25**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2218970**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 30-Jun-2022 15:05
Order number	: ----	Date Analysis Commenced	: 01-Jul-2022
C-O-C number	: ----	Issue Date	: 11-Jul-2022 17:47
Sampler	: LE XI NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- EG020F (Dissolved Metals by ICP-MS): Limit of reporting raised for WKLC2 (EB2218970-002) due to matrix interference.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC1	2022005_C011 WKLC2	2022005_C012 WKLC3	2022005_C09 WKLC4	2022005_C10 WKLC5
				Sampling date / time	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00
					EB2218970-001	EB2218970-002	EB2218970-003	EB2218970-004	EB2218970-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.97**	**5.68**	**7.11**	**8.10**	**7.23**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**184**	**1490**	**272**	**175**	**878**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**20**	**12**	**14**	**21**	**26**
Total Alkalinity as CaCO3	----	1	mg/L		**20**	**12**	**14**	**21**	**26**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**1**	**20**	**2**	<1	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**5**	**396**	**84**	**44**	**242**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**28**	**122**	**2**	**5**	**69**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**16**	**2**	<1	**5**
Magnesium	7439-95-4	1	mg/L		<1	**8**	<1	<1	**4**
Sodium	7440-23-5	1	mg/L		**27**	**239**	**42**	**26**	**135**
Potassium	7440-09-7	1	mg/L		<1	**3**	<1	<1	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.47**	**0.58**	**0.40**	**2.12**	**0.13**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.006**	**0.002**	**0.011**	**0.003**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.003**	**0.036**	**0.021**	**0.005**	**0.020**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.005	<0.001	**0.001**	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.032**	**0.001**	**0.002**	**0.028**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.005	<0.001	**0.001**	**0.001**
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.050**	**0.001**	<0.001	**0.005**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.005	**0.003**	**0.082**	**0.043**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.05	<0.01	**0.04**	**0.07**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC1	2022005_C011 WKLC2	2022005_C012 WKLC3	2022005_C09 WKLC4	2022005_C10 WKLC5
				Sampling date / time	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00	30-Jun-2022 00:00
					EB2218970-001	EB2218970-002	EB2218970-003	EB2218970-004	EB2218970-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.05	<0.01	**0.02**	**0.01**
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.025**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.35**	**0.07**	<0.05	**0.08**
Iron	7439-89-6	0.05	mg/L		**0.14**	**0.40**	**0.07**	**0.28**	**0.10**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.8**	<0.1	**0.3**	**0.4**	**0.5**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**1.29**	**11.9**	**2.08**	**1.48**	**7.50**
ø **Total Cations**	----	0.01	meq/L		**1.17**	**11.9**	**1.93**	**1.37**	**6.50**
ø **Ionic Balance**	----	0.01	%		**----**	**0.01**	**----**	**----**	**7.16**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2222089**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 28-Jul-2022 17:56
Order number	: ----	Date Analysis Commenced	: 30-Jul-2022
C-O-C number	: ----	Issue Date	: 05-Aug-2022 12:39
Sampler	: LE XI NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	202205_C03 WKLC 1 Overburden L2	202205_C011 WKLC 2 Low Grade Coal L2	202205_C012 WKLC 3 Coal L2	202205_C09 WKLC 4 Interburden L2	202205_C010 WKLC 5 Coal Reject L2
				Sampling date / time	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00
					EB2222089-001	EB2222089-002	EB2222089-003	EB2222089-004	EB2222089-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.45**	**5.19**	**6.81**	**7.24**	**7.11**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**139**	**1900**	**295**	**114**	**872**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**19**	**28**	**9**	**12**	**28**
Total Alkalinity as CaCO3	----	1	mg/L		**19**	**28**	**9**	**12**	**28**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**2**	**46**	**3**	**1**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**3**	**509**	**105**	**35**	**274**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**26**	**174**	**1**	**3**	**70**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**28**	**4**	<1	**8**
Magnesium	7439-95-4	1	mg/L		<1	**16**	**2**	<1	**5**
Sodium	7440-23-5	1	mg/L		**27**	**373**	**53**	**23**	**167**
Potassium	7440-09-7	1	mg/L		<1	**4**	**1**	<1	**3**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.41**	**0.93**	**0.24**	**0.41**	**0.08**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.006**	<0.001	**0.006**	**0.002**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.002**	**0.054**	**0.019**	**0.002**	**0.023**
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0002**	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.005**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.053**	**0.001**	**0.002**	**0.041**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.004**	<0.001	<0.001	**0.002**
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.109**	**0.001**	<0.001	**0.005**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.003**	**0.003**	**0.065**	**0.044**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.004**	<0.001	<0.001	**0.001**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	202205_C03 WKLC 1 Overburden L2	202205_C011 WKLC 2 Low Grade Coal L2	202205_C012 WKLC 3 Coal L2	202205_C09 WKLC 4 Interburden L2	202205_C010 WKLC 5 Coal Reject L2
				Sampling date / time	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00	28-Jul-2022 00:00
					EB2222089-001	EB2222089-002	EB2222089-003	EB2222089-004	EB2222089-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	**0.04**	<0.01	**0.03**	**0.07**
Thorium	7440-29-1	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**0.001**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.03**	<0.01	**0.01**	**0.01**
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.005**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.48**	**0.06**	<0.05	**0.08**
Iron	7439-89-6	0.05	mg/L		**0.14**	**0.58**	<0.05	**0.06**	**0.10**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.7**	<0.1	**0.2**	**0.2**	**0.4**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**1.18**	**16.1**	**2.39**	**1.05**	**8.24**
ø Total Cations	----	0.01	meq/L		**1.17**	**19.0**	**2.70**	**1.00**	**8.15**
ø Ionic Balance	----	0.01	%		**----**	**8.48**	**----**	**----**	**0.53**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2225164**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 26-Aug-2022 16:20
Order number	: ----	Date Analysis Commenced	: 27-Aug-2022
C-O-C number	: ----	Issue Date	: 02-Sep-2022 11:31
Sampler	: Le Xi K ng		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- EG035F-LL (Low-Level Dissolved Mercury by FIMS): Limit of reporting raised for some samples due to matrix interference.
- EG020-F (Dissolved Metals by ICP-MS): Limit of reporting raised due to matrix interference.
- EG035F (Dissolved Mercury): Limit of reporting raised for sample 2022005_C011(EB2225164-002) due to matrix interference.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC 1 Overburden L4	2022005_C011 WKLC 2 Low Grade Coal L4	2022005_C012 WKLC 3 Coal L4	2022005_C09 WKLC 4 Interburden L4	2022005_C10 WKLC 5 Coal Reject L4
				Sampling date / time	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00
					EB2225164-001	EB2225164-002	EB2225164-003	EB2225164-004	EB2225164-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.27**	**5.44**	**7.05**	**6.98**	**7.20**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**87**	**1290**	**343**	**123**	**556**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**28**	**40**	**10**	**11**	**30**
Total Alkalinity as CaCO3	----	1	mg/L		**28**	**40**	**10**	**11**	**30**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**2**	**40**	**2**	**2**	**2**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	**388**	**123**	**27**	**152**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**13**	**99**	<1	**3**	**31**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**1**	**16**	**4**	<1	**4**
Magnesium	7439-95-4	1	mg/L		**1**	**10**	**2**	<1	**3**
Sodium	7440-23-5	1	mg/L		**18**	**280**	**63**	**24**	**107**
Potassium	7440-09-7	1	mg/L		<1	**4**	**2**	**1**	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.07**	**2.58**	**0.06**	**0.08**	**0.05**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.005	<0.001	**0.001**	**0.001**
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.005	<0.001	**0.005**	**0.001**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.002**	**0.044**	**0.019**	<0.001	**0.014**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.005**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.063**	**0.002**	**0.002**	**0.034**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	**0.002**
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.069**	**0.002**	**0.001**	**0.004**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.005	<0.001	**0.070**	**0.028**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	**0.001**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	2022005_C03 WKLC 1 Overburden L4	2022005_C011 WKLC 2 Low Grade Coal L4	2022005_C012 WKLC 3 Coal L4	2022005_C09 WKLC 4 Interburden L4	2022005_C10 WKLC 5 Coal Reject L4
				Sampling date / time	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00	26-Aug-2022 00:00
					EB2225164-001	EB2225164-002	EB2225164-003	EB2225164-004	EB2225164-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.05	<0.01	**0.04**	**0.04**
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	**0.001**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.005	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.05	<0.01	<0.01	**0.01**
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.025	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.53**	**0.09**	<0.05	**0.06**
Iron	7439-89-6	0.05	mg/L		<0.05	**1.47**	<0.05	<0.05	**0.06**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	<0.1	**0.2**	**0.1**	**0.4**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.97**	**11.7**	**2.76**	**0.87**	**4.64**
ø Total Cations	----	0.01	meq/L		**0.92**	**13.9**	**3.16**	**1.07**	**5.15**
ø Ionic Balance	----	0.01	%		**----**	**8.73**	**----**	**----**	**5.24**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	2022005_020 WKLC 6 L1	----	----	----	----
			Sampling date / time	26-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2225164-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.42**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**532**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**47**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**47**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**3**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**148**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**20**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**62**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**12**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**31**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**6**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.002**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.120**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.018**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.171**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.008**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	2022005_020 WKLC 6 L1	----	----	----	----
				Sampling date / time	26-Aug-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2225164-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.027**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.15**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**4.58**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**5.58**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**9.82**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2227924**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 21-Sep-2022 16:15
Order number	: ----	Date Analysis Commenced	: 24-Sep-2022
C-O-C number	: ----	Issue Date	: 29-Sep-2022 19:36
Sampler	: LE XI K NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- ED037-P (Alkalinity): It is recognised that duplicate for sample EB2227822-001 has failed. However insufficient sample volume remains for re-extraction and re-analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	2022005_C03	2022005_C011	2022005_C012	2022005_C09	2022005_C10
			Sampling date / time	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00
Compound	CAS Number	LOR	Unit	EB2227924-001	EB2227924-002	EB2227924-003	EB2227924-004	EB2227924-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.48	5.71	7.13	7.17	7.77
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	80	772	337	117	554
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	23	28	11	8	67
Total Alkalinity as CaCO3	----	1	mg/L	23	28	11	8	67
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	26	4	2	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	233	132	37	162
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	12	55	<1	3	29
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	8	2	<1	4
Magnesium	7439-95-4	1	mg/L	<1	3	2	<1	4
Sodium	7440-23-5	1	mg/L	17	164	68	22	123
Potassium	7440-09-7	1	mg/L	<1	2	2	1	3
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.69	0.08	0.04	0.34
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.004	<0.001	0.003	0.002
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.002	0.035	0.017	0.001	0.015
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.002	0.003	0.002	0.002	0.002
Cobalt	7440-48-4	0.001	mg/L	<0.001	0.003	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.002	0.031	0.002	0.003	0.048
Lead	7439-92-1	0.001	mg/L	<0.001	0.002	<0.001	<0.001	0.001
Manganese	7439-96-5	0.001	mg/L	<0.001	0.028	<0.001	<0.001	0.002
Molybdenum	7439-98-7	0.001	mg/L	0.001	0.003	0.005	0.079	0.053
Nickel	7440-02-0	0.001	mg/L	<0.001	0.003	<0.001	<0.001	0.002
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	0.04	0.02

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	2022005_C03	2022005_C011	2022005_C012	2022005_C09	2022005_C10
			Sampling date / time	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00	21-Sep-2022 00:00
Compound	CAS Number	LOR	Unit	EB2227924-001	EB2227924-002	EB2227924-003	EB2227924-004	EB2227924-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.02**	<0.01	<0.01	**0.01**
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.005**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	**0.27**	**0.07**	<0.05	**0.09**
Iron	7439-89-6	0.05	mg/L	<0.05	**1.06**	<0.05	**0.08**	**0.12**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.5**	<0.1	**0.2**	**0.1**	**0.5**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.84**	**6.96**	**2.97**	**1.01**	**5.53**
ø Total Cations	----	0.01	meq/L	**0.74**	**7.83**	**3.27**	**0.98**	**5.96**
ø Ionic Balance	----	0.01	%	**----**	**5.87**	**----**	**----**	**3.71**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	2022005_020	----	----	----	----
			Sampling date / time	21-Sep-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2227924-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.81**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**128**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**5**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**5**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**3**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**45**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**11**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**2**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**8**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**2**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.038**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.002**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.006**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.054**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.003**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	2022005_020	----	----	----	----
				Sampling date / time	21-Sep-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2227924-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.010**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**1.06**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**1.11**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2231031**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 20-Oct-2022 15:41
Order number	: ----	Date Analysis Commenced	: 21-Oct-2022
C-O-C number	: ----	Issue Date	: 28-Oct-2022 12:50
Sampler	: Le Xi K ng		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	WKLC 1 2022005_C03 Overburden	WKLC 2 2022005_C011 Low Grade Coal	WKLC 3 2022005_C012 Coal	WKLC 4 2022005_C09 Interburden	WKLC 5 2022005_C10 Coal Reject
				Sampling date / time	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00
					EB2231031-001	EB2231031-002	EB2231031-003	EB2231031-004	EB2231031-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.48**	**5.80**	**7.13**	**7.24**	**7.17**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**99**	**550**	**334**	**104**	**382**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**18**	**25**	**12**	**10**	**29**
Total Alkalinity as CaCO3	----	1	mg/L		**18**	**25**	**12**	**10**	**29**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**5**	**15**	**4**	**2**	**11**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**3**	**158**	**120**	**33**	**101**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**18**	**38**	<1	**2**	**23**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**8**	**4**	<1	**5**
Magnesium	7439-95-4	1	mg/L		<1	**3**	**2**	<1	**3**
Sodium	7440-23-5	1	mg/L		**19**	**113**	**60**	**21**	**69**
Potassium	7440-09-7	1	mg/L		<1	**2**	**2**	<1	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.45**	**1.20**	**0.12**	**0.36**	**0.06**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.003**	<0.001	**0.004**	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.002**	**0.038**	**0.019**	**0.002**	**0.013**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.003**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.021**	**0.002**	**0.002**	**0.028**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.028**	**0.001**	<0.001	**0.004**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.001**	**0.001**	**0.051**	**0.026**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	WKLC 1 2022005_C03 Overburden	WKLC 2 2022005_C011 Low Grade Coal	WKLC 3 2022005_C012 Coal	WKLC 4 2022005_C09 Interburden	WKLC 5 2022005_C10 Coal Reject
				Sampling date / time	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00	20-Oct-2022 00:00
					EB2231031-001	EB2231031-002	EB2231031-003	EB2231031-004	EB2231031-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.04**	**0.02**
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.24**	**0.11**	<0.05	**0.07**
Iron	7439-89-6	0.05	mg/L		**0.14**	**0.59**	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	<0.1	**0.2**	**0.1**	**0.2**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.93**	**4.86**	**2.74**	**0.94**	**3.33**
ø Total Cations	----	0.01	meq/L		**0.83**	**5.61**	**3.02**	**0.91**	**3.55**
ø Ionic Balance	----	0.01	%		**----**	**7.17**	**4.98**	**----**	**3.16**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 6 2022005_020 Tailings	----	----	----	----
			Sampling date / time	20-Oct-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2231031-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.80**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**322**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**10**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**10**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**4**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**134**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**45**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**7**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**13**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**4**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.089**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.009**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.185**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.005**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 6 2022005_020 Tailings	----	----	----	----
				Sampling date / time	20-Oct-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2231031-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.018**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.16**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**3.07**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**3.49**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**6.32**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2234415**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 17-Nov-2022 16:33
Order number	: ----	Date Analysis Commenced	: 18-Nov-2022
C-O-C number	: ----	Issue Date	: 25-Nov-2022 12:36
Sampler	: ----		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	WKLC 1 2022005_C03	WKLC 2 2022005_C011	WKLC 3 2022005_C012	WKLC 4 2022005_C09	WKLC 5 2022005_C10
				Sampling date / time	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00
					EB2234415-001	EB2234415-002	EB2234415-003	EB2234415-004	EB2234415-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.33**	**5.81**	**6.93**	**6.89**	**7.20**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**104**	**538**	**309**	**67**	**328**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**17**	**30**	**12**	**8**	**32**
Total Alkalinity as CaCO3	----	1	mg/L		**17**	**30**	**12**	**8**	**32**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**3**	**28**	**4**	**3**	**6**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**1**	**147**	**112**	**20**	**98**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**21**	**36**	<1	**2**	**18**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**8**	**4**	<1	**4**
Magnesium	7439-95-4	1	mg/L		<1	**3**	**2**	<1	**2**
Sodium	7440-23-5	1	mg/L		**22**	**117**	**59**	**22**	**63**
Potassium	7440-09-7	1	mg/L		<1	**3**	**2**	<1	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.24**	**0.80**	**0.05**	**0.07**	**0.06**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.003**	<0.001	**0.003**	**0.002**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.002**	**0.033**	**0.020**	<0.001	**0.009**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.003**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.020**	**0.002**	**0.002**	**0.033**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.029**	**0.002**	<0.001	**0.003**
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	**0.002**	**0.002**	**0.026**	**0.027**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.02**	**0.01**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 1 2022005_C03	WKLC 2 2022005_C011	WKLC 3 2022005_C012	WKLC 4 2022005_C09	WKLC 5 2022005_C10
				Sampling date / time	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00	17-Nov-2022 00:00
Compound	CAS Number	LOR	Unit		EB2234415-001	EB2234415-002	EB2234415-003	EB2234415-004	EB2234415-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.006**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.23**	**0.13**	<0.05	**0.08**
Iron	7439-89-6	0.05	mg/L		**0.09**	**0.49**	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.7**	<0.1	**0.2**	**0.1**	**0.3**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.95**	**4.68**	**2.57**	**0.63**	**3.19**
ø Total Cations	----	0.01	meq/L		**0.96**	**5.81**	**2.98**	**0.96**	**3.16**
ø Ionic Balance	----	0.01	%		**----**	**10.8**	**----**	**----**	**0.50**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 6 2022005_020	----	----	----	----
			Sampling date / time	17-Nov-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2234415-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.68**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**529**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**16**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**16**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**8**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**220**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**6**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**66**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**12**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**20**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**5**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.098**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.001**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.010**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.350**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.007**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 6 2022005_020	----	----	----	----
				Sampling date / time	17-Nov-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2234415-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.028**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.25**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**5.07**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**5.28**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**2.02**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2237794**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 15-Dec-2022 15:35
Order number	: ----	Date Analysis Commenced	: 16-Dec-2022
C-O-C number	: ----	Issue Date	: 29-Dec-2022 16:27
Sampler	: LE XI K NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	W KLC 1 2022005_C03 Overburden	W KLC 2 2022005_C011 Low Grade Coal	W KLC 3 2022005_C012 Coal	W KLC 4 2022005_C09 Interburden	W KLC 5 2022005_C10 Coal Reject
				Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00
					EB2237794-001	EB2237794-002	EB2237794-003	EB2237794-004	EB2237794-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.72**	**5.81**	**7.26**	**7.11**	**7.31**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**90**	**428**	**337**	**81**	**154**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**21**	**22**	**14**	**8**	**13**
Total Alkalinity as CaCO3	----	1	mg/L		**21**	**22**	**14**	**8**	**13**
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	**20**	**4**	**1**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	**125**	**142**	**26**	**47**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**14**	**24**	<1	**1**	**6**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**7**	**4**	<1	**2**
Magnesium	7439-95-4	1	mg/L		<1	**2**	**2**	<1	**1**
Sodium	7440-23-5	1	mg/L		**19**	**92**	**65**	**16**	**29**
Potassium	7440-09-7	1	mg/L		<1	**2**	**2**	**1**	**2**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.08**	**0.65**	**0.11**	**0.19**	**0.24**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.002**	<0.001	**0.003**	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.001**	**0.026**	**0.018**	**0.001**	**0.004**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.003**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.017**	**0.002**	**0.002**	**0.014**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.002**	**0.023**	**0.002**	<0.001	**0.001**
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	**0.002**	**0.002**	**0.026**	**0.009**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.003**	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	W KLC 1 2022005_C03 Overburden	W KLC 2 2022005_C011 Low Grade Coal	W KLC 3 2022005_C012 Coal	W KLC 4 2022005_C09 Interburden	W KLC 5 2022005_C10 Coal Reject
				Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00
					EB2237794-001	EB2237794-002	EB2237794-003	EB2237794-004	EB2237794-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.02**	<0.01
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.006**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.20**	**0.14**	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	**0.43**	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	<0.1	**0.2**	**0.1**	**0.1**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.86**	**3.72**	**3.24**	**0.73**	**1.41**
ø Total Cations	----	0.01	meq/L		**0.83**	**4.57**	**3.24**	**0.72**	**1.49**
ø Ionic Balance	----	0.01	%		**----**	**10.2**	**0.10**	**----**	**----**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

				Sample ID	W KLC 6 2022005_C20 Coal Reject	----	----	----	----
				Sampling date / time	15-Dec-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2237794-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.59**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**448**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**13**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**13**	----	----	----	----
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**9**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**174**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**4**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**57**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**11**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**20**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**4**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.04**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.083**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.001**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.011**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.358**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.008**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	W KLC 6 2022005_C20 Coal Reject	----	----	----	----
				Sampling date / time	15-Dec-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2237794-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.031**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.24**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	----	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**4.00**	----	----	----	----
ø Total Cations	----	0.01	meq/L		**4.72**	----	----	----	----
ø Ionic Balance	----	0.01	%		**8.34**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2300796**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 12-Jan-2023 15:57
Order number	: ----	Date Analysis Commenced	: 17-Jan-2023
C-O-C number	: ----	Issue Date	: 18-Jan-2023 10:50
Sampler	: LE XI K NG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 1		
No. of samples analysed	: 1		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- ED045G (Chloride): Sample EB2300796_001 (WKLC 6) was diluted due to matrix interference. LOR adjusted accordingly.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

				Sample ID	WKLC 6 2022005_020 Tailings L6	----	----	----	----
				Sampling date / time	12-Jan-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2300796-001	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.54**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**338**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**9**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**9**	----	----	----	----
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**7**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**137**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<5	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**42**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**9**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**14**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.03**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.072**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.001**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.008**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.277**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.006**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 6 2022005_020 Tailings L6	----	----	----	----
				Sampling date / time	12-Jan-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2300796-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.030**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.19**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**3.03**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**3.52**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**7.48**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2303737**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 09-Feb-2023 15:27
Order number	: ----	Date Analysis Commenced	: 11-Feb-2023
C-O-C number	: ----	Issue Date	: 17-Feb-2023 15:05
Sampler	: PRIYA RAJENDRAN		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 1		
No. of samples analysed	: 1		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 6 2022005_020	----	----	----	----
			Sampling date / time	09-Feb-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2303737-001	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.20**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**271**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**12**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**12**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**4**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**94**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**35**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**7**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**12**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.068**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.009**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.209**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.006**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 6 2022005_020	----	----	----	----
				Sampling date / time	09-Feb-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2303737-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.020**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.21**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**2.28**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**2.92**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2307278**	Page	: 1 of 4
Amendment	: **1**		
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 10-Mar-2023 16:00
Order number	: ----	Date Analysis Commenced	: 14-Mar-2023
C-O-C number	: ----	Issue Date	: 03-Apr-2023 16:27
Sampler	: PRIYA RAJENDRAN		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 1		
No. of samples analysed	: 1		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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 Contract for details.

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Amendment (03/04/2023): This report has been amended following a change to the EA005-P (pH), EA010-P (Conductivity), ED037-P (Alkalinity), EK040P (Flouride) and EN055 (Ionic Balance) results reported for sample WKLC 6 (EB2307278-001) due to a sequence error. All details are recorded in client query 23BNCC144 and a full investigation will be detailed in corrective action request 23BNC045.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: TAILINGS AND REJECTS (Matrix: WATER)			Sample ID	WKLC 6 2022005_020	----	----	----	----
			Sampling date / time	10-Mar-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2307278-001	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.65**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**234**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**6**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**6**	----	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**3**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**91**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**25**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**6**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**10**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**2**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.053**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.006**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.167**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	----	----	----	----

Analytical Results

Sub-Matrix: TAILINGS AND REJECTS (Matrix: WATER)				Sample ID	WKLC 6 2022005_020	----	----	----	----
				Sampling date / time	10-Mar-2023 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2307278-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.018**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.15**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**2.04**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**2.23**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2405382**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 16-Feb-2024 16:13
Order number	: ----	Date Analysis Commenced	: 17-Feb-2024
C-O-C number	: ----	Issue Date	: 23-Feb-2024 21:10
Sampler	: ASITHA JAYASINGHE, LAURA LONG		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 7 Coal L1	WKLC 8 Possible Rejects L1	WKLC 9 Coal L1	WKLC 10 Possible Rejects L1	WKLC 11 Overburden L1
			Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	EB2405382-001	EB2405382-002	EB2405382-003	EB2405382-004	EB2405382-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.13	9.26	7.82	8.14	7.90
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	57	187	84	291	185
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	17	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	16	37	28	46	32
Total Alkalinity as CaCO3	----	1	mg/L	16	54	28	46	32
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	2	<1	2	2	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1	2	2	5	6
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	7	22	10	57	30
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	10	41	18	62	38
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.12	1.73	0.26	1.65	1.21
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.010	0.001	0.010	0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.409	0.079	0.194	0.071	0.068
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 7 Coal L1	WKLC 8 Possible Rejects L1	WKLC 9 Coal L1	WKLC 10 Possible Rejects L1	WKLC 11 Overburden L1
				Sampling date / time	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00	16-Feb-2024 00:00
Compound	CAS Number	LOR	Unit		EB2405382-001	EB2405382-002	EB2405382-003	EB2405382-004	EB2405382-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	**0.002**	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.002**	<0.001	**0.002**	**0.003**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	**0.002**	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.003**	**0.001**	**0.001**	**0.004**	**0.004**
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	**0.004**	**0.001**	**0.017**	**0.001**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.05**	**0.08**	**0.03**	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.008**	<0.005	<0.005	**0.008**	**0.008**
Boron	7440-42-8	0.05	mg/L		<0.05	**0.08**	**0.08**	**0.12**	**0.11**
Iron	7439-89-6	0.05	mg/L		<0.05	**0.31**	<0.05	**0.43**	**0.49**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	**0.4**	**0.2**	**0.2**	**0.2**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.54**	**1.74**	**0.88**	**2.63**	**1.61**
ø Total Cations	----	0.01	meq/L		**0.53**	**1.78**	**0.78**	**2.70**	**1.65**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden L1	----	----	----	----
				Sampling date / time	16-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2405382-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**9.68**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**112**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		**24**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**24**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**48**	----	----	----	----
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**7**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		**26**	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.94**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.008**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.063**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden L1	----	----	----	----
				Sampling date / time	16-Feb-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2405382-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.003**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.02**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.11**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.24**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**1.20**	----	----	----	----
ø Total Cations	----	0.01	meq/L		**1.13**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2408509**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 13-Mar-2024 17:03
Order number	: ----	Date Analysis Commenced	: 14-Mar-2024
C-O-C number	: ----	Issue Date	: 20-Mar-2024 11:26
Sampler	: ----		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 7 Coal	WKLC 8 Possible Rejects	WKLC 9 Coal	WKLC 10 Possible Rejects	WKLC 11 Overburden
			Sampling date / time	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00
Compound	CAS Number	LOR	Unit	EB2408509-001	EB2408509-002	EB2408509-003	EB2408509-004	EB2408509-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.66**	**8.71**	**7.46**	**7.39**	**7.22**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**190**	**122**	**101**	**67**	**241**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	**11**	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**40**	**23**	**29**	**16**	**18**
Total Alkalinity as CaCO3	----	1	mg/L	**40**	**34**	**29**	**16**	**18**
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**2**	<1	**2**	**2**	**2**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	**2**	**2**	**2**	**17**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**34**	**19**	**15**	**11**	**54**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	**40**	**28**	**22**	**18**	**46**
Potassium	7440-09-7	1	mg/L	**1**	<1	<1	<1	**1**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.12**	**0.09**	**0.09**	**0.12**	**0.11**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	**0.003**	**0.006**	**0.001**	**0.002**	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.156**	**0.130**	**0.082**	**0.055**	**0.135**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 7 Coal	WKLC 8 Possible Rejects	WKLC 9 Coal	WKLC 10 Possible Rejects	WKLC 11 Overburden
				Sampling date / time	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00	13-Mar-2024 00:00
Compound	CAS Number	LOR	Unit		EB2408509-001	EB2408509-002	EB2408509-003	EB2408509-004	EB2408509-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.002**	**0.002**	**0.001**	**0.002**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Molybdenum	7439-98-7	0.001	mg/L		**0.007**	**0.006**	**0.004**	**0.004**	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		**0.02**	**0.03**	**0.12**	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.014**	**0.010**	**0.006**	**0.007**	**0.008**
Boron	7440-42-8	0.05	mg/L		**0.23**	**0.18**	**0.18**	**0.22**	**0.16**
Iron	7439-89-6	0.05	mg/L		**0.05**	<0.05	<0.05	**0.05**	**0.06**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.2**	**0.2**	<0.1	**0.1**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**1.80**	**1.26**	**1.04**	**0.67**	**2.24**
ø Total Cations	----	0.01	meq/L		**1.76**	**1.22**	**0.96**	**0.78**	**2.03**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden	----	----	----	----
				Sampling date / time	13-Mar-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2408509-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.60**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**60**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**21**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**21**	----	----	----	----
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**1**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**7**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		**16**	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.10**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.132**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden	----	----	----	----
				Sampling date / time	13-Mar-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2408509-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.001**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.18**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.62**	----	----	----	----
ø Total Cations	----	0.01	meq/L		**0.70**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB2412068**	Page	: 1 of 6
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2022005 Wandoan	Date Samples Received	: 11-Apr-2024 15:36
Order number	: ----	Date Analysis Commenced	: 11-Apr-2024
C-O-C number	: ----	Issue Date	: 17-Apr-2024 16:02
Sampler	: TYLER CONTOR		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC 7 Coal L3	WKLC 8 Possible Rejects L3	WKLC 9 Coal L3	WKLC 10 Possible Rejects L3	WKLC 11 Overburden L3
			Sampling date / time	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00
Compound	CAS Number	LOR	Unit	EB2412068-001	EB2412068-002	EB2412068-003	EB2412068-004	EB2412068-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.75**	**7.91**	**7.77**	**6.89**	**7.14**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**284**	**86**	**126**	**44**	**214**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**56**	**21**	**37**	**10**	**18**
Total Alkalinity as CaCO3	----	1	mg/L	**56**	**21**	**37**	**10**	**18**
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**3**	**1**	**2**	**2**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**4**	**2**	**4**	**1**	**17**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**46**	**13**	**14**	**8**	**38**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	**64**	**17**	**28**	**10**	**38**
Potassium	7440-09-7	1	mg/L	**1**	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.29**	**0.15**	**0.26**	**0.17**	**0.20**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	**0.003**	**0.003**	**0.002**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.012**	**0.007**	**0.018**	**0.009**	**0.002**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 7 Coal L3	WKLC 8 Possible Rejects L3	WKLC 9 Coal L3	WKLC 10 Possible Rejects L3	WKLC 11 Overburden L3
				Sampling date / time	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00	11-Apr-2024 00:00
Compound	CAS Number	LOR	Unit		EB2412068-001	EB2412068-002	EB2412068-003	EB2412068-004	EB2412068-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.002**	**0.004**	<0.001	**0.001**
Lead	7439-92-1	0.001	mg/L		**0.001**	<0.001	**0.001**	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.001**	<0.001	**0.004**	**0.001**	**0.004**
Molybdenum	7439-98-7	0.001	mg/L		**0.005**	**0.004**	**0.005**	**0.001**	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		**0.02**	**0.02**	**0.22**	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.21**	**0.05**	**0.10**	<0.05	**0.05**
Iron	7439-89-6	0.05	mg/L		**0.21**	<0.05	**0.24**	**0.08**	**0.10**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	**0.2**	<0.1	<0.1
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**2.50**	**0.83**	**1.22**	**0.45**	**1.78**
ø Total Cations	----	0.01	meq/L		**2.81**	**0.74**	**1.22**	**0.43**	**1.65**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden L3	----	----	----	----
				Sampling date / time	11-Apr-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2412068-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.24**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**56**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**17**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**17**	----	----	----	----
ED038: Acidity									
Acidity as CaCO3	----	1	mg/L		**2**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**8**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		**10**	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.13**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.005**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC 12 Interburden L3	----	----	----	----
				Sampling date / time	11-Apr-2024 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2412068-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.002**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.09**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.56**	----	----	----	----
ø Total Cations	----	0.01	meq/L		**0.43**	----	----	----	----

Attachment H: Trilab laboratory certificates of analysis

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

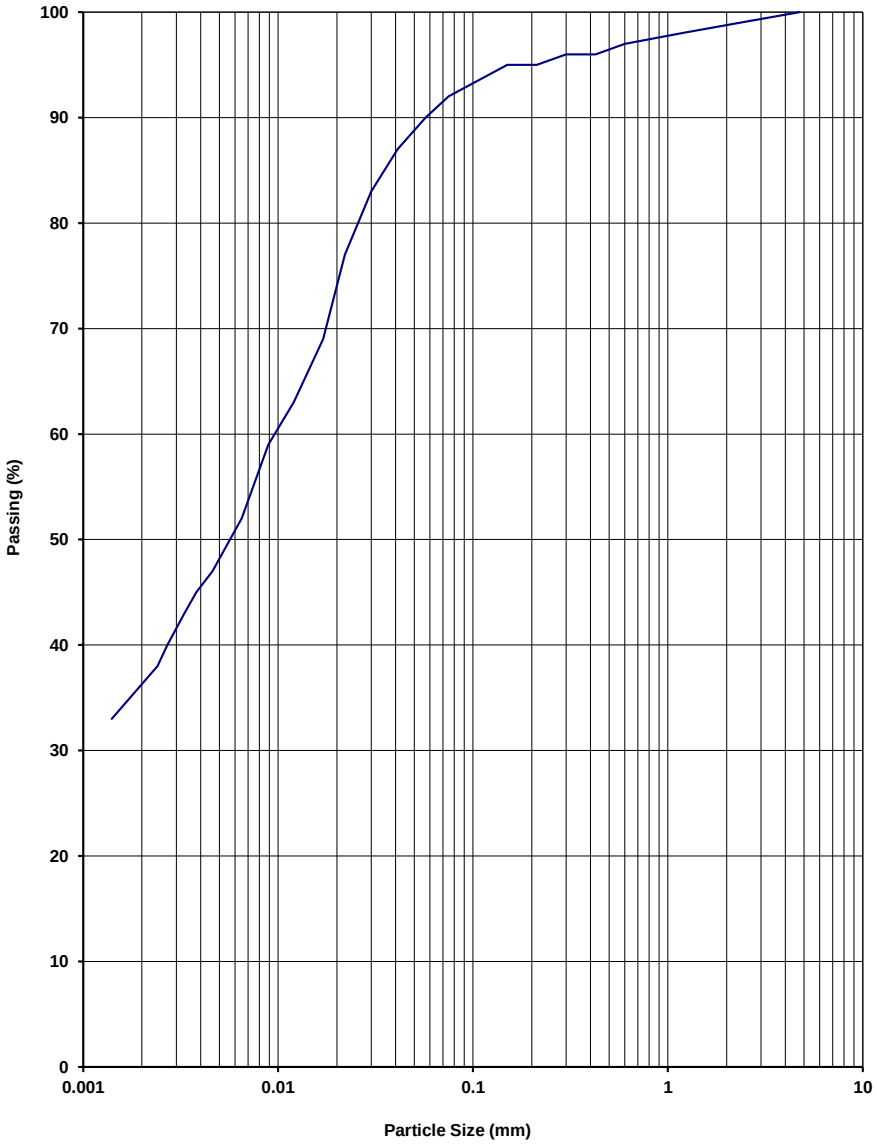
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060467-G
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/6/2022
		Report Date	29/6/2022
Project	2022005 - Glencore Wandoan		
Client ID	4 - 2022005_004	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	98
0.600	97
0.425	96
0.300	96
0.212	95
0.150	95
0.075	92
0.057	90
0.041	87
0.03	83
0.022	77
0.017	69
0.012	63
0.0089	59
0.0065	52
0.0046	47
0.0038	45
0.0033	43
0.0027	40
0.0024	38
0.0014	33



NOTES/REMARKS: -

Moisture Content 10.7% -2.36mm Soil Particle Density(t/m^3) 2.54

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

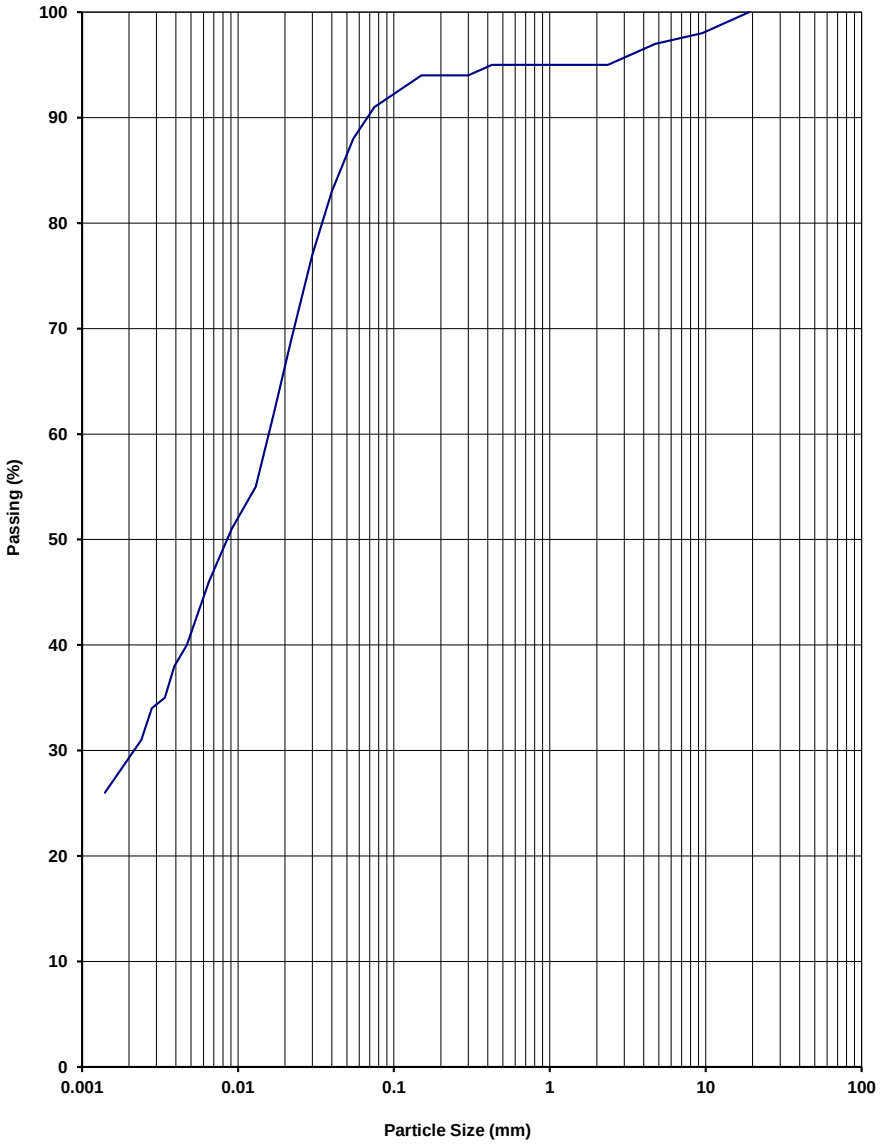
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060468-G
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/6/2022
		Report Date	29/6/2022
Project	2022005 - Glencore Wandoan		
Client ID	5 - 2022005_005	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	100
13.2	99
9.5	98
6.7	97
4.75	97
2.36	95
1.18	95
0.600	95
0.425	95
0.300	94
0.212	94
0.150	94
0.075	91
0.055	88
0.04	83
0.03	77
0.022	69
0.017	62
0.013	55
0.0091	51
0.0065	46
0.0047	40
0.0039	38
0.0034	35
0.0028	34
0.0024	31
0.0014	26



NOTES/REMARKS: -

Moisture Content 8.2% -2.36mm Soil Particle Density(t/m^3) 2.52

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

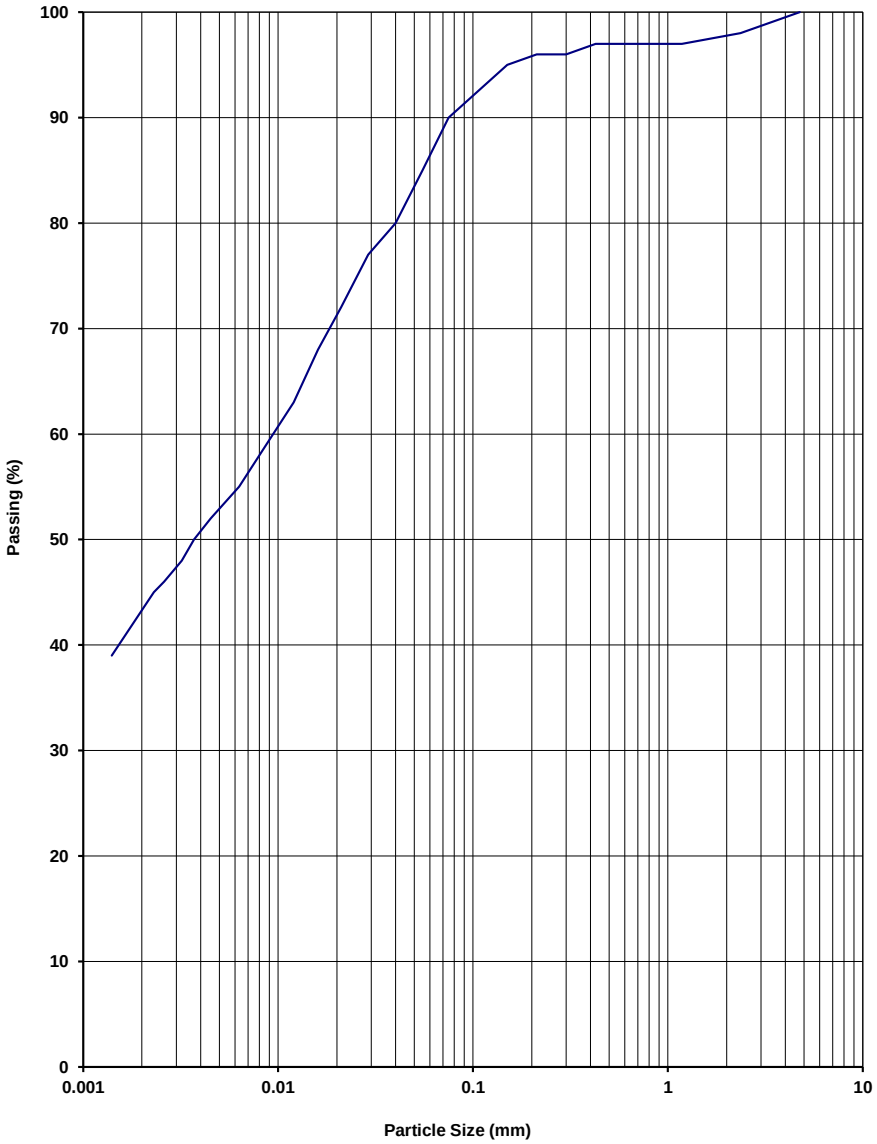
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060464-G
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/6/2022
		Report Date	29/6/2022
Project	2022005 - Glencore Wandoan		
Client ID	1 - 2022005_001	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	98
1.18	97
0.600	97
0.425	97
0.300	96
0.212	96
0.150	95
0.075	90
0.055	85
0.04	80
0.029	77
0.021	72
0.016	68
0.012	63
0.0087	59
0.0063	55
0.0045	52
0.0037	50
0.0032	48
0.0026	46
0.0023	45
0.0014	39



NOTES/REMARKS: -

Moisture Content 10.6% -2.36mm Soil Particle Density(t/m^3) 2.49

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

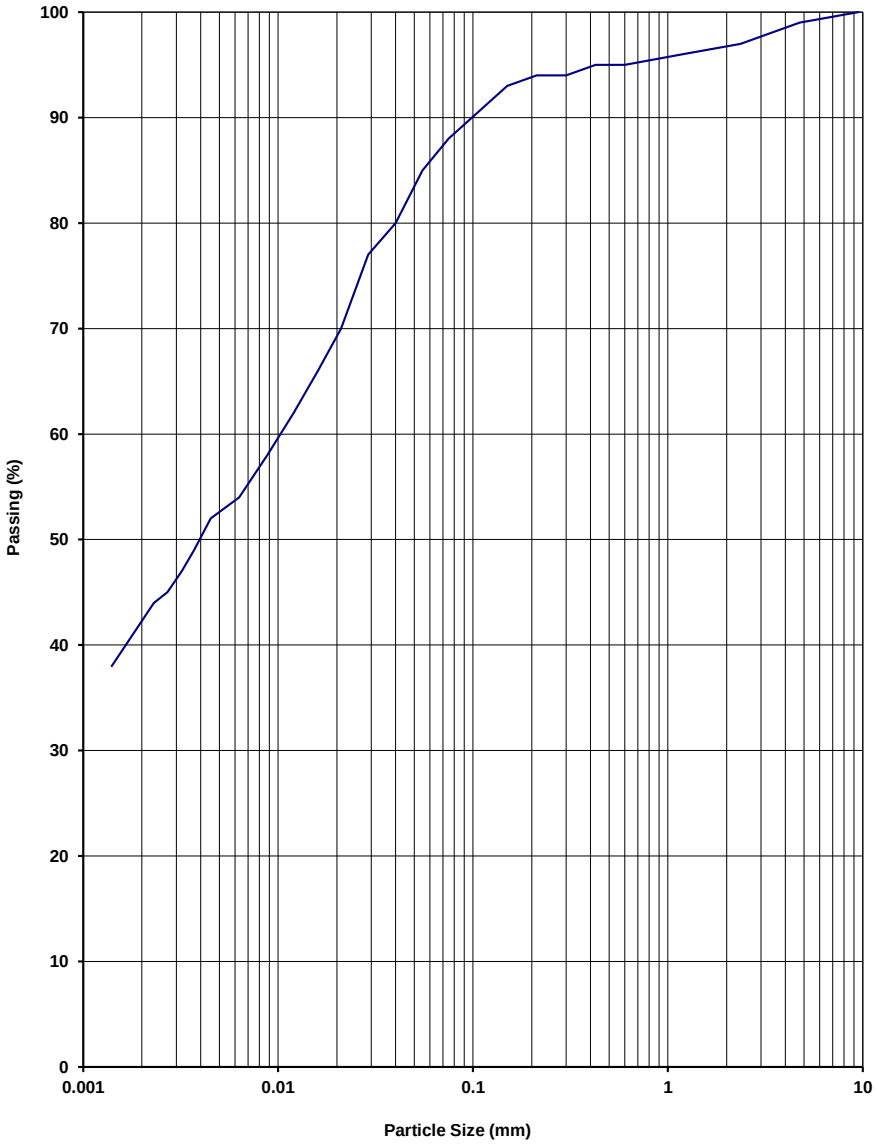
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060465-G
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/6/2022
		Report Date	29/6/2022
Project	2022005 - Glencore Wandoan		
Client ID	2 - 2022005_002	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	100
4.75	99
2.36	97
1.18	96
0.600	95
0.425	95
0.300	94
0.212	94
0.150	93
0.075	88
0.055	85
0.04	80
0.029	77
0.021	70
0.016	66
0.012	62
0.0088	58
0.0063	54
0.0045	52
0.0037	49
0.0032	47
0.0027	45
0.0023	44
0.0014	38



NOTES/REMARKS: -

Moisture Content 9.6% -2.36mm Soil Particle Density(t/m^3) 2.48

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

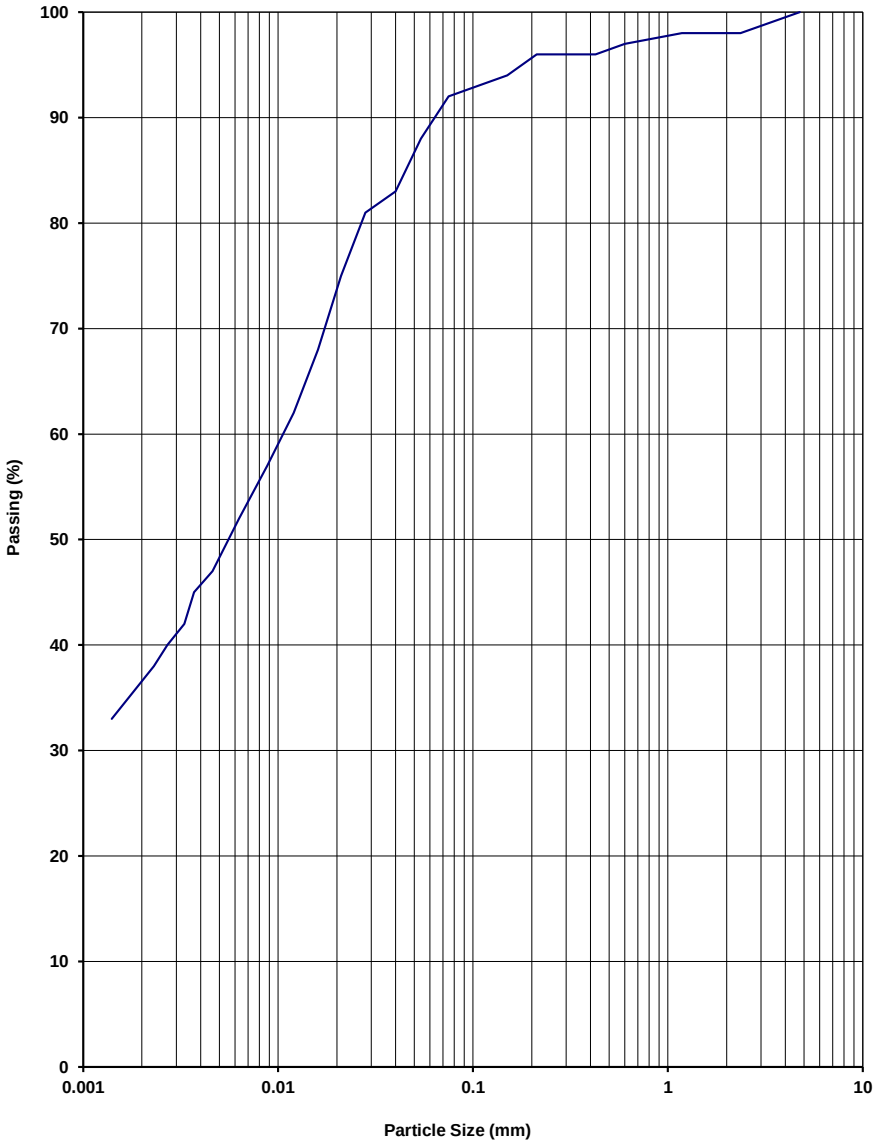
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060466-G
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/6/2022
		Report Date	29/6/2022
Project	2022005 - Glencore Wandoan		
Client ID	3 - 2022005_003	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	98
1.18	98
0.600	97
0.425	96
0.300	96
0.212	96
0.150	94
0.075	92
0.054	88
0.04	83
0.028	81
0.021	75
0.016	68
0.012	62
0.0088	57
0.0063	52
0.0046	47
0.0037	45
0.0033	42
0.0027	40
0.0023	38
0.0014	33



NOTES/REMARKS: -

Moisture Content 10.6% -2.36mm Soil Particle Density(t/m^3) 2.53

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

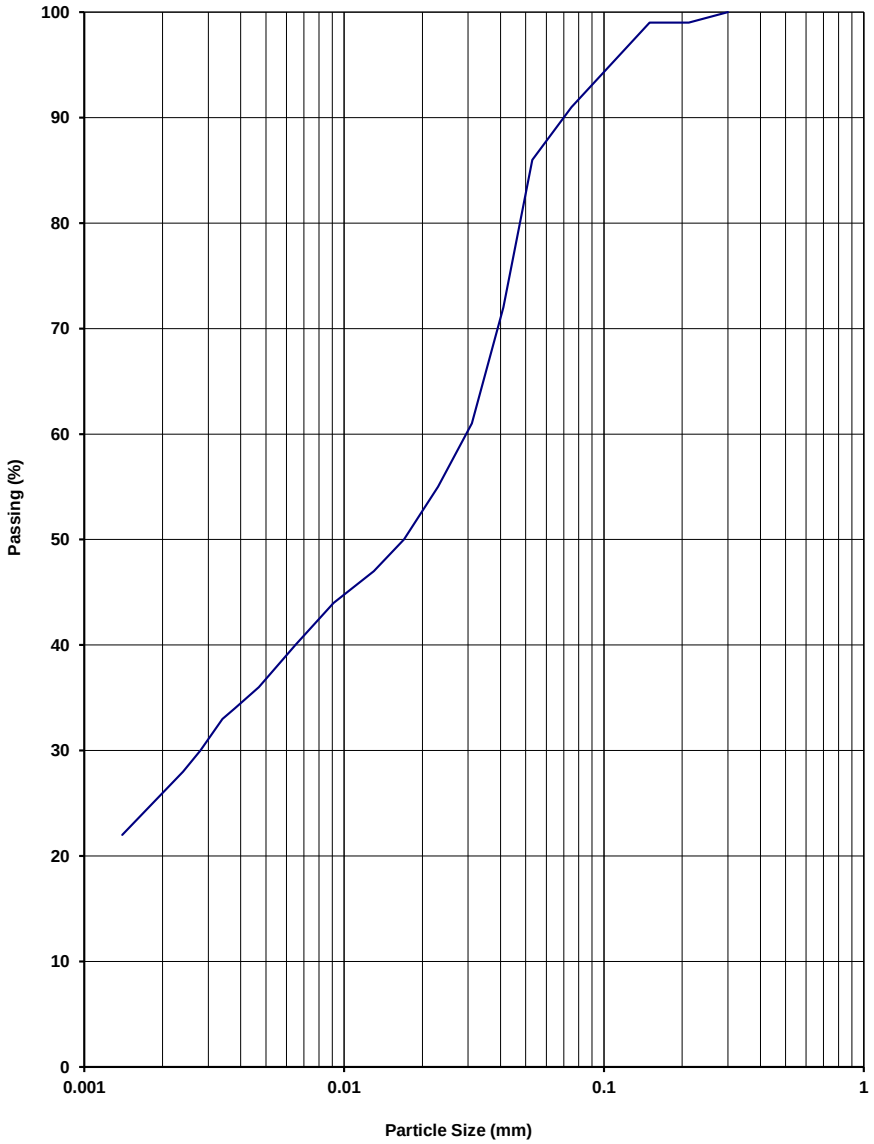
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22081493-G
		Workorder No.	0010201
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	17/9/2022
		Report Date	27/9/2022
Project	2022005 - Glencore Wandoan		
Client ID	2022005_017	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	100
0.212	99
0.150	99
0.075	91
0.053	86
0.041	72
0.031	61
0.023	55
0.017	50
0.013	47
0.0091	44
0.0065	40
0.0047	36
0.0038	34
0.0034	33
0.0028	30
0.0024	28
0.0014	22



NOTES/REMARKS: -

Moisture Content 38.9% -2.36mm Soil Particle Density(t/m^3) 2.55

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

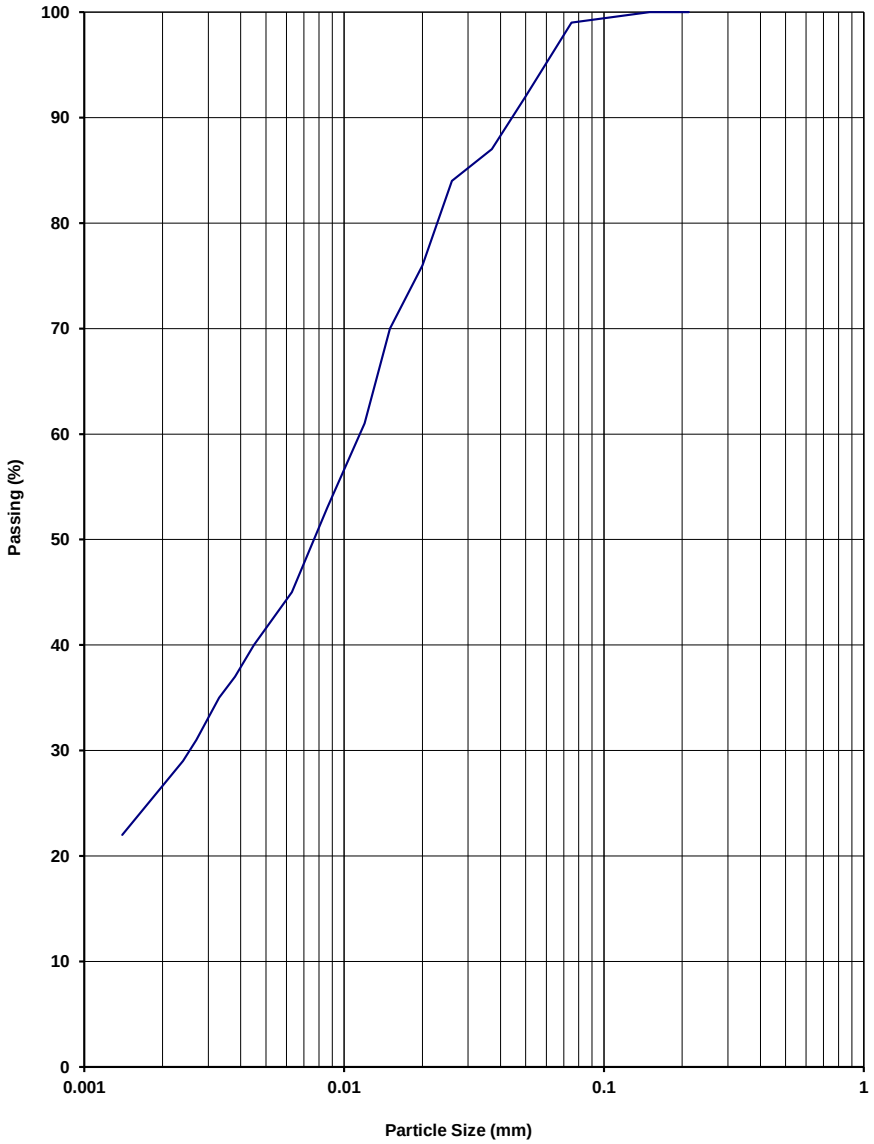
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22081494-G
		Workorder No.	0010201
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	17/9/2022
		Report Date	27/9/2022
Project	2022005 - Glencore Wandoan		
Client ID	2022005_018	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.212	
0.150	100
0.075	99
0.05	92
0.037	87
0.026	84
0.02	76
0.015	70
0.012	61
0.0086	53
0.0063	45
0.0045	40
0.0038	37
0.0033	35
0.0027	31
0.0024	29
0.0014	22



NOTES/REMARKS: -

Moisture Content 43.6% -2.36mm Soil Particle Density(t/m^3) 2.59

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

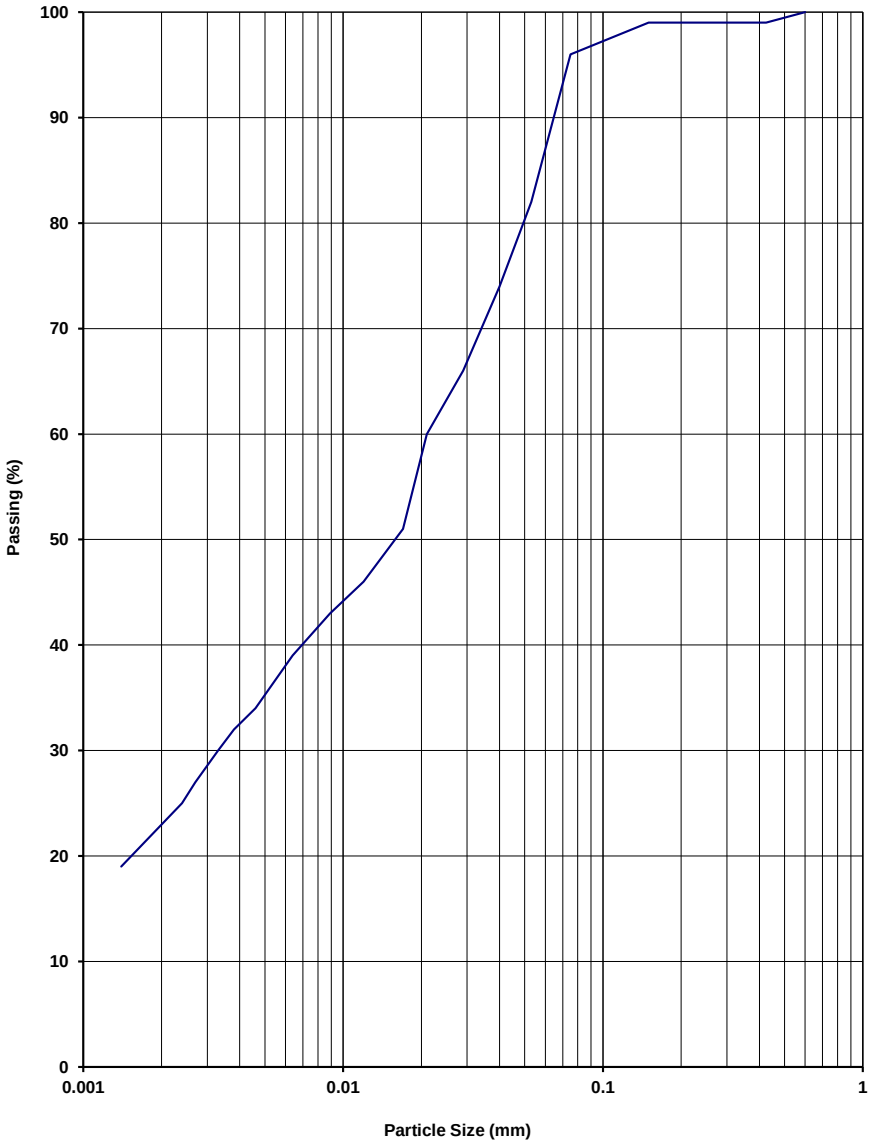
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22081492-G
		Workorder No.	0010201
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	17/9/2022
		Report Date	27/9/2022
Project	2022005 - Glencore Wandoan		
Client ID	2022005_006	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	100
0.425	99
0.300	99
0.212	99
0.150	99
0.075	96
0.053	82
0.04	74
0.029	66
0.021	60
0.017	51
0.012	46
0.0089	43
0.0064	39
0.0046	34
0.0038	32
0.0033	30
0.0027	27
0.0024	25
0.0014	19



NOTES/REMARKS: -

Moisture Content 43.9% -2.36mm Soil Particle Density(t/m^3) 2.61

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI).References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060464-EM
		Workorder No.	9900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/06/2022
		Report Date	29/06/2022
Project	2022005 - Glencore Wandoan		

Sample No.	22060464	22060465	22060466	22060467	22060468	22060469	-
Client ID	1 - 2022005_001	2 - 2022005_002	3 - 2022005_003	4 - 2022005_004	5 - 2022005_005	6 - 2022005_006	-
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	-
Description	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY - brown	Silty CLAY trace gravel - brown	Silty CLAY trace gravel - brown	-
Emerson Class Number	**2**	**2**	**2**	**2**	**1**	**2**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

NOTES/REMARKS:

Sample/s supplied by the client

Tested with Distilled water at 21.7°C

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

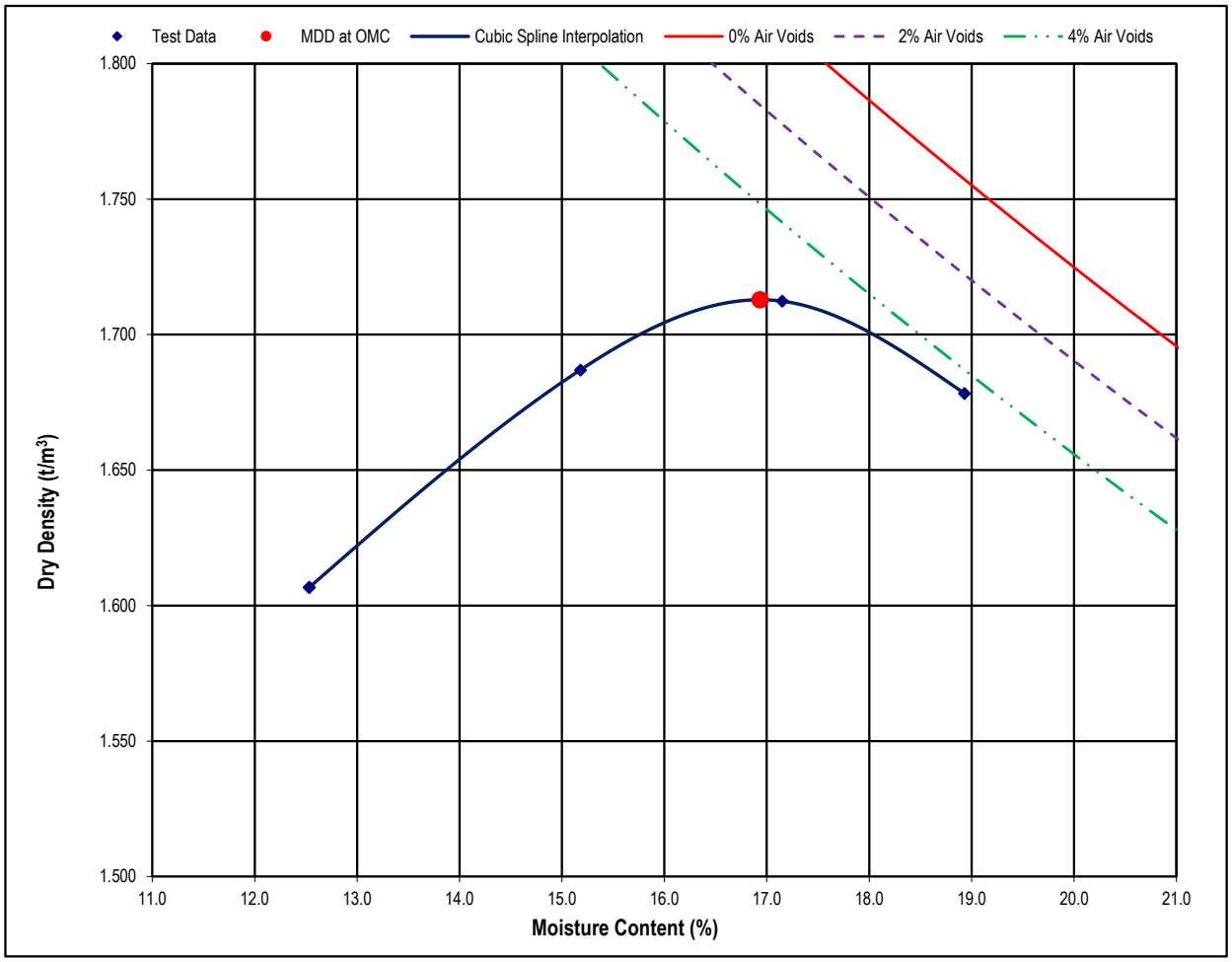
Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060483-MDD
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/06/2022
		Report Date	22/06/2022
Project	2022005 - Glencore Wandoan		
Client ID	21 - 2022005_C02	**Depth (m)**	Not Supplied
Description	Silty CLAY - brown		



Maximum Dry Density (t/m³)	1.71	**Optimum Moisture Content (%)**	16.9
Moisture Content (%)	10.9	**Percentage of Oversize/Sieve Size (mm)**	0 / 19

NOTES/REMARKS:

Sample/s supplied by the client

% Voids based on assumed SG of 2.63

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

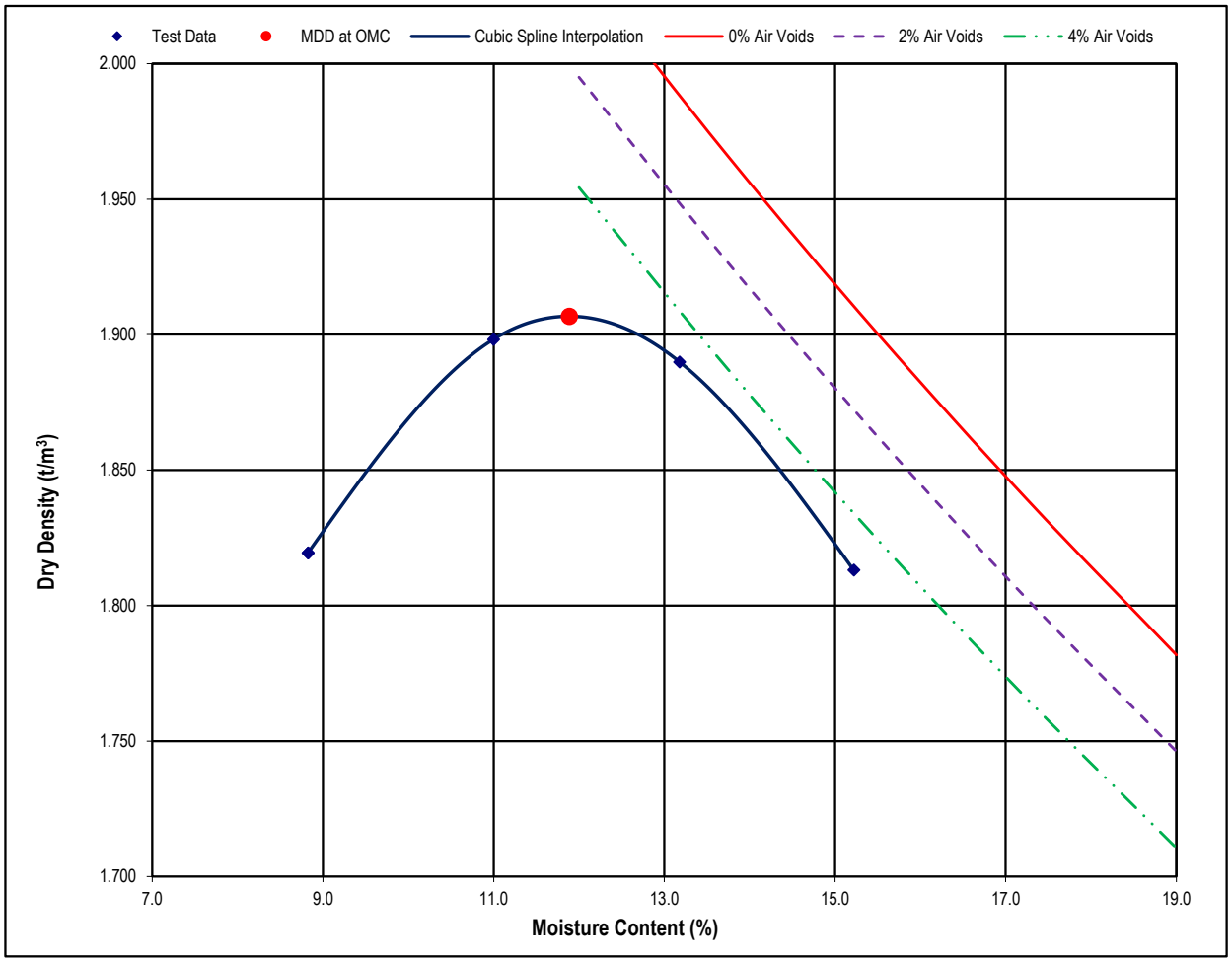
Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060484-MDD
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/06/2022
		Report Date	22/06/2022
Project	2022005 - Glencore Wandoan		
Client ID	22 - 2022005_C03	**Depth (m)**	Not Supplied
Description	Silty CLAY trace gravel - brown		



Maximum Dry Density (t/m³)	1.91	**Optimum Moisture Content (%)**	11.9
Moisture Content (%)	5.8	**Percentage of Oversize/Sieve Size (mm)**	0 / 19

NOTES/REMARKS:

Sample/s supplied by the client

% Voids based on assumed SG of 2.69

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

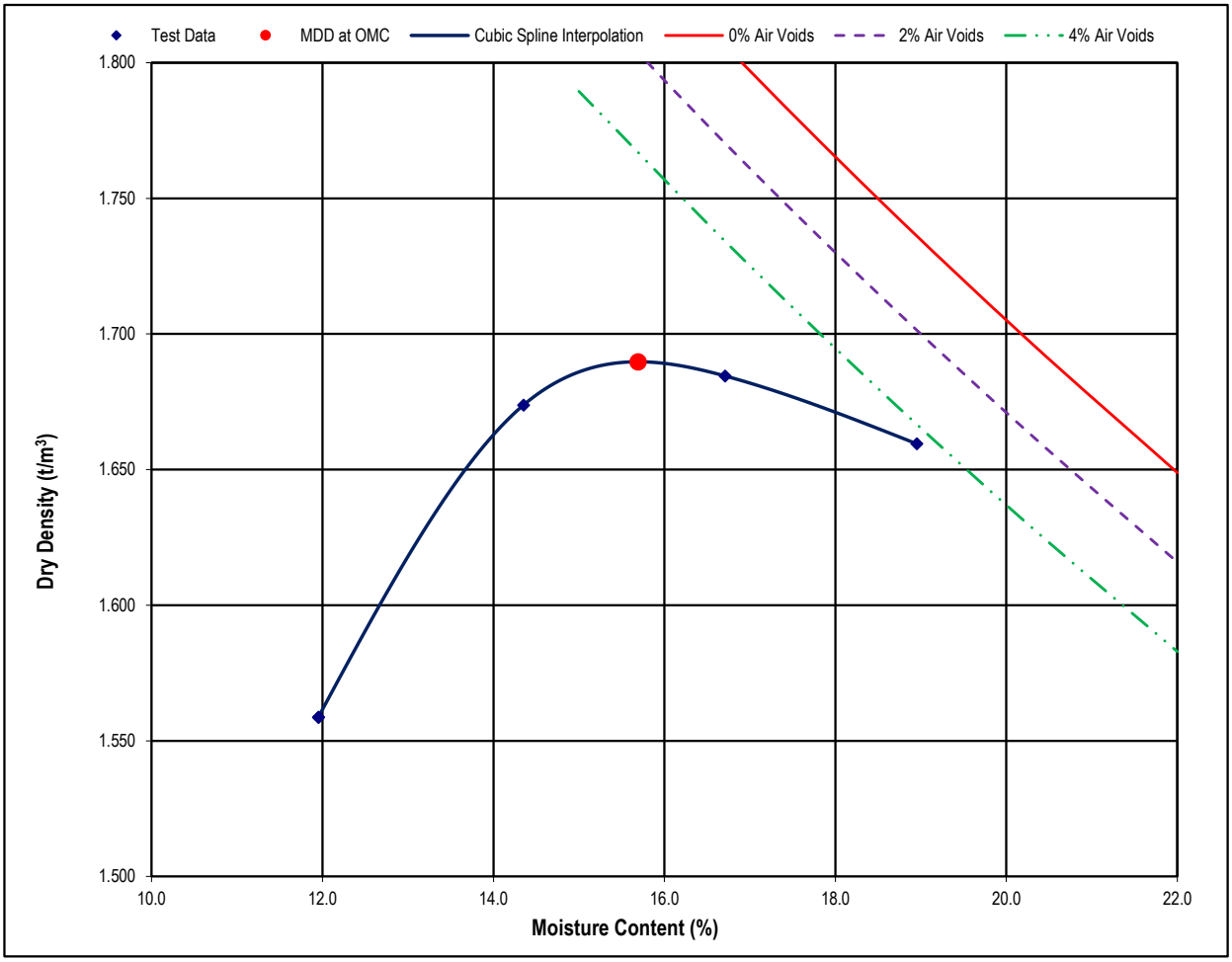
Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060482-MDD
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	21/06/2022
		Report Date	22/06/2022
Project	2022005 - Glencore Wandoan		
Client ID	20 - 2022005_C01	**Depth (m)**	Not Supplied
Description	Silty CLAY- brown		



Maximum Dry Density (t/m³)	1.69	**Optimum Moisture Content (%)**	15.7
Moisture Content (%)	10.4	**Percentage of Oversize/Sieve Size (mm)**	0 / 19

NOTES/REMARKS:

Sample/s supplied by the client

% Voids based on assumed SG of 2.59

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY FALLING HEAD TEST REPORT

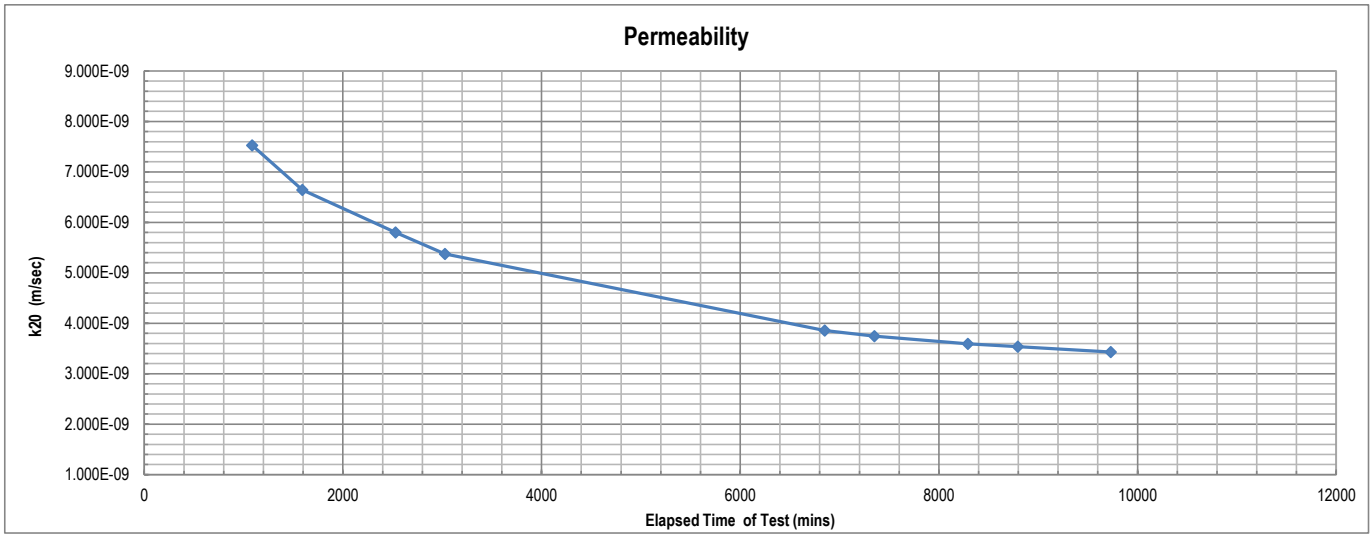
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060482-FHPT
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	29/06/2022
		Report Date	11/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	20 - 2022005_C01	**Depth (m)**	Not Supplied
Description	CLAY-brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.69**	Hydraulic Gradient	**9.4**
Optimum Moisture Content (%)	**15.7**	Surcharge (kPa)	**2.8**
Placement Moisture Content (%)	**16.3**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**103.5**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.76**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**89.5**	Sample Height and Diameter (mm)	**116.65 / 101.45 mm**

PERMEABILITY $k_{(20)} =$ **3.4×10^{-09} (m/sec)**



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI). References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY FALLING HEAD TEST REPORT

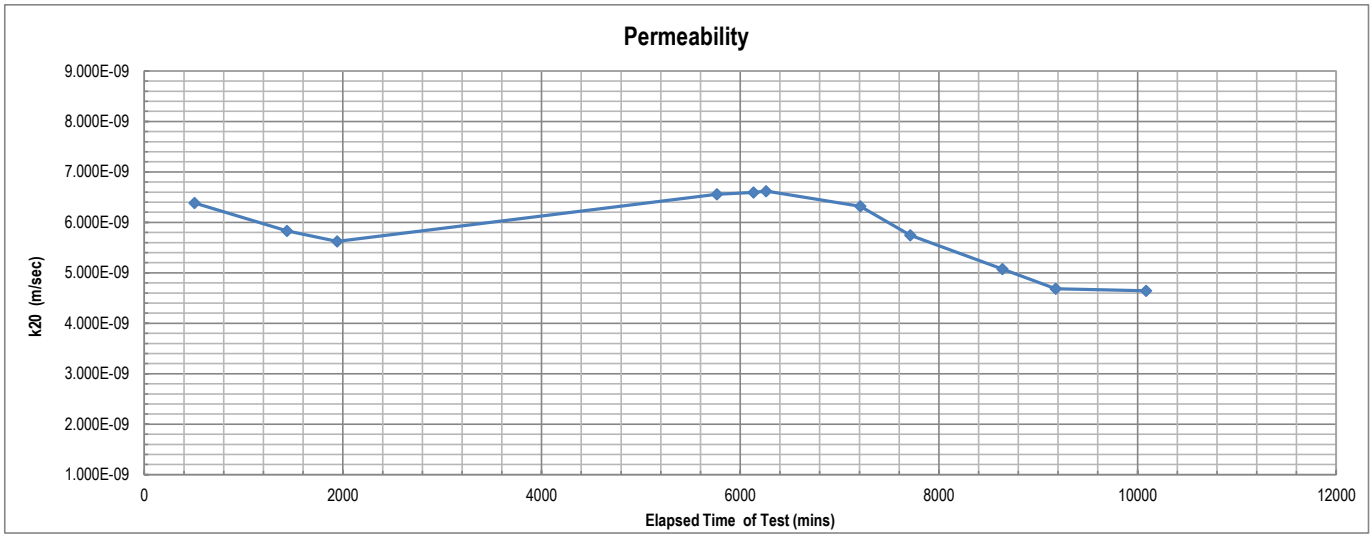
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060483-FHPT
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	30/06/2022
		Report Date	11/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	21 - 2022005_C02	**Depth (m)**	Not Supplied
Description	CLAY-brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.71**	Hydraulic Gradient	**9.4**
Optimum Moisture Content (%)	**16.9**	Surcharge (kPa)	**2.9**
Placement Moisture Content (%)	**17.2**	Head Pressure Applied (kPa)	**10.79**
Moisture Ratio (%)	**101.5**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.80**	Percentage Material Retained/Sieve Size (mm)	**0 % /9.5 mm**
Density Ratio (%)	**89.8**	Sample Height and Diameter (mm)	**116.43 / 101.47 mm**

PERMEABILITY $k_{(20)} =$ **4.6×10^{-09} (m/sec)**



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI). References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY CONSTANT HEAD TEST REPORT

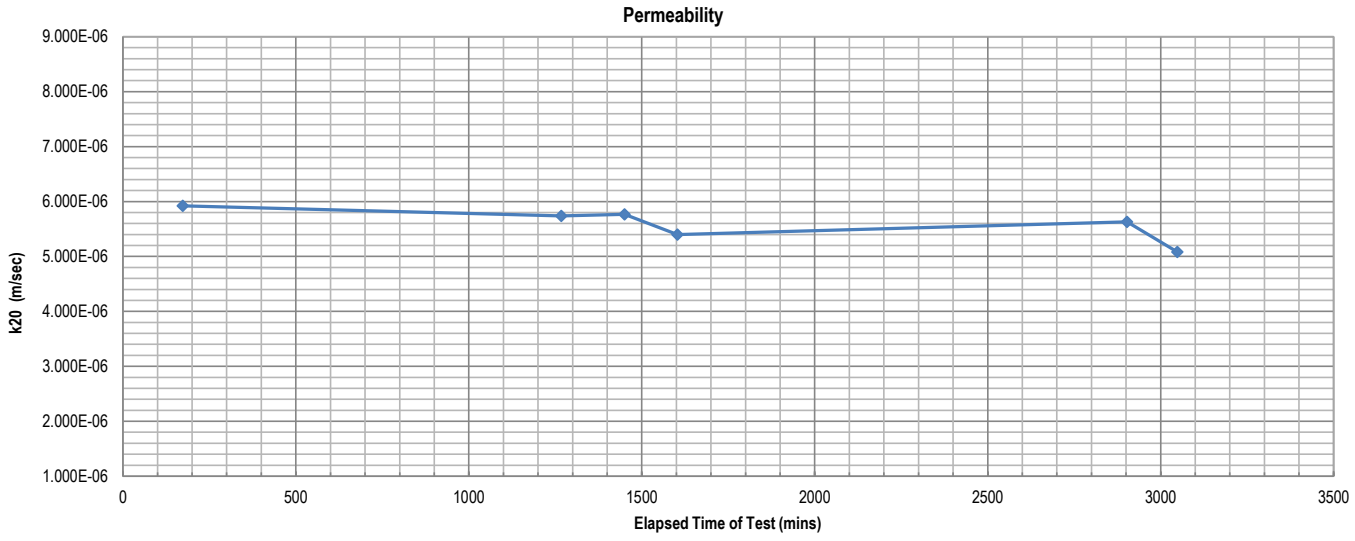
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060484-CHP
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	4/07/2022
		Report Date	11/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	22 - 2022005_C03	**Depth (m)**	Not Supplied
Description	Silty CLAY with gravel - brown	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.91**	Hydraulic Gradient	**0.9**
Optimum Moisture Content (%)	**11.9**	Surcharge (kPa)	**3.7**
Placement Moisture Content (%)	**11.6**	Head Pressure Applied (kPa)	**0.98**
Moisture Ratio (%)	**97.4**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.92**	Percentage Material Retained/Sieve Size (mm)	**0 % / 19 mm**
Density Ratio (%)	**90.2**	Sample Height and Diameter (mm)	**115.07 / 152.47 mm**

PERMEABILITY $k_{(20)}$ = 5.4 x 10^{-06} (m/sec)



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506
ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY CONSTANT HEAD TEST REPORT

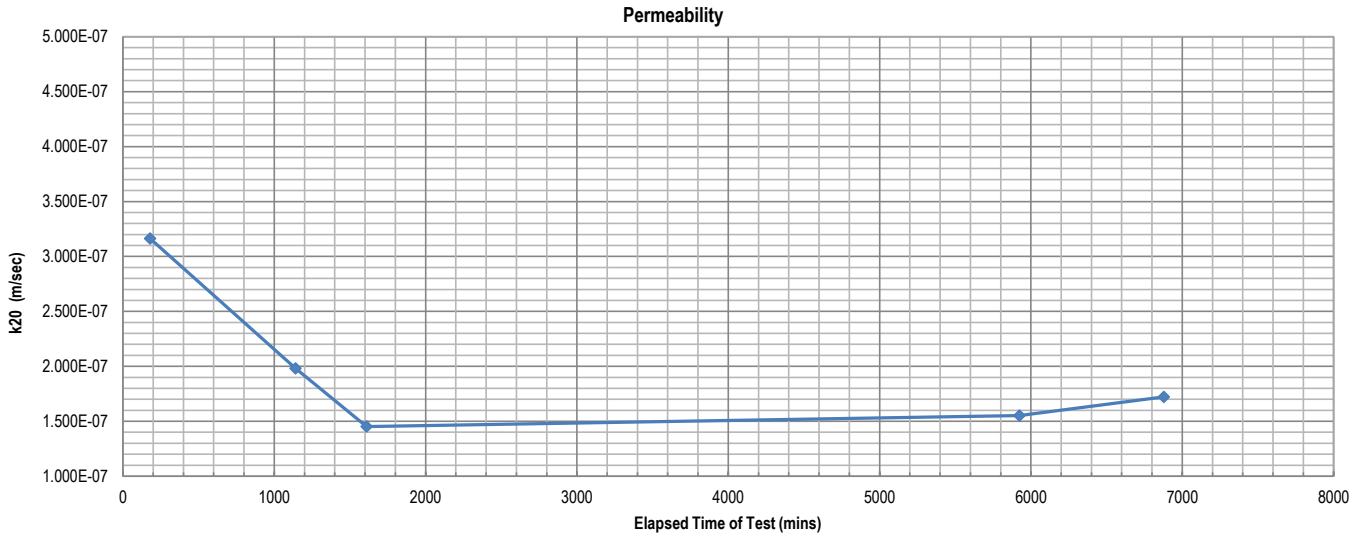
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060490-CHP
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	28/06/2022
		Report Date	7/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	28 - 2022005_C09	**Depth (m)**	Not Supplied
Description	Silty GRAVEL - black	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.77**	Hydraulic Gradient	**2.1**
Optimum Moisture Content (%)	**15.5**	Surcharge (kPa)	**3.6**
Placement Moisture Content (%)	**15.7**	Head Pressure Applied (kPa)	**2.35**
Moisture Ratio (%)	**101.1**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.84**	Percentage Material Retained/Sieve Size (mm)	**0 % / 19 mm**
Density Ratio (%)	**89.9**	Sample Height and Diameter (mm)	**116.97 / 152.66 mm**

PERMEABILITY $k_{(20)}$ = 1.7 x 10^{-07} (m/sec)



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506
ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY CONSTANT HEAD TEST REPORT

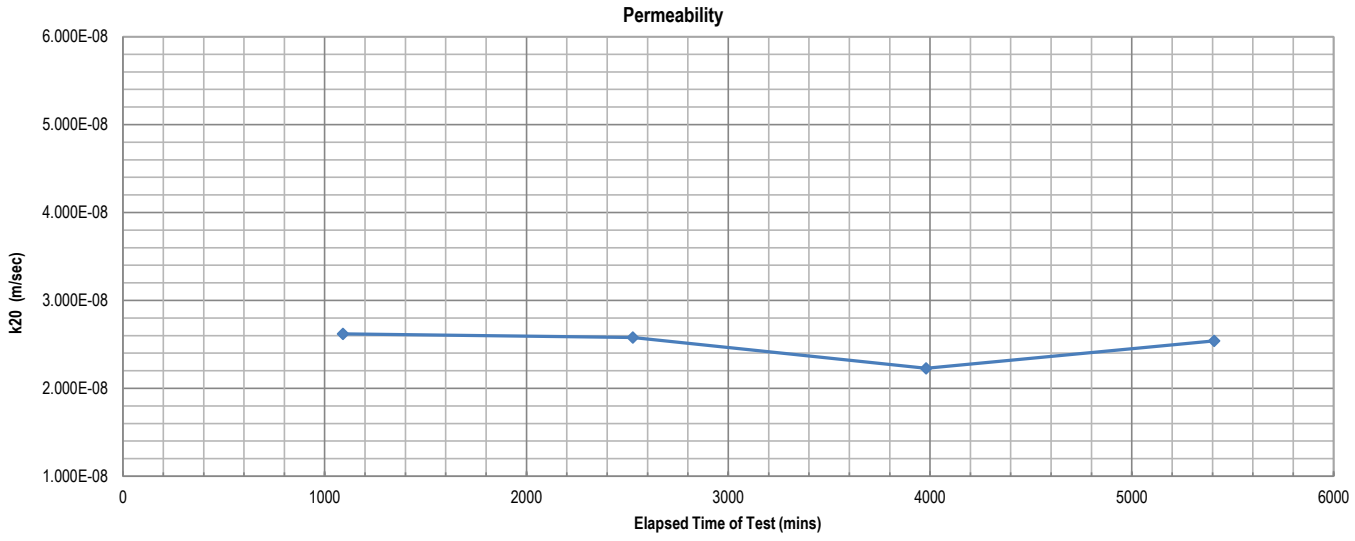
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060491-CHP
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	4/07/2022
		Report Date	11/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	30 - 2022005_C11	**Depth (m)**	Not Supplied
Description	Silty GRAVEL-black	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.00**	Hydraulic Gradient	**0.3**
Optimum Moisture Content (%)	**29.3**	Surcharge (kPa)	**3.7**
Placement Moisture Content (%)	**29.1**	Head Pressure Applied (kPa)	**0.39**
Moisture Ratio (%)	**99.4**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.16**	Percentage Material Retained/Sieve Size (mm)	**0 % / 19 mm**
Density Ratio (%)	**90.1**	Sample Height and Diameter (mm)	**116.57 / 152.36 mm**

PERMEABILITY $k_{(20)}$ = 2.5 x 10^{-08} (m/sec)



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PERMEABILITY BY CONSTANT HEAD TEST REPORT

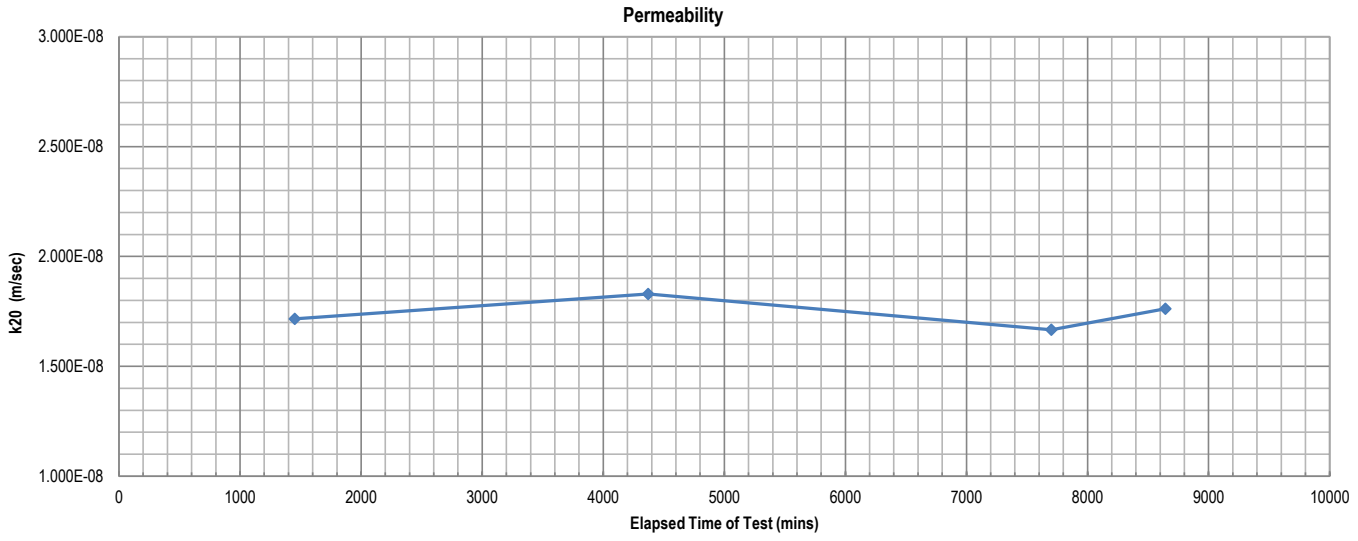
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060492-CHP
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	6/07/2022
		Report Date	13/07/2022
Project	2022005 - Glencore Wandoan		
Client ID	31 - 2022005_C12	**Depth (m)**	Not Supplied
Description	Silty GRAVEL-black	**Sample Type**	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	**AS1289.5.1.1 - Standard Compaction**		
Maximum Dry Density (t/m^3)	**1.12**	Hydraulic Gradient	**0.4**
Optimum Moisture Content (%)	**29.3**	Surcharge (kPa)	**3.7**
Placement Moisture Content (%)	**28.6**	Head Pressure Applied (kPa)	**0.49**
Moisture Ratio (%)	**97.7**	Water Type	**Deaerated**
Placement Wet Density (t/m^3)	**1.30**	Percentage Material Retained/Sieve Size (mm)	**0 % / 19 mm**
Density Ratio (%)	**90.5**	Sample Height and Diameter (mm)	**116.41 / 152.4 mm**

PERMEABILITY $k_{(20)}$ = 1.8 x 10^{-08} (m/sec)



Remarks: The above specimen was remoulded to a target of 90% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Channon

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506
ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

ATTERBERG LIMITS TEST REPORT

Test Methods: AS 1289 2.1.1, 3.2.1, 3.3.1, 3.4.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060464-AL
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Report Date**	28/06/2022
Project	2022005 - Glencore Wandoan		

Sample No.	22060464	22060465	22060466	22060467		
Liquid Limit Determination	AS 1289.3.1.2	AS 1289.3.1.2	AS 1289.3.1.2	AS 1289.3.1.2		
Test Date	23/06/2022	23/06/2022	23/06/2022	23/06/2022		
Client ID	1 - 2022005_001	2 - 2022005_002	3 - 2022005_003	4 - 2022005_004		
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied		
Liquid Limit (%)	48	48	49	48		
Plastic Limit (%)	17	17	19	19		
Plasticity Index (%)	31	31	30	29		
Linear Shrinkage (%)	15.0 +	14.5 +	14.5	14.0		
Moisture Content (%)	10.6	9.6	10.6	10.7		

Sample No.						
Liquid Limit Determination						
Test Date						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

NOTES/REMARKS: The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

CALIFORNIA BEARING RATIO TEST REPORT

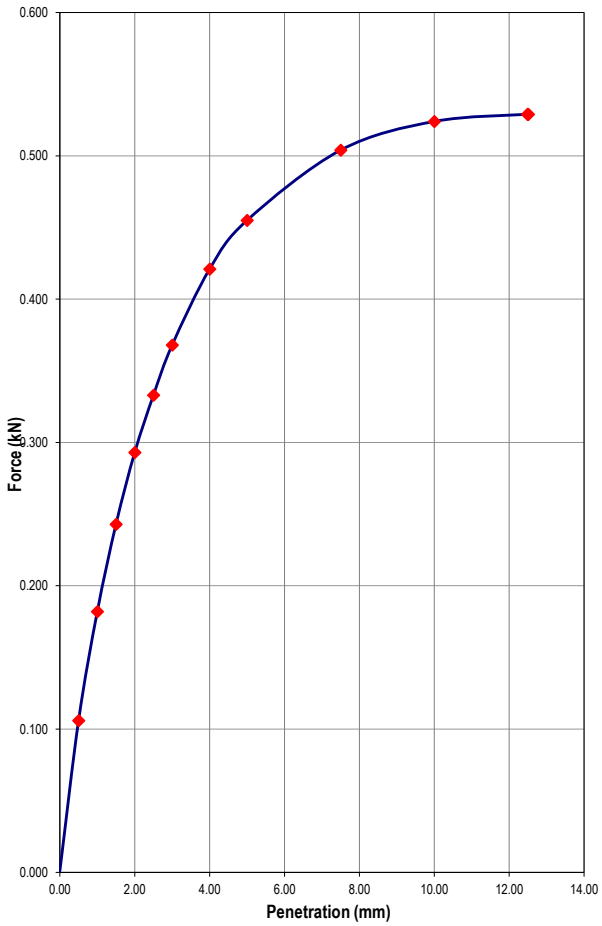
Test Method: AS 1289.6.1.1 & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060483-CBR
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/06/2022
		Report Date	28/06/2022
Project	2022005 - Glencore Wandoan		

Test Results

Sample No.	22060483
Client ID	21 - 2022005_C02
Depth (m)	Not Supplied
Description	Silty CLAY - brown
Compaction Criteria	Standard
Curing Time of Specimen	48 hrs - based on visual/tactile assessment of material.
Condition of Specimen	Soaked
Surcharge (kg)	4.5
Period of Soak (Days)	4
Percentage Retained 19 mm (%) (Not Included in Sample)	0
Field Moisture Content (%)	10.9
Moisture Content of Top 30 mm (%)	24.2
Swell (%)	1.8
Laboratory Moisture Ratio (%)	100.9
Laboratory Density Ratio (%)	89.8
Optimum Moisture Content (%)	16.9
Maximum Dry Density (t/m^3)	1.71

Force v's Penetration



	CBR Penetration (mm)	**2.5**	
	CBR VALUE	**2.5**	

Notes/Remarks :

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

CALIFORNIA BEARING RATIO TEST REPORT

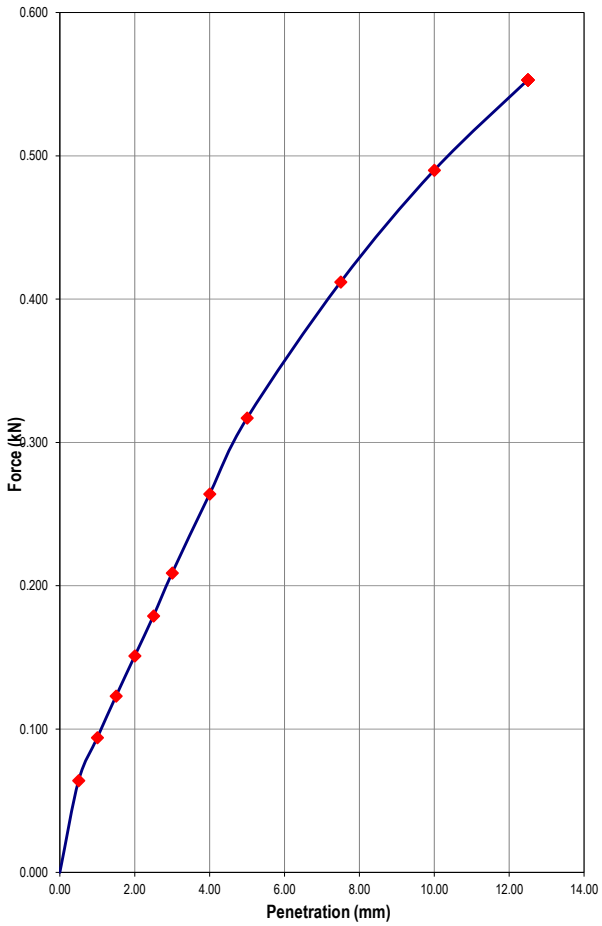
Test Method: AS 1289.6.1.1 & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060484-CBR
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/06/2022
		Report Date	28/06/2022
Project	2022005 - Glencore Wandoan		

Test Results

Sample No.	22060484
Client ID	22 - 2022005_C03
Depth (m)	Not Supplied
Description	Silty CLAY trace gravel - brown
Compaction Criteria	Standard
Curing Time of Specimen	48 hrs - based on visual/tactile assessment of material.
Condition of Specimen	Soaked
Surcharge (kg)	4.5
Period of Soak (Days)	4
Percentage Retained 19 mm (%) (Not Included in Sample)	0
Field Moisture Content (%)	5.8
Moisture Content of Top 30 mm (%)	21.1
Swell (%)	2.0
Laboratory Moisture Ratio (%)	99.7
Laboratory Density Ratio (%)	90.1
Optimum Moisture Content (%)	11.9
Maximum Dry Density (t/m^3)	1.91

Force v's Penetration



	CBR Penetration (mm)	**5.0**	
	CBR VALUE	**1.5**	

Notes/Remarks :

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

CALIFORNIA BEARING RATIO TEST REPORT

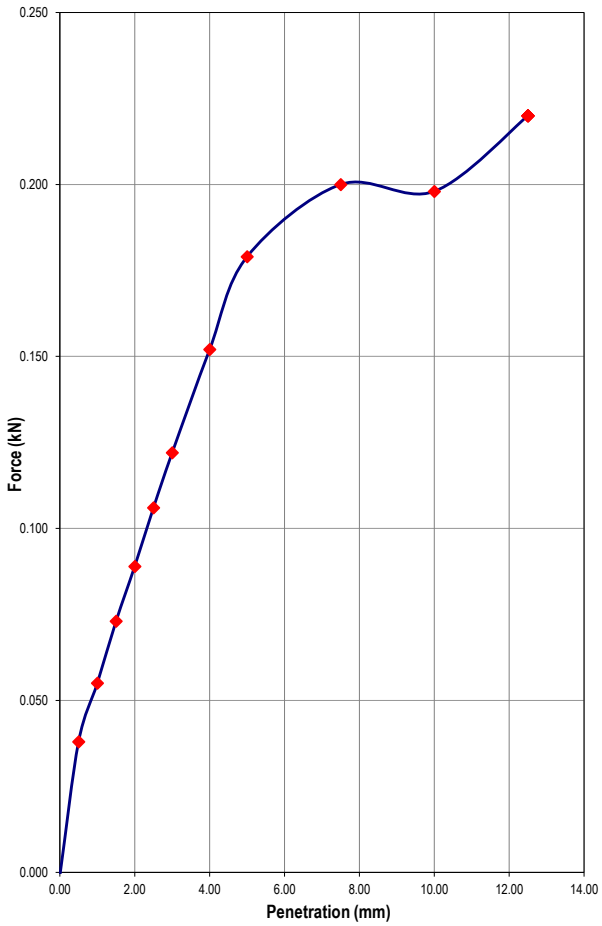
Test Method: AS 1289.6.1.1 & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22060482-CBR
		Workorder No.	0009900
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/06/2022
		Report Date	28/06/2022
Project	2022005 - Glencore Wandoan		

Test Results

Sample No.	22060482
Client ID	20 - 2022005_C01
Depth (m)	Not Supplied
Description	Silty CLAY - brown
Compaction Criteria	Standard
Curing Time of Specimen	48 hrs - based on visual/tactile assessment of material.
Condition of Specimen	Soaked
Surcharge (kg)	4.5
Period of Soak (Days)	4
Percentage Retained 19 mm (%) (Not Included in Sample)	0
Field Moisture Content (%)	10.4
Moisture Content of Top 30 mm (%)	29.0
Swell (%)	4.8
Laboratory Moisture Ratio (%)	99.8
Laboratory Density Ratio (%)	90.0
Optimum Moisture Content (%)	15.7
Maximum Dry Density (t/m^3)	1.69

Force v's Penetration



	CBR Penetration (mm)	**5.0**	
	CBR VALUE	**1**	

Notes/Remarks :

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

NATA WORLD RECOGNISED ACCREDITATION

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

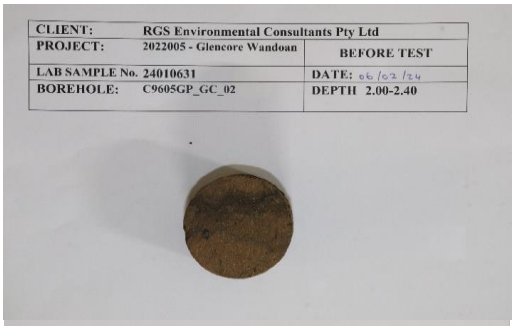
Test Method: AS 4133.4.1

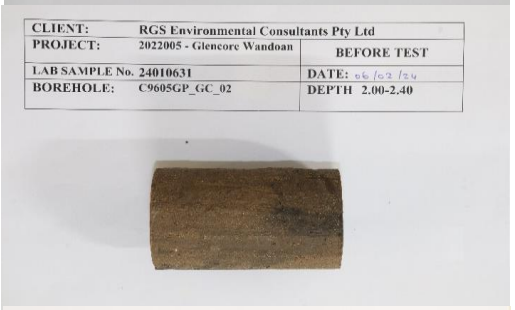
Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010631-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9605GP_GC_02
Location	C9605GP_GC_02
Depth (m)	2.00-2.40
I_s (MPa)	0.12
$I_{s(50)}$ (MPa)	0.12
Failed on Fault	N
Load Direction	Axial

Client ID	C9605GP_GC_02
Location	C9605GP_GC_02
Depth (m)	2.00-2.40
I_s (MPa)	0.13
$I_{s(50)}$ (MPa)	0.13
Failed on Fault	N
Load Direction	Diametral

Photos





NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

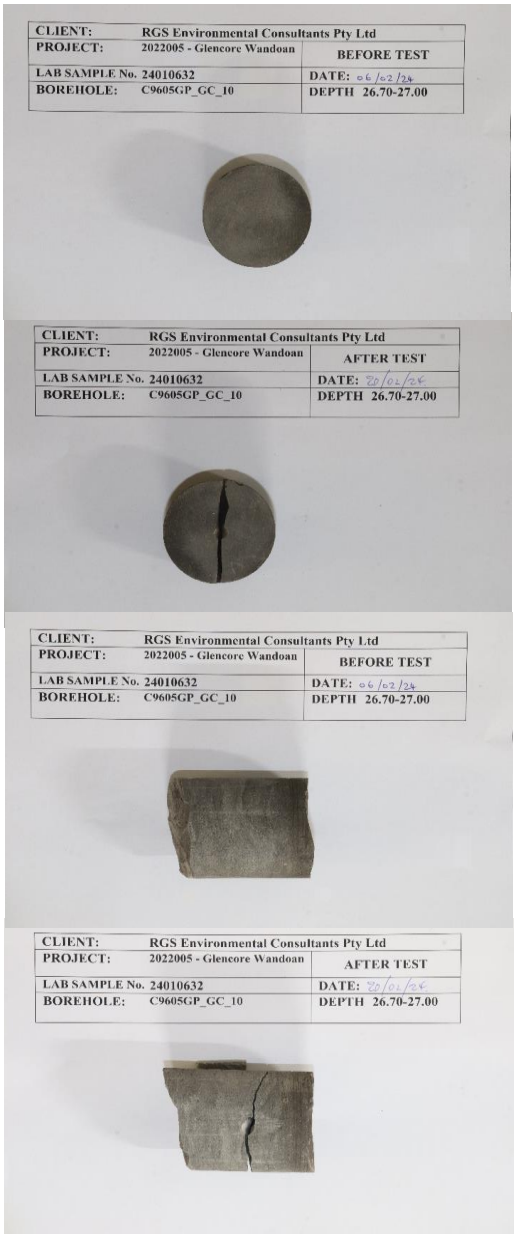
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010632-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9605GP_GC_10
Location	C9605GP_GC_10
Depth (m)	26.70-27.00
I_s (MPa)	1.18
$I_{s(50)}$ (MPa)	1.24
Failed on Fault	N
Load Direction	Axial

Client ID	C9605GP_GC_10
Location	C9605GP_GC_10
Depth (m)	26.70-27.00
I_s (MPa)	0.96
$I_{s(50)}$ (MPa)	1.03
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

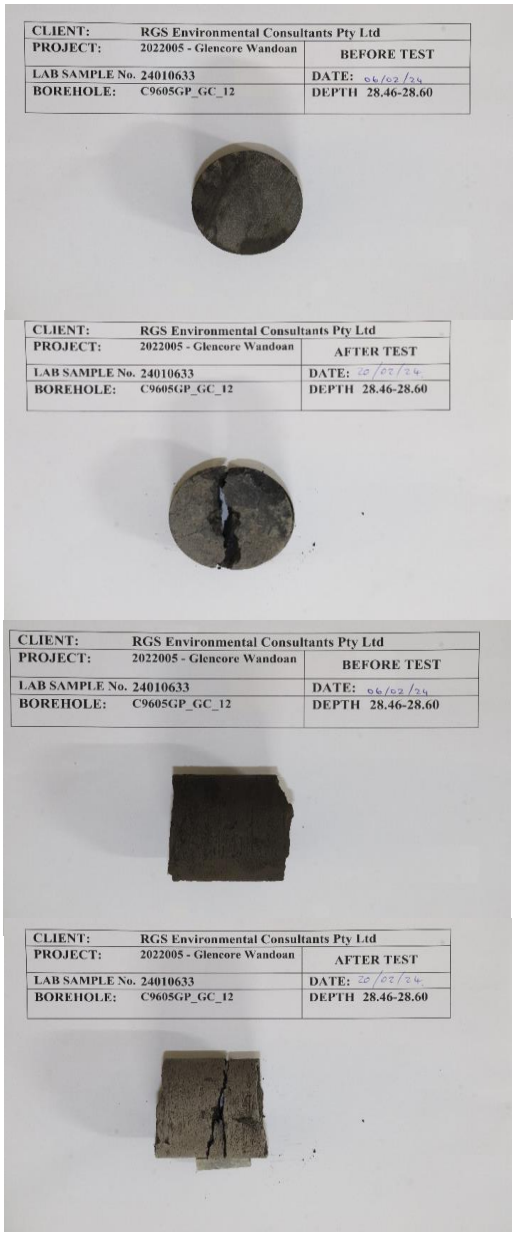
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010633-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9605GP_GC_12
Location	C9605GP_GC_12
Depth (m)	28.46-28.60
I_s (MPa)	0.48
$I_{s(50)}$ (MPa)	0.47
Failed on Fault	N
Load Direction	Axial

Client ID	C9605GP_GC_12
Location	C9605GP_GC_12
Depth (m)	28.46-28.60
I_s (MPa)	0.05
$I_{s(50)}$ (MPa)	0.06
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

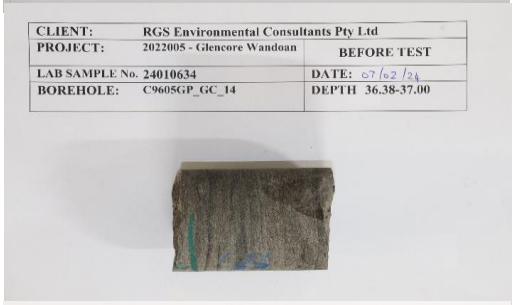
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010634-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9605GP_GC_14
Location	C9605GP_GC_14
Depth (m)	36.38-37.00
I_s (MPa)	1.10
$I_{s(50)}$ (MPa)	1.15
Failed on Fault	N
Load Direction	Axial

Client ID	C9605GP_GC_14
Location	C9605GP_GC_14
Depth (m)	36.38-37.00
I_s (MPa)	0.60
$I_{s(50)}$ (MPa)	0.64
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

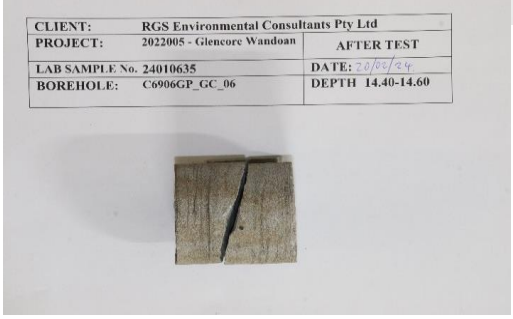
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010635-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C6906GP_GC_06
Location	C6906GP_GC_06
Depth (m)	14.40-14.60
I_s (MPa)	1.00
$I_{s(50)}$ (MPa)	1.02
Failed on Fault	N
Load Direction	Axial

Client ID	C6906GP_GC_06
Location	C6906GP_GC_06
Depth (m)	14.40-14.60
I_s (MPa)	0.55
$I_{s(50)}$ (MPa)	0.58
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010636-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C6906GP_GC_10
Location	C6906GP_GC_10
Depth (m)	23.99-24.50
I_s (MPa)	1.21
$I_{s(50)}$ (MPa)	1.27
Failed on Fault	N
Load Direction	Axial

Client ID	C6906GP_GC_10
Location	C6906GP_GC_10
Depth (m)	23.99-24.50
I_s (MPa)	0.41
$I_{s(50)}$ (MPa)	0.44
Failed on Fault	N
Load Direction	Diametral

Photos

NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

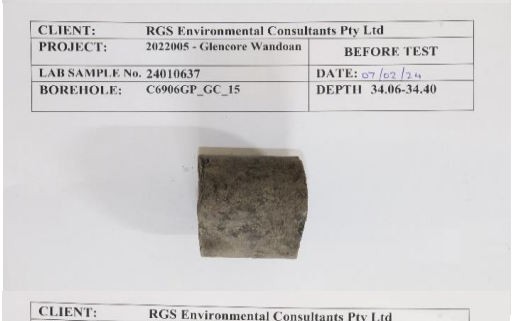
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010637-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C6906GP_GC_15
Location	C6906GP_GC_15
Depth (m)	34.06-34.40
I_s (MPa)	0.44
$I_{s(50)}$ (MPa)	0.43
Failed on Fault	N
Load Direction	Axial

Client ID	C6906GP_GC_15
Location	C6906GP_GC_15
Depth (m)	34.06-34.40
I_s (MPa)	0.30
$I_{s(50)}$ (MPa)	0.32
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received + Irregular Lump

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

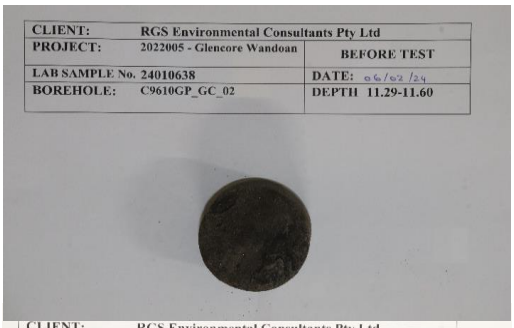
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010638-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9610GP_GC_02
Location	C9610GP_GC_02
Depth (m)	11.29-11.60
I_s (MPa)	0.50
$I_{s(50)}$ (MPa)	0.51
Failed on Fault	N
Load Direction	Axial

Client ID	C9610GP_GC_02
Location	C9610GP_GC_02
Depth (m)	11.29-11.60
I_s (MPa)	0.31
$I_{s(50)}$ (MPa)	0.34
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

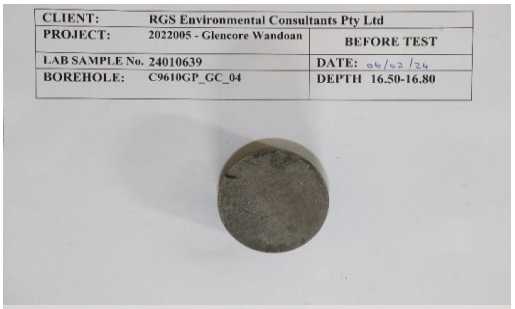
Test Method: AS 4133.4.1

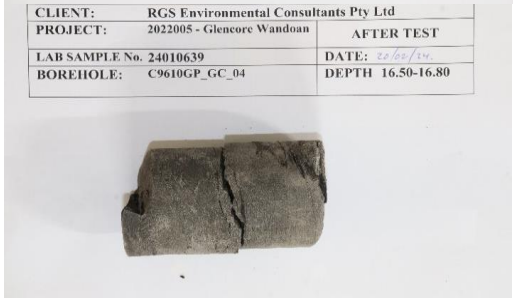
Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010639-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9610GP_GC_04
Location	C9610GP_GC_04
Depth (m)	16.50-16.80
I_s (MPa)	0.43
$I_{s(50)}$ (MPa)	0.47
Failed on Fault	N
Load Direction	Axial

Client ID	C9610GP_GC_04
Location	C9610GP_GC_04
Depth (m)	16.50-16.80
I_s (MPa)	0.11
$I_{s(50)}$ (MPa)	0.12
Failed on Fault	Y
Load Direction	Diametral

Photos





NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

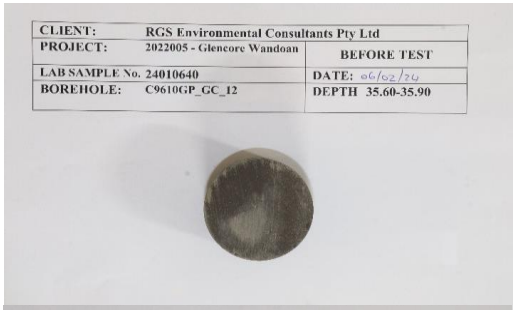
Test Method: AS 4133.4.1

Client	RGS Environmental Consultants Pty Ltd	**Report No.**	24010640-PLS
		Workorder No.	9919/T/67
Address	PO Box 3091 Sunnybank South QLD 4109	**Test Date**	20/02/2024
		Report Date	26/02/2024
Project	2022005 - Glencore Wandoan		

Client ID	C9610GP_GC_04
Location	C9610GP_GC_12
Depth (m)	35.60-35.90
I_s (MPa)	0.43
$I_{s(50)}$ (MPa)	0.46
Failed on Fault	N
Load Direction	Axial

Client ID	C9610GP_GC_04
Location	C9610GP_GC_12
Depth (m)	35.60-35.90
I_s (MPa)	0.27
$I_{s(50)}$ (MPa)	0.29
Failed on Fault	N
Load Direction	Diametral

Photos



NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing

*NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

Tested at Trilab Brisbane Laboratory

Approved Signatory

Neil Maddison

Neil Maddison

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Attachment I: Column settlement results

Figure H-1: Column settlement photographs for topsoil and subsoil

Attachment J: Levay and Co laboratory results

LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

Job No.
L&C-22-139

REPORT

QXRD Analysis of Six Samples

RGS Job No. 2022005 Wandoan
Purchase Order No. 2022028

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Consultants Pty. Ltd.,
3/30 Lensworth Street,
Coopers Plain. QLD. 4108.

Prepared by:

George Levay,
Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 20th June, 2022

Introduction

Levay & Co. Environmental Services received six samples (RGS Job No. 2022005 Wandoan) from RGS Environmental Consultants on the 2nd June, 2022 to determine the mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2022005_C01	22-139-01	Sample1 – Soil
2022005_C02	22-139-02	Sample 2 – Soil
2022005_C03	22-139-03	Sample 3 - Overburden
2022005_C11	22-139-04	Sample 4 – Carbonaceous rocks/Low grade coal
2022005_C012	22-139-05	Sample 5 – Coal
2022005_C10	22-139-06	Sample 6 – Coal reject

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the sample with a Panalytical Aeris Research Powder Diffractometer. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search/match of the ICDD PDF4 2022 Database.

Quantitative results have been determined with full pattern Rietveld refinement software.

The amorphous (non-diffracting) fraction, presumed to be dominated by coal, has been determined by modelling the background using a disordered graphite structure.

Results

The results from QXRD analysis of the sample are shown in Table 2 below. Mineralisation includes silicate (quartz, albite and microcline), clay (montmorillonite, kaolinite and muscovite-illite) and amorphous-coal, as the dominant phases. These samples also contain some amount of carbonate (calcite). All six samples were sediment air-dried and glycol treated for clay mineralogy verification.

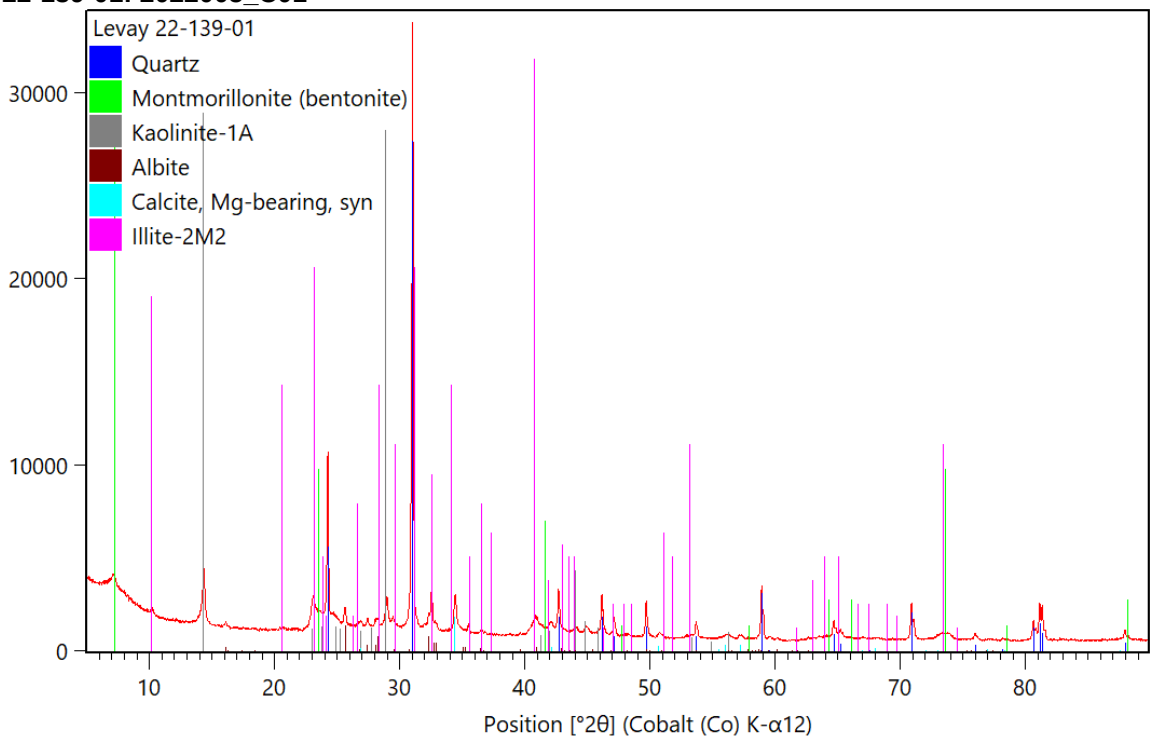
Table 2: QXRD results

Phase	2022005_C01 Weight %[1]	2022005_C02 Weight %[1]	2022005_C03 Weight %[1]	2022005_C11 Weight %[1]	2022005_C012 Weight %[1]	2022005_C10 Weight %[1]
Quartz	38.2	36.0	36.9	22.3	11.1	21.5
Kaolinite	25.6	24.6	21.6	33.0	36.0	35.5
Albite	9.9	13.6	17.0	7.0	ND[2]	3.2
Microcline	0.9	1.4	1.8	0.8	ND[2]	0.9
Montmorillonite/smectite[3]	10.4	9.3	10.3	2.6	3.3	10.8
Calcite	3.7	4.5	1.6	2.1	2.4	0.8
Muscovite-illite	0.4	1.9	2.6	1.8	0.2	1.7
Pyrite	0.5	0.6	0.5	0.4	ND[2]	0.4
Gypsum	0.1	ND[2]	ND[2]	0.1	ND[2]	0.2
Jarosite	ND[2]	0.1	0.2	0.1	ND[2]	0.1
Ankerite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	0.1
Siderite	ND[2]	ND[2]	0.2	ND[2]	ND[2]	0.2
Amorphous – coal[4]	10.3	8.0	7.3	29.8	47.0	24.6

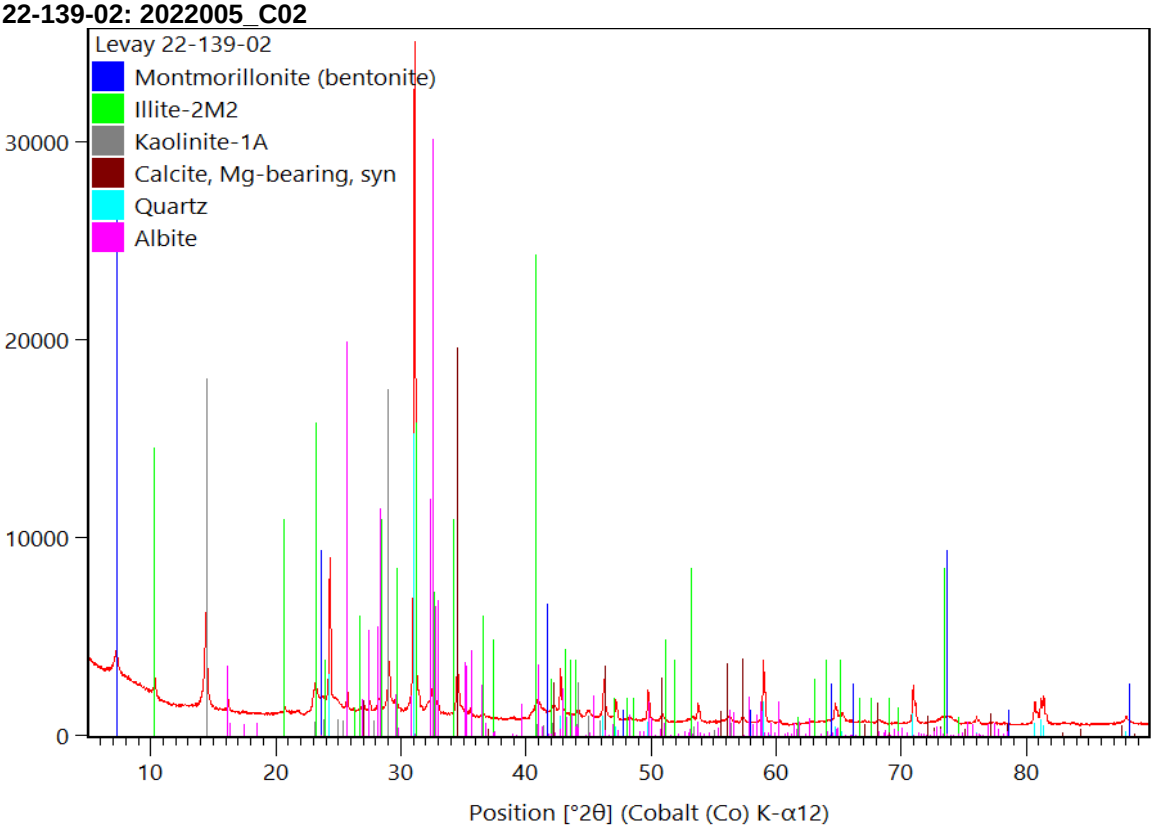
1 Semiquantitative Detection limit ~0.4 wt.%
2 ND = Non Detectable
3 Verified in all six samples from sediment air-dried and glycol treated mounts – see below
4 Amorphous-predominantly coal: The amorphous (non-diffracting) fraction, presumed to be dominated by coal with minor poorly diffracting clay, has been determined by modelling the background using a disordered graphite structure.

Results Graphical – Phase ID

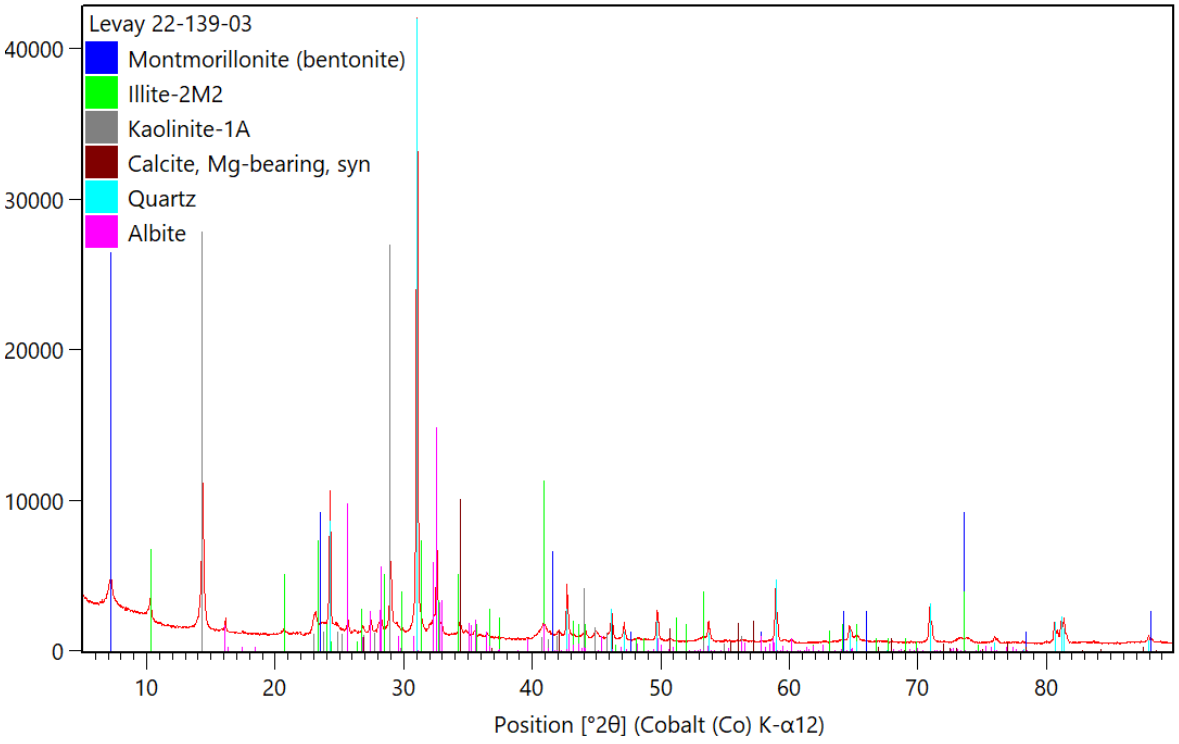
22-139-01: 2022005_C01



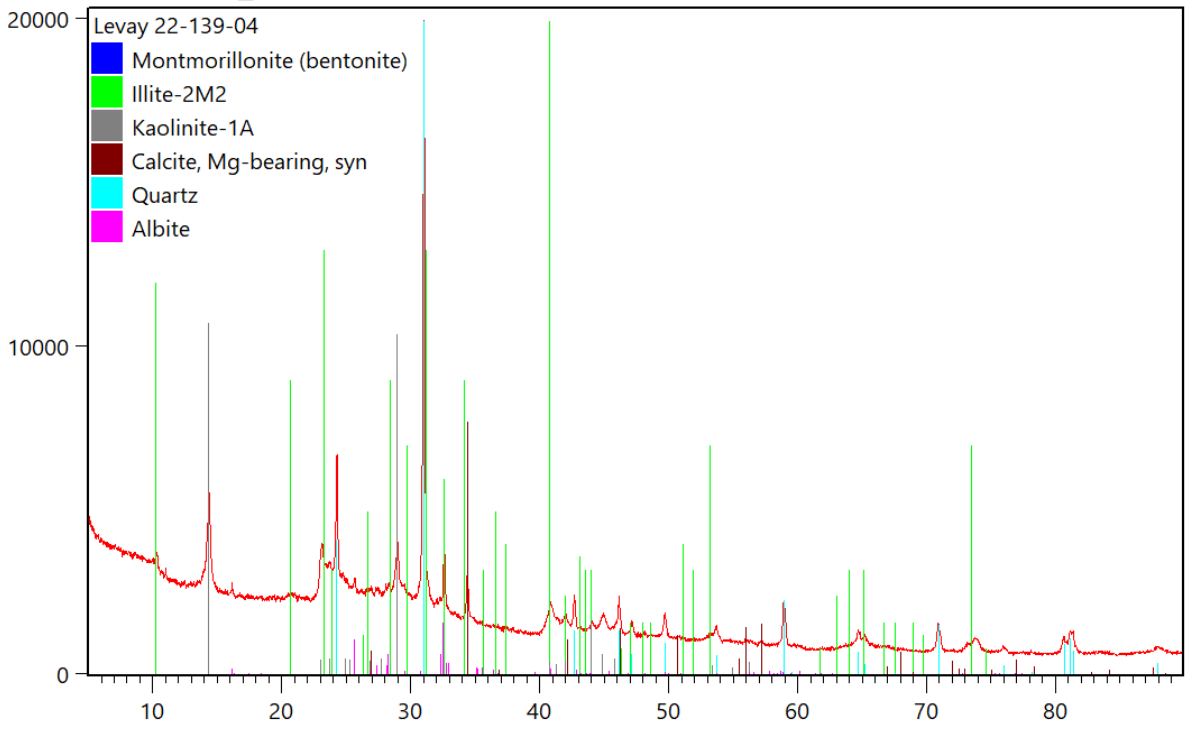
22-139-02: 2022005_C02



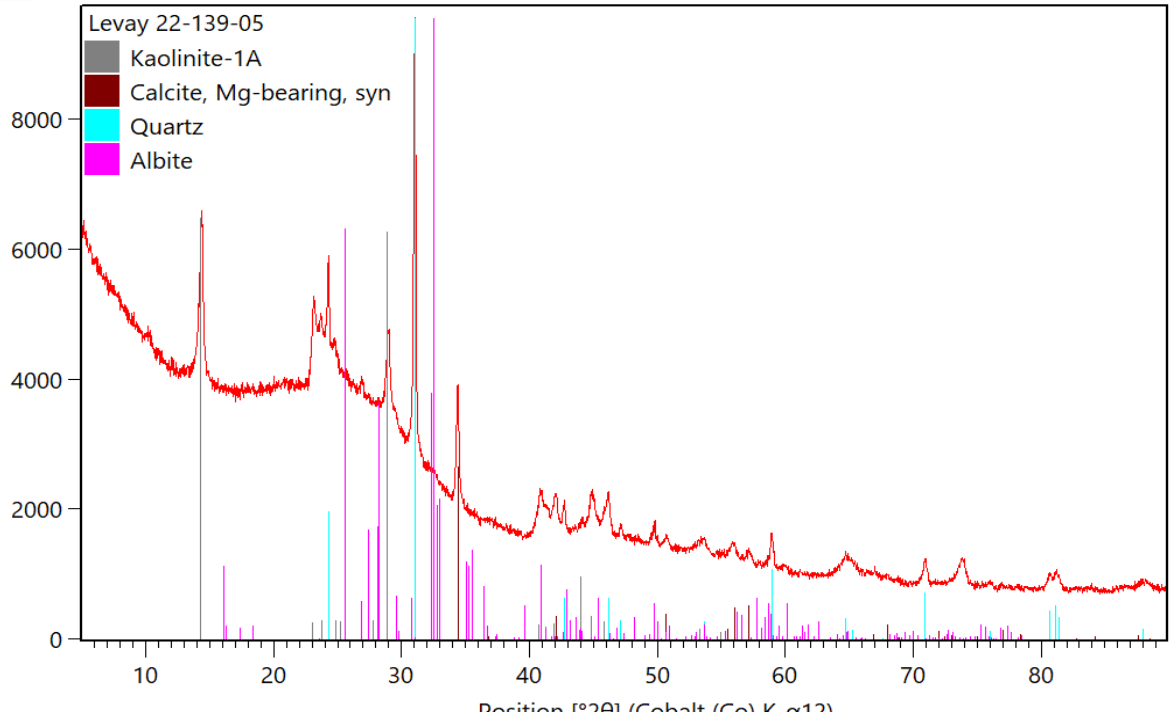
22-139-03: 2022005_C03



22-139-04: 2022005_C11

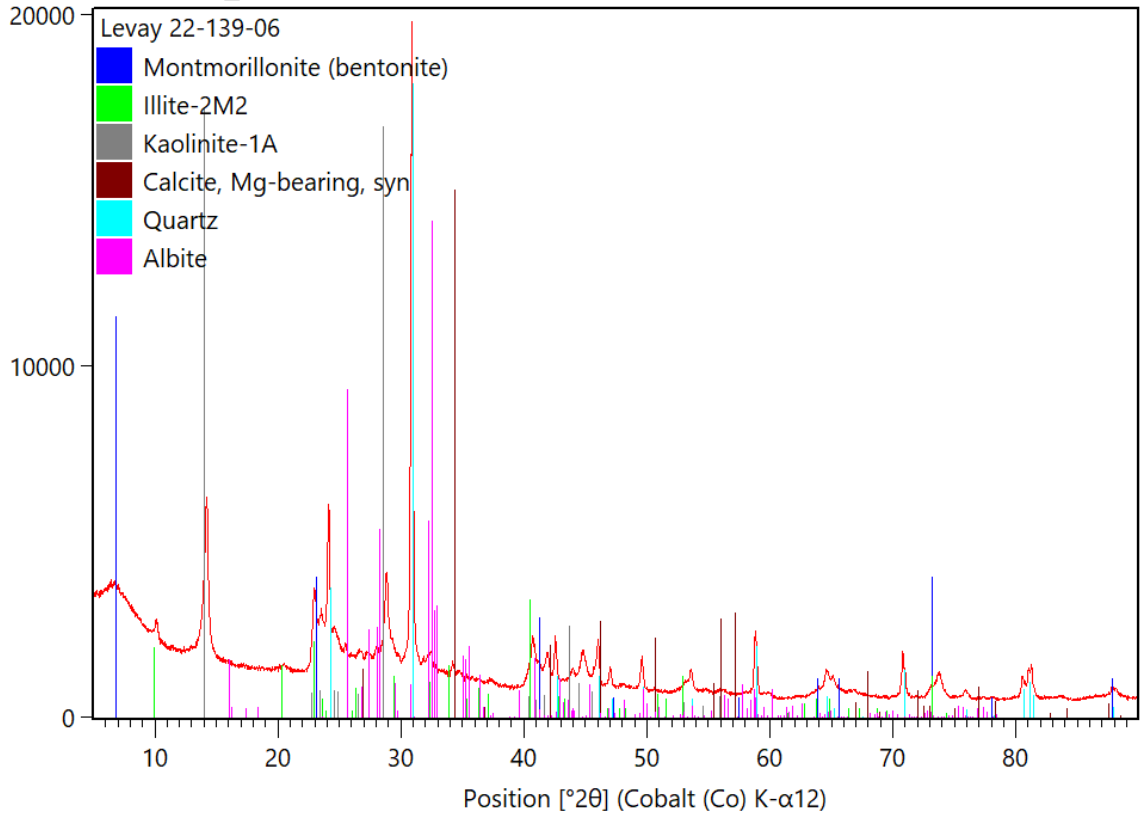


22-139-05: 2022005_C012



High coal sample – note broad swell 10˚ to 40˚ 2Θ

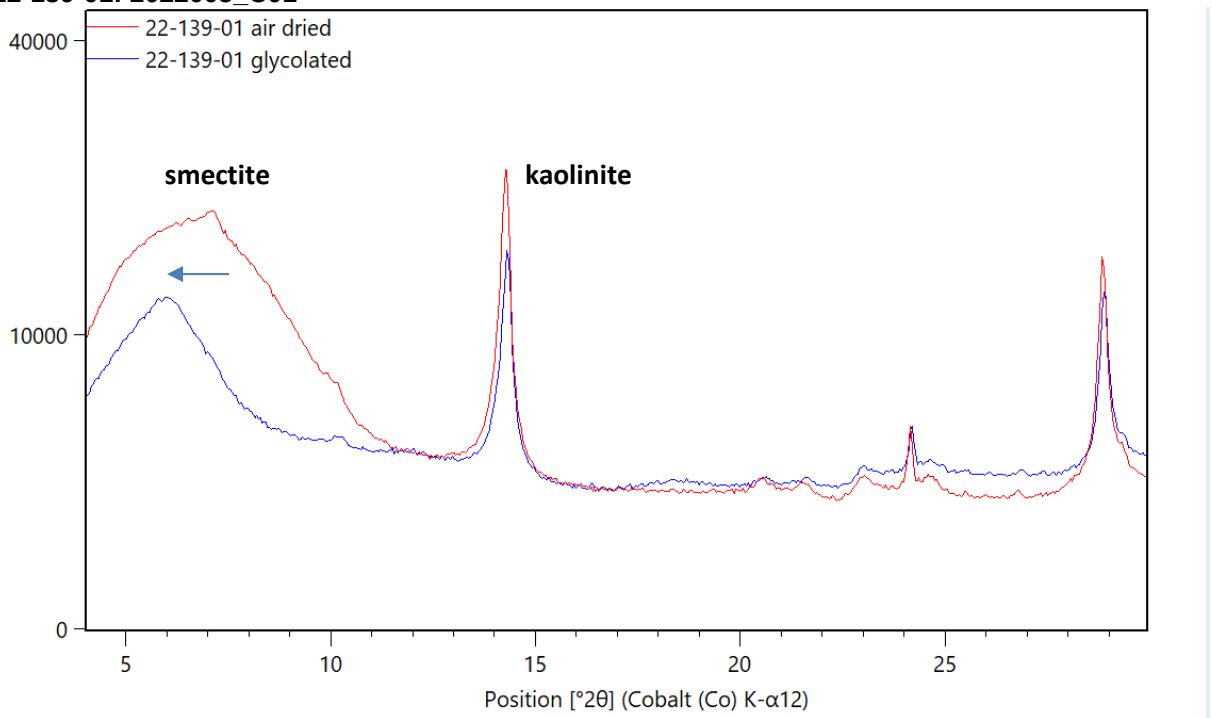
22-139-06: 2022005_C10



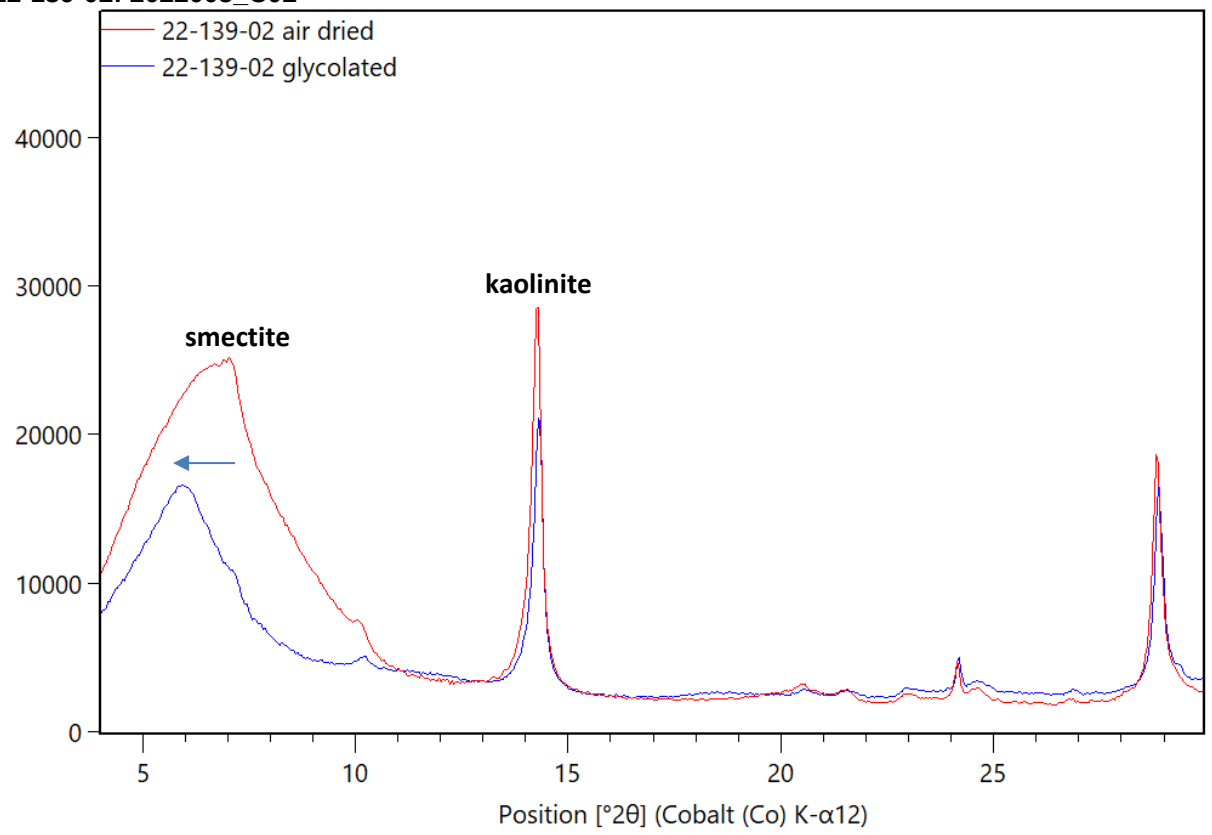
Sedimented Air-Dried and Glycol Treated Results

For the six samples; glycol intercalation results in an expansion of the smectite basal spacing to ~17Å

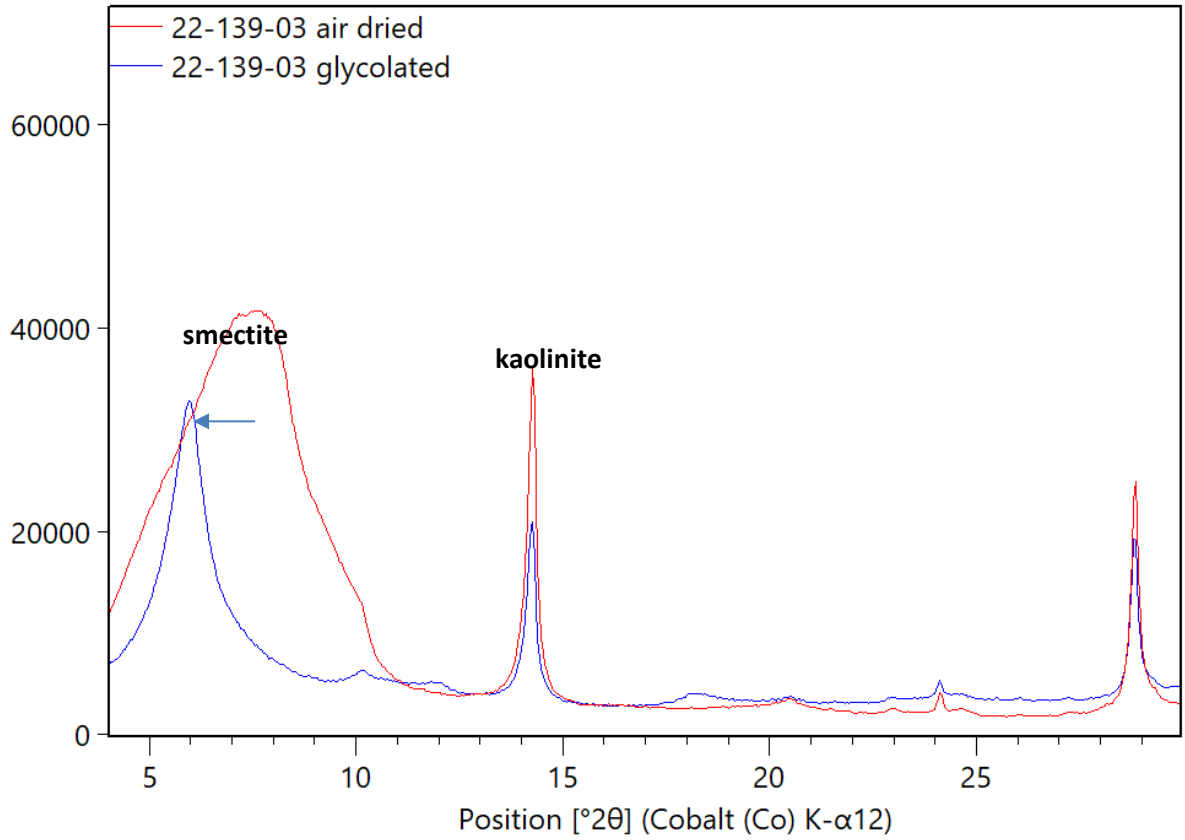
22-139-01: 2022005_C01



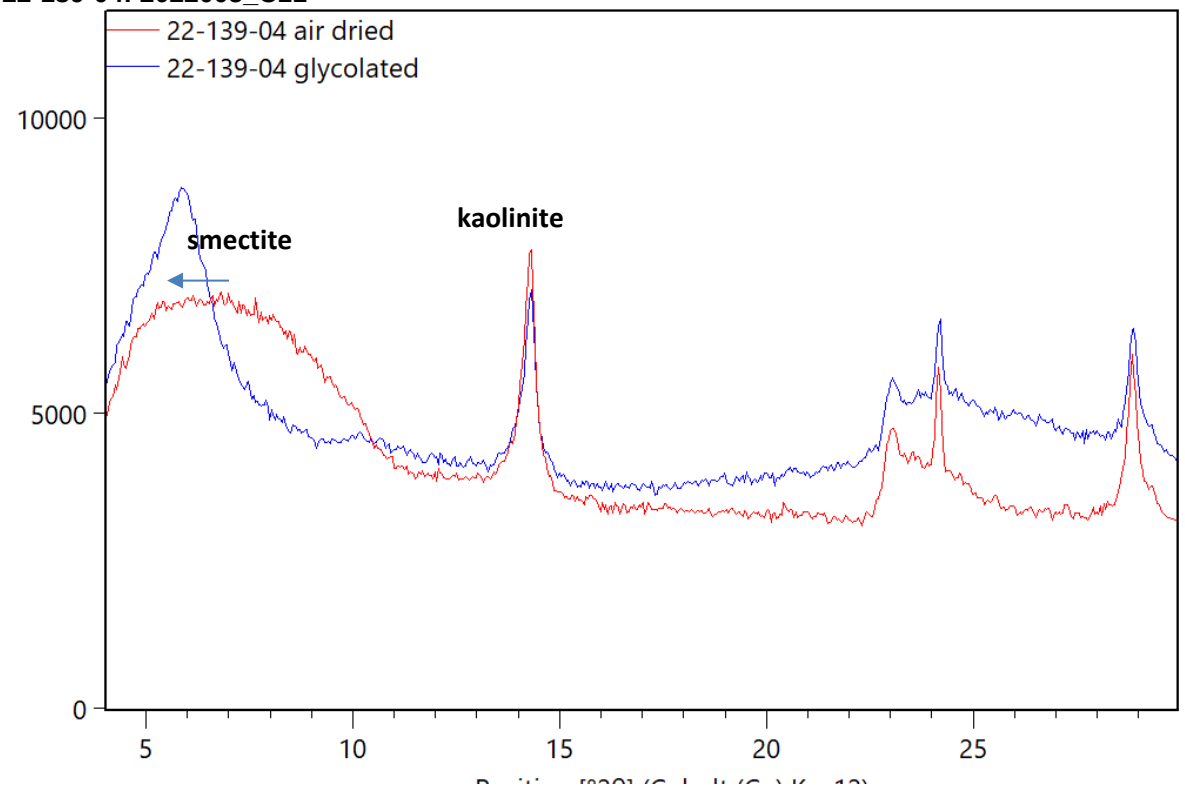
22-139-02: 2022005_C02



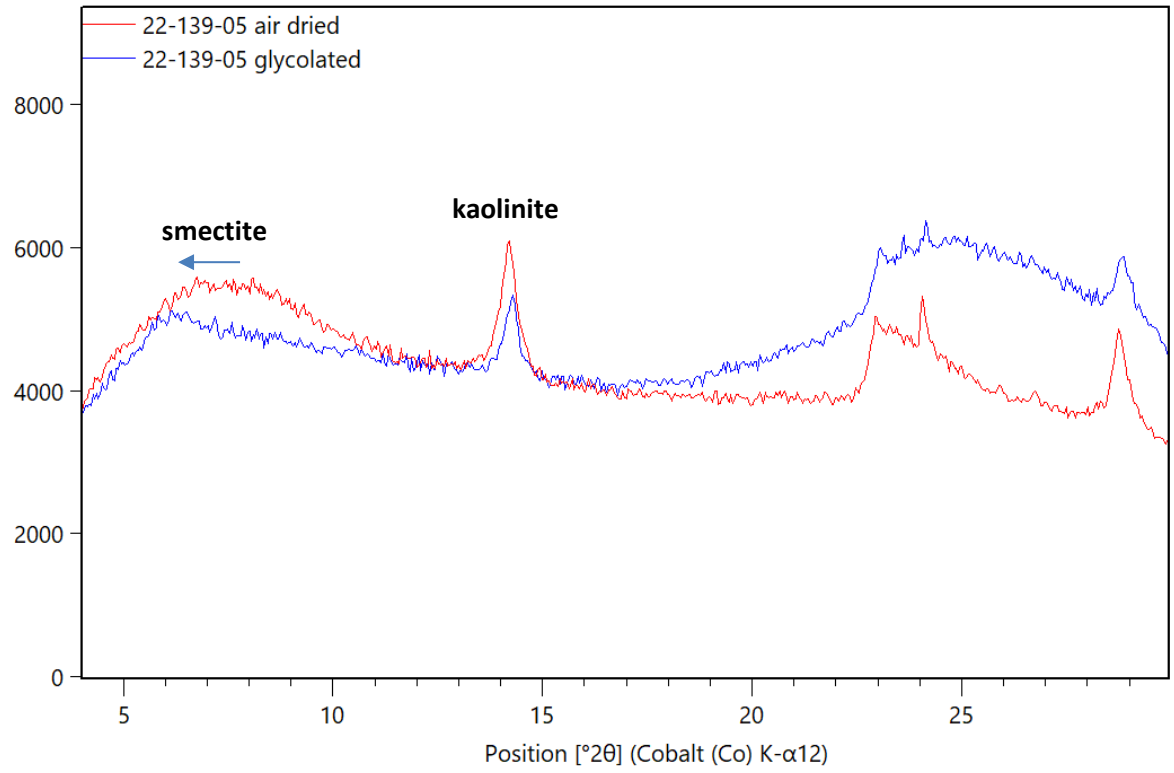
22-139-03: 2022005_C03



22-139-04: 2022005_C11

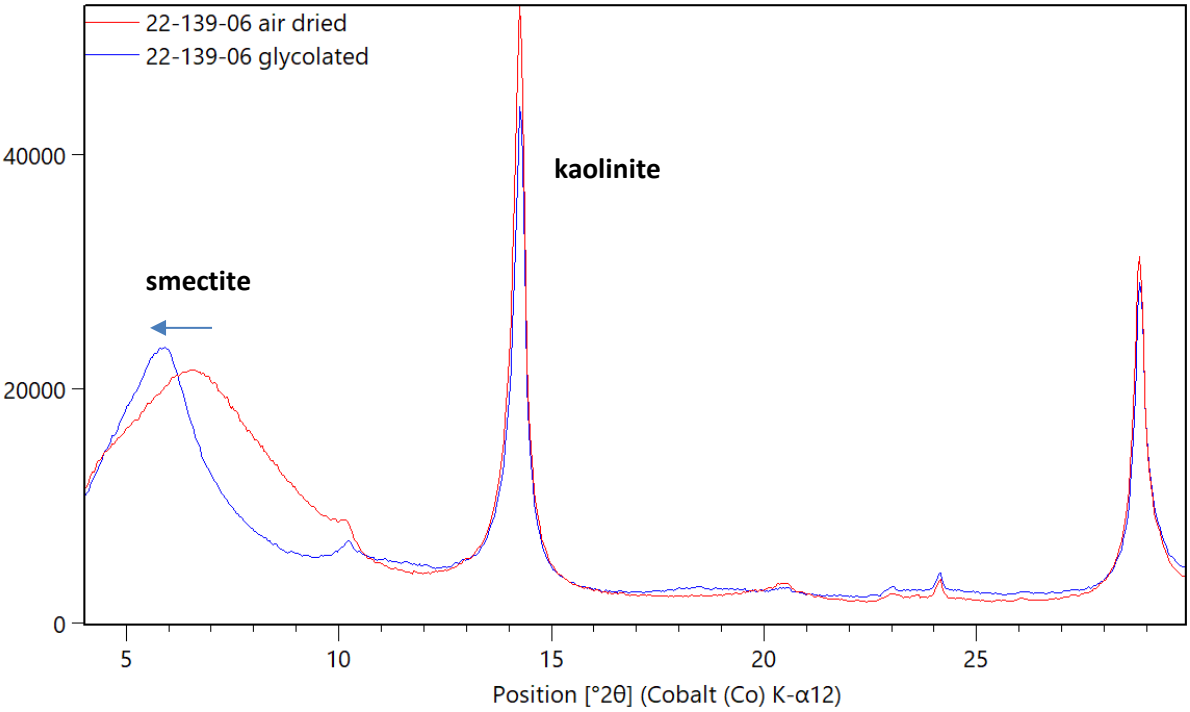


22-139-05: 2022005_C012



high background due to dominant coal content

22-139-06: 2022005_C10



LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

Job No.
L&C-22-191

REPORT

QXRD Analysis of One Sample

Purchase Order No. 2022038

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Consultants Pty. Ltd.,
3/30 Lensworth Street,
Coopers Plain. QLD. 4108.

Prepared by:

George Levay,
Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 1st September, 2022

Introduction

Levay & Co. Environmental Services received one sample from RGS Environmental on the 23rd August, 2022 to determine their mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2022005_0020	22-191-01	Sample 1 - Tailings

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the sample with a Panalytical Aeris Research Powder Diffractometer. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search/match of the ICDD PDF4 2022 Database. Quantitative results have been determined with full pattern Rietveld refinement software.

Results

The result from QXRD analysis of this sample is shown in Table 2 below. Mineralisation includes magnetite and clay (kaolinite, illite, and montmorillonite), as the dominant phases. This sample also contain some amount of silicate (quartz and albite) and sulfide (pyrrhotite and marcasite).

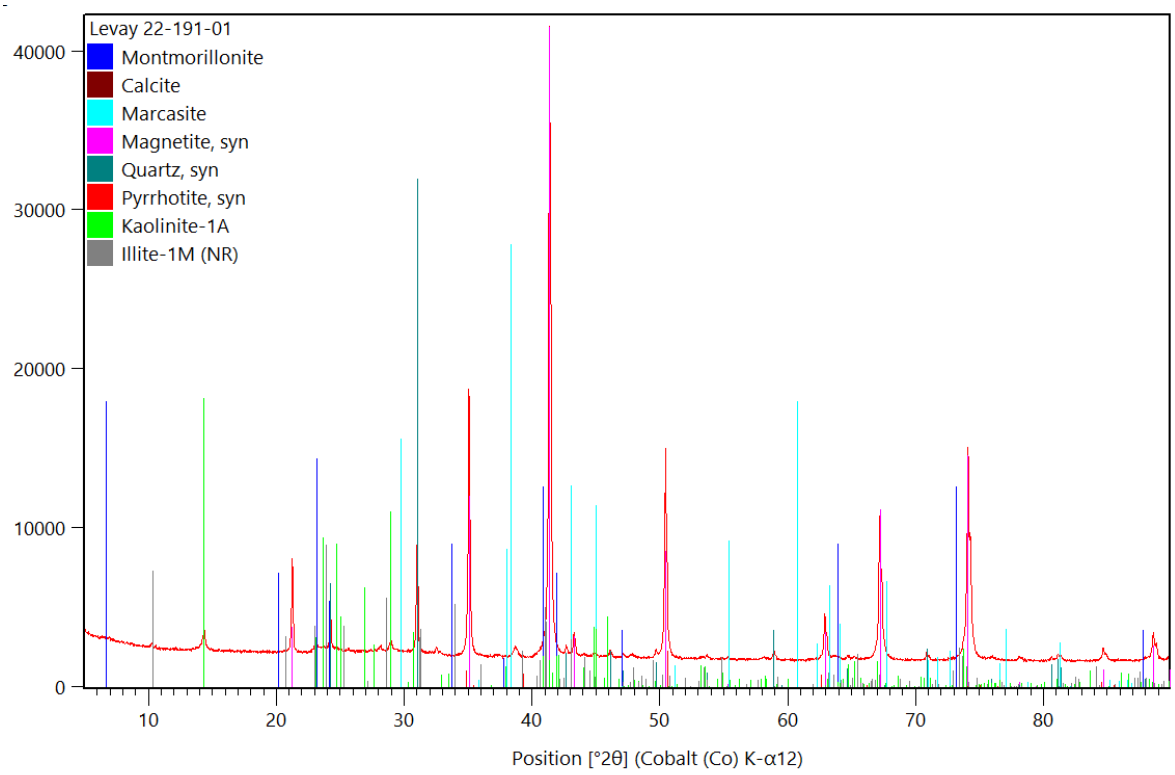
Table 2: QXRD results

Phase	2022005_0020 Weight %[1]
Magnetite	71.6
Kaolinite	11.1
Quartz	7.3
Illite	4.3
Albite	2.4
Pyrrhotite	1.5
Smectite (Montmorillonite)	1.0
Marcasite	0.7
Pyrite	0.1

1 Semiquantitative Detection limit ~0.4 wt.%

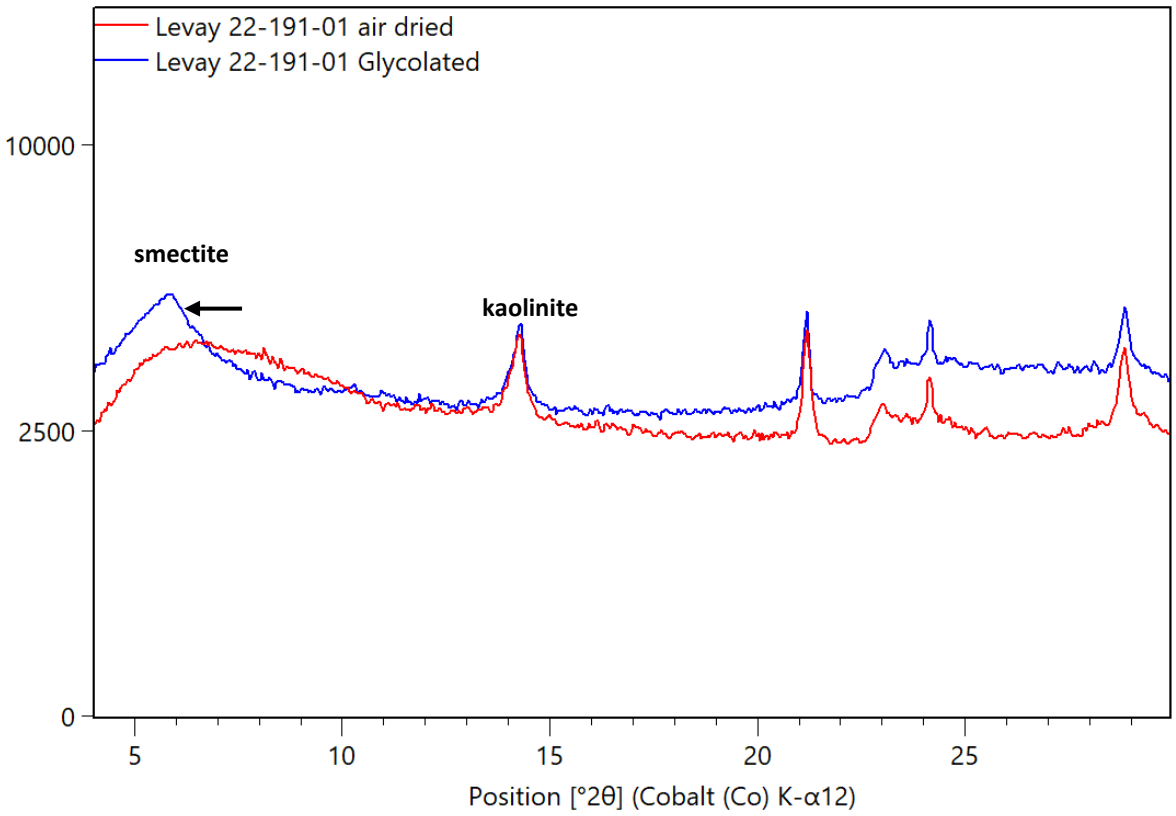
Results Graphical – Phase ID

22-191-01: 2022005_0020 Sample 1 - Tailings



Sedimented and Glycol Treated Samples Result

22-191-01: 2022005_0020 Sample 1 - Tailings



Traces obtained from sedimented air dried and glycolated sample mounts overlaid demonstrate the minor presence of smectite clay (likely montmorillonite).

Attachment K: Soil Water Group laboratory certificates of analysis

SOIL WATER ANALYSIS

45 Gladstone St
East Perth WA 6006
(08) 9228 3060
(08) 9228 3210
admin@soilwatergroup.com
www.soilwatergroup.com

TEST REPORT

Client: RGS Environmental Consultants
Client Contact: Melinda Hilton
Project: Glencore Wandoan
Client Project #:: 2022005
SWA Job No.: JN0809
Date of Analysis: 5th - 30th September 2022
No. Samples Submitted: 3

Method:

• Pressure plate method used in accordance with McKenzie, N., Coughlan, K. and Cresswell, H. (2002). Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing.

• Samples packed to a bulk density of 1.50 g/cm^3 on the pressure plates.

• Samples equilibrated for a 2 week period.

TEST RESULTS

SWA ID	Client ID	Volumetric Moisture Content (%; v/v)					Derived van Genuchten Parameters			
		0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	α (1/cm)	N (-)	θs (cm^3/cm^3)	θr (cm^3/cm^3)
809-01	2021090_C101	37.27	35.56	31.74	22.52	17.34	0.003	2.240	0.3674	0.1709
809-02	2021090_C102	40.26	38.40	33.06	21.56	19.59	0.003	3.110	0.3949	0.1948
809-03	2021090_C103	37.62	34.25	28.13	22.16	19.98	0.006	1.922	0.3743	0.1949

APPROVED SIGNATURE FOR

Adam Pratt
Operations Manager

Attachment L: X-Ray Vision laboratory certificates of analysis

X-ray Vision Australia Pty Ltd
ABN 16 077 701 912
PO Box 8195
Northland Center VIC 3072
M 0418 119 094
E chris.kelaart@xva.com.au

RGS Environmental Consultants Pty Ltd
3/30 Lensworth Street,
Coopers Plains QLD 4108

Attention: Melinda Hilton

March 10, 2024

Report Number: LS3071

Quantitative Analysis of Mineral Materials

Introduction:

Four samples of mineral materials were submitted for qualitative and quantitative phase analysis using X-ray diffraction (XRD).

Sampling & Preparation:

No sampling information was available for the samples submitted. The samples were supplied in a powder form.

The samples were mixed with 20% w/w of zinc oxide to determine the non-crystalline (amorphous) component.

Analytical Method:

The XRD patterns were The XRD patterns were produced using a Bruker-AXS D8 Endeavor XRD with copper radiation at 40 kV and 25 mA, over a range of 5 to 80 degrees 2θ, with an approximately 0.02 degree step and an effective 192 second per step count time using a Lynx-Eye XE-T detector.

The samples were subjected to clay separation treatments with scans over 3.7 to 22 degrees 2θ, with an approximately 0.02 degree step and an effective 192 second per step count time for detailed analysis of the clay components.

Identification of the phases present was carried out using Bruker DIFFRAC.EVA & Search/Match software and the ICDD PDF-5 database (2024) with SIROQUANT version 5 software used to further characterize the samples.

Results:

The XRD scans are attached including the Search/Match information.

Note that the intensity of the peaks in an XRD pattern depend upon the crystallinity as well as the concentration of the phase. The quantitative results are summarised in the following tables:

	SPL ID:	**LS3071-01**	**LS3071-02**
	Customer ID:	**2022005_0087 - C9605GP_SP_05 - Coal - Macalister Lower**	**2022005_0113 - C9610GP_SP_03 - Coal - Wambo**
Phase Name/Formula	**ICDD Ref**	**Weight %**	**Weight %**
Quartz; SiO_2	00-046-1045	≈2	≈6
Kaolinite; $Al_2Si_2O_5(OH)_4$	00-014-0164	≈8	≈11
Muscovite; $KAl_2(Si_3Al)O_{10}(OH,F)_2$	00-006-0263	ND	≈4
Calcite; $CaCO_3$	00-005-0586	≈3	Poss. Trace
Plagioclase Feldspar; $NaAlSi_3O_8$	00-019-1184	ND	Trace
Low Crystallinity Material	N/A	≈87	≈79
Mixed Layer Illite/Smectite	N/A	Probable	Probable

	SPL ID:	**LS3071-03**	**LS3071-04**
	Customer ID:	**2022005_0077 - C6906GP_GC_11 - PR - Macalister Lower**	**2022005_0039 - R9608P_GO_09 - PR - Wambo**
Phase Name/Formula	**ICDD Ref**	**Weight %**	**Weight %**
Quartz; SiO_2	00-046-1045	33	27
Kaolinite; $Al_2Si_2O_5(OH)_4$	00-014-0164	20	15
Muscovite; $KAl_2(Si_3Al)O_{10}(OH,F)_2$	00-006-0263	3	3
Plagioclase Feldspar; $NaAlSi_3O_8$	00-019-1184	6	10
Potassium Feldspar; KAl_3SiO_8	00-031-0966	2	2
Calcite; magnesian; $(Ca, Mg)CO_3$	01-089-1304	2	1
Chlorite; $(Mg, Fe)_6(Si, Al)_4O_{10}(OH)_8$	00-029-0701	Poss. Trace	2
Anatase; TiO_2	00-021-1272		Poss. Trace
Mixed Layer Illite/Smectite	N/A	34	40

Results and Discussion:

The results of the analysis are summarised in the tables and scans attached. Results are given as % of the total.

The scans for the coal samples 1 & 2 showed a significant hump characteristic of semi-crystalline material which was modelled using an amorphous silica structure to estimate the quantitative concentrations of all minerals. These values should be used as a guide only.

The limitations of qualitative XRD analysis are as follows:

1. There is a limit of detection of 1-2% on most crystalline phases.
2. Where there exist multiple phases, overlap of diffracted reflections can occur, thus rendering some ambiguity into the interpretation.
3. Some phases cannot be unambiguously identified as they are present in minor or trace amounts.

The limitations of quantitative XRD analysis by a full-profile Rietveld method are as follows:

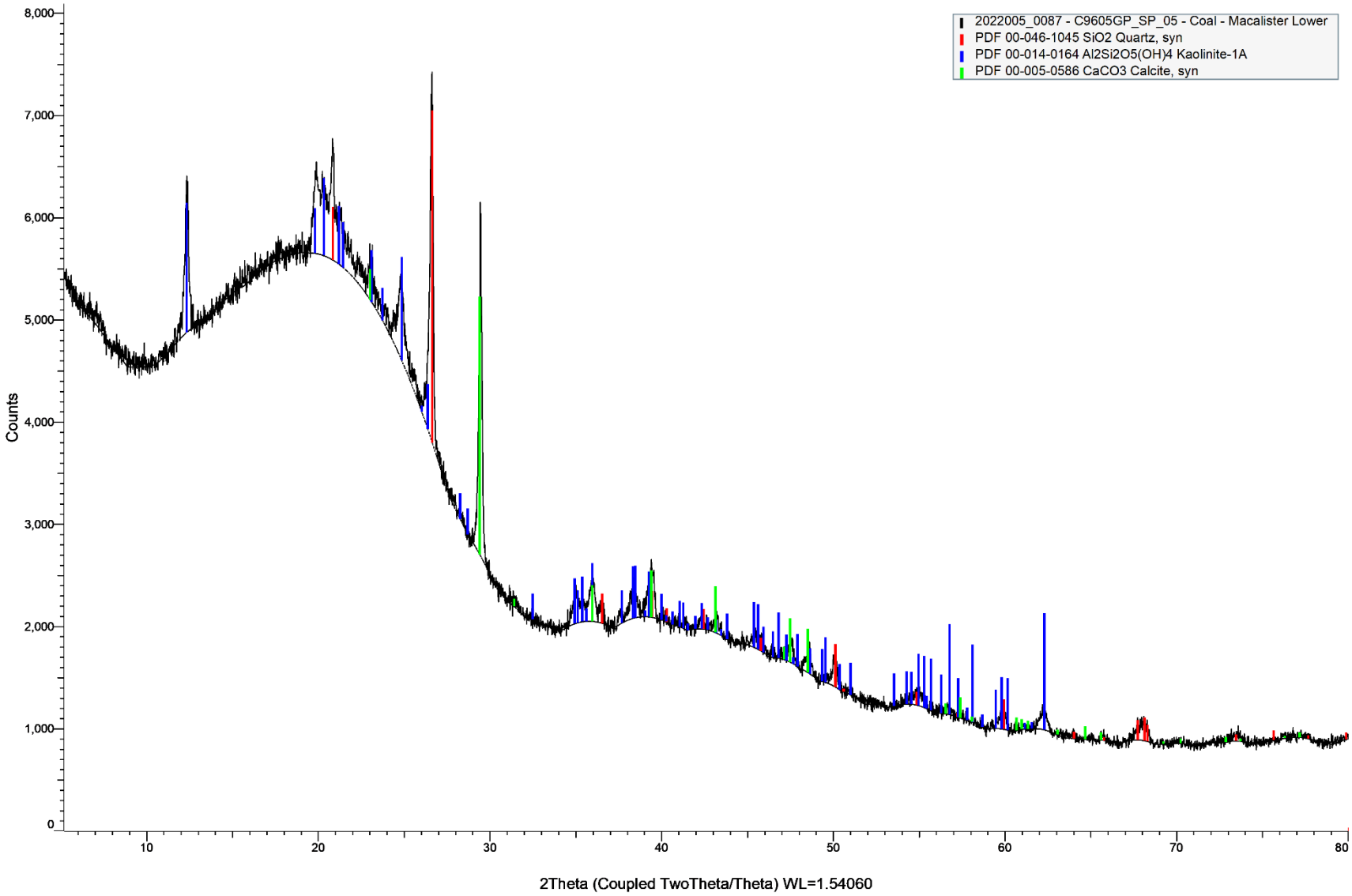
1. The limitations for qualitative XRD analysis all apply
2. The method as described is standardless as it relies solely on the published crystallographic data available for each phase. Some crystallographic data may not exactly describe the phases present.
3. Results are normalized to 100% and do not include estimates of unidentified or amorphous materials unless otherwise stated.

Potential limitations on the quantitative analysis can also include effects from varying crystallinity of each mineral, their preferred orientation in the sample preparation and their differing absorption of the X-rays.

Christopher Kelaart
X-Ray Vision Australia Pty Ltd

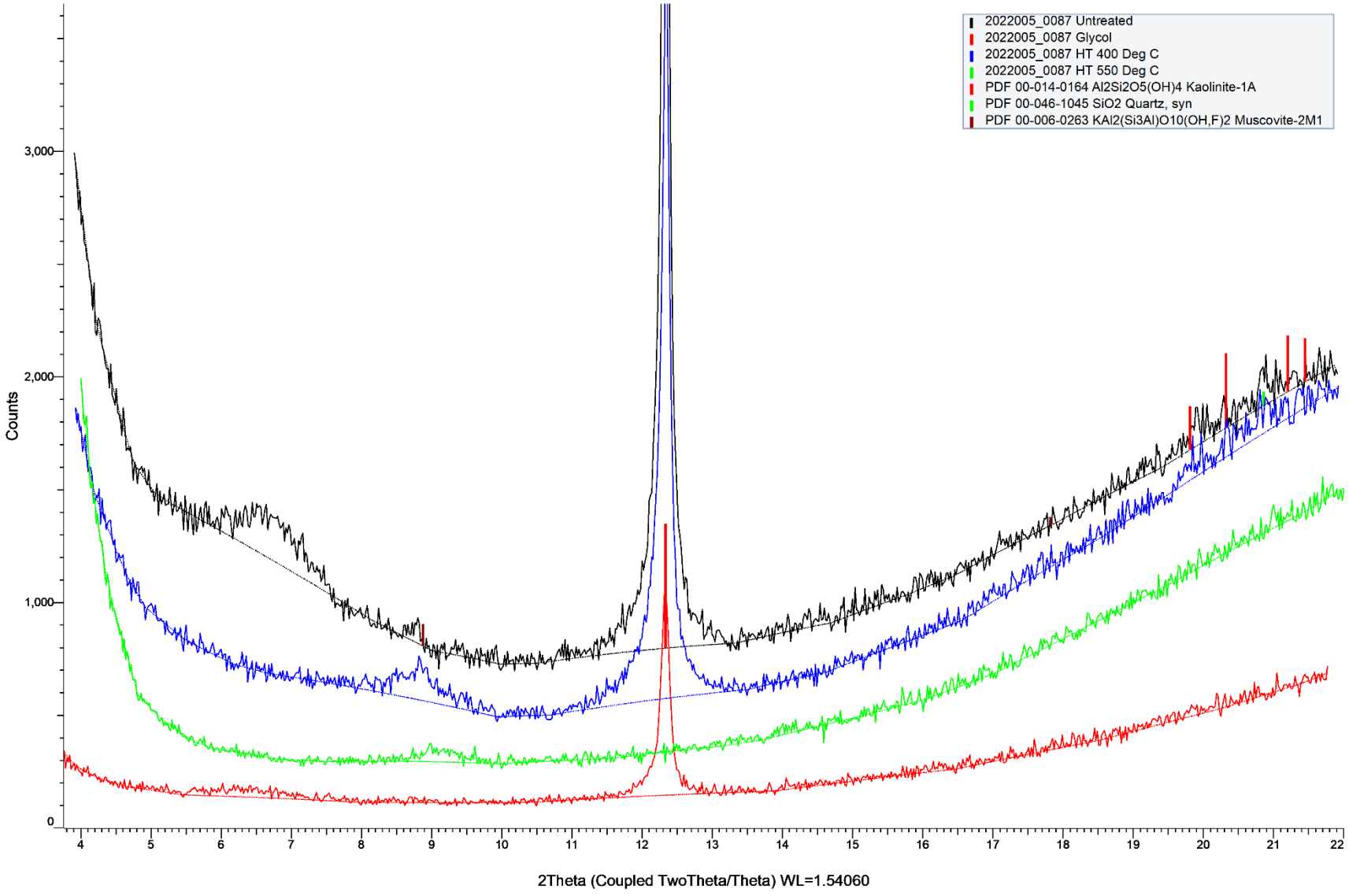
X-RAYvision
AUSTRALIA

LS3071-01 Bulk Sample



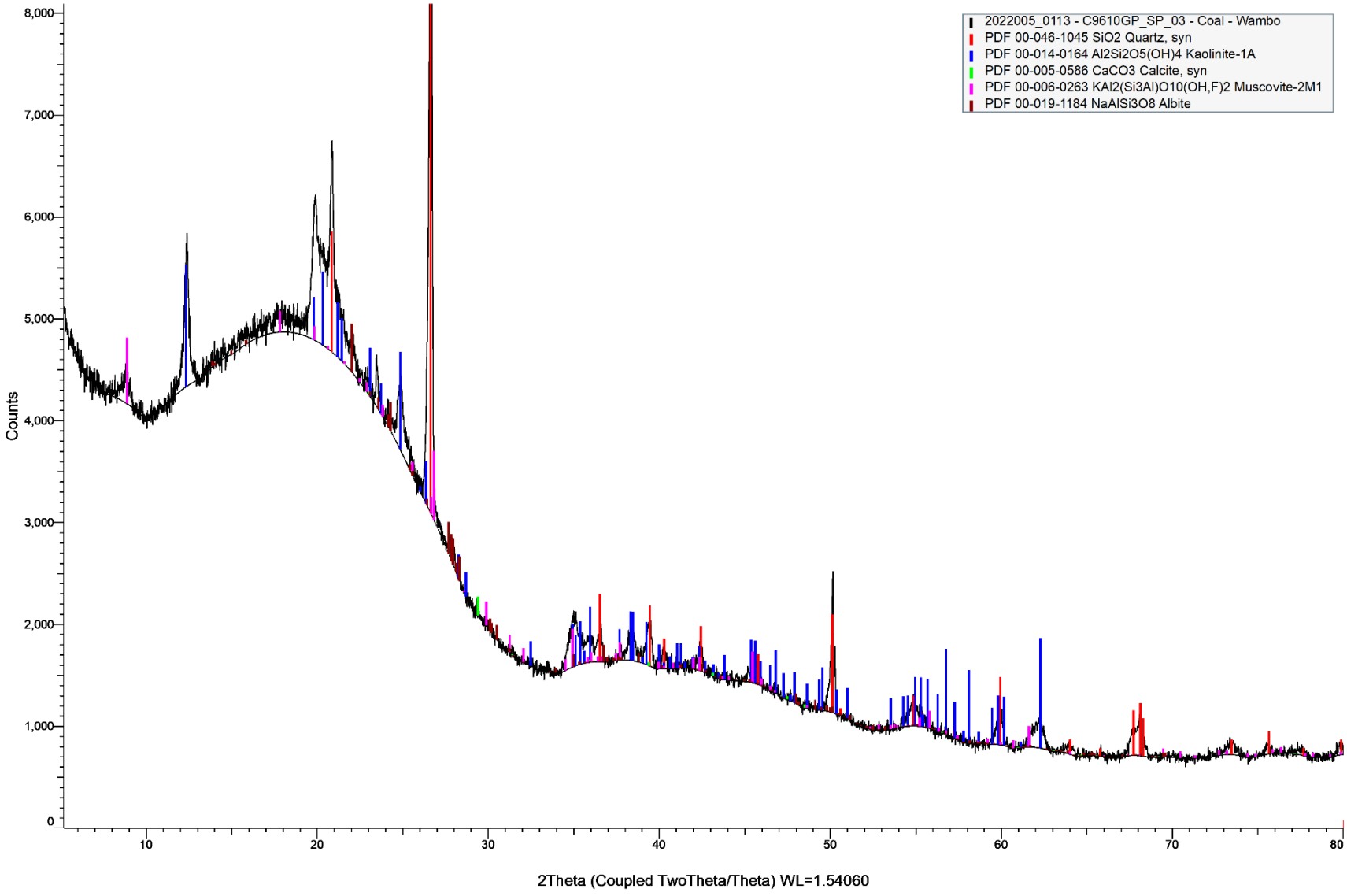
X-RAYvision
AUSTRALIA

LS3071-01 Clay Fraction



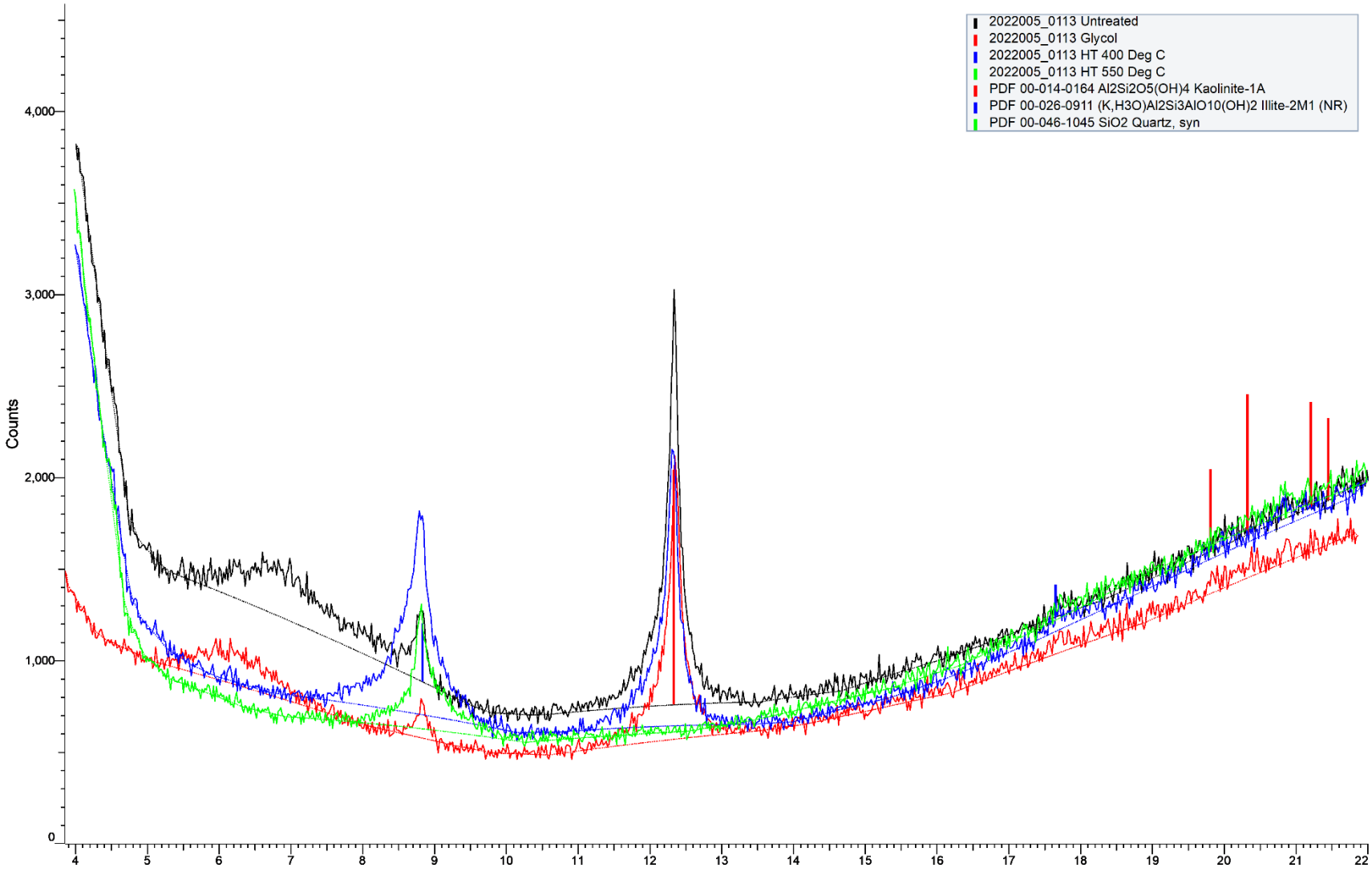
X-RAYvision AUSTRALIA

LS3071-02 Bulk Sample



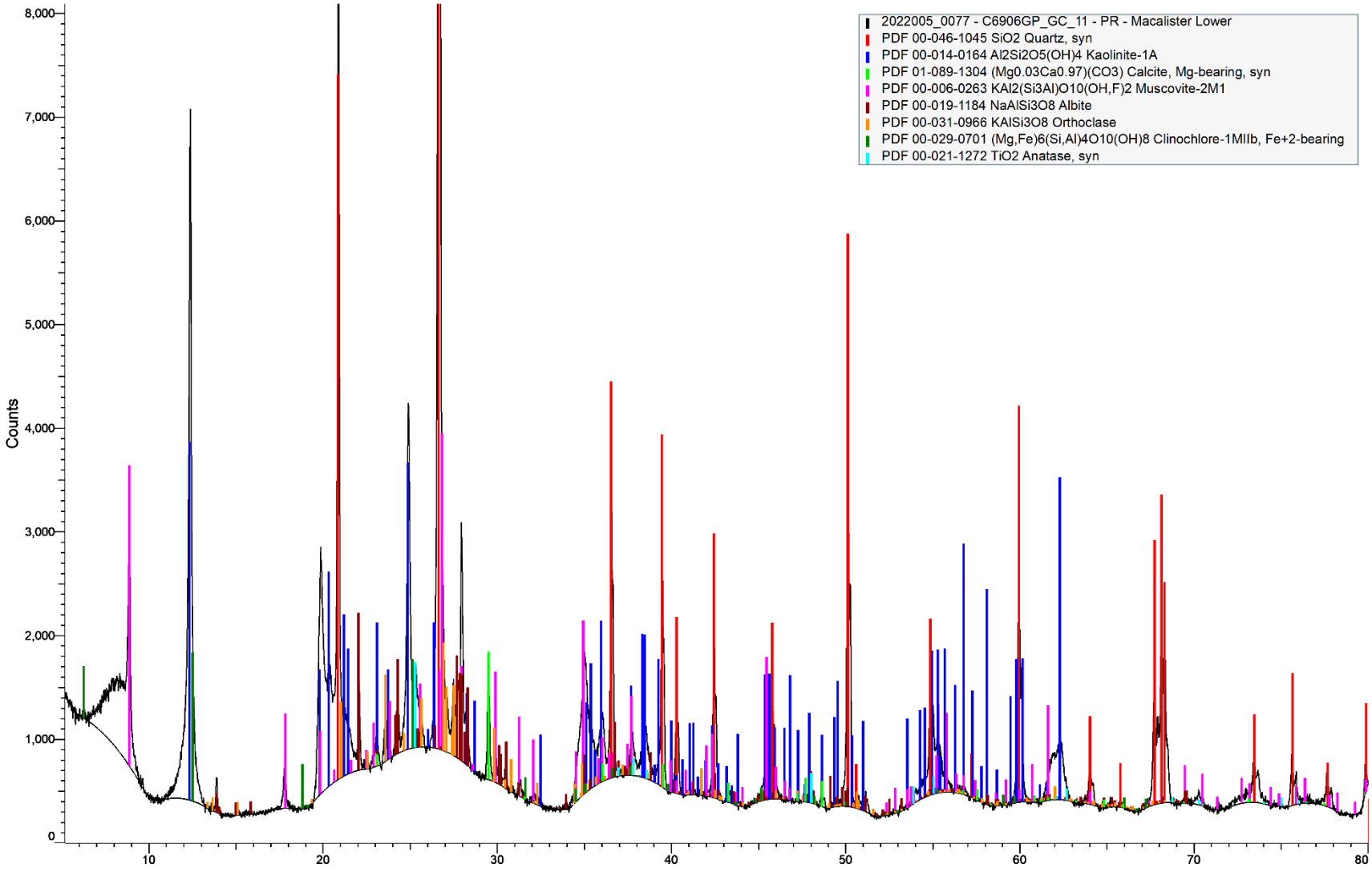
X-RAYvision
AUSTRALIA

LS3071-02 Clay Fraction



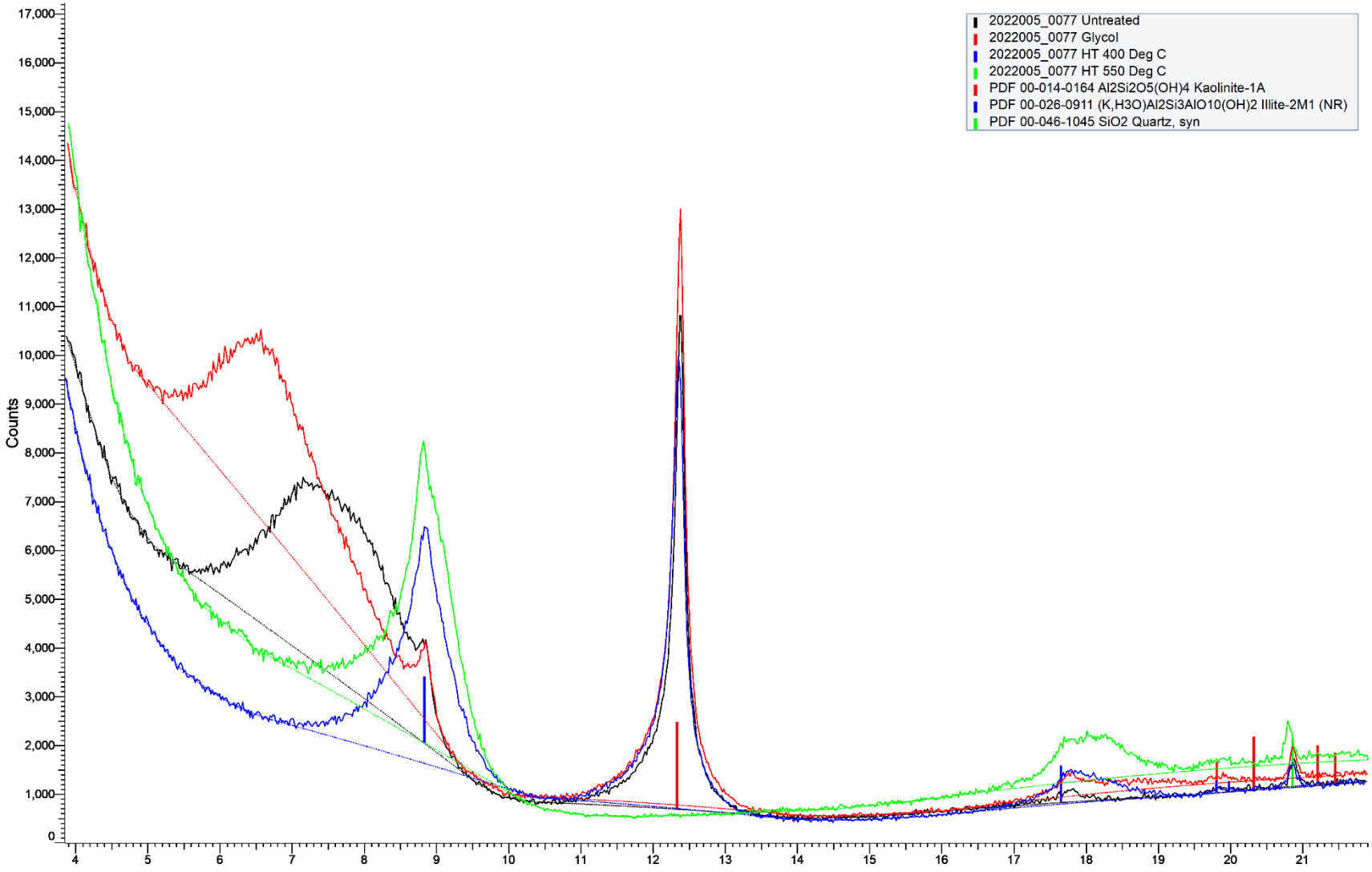
X-RAYvision AUSTRALIA

LS3071-03 Bulk Sample



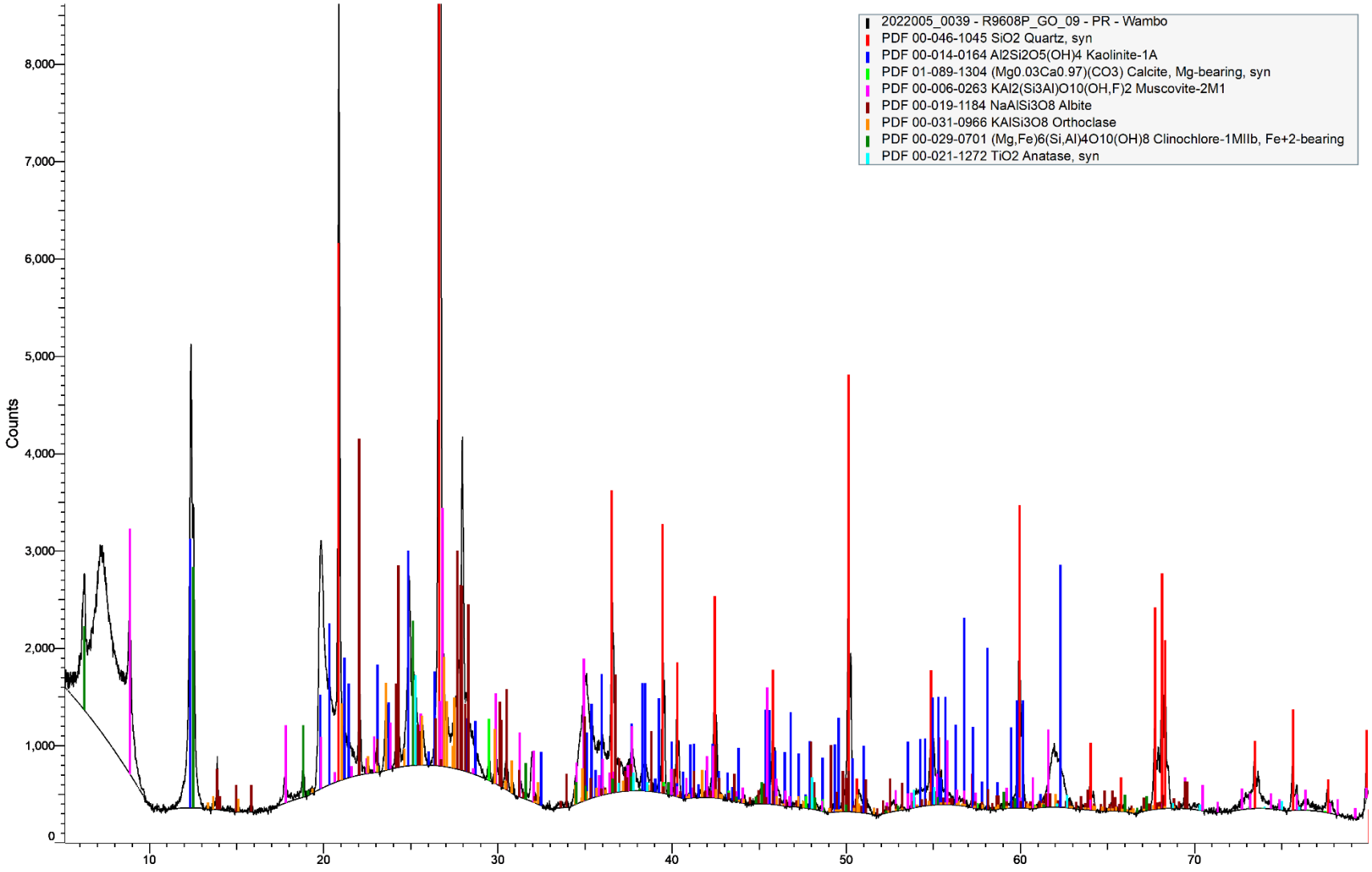
X-RAYvision AUSTRALIA

LS3071-03 Clay Fraction



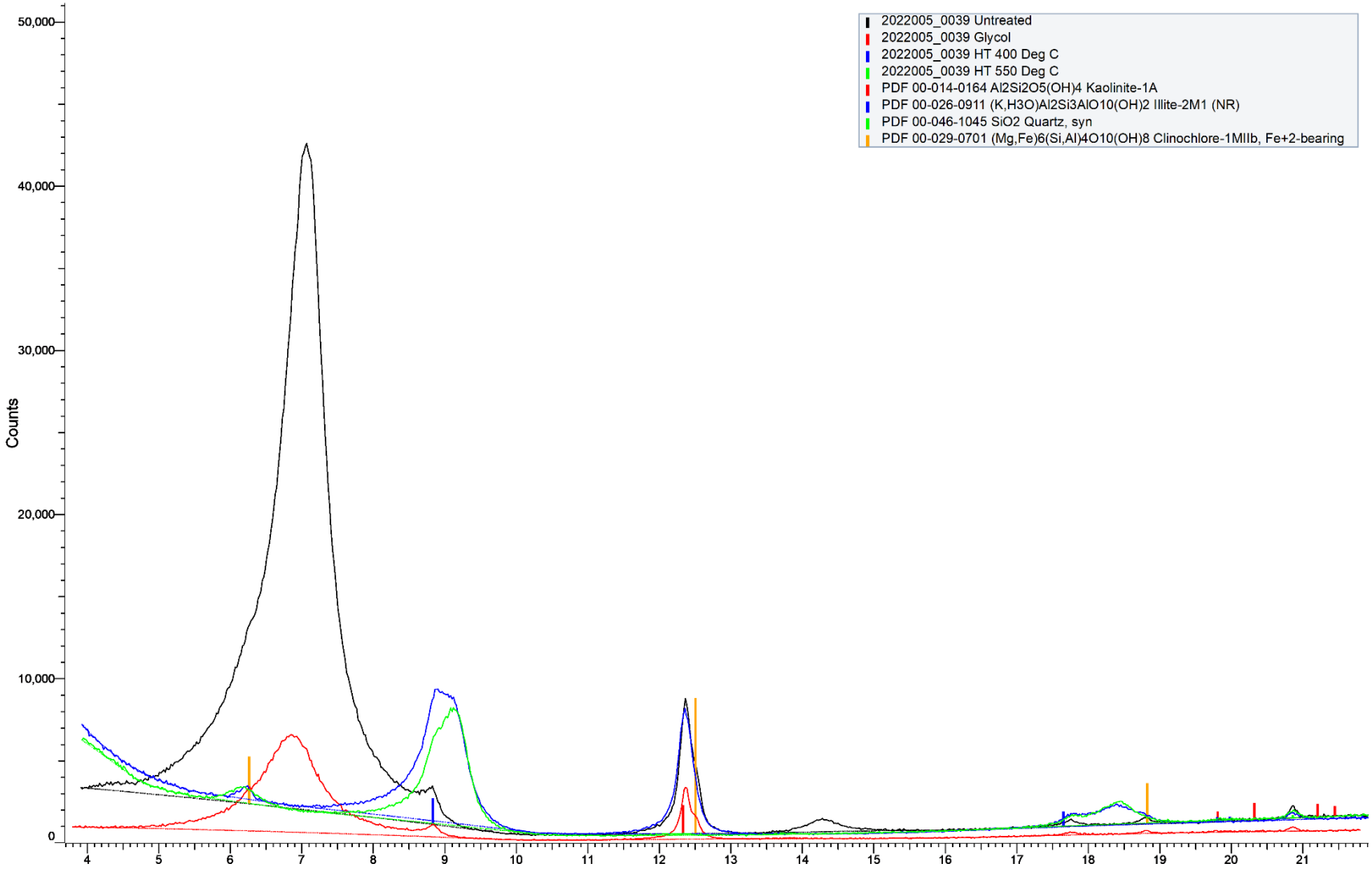
X-RAYvision AUSTRALIA

LS3071-04 Bulk Sample



X-RAYvision AUSTRALIA

LS3071-04 Clay Fraction



MINE WASTE AND
WATER MANAGEMENT

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

Level 23, 300 George Street, Brisbane QLD 4000

Prepared by:

SLR Consulting Australia

Level 1, Suite 1.06, 14 Spence Street, Cairns QLD 4870, Australia

SLR Project No.: 626.30100.00200

12 June 2024

Revision: v2.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	16 February 2024	Rhiannon Williams, Lauren Heilbronn	Scott Harte	Scott Harte
2.0	12 June 2024	Rhiannon Williams, Lauren Heilbronn	John Keep, Scott Harte	Scott Harte

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Glencore Coal Assets Australia Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Basis of Report ..... **i**
1.0 Introduction **1**
1.1 Project background 1
1.2 Study context 1
1.3 Scope of work 1
2.0 Regulatory framework **5**
2.1 Australian Government legislation 5
2.1.1 Environment Protection and Biodiversity Conservation Act 1999 5
2.2 State legislation 5
2.2.1 Environmental Protection Act 1994 5
2.2.2 Vegetation Management Act 1999 5
2.2.3 Nature Conservation Act 1992 6
2.2.4 Biosecurity Act 2014 7
2.2.5 Queensland environmental offsets framework 8
3.0 Methods **8**
3.1 General approach 8
3.2 Nomenclature and taxonomy 8
3.3 Desktop assessment 9
3.3.1 Review of previous studies 9
3.3.2 Database searches 9
3.3.3 Mapping resources 10
3.4 Field survey 11
3.4.1 Flora 12
3.4.2 Fauna 20
4.0 Results **32**
4.1 Regional and local context 32
4.2 Survey conditions 32
4.3 Flora 35
4.3.1 Regional ecosystems 35
4.3.2 Threatened ecological communities 42
4.3.3 Environmentally sensitive areas 44
4.3.4 Regulated vegetation 44
4.3.5 Vegetation condition 46
4.3.6 Native flora species 46

4.3.7 Conservation significant flora species 50
4.3.8 Weed species 54
4.4 Fauna 58
4.4.1 Fauna habitats 58
4.4.2 Fauna species 62
4.4.3 Pest species 87
5.0 Summary 94
5.1 Matters of national environmental significance 94
5.2 Matters of state environmental significance 94
5.3 Constraints heatmap 94
5.4 Further survey 95
6.0 References 97

Tables in Text

Table 1 Key assessment criteria for likelihood of occurrence of conservation significant species 10
Table 2 Condition categories and thresholds for the Poplar Box TEC (DoEE, 2019) 15
Table 3 Scoring and weighting of site-based attributes 17
Table 4 Description of BioCondition classes 17
Table 5 Systematic fauna survey techniques 21
Table 6 Systematic fauna survey effort 22
Table 7 Targeted survey techniques and effort 24
Table 8 Species habitat attributes and corresponding factors 29
Table 9 Weather conditions during the survey periods 32
Table 10 State-mapped and PBA verified regional ecosystems in the study area 35
Table 11 Ground-truthed regional ecosystems in the study area 37
Table 12 Summary of BioCondition assessment results 46
Table 13 Conservation significant flora species identified from database searches 51
Table 14 Listed weeds recorded in the study area 55
Table 15 Systematic fauna survey sites and corresponding habitat 60
Table 16 Conservation significant fauna species identified from database searches 64
Table 17 Average species habitat scores for conservation-significant fauna species and vegetation community (RE) 86
Table 18 Combination of average BioCondition and species habitat scores to determine final habitat quality score 86

Figures in Text

Figure 1 Project location 3
Figure 2 Project layout and study area 4
Figure 3 Vegetation management regional ecosystem map and flora survey locations 19
Figure 4 General habitat assessments and systematic fauna trap sites 28
Figure 5 Targeted fauna surveys and habitat quality assessments 31
Figure 6 Mean (1912-2024) and total monthly rainfall (January 2023-February 2024) recorded at the Woleebee Nevasa Station (BoM, 2024) 34
Figure 7 Ground-truthed regional ecosystems 47
Figure 8 Confirmed and potential TECs and Category B ESAs 48
Figure 9 Field-verified regulated vegetation in the study area 49
Figure 10 Suitable habitat for Belson's Panic 56
Figure 11 Weed species locations 57
Figure 12 Fauna habitats in the study area 88
Figure 13 Conservation significant fauna species recorded in the study area 89
Figure 14 Suitable habitat for Glossy Black-Cockatoo in the study area 90
Figure 15 Suitable habitat for Koala in the study area 91
Figure 16 Suitable habitat for Central Greater Glider in the study area 92
Figure 17 Suitable habitat for Golden-tailed Gecko in the study area 93
Figure 18 Constraints heatmap 96

Photos in Text

Photo 1 RE 11.3.2 40
Photo 2 RE 11.3.25 40
Photo 3 RE 11.9.2 40
Photo 4 RE 11.9.5 40
Photo 5 RE 11.9.7 40
Photo 6 RE 11.9.10 40
Photo 7 Non-remnant 41

Appendices

Appendix A EPBC Act Protected Matters Report

Appendix B WildNet Species List

Appendix C Species Lists

C.1 Flora species recorded in the study area

C.2 Fauna species recorded in the study area

C.3 Fauna species recorded during the 2023 post-wet season survey

C.4 Fauna species recorded during the 2023 pre-wet season survey

Appendix D Ground-truthed Regional Ecosystems

D.1 Descriptions, floristic composition and structure of ground-truthed REs within the study area

Appendix E Flora Survey Trigger Map

Appendix F Likelihood of Occurrence

F.1 Likelihood of occurrence assessments for conservation significant flora species identified in database searches

F.2 Likelihood of occurrence assessments for conservation significant fauna species identified in database searches

1.0 Introduction

1.1 Project background

Wandoan Holdings Pty Limited (WHPL) on behalf of the Wandoan Joint Venture (WJV) parties (i.e., Wandoan Holdings Pty Limited and Scap Wandoan Pty Ltd), engaged SLR Consulting Australia Pty Ltd (SLR) to undertake a terrestrial ecology assessment for the development of the Wandoan Coal Project (WCP) Progressive Rehabilitation and Closure Plan (PRCP) and to contemporise the environmental approvals for the WCP.

The intent of this report is to provide detailed methods and results that describe the ecological values and constraints present in the study area (and their condition), for use in the PRCP and in future impact assessment rather than produce a detailed impact assessment.

The WCP is an approved open-cut coal mine, located in the Western Downs region of Queensland approximately 300 kilometres (km) southeast of Emerald and 250 km southwest of Gladstone (**Figure 1**). The WCP was issued with State and Federal environmental approvals between 2011 and 2013, with Mining Leases (ML) granted in 2017. The mine is authorised under a single Environmental Authority (EA) (EPML00297613) and operates on three MLs, ML50229, ML50230 and ML50231. Approval under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the WCP was granted on 14 March 2011 (EPBC No 2008/4284). The WCP has remained undeveloped.

1.2 Study context

For the purpose of this assessment and report, the study area comprised ML50230, ML50231 and an area in the southwest where Jackson Wandoan Road intersects Woleebee Creek (shown on **Figure 2**). The outline of the proposed disturbance footprint is for the first 35 years of mining at the WCP (within ML50230 and ML50231).

In 2007 and 2008, terrestrial ecology surveys were undertaken by Parsons Brinkerhoff Australia Pty Ltd (PBA) for the Environmental Impact Assessment (EIS) for the WCP.

Due to the time period since last assessed and revised Federal and State approval requirements during this period, comprehensive baseline surveys of all current protected matters within the study area were undertaken.

1.3 Scope of work

The baseline surveys were designed to determine the presence and describe the extent of ecological values in the study area. In addition to baseline surveys, the condition and extent of Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES) likely to require offsets under the EPBC Act and/or the Queensland *Environmental Offsets Act 2014* (EO Act) were assessed.

SLR undertook field surveys in spring 2023 and autumn 2023 and 2024 (in line with recommendations provided in Eyre *et al.* (2022a) for the Brigalow Belt bioregion). The field survey included the collection of contemporary and baseline information on the following:

- The extent and condition of vegetation communities within the proposed disturbance footprint;
- Targeted surveys to identify the likely occurrence of critically endangered, endangered, vulnerable, near threatened, migratory or special least concern flora

and fauna species (as listed under the Queensland *Nature Conservation Act 1992* and the EPBC Act) and their habitats;

- The location and abundance of pest flora and fauna species, particularly restricted pest species listed under the Queensland *Biosecurity Act 2014* (Biosecurity Act) or Australian Government Weeds of National Significance (WoNS); and
- Vegetation/habitat condition assessments for MNES and MSES likely to require offsets under the EPBC Act and/or EO Act.

This Terrestrial Ecology Technical Report, outlines the following:

- Vegetation community descriptions (including regulated vegetation);
- The presence/absence of conservation significant flora and fauna species and their habitats;
- The location and abundance of pest flora and fauna species;
- A general description of the fauna assemblage and fauna habitat values within the study area;
- Connectivity values associated with remnant vegetation within the study area; and
- The presence, nature and condition of MNES and MSES in the study area.

800,000
900,000
1,000,000
1,100,000
7,300,000
7,200,000
7,100,000

GLADSTONE
BUNDABERG
TAROOM
WANDOAN
GYMPIE

Dawson Highway
Burnett Highway
Leichhardt Highway
Bruce Highway
Childers Road
Isis Highway
Wide Bay Highway

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

PROJECT LOCATION

FIGURE 1

LEGEND

- Town/City
- State Controlled Road
- Railway
- Wandoan Mining Lease

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 10 20 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,000,000 at A3
Project Number:	626.30100.00200
Date Drawn:	12-Feb-2024
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp31992\Untitled\Untitled.aprx

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

PROJECT LAYOUT

FIGURE 2

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Juandah Creek

Groamont Road

Leichhardt Highway

Jackson Wandoan Road

ML 50231

ML 50230

Waleebee Creek

LEGEND

- Hydrogen Facility and Ancillary infrastructure
- Wandoan Mine Infrastructure
- Main Road
- Major Watercourse
- Study Area
- Wandoan Mining Lease
- Pit Extent

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	21-Dec-2023
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp48400\Untitled\Untitled.aprx

2.0 Regulatory framework

2.1 Australian Government legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW). The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES). The MNES listed in the EPBC Act that are relevant to this report are:

- Nationally threatened species and ecological communities; and
- Migratory species.

EPBC Act approval for the WCP was granted on 14 March 2011 (EPBC No 2008/4284) and authorised impacts to listed threatened species and communities.

2.2 State legislation

2.2.1 Environmental Protection Act 1994

The Queensland *Environmental Protection Act 1994* (EP Act) regulates environmentally relevant activities (ERAs). The Queensland Department of Environment, Science and Innovation (DESI) assesses applications to undertake ERAs, and issues EAs that identify environmental conditions to be met to ensure the prevention or minimisation of environmental harm caused by the authorised ERAs. The mine is authorised under a single EA (EPML00297613) and three MLs: ML50229, ML50230 and ML50231.

Environmentally Sensitive Areas (ESAs) are defined under Schedule 19 of the Queensland *Environmental Protection Regulation 2019* (EP Regulation), and are regulated in accordance with the following documents:

- Eligibility criteria and standard conditions for exploration and mineral development projects – Version 2; and
- Eligibility criteria and standard conditions for mining lease activities – Version 2.

2.2.2 Vegetation Management Act 1999

The Queensland *Vegetation Management Act 1999* (VM Act) is administered by the Queensland Department of Resources (DoR) and protects Queensland's biodiversity by conserving native vegetation and addressing land degradation issues.

Queensland's vegetation management framework regulates the clearing of certain native vegetation. Regional Ecosystem (RE) maps published by DoR and DESI describe the extent and conservation status of vegetation communities in Queensland. The classification of REs is relevant to identifying vegetation communities of conservation significance in a regional context, including those classified as ESAs, and potential environmental offset requirements under the Queensland environmental offsets framework.

2.2.3 Nature Conservation Act 1992

The Queensland *Nature Conservation Act 1992* (NC Act) is administered by DESI and provides the framework for the declaration and management of protected areas, and protection of wildlife listed under the Queensland *Nature Conservation (Animals) Regulation 2020* (NC Animals Regulation), the Queensland *Nature Conservation (Plants) Regulation 2020* (NC Plants Regulation) and the Queensland *Nature Conservation (Protected Areas Management) Regulation 2017* (NC Protected Areas Regulation).

2.2.3.1 Protected areas

Protected areas are declared under the NC Act for the conservation of Queensland's natural and cultural resources. Classes of protected areas under the NC Act include national parks, regional parks and nature refuges. An environmental offset may be required for actions resulting in significant residual impacts within a protected area.

Under the Queensland environmental offsets framework, an impact on a protected area is significant if a prescribed activity results, or is likely to result, in one or more of the following:

- Authorised clearing or inundation of all or part of the protected area for the construction of private or publicly owned infrastructure on the area;
- The exclusion of, or reduction in, the public use or enjoyment of all or part of the protected area; and
- A reduction in the natural or cultural values of all or part of the protected area.

2.2.3.2 Protected wildlife

The purpose of the NC Animals Regulation and NC Plants Regulation is to prescribe wildlife as one of the following classes of wildlife:

- Extinct in the wild;
- Critically endangered;
- Endangered;
- Vulnerable;
- Near threatened;
- Special least concern; and
- Least concern.

Threatened wildlife under the NC Act is wildlife prescribed as extinct in the wild, critically endangered, endangered or vulnerable. All native flora and fauna species are protected under the Act, and 'permits to take' protected wildlife are required from DESI.

DESI provides the WildNet database, which can be searched to generate a list of all species recorded within a specified area. This tool is useful for determining the presence or likelihood of occurrence of threatened species in an area.

A Protected Plants Flora Survey Trigger Map is also available, which shows high risk areas for protected plants (those listed as critically endangered, endangered, vulnerable or near threatened under the NC Act) and is used to help determine flora survey and clearing permit requirements for a specified area. If the study area is located within a high-risk area, a comprehensive flora survey is required to be undertaken before any clearing of protected plants can occur. This survey must comply with Queensland's Flora Survey Guidelines – Protected Plants v2.01 (DESI, 2020a).

If protected plants are found to occur within the high-risk area during the field survey and these are likely to be cleared or impacted by the proposed project, an application for a clearing permit from DESI will be required. This application must be accompanied by the flora survey results and potential impact management options for the protected plants that include appropriate avoidance, mitigation or offsetting measures.

In addition, if protected plants are found outside a high-risk area during the field survey, and these plants are likely to be cleared or impacted by the proposed project, a clearing permit will also be required. Where a flora survey identifies that there are no protected plants present or impacts can be avoided, clearing will be exempt from requiring a permit under the NC Act.

2.2.4 Biosecurity Act 2014

The Queensland *Biosecurity Act 2014* (Biosecurity Act) and the Queensland *Biosecurity Regulation 2016* defines three types of invasive plant species:

- Prohibited invasive plants: Plants not considered to be present in Queensland;
- Restricted Invasive plants: Established plants that are considered a threat to Queensland's primary industries and environment; and
- Invasive plants.

Under the Biosecurity Act, restricted invasive plants may fall into one or more categories, with different restrictions relevant to each category.

Restricted invasive plant categories and restrictions:

- Category 2: the invasive plant must be reported within 24 hours to Biosecurity Queensland;
- Category 3: the invasive plant must not be distributed or released into the environment;
- Category 4: the invasive plant must not be moved; and
- Category 5: the invasive plant must not be kept.

Invasive plants include species that are not listed as prohibited or restricted invasive plants, but the species has, or is likely to have, an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of said species in an area. Everyone is required under their 'general biosecurity obligation' (GBO) to take all reasonable and practical steps to minimise the risks associated with invasive plants under their control.

Invasive animals are classified in a similar manner to plants and include prohibited and restricted classifications. Landholder responsibilities and restrictions pertaining to these classifications are specific for each category and an invasive animal may be listed under multiple categories. Category actions that must or must not be carried out are defined under the Biosecurity Act, however, additional obligations may be specified in the relevant local government Biosecurity Plan.

The following categories of restricted invasive animals are relevant to this report:

- Category 3: The invasive animal must not be distributed either by sale or gift, or released into the environment;
- Category 4: The invasive animal must not be moved;
- Category 5: The invasive animal must not be kept; and

- Category 6: The invasive animal must not be fed.

2.2.5 Queensland environmental offsets framework

The Queensland environmental offsets framework includes an Act (EO Act), a regulation and a single policy, which replaces the five previous single-issue policies.

The Queensland *Environmental Offsets Regulation 2014* (EO Regulation) provides details of the prescribed activities regulated under legislation and the prescribed environmental matters (*i.e.*, MSES) to which the framework applies. The MSES relevant to this report are:

- Regulated vegetation; and
- Protected wildlife habitat.

For any new development, all impacts to MSES must be avoided or minimised where possible. Where there is a significant residual impact to MSES, an environmental offset may be required in accordance with the Queensland Environmental Offsets Policy.

3.0 Methods

3.1 General approach

The following tasks have been undertaken to identify the terrestrial ecology values in the study area.

- Desktop assessment involving:
  - review of previous studies;
  - database searches for species records and habitats; and
  - review of mapping resources relevant to the scope.
- Flora and fauna surveys including:
  - vegetation community mapping and assessments;
  - systematic, targeted and incidental flora surveys; and
  - systematic, targeted and incidental fauna surveys.

Apart from technical descriptions and tables, all flora and fauna species are referred to by their common names throughout this report, with their scientific names given in brackets after the first reference.

3.2 Nomenclature and taxonomy

Scientific names for flora species within this report follow the *Census of the Queensland Flora and Fungi* 2022 (Laidlaw, 2022). Where no common name is provided in reference texts, a search was conducted for other accepted common names and, if none were found, only the scientific name was used.

The use of scientific and common names for fauna species is in accordance with the following:

- Birds: Australian Bird Guide (ABG): Menkhorst *et al.* (2017);
- Amphibians: Vanderduys (2012);
- Reptiles: Wilson & Swan (2021);

- Mammals (except bats and Greater Glider): Baker & Gynther (2023); and
- Bats: Armstrong *et al.* (2020).

The taxonomic classification of the Greater Glider is currently uncertain following genetic analysis by McGregor *et al.* (2020) that supports an earlier classification of the Greater Glider as three distinct species. The proposed split of Greater Gliders results in the populations from central Queensland to Taravale north of Townsville being classified as Central (*Petauroides armillatus*), populations north from Taravale to the Windsor Tablelands to be classified as Northern (*Petauroides minor*) and populations south from approximately Bundaberg, Queensland to Victoria being classified as Southern Greater Glider (*Petauroides volans*) (McGregor *et al.*, 2020).

The current Australian Government EPBC listing of *Petauroides volans* (Southern and Central Greater Glider) encompasses the Central and Southern Greater Gliders populations. The NC Act listing uses the nomenclature specifically for the Central Greater Glider (*Petauroides armillatus*).

Until the ambiguity with the taxonomy is resolved and the split is formally recognised, in this report *P. armillatus* will be recognised as a distinct species based on genetic analysis by McGregor *et al.* (2020). *P. volans* is herein considered to be synonymous with *P. armillatus*.

3.3 Desktop assessment

3.3.1 Review of previous studies

A gap analysis was undertaken by SLR to assist WHPL in understanding the specialist work required to support contemporising the environmental approvals for the WCP. Terrestrial ecology surveys and assessments were undertaken by PBA for the WCP to support an EIS in 2007 and 2008. The following documents prepared as part of the WCP EIS were reviewed during the desktop assessment:

- WCP Mining Lease Application (MLA) area and surrounds: Terrestrial ecology impact assessment (PBA, 2008a);
- WCP EIS: Terrestrial ecology chapter (PBA, 2008b);
- WCP Draft Biodiversity Offsets Strategy (PBA, 2008c);
- WCP MLA areas and gas supply pipeline: Supplementary terrestrial ecology impact assessment (PBA, 2009a); and
- WCP, Supplementary EIS: Terrestrial ecology chapter (PBA, 2009b).

3.3.2 Database searches

The following databases were searched to determine conservation-significant species[1], communities, and areas of conservation significance with potential relevance to the study area.

- DCCEEW Protected Matters Search Tool (PMST) (DCCEEW, 2023a; **Appendix A**) – 10 km search area around the boundary of ML50230 and ML50231;

[1] Includes species listed as critically endangered, endangered, vulnerable, near threatened, special least concern or migratory under the NC Act and/or the EPBC Act.

- Queensland Government WildNet database (DESI, 2023a; **Appendix B**) – 30 km search around a point central to the study area (-26.0767, 149.8485); and
- Atlas of Living Australia (ALA) database (ALA, 2023) – used to review records of conservation significant species in proximity to the study area.

SLR has developed an approach to determine the likelihood of occurrence of conservation significant species within the study area. The approach is based on the presence of local records and/or distribution modelling and the habitat requirements for each species, in accordance with recommendations for desktop impact assessment in Eyre *et al.,* (2022a). Details of the criteria used to assess the likelihood of occurrence for conservation significant species are provided in **Table 1**.

Table 1 Key assessment criteria for likelihood of occurrence of conservation significant species

Likelihood of occurring	Key criteria	Definition
Present	Present during survey or historical records in the study area.	Species was recorded during current or previous field surveys, or a historical record of the species was located in the study area.
High	Known records (< 30 km) or within species core range, AND Suitable habitat of high quality is present.	Historical records of the species occur within a 30 km radius of the study area, or the study area is within the species known range. Suitable habitat of high quality exists with the study area.
Moderate	Known records (< 30 km) or within species non-core range, AND Potentially suitable habitat is present, but sub-optimal or degraded.	Historical records of the species occur within a 30 km radius of the study area, or the study area is within the species known range. Potentially suitable habitat is present but is sub-optimal for the species or significantly degraded or fragmented.
Low	No records (< 30 km) and not within species known range, OR Habitat present is unsuitable, absent, or highly degraded.	No historical records of this species occur within a 30 km radius of the study area and/or the study area is not within the known range for this species, OR The habitat within the study area is not suitable and/or is in extremely poor condition or is absent for the species.

3.3.3 Mapping resources

The following mapping resources were reviewed as part of the desktop analysis:

- Queensland Globe interactive mapping (QLD Globe, 2023) including:
  - Vegetation Management RE map (DoR, 2023a);
  - Vegetation Management watercourse and drainage feature map (DoR, 2023b);
  - surface geology mapping (DoR, 2023c);

  - DESI RE mapping (DESI, 2023b);
  - Atlas of Australian Soils mapping (ASRIS, 2023);
  - protected plants flora survey trigger mapping (DESI, 2023c);
  - essential habitat mapping (DoR, 2023d);
  - Broad Vegetation Group (BVG) mapping (1:2 million scale) (DESI, 2023d); and
  - protected areas and forests (DESI, 2023e).
- DESI environmental reports:
  - MSES mapping (DESI, 2023f); and
  - maps of ESAs (DESI, 2023g).
- DoR Vegetation Management Property reports (DoR, 2023e).

3.4 Field survey

There is a two-season climatic pattern in northern Australia and seasonal variation was specifically incorporated into the survey design. This approach ensured that the surveys were undertaken at optimal times of year. Field surveys were undertaken in autumn (*i.e.,* March to mid-May) and in spring (*i.e.,* September to mid-November) in line with recommendations in Eyre *et al.* (2022a) and Eyre *et al.* (2015), as follows:

- A post-wet season/autumn survey was undertaken at the study area by two teams of two ecologists between 9 and 22 March 2023. It is important to survey at this time of year because many fauna species are active after wet season rains, and vegetation is in peak condition.
- A pre-wet season/spring survey was undertaken at the study area by two teams of two ecologists between 18 and 27 October 2023. As temperatures begin to warm up after winter there is a peak in vertebrate activity with the commencement of breeding activity in many species.
- A post-wet season/autumn survey was undertaken at the study area by two teams of two ecologists between 2 and 8 March 2024. These surveys targeted threatened bat species potentially occurring within the study area and provided greater resolution for vegetation communities in the study area.

Survey methods and effort outlined in the following relevant guideline documents was incorporated into the design and implementation of the survey program as appropriate:

- Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (Neldner *et al.,* 2022);
- BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland (Eyre *et al.,* 2015);
- Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland (Eyre *et al.,* 2022a);
- Survey guidelines for Australia's threatened birds (DEWHA, 2010a);
- Survey guidelines for Australia's threatened bats (DEWHA, 2010b);
- Survey guidelines for Australia's threatened reptiles (DSEWPC, 2011a);
- Survey guidelines for Australia's threatened mammals (DSEWPC, 2011b);

- Glossy black-cockatoo, *Calyptorhynchus lathami.* Targeted species survey guidelines (Hourigan, 2012);
- Painted honeyeater *Grantiella picta*. Targeted species survey guidelines. (Rowland, 2012a);
- A review of koala habitat assessment criteria and methods (Youngentob *et al.*, 2021);
- Common death adder *Acanthophis antarcticus*. Targeted species survey guidelines. (Rowland & Ferguson, 2012); and
- Grey snake, *Hemiaspis damelii*. Targeted species survey guidelines (Rowland, 2012b).

Flora and fauna survey tasks broadly included the following (which are described in detail below):

- Flora survey:
  - vegetation community assessment and mapping;
  - targeted survey for conservation significant flora species; and
  - weed survey.
- Fauna survey:
  - habitat assessments;
  - systematic survey;
  - targeted survey for conservation significant fauna species; and
  - pest fauna survey.

3.4.1 Flora

3.4.1.1 Vegetation community assessment and mapping

Regional ecosystem verification

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil (Sattler & Williams, 1999). Verification of the REs in the study area was undertaken via tertiary and quaternary assessments. Tertiary assessments were undertaken for classification and detailed descriptions of REs that were widespread/common in the study area. More rapid, quaternary assessments were undertaken as a record of field traverses and to verify regional ecosystem/vegetation mapping throughout the study area.

The assessments were undertaken in accordance with Neldner *et al.* (2022) as follows:

- Five tertiary assessments were undertaken (presented on **Figure 3**) which involved collection of the following information in a 10 m x 50 m plot:
  - location (measured using a hand-held GPS);
  - landform, geology, and soils (determined by field observations and mapping resources);
  - overall vegetation structural information;
    - mean height of each layer (measured using a clinometer); and

    - cover of each layer (using the line intercept method).
  - comprehensive list of woody species;
  - individual woody species cover by layer (using the line intercept method);
  - woody species basal area measure of abundance (using the Bitterlich stick method) and stem counts; and
  - dominant or conspicuous species in the ground layer (as a minimum).
- 176 quaternary assessments were undertaken (presented on **Figure 3**) which involved collection of the following information:
  - location;
  - landform, geology and soils;
  - vegetation structure including height of each stratum and cover density; and
  - key species within each stratum.

To identify the RE types in the study area, data from the tertiary and quaternary sites were compared to RE descriptions in the Queensland Herbarium's Regional Ecosystem Description Database (REDD) (Queensland Herbarium, 2023a) and RE Technical Descriptions (Pollock, 2018).

The remnant status of the vegetation (*i.e.,* whether it was remnant, high value regrowth (HVR) or non-remnant) was determined using species composition, vegetation height and vegetation cover data from the tertiary and quaternary sites, compared to the BioCondition Benchmark values (Queensland Herbarium, 2023b) for each RE type.

Remnant and HVR vegetation are defined under the VM Act as follows:

1. *remnant vegetation means vegetation—*
   a. *that is—*
      i. *an endangered regional ecosystem; or*
      ii. *an of concern regional ecosystem; or*
      iii. *a least concern regional ecosystem; and*
   b. *forming the predominant canopy of the vegetation—*
      i. *covering more than 50% of the undisturbed predominant canopy; and*
      ii. *averaging more than 70% of the vegetation's undisturbed height; and*
      iii. *composed of species characteristic of the vegetation's undisturbed predominant canopy.*
2. *high value regrowth vegetation means vegetation located—*
   a. *on freehold land, indigenous land, or land subject of a lease issued under the Land Act 1994 for agriculture or grazing purposes or an occupation licence under that Act; and*
   b. *in an area that has not been cleared (other than for relevant clearing activities) for at least 15 years, if the area is—*
      i. *an endangered regional ecosystem; or*
      ii. *an of concern regional ecosystem; or*
      iii. *a least concern regional ecosystem*.

Regional ecosystem mapping

Following the field assessment, ground-truthed REs were mapped using a combination of:

- Government RE mapping layers;
- Ground-truth vegetation assessment site data, GPS data and photographs;

- Recent aerial imagery (from GoogleEarth and Queensland Globe (Google Earth, 2023; QLD Globe, 2023)); and
- Historical aerial imagery (from QImagery (QImagery, 2023)).

Vegetation assessment site sampling density was in accordance with Neldner *et al.* (2022). Individual RE polygons were mapped at a minimum size of 5 ha, and 75 m wide for linear features, in accordance with recommendations in Neldner *et al.* (2022) for inland areas.

Threatened ecological community assessment

To determine the presence of threatened ecological communities (TECs) within the study area, assessments of vegetation communities against key diagnostic characteristics and condition thresholds for the following TECs were undertaken:

- Brigalow (*Acacia harpophylla*) dominant and co-dominant TEC (Brigalow TEC); and
- Poplar Box (*Eucalyptus populnea*) Grassy Woodland on Alluvial Plains (Poplar Box TEC).

Sixty-nine TEC assessments were undertaken in the study area, which are presented on **Figure 3**.

The key diagnostic characteristics and condition thresholds for these TECs are as follows.

Brigalow TEC

DoE (2013a) defines the key diagnostic characteristics and condition thresholds for the Brigalow TEC (in the Queensland Brigalow Belt Bioregion) as follows:

- Key diagnostic characteristics: a patch must include the following key diagnostic characteristics to be considered the Brigalow TEC.
    - The presence of *Acacia harpophylla* as one of the most abundant tree species in the patch. *Acacia harpophylla* is either dominant in the tree layer, or co-dominant with other species (notably *Casuarina cristata*, other species of *Acacia*, or species of *Eucalyptus*). AND
    - In the Queensland Brigalow Belt Bioregion (RE 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14 or 11.12.21). AND/OR
    - The vegetation in the patch is brigalow regrowth with species composition and structural elements broadly typical of one of the identified Queensland REs (although species density may be reduced). This can be assumed to be the case where it has been at least 15 years since it was last comprehensively cleared (not just thinned); unless direct evidence proves otherwise.
- Condition thresholds: a patch must meet the following condition thresholds to be considered the Brigalow TEC.
    - The patch is 0.5 ha or more in size. AND
    - Exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha (100 m by 50 m), that is representative of the patch.

Poplar Box TEC

DoEE (2019) defines the key diagnostic characteristics for the Poplar Box TEC (in the Queensland Brigalow Belt Bioregion) as follows:

- Location and physical environment:

- Associated with ancient and recent depositional alluvial plains with clay, clay-loam, loam and sandy loam, typically duplex soils or sodosols. This includes areas that may not be part of currently defined floodplains.

- Structure:
  - A grassy woodland to grassy open woodland with a tree crown cover of 10% or more at patch scale;
  - A tree canopy must be present that shows these features:
    - canopy tree species are capable of reaching 10 m or more in height;
    - Poplar Box must be present in the canopy and is the dominant tree species; and
    - where hybrids of Poplar Box with other *Eucalyptus* spp are present, they should be counted as part of the *Eucalyptus populnea* component of the tree canopy when assessing the previous criterion.
  - Mid layer (1-10 m) crown cover of shrubs to small trees is low, about 30% or less; and
  - A ground layer (<1 m) mostly dominated across a patch by native grasses, other herbs and occasionally chenopods (during extended dry periods), ranging from sparse to thick (in response to canopy development, soil moisture, disturbance and/or management history).

For a vegetation community to be classified as the Poplar Box TEC, it must also meet the minimum condition thresholds set out in DoEE (2019) and presented in **Table 2**.

Table 2 Condition categories and thresholds for the Poplar Box TEC (DoEE, 2019)

Category and rationale	Native cover and diversity thresholds	Minimum patch size thresholds*
CLASS A HIGHEST QUALITY		
Category A1 Little to no perennial weeds and diverse native understorey.	The crown cover of canopy trees in the patch is ≥10% **AND** ≥90% of perennial vegetation cover in the ground layer** is native **AND** ≥30 native plant species per patch in the ground layer	≥ 1 ha
Category A2 A large patch with low perennial weeds and diverse native understorey	The crown cover of canopy trees in the patch is ≥10% **AND** ≥70% of perennial vegetation cover in the ground layer** is native **AND** ≥30 native plant spp. per patch in the ground layer	≥ 5 ha
CLASS B GOOD QUALITY		
Category B A large patch with good quality native understorey or with mature trees	The crown cover of canopy trees in the patch is ≥10% **AND** ≥50% of perennial vegetation cover in ground layer** is native	≥ 5 ha

Category and rationale	Native cover and diversity thresholds	Minimum patch size thresholds*
	AND EITHER ≥20 perennial native plant species per patch in the ground layer **OR** ≥10 mature trees+ per ha with ≥30cm dbh*** (and/or hollows)	
CLASS C MODERATE QUALITY		
Category C A large patch with low native cover but retains good native understorey diversity and habitat features of mature trees	The crown cover of canopy trees in the patch is ≥10% **AND** **If** <50% of perennial vegetation cover in ground layer** is native, then the patch **must** have: ≥20 native plant spp. per patch in the ground layer **AND** ≥10 mature trees+ per ha with ≥30cm dbh*** (and/or hollows) **AND** smaller trees+, saplings or seedlings suggestive of periodic recruitment	≥ 5 ha

* **Minimum patch size thresholds** apply to patches of various shapes but, a minimum patch width threshold applies to linear remnants, such as along roadsides or former travelling stock routes. These are explained in the next section on 'Defining a patch'.

** **Perennial native vegetation cover in the ground layer** (*i.e.*, below the tree canopy) includes vascular plant species of the ground layer with a life-cycle of more than two growing seasons. The ground layer includes grasses and herbs (i.e. forbs) and some low shrubs (woody plants ≤ 1 m high). Measurement of perennial ground layer vegetation cover excludes annuals, cryptogams (i.e. mosses, lichens and related flora), leaf litter or exposed soil.

*** **dbh** (diameter at breast height) refers to the tree diameter measured at 1.3 m above the ground.

+ **Trees** – Refers to Poplar Box and/or hybrids of Poplar Box with other Eucalyptus species (for instance Coolibah).

Vegetation condition assessment

To provide an understanding of offset liability within the proposed disturbance footprint, BioCondition assessments with reference to the *Queensland BioCondition Assessment Manual* (Eyre *et al.*, 2015) and the *Guide to determining terrestrial habitat quality* (DESI, 2020b) were undertaken. Seventeen BioCondition assessments were undertaken, which are presented in **Section 4.3** (**Figure 3**).

The following information was collected at BioCondition sites in accordance with Eyre *et al.* (2015) and DESI (2020b):

- Along a 100 m transect:
  - tree and shrub canopy cover.
- Within a 100 m x 50 m plot:
  - tree height;
  - number and DBH of large eucalypt and non-eucalypt trees;
  - native tree and shrub species richness; and
  - recruitment of woody perennial species.
- Within a 50 x 20 m sub-plot:

  - coarse woody debris.
- Within a 50 x 10 m sub-plot:
  - native grass and forb species richness; and
  - non-native plant cover.
- Within five 1 x 1 m quadrats:
  - total native perennial grass cover; and
  - organic litter cover.

Site-based attributes (**Table 3**) from each of the BioCondition sites were compared to Benchmark values (Queensland Herbarium, 2023b) for the relevant RE type(s) and used to calculate site condition scores. A description of those scores is given in **Table 4**.

Table 3 Scoring and weighting of site-based attributes

Site-based attribute	Weighting (%)
Large trees (DBH)	15
Tree canopy height (m)	5
Recruitment of canopy species	5
Tree canopy cover (%)	5
Shrub layer cover (%)	5
Coarse woody debris (m)	5
Native plant species richness for four life forms	20
Non-native plant cover	10
Native perennial grass cover (%)	5
Litter cover (%)	5
Maximum site-based score	**80**

Table 4 Description of BioCondition classes

Site-based score ($S_{c)}$	BioCondition class	Description[1]
>0.80	1	Functional
>0.60 – 0.80	2	Moderately functional
0.40 – 0.59	3	Moderately dysfunctional
<0.40	4	Dysfunctional

1. BioCondition classes are described in Eyre *et al.* (2015) to range from functional to dysfunctional. SLR has stratified the intermediary classes to aid in describing site-based attribute condition.

3.4.1.2 Targeted survey for conservation significant flora species

Targeted surveys for conservation significant flora species and their habitat identified by the desktop assessment as having the potential to occur in the study area were undertaken as follows:

- Habitat assessments were undertaken to confirm the presence/absence of potentially suitable habitat for conservation significant flora species;
- Searches for conservation significant flora species in areas of potentially suitable habitat;
- Random meander surveys in accordance with the Flora Survey Guidelines - Protected Plants (DESI, 2020a); and
- Where conservation significant species were confirmed as present, the extent of suitable habitat was mapped.

3.4.1.3 Weed survey

Searches for pest flora species were undertaken in the study area, in particular those listed under the Biosecurity Act, listed by the Australian Government as a WoNS, or priority weeds listed in the local government biosecurity plan (*i.e.,* the Western Downs Regional Council Biosecurity Plan (WDRC, 2017)) (*i.e.* listed weeds). The abundance and location of listed weeds were noted and marked with a hand-held GPS.

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Cromont Road

Jackson Wandoan Road

Leichhardt Highway

ML 50231

ML 50230

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

VEGETATION MANAGEMENT STATE-MAPPED REGIONAL ECOSYSTEM MAP

FIGURE 3

LEGEND

Vegetation Assessment Site

- Quaternary
- BioCondition
- Tertiary
- Main Road
- Major Watercourse
- Survey Track
- Study Area
- Wandoan Mining Lease

Vegetation Management Regional Ecosystem

- High Value Regrowth- Endangered
- High Value Regrowth- Of Concern
- Remnant- Endangered
- Remnant- Of Concern
- Non-Remnant

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	12-Jun-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

3.4.2 Fauna

3.4.2.1 General habitat assessments

General habitat assessments were undertaken throughout the study area (in areas of remnant, high value regrowth and non-remnant vegetation). A total of 56 assessments were undertaken, which are presented on **Figure 4**.

The presence, absence and abundance of the following fauna habitat characteristics were recorded at these sites:

- Vegetated ground cover and proportion of exotics;
- Leaf litter cover and depth;
- Flowering eucalypt species;
- Koala food trees;
- Hollow bearing trees;
- Decorticating bark;
- Woody debris;
- Soil cracks and gilgai;
- Water type;
- Roost sites for microbats;
- Mistletoe species;
- Connectivity; and
- Threats (*e.g.,* clearing, grazing, erosion, fire).

3.4.2.2 Systematic survey

Seven systematic fauna survey sites were established within the study area, positioned to sample the variety of habitats present (presented on **Figure 4**). At each fauna survey site, a description of the habitat values and features of potential relevance to fauna species were recorded, as well as photographs taken.

In line with Eyre *et al.* (2022a), fauna trapping methods were deployed for a minimum of four nights per site, and include an array of fauna trapping and survey techniques as follows:

- Fauna trapping methods (Elliot, funnel, pitfall, and cage trapping);
- Camera trapping;
- Diurnal bird surveys;
- Diurnal active searches;
- Microbat call detection;
- Nocturnal spotlight searches; and
- Harp trapping.

A description of each of these techniques is provided in **Table 5**, and the survey effort employed is provided in **Table 6**.

Table 5 Systematic fauna survey techniques

Survey method	Description
Elliott traps	At each trapping site, type-A Elliott traps were placed on the ground approximately 10 m apart in a straight line. Twenty traps were employed at each site. All traps were baited with a mixture of rolled oats, peanut butter, and honey. Elliott traps were placed in areas of dense low vegetation, under or beside logs and other woody debris, near rocks and crevices, and in other locations of habitat complexity where small mammals were most likely to encounter traps. These areas also provided shade to optimise welfare outcomes for trapped fauna.
Funnel traps	Drift fence lines incorporating funnel traps were established for four nights at each site. Six funnel traps were located along the drift fencing at each site. A shade cloth was placed over each funnel trap to protect trapped species from exposure.
Pitfall traps	Four pitfall traps (20 L buckets) were buried flush with the ground surface with the drift fence intersecting the centre of each bucket at each site.
Cage traps	A cage trap was installed at each site and baited with a mixture of rolled oats, peanut butter and honey and tuna. These were placed in areas with high mammal habitat values such as near hollow-bearing large trees and rock outcropping to maximise likelihood of capture of target mammals.
Camera trapping	Camera traps (motion-sensing infrared cameras) were utilised at each site and multiple locations within the study area to target fauna that may be too large or elusive to be detected by other trapping techniques, or utilising areas outside the main trapping sites. Camera traps were baited with the rolled oat mixture and tuna.
Diurnal bird surveys	Birds were surveyed at each site (and throughout the study area) at multiple periods throughout the day, but with a particular focus during peak activity in the morning. Passive observations of water points were undertaken targeting the early morning and evening. Incidental observations made whilst conducting other survey techniques were also recorded. Birds were identified from either direct observation or by their calls.
Active diurnal searches	Active diurnal searches were undertaken at each site (and throughout the study area). This technique involved intensive investigation of ground layer habitat features (such as under logs, rocks, and leaf litter), low vegetation (under bark and tree stumps) for cryptic fauna, particularly reptiles. Searches were focussed during times of the day when reptile activity was likely to be at its peak.
Bat detectors	A microbat echolocation call detector was deployed for at least four nights at each trap site. The detector was installed in appropriate flyways to maximise call recording success.
Nocturnal surveys	High-powered spotlights were used to survey nocturnal mammals (flying, arboreal and terrestrial), birds (active nocturnal species, and roosting diurnal species), reptiles and frogs at each site and throughout the study area in areas of suitable habitat.
Harp traps	Harp traps were installed overnight in suitable habitats and potential flyways (e.g., creeklines). They were check twice during evenings and at dawn upon pack-down. Harp trapping was undertaken over five consecutive nights each during the 2023 pre-wet season survey and 2024 post-wet season survey.

Table 6 Systematic fauna survey effort

Survey method	Post-wet season	Pre-wet season	Total survey effort
Elliott traps	240 trap nights	320 trap nights	560 trap nights
Funnel traps	72 trap nights	96 trap nights	168 trap nights
Pitfall traps	36 trap nights	64 trap nights	100 trap nights
Cage Traps	12 trap nights	16 trap nights	28 trap nights
Camera trapping	32 trap nights	55 trap nights	87 trap nights
Diurnal bird surveys	64 person hours	80 person hours	144 person hours
Diurnal active searches	64 person hours	100 person hours	164 person hours
Echolocation call detection	14 trap nights	19 trap nights	33 trap nights
Nocturnal spotlight searches	24 person hours	15 person hours	39 person hours
Harp trapping	10 trap nights*	10 trap nights	20 trap nights

*Harp trapping undertaken in post-wet season 2024

3.4.2.3 Targeted survey for conservation significant fauna species

Targeted surveys for conservation significant fauna species and their habitat identified as having the potential to occur in the study area were undertaken as follows:

- Habitat assessments were undertaken to confirm the presence/absence of potentially suitable habitat for conservation significant fauna species;
- Where suitable habitat was identified, targeted surveys were undertaken in accordance with relevant Queensland and Federal Government guidelines; and
- Where conservation significant species were confirmed as present, the extent of suitable habitat was mapped.

The threatened species targeted during the field surveys were:

- Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*);
- Squatter Pigeon (Southern) (*Geophaps scripta scripta*);
- Painted Honeyeater (*Grantiella picta*);
- Brigalow Woodland Snail (*Adclarkia cameroni*);
- Dulacca Woodland Snail (*Adclarkia dulacca*);
- Yellow-bellied Glider (Southern) (*Petaurus australis australis*);
- Koala (*Phascolarctos cinereus*);
- Central Greater Glider (*Petauroides armillatus*);
- Corben's Long-eared Bat (*Nyctophilus corbeni*);
- Golden-tailed Gecko (*Strophurus taenicauda*);
- Common Death Adder (*Acanthophis antarcticus*);
- Dunmall's Snake (*Furina dunmalli*);

- Grey Snake (*Hemiaspis damelii*); and
- Yakka Skink (*Egernia rugosa*).

Targeted fauna survey techniques included (but were not limited to) the following:

- Diurnal bird surveys;
- Active searches for individual animals and signs (i.e., scats, scratches, burrows, feeding remains, nesting material, mistletoes);
- Diurnal transect and flushing surveys (walked and driving);
- Waterbody watches;
- Nocturnal spotlighting surveys;
- Nocturnal call playback surveys;
- Acoustic call detection;
- Harp trapping;
- Pitfall trapping;
- Funnel trapping; and
- Nocturnal vehicle transects.

A description of the techniques used to target each species and the survey effort employed is provided in **Table 7**. The locations of targeted surveys are presented on **Figure 5**.

Table 7 Targeted survey techniques and effort

Common name	Post-wet season (both 2023 and 2024)	Pre-wet season	Total	Relevant guideline(s)
Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*)	• 64 hours diurnal bird surveys (16 days). • 24 hours targeted diurnal surveys for orts and breeding places (10 days).	• 80 hours diurnal bird surveys (10 days). • 40 hours targeted diurnal surveys for orts and breeding places (10 days).	• 144 hours diurnal bird surveys (23 days). • 64 hours targeted diurnal surveys for orts and breeding places (20 days).	Glossy black-cockatoo, *Calyptorhynchus lathami.* Targeted species survey guidelines (Hourigan, 2012).
Squatter Pigeon (Southern) (*Geophaps scripta scripta*)	• 64 hours diurnal bird surveys/area searches (16 days). • 64 hours driving transect surveys (13 days). • 256 hours walked flushing surveys) (13 days).	• 80 hours diurnal bird surveys/area searches (10 days). • 80 hours driving transect surveys) (10 days). • 160 hours walked flushing surveys) (10 days). • 12 hours waterbody watching surveys (10 days).	• 144 hours diurnal bird surveys/area searches (23 days). • 144 hours driving transect surveys (23 days). • 416 hours walked flushing surveys) (23 days). • 12 hours waterbody watching surveys (10 days).	Survey guidelines for Australia's threatened birds (DEWHA, 2010a). Methods described in the Proceedings from the workshop for the Squatter Pigeon (southern. (Squatter Pigeon Workshop, 2011).
Painted Honeyeater (*Grantiella picta*)	• 64 hours diurnal bird surveys (16 days). • 24 hours targeted diurnal surveys for suitable habitat (10 days).	• 80 hours diurnal bird surveys (10 days). • 40 hours targeted diurnal surveys for suitable habitat (10 days).	• 144 hours diurnal bird surveys (23 days). • 64 hours targeted diurnal surveys for suitable habitat (20 days).	Painted honeyeater *Grantiella picta*. Targeted species survey guidelines. (Rowland, 2012a).
Brigalow Woodland Snail (*Adclarkia cameroni*)	• 36 hours active searching (raking leaf litter, lifting logs and rocks) (10 days).	• 30 hours active searching (raking leaf litter, lifting logs and rocks) (10 days).	• 66 hours active searching (raking leaf litter, lifting logs and rocks) (20 days).	No species-specific guideline. Methods provided in Conservation Advice *Adclarkia cameroni* (TSSC, 2016a).
Dulacca Woodland Snail				No species-specific guideline. Methods provided in

Common name	Post-wet season (both 2023 and 2024)	Pre-wet season	Total	Relevant guideline(s)
(*Adclarkia dulacca*)				Conservation Advice *Adclarkia dulacca* (TSSC, 2016b).
Yellow-bellied Glider (Southern) (*Petaurus australis australis*)	• 24 hours spotlighting (3 nights). • 3 call playback surveys (3 nights). • 38 hours targeted diurnal searches for scats and scratches (13 days).	• 15 hours spotlighting (5 nights). • 3 call playback surveys (3 nights). • 40 hours targeted diurnal searches for scats and scratches (10 days).	• 39 hours spotlighting (8 nights). • 6 call playback surveys (6 nights). • 78 hours targeted diurnal searches for scats and scratches (23 days).	No species-specific guideline. Survey guidelines for Australia's threatened mammals (DSEWPC, 2011b). Methods provided in Conservation Advice for *Petaurus australis australis* (yellowbellied glider (south-eastern)) (DAWE, 2022a) and Eyre *et al.* (2022a).
Koala (*Phascolarctos cinereus*)	• 24 hours spotlighting (3 nights). • 38 hours targeted diurnal searches for scats and scratches (13 days).	• 15 hours spotlighting (5 nights). • 30 hours targeted diurnal searches for scats and scratches (10 days). • Thermal drone surveys (41km) (3 days*).	• 39 hours spotlighting (8 nights). • 68 hours targeted diurnal searches for scats and scratches (23 days). • Thermal drone surveys (41km) (3 days*).	No species-specific guideline. Methods provided in superseded EPBC Act referral guidelines for the vulnerable koala (DoE, 2014) and A review of koala habitat assessment criteria and methods (Youngentob *et al.,* 2021).
Central Greater Glider (*Petauroides armillatus*)	• 24 hours spotlighting (3 nights). • 38 hours targeted diurnal searches for scats and scratches (13 days).	• 15 hours spotlighting (5 nights). • 30 hours targeted diurnal searches for scats and scratches (10 days).	• 39 hours spotlighting (8 nights). • 68 hours targeted diurnal searches for scats and scratches (23 days).	No species-specific guideline. Methods provided in Eyre *et al.* (2022a).
Corben's Long-eared Bat (*Nyctophilus corbeni*)	• 14 acoustic detector nights (14 nights). • 10 harp trap nights (2 traps, 5 nights) (undertaken	• 19 acoustic detector nights (10 nights). • 10 harp trap nights (2 traps, 5 nights).	• 33 acoustic detector nights (23 nights). • 20 harp trap nights (10 harp trap nights (2 traps, 5 nights) during the 2023 and	Survey guidelines for Australia's threatened bats (DEWHA, 2010b). NOTE: Harp trapping effort recommended in DEWHA (2010b) is a total of 20 nights. However, a total of

Common name	Post-wet season (both 2023 and 2024)	Pre-wet season	Total	Relevant guideline(s)
	in **2024** post-wet season survey).		2024 post-wet season surveys).	67 harp trapping nights were formerly undertaken by PBA in 2007-2008 and this species was not detected.
Golden-tailed Gecko (*Strophurus taenicauda*)	• 36 pitfall trap nights (4 nights). • 72 funnel trap nights (4 nights). • 24 hours spotlighting (3 nights). • 8 hours road cruising (290km) (3 nights).	• 64 pitfall trap nights (4 nights). • 96 funnel trap nights (4 nights). • 15 hours spotlighting (5 nights). • 15 hours road cruising (250km) (5 nights).	• 100 pitfall trap nights (8 nights). • 168 funnel trap nights (8 nights). • 39 hours spotlighting (8 nights). • 23 hours road cruising (540km) (8 nights).	No species-specific guideline. Methods for geckos provided in Eyre *et al.* (2022a).
Common Death Adder (*Acanthophis antarcticus)*	• 36 pitfall trap nights (4 nights). • 72 funnel trap nights (4 nights). • 64 hours active searching (raking leaf litter, lifting logs and rocks) (13 days). • 18 hours road cruising (290 km) (3 nights).	• 64 pitfall trap nights (4 nights). • 96 funnel trap nights (4 nights). • 30 hours active searching (raking leaf litter, lifting logs and rocks) (10 days). • 15 hours road cruising (250km) (5 nights).	• 100 pitfall trap nights (8 nights). • 168 funnel trap nights (8 nights). • 94 hours active searching (raking leaf litter, lifting logs and rocks) (23 days). • 23 hours road cruising (540km) (8 nights).	Common death adder *Acanthophis antarcticus*. Targeted species survey guidelines. (Rowland & Ferguson, 2012). NOTE: During road-cruising, all suitable roads in the study area were surveyed multiple times.
Dunmall's Snake (*Furina dunmalli*)	• 36 pitfall trap nights (4 nights). • 64 hours diurnal active searching (raking leaf litter, lifting logs and rocks) (13 days). • 18 hours road cruising (290 km) (3 nights).	• 64 pitfall trap nights (4 nights). • 30 hours active searching (raking leaf litter, lifting logs and rocks) (10 days). • 15 hours road cruising (250km) (5 nights).	• 100 pitfall trap nights (8 nights). • 94 hours active searching (raking leaf litter, lifting logs and rocks) (23 days). • 23 hours road cruising (540km) (8 nights).	Survey guidelines for Australia's threatened reptiles (DSEWPC, 2011a).

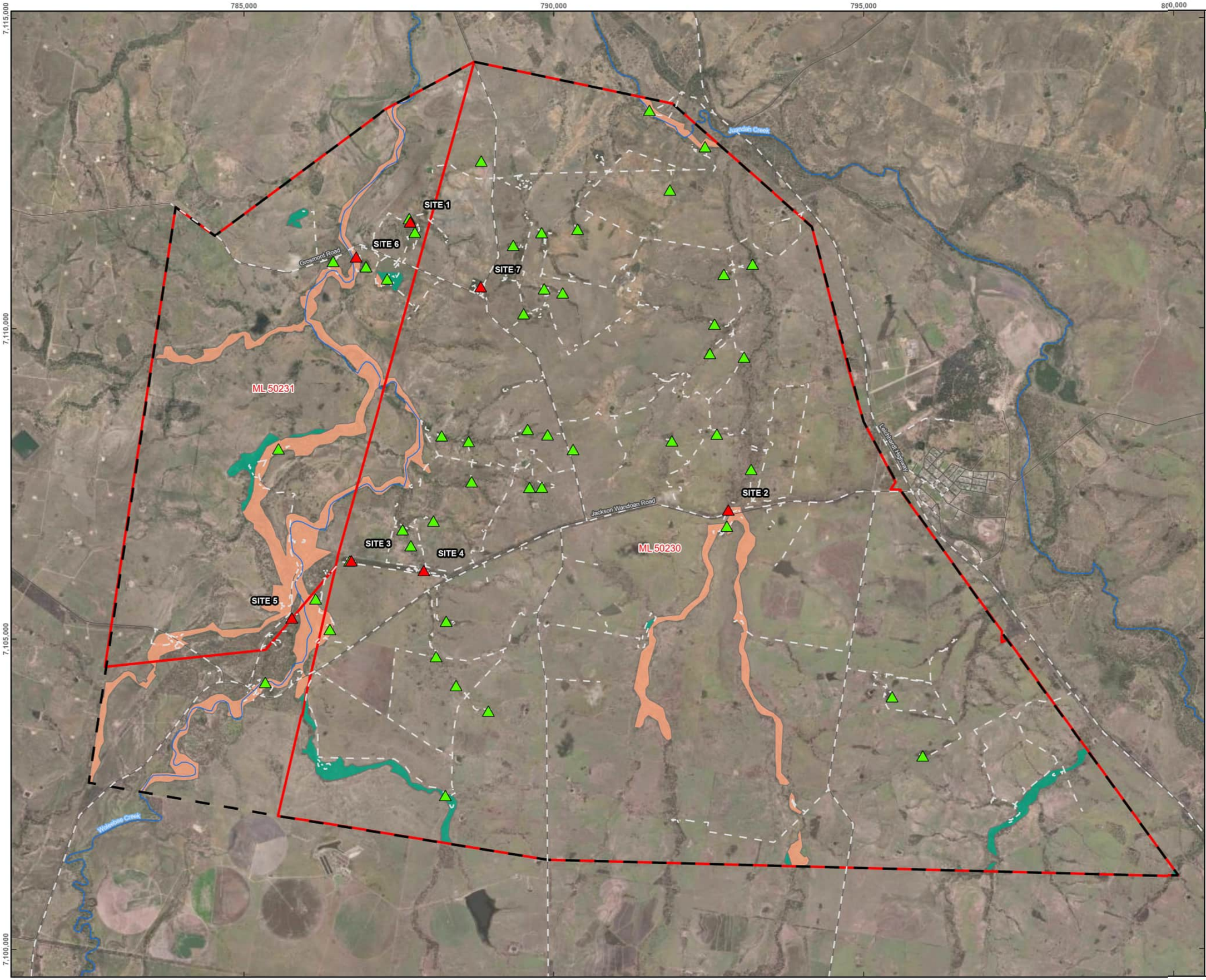
Common name	Post-wet season (both 2023 and 2024)	Pre-wet season	Total	Relevant guideline(s)
Grey Snake (*Hemiaspis damelii*)	• 36 pitfall trap nights (4 nights). • 72 funnel trap nights (4 nights). • 24 hours passive nocturnal search (3 nights). • 64 hours diurnal active searching (raking leaf litter, lifting logs and rocks) (13 days). • 18 hours road cruising (290 km) (3 nights).	• 64 pitfall trap nights (4 nights). • 96 funnel trap nights (4 nights). • 15 hours passive nocturnal search (5 nights). • 30 hours active searching (raking leaf litter, lifting logs and rocks) (10 days). • 15 hours road cruising (250km) (5 nights).	• 100 pitfall trap nights (8 nights). • 168 funnel trap nights (8 nights). • 38 hours passive nocturnal search (8 nights). • 94 hours active searching (raking leaf litter, lifting logs and rocks) (23 days). • 23 hours road cruising (540km) (8 nights).	Grey snake, *Hemiaspis damelii*. Targeted species survey guidelines (Rowland, 2012b). NOTE: During road-cruising, all suitable roads in the study area were surveyed multiple times.
Yakka Skink (*Egernia rugosa*).	• 240 Elliot trap nights (4 nights). • 64 hours diurnal searches for burrows (13 days). • 24 hours spotlighting (3 nights).	• 320 Elliot trap nights (4 nights). • 30 hours diurnal searches for burrows (10 days). • 15 hours spotlighting (5 nights).	• 560 Elliot trap nights (8 nights). • 94 hours diurnal searches for burrows (23 days). • 39 hours spotlighting (8 nights).	Survey guidelines for Australia's threatened reptiles (DSEWPC, 2011a).

Undertaken by DPM Enviroscience on 19th, 21st and 25th October 2023 using a thermal drone (DJI Matrice 350 with Zenmuse H20N camera) at around dawn).

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

GENERAL HABITAT ASSESSMENTS AND SYSTEMATIC FAUNA SITES

FIGURE 4



LEGEND

- General Habitat Assessment

Fauna Survey Effort

- Systematic Trap Site
- Major Watercourse
- Main Road
- Survey Track
- Study Area
- Wandoan Mining Lease

Remnant Broad Vegetation Groups

- BVG 16 – Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains
- BVG 25 – Brigalow sometimes with Belah open forests to woodlands on heavy clay soils

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	31-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

3.4.2.4 Habitat quality assessments

To provide an understanding of offset liability within the proposed disturbance footprint, fauna habitat quality assessments with reference to the *Guide to determining terrestrial habitat quality* (DESI, 2020b) were undertaken. A total of 17 habitat quality assessments were undertaken (presented on **Figure 5**) for the following conservation significant fauna species:

- Glossy Black-cockatoo (four assessments);
- Koala (nine assessments); and
- Central Greater Glider (four assessments).

Habitat quality for conservation significant fauna species is dependent on:

- Site-based attributes (determined through BioCondition assessments which are described in **Section 3.4.1.1**); and
- Species habitat attributes.

A literature review was undertaken to identify factors that constitute, and may affect, each of the following species habitat attributes:

- Quality and availability of food and habitat required for foraging;
- Quality and availability of habitat required for shelter and breeding;
- Quality and availability of habitat required for mobility; and
- Absence of threats.

The species-specific factors for each attribute are presented in **Table 8**. Factors were scored at each assessment site according to the methods detailed in DESI (2020b). The following reference documents were reviewed to determine the relevant factors:

- Conservation Advice for *Calyptorhynchus lathami lathami* (South-eastern Glossy Black-cockatoo) (DCCEEW, 2022a);
- Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales, and the Australian Capital Territory (DAWE, 2022b);
- A review of koala habitat assessment criteria and methods (Youngentob *et al.,* 2021);
- Conservation Advice for *Petauroides volans* (greater glider (southern and central)) (DCCEEW, 2022b); and
- Guide to greater glider habitat in Queensland (Eyre *et al.,* 2022b).

Table 8 Species habitat attributes and corresponding factors

Attribute	Species-specific factors		
	Glossy Black-cockatoo	Koala	Central Greater Glider
Quality and availability of food and habitat required for foraging	Canopy cover comprised of *Casuarina* and *Allocasuarina* species.	Density of Eucalypt food trees.	Canopy cover of Eucalyptus feed trees.
		Distance trees are situated from permanent or semi-permanent water	Density of large trees (>50 cm DBH) per ha.

Attribute	Species-specific factors		
	Glossy Black-cockatoo	Koala	Central Greater Glider
		sources (inland habitat).	
Quality and availability of habitat required for shelter and breeding	Density of suitable hollows (>8 m up, branch >30 cm diameter, angle vertical to 45, entrance diameter >15 cm) in Eucalypt species.	Structural complexity – number of strata (providing shelter from heat and predation).	Hollow-bearing trees present (or likely present based on presence of large trees).
	Distance to water (breeding habitat usually within 200 m).	Canopy cover.	Canopy height (avoiding predation, shelter from the elements).
Quality and availability of habitat required for mobility	Landscape-scale connectivity.	Landscape-scale connectivity.	Landscape-scale connectivity.
	Local-scale connectivity.	Local-scale connectivity.	
Absence of threats	Habitat clearing.	Habitat clearing and fragmentation.	Habitat clearing.
	Habitat fragmentation.	Heat wave and drought.	Habitat fragmentation.
	Inappropriate fire regimes.	Predation from invasive species.	Inappropriate fire regimes.
		Vehicle strike.	

3.4.2.5 Pest fauna survey

The location and abundance of pest species (*i.e.,* non-native fauna species) listed under the Biosecurity Act were recorded and are listed in **Appendix C**.

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

TARGETED FAUNA SURVEYS AND HABITAT QUALITY ASSESSMENTS

FIGURE 5

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Inset A

Inset B

ML 50231

ML 50230

Grosmont Road

Jackson Wandoan Road

Leichhardt Highway

Juandah Creek

Wolebee Creek

Inset A Scale 1:30,000

Inset B Scale 1:35,000

LEGEND

Fauna Survey Effort

- Active Search
- Spotlighting
- Bird Survey/Waterbody Watches
- Bat Detector
- Call Playback
- Camera trap
- Harp Trapping
- Bird Survey- Transects
- Road Cruising
- Thermal Drone Survey
- Habitat Quality Assessment
- Survey Track
- Study Area
- Wandoan Mining Lease
- Main Road
- Major Watercourse

Remnant Broad Vegetation Groups

- BVG 16 – Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains
- BVG 25 – Brigalow sometimes with Belah open forests to woodlands on heavy clay soils

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	30-Apr-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

4.0 Results

4.1 Regional and local context

The study area is in the Taroom Downs subregion of the Brigalow Belt biogeographic region (BRB bioregion). The BRB bioregion is comprised of undulating to hilly areas as well as flat alluvial plains. Vegetation communities are predominantly mixed eucalypt woodland communities; however, this bioregion is characterised by the presence of Brigalow woodlands. The bioregion has undergone considerable modification in the last 70 years, due to agriculture and mining. Remnant vegetation in the Taroom Downs subregion has been reduced to 7% of its former extent (Accad *et al.,* 2023). This broadscale clearing has disproportionately affected areas and communities with fertile soils.

The study area is predominantly gently to undulating, rolling hills underlain by fine-grained sedimentary rocks (*i.e.,* sandstone, siltstone, mudstone) with grey cracking clay soils. Areas of flood-plain alluvium are also present adjacent to the larger watercourse systems. Soils are hard pedal yellow duplex soils in floodplain areas; and clay, silt, sand, and gravel in riparian areas (DoR, 2023c; ASRIS, 2023). Most of the study area is comprised of non-remnant vegetation that has been cleared for agriculture (cattle grazing and crops). Large areas of remnant eucalypt vegetation communities are associated with the Woleebee and Frank Creek riparian and floodplain areas. Small, isolated patches of regrowth vegetation (predominately Brigalow communities) are also present.

4.2 Survey conditions

Overall, weather conditions during the survey periods (2023 post- and pre-wet and 2024 post-wet) were considered favourable for detecting most vertebrate fauna groups. Rainfall before and during the post-wet season surveys (20 mm between 10-12 March 2023 and 14 mm on 4 March 2024) was ideal for plant growth and resulted in fertile material being present for many species, assisting in their identification. Rainfall in the 2022-2023 season was below average. Conditions during the pre-wet season survey were very dry, and sub-optimal for detailed botanical surveys (*i.e.,* of annual species). Rainfall in the 2023-2024 season was also below average except in January where 154 mm of rain was recorded compared to the average of 80 mm. This allowed for more favourable conditions for the identification of flora species.

Weather data relevant to the fauna survey periods was obtained from the Bureau of Meteorology (BoM) Woleebee Nevasa Station (station number 35081) (BoM, 2024). A summary of the relevant weather data is provided in **Table 9**. Mean monthly rainfall (1912-2024) and total monthly rainfall for the 2023-2024 season (January 2023-February 2024) are presented in **Figure 6**.

Table 9 Weather conditions during the survey periods

Period	Date	Rainfall (mm)	Temperature (°C)	
			Minimum	Maximum
Post-wet season survey (2023)	9 March 2023	0.0	22.7	26.8
	10 March 2023	4.0	21.2	26.1
	11 March 2023	9.0	20.9	31.7
	12 March 2023	7.0	23.0	34.4
	13 March 2023	0.0	20.9	34.2

Period	Date	Rainfall (mm)	Temperature (°C)	
			Minimum	Maximum
	14 March 2023	0.0	21.7	34.2
	15 March 2023	0.0	23.3	33.6
	16 March 2023	0.0	21.9	35.8
	17 March 2023	0.0	18.8	36.7
	18 March 2023	0.0	22.4	35.2
	19 March 2023	0.0	18.1	33.8
	20 March 2023	0.0	16.3	33.7
	21 March 2023	0.0	19.6	32.2
	22 March 2023	0.0	17.2	31.8
Pre-wet season survey (2023)	18 October 2023	0.0	15.3	31.3
	19 October 2023	0.0	14.3	31.4
	20 October 2023	0.0	14.8	33.8
	21 October 2023	0.0	16.1	34.5
	22 October 2023	0.0	19.1	37.2
	23 October 2023	0.0	20.4	38.6
	24 October 2023	0.0	21.2	37.7
	25 October 2023	0.0	19.8	38.3
	26 October 2023	0.0	19.8	30.7
	27 October 2023	0.0	11.7	25.6
Post-wet season survey (2024)	02 March 2024	0.0	21.3	36.8
	03 March 2024	0.0	22.7	36.3
	04 March 2024	14.0	22.0	34.1
	05 March 2024	0.0	18.8	31.8
	06 March 2024	0.0	17.9	33.6
	07 March 2024	0.0	17.6	33.8
	08 March 2024	0.0	18.7	31.1

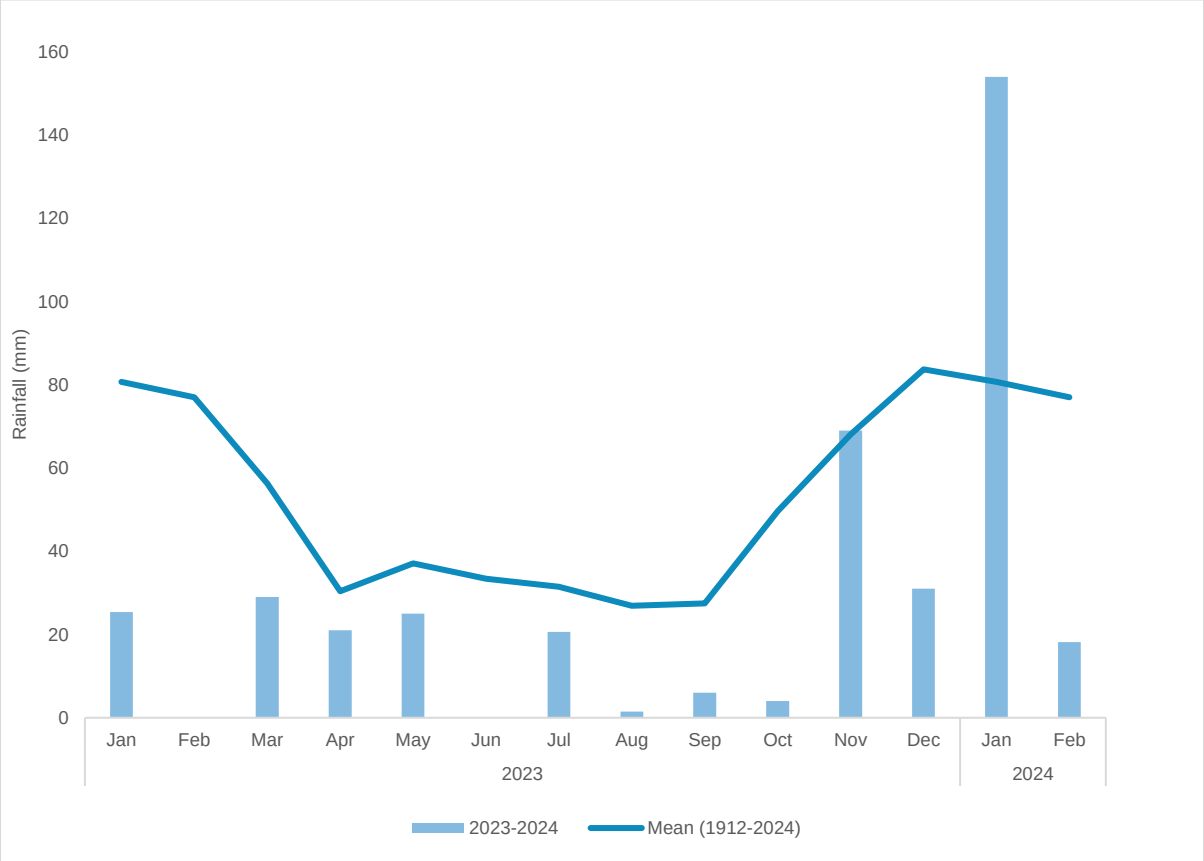


Figure 6 Mean (1912-2024) and total monthly rainfall (January 2023-February 2024) recorded at the Woleebee Nevasa Station (BoM, 2024)

4.3 Flora

4.3.1 Regional ecosystems

4.3.1.1 Desktop assessment

The DoR and DESI RE mapping layers (QLD Globe, 2023) for the study area include five REs, comprising remnant, HVR and non-remnant vegetation; these are described in **Table 10** and presented on **Figure 3**. PBA ground-truthed two additional REs (also presented in **Table 10**).

Table 10 State-mapped and PBA verified regional ecosystems in the study area

RE code	Status		REDD short description[1]
	VM class	BD status	
11.3.2	Of concern	Of concern	*Eucalyptus populnea* woodland on alluvial plains
11.3.19	Least concern	No concern at present	*Callitris glaucophylla*, *Corymbia spp*. and/or *Eucalyptus melanophloia* woodland on Cainozoic alluvial plains
11.3.25	Least concern	Of concern	*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines
11.9.5	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks
11.9.7*	Of concern	Of concern	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks
11.9.10	Of concern	Endangered	*Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks
11.10.9*	Least concern	No concern at present	*Callitris glaucophylla* woodland on coarse-grained sedimentary rocks

[1] REDD = Regional Ecosystem Description Database (Queensland Herbarium, 2023b)

* PBA mapped.

4.3.1.2 Field survey

Regional ecosystem status and mapping

SLR undertook five tertiary and 176 quaternary assessments in the study area to verify the mapped REs. Vegetation assessment sites are presented on **Figure 3**.

Ground truthing confirmed that the study area is comprised largely of non-remnant vegetation. The remnant vegetation communities are predominantly associated with the Woleebee and Frank Creek riparian and floodplain areas. Small, isolated patches of HVR vegetation were also present.

Six REs were ground-truthed to occur in the study area (**Table 11**), including remnant, HVR and non-remnant vegetation. The legislative status of the ground-truthed REs is summarised as follows.

- VM class:

  - one endangered RE;
  - three of concern REs; and
  - two least concern REs.
- Biodiversity status (BD status):
  - two endangered REs;
  - three of concern REs; and
  - one no concern at present RE.

State and PBA mapping of the REs in the study area was found to be largely accurate. However, SLR made the following changes to the RE mapping of note:

- The extent of remnant RE 11.9.5, was reduced compared to the state RE mapping. Some polygons of this RE were verified as RE 11.9.2 or 11.9.7;
- State-mapped HVR vegetation (RE 11.3.2) in the Woleebee Creek floodplain was found to be remnant and extend over a larger area than mapped;
- Areas State-mapped as RE 11.9.10 in the southwest of the study area, better corresponded with the description of riparian/floodplain vegetation (REs 11.3.25 and 11.3.2), along the larger watercourses;
- Areas State-mapped as mixed polygons with RE 11.3.19, were ground-truthed as RE 11.3.25 and/or 11.3.2; and
- PBA mapped areas of RE 11.10.9 in the study area. The geology, soils and composition of the vegetation in these areas corresponds more closely to the description of RE 11.9.2 or 11.9.7.

Ground-truthed REs are presented on **Figure 7** and presented in **Table 11**.

Table 11 Ground-truthed regional ecosystems in the study area

RE code	Status			REDD short description[1]	Area (ha)
	VM class	BD status	Remnant status		
11.3.2	Of concern	Of concern	Remnant	*Eucalyptus populnea* woodland on alluvial plains	361.70
11.3.25	Least concern	Of concern	Remnant	*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines	666.24
			HVR		139.28
11.3.25/ 11.3.2	Of concern	-	Remnant	-	66.22
11.9.2	Least concern	No concern at present	Remnant	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-grained sedimentary rocks	79.46
11.9.5	Endangered	Endangered	Remnant	*Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks	21.17
			HVR		826.49
11.9.7	Of concern	Of concern	Remnant	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	26.33
			HVR		6.01
11.9.10	Of concern	Endangered	Remnant	*Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks	-
			HVR		18.88
11.3.2/ 11.3.25/ 11.3.19	Of concern	-	HVR	-	13.40
Non-remnant					12,666.4
Total					14,892.0

[1] REDD: Regional Ecosystem Description Database (Queensland Herbarium, 2023b)

RE descriptions

Descriptions of each ground-truthed RE and its occurrence in the study area is provided below. A description of the floristic composition and structure of ground-truthed REs within the study area (using the tertiary and quaternary assessment data) is provided in **Appendix D**.

RE 11.3.2

This vegetation community occurred as remnant vegetation on alluvial plains, adjacent to the larger watercourses in the study area. Large, extensive areas of remnant RE 11.3.2 occurred as homogenous polygons in the Woleebee Creek floodplain in the southwest of the study area; and heterogenous polygons with RE 11.3.25, occur along Woleebee and Frank Creeks in areas of more narrow riparian vegetation, where adjacent land has been cleared.

The canopy was sparse (10-30% cover), Poplar Box was the dominant species, and Silver-leaved Ironbark (*Eucalyptus melanophloia*) was sometimes sub-dominant. The shrub layer was very sparse (<30% cover) with species such as False Sandalwood (*Eremophila mitchellii*), Wilga (*Geijera parviflora*) and Pretty Wattle (*Acacia decora*). In areas of better condition, contiguous habitat in the ground layer was diverse with species such as Kangaroo Grass (*Themeda triandra*), Black Speargrass (*Heteropogon contortus*) and Wiregrass (*Aristida sp.*). In areas of lesser condition, Buffel Grass (*Cenchrus ciliaris*) was sometimes dominant. Soils were clays or hard pedal yellow duplex soils. A representative photograph of this community is shown in **Photo 1**.

RE 11.3.25

This vegetation community occurred as remnant vegetation fringing the larger watercourses in the study area (*e.g.,* Woleebee Creek and Frank Creek). The community has been mapped as homogenous polygons where extensive areas of remnant vegetation occurred (Woleebee Creek), and mixed heterogenous polygons with REs 11.3.2 or 11.9.10, in areas of more narrow riparian vegetation, where adjacent land has been cleared.

The canopy was mid-dense (30-70% cover) generally dominated by Blue Gum (*Eucalyptus tereticornis*), with the following species often sub-dominant or associated: River She-oak (*Casuarina cunninghamiana*), Rough-barked Apple (*Angophora floribunda*), Silver-leaved Ironbark and Poplar Box. A shrub layer was sometimes present and sparse (<30% cover), with species such as Wilga, Ironwood Wattle (*Acacia excelsa*) and Myrtle Tree (*Psydrax oleifolia*). The ground layer in most areas was dominated with non-native species such as Buffel Grass and Guinea Grass (*Megathyrsus maximus*). Native species such as Kangaroo Grass, Spiny-headed Mat-rush (*Lomandra longifolia*) and Queensland Hemp (*Sida hackettiana*) were present and/or locally dominant. Soils were clay, silt, sand, and gravel. A representative photograph of this community is shown in **Photo 2**.

RE 11.9.2

This vegetation community occurred as remnant vegetation on undulating hills and rises of sedimentary rocks in the study area. This community occurred as homogenous polygons, in small, isolated patches, or associated with remnant vegetation near Woleebee Creek.

The canopy was sparse (10-30% cover) and dominated by Silver-leaved Ironbark or Mountain Coolibah (*Eucalyptus orgadophila*). White Cypress Pine (*Callitris glaucophylla*) and Poplar Box were associated. Brigalow may form a sparse sub-canopy layer. The shrub layer was sparse (<30% cover) with species such as False Sandalwood, Wilga, and Ironwood

Wattle. The ground layer was generally dominated by non-native Buffel Grass. Soils were grey cracking clay soils. A representative photograph of this community is shown in **Photo 3**.

RE 11.9.5

This vegetation community occurred as remnant and HVR vegetation on undulating hills and rises of sedimentary rocks in the study area. This community also occurred as homogenous polygons, in small, isolated patches, sometimes associated with remnant vegetation near Woleebee Creek.

The canopy was mid-dense (30-70% cover) and dominated with Brigalow and/or Belah. Ebony Tree (*Lysiphyllum carronii*) and Whitewood (*Atalaya hemiglauca*) was sometimes present and locally dominant. The shrub layer was relatively sparse (<30% cover) with species such as False Sandalwood, Wilga, and Myrtle Tree common. A lower shrub layer with Bush Caper (*Capparis lasiantha*) was sometimes present. The ground layer was dominated with Buffel Grass throughout the study area. Native ground cover species were present in areas with dense shading, such as native grasses (*Paspalidium* sp. and *Sporobolus* sp.), Saltbushes (Ruby Salt Bush (*Enchylaena tomentosa*), Berry Saltbush (*Einadia hastata*) and (*Atriplex* sp.)) and Rock Fern (*Cheilanthes* sp.). Soils were grey cracking clay soils. A representative photograph of this community is shown in **Photo 4**.

RE 11.9.7

This vegetation community occurred as remnant and HVR vegetation on undulating hills and rises of sedimentary rocks in the study area. This community occurred as homogenous polygons, in small, isolated patches, or associated with smaller drainage lines.

The canopy was sparse (10-30% cover) and dominated with Poplar Box. Silver-leaved Ironbark and White Cypress Pine were often sub-dominant or associated. The shrub layer was relatively sparse (<30% cover) and dominated with False Sandalwood and Wilga; other species include Bitterbark (*Alstonia constricta*), Holly Bush (*Alectryon diversifolius*) and Ironwood Wattle. The ground layer was dominated with Buffel Grass. Soils were grey cracking clay soils. A representative photograph of this community is shown in **Photo 5**.

RE 11.9.10

This vegetation community occurred as remnant and HVR vegetation on undulating hills and rises of sedimentary rocks in the study area. This community occurred as homogenous polygons, in small, isolated patches, or associated with smaller drainage lines.

The canopy was mid-dense (30-60% cover) and dominated with Poplar Box. Brigalow and Belah are often sub-dominant or locally dominant in the canopy; or form a subcanopy layer. The shrub layer was often dominated by Desert Lime (*Citrus glauca*) and Current Bush (*Carissa ovata*); with other species present such as Holly Bush and Sally Wattle (*Acacia salicina*). The ground layer was dominated with Buffel Grass. Soils were grey cracking clay soils. A representative photograph of this community is shown in **Photo 6**.

Non-remnant

Most of the study area was comprised of non-remnant vegetation. This included vast areas of Buffel Grass paddocks, that have been cleared for agriculture and contain little to no trees. Some Leucaena (*Leucaena leucocephala*) plantations were also present. Isolated,

mature eucalypt trees were present, primarily along the creek lines; and patches of Brigalow regrowth (*i.e.,* suckers) were scattered throughout the small drainage lines in the study area. A representative photograph of this community is shown in **Photo 7**.

Photo 1 RE 11.3.2

Photo 2 RE 11.3.25

Photo 3 RE 11.9.2

Photo 4 RE 11.9.5

Photo 5 RE 11.9.7

Photo 6 RE 11.9.10

Photo 7 Non-remnant

4.3.2 Threatened ecological communities

4.3.2.1 Desktop assessment

During the desktop assessment, five endangered TECs, as defined under the EPBC Act, were identified by the EPBC Act PMST (**Appendix A**) as potentially occurring within 30 km of the study area:

- Brigalow (*Acacia harpophylla*) dominant and co-dominant TEC (Brigalow TEC);
- Coolibah (*Eucalyptus coolabah subsp. coolabah*) - Black Box (*Eucalyptus largiflorens*) Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions;
- Poplar Box (*Eucalyptus populnea*) Grassy Woodland on Alluvial Plains (Poplar Box TEC);
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Vine Thicket TEC); and
- Weeping Myall (*Acacia pendula*) Woodlands.

PBA identified the Brigalow TEC during the 2007-2008 field surveys in the current study area[2].

4.3.2.2 Field survey

SLR assessed the presence of TECs in the study area during the 2023 and 2024 field surveys. The following two TECs were identified in the study area:

- Brigalow TEC (due to the presence of RE 11.9.5 which is included in the DoE (2013a) definition); and
- Poplar Box TEC due to the presence of RE 11.3.2 which is included in the DoEE (2019) definition).

The other TECs identified by the desktop assessment were considered unlikely to occur, as Coolibah, Black Box and Weeping Myall were not recorded in the study area, and no communities dominated by these species were found to occur. In addition, no semi-evergreen vine thicket communities were present; however, some vine thicket species were present in the understorey of Brigalow woodland communities.

To assess the presence of the Brigalow and Poplar Box TECs, assessments of vegetation communities were undertaken against the relevant key diagnostic characteristics and condition thresholds.

Brigalow TEC

Brigalow TEC occurs within Queensland and New South Wales and is characterised by open forests or woodlands with Brigalow as one of the most abundant tree species (DoE, 2013a; Butler, 2007). In Queensland, most of the Brigalow TEC occurs on flat to gently undulating Cainozoic clay plains.

Brigalow communities are known to support a range of different native plants and animals, including many threatened species (Peeters & Butler, 2014). Leaf litter and woody debris in these communities are of value to fauna species, particularly reptiles and invertebrates

[2] PBA also identified the Vine Thicket TEC outside of the study area for this assessment.

(DoE, 2013a). Other habitat features of importance in these communities are tree hollows of various sizes (providing roost sites for a variety of birds and mammals) and Mistletoes (which produce nectar and fleshy fruits which are eaten by numerous species) (Oliver *et al.*, 2003). These key habitat features are more common in relatively undisturbed brigalow woodlands and in higher rainfall environments. Mature, undisturbed Brigalow TEC is expected to be of greater value to faunal biodiversity than younger or more frequently disturbed woodlands (DoE, 2013a). However, Brigalow regrowth also provides habitat for a number of fauna and flora species suited to early 'successional' environments (DoE, 2013a).

Threats to the Brigalow TEC include factors that may further reduce its extent or cause a decline in condition. The most significant threats to this community are provided in DoE (2013a) as follows.

- Clearing: the Brigalow TEC has been extensively cleared, with most remnant vegetation fragmented in a highly modified landscape;
- Fire: native groundcover and biomass in Brigalow TEC is typically low, suggesting that fire has been historically rare in these communities (DoE, 2013a). The intrusion of weedy grasses (*e.g.,* Buffel Grass, Rhodes Grass (*Chloris gayana*) and Guinea Grass) in or adjacent to Brigalow woodlands is changing the fuel characteristics of these communities;
- Weeds: invasion of weed species into these communities can change their structure, function and habitat suitability for native species;
- Pest animals: Feral Pigs pose the greatest threat to this community through soil disturbance and degradation. Other species (e.g. Goats, Cane Toads, Feral Cats and Foxes) also pose serious threats such as predation of native species;
- Inappropriate grazing regimes: grazing can affect the recruitment of native shrubs and trees; and trampling can compress the soils and reduce the amount of leaf litter and woody debris in these communities (DoE, 2013a); and
- Climate change: hot and drier conditions may lead to exacerbation of threats such as fire; and fauna species dispersing between small, fragmented patches of Brigalow TEC may be vulnerable.

Assessments were undertaken in areas ground-truthed as RE 11.9.5, which met the key diagnostic characteristics of the TEC. However, the majority of the areas assessed did not meet the condition thresholds for the TEC due to the dominance of the non-native pasture grass species, Buffel Grass, in the ground layer (**Figure 8**). A few polygons met the condition threshold for the Brigalow TEC and its extent is provided in **Figure 8**.

Poplar Box TEC

Poplar Box TEC (endangered under the EPBC Act) was confirmed as present in the study area (**Figure 8**), and its potential extent is provided on **Figure 8**. This community occurs on ancient and recent depositional alluvial plains of clay, loam and sandy loam in central Queensland and in New South Wales.

DoEE (2019) lists threats to the Poplar Box TEC, that may further reduce its extent or cause a decline in condition. The most significant threats to this community that are relevant to the proposed project are:

- Clearing and fragmentation: historically driven by clearing or degradation associated with agriculture, but currently includes development for mining and gas;

- Weed invasion: weeds, especially Buffel Grass in the north of its range, reduce the native flora species diversity of the community;
- Fire: changes to patchiness, intensity, and frequency of fire, often driven by pasture grasses and other weeds, reduce ground cover diversity;
- Pest animals and livestock grazing: introduce or spread weeds, and alter vegetation composition;
- Hydrological change: alteration to hydrological regimes such as diversions and groundwater drawdown can lead to canopy dieback and other transformative impacts; and
- Climate change: hotter, drier, and less seasonally consistent conditions may lead to exacerbation of threats such as fire, leading to compounding of various threatening processes.

Assessments were undertaken in areas ground-truthed as RE 11.3.2, which met the key diagnostic characteristics of the TEC. Most of these areas met the minimum condition thresholds for the TEC. However, some areas adjacent to Jackson Wandoan Road, including where the road crosses Woleebee Creek, did not meet the minimum condition thresholds due to the dominance of Buffel Grass in the ground layer (**Figure 8**).

4.3.3 Environmentally sensitive areas

4.3.3.1 Desktop assessment

One Category B ESA is mapped to occur in the study area – Endangered RE (DESI Biodiversity Status); including areas of both remnant and HVR vegetation.

4.3.3.2 Field survey

The following REs ground-truthed in the study area are Category B ESAs (and are presented on **Figure 8**):

- RE 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks (remnant and HVR); and
- RE 11.9.10 *Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks (remnant and HVR).

4.3.4 Regulated vegetation

4.3.4.1 Desktop assessment

The following types of regulated vegetation (defined under the EO Regulation), that are also MSES, are mapped in the study area:

- Remnant endangered REs (VM class);
- Remnant of concern REs (VM class);
- Remnant RE intersecting a wetland on the VM wetlands map;
- Remnant RE within a defined distance from the defining banks of a relevant watercourse or drainage feature; and
- Essential habitat on the essential habitat map (for Glossy Black-cockatoo, Koala, Central Greater Glider and Belson's Panic).

Two VM Act wetlands are mapped to occur in the study area (shown in **Figure 9**), and remnant REs 11.3.25 and 11.3.2 are mapped to intersect with the wetlands. A number of constraints prevented field verification and should be undertaken in future assessments.

4.3.4.2 Field survey

The presence of regulated vegetation in the study area was assessed via quaternary vegetation assessments and general habitat assessments (for mapped essential habitat). Field-verified regulated vegetation in the study area is presented on **Figure 9** and described below.

Remnant endangered REs

One remnant endangered RE (VM class) was ground-truthed to occur in the study area – RE 11.9.5.

Remnant of concern REs

Three remnant of concern REs (VM class) were ground-truthed to occur in the study area – REs 11.3.2, 11.9.7 and 11.9.10.

Remnant RE intersecting a watercourse

The following remnant REs intersect VM Act mapped watercourses/drainage features in the study area: REs 11.3.2, 11.3.25, 11.9.2, 11.9.5, 11.9.7, 11.9.10.

These remnant REs are considered MSESs to the extent that they are within a defined distance from the defining banks of a watercourse/drainage feature. The study area is located within a non-coastal bioregion; therefore, according to the Queensland *Environmental Offsets Policy* (EO Policy) (DESI, 2023h), the defined distance from watercourses/drainage features depends on the stream order as follows:

- One or two – 25 m;
- Three or four – 50 m; and
- Five or greater – 100 m.

For potential future significant residual impact assessments, determination of the defining banks of watercourses in the area will be required. The defining banks of a watercourse/draining feature are defined in the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP, 2014) as '*the bank which confines the seasonal flows but may be inundated by flooding from time to time. This can be either:*

a) the bank or terrace that confines the water before the point of flooding, or

b) where there is no bank the seasonal high water line which represents the point of flooding.'

The defining banks of watercourses/drainage features were mapped (see **Figure 9**) based on field verification and aerial imagery as follows:

- Stream order one or two: 5 m wide channel;
- Stream order three or four: 10 m wide channel; and
- Stream order five or greater: 20 m wide channel.

The above information can be used in line with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (DEHP, 2014) and will assist in determining whether significant residual impacts to vegetation associated with watercourses will occur.

Essential habitat

Areas mapped as essential habitat within the study area met the essential habitat factors for Glossy Black-cockatoo, Koala, Central Greater Glider and/or Belson's Panic, as defined in the vegetation management property reports (DoR, 2023e). State-mapped essential habitat has therefore been incorporated into field-verified regulated vegetation mapping (**Figure 9**).

4.3.5 Vegetation condition

Moderate to major impacts from weeds, cattle grazing and clearing were observed in vegetation communities in the study area. The majority of the study area is comprised of non-remnant vegetation; cleared for agriculture (cattle grazing and feed crops). Non-native plant species were present in all the vegetation communities and were generally dominant in the ground layer. Cleared areas were mostly dominated with Buffel Grass with occasional stands of mature eucalypt trees and regrowth Brigalow suckers (along watercourses/drainage features or roadsides).

Signs of cattle grazing (*e.g.*, presence of pastoral species, areas with limited ground vegetation cover) were present throughout the remnant and HVR vegetation in the study area. Minimal impacts from fire were observed (*e.g.*, burn marks on trees <50 cm from ground level). Fire scar mapping by North Australia & Rangelands Fire Information (NAFI) suggests that widespread fires have not taken place in the study area (since records began in 2000). Patchy, localised fires took place in 2015, 2012 and 2011 (NAFI, 2023).

Seventeen BioCondition assessments were undertaken in the study area to provide an understanding of offset liability within the proposed disturbance footprint. Most REs in the disturbance footprint were classified as having a BioCondition class of 3 (moderately dysfunctional), with the exception of regional ecosystem 11.9.7 which fell into class 4 (dysfunctional).

A summary of key BioCondition assessment results is provided in **Table 12.**

Table 12 Summary of BioCondition assessment results

RE code	Number of assessments[1]	BioCondition S_c[2]	S_c out of 10	BioCondition status
11.3.2	5	0.58	6	3 – Moderately dysfunctional
11.3.25	3	0.52	5	3 – Moderately dysfunctional
11.9.2	2	0.52	5	3 – Moderately dysfunctional
11.9.5	5	0.46	5	3 – Moderately dysfunctional
11.9.7	1	0.39	4	4 – Dysfunctional
11.9.10	1	0.44	4	3 – Moderately dysfunctional

[1] Where there are multiple assessments, BioCondition scores have been averaged.

[2] 80% is the maximum weighting percentage for site-based attributes.

4.3.6 Native flora species

A total of 187 native flora species were recorded in the study area during the field surveys. A flora species list is provided in **Appendix C**.

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

GROUND-TRUTHED REGIONAL ECOSYSTEMS

FIGURE 7

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Blackant Creek
Wandoan Creek
Woleebee Creek
Grosmont Road
Jackson Wandoan Road
Juandah Creek
Waringa Creek
Leichhardt Highway
Two Mile Creek
Hallway Creek
Frank Creek
ML 50231
ML 50230

LEGEND

- BioCondition
- Tertiary
- Quaternary
- Main Road
- Major Watercourse
- Minor Watercourse
- Survey Track
- Study Area
- Wandoan Mining Lease
- Category B ESA's

Ground-Truthed Regional Ecosystems (VM Status)

- High Value Regrowth- Endangered
- High Value Regrowth- Of Concern
- Remnant- Endangered
- Remnant- Of Concern
- Remnant- Least Concern

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	10-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000

Grosmont Road
Juandah Creek
Leichhardt Highway
Jackson Wandoan Road
ML 50231
ML 50230
Widgebee Creek

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

CONFIRMED AND POTENTIAL THREATENED ECOLOGICAL COMMUNITIES

FIGURE 8

LEGEND

TEC Assessment

- Confirmed
- Absent
- Main Road
- Major Watercourse
- Study Area
- Wandoan Mining Lease

Potential Threatened Ecological Communities

- Brigalow TEC
- Poplar Box

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	30-Apr-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

FIELD-VERIFIED REGULATED VEGETATION IN THE STUDY AREA

FIGURE 9

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Grosmont Road
Jackson Wandoan Road
Leichhardt Highway
Blackant Creek
Wandoan Creek
Woleebee Creek
Halfway Creek
Frank Creek
Two Mile Creek
Juandah Creek
Weringa Creek
ML 50231
ML 50230
11.3.25/11.3.2
11.9.7
11.3.2
11.3.5
11.9.10/11.3.25

LEGEND

- Main Road

VM Act Watercourse

- Major Watercourse
- Minor Watercourse
- VM Act Wetland
- Wandoan Mining Lease
- Study Area

Regulated Vegetation Types

- Remnant Endangered RE (VM status)
- Remnant Of concern RE (VM status)
- Remnant RE Intersecting a Watercourse
- Remnant RE Intersecting a Wetland
- Essential Habitat

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	18-Dec-2023
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp58488\Untitled\Untitled.aprx

4.3.7 Conservation significant flora species

4.3.7.1 Desktop assessment

A high risk area on the flora survey trigger map (DESI, 2023c) occurs in the study area (within the proposed southern pit) (**Appendix D**). MSES essential habitat and protected wildlife habitat are also mapped in this area for Belson's Panic (*Homopholis belsonii*) (vulnerable EPBC Act, endangered NC Act).

The EPBC Act PMST (DCCEEW, 2023a; included in **Appendix A**), the WO Database search (DES, 2023a; included in **Appendix B**) and a review of ALA records (ALA, 2023) collectively returned ten conservation significant flora species potentially relevant to the project. One species - Belson's Panic – was recorded by PBA during the 2007-2008 surveys in several locations within the study area (presented on **Figure 10**).

The likelihood of occurrence for conservation significant flora species is as follows:

- One species was present;
- Two species with a moderate likelihood of occurrence; and
- Seven species with a low likelihood of occurrence.

Justification for the likelihood of occurrence determination for each species is provided in **Appendix F**. Conservation significant flora species identified from the desktop assessment are shown in **Table 13**. Species with a low likelihood of occurrence are not discussed further in this report.

Table 13 Conservation significant flora species identified from database searches

Status[1]		Family	Scientific name	Common name	Source[2]	Number of WN records	Likelihood of occurrence
EPBC	NC						
E	E	Acanthaceae	*Xerothamnella herbacea*	-	PM	0	Moderate
E	E	Apocynaceae	*Vincetoxicum forsteri* (syn *Tylophora linearis)*	-	PM	0	Low
E	LC	Brassicaceae	*Lepidium monoplocoides*	Winged Pepper-cress	PM	0	Low
V	V	Leguminosae	*Acacia curranii*	Curly-bark Wattle	PM, PBA	0	Low
V	V	Poaceae	*Arthraxon hispidus*	Hairy-joint Grass	PM, PBA	0	Low
V	LC	Poaceae	*Dichanthium setosum*	Bluegrass	PM	0	Low
-	NT	Poaceae	*Digitaria porrecta*	-	WN, PBA	2	Low
V	E	Poaceae	*Homopholis belsonii*	Belson's Panic	WN, PM, PBA	2	Present
V	V	Santalaceae	*Thesium australe*	Austral Toadflax	PM	0	Low
V	V	Surianaceae	*Cadellia pentastylis*	Ooline	WN, PM, PBA	6	Moderate

[1] Status: NC = Queensland *Nature Conservation Act 1992*; EPBC = Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Categories include: Least Concern (LC), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed.

[2] 10km search radius for EPBC Act Protected Matters Report (PM) records; 30 km search radius for WildNet database (WN) records. Review of additional Atlas of Living Australia records (ALA) in proximity to the study area. Species assessed during the PBA 2008 and 2009 EIS (PBA).

4.3.7.2 Field survey

Habitat assessments and searches were undertaken for conservation significant flora species identified as present, or with a high and moderate likelihood of occurrence in the study area. Six random meanders surveys were also undertaken in habitat suitable for Belson's Panic that was within a high risk area on the flora survey trigger map and/or the location of a record from previous surveys (presented on **Figure 10**).

No conservation significant flora species were detected during SLR's flora survey.

Given Belson's Panic has previously been recorded in the study area, a precautionary approach was taken, and it was assumed to still be present. A description of the species, and potentially suitable habitats in the study area is provided below.

The following species were assessed as having a moderate likelihood of occurrence but were not recorded in the study area during the field survey:

- Ooline (*Cadellia pentastylis*); and
- *Xerothamnella herbacea.*

A description of each species, and their potential presence or absence in the study area is provided below.

Belson's Panic

Belson's Panic (vulnerable NC Act, endangered EPBC Act) is a perennial grass, growing to 0.5 m (DEWHA, 2008a). It occurs within the southern Brigalow belt, Queensland and on the north-western slopes and plains of NSW, at elevations from 200 to 520 m above sea level. It is known to occur in dry woodlands with poor soils, such as the following (DECC NSW, 2005; Leigh *et al.*, 1984; Menkins, 1998; Trémont & Whalley, 1993):

- Rocky hills supporting White Box (*Eucalyptus albens*) and in Wilga woodland;
- Flat to gently undulating alluvial areas supporting Belah forest;
- Soils and plant communities of Poplar Box woodlands;
- Shadier areas of Brigalow, Yarran (*Acacia melvillei*), and Weeping Myall communities; and
- Mountain Coolibah communities.

DEWHA (2008a) lists the main threats to this species as:

- Clearing of habitat for agriculture;
- Development or pasture improvement; overgrazing of habitat by domestic stock; invasion of habitat by introduced weeds; and
- Clearing of habitat for mining.

Belson's Panic was recorded during previous surveys in the study area. Suitable habitat for this species was ground-truthed and mapped in remnant and regrowth vegetation dominated by Brigalow and/or Poplar Box communities on sedimentary rocks or alluvial floodplains.

Although flora surveys were undertaken during the known flowering/fruiting period for Belson's Panic (February-May (Sharp & Simon, 2001)), it was not detected during the SLR field surveys. This may be reflective of low population densities of this species – suitable habitat in the study area is generally in poor condition with a high degree of weed invasion.

Suitable habitat for this species, and previous records, are presented on **Figure 10**. The following remnant and HVR REs were considered suitable habitat for this species (based on previous records, published habitat descriptions in DEWHA (2008a) and DESI modelled species habitat): remnant and HVR REs 11.9.5, 11.9.10 and 11.3.2.

Ooline

Ooline (vulnerable NC Act and EPBC Act) is a medium sized tree, with glossy green leaves, growing to 10 m. This species has a scattered distribution on the western slopes of the Great Dividing Range, occurring in vine thickets and sclerophyll vegetation at altitudes greater than 300 m above sea level (DEWHA, 2008b).

DEWHA (2008b) lists the main threats to this species as:

- Localised extinction due to small and scattered populations;
- Clearing for agriculture;
- Grazing and soil compaction by domestic stock, Feral Goats (*Capra hircus*) and Feral Pigs;
- Invasion of habitat by weeds, such as Tiger Pear (*Opuntia aurantiaca*);
- Frequent fires;
- Tunnel and sheet erosion;
- Damage to roadside populations during roadworks; and
- High insect attack.

Brigalow woodland communities in the study area provide potentially suitable habitat for this species; however, its preferred vine thicket habitat is not present.

Ooline was not recorded during the SLR surveys (or previous surveys). In addition, habitats in the study area are generally in poor condition with a high degree of weed invasion. Ooline is a relatively large, distinctive plant that was not observed during several extensive survey programs in the study area. On this basis, the study area is deemed unlikely to support a population of Ooline.

Xerothamnella herbacea

Xerothamnella herbacea (endangered NC Act and EPBC Act) is a sprawling, perennial herb growing to 30 cm. This species is known from northeast of Chinchilla, near Theodore and near Yelarbon east of Goondiwindi, Queensland (DEWHA, 2008c). It occurs in Brigalow dominated communities in shaded situations, often in leaf litter and is associated with gilgais. Soils are heavy, grey to dark brown clays. It has also been recorded in areas of non-remnant vegetation (DEWHA, 2008c).

DEWHA (2008c) lists the main threats to this species as:

- Competition from invasive plant species such as Green Panic (*Megathyrsus maximus var. pubiglumis*) and Buffel Grass;
- Changing fire regimes;
- Road widening and maintenance activities;
- Surface erosion; and
- Grazing and trampling by cattle and native macropods.

Brigalow woodland communities in the study area provide potentially suitable habitat for this species. *Xerothamnella herbacea* was not recorded during the SLR surveys (or previous surveys). In addition, habitats in the study area are generally in poor condition with a high degree of weed invasion (primarily Buffel Grass). On this basis, the study area is deemed unlikely to support a population of *Xerothamnella herbacea*.

4.3.8 Weed species

A total of 46 non-native flora species were identified within the study area six of which were listed weeds. These are given in **Table 14** and presented on **Figure 11**. The following listed weeds were recorded in the study area:

- Parthenium Weed (*Parthenium hysterophorus*);
- Noogoora Burr (*Xanthium occidentale*);
- Velvet Tree Pear (*Opuntia tomentosa*);
- Mother of Millions (*Bryophyllum delagoense*);
- Mimosa Bush (*Vachellia farnesiana*); and
- Athel Pine (*Tamarix aphylla*).

Introduced pasture grasses (which are not listed weeds) are having a detrimental impact on vegetation communities in the study area. Buffel Grass is dominant in the ground layer throughout the study area, and Guinea Grass is prevalent in some riparian communities. These species are outcompeting native ground layer species and hence reducing the biodiversity and habitat values of the vegetation communities.

Table 14 Listed weeds recorded in the study area

Family	Species name	Common name	Status [1]			Distribution
			Biosecurity Act	WoNS	WDRC (2017)	
Asteraceae	*Parthenium hysterophorus*	Parthenium Weed	Category 3	Yes	High	Widespread Parthenium infestations were recorded in riparian areas adjacent to Frank Creek, and further east along minor watercourses/drainage lines. It was observed most frequently in remnant RE 11.3.25 and non-remnant vegetation.
	Xanthium occidentale	Noogoora Burr	-	-	Low	Widespread Noogoora Burr infestations were recorded in riparian areas along Woleebee Creek, Frank Creek and along minor watercourses/drainage lines. It was observed most frequently in remnant RE 11.3.25 and non-remnant vegetation.
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	Category 3	Yes	High	Velvet Tree Pear is widespread in the study area at very low densities. It was observed most frequently in Brigalow communities (*e.g.,* RE 11.9.5).
Crassulaceae	*Bryophyllum delagoense*	Mother of Millions	Category 3	No	High	Mother of Millions generally occurs as localised, dense infestations associated with HVR or non-remnant Brigalow communities (RE 11.9.5) in the study area. Most infestations were found in the northern proposed pit.
Leguminosae	*Vachellia farnesiana*	Mimosa Bush	-	-	Low	Mimosa Bush occurs as scattered, localised infestations in the study area. It was generally in riparian areas (along watercourses/drainage lines) with non-remnant vegetation or remnant RE 11.3.25.
Tamaricaceae	*Tamarix aphylla*	Athel Pine	Category 3	Yes	-	One mature individual Athel Pine was recorded in the study area. It was adjacent to a homestead, and most likely a planted tree.

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000

Inset Map A
Inset Map A Scale 1:20,000
Inset Map B
Inset Map B Scale 1:20,000
Jugiah Creek
Gregmont Road
Jackson Wandoan Road
Leichhardt Highway
Wallumbe Creek

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR BELSON'S PANIC

FIGURE 10

LEGEND

- Existing records of Belson's Panic
- Meander Survey
- Main Road
- Major Watercourse
- Survey Track
- Study Area
- Wandoan Mining Lease
- Potential Habitat for Belson's

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	03-Jun-2024
Drawn by:	AS

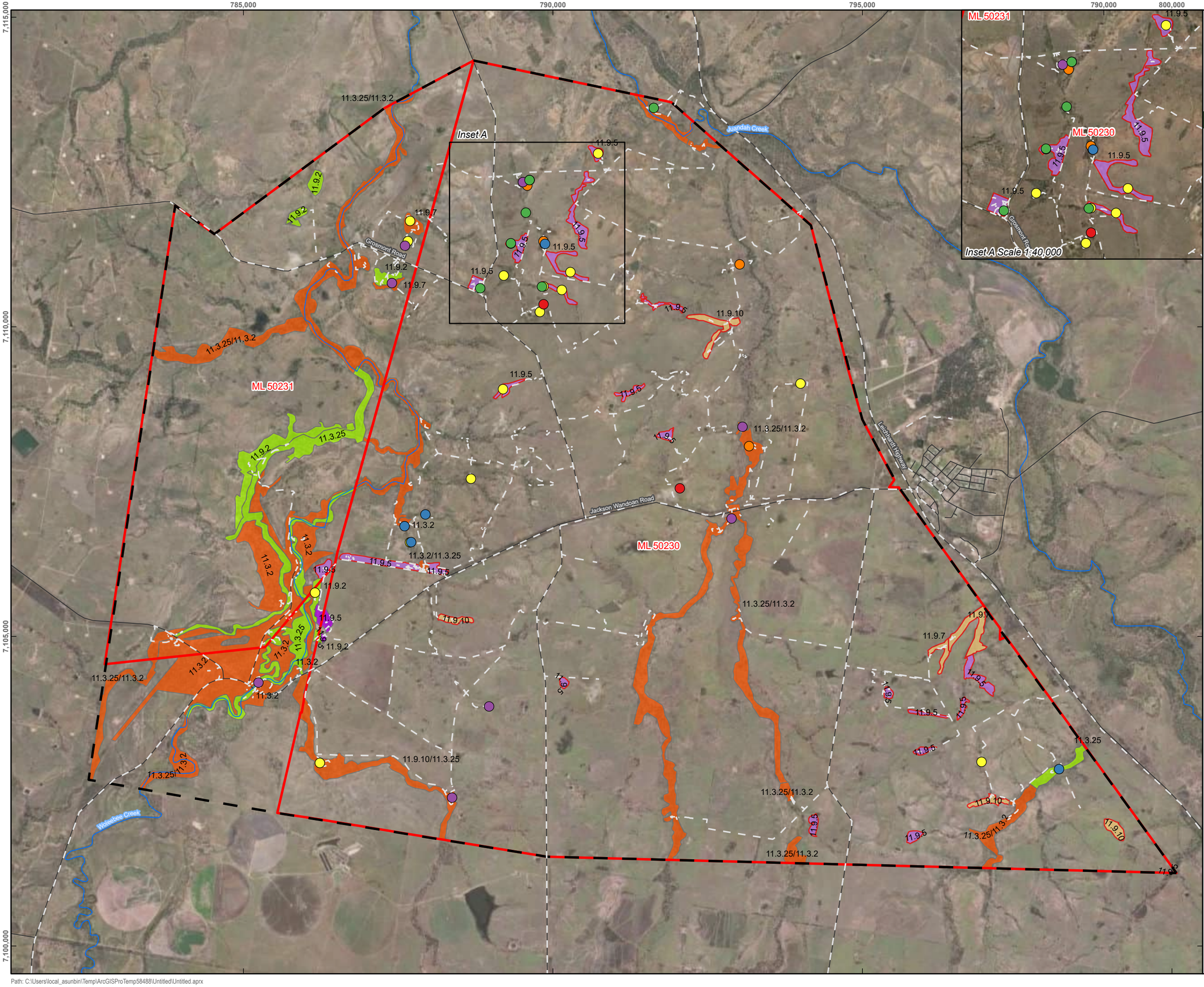
SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

WEED SPECIES LOCATIONS

FIGURE 11



LEGEND

Weeds

- Athel Pine
- Mimosa Bush
- Mother of Millions
- Noogoora Burr
- Parthenium
- Tree Pear

- Main Road
- Major Watercourse
- Survey Track
- Study Area
- Wandoan Mining Lease

Ground-Truthed Regional Ecosystems (VM Status)

- High Value Regrowth- Endangered
- High Value Regrowth- Of Concern
- Remnant- Endangered
- Remnant- Of Concern
- Remnant- Least Concern

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	18-Dec-2023
Drawn by:	AS

SLR

4.4 Fauna

4.4.1 Fauna habitats

4.4.1.1 Desktop assessment

The following BVGs (1:2 million) are mapped to occur in the study area (descriptions provided from Neldner *et al.,* (2023)) and are presented on **Figure 4**:

- BVG 16 – *Eucalyptus* spp. dominated open forest and woodlands drainage lines and alluvial plains.
    - This is mapped to occur in the remnant, riparian vegetation adjacent to Woleebee and Frank Creeks.
- BVG 25 – Brigalow sometimes with Belah open forests to woodlands on heavy clay soils.
    - This is mapped to occur in the remaining remnant vegetation in the study area, along the smaller watercourses, adjacent to Woleebee Creek and in smaller, isolated patches.

Protected wildlife habitat occurs within the project area (DESI, 2023f), in the remnant and HVR vegetation associated with Woleebee Creek, for the following species:

- NC Act listed special least concern Echidna (*Tachyglossus aculeatus*); and
- NC Act listed species Glossy Black-cockatoo (vulnerable), Koala (endangered), and Central Greater Glider (vulnerable).

4.4.1.2 Field survey

Habitat types

The following habitat types (*i.e.,* BVG 1:2 million) were ground-truthed in the study area:

- BVG 16 – *Eucalyptus* spp. dominated open forest and woodlands drainage lines and alluvial plains;
- BVG 17 – Poplar Box or Silver-leaved Ironbark dry woodlands to open woodlands on sandplains or depositional plains; and
- BVG 25 – Brigalow sometimes with Belah open forests to woodlands on heavy clay soils.

A description of each habitat type and their distribution within the study area is provided below and presented on **Figure 12**.

Eucalyptus spp. dominated open forest and woodlands on drainage lines and alluvial plains

This habitat type is characterised by large Queensland Blue Gums (*E. tereticornis*) along Woleebee Creek, Frank Creek, and associated tributaries. This eucalypt species provides several faunal habitat values. Small and large arboreal hollows form in larger trees which are utilised for roosting and breeding by Greater Gliders, Glossy Black-cockatoos, Sugar Gliders, Squirrel Gliders, Brushtail Possums, and microbat species. Queensland Blue Gums frequently used by Koalas for feeding and shelter in these communities, and the flowers provide nectar for gliders and flying foxes.

Decorticating bark ranges from sparse to common, depending on the abundance of tree species such as Silver-leaved Ironbark (*E. melanophloia*) in these communities. The ground cover is generally seasonally dense, largely due to weed species such as Guinea Grass (*Megathyrsus maximus*) and Buffel Grass (*Cenchrus ciliaris*), however the native *Sida hackettiana* is also well represented in the ground layer.

Low to moderate leaf litter density and sandy/loamy, friable soils provide cover for small mammals and reptiles (*e.g.*, dunnarts, rodents, snakes, skinks) and fossorial reptiles such as *Lerista* spp. Occasional to sparse mistletoes in this habitat type may irregularly support honeyeaters.

Poplar Box or Silver-leaved Ironbark dry woodlands to open woodlands on sandplains or depositional plains

This habitat type is characterised by woodland tree species which generally develop small hollows, and less commonly large hollows. These can provide roosting and nesting habitat for a number of birds, particularly parrot species and some birds of prey, as well as mammals such as possums and gliders. Silver-leaved Ironbark develops high-quality decorticating bark, which is ideal habitat for microbats, arboreal reptiles (*e.g.*, velvet geckoes, dtellas, and pale-headed snakes) and their prey (*e.g.*, frogs, insects, and spiders).

Groundcover in most areas is predominantly dense Buffel Grass (*C. ciliaris*), however there are areas of Poplar Box woodland which encompass a greater diversity of native ground cover species. This is likely to support macropods and granivorous fauna species such as finches and doves.

Brigalow sometimes with Belah open forests to woodlands on heavy clay soils

In the study area, this habitat type is characterised by a low EDL comprising of Brigalow (*A. harpophylla*). Most Brigalow habitats in the study area are either regrowth woodland/forest (see **Figure 7**) or modified for cattle grazing, which has reduced the basal area in this habitat type. Belah (*Casuarina cristata*) is rarely present in these open forests/woodlands, however deep cracking clay is present and provides a microhabitat feature that a number of Brigalow Belt reptiles are dependent on.

General habitat assessments

Fifty-six general habitat assessments were undertaken in the study area (presented on **Figure 4**), to identify habitat features and resources of importance to fauna species (with a focus on conservation significant fauna species).

The following habitat values/features were presented in the study area:

- Seeding grassy understorey;
- Mistletoe species;
- Flowering/fruiting Eucalypts and shrubs;
- High canopy cover (varying conditions of shade);
- Woody debris;
- Leaf litter;
- Tree hollows; and
- Permanent (farm dams) and semi-permanent (creeks) water sources.

Protected wildlife habitat for the following species was also confirmed as present (and will be discussed further in **Section 4.4.2**:

- Special least concern: Echidna (little permanent water is present in the study area; therefore, habitat is not considered suitable for Platypus); and
- Vulnerable and endangered species: Glossy Black-cockatoo, Koala and Central Greater Glider.

Systematic survey sites

Seven systematic survey sites were established during the survey, and an array of fauna trapping and survey techniques were employed at each site. A description of the habitat present at each systematic survey site is provided in **Table 15**. The location of each survey site is provided in **Figure 4**. A fauna species list for each site is provided in **Appendix C**.

Table 15 Systematic fauna survey sites and corresponding habitat

Site number	Habitat description	Representative photograph
Site 1	Remnant woodland dominated with Cypress Pine (*Callitris glaucophylla*), with Poplar Box (*Eucalyptus populnea*) and Silver-leaved Ironbark (*E. melanophloia*) on sedimentary rocks. (RE 11.9.7, BVG2M: 17)	
Site 2	Remnant riparian open forest dominated with Queensland Blue Gum (*Eucalyptus tereticornis*), with Rough-barked Apple (*Angophora floribunda*), on fringing alluvial drainage lines. (RE 11.3.25, BVG2M: 16)	

Site number	Habitat description	Representative photograph
Site 3	Remnant woodland with co-dominant Brigalow (*Acacia harpophylla*) and Belah (*Casuarina cristata*) on sedimentary rocks. (RE 11.9.5, BVG2M: 25)	
Site 4	Remnant woodland dominated by Brigalow (*Acacia harpophylla*) with sub-dominant Belah (*Casuarina cristata*). (RE 11.9.5, BVG2M: 25)	
Site 5	Remnant woodland dominated with Poplar Box (*Eucalyptus populnea*) on alluvium. (RE 11.3.2, BVG2M: 17)	

Site number	Habitat description	Representative photograph
Site 6	Remnant riparian woodland with dominant Queensland Blue Gum (*Eucalyptus tereticornis*) and sub-dominant Black She-oak (*Casuarina littoralis*). (RE 11.3.25, BVG2M: 16)	
Site 7	Low open forest (HVR), False Sandalwood (*Eremophila mitchellii*) dominant in T2 EDL, with sub-dominant Ebony Tree (*Lysiphyllum carronii*) and Whitewood (*Atalaya hemiglauca*). (RE 11.9.5, BVG2M: 25	

4.4.2 Fauna species

4.4.2.1 Desktop assessment

The EPBC Act PMST (DCCEEW, 2023a; included in **Appendix A**), the WildNet Database search (DESI, 2023a; included in **Appendix B**) and a review of ALA records (ALA, 2023) collectively returned 40 conservation significant fauna species potentially relevant to the project.

Threatened or near threatened species

Twenty-nine threatened or near threatened fauna species were returned from the database searches. The following four species were confirmed as present during the PBA 2007-2008 surveys:

- Glossy Black-cockatoo;
- Koala;
- Central Greater Glider; and
- Golden-tailed Gecko[3].

[3] Recorded outside of SLR's study area.

The likelihood of occurrence for threatened and near threatened fauna species in the study area is as follows:

- 4 species were present;
- 14 species with a moderate likelihood of occurrence; and
- 11 species with a low likelihood of occurrence.

Migratory and special least concern species

Twelve migratory species were returned from the database searches. One species - Short-beaked Echidna – was confirmed as present during the PBA 2007-2008 surveys.

The likelihood of occurrence for migratory and special least concern fauna species in the study area is as follows:

- 2 species were present (Short-beaked Echidna, Fork-tailed Swift);
- 3 species with a moderate likelihood of occurrence; and
- 7 species with a low likelihood of occurrence.

Justification for the likelihood of occurrence determination for each species is provided in **Appendix F**. Conservation significant fauna species identified from the desktop assessment are shown in **Table 16**. Species with a low likelihood of occurrence are not discussed further in this report.

Table 16 Conservation significant fauna species identified from database searches

Status[1]		Family	Scientific name	Common name	Source[2]	Number of WN records	Likelihood of occurrence
NCA	EPBC						
BIRDS							
V	V	Acanthizidae	*Aphelocephala leucopsis*	Southern Whiteface	PM	0	Low
E	E	Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	PM, PBA	0	Low
M	SL	Apodidae	*Apus pacificus*	Fork-tailed Swift	WN, PBA	4	Present
V, M	V	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	PM, WN, PBA	3	Moderate
V	V	Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy Black-cockatoo (eastern)	PM, WN, PBA	1	Present
E	V	Cacatuidae	*Lophochroa leadbeateri*	Major Mitchell's Cockatoo	PBA	0	Low
V	V	Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (south-eastern)	PM, PBA	0	Low
V	V	Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (southern subspecies)	PM, WN, PBA	1	Moderate
M	SL	Cuculidae	*Cuculus optatus*	Oriental Cuckoo	PM	0	Low
E	E	Estrildidae	*Neochmia ruficauda ruficauda*	Star Finch	PM, PBA	0	Low
V	V	Estrildidae	*Stagonopleura guttata*	Diamond Firetail	PM, PBA	0	Low
V	V	Falconidae	*Falco hypoleucos*	Grey Falcon	PM, PBA	0	Low
V	V	Meliphagidae	*Grantiella picta*	Painted Honeyeater	PM, PBA	0	Moderate
M	SL	Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher	PBA	0	Moderate
M	SL	Motacillidae	*Motacilla flava*	Yellow Wagtail	PM	0	Low
M	SL	Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail	PM	0	Low

Status[1]		Family	Scientific name	Common name	Source[2]	Number of WN records	Likelihood of occurrence
NCA	EPBC						
E	E	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	PM, PBA	0	Moderate
M	SL	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	PM	0	Low
M	SL	Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	PM	0	Low
CE, M	CE	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	PM	0	Low
M	SL	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	PM	0	Low
M	SL	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	PBA	0	Moderate
V	V	Turnicidae	*Turnix melanogaster*	Black-breasted Button-quail	PM, PBA	0	Low
INVERTEBRATES							
E	V	Camaenidae	*Adclarkia cameroni*	Brigalow Woodland Snail	PM	0	Moderate
E	E	Camaenidae	*Adclarkia dulacca*	Dulacca Woodland Snail	PM	0	Moderate
MAMMALS							
E	LC	Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	PM, PBA	0	Low
V	E	Megadermatidae	*Macroderma gigas*	Ghost Bat	PM	0	Low
V	V	Petauridae	*Petaurus australis australis*	Yellow-bellied Glider (southern subspecies)	PM, WN, PBA	9	Moderate
E	E	Phascolarctidae	*Phascolarctos cinereus*	Koala	PM, WN, PBA	7	Present
E	E	Pseudocheiridae	*Petauroides armillatus (syn Petauroides volans)*	Central Greater Glider	PM, WN, PBA	1	Present
-	SL	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	WN, PBA	15	Present
E	V	Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	PM, PBA	0	Low

Status[1]		Family	Scientific name	Common name	Source[2]	Number of WN records	Likelihood of occurrence
NCA	EPBC						
V	V	Vespertilionidae	*Nyctophilus corbeni (syn Nyctophilus timoriensis)*	Corben's Long-eared Bat	PM, PBA	0	Moderate
REPTILES							
-	NT	Diplodactylidae	*Strophurus taenicauda*	Golden-tailed Gecko	WN, PBA	12	Present
-	V	Elapidae	*Acanthophis antarcticus*	Common Death Adder	PBA	0	Moderate
V	V	Elapidae	*Furina dunmalli*	Dunmall's Snake	PM, PBA	0	Moderate
E	E	Elapidae	*Hemiaspis damelii*	Grey Snake	PM, PBA	0	Moderate
V	V	Pygopodidae	*Delma torquata*	Adorned Delma	PM, PBA	0	Low
V	E	Scincidae	*Anomalopus mackayi*	Five-clawed Worm-skink	PM, PBA	0	Low
V	V	Scincidae	*Egernia rugosa*	Yakka Skink	PM, PBA	0	Moderate

[1] Status: NCA = Queensland *Nature Conservation Act 1992*; EPBC = Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Categories include: Least Concern (LC), Near Threatened (NT), Vulnerable (V), Endangered (E), Critically Endangered (CE), Special Least Concern (SL) or Migratory (M). '-' indicates not listed.

[2] 10km search radius for EPBC Act Protected Matters Report (PM) records; 30km search radius for WildNet database (WN) records.

4.4.2.2 Field survey

Overview of detected fauna

A number of fauna species were identified in the study area using both active and passive survey techniques. A full list of fauna species identified during the field survey is provided in **Appendix C**. The following sections provide a brief discussion of the species observed for each vertebrate taxonomic group.

Amphibians

Eleven amphibians were detected during field surveys, only four of which were recorded during the pre-wet season survey. Most were burrowing frogs (*Platyplectrum ornatum* and *Cyclorana alboguttata*) and ground-dwelling frogs (*Limnodynastes* spp., *Uperoleia rugosa*, and *Litoria latopalmata*), detected from pitfall traps and/or spotlighting efforts, however some tree frogs (*L. caerulea* and *L. peronii*) were also recorded. All were least concern NC Act species, with the exception of the introduced Cane Toad (*Rhinella marina*) which was detected through trapping efforts and also spotlighting throughout the WCP area.

Birds

116 bird species were observed from the collective 2023-2024 field surveys, including a large diversity of waders, woodland species, and raptors.

No Squatter Pigeons (southern) were observed during waterbody watches or flushing surveys. The EPBC listed (migratory) Fork-tailed Swift was detected flying over the WCP area during the post-wet season survey.

Evidence of Glossy Black-cockatoos was found in the form of ‘orts’ (chewed cones of *Allocasuarina* and *Casuarina* spp.) in the WCP area where the species has previously been observed (**Figure 13**). Yellow-tailed Black-cockatoos frequent the study area, and were observed in remnant vegetation along V Road, intersecting Jackson Wandoan Road. Although the species has a less specialised diet than Glossy Black-cockatoo, it is known to favour she-oak seeds.

Mammals

Forty-one mammal species were detected in the WCP area, including EPBC Act endangered Koala and Greater Glider, and NC Act special least concern Short-beaked Echidna.

Short-beaked Echidna was detected during the 2023 post-wet season survey from a camera trap at fauna site 6, and Central Greater Gliders were detected from spotlighting efforts during both surveys. Koalas were detected by DPM Enviroscіences during the 2023 pre-wet season survey via thermal drone as well as incidentally along creeks in RE 11.3.25, and one opportunistic observation was made during the 2024 post-wet season survey (**Figure 13**).

A number of grazing stock and introduced/pest species were observed during the collective 2023 surveys, including:

- Domestic Cow (*Bos taurus*);
- Dingo (*Canis familiaris (dingo)*);
- Horse (*Equus caballus*);
- Feral Cat (*Felis catus*);
- European Brown Hare (*Lepus europaeus*);
- Rabbit (*Oryctolagus cuniculus*);

- House Mouse (*Mus musculus*); and
- Feral Pig (*Sus scrofa*).

Reptiles

A total of thirty-two reptile species were either captured or identified through other methods during both the post-wet and pre-wet season surveys. These species are known to utilise a range of microhabitats.

No arboreal reptiles were captured in traps – all were detected either whilst spotlighting or were incidental observations. Representative species included Snake-eyed Skinks (*Cryptoblepharus* sp.), Velvet Geckoes (*Oedura* sp.), Dtellas (*Gehyra dubia*), and monitors (*Varanus varius* and *V. panoptes*). *V. varius* was also detected on a camera trap hunting fish in a wetland in the mine project area. None of the species which were captured or observed were EPBC Act listed or NC Act listed EVNT species.

Ground-dwelling/litter skinks (*Carlia* sp., *Morethia boulengeri*, *Lygisaurus foliorum*) and fossorial reptile species (*Lerista punctatovittata* and *L. timida*) were captured in pitfall traps in Brigalow-dominated habitat, co-dominant Brigalow/Belah habitat, and Cypress Pine woodland. Trap sites were situated in habitats which were less impacted by cattle; soils were generally soft and friable, and leaf litter and/or ground cover was present in patches.

Few snakes were detected during either survey. None were recorded during the pre-wet season survey, while four were recorded during the post-wet season survey. An Eastern Small-eyed Snake (*Cryptophis nigrescens*) was recorded during nocturnal road cruising/spotlighting, and a deceased Keelback (*Tropidonophis mairii*) was recorded on the road in the study area.

Threatened and near threatened species

Targeted surveys were undertaken for threatened and near threatened fauna species confirmed as present (by previous surveys), or with a high or moderate likelihood of occurrence in the study area. Survey techniques and effort were in accordance with relevant Queensland and Australian Government guidelines (summarised in **Table 7**).

The following three species were confirmed as present in the study area during the field surveys:

- Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*);
- Koala (*Phascolarctos cinereus*); and
- Central Greater Glider (*Petauroides armillatus)*.

One species – Golden-tailed Gecko – was not detected in the study area by SLR, but was recorded during previous surveys (PBA, 2008a). This species is also considered to be present in the study area.

A description of each of these species, and potentially suitable habitats in the study area is provided below.

The following species were assessed as having a moderate likelihood of occurrence but were not recorded in the study area during the field survey:

- Squatter Pigeon (*Geophaps scripta scripta);*
- Painted Honeyeater (*Grantiella picta*);
- White-throated Needletail (*Hirundapus caudacutus*);
- Australian Painted Snipe (*Rostratula australis*);

- Brigalow Woodland Snail (*Adclarkia cameroni*);
- Dulacca Woodland Snail (*Adclarkia dulacca*);
- Yellow-bellied Glider (*Petaurus australis australis);*
- Corben's Long-eared Bat (*Nyctophilus corbeni);*
- Common Death Adder (*Acanthophis antarcticus);*
- Dunmall's Snake (*Furina dunmalli);*
- Grey Snake (*Hemiaspis damelii); and*
- Yakka Skink (*Egernia rugosa)*.

A description of each species, and their potential presence or absence in the study area is provided below.

Australian Painted Snipe

The Australian Painted Snipe (*Rostratula australis*) is listed as Endangered and Marine under the EPBC Act and Endangered under the NC Act. The Australian Painted Snipe is a wading bird recorded at wetlands in all states of Australia. This species is mostly common in eastern Australia in Queensland, NSW, Victoria and south-eastern South Australia, and less common in western South Australia, NT and WA (Barrett *et al.* 2003; Blakers *et al.* 1984).

Suitable habitat for the Australian Painted Snipe is shallow terrestrial freshwater wetlands. This may include temporary and permanent lakes, swamps, claypans, inundated or waterlogged grasslands, saltmarsh and dams. Often these habitats comprise of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (Marchant & Higgins 1993).

For breeding, the Australian Painted Snipe requires very shallow wetlands with areas of bare wet mud with both upper and canopy cover nearby. Breeding seems to depend on wetland conditions rather than during a particular season; breeding has been recorded in all months in Australia (Marchant & Higgins 1993). The Australian Painted Snipe is predominantly recorded singly or in pairs during the non-breeding season (Marchant & Higgins 1993) but has been recorded in flocks around groups of nests during time of breeding.

The area of occupancy for the Australian Painted Snipe has undoubtedly declined as approximately 50% of wetlands in Australia have been removed since European settlement (Environment Australia 1997); habitat loss and degradation are the major threats to this species. Drainage of wetlands and diversion of water to agriculture and reservoirs have altered essential habitat by reducing flooding and precluding the formation of temporary shallow wetlands (Garnett & Crowley 2000; Rogers *et al.* 2005; Watkins 1993). Reduced water quality from increased nutrient and saline content which in turn can impact this species by changing aquatic vegetation present at this site. Other threats include grazing and trampling of suitable habitat vegetation, fire regimes, invasive weeds, and feral species.

While the Australian Painted Snipe may be recorded in the survey area, visits may be short, irregular and infrequent as suitable habitat and required resources for this species is absent. Dams and wetlands present in the study have limited suitable aquatic vegetation, some completely dry out during the dry periods, and are unlikely to support a population of Australian Painted Snipe.

Glossy Black-cockatoo

The eastern subspecies of Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*) is listed as vulnerable under the EPBC Act and the NC Act. This subspecies is uncommon

across a broad distribution in south-eastern Australia, occurring from Mitchell in central southern Queensland to East Gippsland, Victoria. The species feeds almost exclusively on the seeds of *Casuarina* and *Allocasuarina* spp. (she-oaks), with nine known food tree species in these genera. Glossy Black-cockatoos have strong preferences for individual trees, that is the most profitable in terms of cone abundance, cone profitability and proximity to other resources such as nest-trees (Chapman, 2007). In lowland South-eastern Queensland the species appears to prefer Black She-oak (Chapman 2007). The south-eastern Glossy Black-cockatoos likely spend > 88% of their day foraging and feeding, suggesting that the rate of intake is likely to be critical (Clout 1989). This species is believed to be a seasonal migrant in south-east Queensland, likely as a response to changing of resource availability or breeding requirements (Stock & Wild 2005), although little is known about movement pattens for this species.

Breeding habitat consists of large eucalypt trees with hollows that are importantly: >8 m above ground, in branches of >30 cm diameter and vertical to 45°, and with a minimum entrance diameter of >15 cm (Morcombe 2000).

Threats to this species include habitat loss, degradation and fragmentation; this is the main threat affecting the current decline of the species. Wildfire, including inappropriate fire management strategies and increasing risk of severe bushfires exacerbated by climate change, loss of breeding hollows associated with logging and habitat clearing and, to a lesser degree, grazing and environmental weeds.

Signs of this species were observed in riparian vegetation along Woleebee Creek (RE 11.3.25), and Brigalow woodlands (RE 11.9.5), where Belah was present (see **Figure 14**). Potential breeding habitat is present in the study area in the Blue Gum dominated riparian areas along Woleebee and Frank Creeks, and potential foraging habitat is present in remnant and HVR vegetation where Belah is common. This species was detected during previous field assessments.

Given that records of this species occur in the study area, foraging and nesting habitats are present, and evidence of the species was recorded during 2023 survey efforts, the WCP area supports habitat for this species.

Painted Honeyeater

Painted Honeyeater (*Grantiella picta*) is listed as vulnerable under the EPBC Act and the NC Act. This nomadic and migratory species occurs in low densities mainly west of the Great Dividing Range in Queensland, during winter. The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe species (epiphytic plants), to which its breeding season is closely linked (Rowland, 2012). The entire species is generally regarded as one population, which migrates to central and northern Queensland, NT and inland NSW during the winter non-breeding season (Garnett *et al.*, 2011). The species breeds in southeastern Australia during the summer. In its non-breeding range the species is spread over a vast area relative to its breeding range.

Painted Honeyeater mostly occurs in woodland habitats that have an abundance of mistletoe. These woodlands are usually dominated by *Acacia* spp. (esp. *Acacia harpophylla*, *Acacia pendula* and *Acacia aneura*), Belah (*Casuarina cristata*) and Bull-oak (*Allocasuarina luehmannii*). Riparian eucalypt woodlands are also utilised, particularly those with an understorey of *Acacia* spp. shrubs (Rowland, 2012).

Threats to the species include loss and ageing of breeding (as well as non-breeding) habitat due to clearing, habitat degradation by livestock and feral mammals resulting in loss of tree recruitment, competition with invasive birds, predation and nest predation by invasive animals and over-abundant native birds, destruction of mistletoe and pasture improvement activities (TSSC, 2015b).

Painted Honeyeater was not recorded during field surveys, either in 2008 or contemporary studies by SLR. Elements of suitable habitat, such as riparian corridors and small, disjunct communities containing mistletoe (occasionally at appreciable densities) occur in the study area. Mistletoes were particularly common on Poplar Box and Blue Gum in REs 11.3.2 and 11.3.25. While present, foraging features were patchily distributed among tracts of remnant vegetation and no extensive areas of Painted Honeyeater habitat were identified. While the site presents some areas of potential foraging value for Painted Honeyeater, lack of observation of this species during several field survey programs suggests that any occurrence in the study area would be brief. Habitat use would be transient and by individuals passing between greater tracts of suitable habitat between breeding habitats to the south and wintering habitats to the north.

While Painted Honeyeater may occur in the study area, occurrences are likely to be brief and habitats in the study area are unlikely to be relied upon by the species. The study area is not likely to support a population of Painted Honeyeater.

Squatter Pigeon

Squatter Pigeon (southern) (*Geophaps scripta scripta*) is listed as vulnerable under both the NC Act and EPBC Act. This is a ground-dwelling granivorous pigeon occurring in Queensland and northern NSW. The southern subspecies of Squatter Pigeon has undergone marked declines in the south of its range (southern Queensland and New South Wales) (Cooper *et al.*, 2014) and is affected by several pressures further north. Habitat clearing and fragmentation (particularly for agriculture) and grazing pressures are the primary drivers of the subspecies' decline to date (Garnett & Crowley, 2000). These are ongoing pressures, though cattle grazing is considered less impactful than sheep grazing, as some pasture improvement species are eaten by Squatter Pigeons and cattle grazing does not always involve vegetation clearing. Other current threats include grazing by feral mammals, predation by feral predators, transformation of habitats by weeds, fire regime change, and illegal shooting (TSSC, 2015a), and vehicle strike.

Squatter Pigeons have specific habitat requirements relating to vegetation structure and composition. Sparse, patchy ground cover, allowing freedom of movement while foraging on the ground, is preferred. This tends to consist of native perennial tussock grasses to approximately 33% cover, with or without low shrubs and native forbs (the seeds of some non-native forbs, such as *Stylosanthes* spp., are also eaten) and interspersed with bare, dusty ground, leaf litter and coarse woody debris. Low shrubs with bare ground and leaf litter underneath serve as shelter. These habitat characteristics appear to provide the balance of openness to facilitate foraging, complexity to provide cover, and vantage points from which to view potential threats.

Suitable habitats can be identified with some confidence by soil type. The preferred habitats generally occur on well-draining gravelly, sandy or loamy soils. In Queensland, suitable habitats are generally limited to land zones 5 and 7—sandy to loamy soils on low to gently rising or undulating plains and low lateritic escarpments. It often occurs in burnt areas and, like many granivorous birds, is often encountered on tracks and roadsides (Higgins & Davies, 1996; Garnett & Crowley, 2000). Being granivorous, Squatter Pigeons must drink daily, and birds are rarely seen more than 3 km from water; proximity to water is also important for breeding, and locations <1 km from water appear key for breeding.

Squatter Pigeon was not recorded in the study area during the survey programs to date. The species was deemed moderately likely to occur as nearby recent records indicate its persistence in the region, but habitats in the study area are disturbed by prior clearing and livestock grazing. Field survey effort further revealed that the prevalence of Buffel Grass and other introduced pasture grasses in the study area greatly reduces the structural complexity and diversity of lower vegetation strata. The complex and patchy mix of bare ground needed

for movement and the diverse mix of native grasses needed for foraging are effectively absent in the study area. This, coupled with the lack of observation of the species during several survey events including substantial targeted survey effort (144 hours of bird surveys, 560 hours of walking and driving and 12 hours of waterhole watches in 2023) implies that the study area does not support a population of Squatter Pigeon. As the species is sedentary, diurnal, readily flushed, and often occurs near tracks and other clearings, it was unlikely to go undetected during the surveys if present.

Given the poor quality of available habitat and lack of observation, the study area is unlikely to support a population of Squatter Pigeon and habitats are not considered important for the species.

White-throated Needletail

The White-throated Needletail (*Hirundapus caudacutus*) is listed as Vulnerable and Marine and Migratory under the EPBC Act and Vulnerable under the NC Act. This species is a large gregarious swift, often seen aerially, flying in large flocks of the same species or in mixed flocks with other aerial insectivores.

The White-throated Needletail is widespread across eastern Australia (Barrett *et al.* 2003; Blakers *et al.* 1984; Higgins 1999), in coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Dividing Range and occasionally onto the adjacent inland plains. This species is found in east and south of Victoria, south-eastern South Australia and is widespread in Tasmania. White-throated Needletails only occur as vagrants in the Northern Territory and in Western Australia (Barrett *et al.* 2003; Blakers *et al.* 1984).

The White-throated Needle-tail does not breed in Australia (Higgens, 1999) and spends this non-breeding time predominantly aerially from 1 m to 1000 m above the ground (Coventry 1989; Tarburton, 1993). This species generally flies over wooded areas and has been recorded to fly under canopies amongst trees. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks (Tarburton, 1993). White-throated Needle-tails roost in tree hollows or amongst dense foliage in the canopy (Corben *et al.* 1982).

The most severe threat to the White-throated Needle-tail is habitat loss and fragmentation in both breeding habitats in the Northern Hemisphere where the loss of old, hollow bearing trees in the breeding range reduces breeding success, and in non-breeding ranges in Australia contributing the loss of roosting sites and reduction in invertebrate prey (Tarburton, 2014). Mortality from wind turbines and overhead turbines is another threat to the White-throated Needle-tail, although is considered to affect a small number of birds (Hull 2013). The use of insecticides may also threaten the White-throated Needletail, either through a decrease in the abundance of invertebrates or from secondary poisoning by insecticides accumulated as sublethal doses in the prey (Tarburton, 2014; TSSC, 2019).

The White-throated Needle-tail may occur transiently in the airspace above terrestrial habitats in the survey area. Its presence is likely to be temporary and sporadic.

Corben's Long-eared Bat

Corben’s Long Eared Bat (*Nyctophilus corbeni*) is listed as Vulnerable under the EPBC Act and NC Act. The Corben’s Long Eared Bat is a large bat and as the name suggests, it has large ears. This species has a patchy distribution, southern central Queensland, central western New South Wales, north-western Victoria, and eastern South Australia.

Corben’s Long-eared Bat inhabits woodland vegetation types comprised of box / ironbark / cypress pine woodlands, Buloke woodlands, Brigalow woodland, Belah woodland, smooth-barked apple woodland, river red gum forest, black box woodland, and various types of tree mallee (Duncan *et al.*, 1999; Schulz and Lumsden 2010; Woinarski *et al.*, 2014). This

species is believed to have a large home range due to higher abundance records in larger vegetation areas (Turbill and Ellis 2006). The species also has a higher abundance in habitats that have a tree canopy and a dense, cluttered understorey layer (Turbill and Ellis 2006). Old growth vegetation is a critical habitat component in the Victorian distribution (Lumsden *et al.*, 2008). Corben's Long-eared Bats roosts solitary in dead trees or in mallee eucalypts, with some under bark or in fissures of dead Buloke or Belah trees (Lumsden *et al.*, 2008).

Corben's Long-eared Bats is insectivorous, feeding on flying prey, by foliage-gleaning in flight or by foraging on the ground (Lumsden and Bennett 2000; Schulz and Lumsden 2010). Foraging appears to be concentrated around patches of trees, with many individuals from different species of bat sharing the same foraging area (DCCEEW, 2013; TSSC, 2015).

Threats to Corben's Long-eared Bats include habitat loss and fragmentation; 75% of the eastern part of the species' range has been cleared in New South Wales (Duncan *et al.*, 1999). Another threat to this species is habitat degradation associated with altered fire regimes which can directly harm the bats during bushfire events and cause harm through the loss of foraging habitat and roosting sites such as hollows, which take a long time to develop (Schulz and Lumsden 2010). Agrichemicals used in farming also pose threats to the Corben's Long-eared Bat through bioaccumulation of chemicals driven by the ingestion of insects that have been exposed to these chemicals. Feral animals may also pose a threat to this species, although the risk is unknown.

Harp trapping was undertaken on five consecutive nights, with two harp traps to target Corben's Long-eared Bat. This provides contemporary data to ten nights of trapping initially completed in 2009 (PBA, 2009b), during which trapping for Corben's Long-eared Bat was unsuccessful. Traps were set in all habitat types within the study area including: riparian habitats, Brigalow woodlands, woodlands dominated with Silver-leaved Ironbark, and, areas of intact remnant vegetation, and smaller isolated patches. One species of *Nyctophilu*s was caught during the harp trapping – Lesser Long-eared Bat (*Nyctophilus geoffroyi*). This species is common in disturbed/modified habitats (*pers comm.* Greg Ford). Habitat within the study area is not likely to constitute suitable roosting or foraging habitat for this species. Large areas of intact, remnant vegetation and communities dominated with Narrow-leaved Ironbark (*Eucalyptus crebra*) are absent. However, Woleebee Creek provides a potential flyway and connectivity at a landscape scale between large areas of remnant vegetation. The connectivity values associated with Woleebee Creek may be important for this species.

Central Greater Glider

Central Greater Glider (*Petauroides armillatus*) is listed as endangered under the NC Act and vulnerable (as *P. volans*) under the EPBC Act. This species occurs in forests and woodlands dominated by *Eucalyptus* spp. trees, the leaves of which constitute most of its diet (the species is also known to eat eucalypt flowers). Tall, moist, high-altitude forests constitute ideal habitat for the species, and the highest population densities occur in these habitats. Vegetation communities with multiple eucalypt species are favoured, as the species' food tree preference varies seasonally. Other critical components of habitat suitability are large arboreal hollows for shelter, and connectivity with sufficiently extensive areas of suitable habitat for the maintenance of populations (TSSC 2022a, 2016c). Populations in southern Queensland require approximately 1-2 hollows per hectare. The species is absent from regenerating forests that lack mature trees and hollows. In drier parts of its range the species often relies on riparian vegetation. This is likely due to the size and abundance of large arboreal hollows in these habitats, where large trees such as *Eucalyptus tereticornis* occur.

The extent of occurrence of Greater Glider is not considered to have changed since European settlement, but the area of occupancy of this species has decreased substantially,

largely due to habitat loss and fragmentation. Habitat loss is the main threat facing this species, with estimates of an 89 % decline in Greater Glider populations in central Queensland between 1973 and 2002 (Woinarski *et al.* 2006). This is ongoing, and other current and future threats to the species include fire, forestry activities, climate change and the effects of Phytophthora root fungus on eucalypts (Kearney *et al.* 2010; Lindenmayer *et al.*, 2013; Lumsden *et al.*, 2013; Woinarski *et al.*, 2014). Threats likely operating in the Brigalow Belt and Einasleigh Uplands bioregions are habitat loss and fragmentation, mostly due to land clearing for agriculture, and climate change, which is considered likely to be a catastrophic threat to northern populations of Greater Glider in the future (TSSC 2022a, 2016c). The transformation of riparian habitats and loss of canopy structure resulting from weed infestation (particularly of vines that threaten canopy integrity) may threaten this species in drier landscapes.

Greater Glider and suitable habitat for the species was found to occur in the study area (see **Figure 16**); individuals were observed during spotlighting surveys on Woleebee Creek. Observations were limited to RE 11.3.25 (Blue Gum fringing woodland), which is considered breeding habitat for the species in the area due to size of canopy trees and density of arboreal hollows. Breeding habitat was mapped on Woleebee, Frank and Two Mile Creeks. Though the species was not observed on other systems, RE 11.3.25 on Frank and Two Mile Creeks were assessed as breeding habitat on the basis of Blue Gum density and arboreal hollow density. Eucalypt woodlands adjacent to RE 11.3.25 were deemed foraging habitat; this was largely restricted to the remnant Poplar Box woodlands associated with the Woleebee Creek floodplain. As connectivity is a key element of habitat suitability, small disjunct patches of vegetation were deemed unsuitable for this species.

Koala

Koala (*Phascolarctos cinereus*) is listed as Endangered under the NC Act and EPBC Act. In Queensland, the species occurs from the Einasleigh Uplands south through central and Coastal Queensland. Koalas inhabit forests, woodlands and open woodlands dominated by *Eucalyptus* species (Melzer *et al.* 2000). Koalas are tree-dwelling, obligate folivores with a highly specialised diet consisting of leaves of a variety of *Eucalyptus*, *Corymbia* and *Angophora* species. Diets are generally restricted to one or a few species, which varies regionally and seasonally; assessment of Koala habitat at a given location requires an understanding of the local food tree preferences (Moore & Foley 2005; Moore *et al.* 2010). Food tree preference is strongly influenced by elevation, temperature, soil nutrients and water content of leaves. The latter results in a preference for riparian habitats in drier environments (Sullivan *et al.*, 2004; Davies *et al.* 2013a; Smith *et al.* 2013). These habitats provide refugia and habitat connectivity for Koalas in times of drought and extreme heat (Smith *et al.* 2013).

In the Western Downs Regional Council area, where the study area occurs, preferred food trees that occur in the study area are identified in Youngentob *et al.* (2021) are *E. orgadophila* and *Eucalyptus populnea*. In addition, *E. camaldulensis* ssp*. camaldulensis* is listed as a key species; this species was not identified on site, rather *E. tereticornis* (Blue Gum) was the floodplain and riparian eucalypt of fringing vegetation. Records of Koala in the vicinity of the study area are sparse and typically associated with riparian areas (ALA 2023). This may be driven by preference for Blue Gum, or by the fact that most remnant vegetation in the area is riparian (or both).

Current threats to Koala include habitat loss (particularly climatically stable habitat), degradation and fragmentation; increased intensity/frequency of droughts, heatwaves and bushfires; mortality due to vehicles and dog attack; and disease (McAlpine *et al.* 2015; Melzer *et al.* 2000; Sherwin *et al.* 2000). Periods of abnormally low rainfall have been linked

to population declines and crashes, and movement of Koalas to critical riparian areas (Davies *et al.* 2013b; Seabrook *et al.* 2012).

Koala was confirmed present in the study area; individuals and evidence of Koala were recorded on Woleebee Creek and Frank Creek. One Koala sighting on Woleebee Creek was of an adult female Koala with young, demonstrating that Blue Gum fringing woodland on this system is breeding habitat for the species. Another individual was recorded on a tributary of Frank Creek indicating that RE 11.3.25 provides habitat suitable to this species.

Breeding, foraging and dispersal habitats were mapped for Koala based on elements of vegetation structure and composition and position in the landscape (i.e., proximity to water). As the Koala has no key habitat requirements for breeding (such as nesting requirements), breeding and foraging habitats were combined. Vegetation fringing Woleebee and Frank Creeks, as well as Two Mile Creek in the southeast of the study area, was mapped as breeding/foraging habitat; Poplar Box and other woodlands associated with the anastomoses of Woleebee Creek were also mapped as such. Some disjunct patches of remnant eucalypt woodland were also mapped as breeding/foraging habitat, and remnant vegetation lacking a eucalypt canopy (within 1 km of remnant RE 11.3.25) was mapped as dispersal habitat. Non-remnant vegetation, and small patches of vegetation far from mapped breeding/foraging habitat, are not considered of value to Koala.

The WCP area supports breeding and foraging habitat for this species and ground-truthed mapping of their habitats can be found in **Figure 15**.

Yellow-bellied Glider

The Yellow-bellied Glider (south-eastern) (*Petaurus australis australis*) is listed as Vulnerable under the EPBC Act and NC Act. The Yellow-bellied Glider is an arboreal nocturnal marsupial, Australia's second largest glider with a white to yellow belly. There are two subspecies, the Wet Tropics subspecies (*Petaurus australis*) and the south-eastern subspecies whose distribution extends to the study area.

The distribution of the Yellow-bellied Glider (south-eastern) overlaps with Gondwana Rainforests of Australia World Heritage Area (van der Ree *et al.* 2004). Their range extends in coastal forests across south-east Queensland to far south-eastern SA, and inland to the western slopes of the Great Dividing Range. They have been recorded at altitudes ranging from sea level to 1400 m, but distributions are patchy due to a combination of biogeographic processes, specific habitats requirements and land clearing. In Queensland, distribution is coastal extending north of Mackay and down to the NSW/Queensland border with isolated populations in Blackdown and Canarvon Ranges of central Queensland (Eyre 2004). This subspecies is believed to be potentially extinct from SA (DCCEEW 2023b).

Habitat requirements for the Yellow-bellied Glider (south-eastern) are specific, contributing to the disjunct distribution (Eyre 2004). This subspecies lives in eucalypt-dominated woodlands and forests (Kavanagh *et al.* 1995) with large patches of mature old growth forest that provide suitable trees for foraging and shelter (Milledge *et al.*1991) and have a high proportion of winter-flowering and smooth-barked eucalypts (Kavanagh 1987a; Eyre & Smith 1997; Eyre 2004). These forests must have a variety of eucalypt species which flower at different times to provide a year-round food supply. Smooth barked eucalypts are vital to the Yellow-bellied Glider as they provide a flowers and the bark strips provide shelter for insect prey (Eyre & Smith 1997). Some trees are also used for sap feeding. Hollow-bearing trees are also a critical habitat feature for this subspecies as they roost in hollows during the day (Goldingay 2011; Goldingay *et al.* 2019).

Small social groups of Yellow-bellied Gilders occupy large home ranges at low densities (Henry & Craig 1984). Home ranges are necessarily large as food trees are dispersed and

use of trees can vary through time and space (Woinarski *et al.* 2014). Therefore, large areas of forests are required to maintain a population of Yellow-bellies Gliders.

Habitat loss and fragmentation is the largest threat to the Yellow-bellied Gilder (south-eastern). Fragmentation of this subspecies habitat is likely driving genetic isolation, reducing genetic diversity in isolated populations over small spatial scales and short times frames, as seen in a related species, the Squirrel Glider (*Petaurus norfolcensis*) (Taylor *et al.*, 2011)). Bushfires are another huge threat to the Yellow-bellied Glider; through direct mortality and indirectly by death sap trees and hollow-bearing trees. Furthermore, climate change and the combinations of threats it poses to the Yellow-bellied Gilders will be harmful for this subspecies; drought conditions can act in tandem with bushfires to reduce populations of this subspecies. Changing climates may also impact sap flow from sap feeding trees. Rising temperatures may increase the need for water for arboreal marsupials and in some cases may cause water stress and lead to range contraction into climate refugia (Kearney *et al.* 2010). Introduced species like the European red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) also pose threats to the Yellow-bellied Gilders.

Although the species uses habitat similarly to the Greater Glider, no records occur in the WCP area, and the species was not detected during previous (PBA, 2009b) or contemporary surveys. Nearby records occur in state forests in REs which are not present on-site (e.g., rock escapments with different floristic composition). Species records are not associated with Woleebee Creek, as is the case for Greater Gliders. Given these factors, anticipated activities are not expected to adversely affect the species.

Common Death Adder

Common Death Adder (*Acanthophis antarcticus*) is listed as vulnerable under the NC Act. This species occurs throughout much of Queensland, except for Cape York Peninsula and the southwest and northwest of the state and is likely most common on the east coast (ALA, 2023; Covacevich and Couper 1991; Wilson 2005; Borsboom 2009). It is also distributed across much of New South Wales; there are records from the northern border of Victoria, and it occurs across the southern coast of South Australia and Western Australia and in the Perth region (ALA, 2023).

Common Death Adder occurs in a wide variety of vegetation communities including rainforests, wet and dry sclerophyll forests, woodlands, shrublands, heaths, grasslands and modified (including semi-urban) environments, and landform and landscape requirements are varied but include well-draining soils; the species needs ground cover features such as deep leaf litter, friable sand or low foliage for shelter and ambushing prey (Cogger 2000; Wilson and Swan 2010).

Key parts of this species' range overlap with areas heavily cleared for urban expansion, agriculture and industry, and the species is known to be undergoing declines in many parts of its range particularly due to clearing and changes in fire regimes (Wilson and Swan, 2022). Other threats to the species include mortality due to vehicle strike and deliberate killing; predation by feral predators and poisoning by ingesting poisoned rodents or Cane Toads; and trampling by livestock.

Common Death Adder was not recorded during field surveys. The species has the potential to occur in the study area and, given its cryptic nature, the risk of false negative detection of the species is high. Habitats in the study area are substantially degraded and disjunct due to prior vegetation clearing and ongoing impacts such as introduced pasture grass cover and livestock grazing. Cane Toad is also known to occur on site and presents an additional threatening process to Common Death Adder (Nelson *et al.*, 2010). In all, low habitat suitability and presence of multiple threatening processes suggests that the study area is unlikely to support a population of Common Death Adder.

Dunmall's Snake

Dunmall's Snake (*Furina dunmalli*) is listed as Vulnerable under the EPBC Act and NC Act. This species occurs primarily in the Brigalow Belt region in the south-eastern interior of Queensland. Records indicate this species occupies sites at elevations between 200 and 500 m ASL. This species is very rare or secretive with limited records existing. This species has been found in a broad range of habitats, including; forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow, other wattles, native Cypress or Bull-oak, and various Blue Spotted Gum, Ironbark, White Cypress Pine and Bull-oak open forest and woodland association on sandstone derived soils.

Threats to the Dunmall's Snake include habitat loss driven by extensive clearing for mining, urban areas and agriculture. Overgrazing of habitat by livestock is also detrimental to this Dunmall's Snake. Reduced microrefugia within habitats like fallen logs and leaflitter; impelled by fuel reduction burns and firewood collection. Invasive species introduced weeds and drainage of swamps (Cogger *et al.* 1993; McDonald *et al.* 1991).

Dunmall's Snake was not recorded during field surveys. Patches of remnant Brigalow and other potentially suitable vegetation occurs but, due to small patch size, moderate to severe impacts of livestock and non-native and invasive plants (particularly Buffel Grass), these habitats are generally severely degraded and provide limited habitat value for the species. Suitable habitats are highly disjunct, though some are connected by riparian woodland.

There is an overall lack of habitat extent, condition and connectivity in the study area. Habitat patches are in very poor condition. Trampling by livestock and non-native plant prevalence reduce the availability of shelter and the functionality of habitats in non-remnant areas; and lack of connectivity of remnant Brigalow and Cypress Pine communities reduces the likelihood that these habitats can sustain populations of the species.

Grey Snake

The Grey Snake (*Hemiaspis damelii*) is listed as Endangered under the EPBC Act and the NC Act. The Grey Snake is a venomous, front-fanged snake, distributed from south-eastern Queensland to southern NSW between elevations 70 m to 540 m above sea levels. In Queensland, the Grey Snake has a broader and more dispersed distribution, with most records along the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt from Goondiwindi and Dalby west to Glenmorgan, on the Darling Downs and western Lockyer Valley, near Rockhampton on the central Queensland coast, and on the Darling Riverine Plains near Currawinya in south-western Queensland (Hobson 2012; Rowland 2012b; Queensland Government 2020; TSSC, 2022b).

The Grey Snake inhabits Brigalow (*Acacia harpophylla*) and Belah (*Casuarina cristata*) woodlands in Queensland with dark cracking clay soils where this species takes refuge in these soil cracks as well as under logs and rocks (Queensland Government 2020). The Grey Snake occurrence on the western downs of Queensland is associated with red sodosol soils which have a strong texture contrast between the A horizon and sodic B horizon, and which are often quite dense and coarsely structured (blocky, prismatic, or columnar peds) favouring the crack-inhabiting and foraging ecology of this species (Apan *et al.* 2010).

The Grey Snake feeds predominantly on ground dwelling frog species at dusk or night, and the lack of lizards in their diet may be due to the location and time of which this snake forages not overlapping when lizards are present, or cannot catch them (Shine, 1987). The Grey Snake hunts for frogs, within soil cracks in floodplains when soil cracks become inundated after rain or occasionally in the hot weather (Rowland 2012b). The concentration of ground dwelling frogs in the area around floodplain wetlands and rain-fed ponds may also explain the distribution of the Grey Snake in these habitats.

Threats to the Grey Snake include extensive land clearing; two Regional Ecosystems (REs) (REs 11.3.1 and 11.3.21) that are essential habitat for this species have been extensively cleared. Only 13% of Brigalow woodlands in the Brigalow Belt remain (Neldner *et al.* 2017). Alterations to the landscape and soil structure caused by heavy machinery and pasture improvements in cracking soils is also detrimental for this species by reducing habitat and foraging areas. Altering floodplains and waterways also poses a significant threat to the Grey Snake. River regulations, water extraction and the conversion of wetlands to agricultural land changes floodplain landscapes (Kingsford 2000), degrading essential habitat for this species. Another threat for the Grey Snake is the bioaccumulation of agrichemicals and other contaminants in their environment through the consumption of wetland frogs and living in contaminated habitats (Lettoof *et al.* 2020). Introduced species are also harmful to the Grey Snake through consumption by cane toads (*Rhinella marina*) or predation by feral cats (*Felis catus*) and foxes (*Vulpes vulpes*). Mining is another threat to the Grey Snake which increases habitat fragmentation and alters hydrology on floodplains (Pavey *et al.* 2021). Bushfires change the vegetation communities and may impact populations of the Grey Snake.

The Grey Snake was not recorded during field surveys. This species has the potential to occur in the study area and, given its cryptic nature, the risk of false negative detection of the species is high; however, with substantial repeated survey effort including pit-fall and funnel trapping, there can be confidence that the species is absent or that population density is very low. Habitats in the study area are substantially degraded and disjunct due to prior vegetation clearing and ongoing impacts such as introduced pasture grass cover and livestock grazing. Cane Toad is also known to occur on site, another threat to the Grey Snake. In all, low habitat suitability and presence of multiple threatening processes suggests that the study area is unlikely to support a population of the Grey Snake.

Golden-tailed Gecko

The Golden-tailed Gecko (*Strophurus taenicauda*) is listed as near threatened under the NC Act. The Golden-tailed Gecko is a distinctive reptile endemic to the Brigalow Belt North and South IBRA regions. This nocturnal gecko is renowned for its vibrant coloration, featuring a golden-yellow tail that contrasts with its predominantly grey and brown body (Brown *et al.* 2012). There are three subspecies (Brown *et al.* in 2012) of the Golden-tailed Gecko; subspecies *Strophurus t. taenicauda* was found during previous survey efforts in Wandoan (PBA, 2008a). This subspecies has a red to orange eye, large dorsal spots (4–12 scales in size) and a single tail stripe with either undulating margins or transverse extensions. The range of *Strophurus t. taenicauda* is found in the south-east of the Brigalow Belt South IBRA region, in forests dominated by Brigalow (*Acacia harpophylla)*, Belah *(Casuarina cristata*), Bull Oak *(Allocasuarina luehmannii*), Narrow-leaved Ironbark *(Eucalyptus crebra*) and White Cypress *(Callitris glaucophylla*) (Brown *et al.* 2012).

The Golden-tailed Gecko is predominately arboreal, often found on trunks during the night, and occupies small home ranges of about 10 ha within continuous vegetation and smaller fragments. This species can also be found on the ground amongst leaf-litter or ground debris and takes refuge under loose bark in trees and in tree hollows during the day. This species feeds primarily on insects, preying on a variety of small invertebrates, such as spiders and ants, using their keen sense of vision to locate prey in low light conditions.

Habitat loss is the main threat facing the Golden-tailed Gecko; high habitat loss and fragmentation occurs in the Brigalow Belt bioregions driven by land clearing for agriculture (Wilson *et al.* 2002). This in turns reduces availability of suitable nesting sites and availability of prey. Other current and future threats to the species include fire, forestry activities and climate change.

Despite this, the Golden-tailed Gecko is tolerant of disturbance and can persist in fragmented habitat provided the fragments have adequate cover of suitable trees, like White Cypress (Pavey *et al.* 2021). This species was recorded during previous PBA surveys northwest of the study area. Brigalow woodlands (RE 11.9.5) in the study area are marginally suitable for this species, although it was not detected despite a high targeted survey effort. Small, isolated patches of RE 11.9.5 are unlikely to be suitable (given the limited mobility of this species). This species may be present, but in low densities, in RE 11.9.5 that is adjacent to, and connected to, the remnant vegetation along Woleebee Creek.

Yakka Skink

Yakka Skink (*Egernia rugosa*) is listed as vulnerable under the NC Act and EPBC Act. This is a diurnal but secretive species, individuals rarely venturing far from communal burrows/shelter sites and retreating quickly in response to perceived threats. It is a highly gregarious skink, large family groups often sharing burrow systems and using communal latrines (defecating sites) near the burrow (Wilson, 2003). The species' extent of occurrence incorporates portions of the Brigalow Belt, Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula biogeographical regions, with the core distribution in the Mulga Lands and southern Brigalow bioregions. In Queensland, the species has been recorded in land zones 3, 4, 5, 7, 9 and 10. Suitable habitats include dry sclerophyll open-forests, woodlands and scrub. Typical vegetation communities in which the species occurs include woodlands and open forests of Ironbark, Brigalow, Mulga, Bendee, Belah, Poplar Box, White Cypress Pine and Lancewood. Yakka Skinks display high home-site fidelity and require specific shelter features. Most typically these include firm but friable soils and high densities of large woody debris or rock piles (Wilson and Knowles, 1988; Cogger, 2000). This species often takes refuge in large hollow logs and has been known to excavate deep burrow systems at the base of woody debris, under dense low vegetation, under and between partly buried rocks, logs or tree stumps and root cavities (Ehmann, 1992). In cleared habitat, Yakka Skinks may persist where sufficient shelter sites such as raked log piles, deep gullies, tunnel erosion/sinkholes and rabbit warrens exist (TSN, 2008).

The primary threat to Yakka Skink is habitat loss and degradation—this has particularly affected the species in the Brigalow Belt, where extensive land clearing for agricultural development has resulted in severe habitat loss and fragmentation (McDonald *et al.*, 1991; Cogger *et al.*, 1993; Covacevich *et al.*, 1998). Road widening and associated activities such as the removal of microhabitat features threaten the species with further habitat degradation, and the species is likely preyed upon by feral cats and foxes (TSN, 2008); these impacts likely compound as the species is less able to evade predators in more open environs. Due to the high fidelity of individuals and social groups to communal shelter sites, the loss of such sites is likely to have significant implications for local populations—the species may experience population crashes or localised extinction due to substantial disturbance or prolonged unfavourable conditions such as drought.

Yakka Skink, and signs thereof, were not observed during baseline field surveys. Targeted survey effort, including searches and trapping, was undertaken in areas of potentially suitable habitat for the species. Discrete patches containing suitable habitat elements were observed in the Project area (particularly in RE 11.3.2) but were degraded or of marginal quality and suitability. Microhabitat features such as large woody debris, fallen logs, rock piles and similar were sparse. Impacts of livestock and introduced pasture grasses on soil and ground cover structure significantly reduced habitat suitability and quality in most patches of potential habitat. Lack of connectivity with more extensive areas of habitat led to the conclusion that the disjunct habitat areas were unlikely to support functioning Yakka Skink populations.

Brigalow Woodland Snail and Dulacca Woodland Snail

The Brigalow Woodland Snail (*Adclarkia cameroni*) is listed as Endangered under the EPBC Act and Vulnerable under the NC Act. The Brigalow Woodland Snail is endemic to brigalow scrub and eucalypt woodland patches and found mostly on the Condamine River floodplain which acts as refugia for this species from extensive clearing in the surrounding areas. This species differs from Dulacca Woodland Snail (*Adclarkia dulacca*) by having a less flattened shell, with 'looser' coiling (Stanisic *et al.*, 2010).

The Brigalow Woodland Snail shelters under logs and leaflitter microhabitats, which provide food sources like fungi, lichen, algae and other detritus/biofilm growing on forest debris, thereby recycling nutrients into the soil (Stanisic 2011). Canopy cover and log microhabitats are essential for the brigalow woodland snail for survival and egg-laying (Stanisic 2011) and explains a higher abundance of this species in the Condamine River floodplain. This canopy and ground debris assists in maintaining relative humidity in the microhabitats ameliorates effects of droughts causing desiccation in land snails, and feeding for these snails likely occurs during periods of high humidity, such as evenings and rain events (Stanisic 2011).

The Dulacca Woodland Snail is listed as Endangered under the EPBC Act and NC Act. The Dulacca Woodland Snail inhabits a variety of remnant and scattered habitats, such as vine thicket and Brigalow woodland patches on rocky outcrops with clay to loam soils (Stanisic 2011), as well as Eucalyptus (ironbark) species and Lancewood (*Acacia shirleyi)* woodlands on ridges, and Gum-topped Box (*Eucalyptus woollsiana*) woodland (Eddie 2016; TCCC, 2016b). The Dulacca woodland snail is also able to exist in brigalow regrowth and cleared paddocks where suitable microhabitat is present (Eddie 2016). The Dulacca Woodland Snail lives in microhabitats like under rocks, logs or loose bark at the base of trees (Stanisic *et al.*, 2010). Like the Brigalow Woodland Snail, canopy cover and woody debris microhabitats are vital for the Dulacca Woodland Snail, as desiccation is the greatest threat to land snail eggs. The Dulacca Woodland Snail is also believed to feed on fungi, lichen, algae, and other detritus/biofilm on forest debris (Stanisic 2011).

Dispersal of the Brigalow Woodland Snail and the Dulacca Woodland Snail is low; under favourable conditions, such as rain, these species can move between suitable areas of microhabitat, but the extent to which this occurs will be limited by the spatial arrangement of habitat patches (TSSC, 2010).

Threats to the Brigalow Woodland Snail and the Dulacca Woodland Snail includes habitat clearing and disturbance, invasive species, cattle and horses, and fire. The reduction in habitat canopy and loss of logs for microhabitats threatens the survival and dispersal of the Brigalow Woodland Snail (Stanisic 2016). Introduced species are threating the Brigalow Woodland Snail as Rats (*Rattus spp*.), mice (*Mus musculus*) and feral pigs (*Sus scrofa*) are known to prey on land snails (Stanisic 2011), the invasion of buffel grass (*Cenchrus ciliaris*) leads to more intense fires which can cause loss of snails and impact habitat, and cattle and horses are known to directly kill the snails and destroy essential microhabitat.

Much of the vegetation in the study area has been cleared, and intact vegetation is highly fragmented. Remnant vegetation is subject to various ongoing threatening processes such as proliferation of introduced grasses, livestock grazing and edge effects. Brigalow Woodland Snail and Dulacca Woodland Snail are very small invertebrates with very low capacity for dispersal; while small populations may have remained in remnant patches for a time, these populations were likely highly susceptible to both ongoing and stochastic threats, including drought, fire and flood. It is likely that these populations were lost over time. It is unlikely that the study area continues to support viable populations of either Brigalow Woodland Snail or Dulacca Woodland Snail.

Migratory and special least concern species

One migratory and one Special Least Concern species were confirmed as present in the study area during the field surveys – Fork-tailed Swift (*Apus pacificus*) and Short-beaked Echidna. A description of these species, and potentially suitable habitat in the study area is provided below.

The following species were assessed as having a moderate likelihood of occurrence but were not recorded in the study area during the field survey:

- Moderate
  - White-throated Needletail (*Hirundapus caudacutus*);
  - Satin Flycatcher (*Myiagra cyanoleuca*); and
  - Latham's snipe (*Gallinago hardwickii*).

A description of each species, and their potential presence or absence in the study area is provided below. Note that the White-throated Needletail is discussed in the section above.

Fork-tailed Swift

Fork-tailed Swift (*Apus pacificus*) is listed as migratory under the EPBC Act. This species is widespread across much of Asia and the Pacific from Siberia to Australia. The nominate subspecies *A.pacificus* migrates from Siberia, Mongolia, China and Japan to southern Asia and Australia during the non-breeding season and occurs in all Australian states and territories (Higgins 1999). In Queensland the species is most common over the northeast coast, from Cooktown to south of Townsville, but is regularly recorded further south and west of the Great Dividing Range, being possibly less common in the far southwest. It is likely most abundant over inland plains but has been recorded over effectively all Australian habitats including over the sea (Higgins 1999; Menkhorst *et al.*, 2017). Fork-tailed Swift is a highly aerial species, effectively spending all its time in Australia over land between 1m and 300 m above-ground (higher when traveling). It forages for insects on the fronts of low-pressure systems.

There are no distinct threats to the species in Australia due to the wide range of the species and its aerial habits; habitat degradation (possibly resulting in reduced foraging resources) and predation by feral animals are listed as potential threats but are considered negligible (Birdlife International 2009).

Fork-tailed Swift was observed in the Project area during baseline surveys; a flock of Fork-tailed Swift were seen foraging over Woleebee Creek during the post-wet season survey 2023. The birds were likely following a storm front in the region and were observed during one brief fly-over; no further observations of the species were made. The species has the potential to forage aerially over all the habitats in the study area and is most likely to occur during and prior to storm events. The species very rarely ceases flying or comes to rest during its Australian migration and is unlikely to rely on terrestrial habitat values other than the presence of small flying insects.

Latham's Snipe

Latham's Snipe (*Gallinago hardwickii*) is listed as migratory under the EPBC Act. This species migrates to Australia from breeding grounds in eastern Russia and Japan during the Australian summer, occurring mostly on the east coast from Cape York Peninsula south to South Australia. Most individuals travel further south than Queensland, and northern Queensland is considered a passage area for the species (Higgins & Davies 1996). Records inland of the Great Dividing Range in Queensland are very sparse (ALA, 2023; Barrett *et al.* 2003; Blakers *et al.* 1984; Frith *et al.* 1977). Preferred habitat for this species is a variety of

permanent and ephemeral wetlands including swamps, lagoons, flooded pastures, bogs, waterholes, billabongs, lagoons, lakes, creek or river margins, river pools and floodplains (Naarding 1981). Latham's Snipe can be found in preferred habitats that are near human activity (Frith *et al.* 1977; Naarding 1983).

Historical and ongoing loss and degradation of wetland habitats threaten the Latham's Snipe in Australia (Frith *et al.* 1977; Littler 1910; Naarding 1985). Drainage and diversion of water sources for agriculture and water storage, mowing of suitable habitats, and replacement of suitable habitats through unfavourable vegetative succession result in significant losses of habitat for the species.

Latham's Snipe was not recorded during field surveys. Several large livestock dams in the study area are fringed by wetland plants and other low vegetation. The banks of larger livestock dams provide suitable habitat, particularly where these are protected from severe trampling by livestock through exclusion or spelling. The species may occur occasionally and at very low densities in the study area under appropriate conditions, but habitats are not ideal for the species and individuals are unlikely to rely on these values for extended periods, or for important events such as breeding.

Satin Flycatcher

Satin Flycatcher (*Myiagra cyanoleuca*) is listed as migratory under the EPBC Act. It is widespread in eastern Australia from the southern islands of the Torres Strait to the Adelaide region, South Australia (Blakers *et al.* 1984; Coates 1990a). In Queensland, the species is scattered in the north, occurring mostly on the eastern side of the GDR; further south it is widespread and comparatively common, occurring further inland from approximately Rockhampton (Blakers *et al.* 1984). Satin Flycatcher is migratory, spending winter in New Guinea and breeding in the summer in the south of its range; it moves north from February to May, mostly along the GDR (Blakers *et al.* 1984; Longmore 1978; Roberts 1979; Templeton 1992). The species primarily inhabits heavily vegetated gullies and riparian vegetation in eucalypt forests and tall woodlands but utilises more varied habitats during migration including coastal forests and woodlands, dry woodlands and open forests, and mangroves (Blakers *et al.* 1984; Emison *et al.* 1987; Officer 1969). They have been recorded in Blue Gum riparian vegetation when on passage.

The species is thought to have suffered population losses due to the clearing and logging of forests in the south of its range—it is largely absent from regrowth forests (Blakers *et al.* 1984). Due to the erratic nature of its presence in the north during migration and the non-breeding period, potentially impactful processes in the north of its range are unlikely to represent significant threats to the species.

Satin Flycatcher was not recorded in the study area during field surveys. The tall riparian vegetation fringing Woleebee Creek may constitute sub-optimal habitat for the species, however it is not densely vegetated, and any occurrence is likely to be brief and transient. The species is unlikely to rely on habitat values in the study area.

Short-beaked Echidna

The Short-beaked Echidna (*Tachyglossus aculeatus*) is listed as Special Least Concern under the NC Act. This well-known monotreme is the most widespread native mammal in Australia (Rismiller and McKelvey, 2000), occurring in all states and territories and in almost all terrestrial habitats, from deserts to rainforests—the species is only absent from intensively managed farmland (Menkhorst & Knight, 2011). Mostly solitary, Short-beaked Echidnas occupy large home ranges (up to 268 ha in arid environments) and feed on soil invertebrates including larvae, beetles, worms, ants and termites (Rismiller and McKelvey, 2000; Badgery *et al.*, 2021). The Short-beaked Echidna breeds in autumn-spring, when the usually solitary animals congregate—males detect a female by scent and often multiple

males follow a female in a ‘train’, though this behaviour is thought to be related to the low reproductive frequency of populations relative to population density, rather than a necessary courtship behaviour. Female echidnas breed at unpredictable frequencies, generally once every 2-6 years and rarely every year (Rismiller and McKelvey, 2000).

Though the species is widespread and well-studied, there is no knowledge of the population size of the species prior to European settlement and therefore how the species has responded overall to the resultant widespread landscape changes such as changes in fire regimes, introductions of various terrestrial predators and extensive land clearing for agriculture and urbanisation (Rismiller and McKelvey, 2000). Threats to the species more broadly are poorly known, and given the wide distribution of the species it is unlikely to be threatened by any individual process, but known threats to the species include:

- predation by feral cats, domestic dogs, feral pigs and foxes;
- habitat loss and degradation, including likely loss of movement corridors in heavily modified areas; an
- road mortality.

Patches of protected wildlife habitat for the species is mapped in the WCP area along and adjacent to Woleebee Creek (DESI, 2023f). This species has previously been recorded in the study area, associated with all habitat types including non-remnant vegetation (PBA, 2008b), and was recorded on trail cameras during the 2023 field surveys. Suitable habitat occurs throughout the study area, including non-remnant areas with adequate ground cover/habitat features (e.g., fallen logs), and 15 records occur within 30 km of the study area.

Given this species presence in the study area and availability of suitable habitat, the study area likely supports a population of Short-beaked Echidnas.

Mapping suitable habitat

Data from the general habitat assessment sites was used to map suitable habitat for the following threatened species, known to be present in the study area:

- Glossy Black-cockatoo (**Figure 14**);
- Koala (**Figure 15**);
- Central Greater Glider (**Figure 16**); and
- Golden-tailed Gecko (**Figure 17**).

Suitable habitat was not mapped for Golden-tailed Gecko. One individual of the species was recorded outside the ML (and SLR’s study area) during the PBA 2007-2008 surveys, and the species was not detected during extensive targeted surveys in 2023. Therefore, suitable habitat was not mapped for Golden-tailed Gecko.

Specific suitable habitat mapping was not undertaken for Echidna and Fork-tailed Swift as the entirety of the WCP area was deemed suitable for their occurrence.

The following resources were consulted to assist in defining suitable habitat for each species:

- DCCEEW Species Profile and Threats Database (SPRAT) (DCCEEW, 2023b);
- conservation advice documents (DAWE, 2022b; DCCEEW, 2022a; DCCEEW, 2022b);
- DESI species profiles (DESI, 2023i); and

- other relevant peer-reviewed scientific literature (Davies *et al.*, 2013; Smith *et al.*, 2013; Youngentob *et al.*, 2021; Eyre *et al.,* 2022b).

Suitable habitat was categorised into breeding, foraging and/or dispersal habitat for each species as follows.

Glossy Black-cockatoo

- Breeding habitat: remnant, HVR or non-remnant RE 11.3.25, with large hollow-bearing Eucalypts. Breeding habitat may also be foraging habitat where River Sheoak is present.
- Foraging habitat: remnant or HVR RE 11.9.5, with food trees common or sometimes dominant (*i.e.,* Belah).
- Dispersal habitat: other remnant vegetation adjacent to breeding or foraging habitat, and areas that provide connectivity within the study area.

Koala

- Breeding and foraging habitat: remnant, HVR and non-remnant REs where:
  - the canopy cover is predominantly food trees (>50% cover);
  - within 580 m[4] of a stream order three or above watercourse with riparian vegetation conforming to RE 11.3.25; and
  - connectivity is present at a landscape-scale.
- Dispersal habitat: remnant or HVR regional ecosystem within 1000m[5] of a stream order three or above watercourse conforming to RE 11.3.25.

Central Greater Glider

- Breeding: remnant, HVR or non-remnant RE 11.3.25 with large hollow-bearing trees common (*i.e.,* Blue Gum, Silver-leaved Ironbark and/or Poplar Box). Connectivity is present at a landscape-scale. Breeding habitat may also be used for foraging where suitable food trees are present.
- Foraging: remnant vegetation with suitable food trees (>50% cover), where the canopy is sparse (<30% cover) and/or hollow bearing trees are infrequent (<2 per ha), and/or no permanent/semi-permanent water is present. Connectivity is present at a landscape-scale.
- Dispersal: remnant vegetation within 100 m[6] of suitable foraging or breeding habitat. Connectivity is present at a landscape-scale.

[4] represents Koala foraging movements as per Davies *et al.* (2013).

[5] represents dispersal movements as per Davies *et al.* (2013), Smith *et al.* (2013) and Youngentob *et al.* (2021).

[6] This species can glide up to 100m (McCarthy and Lindenmayer, 1999).

Habitat quality assessments

Table 17 provides the average habitat scores for Koala, Central Greater Glider, and Glossy Black-cockatoo within each ground-truthed RE and an overall habitat score out of ten. **Table** 18 combines BioCondition and average habitat scores for the abovementioned species to determine an overall final habitat quality score to be used for land-based offset liability. These results are only intended for initial inferences; once the design footprint is finalised, further RE-specific BioCondition data can be collected to assist with assessment for potential significant residual impacts to MSES.

Table 17 Average species habitat scores for conservation-significant fauna species and vegetation community (RE)

Species	RE code					
	11.3.2	11.3.25	11.9.2	11.9.5	11.9.7	11.9.10
Koala						
Average habitat score	48.5	55.3	35.5	44.0	37.0	25.5
Habitat score out of 10	5	6	4	4	4	3
Central Greater Glider						
Average habitat score	57.3	61.5	—	—	—	—
Habitat score out of 10	6	6	—	—	—	—
Glossy Black-cockatoo						
Average habitat score	—	69.0	—	42.8	—	—
Habitat score out of 10	—	7	—	4	—	—

Table 18 Combination of average BioCondition and species habitat scores to determine final habitat quality score

Species	RE code						Calculation	Final score
	11.3.2	11.3.25	11.9.2	11.9.5	11.9.7	11.9.10		
Koala	(6+5)/2= 5.4	(5+6)/2= 5.3	(5+4)/2= 4.3	(5+4)/2= 4.7	(4+4)/2= 3.9	(4+3)/2= 3.3	(5.4+5.3+4.3+4.7+3.9+3.3)/6= 4.5	5
Central Greater Glider	(6+6)/2= 5.9	(5+6)/2= 5.6	—	—	—	—	(5.9+5.6)/2= 5.8	6
Glossy Black-cockatoo	—	(5+7)/2= 6.0	—	(5+4)/2= 4.6	—	—	(6.0+4.6)/2= 5.3	5

Scores for Koala habitat varied from three to six and were highest in REs 11.3.2 and 11.3.25 (**Table 17**). Proximity to permanent or semi-permanent water sources and high densities of eucalypt food trees were generally the greatest contributing factors to habitat suitability, in addition to landscape-scale connectivity. A moderate score (five) was calculated for overall habitat quality in the WCP area, an outcome which was not largely affected by less suitable REs with lower habitat scores (**Table 18**). The final habitat score for Central Greater Glider was similar (six), largely due to landscape-scale connectivity in REs 11.3.2 and 11.3.25, an the presence of large, hollow-bearing trees which provide habitat for shelter and breeding.

The final habitat quality score for Glossy Black-cockatoo habitat was moderate (five), improved by critical food trees (*Allocasuarina cunninghamiana* and *Casuarina* spp.) in RE 11.3.25. Habitat quality in RE 11.9.5 negatively affected the final score, reporting fewer large non-eucalypts, low canopy cover, and low average recruitment. This has affected the availability of seeds from *Allocasuarina* and *Casuarina* spp. which are a critical food source of Glossy Black-cockatoos.

The main factors which have negatively affected final habitat quality scores are the quantity of large trees, recruitment of canopy species, and grass species richness and cover. These factors can be attributed to historic land use (i.e., land clearing, grazing) in the WCP area. These results are based on relatively few RE-specific BioCondition and habitat quality data and only provide initial outcomes of habitat quality assessment scores.

4.4.3 Pest species

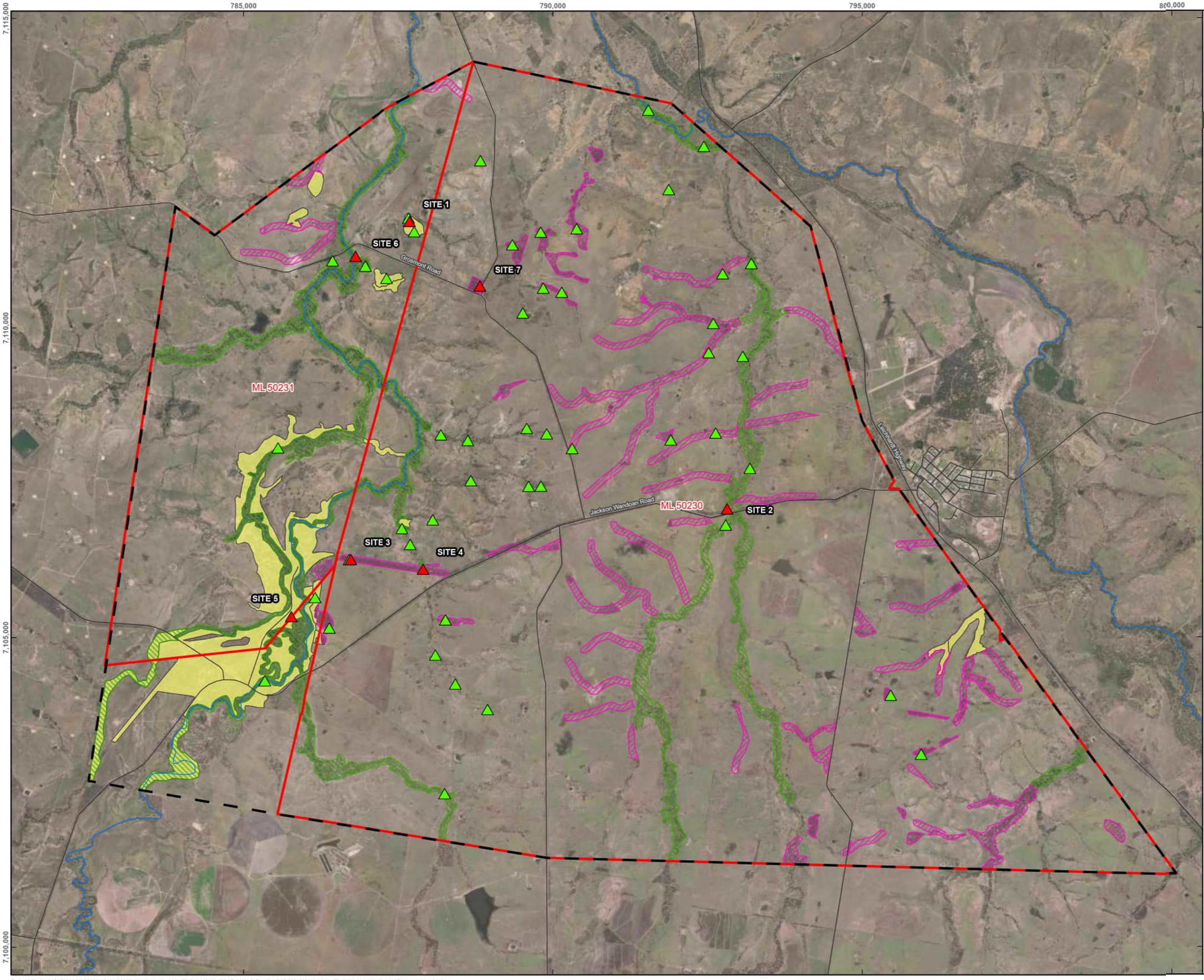
Ten non-native fauna species were present in the study area. The following pest fauna species listed under the Biosecurity Act (as invasive animals) and/or WDRC (2017) were recorded:

- Dingo (*Canis familiaris (dingo)*) – Category 3, 4 and 6 Biosecurity Act; high priority WDRC (2017);
- Feral Cat (*Felis catus*) – Category 3, 4 and 6 Biosecurity Act; low priority WDRC (2017);
- Rabbit (*Oryctolagus cuniculus*) – Category 3, 4, 5 and 6 Biosecurity Act; low priority WDRC (2017);
- Feral Pigs (*Sus scrofa*) – Category 3, 4 and 6 Biosecurity Act; high priority WDRC (2017);
- Cane Toad (*Rhinella marina*) – low priority WDRC (2017);
- Horse (*Equus caballus*) – low priority WDRC (2017); and
- Common Myna (*Acridotheres tristis*) – low priority WDRC (2017).

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

FAUNA HABITATS IN THE STUDY AREA

FIGURE 12



LEGEND

- Systematic Trap Site
- General Habitat Assessment
- Study Area
- Wandoan Mining Lease
- Main Road
- Major Watercourse

Fauna Habitat Types

- Brigalow sometimes with Belah open forests to woodlands on heavy clay soils
- Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains
- Poplar Box or Silver-leaved Ironbark dry woodlands to open woodlands on sandplains or depositional plains

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	31-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000

Grosmont Road
ML 50231
Jackson Wandoan Road
ML 50230
Leichhardt Highway

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR CONSERVATION SIGNIFICANT FLORA SPECIES

FIGURE 13

LEGEND

Existing Records

- Glossy Black-Cockatoo
- Golden-Tailed Gecko

Records from this Survey

- Central Greater Glider
- Fork-tailed Swift
- Koala

Signs from this Survey

- Glossy Black-Cockatoo
- Koala
- Study Area
- Main Road
- Major Watercourse
- Wandoan Mining Lease
- Brigalow sometimes with Belah open forests to woodlands on heavy clay soils
- Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains
- Poplar Box or Silver-leaved Ironbark dry woodlands to open woodlands on sandplains or depositional plains

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	08-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Grosmont Road

Jackson Wandoan Road

Leichhardt Highway

ML 50231

ML 50230

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR GLOSSY BLACK-COCKATOO IN THE STUDY AREA

FIGURE 14

LEGEND

- Existing Records
- Signs from this Survey
- Study Area
- Main Road
- Major Watercourse
- Wandoan Mining Lease

Glossy Black-Cockatoo

- Breeding Habitat
- Foraging Habitat
- Dispersal Habitat

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:60,000 at A3
Project Number:	626.30100.00200
Date Drawn:	18-Dec-2023
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp58488\Untitled\Untitled.aprx

785,000 790,000 795,000 800,000

7,115,000 7,110,000 7,105,000 7,100,000

Grosmont Road

ML 50231

Jackson Wandoan Road

ML 50230

Leichhardt Highway

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR KOALAS IN THE STUDY AREA

FIGURE 15

LEGEND

- Records from this Survey
- Signs from this Survey
- Main Road
- Major Watercourse
- Wandoan Mining Lease
- Study Area
- Breeding and Foraging Habitat
- Dispersal Habitat

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	08-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000

Gresmont Road
Jackson Wandoan Road
Leichhardt Highway
ML 50231
ML 50230

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR CENTRAL GREATER GLIDER IN THE STUDY AREA

FIGURE 16

LEGEND

- Records from this Survey
- Study Area
- Wandoan Mining Lease
- Main Road
- Major Watercourse

Central Greater Glider

- Breeding Habitat
- Foraging Habitat
- Dispersal Habitat

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:60,000 at A3
Project Number:	626.30100.00200
Date Drawn:	18-Dec-2023
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp58488\Untitled\Untitled.aprx

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000
Grosmont Road
Jackson Wandoan Road
Leichhardt Highway
ML 50231
ML 50230

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

SUITABLE HABITAT FOR GOLDEN-TAILED GECKOS IN THE STUDY AREA

FIGURE 17

LEGEND

- Main Road
- Major Watercourse
- Wandoan Mining Lease
- Study Area
- Golden-Tailed Gecko Habitat

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	09-May-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan EA Amendment\Wandoan EA Amendment.aprx

5.0 Summary

5.1 Matters of national environmental significance

The following MNES were recorded in the survey area:

- TECs:
  - Brigalow TEC (potential); and
  - Poplar Box TEC (confirmed).
- Threatened species:
  - Belson's Panic;
  - Glossy Black-cockatoo;
  - Koala; and
  - Central Greater Glider.
- Migratory species:
  - Fork-tailed Swift.

Initial assessments have identified MNES in the WCP area (provided in **Figure 8**, **Figure 10**, and **Figure 13**).

5.2 Matters of state environmental significance

The following MSES were recorded in the survey area:

- Remnant endangered REs (VM class);
- Remnant of concern REs (VM class);
- Remnant RE intersecting a wetland;
- Remnant RE intersecting a watercourse;
- Essential habitat on the essential habitat map (for Glossy Black-cockatoo, Koala, Central Greater Glider and Belson's Panic);
- Protected wildlife habitat for vulnerable or endangered species (Glossy Black-cockatoo, Koala, Central Greater Glider); and
- Protected wildlife habitat for special least concern species (Short-beaked Echidna).

Overall habitat condition scores (combining BioCondition and habitat quality assessments) for conservation significant species were completed as initial assessments. If significant residual impacts requiring offsets will occur to MSESs, additional data will be required.

5.3 Constraints heatmap

To provide an understanding of the geographic spread of ecological constraints (with potential legislative implications for the project) a 'constraints heatmap' was created, by mapping the following identified environmental matters:

- Potential TECs;
- Category B ESAs;

- Field verified regulated vegetation;
  - remnant endangered REs;
  - remnant of concern REs
  - remnant RE intersecting a wetland;
  - remnant RE intersecting a watercourse; and
  - essential habitat.
- Suitable habitat for Belson's Panic;
- High-risk area on flora survey trigger map;
- Suitable habitat for Glossy Black-cockatoo;
- Suitable habitat for Koala;
- Suitable habitat for Central Greater Glider; and
- Protected wildlife habitat (special least concern species).

The constraints heatmap is provided in **Figure 18**. The most highly constrained part of the study area is the riparian vegetation associated with Woleebee Creek. This area provides habitat for several EPBC Act and NC Act listed species (which are both MNES and/or MSES, as described above), a TEC (Poplar Box TEC), regulated vegetation (of concern RE 11.3.2, RE intersecting a watercourse, essential habitat), and a high-risk area on flora survey trigger map.

Project-related disturbance, other than that currently approved in this area, has the potential to result in a significant (residual) impact on MNES and MSES and trigger the requirement for offsets.

5.4 Further survey

Field assessments to date have been compliant with the Australian Government survey guidelines (DEWHA, 2010b), however if future significant impact assessments identify that offsets are required under the EPBC Act, further desktop and survey work will be needed to identify suitable areas for land-based offsets.

785,000
790,000
795,000
800,000
7,115,000
7,110,000
7,105,000
7,100,000
ML 50231
ML 50230

WANDOAN COAL PROJECT – TERRESTRIAL ECOLOGY TECHNICAL REPORT

CONSTRAINTS HEATMAP

FIGURE 18

LEGEND

Study Area

Wandoan Mining Lease

Environmental Constraints Heatmap

Many Constraints

Few Constraints

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:55,000 at A3
Project Number:	626.30100.00200
Date Drawn:	21-Dec-2023
Drawn by:	AS

SLR

Path: C:\Users\local_asunbin\Temp\ArcGISProTemp48400\Untitled\Untitled.aprx

6.0 References

Accad, A. Kelley, J.A.R., Richter, D., Li, J., Neldner, V.J. and Ryan T.S. (2023). Remnant Regional Ecosystem Vegetation in Queensland (Version 13.0), Analysis 1997-2021. Queensland Department of Environment and Science: Brisbane.

ALA (2023). Atlas of Living Australia. Available at http://www.ala.org.au.

Armstrong, K.N., Reardon, T.B., and Jackson, S.M. (2020). A current taxonomic list of Australian Chiroptera. Australasian Bat Society. Version 2020-06-09.

ASRIS, (2023). ASRIS - Australian Soil Resource Information System. http://www.asris.csiro.au. Accessed December 11, 2023.

Badgery G., J, Lawes J., C, Leggett K., E., A. (2021) Short-beaked echidna (*Tachyglossus aculeatus*) home range at Fowlers Gap Arid Zone Research Station, NSW. *PLOS ONE* 16(4): e0242298. https://doi.org/10.1371/journal.pone.0242298

Baker, A.M. & Gynther, I.C. (2023). Strahan's Mammals of Australia. Fourth edition. Reed New Holland Publishers.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R., and Poulter, P. (2003). *The New Atlas of Australian Birds.* Melbourne, Victoria: Birds Australia.

BirdLife International (2009). *Apus pacificus* In**:** IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. *Apus pacificus*. IUCN Red List.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984). *The Atlas of Australian Birds*. Melbourne, Victoria: Melbourne University Press.

Borsboom, A. (2009). Nomination to re-classify the 'rare' listed *Acanthophis antarcticus* to 'vulnerable' under the Nature Conservation Act 1992. Department of Environment and Resource Management: Brisbane.

Brown, D., Worthington Wilmer, J. and McDonald, S. (2012). A revision of *Strophurus taenicauda* (*Squamata; Diplodactylidae*) with the description of two new subspecies from central Queensland and a southerly range extension. *Zootaxa* 3243, 1-28.

Butler, D. W. (2007). Recovery plan for the "Brigalow (Acacia harpophylla dominant and co-dominant" endangered ecological community (draft of 1 May 2007). Report to the Department of the Environment and Water Resources, Canberra. Qld National Parks and Wildlife Service, Brisbane.

Chapman, Tamra. (2007). Foods of the glossy Black-cockatoo *Calyptorhynchus lathami*. 24. 30-36.

Clout MN (1989) Foraging Behaviour of Glossy Black-cockatoos. *Wildlife Research* 16, 4, 467- 473.

Coates, B. J. (1990). *The Birds of Papua New Guinea Including the Bismarck Archipelago and Bougainville.* Volume 2 Passerines. Alderley, Queensland: Dove Publications.

Cogger, H. G. (2000). *Reptiles and amphibians of Australia*. Reed New Holland: Sydney.

Cogger, H. G., Cameron, E. E, Sadlier, R. A., and Eggler, P. (1993). The Action Plan for Australian Reptiles. Canberra, ACT: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html

Cooper RM, McAllan IAW and Curtis BR (2014). *The Atlas of the Birds of NSW and the ACT*. Mini-Publishing, Gordon, New South Wales.

Corben, C., G. Roberts & A. Smyth (1982). Roosting of a White-throated Needletail. *Sunbird*. 12:47-48.

Covacevich, J. A. and Couper, P. J. (1991). The reptile records. In *An atlas of Queensland's frogs, reptiles, birds and mammals.* (Eds G. J. Ingram, R. J. Raven) pp. 125. Queensland Museum: Brisbane.

Covacevich J. A, Coupler PJ and McDonald KR (1998). Reptile diversity at risk in the Brigalow Belt, Queensland. Memoirs of the Queensland Museum. 42 (2):475-486.

Coventry, P. (1989). Comments on airborne sightings of White-throated Needletails *Hirundapus caudacutus*. Australian Bird Watcher. 13:36-37.

Davies, N., Gramotnev, G., Seabrook, L., Bradley, A., Baxter, G., Rhodes, J., Lunney, D. & McAlpine, C. (2013). Movement patterns of an arboreal marsupial at the edge of its range: a case study of the koala Movement Ecology, 1:8.

DAWE (2022a). Conservation Advice for *Petaurus australis australis* (yellow-bellied glider (south-eastern)). Australian Government Department of Agriculture, Water and the Environment, Canberra.

DAWE (2022b). Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory. Australian Government Department of Agriculture, Water and the Environment, Canberra.

DCCEEW (2022a). Conservation Advice for *Calyptorhynchus lathami lathami* (South-eastern Glossy Black-cockatoo). Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

DCCEEW (2022b). Conservation Advice for *Petauroides volans* (greater glider (southern and central)). Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

DCCEEW (2023a). EPBC Act Protected Matters Report. Report created 29/11/2023. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

DCCEEW (2023b). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

DECC (2005). Belson's Panic – profile, Department of Environment and Climate Change NSW viewed 27 May 2008, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10925>.

DEHP (2014). Queensland Environmental Offsets Policy: Significant Residual Impact Guideline: Nature Conservation Act 1992, Environmental Protection Act 1994, Marine Parks Act 2004. Queensland Department of Environment and Heritage Protection, Brisbane.

DESI (2020a). Flora Survey Guidelines - Protected Plants. Version 2.01. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2020b). Guide to determining terrestrial habitat quality. Methods for assessing habitat quality under the Queensland Environmental Offsets Policy Version 1.3. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023a). Queensland Government WildNet species list. Extract date 29/11/2023. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023b). Biodiversity status of 2021 remnant regional ecosystems – Queensland. Queensland Department of Environment and Science, Brisbane.

DESI (2023c). Flora Survey Trigger Map for Clearing Protected Plants in Queensland - Version 10.0. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023d). Remnant 2021 broad vegetation groups – Queensland. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023e). Protected areas of Queensland. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023f). Environmental reports online. Queensland Department of Environment, Science and Innovation, Brisbane. Accessed on 12 December 2023 via https://www.qld.gov.au/.

DESI (2023g). Maps of environmentally sensitive areas. Queensland Department of Environment, Science and Innovation, Brisbane. Accessed on 12 December 2023 via https://www.qld.gov.au/.

DESI (2023h). Queensland Environmental Offsets Policy. EPP/2015/1658, Version 1.15, 8 December 2023. Queensland Department of Environment, Science and Innovation, Brisbane.

DESI (2023i). Species profiles. Accessed via: https://apps.des.qld.gov.au/. Queensland Department of Environment, Science and Innovation, Brisbane.

DEWHA (2008a). Approved Conservation Advice for *Homopholis belsonii*. Australian Government Department of Environment, Water, Heritage and the Arts, Canberra.

DEWHA (2008b). Approved Conservation Advice for *Cadellia pentastylis* (Ooline). Australian Government Department of Environment, Water, Heritage and the Arts, Canberra.

DEWHA (2008c). Approved Conservation Advice for *Xerothamnella herbacea*. Australian Government Department of Environment, Water, Heritage and the Arts, Canberra.

DEWHA (2010a). Survey guidelines for Australia's threatened birds. Australian Government Department of Environment, Water, Heritage and the Arts, Canberra.

DEWHA (2010b). Survey guidelines for Australia's threatened bats. Australian Government Department of Environment, Water, Heritage and the Arts, Canberra.

DoE (2013a). Approved Conservation Advice for the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community. Canberra: Department of the Environment.

DoEE (2019). Conservation Advice (including listing advice) for the Poplar Box Grassy Woodland on Alluvial Plains. Canberra: Department of the Environment and Energy.

DoR (2023a). Vegetation management regional ecosystem map - version 13.00 - By Area Of Interest. Queensland Department of Resources, Brisbane.

DoR (2023b). Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - Queensland except South East Queensland Version 7.00. Queensland Department of Resources, Brisbane.

DoR (2023c). Detailed surface geology – Queensland. Queensland Department of Resources, Brisbane.

DoR (2023d). Vegetation management essential habitat map no attribute - version 12.01. Queensland Department of Resources, Brisbane.

DoR (2023e). Vegetation management property reports. Queensland Department of Resources, Brisbane.

DSEWPC (2011a). Survey guidelines for Australia's threatened reptiles. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPC (2011b). Survey guidelines for Australia's threatened mammals. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Duncan A, Baker GB, Montgomery N (1999). The action plan for Australian bats. Environment Australia. Canberra, Australia.

Eddie, C. (2016). Personal communication by email, 31 July 2016, Boobook Ecological Consulting.

Ehmann H (1992). Reptiles. In: Strahan, R., ed. Encyclopedia of Australian Animals. Sydney: Angus and Robertson.

Emison,W.B., C.M. Beardsell, F.I. Norman, R.H. Loyn & S.C. Bennett (1987). Atlas of Victorian Birds. Melbourne: Department of Conservation (Forest & Lands) & Royal Australian Ornithological Union.

Environment Australia (1997). *The Wetlands Policy of the Commonwealth Government of Australia*. Canberra: Environment Australia.

Eyre TJ, Ferguson DJ, Smith GC, Mathieson MT, Venz MF, Hogan, LD, Hourigan CL, Kelly, AL & Rowland, J. (2022a). Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland, Version 4.0. Brisbane: Department of Environment and Science, Queensland Government.

Eyre TJ, Smith GC, Venz MF, Mathieson MT, Hogan LD, Starr, C, Winter, J and McDonald, K. (2022b). Guide to greater glider habitat in Queensland, report prepared for the Department of Agriculture, Water and the Environment, Canberra. Department of Environment and Science, Queensland Government, Brisbane. CC BY 4.0.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Eyre TJ (2004) Distribution and conservation status of the possums and gliders of southern Queensland, in RL Goldingay &SM Jackson (eds) *The Biology of Australian Possums and Gliders*. Surrey Beatty and Sons Chipping Norton, New South Wales. pp. 1-25.

Eyre TJ & Smith AP (1997) Floristic and structural habitat preferences of yellow-bellied gliders (Petaurus australis) and selective logging impacts in southeast Queensland, Australia. *Forest Ecology and Management* 98, 281-295.

Frith, H.J., F.H.J. Crome & B.K. Brown (1977). Aspects of the Biology of the Japanese Snipe *Gallinago hardwickii*. *Australian Journal of Ecology*. 2:341-368.

Garnett ST and Crowley GM (2000). *The Action Plan for Australian Birds 2000*. Environment Australia, Canberra.

Garnett, S. T., Szabo, J. K. and Dutson, G. (2011). The Action Plan for Australian Birds 2010. CSIRO, Melbourne.

Google Earth (2023). Google Earth Pro aerial imagery. Accessed on 12 December 2023.

Higgins, P.J. (ed.) (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Vol 4. Parrots to Dollarbird*. Melbourne: Oxford University Press.

Higgins PJ and Davies SJJF (1996). *Handbook of Australian, New Zealand, and Antarctic Birds. Vol. 3. Snipe to Pigeons.* Oxford University Press, Melbourne.

Hobson R (2012) Grey snake, *Hemiaspis damelii*. In 'Queensland's Threatened Animals' (Eds L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus) pp. 245-246. CSIRO Publishing: Collingwood

Hourigan, C. (2012). Glossy black-cockatoo, *Calyptorhynchus lathami*. Targeted species survey guidelines. Queensland Herbarium, Department of Environment and Science, Brisbane.

Hull, C.L., Stark, E.M., Peruzzo, S. & Sims, C.C. (2013). Avian collisions at two wind farms in Tasmania, Australia: taxonomic and ecological characteristics of colliders versus noncolliders. *New Zealand Journal of Zoology* 40, 47-62.

Kavanagh RP (1987a) Forest phenology and its effect on foraging behavior and selection of habitat by the yellow-Bellied glider, Petaurus australis Shaw. *Wildlife Research* 14, 371- 384.

Kavanagh RP, Debus S, Tweedie T & Webster R (1995) Distribution of nocturnal forest birds and mammals in north-eastern New South Wales: relationships with environmental variables and management history. *Wildlife Research* 22, 359–377

Kearney, M. R., Wintle, B. A., & Porter, W. P. (2010). Correlative and mechanistic models of species distribution provide congruent forecasts under climate change. *Conservation Letters* 3, 203-213.

Kingsford RT (2000) Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia*. Austral Ecology* 25:109-127.

Laidlaw, M.J. (2022). Census of the Queensland Flora and Fungi 2022. Queensland Department of Environment and Science, Queensland Government.

Leigh, J, Boden, R & Briggs, J. (1984). Extinct and Endangered Plants of Australia, Macmillan, Melbourne.

Lettoof DC, Bateman PW, Aubret and Gagnon MM (2020) The broad-scale analysis of metals, trace elements, organochlorine pesticides and polycyclic aromatic hydrocarbons in wetlands along an urban gradient, and the use of a high trophic snake as a bioindicator. *Archives of Environmental Contamination and Toxicology*, 78(4), pp.631-645.

Lindenmayer, D.B., Blanchard, W., McBurney, L., Blair, D., Driscoll, D., Smith, A.L. & Gill, A.M. (2013) Fire severity and landscape context effects on arboreal marsupials. *Biological Conservation* 167, 137-148.

Littler, F.M. (1910). *A Handbook of the Birds of Tasmania and its Dependencies*. Launceston: Published privately.

Longmore, N.W. (1978). Avifauna of the Rockhampton area, Queensland. Sunbird. 9:25-53.

Lumsden L, Nelson J, Lindeman M (2008). Ecological research on the Eastern Long-eared Bat *Nyctophilus timoriensis* (south-eastern form). A report to the Mallee Catchment Management Authority. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment. Melbourne, Australia.

Lumsden, L.F., Nelson, J.L., Todd, C.R., Scroggie, M.P., McNabb, E.G., Raadik, T.A., Smith, S.J., Acevedo, S., Cheers, G., Jemison, M.L. & Nicol, M.D. (2013). A New Strategic Approach to Biodiversity Management – Research Component. Arthur Rylah Institute for Environmental Research. Unpublished Client Report for the Department of Environment and Primary Industries, Heidelberg, Victoria.

Marchant, S. & P.J. Higgins, eds. (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings*. Melbourne, Victoria: Oxford University Press.

McAlpine C, Lunney D, Melzer A, Menkhorst P, Phillips S, Phalen D, Ellis W, Foley W, Baxter G, de Villiers D, Kavanagh R, Adams-Hosking C, Todd C, Whisson D, Molsher R, Walter M, Lawler I & Close R (2015). Conserving koalas: A review of the contrasting regional trends, outlooks and policy challenges. Biological Conservation 192,226-236.

McCarthy, M. & Lindenmayer, D. (1999). Conservation of the greater glider (*Petauroides volans*) in remnant native vegetation within exotic plantation forest. Animal Conservation forum , Volume 2 , Issue 3 , August 1999 , pp. 203 – 209.

McDonald KR, Covacevich JA, Ingram GJ and Couper PJ (1991). The status of frogs and reptiles. In: Ingram, G.J. & R.J. Raven, eds. An Atlas of Queensland's Frogs, Reptiles, Birds and Mammals. Page(s) 338-345. Brisbane: Queensland Museum.

McGregor, D., Padovan, A., Georges, A., Krockenberger, A., Yoon, H., Youngentob, K. (2020). Genetic evidence supports three previously described species of greater glider, *Petauroides volans*, *P. minor*, and *P. armillatus*. Scientific Reports (10) November 2020.

Melzer A, Carrick F, Menkhorst P, Lunney D & John BS (2000). Overview, critical assessment, and conservation implications of koala distribution and abundance. Conservation Biology 14,619-628.

Menkhorst, P., Rogers, D., Clarke, R., Davies, J., Marsack, P. & Franklin, K. (2017). The Australian Bird Guide. CSIRO.

Menkhorst, Peter & Knight, Frank. (2011). A Field Guide to the Mammals of Australia.

Menkins, I. (1998). Draft report for survey of Homopholis belsonii C.E. Hubb. on the Darling Downs, Toowoomba and Region Environment Council Inc, Toowoomba.

Milledge DR, Palmer CL & Nelson JL (1991) *Barometers of change: the distribution of large owls and gliders in Mountain Ash forests of the Victorian Central Highlands and their potential as management indicators*. Conservation of Australia’s forest fauna Royal Zoological Society of New South Wales, Sydney, 55-65.

Morcombe, M.. Field guide to Australian Birds.. Steve Parish Publishing, 2000.

Moore BD & Foley WJ (2005). Tree use by koalas in a chemically complex landscape. *Nature* 435,488-490.

Moore BD, Lawler IR, Wallis IR, Beale CM & Foley WJ (2010). Palatability mapping: a koala's eye view of spatial variation in habitat quality. Ecology 91,3165-3176.NAFI (2023). Fire scars by year. North Australia Fire Information. Retrieved from https://firenorth.org.au/nafi3/.

Naarding, J.A. (1981). Latham's Snipe (*Gallinago hardwickii*) in Tasmania. Wildlife Division Technical Report. 81/2. Tasmania: National Parks and Wildlife Service.

Naarding, J.A. (1983). Latham's Snipe (*Gallinago hardwickii*) in Southern Australia. Wildlife Division Technical Report. 83/01. Tasmania: National Parks and Wildlife Service.

Naarding, J.A. (1985). Latham's Snipe (Gallinago hardwickii) in Australia and Japan. Wildlife Division Technical Report. 85/2. Tasmania: National Parks and Wildlife Service.

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. and Accad, A. (2023). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version

6.0. Queensland Herbarium and Biodiversity Science, Department of Environment and Science, Brisbane.

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Richter, D., Addicott, E.P. and Appelman, C.N. (2023) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 7.0. Updated December 2023. Queensland Herbarium, Queensland Department of Environment, Science and Innovation, Brisbane.

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J., Accad, A. (2017). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 3. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane. Ocock JF, Kingsford RT, Penman TD and Rowley JJ (2014) Frogs during the flood: differential behaviours of two amphibian species in a dryland floodplain wetland. *Austral Ecology*, 39(8), pp.929-940.

Nelson, D.W.M., Crossland, M.R., & Shine, R. (2010. *Indirect ecological impacts of an invasive toad on predator-prey interaction among native species.* Biological Invasions (12) pp. 3363-3369.

Officer, H.R. (1969). *Australian Flycatchers and Their Allies*. Melbourne: The Bird Observers Club.

Oliver, D. L., Chambers, M. A. & Parker, D. G. (2003). Habitat and resource selection of the Painted Honeyeater (Grantiella picta) on the northern floodplains region of New South Wales. Emu: Austral Ornithology 103: 171–176.

Pavey, C. R., Vanderduys, E. and Raghu, S. (2016) Habitat selection by two focal species; golden-tailed gecko and glossy black-cockatoo. A report to the Gas Industry Social and Environmental Research Alliance (GISERA). May 2016. *CSIRO*, Alice Springs

Pavey, C. R, Vanderduys, E., and Raghu, S (2021). *The golden-tailed gecko: a disturbance-tolerant species in a fragmenting environment*. Wildlife Research (48) pp. 643–653.

PBA (2008a). Wandoan Coal Project, MLA area and surrounds: Terrestrial ecology impact assessment. Prepared by Parsons Brinckerhoff Australia Pty Limited, on behalf of Xstrata Coal Queensland Pty Ltd, November 2008.

PBA (2008b). Wandoan Coal Project, Environmental Impact Assessment, Volume 1: Terrestrial Ecology Chapter. Prepared by Parsons Brinckerhoff Australia Pty Limited, on behalf of Xstrata Coal Queensland Pty Ltd, December 2008.

PBA (2008c). Wandoan Coal Project, Draft Biodiversity Offsets Strategy. Prepared by Parsons Brinckerhoff Australia Pty Limited, on behalf of Xstrata Coal Queensland Pty Ltd, November 2008.

PBA (2009a). Wandoan Coal Project, MLA Areas and Gas Supply Pipeline: Supplementary Terrestrial Ecology Impact Assessment. Prepared by Parsons Brinckerhoff Australia Pty Limited, on behalf of Xstrata Coal Queensland Pty Ltd, September 2009.

PBA (2009b). Wandoan Coal Project, Supplementary Environmental Impact Assessment, Volume 1: Terrestrial Ecology Chapter. Prepared by Parsons Brinckerhoff Australia Pty Limited, on behalf of Xstrata Coal Queensland Pty Ltd, September 2009.

Peeters, P. J. & Butler, D. W. (2014). Brigalow: regrowth benefits management guideline. Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Pollock, A.B., (ed.) (2018). Technical Descriptions of Regional Ecosystems of the Brigalow Belt North, (November 2018) (Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

QImagery (2023). QImagery - Queensland Government. Accessed on 12 December 2023 via: https://qimagery.information.qld.gov.au/.

QLD Globe (2023). Queensland Globe. Available from: https://qldglobe.information.qld.gov.au/.

Queensland Government (2020) https://environment.des.qld.gov.au/wildlife/threatenedspecies/endangered/grey-snake. Accessed on 8 Feb 2023.

Queensland Herbarium (2023a). BioCondition Benchmark Database. Version 3.4 (April 2023). Queensland Department of Environment and Science, Brisbane.

Queensland Herbarium (2023b). Regional Ecosystem Description Database (REDD). Version 13. Queensland Department of Environment and Science, Brisbane.

Rismiller, P. D., and McKelvey, M. W. (2000). Frequency of Breeding and Recruitment in the Short-Beaked Echidna, Tachyglossus aculeatus. *Journal of Mammalogy*, *81*(1), 1–17. http://www.jstor.org/stable/1383123

Roberts, G.J. (1979). *The Birds of South-East Queensland. Brisbane:* Queensland Conservation Council.

Rogers, D., I. Hance, S. Paton, C. Tzaros, P. Griffioen, M. Herring, R. Jaensch, L. Oring, A. Silcocks and M. Weston (2005). The breeding bottleneck: breeding habitat and population decline in the Australian Painted Snipe. In: Straw, P., ed. *Status and Conservation of Seabirds in the East Asian-Australasian Flyway*. Pp. 15-23.

Rowland, J. (2012a). Painted honeyeater, *Grantiella picta*. Targeted species survey guidelines. Queensland Herbarium, Department of Environment and Science, Brisbane.

Rowland, J. (2012b). Grey snake, *Hemiaspis damelii*. Targeted species survey guidelines. Queensland Herbarium, Department of Environment and Science, Brisbane.

Rowland, J. and Ferguson, D. (2012). Common death adder, *Acanthophis antarcticus*. Targeted species survey guidelines. Queensland Herbarium, Department of Environment and Science, Brisbane.

Sattler P.S. and Williams R.D. (eds) (1999), The Conservation Status of Queensland Bioregional Ecosystems. Environmental Protection Agency, Brisbane.

Seabrook, Leonie & Mcalpine, Clive & Baxter, Greg & Jonathan, Rhodes & Bradley, Adrian & Lunney, Daniel. (2012). Drought-driven change in wildlife distribution and numbers: A case study of koalas in south west Queensland. *CSIRO Wildlife Research*. 38. 509-524. 10.1071/WR11064.

Schulz M and Lumsden L (2010). Draft national recovery plan for the south-eastern long-eared bat *Nyctophilus corbeni*. Victorian Government Department of Sustainability and Environment. Melbourne, Australia.

Sherwin WB, Timms P, Wilcken J & Houlden B (2000). Analysis and Conservation Implications of Koala Genetics. *Conservation Biology* 14,639-649.

Shine R (1987) Food habits and reproductive biology of Australian snakes of the genus Hemiaspis (Elapidae). *Journal of Herpetology* 21:71-74.

Sharp, D. & B. Simon (2001). Ausgrass: Encyclopedia of Australian Grasses. Canberra: CSIRO Publishing & Australian Biological Resources Study.

Smith, A.G., McAlpine, C., Rhodes, J., Seabrook, L., Lunney, D. & Baxter, G. (2013). Are there habitat thresholds in koala occupancy in the semiarid landscapes of the Mulgalands Bioregion? Wildlife research (East Melbourne) 40(5), 413–426.

Stanisic, J., Shea, M., Potter, D. & Griffiths, O. (2010). *Australian land snails. A field guide to eastern Australian species.* Vol. 1. Bioculture Press, Rivière des Anguilles, Mauritius.

Stanisic, J. (2011). Personal communication by email, 19 September 2011, Biodiversity Assessment and Management Pty Ltd.

Stanisic, J. (2016). Personal communication by email, 28 July 2016, Biodiversity Assessment and Management Pty Ltd.

Stock, M., J & Wild,. C. H. (2005). Seasonal Variation in Glossy Black-cockatoo Calyptorhynchus lathami Sighting on the Gold Coast, Queensland. *Corella* 29, 4, 88-90.

Sullivan B. J. , Baxter G. S. , Lisle A. T. , Pahl L. Norris W. M. (2004) Low-density koala (Phascolarctos cinereus) populations in the mulgalands of south-west Queensland. IV. Abundance and conservation status. *Wildlife Research* 31, 19-29.Tarburton, M.K. (1993). Radiotracking a White-throated Needletail to roost. *Emu*. 93:121—124.

Tarburton, M.K. (2014). Status of the White-throated Needletail *Hirundapus caudacutus* in Australia: Evidence for a marked decline. *Australian Field Ornithology* 31, 122-140.

Taylor, A.C., Walker, F.M., Goldingay, R.L., Ball, T. & van der Ree, R. (2011). Degree of landscape fragmentation influences genetic isolation among populations of a gliding mammal. *PLoS ONE* 6, e26651.

Templeton, M.T. (1992). Birds of Nanango, South-East Queensland. *Sunbird*. 22:87-110.

Threatened Species Network (TSN) (2008). Yakka Skink: *Egernia rugosa*: National Threatened Species Day Information Sheet: Threatened Species Network; Department of the Environment, Water, Heritage and the Arts. Available on the Internet at: http://www.environment.gov.au/biodiversity/threatened/publications/tsday08-skink.html

Threatened Species Scientific Committee (TSSC). (2010). Conservation Advice *Adclarkia cameroni* Brigalow woodland snail. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2015a). Conservation Advice *Geophaps scripta scripta* Squatter Pigeon (Southern*)*. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2015b). Commonwealth listing advice on *Grantiella picta* (Painted Honeyeater). Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2015c). Conservation Advice *Nyctophilus corbeni* south-eastern long-eared bat Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2016a). *NON-CURRENT* Conservation Advice *Petauroides volans* Greater Glider. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2016b). Conservation Advice *Adclarkia dulacca* Dulacca woodland snail. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2019). *Hirundapus caudacutus* (White-throated Needletail) Conservation Advice. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2022a). Conservation Advice *Petauroides volans* Greater Glider. Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Threatened Species Scientific Committee (TSSC). (2022b). Conservation Advice for *Hemiaspis damelii* (grey snake). Australian Government Department of Climate Change, Energy, the Environment and Water, Canberra.

Trémont, RM & Whalley, DB. (1993). Final Report for Survey for *Homopholis belsonii*, Toowoomba and Region Environment Council Inc, Toowoomba.

TSSC (2016a). Conservation Advice *Adclarkia cameroni* brigalow woodland snail. Threatened Species Scientific Committee. Australian Government Department of the Environment and Energy, Brisbane.

TSSC (2016b). Conservation Advice *Adclarkia dulacca* Dulacca woodland snail. Australian Government Department of the Environment and Energy, Brisbane.

Turbill C and Ellis M (2006). Distribution and abundance of the south-eastern form of the Greater Long-eared Bat *Nyctophilus timoriensis*. *Australian Mammology* 28: 1-7.

Van Dyck, S., Gynther, I., and Baker, A. (2013). Field companion to the mammals of Australia. Sydney: New Holland Publishers.

Vanderduys, E. (2012). Field guide to the frogs of Queensland. Collingwood, Victoria: CSIRO Publishing.

Van der Ree, R., Ward, S.J. & Handasyde, K.A. (2004). Distribution and conservation status of possums and gliders in Victoria, in RL Goldingay & SM Jackson (eds), *The Biology of Australian Possums and Gliders.* Surrey Beatty and Sons Chipping Norton, New South Wales. pp. 91-110.

Watkins, D. (1993). A national plan for shorebird conservation in Australia. *RAOU Report Series*. 90.

WDRC (2017). Western Downs Regional Council Biosecurity Plan. Western Downs Regional Council, July 2017.

Wilson, S. & Swan, G. (2021). A Complete Field guide to the reptiles of Australia. Sixth edition. Sydney: New Holland Publishers.

Wilson, S. (2003). *Reptiles of the Southern Brigalow Belt*. WWF-Australia.

Wilson, S. (2005). *A field guide to reptiles of Queensland*. New Holland Publishers: Sydney.

Wilson, S.K. and Knowles, D.G. (1988). Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia: *Collins Publishers*

Wilson, B. A., Neldner, V. J., and Accad, A. (2002). The extent and status of remnant vegetation in Queensland and its implications for statewide vegetation management and legislation. *The Rangeland Journal* 24, 6–35. doi:10.1071/RJ02001

Woinarski, J. C. Z., McCosker, J. C., Gordon, G., Lawrie, B., James, C., Augusteyn, J., Slater, L., & Danvers, T. (2006). Monitoring change in the vertebrate fauna of central

Queensland, Australia, over a period of broad-scale vegetation clearance, 1975-2002. *Wildlife Research* 33, 263-274.
Woinarski, J. C. Z., Burbidge, A. A., & Harrison, P. L. (2014). *The Action Plan for Australian Mammals 2012*. *CSIRO Publishing*, Collingwood.

Youngentob, K.N, Marsh, K.F., Skewes, J. (2021). A review of koala habitat assessment criteria and methods, report prepared for the Department of Agriculture, Water and the Environment, Canberra, November. CC BY 4.0.

Appendix A EPBC Act Protected Matters Report

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Nov-2023

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	37
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	27
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area	In feature area
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area	In feature area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area	In feature area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area	In buffer area only
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calyptorhynchus lathami lathami South-eastern Glossy Black-Cockatoo [67036]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area	In feature area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat may occur within area	In buffer area only
MAMMAL			
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Endangered	Species or species habitat may occur within area	In buffer area only
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area	In feature area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area	In feature area
PLANT			
Acacia curranii Curly-bark Wattle [3908]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Arthraxon hispidus Hairy-joint Grass [9338]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat may occur within area	In feature area
Homopholis belsonii Belson's Panic [2406]	Vulnerable	Species or species habitat may occur within area	In feature area
Lepidium monoplocoides Winged Pepper-cress [9190]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Thesium australe](#) Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area	In feature area
[Vincetoxicum forsteri listed as Tylophora linearis](#) [92384]	Endangered	Species or species habitat may occur within area	In buffer area only
[Xerothamnella herbacea](#) [4146]	Endangered	Species or species habitat may occur within area	In feature area
REPTILE			
[Anomalopus mackayi](#) Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat may occur within area	In feature area
[Delma torquata](#) Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area	In feature area
[Egernia rugosa](#) Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area	In feature area
[Elseya albagula](#) Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Furina dunmalli](#) Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area	In feature area
[Hemiaspis damelii](#) Grey Snake [1179]	Endangered	Species or species habitat likely to occur within area	In feature area
[Rheodytes leukops](#) Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area	In feature area
SNAIL			
[Adclarkia cameroni](#) Brigalow Woodland Snail [83886]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Adclarkia dulacca			
Dulacca Woodland Snail [83885]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Cuculus optatus			
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundapus caudacutus			
White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Rhipidura rufifrons			
Rufous Fantail [592]		Species or species habitat known to occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata			
Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis			
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Atlas Stage 3 Gas Project	2022/09410		Assessment	In feature area
Coal Seam Gas Field Development for Natural Gas Liquefaction Park, Curtis Island	2008/4059		Post-Approval	In feature area
Construction of the Central Surat Rail Project	2013/6729		Completed	In feature area
Development of Existing Coal Seam Gas Fields	2008/4398		Post-Approval	In buffer area only
The Range Project	2011/5860		Completed	In feature area
Controlled action				
Construct and operate 447km high pressure gas transmission pipeline	2009/4976	Controlled Action	Post-Approval	In feature area
Construction and operation of Nathan Dam and associated water delivery infrastructure	2008/4313	Controlled Action	Post-Approval	In feature area
Development of new natural gas acreage in Surat Basin	2013/7047	Controlled Action	Post-Approval	In buffer area only
Expansion of Coal Seam Gas Fields	2009/4974	Controlled Action	Post-Approval	In feature area
Expansion Of Coal Seam Gas Operations	2010/5344	Controlled Action	Post-Approval	In feature area
Future Gas Supply Area Project	2012/6357	Controlled Action	Completed	In feature area
North Surat Coal Project-Collingwood	2012/6236	Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
North Surat Coal Project- Taroom	2012/6237	Controlled Action	Completed	In feature area
Queensland Curtis LNG Project - Pipeline Network	2008/4399	Controlled Action	Post-Approval	In buffer area only
Reedy Creek to Glebe Weir Pipeline Project	2011/6181	Controlled Action	Post-Approval	In feature area
Santos GLNG Gas Field Development Project, QLD	2012/6615	Controlled Action	Post-Approval	In feature area
Surat North CSG Project, Qld	2018/8276	Controlled Action	Post-Approval	In buffer area only
Wandoan Coal Mine and Infrastructure Project	2008/4284	Controlled Action	Post-Approval	In feature area
Wandoan Coal Project - Coal Seam Methane Water Supply South	2008/4287	Controlled Action	Post-Approval	In feature area
Wandoan Coal Project Coal Seam Methane Water Supply West	2008/4283	Controlled Action	Completed	In feature area
Wandoan Coal Project Glebe Weir Raising	2008/4285	Controlled Action	Post-Approval	In feature area
Not controlled action				
Elimatta Open Cut Coal Mine and Coal Processing Plant	2008/4130	Not Controlled Action	Completed	In buffer area only
High Voltage Transmission line Development	2007/3230	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Project Atlas CSG Project, between Wollumbilla and Wandoan, Qld	2018/8329	Not Controlled Action	Completed	In buffer area only
Surat Basin Railway	2008/3944	Not Controlled Action	Completed	In feature area
Referral decision				
Development of an underground longwall coal mine	2011/6129	Referral Decision	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix B WildNet Species List

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Queensland status: Rare and threatened species
Records: All
Date: All
Latitude: -26.0767
Longitude: 149.8485
Distance: 30
Email: lheilbronn@slrconsulting.com
Date submitted: Wednesday 29 Nov 2023 10:25:43
Date extracted: Wednesday 29 Nov 2023 10:30:03

The number of records retrieved = 10

Disclaimer
Information presented on this product is distributed by the Queensland Government as an information source only. While every care is taken to ensure the accuracy of this data, the State of Queensland makes no statements, representations or warranties about the accuracy, reliability, completeness or suitability of any information contained in this product.
The State of Queensland disclaims all responsibility for information contained in this product and all liability (including liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.
Information about your Species lists request is logged for quality assurance, user support and product enhancement purposes only.
The information provided should be appropriately acknowledged as being derived from WildNet database when it is used. As the WildNet Program is still in a process of collating and vetting data, it is possible the information given is not complete. Go to the WildNet database webpage (https://www.qld.gov.au/environment/plants-animals/species-information/wildnet) to find out more about WildNet and where to access other WildNet information products approved for publication. Feedback about WildNet species lists should be emailed to wildlife.online@des.qld.gov.au.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Apodidae	*Hirundapus caudacutus*	white-throated needletail		V	V	3
animals	birds	Cacatuidae	*Calyptorhynchus lathami lathami*	glossy black-cockatoo (eastern)		V	V	1
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	1
animals	mammals	Petauridae	*Petaurus australis australis*	yellow-bellied glider (southern subspecies)		V	V	9
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		E	E	7
animals	mammals	Pseudocheiridae	*Petauroides armillatus*	central greater glider		E	E	1
animals	reptiles	Diplodactylidae	*Strophurus taenicauda*	golden-tailed gecko		NT		12
plants	land plants	Poaceae	*Digitaria porrecta*			NT		2
plants	land plants	Poaceae	*Homopholis belsonii*	Belson's panic		E	V	2/1
plants	land plants	Surianaceae	*Cadellia pentastylis*	ooline		V	V	7/7

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.*
The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.*
The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).
This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix C Species Lists

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

C.1 Flora species recorded in the study area

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Acanthaceae	*Brunoniella australis*		-	LC
Acanthaceae	*Dipteracanthus australasicus*		-	LC
Acanthaceae	*Pseuderanthemum variabile*	Love Flower	-	LC
Acanthaceae	*Rostellularia adscendens*		-	LC
Agavaceae	*Agave americana*		-	*
Aizoaceae	*Tetragonia tetragonoides*	Warrigal Cabage	-	LC
Aizoaceae	*Trianthema portulacastrum*	Black Pigweed	-	*
Amaranthaceae	*Achyranthes aspera*	Chaff Weed	-	LC
Amaranthaceae	*Alternanthera denticulata*		-	LC
Amaranthaceae	*Alternanthera pungens*	Khaki Weed	-	*
Amaranthaceae	*Gomphrena celosioides*		-	*
Amaranthaceae	*Nyssanthes erecta*		-	LC
Amaranthaceae	*Ptilotus semilanatus*	Lamb's Tails	-	LC
Amaryllidaceae	*Crinum flaccidum*		-	LC
Apiaceae	*Cyclospermum leptophyllum*		-	*
Apocynaceae	*Alstonia constricta*	Bitter Bark	-	LC
Apocynaceae	*Carissa ovata*		-	LC
Apocynaceae	*Cynanchum viminale*		-	LC
Apocynaceae	*Gomphocarpus physocarpus*	Balloon Cotton-bush	-	*
Apocynaceae	*Leichhardtia viridiflora subsp. viridiflora*		-	LC
Apocynaceae	*Parsonsia eucalyptophylla*		-	LC
Apocynaceae	*Parsonsia sp.*		-	LC
Asteraceae	*Bidens bipinnata*	Spanish Needles	-	*
Asteraceae	*Calotis cuneifolia*		-	LC
Asteraceae	*Calotis lappulacea*	Yellow Burr Daisy	-	LC
Asteraceae	*Calotis scabiosifolia*		-	LC
Asteraceae	*Centipeda minima*		-	LC
Asteraceae	*Chrysocephalum apiculatum*		-	LC
Asteraceae	*Cirsium vulgare*	Spear Thistle	-	*
Asteraceae	*Cyanthillium cinereum*		-	LC
Asteraceae	*Erigeron bonariensis*		-	*
Asteraceae	*Flaveria trinervia*		-	*
Asteraceae	*Glossocardia bidens*	Native Cobbler's Pegs	-	LC
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	-	LC
Asteraceae	*Parthenium hysterophorus*		-	*

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Asteraceae	*Pterocaulon sp.*		-	LC
Asteraceae	*Schkuhria pinnata*	Dwarf Marigold	-	*
Asteraceae	*Sigesbeckia orientalis*		-	LC
Asteraceae	*Symphyotrichum subulatum*		-	*
Asteraceae	*Tagetes minuta*	Stinking Roger	-	*
Asteraceae	*Verbesina encelioides*	Crownbeard	-	*
Asteraceae	*Xanthium occidentale*	Noogoora Burr	-	*
Asteraceae	*Xanthium spinosum*	Bathurst Burr	-	*
Asteraceae	*Zinnia peruviana*	Wild Zinnia	-	*
Boraginaceae	*Ehretia membranifolia*		-	LC
Brassicaceae	*Arabidella eremigena*		-	LC
Cactaceae	*Opuntia stricta*		-	*
Cactaceae	*Opuntia tomentosa*		-	*
Campanulaceae	*Wahlenbergia gracilis*		-	LC
Capparaceae	*Capparis anomala*		-	LC
Capparaceae	*Capparis canescens*		-	LC
Capparaceae	*Capparis lasiantha*		-	LC
Capparaceae	*Capparis loranthifolia*		-	LC
Casuarinaceae	*Casuarina cristata*	Bull Oak	-	LC
Casuarinaceae	*Casuarina cunninghamiana*		-	LC
Celastraceae	*Denhamia pittosporoides*		-	LC
Chenopodiaceae	*Atriplex eardleyae*		-	LC
Chenopodiaceae	*Atriplex leptocarpa*	Slender-fruited Saltbush	-	LC
Chenopodiaceae	*Einadia nutans*		-	LC
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	-	LC
Chenopodiaceae	*Maireana microphylla*		-	LC
Chenopodiaceae	*Salsola australis*		-	LC
Chenopodiaceae	*Sclerolaena bicornis*	Goathead Burr	-	LC
Chenopodiaceae	*Sclerolaena calcarata*		-	LC
Chenopodiaceae	*Sclerolaena muricata*		-	LC
Commelinaceae	*Commelina ensifolia*		-	LC
Commelinaceae	*Commelina lanceolata*		-	LC
Commelinaceae	*Murdannia graminea*		-	LC
Convolvulaceae	*Evolvulus alsinoides*		-	LC
Convolvulaceae	*Dichondra repens*	Kidney Weed	-	LC
Convolvulaceae	*Ipomoea plebeia*		-	LC

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Convolvulaceae	*Polymeria pusilla*		-	LC
Crassulaceae	*Bryophyllum delagoense*		-	*
Cucurbitaceae	*Cucumis picrocarpus*		-	LC
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	-	LC
Cyperaceae	*Cyperus gracilis*		-	LC
Cyperaceae	*Cyperus difformis*	Dirty Dora	-	LC
Cyperaceae	*Cyperus exaltatus*		-	LC
Cyperaceae	*Fimbristylis dichotoma*	Common Finger Rush	-	LC
Ebenaceae	*Diospyros humilis*		-	LC
Euphorbiaceae	*Croton insularis*		-	LC
Euphorbiaceae	*Euphorbia drummondii*		-	LC
Euphorbiaceae	*Ricinus communis*	Caster Oil Plant	-	*
Goodeniaceae	*Goodenia sp.*		-	LC
Goodeniaceae	*Scaevola spinescens*		-	LC
Hemerocallidaceae	*Dianella sp.*		-	LC
Hypoxidaceae	*Hypoxis pratensis*		-	LC
Lauraceae	*Cassytha filiformis*		-	LC
Lamiaceae	*Basilicum polystachyon*		-	LC
Lamiaceae	*Salvia reflexa*	Mintweed	-	*
Lamiaceae	*Teucrium junceum*	Bead Bush	-	LC
Laxmanniaceae	*Eustrephus latifolius*		-	LC
Laxmanniaceae	*Lomandra longifolia*		-	LC
Leguminosae	*Acacia excelsa*		-	LC
Leguminosae	*Acacia decora*		-	LC
Leguminosae	*Acacia harpophylla*		-	LC
Leguminosae	*Acacia leiocalyx*		-	LC
Leguminosae	*Acacia salicina*	Sally Wattle	-	LC
Leguminosae	*Aeschynomene indica*	Budda Pea	-	LC
Leguminosae	*Chamaecrista absus*		-	LC
Leguminosae	*Cullen tenax*	Emu Foot	-	LC
Leguminosae	*Desmodium brachypodum*	Large Ticktrefoil	-	LC
Leguminosae	*Galactia tenuiflora*		-	LC
Leguminosae	*Glycine sp.*		-	LC
Leguminosae	*Indigofera linifolia*		-	LC
Leguminosae	*Indigofera linnaei*		-	LC
Leguminosae	*Leucaena leucocephala*		-	*

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Leguminosae	*Lotus australis*		-	LC
Leguminosae	*Lysiphyllum carronii*		-	LC
Leguminosae	*Macroptilium atropurpureum*		-	*
Leguminosae	*Macroptilium lathyroides*		-	*
Leguminosae	*Neptunia gracilis*		-	LC
Leguminosae	*Rhynchosia minima*		-	LC
Leguminosae	*Senna barclayana*		-	LC
Leguminosae	*Sesbania cannabina*		-	LC
Leguminosae	*Stylosanthes scabra*		-	*
Leguminosae	*Vachellia farnesiana*		-	*
Leguminosae	*Zornia sp.*		-	LC
Loranthaceae	*Amyema cambagei*		-	LC
Loranthaceae	*Amyema congener subsp. rotundifolia*		-	LC
Loranthaceae	*Amyema maidenii subsp. maidenii*		-	LC
Loranthaceae	*Amyema miquelii*		-	LC
Loranthaceae	*Lysiana exocarpi subsp. tenuis*		-	LC
Loranthaceae	*Lysiana subfalcata*		-	LC
Malvaceae	*Abutilon fraseri*	Dwarf Lantern Flower	-	LC
Malvaceae	*Abutilon malvifolium*		-	LC
Malvaceae	*Abutilon sp.*		-	LC
Malvaceae	*Hibiscus brachysiphonius*		-	LC
Malvaceae	*Malvastrum americanum*		-	*
Malvaceae	*Malvastrum coromandelianum*		-	*
Malvaceae	*Sida hackettiana*		-	LC
Malvaceae	*Sida rhombifolia*		-	*
Malvaceae	*Sida trichopoda*		-	LC
Marsileaceae	*Marsilea drummondii*		-	LC
Meliaceae	*Owenia acidula*		-	LC
Myrtaceae	*Corymbia clarksoniana*		-	LC
Myrtaceae	*Corymbia erythrophloia*		-	LC
Myrtaceae	*Eucalyptus camaldulensis*		-	LC
Myrtaceae	*Eucalyptus crebra*		-	LC
Myrtaceae	*Eucalyptus melanophloia*		-	LC
Myrtaceae	*Eucalyptus orgadophila*		-	LC
Myrtaceae	*Eucalyptus populnea*		-	LC
Nyctaginaceae	*Boerhavia dominii*		-	LC

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Oleaceae	*Jasminum didymum*		-	LC
Oleaceae	*Jasminum simplicifolium*		-	LC
Oleaceae	*Notelaea microcarpa*	Fine Minute Grass	-	LC
Onagraceae	*Ludwigia octovalvis*		-	LC
Onagraceae	*Ludwigia peploides*	Water Primrose	-	LC
Orchidaceae	*Cymbidium canaliculatum*		-	LC
Oxalidaceae	*Oxalis perennans*		-	LC
Oxalidaceae	*Oxalis radicosa*		-	LC
Phyllanthaceae	*Breynia oblongifolia*		-	LC
Phyllanthaceae	*Phyllanthus maderaspatensis*		-	LC
Picrodendraceae	*Petalostigma pubescens*		-	LC
Pittosporaceae	*Auranticarpa rhombifolia*	Diamond Pittosporum	-	LC
Pittosporaceae	*Pittosporum angustifolium*		-	LC
Pittosporaceae	*Pittosporum spinescens*		-	LC
Poaceae	*Ancistrachne uncinulata*	Hooky Grass	-	LC
Poaceae	*Aristida calycina*		-	LC
Poaceae	*Aristida caput-medusae*		-	LC
Poaceae	*Aristida latifolia*		-	LC
Poaceae	*Aristida leptopoda*		-	LC
Poaceae	*Bothriochloa bladhii*		-	LC
Poaceae	*Bothriochloa pertusa*		-	*
Poaceae	*Cenchrus ciliaris*	Buffel Grass	-	*
Poaceae	*Chloris gayana*		-	*
Poaceae	*Chrysopogon fallax*		-	LC
Poaceae	*Cymbopogon obtectus*		-	LC
Poaceae	*Cynodon dactylon*	Couch Grass	-	*
Poaceae	*Dactyloctenium radulans*		-	LC
Poaceae	*Dichanthium sericeum*		-	LC
Poaceae	*Enneapogon lindleyanus*		-	LC
Poaceae	*Enteropogon minutus*		-	LC
Poaceae	*Enteropogon ramosus*		-	LC
Poaceae	*Enteropogon unispiceus*		-	LC
Poaceae	*Eragrostis leptostachya*		-	LC
Poaceae	*Eragrostis sororia*		-	LC
Poaceae	*Heteropogon contortus*		-	LC
Poaceae	*Leptochloa digitata*		-	LC

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Poaceae	*Megathyrsus maximus*		-	*
Poaceae	*Melinis repens*		-	*
Poaceae	*Panicum decompositum*		-	LC
Poaceae	*Panicum effusum*		-	LC
Poaceae	*Paspalidium caespitosum*		-	LC
Poaceae	*Perotis rara*		-	LC
Poaceae	*Setaria incrassata*		-	LC
Poaceae	*Sorghum halepense*		-	*
Poaceae	*Sporobolus actinocladus*		-	LC
Poaceae	*Sporobolus caroli*		-	LC
Poaceae	*Sporobolus sp.*		-	LC
Poaceae	*Themeda avenacea*		-	LC
Poaceae	*Themeda triandra*		-	LC
Poaceae	*Tragus australianus*		-	LC
Poaceae	*Tripogon loliiformis*	Fine Minute Grass	-	LC
Poaceae	*Urochloa mosambicensis*	Sabi Grass	-	*
Portulacaceae	*Portulaca australis*		-	LC
Portulacaceae	*Portulaca oleracea*		-	*
Portulacaceae	*Portulaca pilosa*		-	*
Pteridaceae	*Cheilanthes brownii*		-	LC
Pteridaceae	*Cheilanthes distans*		-	LC
Pteridaceae	*Cheilanthes sieberi*		-	LC
Rhamnaceae	*Ventilago viminalis*		-	LC
Rubiaceae	*Everistia vacciniifolia*		-	LC
Rubiaceae	*Psydrax odorata*		-	LC
Rubiaceae	*Psydrax oleifolia*		-	LC
Rutaceae	*Citrus glauca*		-	LC
Rutaceae	*Geijera parviflora*		-	LC
Rutaceae	*Flindersia maculosa*		-	LC
Santalaceae	*Santalum lanceolatum*	Sandalwood	-	LC
Sapindaceae	*Atalaya hemiglauca*	Whitewood	-	LC
Sapindaceae	*Alectryon diversifolius*		-	LC
Sapindaceae	*Dodonaea sp.*		-	LC
Sapotaceae	*Planchonella cotinifolia var. pubescens*		-	LC
Scrophulariaceae	*Eremophila debilis*		-	LC
Scrophulariaceae	*Eremophila mitchelli*		-	LC

Family	Scientific Name	Common Name	Status[1]	
			EPBC	NC
Solanaceae	*Nicotiana megalosiphon*		-	LC
Solanaceae	*Physalis lanceifolia*		-	*
Solanaceae	*Solanum coracinum*		-	LC
Solanaceae	*Solanum parvifolium*		-	LC
Solanaceae	*Solanum esuriale*		-	LC
Solanaceae	*Solanum americanum*		-	*
Sparrmanniaceae	*Grewia latifolia*		-	LC
Stackhousiaceae	*Stackhousia muricata*	Western Stachousia	-	LC
Sterculiaceae	*Brachychiton rupestris*		-	LC
Tamaricaceae	*Tamarix aphylla*	Athel Pine	-	*
Thymelaeaceae	*Pimelea microcephala*		-	LC
Typhaceae	*Typha orientalis*		-	LC
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	-	LC
Verbenaceae	*Phyla canescens*		-	*
Verbenaceae	*Verbena bonariensis*	Purple Top	-	*
Verbenaceae	*Verbena gaudichaudii*	Common Verbena	-	LC
Vitaceae	*Clematicissus opaca*		-	LC
Zygophyllaceae	*Tribulus terrestris*		-	LC

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed. -*- indicates non-native species.

C.2 Fauna species recorded in the study area

Family	Scientific Name	Common Name	Status[1]		Post-wet 2023	Pre-wet 2023	Post-wet 2024
			EPBC	NC			
AMPHIBIANS							
Bufonidae	*Rhinella marina*	Cane Toad	-	*	X	X	
Hylidae	*Cyclorana alboguttata*	Striped Burrowing Frog	-	LC	X		
Hylidae	*Litoria caerulea*	Green Tree Frog	-	LC	X		
Hylidae	*Litoria latopalmata*	Broad-palmed Rocket Frog	-	LC	X	X	
Hylidae	*Litoria peronii*	Peron's Tree Frog	-	LC	X		
Limnodynastidae	*Limnodynastes fletcheri*	Barking Frog	-	LC	X		
Limnodynastidae	*Limnodynastes salmini*	Salmon Striped Frog	-	LC	X		
Limnodynastidae	*Limnodynastes tasmaniensis*	Spotted Marsh Frog	-	LC	X	X	
Limnodynastidae	*Platyplectrum ornatum*	Ornate Burrowing Frog	-	LC	X	X	
Limnodynastidae	*Limnodynastes convexiusculus*	Marbled frog	-	LC	X		
Myobatrachidae	*Uperoleia rugosa*	Chubby Gungan	-	LC	X		
BIRDS							
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	-	LC	X	X	
Acanthizidae	*Smicrornis brevirostris*	Weebill	-	LC	X		
Acanthizidae	*Acanthiza nana*	Yellow Thornbill	-	LC	X		
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone	-	LC	X	X	
Accipitridae	*Aquila audax*	Wedge-tailed Eagle	-	LC	X	X	
Accipitridae	*Haliastur sphenurus*	Whistling Kite	-	LC	X	X	
Accipitridae	*Elanus axillaris*	Black-shouldered Kite	-	LC	X	X	
Accipitridae	*Milvus migrans*	Black Kite	-	LC	X		
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	-	LC	X		
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	-	LC	X	X	
Alcedinidae	*Todiramphus macleayii*	Forest Kingfisher	-	LC		X	
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher	-	LC			X
Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher	-	LC	X	X	
Anatidae	*Anas gracilis*	Grey Teal	-	LC	X	X	
Anatidae	*Anas superciliosa*	Pacific Black Duck	-	LC	X	X	
Anatidae	*Chenonetta jubata*	Maned Duck	-	LC	X	X	
Anatidae	*Dendrocygna eytoni*	Plumed Whistling Duck	-	LC	X		
Anatidae	*Aythya australis*	Hardhead	-	LC	X	X	
Anhingidae	*Anhinga novaehollandiae*	Australasian Darter	-	LC	X	X	
Apodidae	*Apus pacificus*	Fork-tailed Swift	M	SLC	X		
Ardeidae	*Ardea alba*	Eastern Great Egret	-	LC		X	
Ardeidae	*Ardea intermedia*	Intermediate Egret	-	LC	X	X	
Ardeidae	*Ardea pacifica*	White-necked Heron	-	LC	X	X	
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	-	LC	X	X	
Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron	-	LC		X	
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	-	LC	X	X	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	-	LC	X	X	
Artamidae	*Gymnorhina tibicen*	Australian Magpie	-	LC	X	X	
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	-	LC	X		
Artamidae	*Strepera graculina*	Pied Currawong	-	LC	X		
Cacatuidae	*Cacatua galerita*	Sulfur-crested Cockatoo	-	LC	X	X	
Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy Black-cockatoo (eastern)	V	V	X	X	
Cacatuidae	*Eolophus roseicapilla*	Galah	-	LC	X	X	
Cacatuidae	*Nymphicus hollandicus*	Cockatiel	-	LC	X	X	
Campephagidae	*Coracina maxima*	Ground Cuckooshrike	-	LC			X
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckooshrike	-	LC	X	X	
Campephagidae	*Lalage tricolor*	White-winged Triller	-	LC		X	
Casuariidae	*Dromaius novaehollandiae*	Emu	-	LC	X		
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	-	LC	X	X	
Charadriidae	*Vanellus miles*	Masked Lapwing	-	LC	X		

Family	Scientific Name	Common Name	Status[1]		Post-wet 2023	Pre-wet 2023	Post-wet 2024
			EPBC	NC			
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	-	LC		X	
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	-	LC	X		
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	-	LC	X	X	
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	-	LC	X	X	
Columbidae	*Geopelia placida*	Peaceful Dove	-	LC	X	X	
Coraciidae	*Eurystomus orientalis*	Dollarbird	-	LC	X	X	
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	-	LC	X	X	
Corcoracidae	*Struthidea cinerea*	Apostlebird	-	LC	X	X	
Corvidae	*Corvus orru*	Torresian Crow	-	LC	X	X	
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	-	LC		X	
Cuculidae	*Cacomantis pallidus*	Pallid Cuckoo	-	LC	X		
Cuculidae	*Centropus phasianinus*	Pheasant Coucal	-	LC	X	X	
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	-	LC	X	X	
Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	-	LC		X	
Estrildidae	*Neochmia temporalis*	Red-browed Finch	-	LC		X	
Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	-	LC	X	X	
Estrildidae	*Taeniopygia guttata*	Zebra Finch	-	LC		X	
Eurostopodidae	*Eurostopodus argus*	Spotted Nightjar	-	LC	X		
Falconidae	*Falco berigora*	Brown Falcon	-	LC	X	X	
Falconidae	*Falco cenchroides*	Nankeen Kestrel	-	LC	X		
Falconidae	*Falco longipennis*	Australian Hobby	-	LC	X		
Gruidae	*Antigone rubicunda*	Brolga	-	LC	X	X	
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	-	LC	X		
Hirundinidae	*Petrochelidon nigricans*	Tree Martin	-	LC		X	
Hirundinidae	*Cheramoeca leucosterna*	White-backed Swallow	-	LC	X		
Locustellidae	*Cincloramphus cruralis*	Brown Songlark	-	LC	X	X	
Maluridae	*Malurus lamberti*	Variegated Fairywren	-	LC	X	X	
Maluridae	*Malurus leucopterus*	White-winged Fairywren	-	LC		X	
Maluridae	*Malurus melanocephalus*	Red-backed Fairywren	-	LC		X	
Maluridae	*Malurus cyaneus*	Superb Fairywren	-	LC	X	X	
Maluridae	*Malurus leucopterus*	White-winged Fairywren	-	LC	X		
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	-	LC	X	X	
Meliphagidae	*Gavicalis virescens*	Singing Honeyeater	-	LC	X		
Meliphagidae	*Lichmera indistincta*	Brown Honeyeater	-	LC	X	X	
Meliphagidae	*Manorina flavigula*	Yellow-throated Miner	-	LC		X	
Meliphagidae	*Manorina melanocephala*	Noisy Miner	-	LC	X	X	
Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	-	LC	X	X	
Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	-	LC	X	X	
Meliphagidae	*Manorina flavigula*	Yellow -throated Miner	-	LC	X		
Meliphagidae	*Melithreptus albogularis*	White-throated Honeyeater	-	LC	X		
Meliphagidae	*Philemon buceroides*	Helmeted Friarbird	-	LC		X	
Meliphagidae	*Philemon citreogularis*	Little Friarbird	-	LC	X	X	
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	-	LC	X	X	
Meropidae	*Merops ornatus*	Rainbow Bee-eater	-	LC		X	
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	-	LC	X	X	
Monarchidae	*Myiagra inquieta*	Restless Flycatcher	-	LC	X		
Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	-	LC	X	X	
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	-	LC	X	X	
Oriolidae	*Sphecotheres vieilloti*	Australasian figbird	-	LC	X		
Otididae	*Ardeotis australis*	Bustard	-	LC	X		
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	-	LC	X	X	
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	-	LC	X	X	
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	-	LC	X		
Phasianidae	*Synoicus ypsilophorus*	Brown Quail	-	LC	X		

Family	Scientific Name	Common Name	Status[1]		Post-wet 2023	Pre-wet 2023	Post-wet 2024
			EPBC	NC			
Podargidae	*Podargus strigoides*	Tawny Frogmouth	-	LC	X		
Podicipedidae	*Podiceps cristatus*	Great-crested Grebe	-	LC	X		
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	-	LC	X	X	
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	-	LC	X	X	
Psittaculidae	*Barnardius zonarius*	Australian Ringneck	-	LC	X		
Psittaculidae	*Psephotus haematonotus*	Red-rumped Parrot	-	LC	X	X	
Psittaculidae	*Aprosmictus erythropterus*	Red-winged Parrot	-	LC	X	X	
Psittaculidae	*Parvipsitta pusilla*	Little Lorikeet	-	LC		X	
Psittaculidae	*Platycercus adscitus*	Pale-headed Rosella	-	LC	X	X	
Psittaculidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	-	LC	X		
Psittaculidae	*Trichoglossus moluccanus*	Rainbow Lorikeet	-	LC	X	X	
Ptilonorhynchidae	*Chlamydera maculata*	Spotted Bowerbird	-	LC	X	X	
Rallidae	*Fulica atra*	Eurasian Coot	-	LC	X		
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	-	LC		X	
Recurvirostridae	*Himantopus leucocephalus*	Pied Stilt	-	LC	X		
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	-	LC			
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	-	LC	X	X	
Strigidae	*Ninox boobook*	Southern Boobook	-	LC	X		
Sturnidae	*Acridotheres tristis*	Common Myna	-	*	X	X	
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill	-	LC		X	
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	-	LC		X	
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	-	LC	X		
Tytonidae	*Tyto javanica*	Eastern Barn Owl	-	LC	X		
MAMMALS							
Bovidae	*Bos taurus*	Domestic Cow	-	*	X	X	
Canidae	*Canis familiaris (dingo)*	Dingo	-	*	X		
Dasyuridae	*Sminthopsis macroura*	Striped-faced Dunnart	-	LC	X		
Dasyuridae	*Sminthopsis murina*	Common Dunnart	-	LC	X		
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	-	LC	X	X	
Equidae	*Equus caballus*	Horse	-	*		X	
Felidae	*Felis catus*	Feral Cat	-	*	X		
Leporidae	*Lepus europaeus*	European Brown Hare	-	*	X	X	
Leporidae	*Oryctolagus cuniculus*	Rabbit	-	*	X		
Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	-	LC	X	X	
Macropodidae	*Osphranter rufus*	Red Kangaroo	-	LC	X		
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	-	LC	X	X	
Macropodidae	*Notamacropus parryi*	Whiptail Wallaby	-	LC		X	
Macropodidae	*Notamacropus rufogriseus*	Red-necked Wallaby	-	LC	X	X	
Miniopteridae	*Miniopterus orianae oceanensis*	Eastern Bent-wing Bat	-	LC	X		
Molossidae	*Austronomus australis*	White-striped Freetail Bat	-	LC	X	X	
Molossidae	*Chaerephon jobensis*	Northern Freetail Bat	-	LC	X	X	
Molossidae	*Mormopterus (Ozimops) lumsdenae*	Northern Free-tailed Bat	-	LC	X	X	
Molossidae	*Mormopterus (Ozimops) ridei*	Eastern Free-tailed Bat	-	LC	X	X	
Muridae	*Mus musculus*	House Mouse	-	*	X	X	
Muridae	*Pseudomys desertor*	Desert Mouse	-	LC		X	
Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	-	LC	X	X	
Petauridae	*Petaurus breviceps sensu lato*	Sugar Glider	-	LC	X		
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	-	LC	X		
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	-	LC	X	X	
Phascolarctidae	*Phascolarctos cinereus*	Koala	E	E	X		X
Potoroidae	*Aepyprymnus rufescens*	Rufous Bettong	-	LC	X	X	
Pseudocheiridae	*Petauroides armillatus*	Central Greater Glider	E	E	X	X	X
Pteropodidae	*Pteropus scapulatus*	Little Red Flying-fox	-	LC		X	
Suidae	*Sus scrofa*	Feral Pig	-	*	X	X	

Family	Scientific Name	Common Name	Status[1]		Post-wet 2023	Pre-wet 2023	Post-wet 2024
			EPBC	NC			
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	-	SLC	X		
Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	-	LC		X	
Vespertilionidae	*Nyctophilus sp.*	Long-eared Bats	-	LC	X	X	
Vespertilionidae	*Scotorepens balstoni*	Inland Broad-nosed Bat	-	LC	X	X	
Vespertilionidae	*Scotorepens greyii*	Little Broad-nosed Bat	-	LC	X	X	
Vespertilionidae	*Vespadelus baverstocki*	Inland Forest Bat	-	LC	X		
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	-	LC	X	X	
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	-	LC	X	X	
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	-	LC	X	X	
Vespertilionidae	*Chalinolobus nigrogriseus*	Hoary Wattled Bat	-	LC	X	X	
Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	-	LC	X	X	
REPTILES							
Agamidae	*Pogona barbata*	Bearded Dragon	-	LC	X		
Chelidae	*Chelodina expansa*	Broad-shelled River Turtle	-	LC	X		
Colubridae	*Tropidonophis mairii*	Keelback	-	LC	X		
Diplodactylidae	*Oedura sp.*	Velvet Gecko	-	LC		X	
Elapidae	*Cryptophis nigrescens*	Eastern Small-eyed Snake	-	LC	X		
Elapidae	*Pseudonaja textilis*	Eastern Brown	-	LC	X		
Gekkonidae	*Gehyra dubia*	Dubious Dtella	-	LC	X	X	
Gekkonidae	*Gehyra sp.*	Web-toed Gecko	-	LC	X		
Gekkonidae	*Heteronotia binoei*	Bynoes Gecko	-	LC	X		
Scincidae	*Carlia munda*	Shaded Litter Rainbow Skink	-	LC	X		
Scincidae	*Carlia sp.*	Rainbow Skink	-	LC	X	X	
Scincidae	*Cryptoblepharus sp.*	Snake-eyed Skink	-	LC	X	X	
Scincidae	*Ctenotus robustus sensu lato*	Eastern Striped Skink	-	LC	X		
Scincidae	*Lerista punctatovittata*	Eastern Robust Slider	-	LC		X	
Scincidae	*Lerista timida*	Timid Slider	-	LC		X	
Scincidae	*Lygisaurus foliorum*	Tree-base Litter Skink	-	LC	X	X	
Scincidae	*Menetia greyii*	Common Dwarf Skink	-	LC	X		
Scincidae	*Morethia boulengeri*	South-eastern Morethia Skink	-	LC	X	X	
Scincidae	*Tiliqua rugosa*	Shingle-back	-	LC	X		
Scincidae	*Morethia sp.*	Firetail Skink	-	LC	X		
Typhlopidae	*Anilios proximus*	Blind Snake	-	LC	X		
Varanidae	*Varanus varius*	Lace Monitor	-	LC	X	X	
Varanidae	*Varanus panoptes*	Yellow-Spotted Monitor	-	LC	X		

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Special Least Concern (SLC), Migratory (M), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed. '*' indicates a non-native species.

[2] Comprehensive species lists were kept only for 2023 field surveys, while only novel species were recorded during the 2024 survey

C.3 Fauna species recorded during the 2023 post-wet season survey

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites			
EPBC	NC					Site 1	Site 2	Site 3	Site 4
AMPHIBIANS									
-	*	Bufonidae	*Rhinella marina*	Cane Toad	Pitfall, spotlighting	-	X	-	-
-	LC	Hylidae	*Litoria latopalmata*	Broad-palmed Rocketfrog	Spotlighting	-	-	-	-
-	LC	Limnodynastidae	*Limnodynastes tasmaniensis*	Spotted Marsh Frog	Spotlighting	-	-	-	-
-	LC	Limnodynastidae	*Platyplectrum ornatum*	Ornate Burrowing Frog	Pitfall	-	X	-	-
BIRDS									
-	LC	Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	Incidental	-	-	-	-
-	LC	Acanthizidae	*Gerygone olivacea*	White-throated Gerygone	Incidental	-	X	-	-
-	LC	Accipitridae	*Aquila audax*	Wedge-tailed Eagle	Camera, incidental	-	X	-	-
-	LC	Accipitridae	*Haliastur sphenurus*	Whistling Kite	Camera, incidental	-	-	-	-
-	LC	Accipitridae	*Elanus axillaris*	Black-shouldered Kite	Incidental	-	-	-	-
-	LC	Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	Incidental	-	-	-	-
-	LC	Alcedinidae	*Todiramphus macleayii*	Forest Kingfisher	Incidental	-	-	-	-
-	LC	Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher	Camera, incidental	-	-	-	-
-	LC	Anatidae	*Anas gracilis*	Grey Teal	Camera, incidental	-	-	-	-
-	LC	Anatidae	*Anas superciliosa*	Pacific Black Duck	Camera, incidental	-	-	-	-
-	LC	Anatidae	*Chenonetta jubata*	Maned Duck	Camera, incidental	-	-	-	-
-	LC	Anatidae	*Aythya australis*	Hardhead	Incidental	-	-	-	-
-	LC	Anhingidae	*Anhinga novaehollandiae*	Australasian Darter	Incidental	-	-	-	-
-	LC	Ardeidae	*Ardea alba*	Eastern Great Egret	Camera, incidental	-	-	-	-
-	LC	Ardeidae	*Ardea intermedia*	Intermediate Egret	Incidental	-	-	-	-
-	LC	Ardeidae	*Ardea pacifica*	White-necked Heron	Camera, incidental	-	-	-	-
-	LC	Ardeidae	*Egretta novaehollandiae*	White-faced Heron	Camera, incidental	-	-	-	-
-	LC	Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron	Incidental	-	-	-	-
-	LC	Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	Incidental	-	X	-	-
-	LC	Artamidae	*Cracticus torquatus*	Grey Butcherbird	Incidental	-	-	-	X
-	LC	Artamidae	*Gymnorhina tibicen*	Australian Magpie	Camera, incidental	-	-	-	-
-	LC	Cacatuidae	*Cacatua galerita*	Sulfur-crested Cockatoo	Camera, incidental	-	-	-	-
V	V	Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy Black-cockatoo (eastern)	Incidental	-	-	-	-
-	LC	Cacatuidae	*Eolophus roseicapilla*	Galah	Camera, incidental	-	X	-	-
-	LC	Cacatuidae	*Nymphicus hollandicus*	Cockatiel	Incidental	-	-	-	-
-	LC	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckooshrike	Incidental	-	-	-	-
-	LC	Campephagidae	*Lalage tricolor*	White-winged Triller	Incidental	-	-	-	-
-	LC	Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	Incidental	-	-	-	-
-	LC	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	Incidental	-	-	-	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites			
EPBC	NC					Site 1	Site 2	Site 3	Site 4
-	LC	Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	Camera, incidental	-	-	-	-
-	LC	Columbidae	*Ocyphaps lophotes*	Crested Pigeon	Camera, incidental	-	-	-	-
-	LC	Columbidae	*Geopelia placida*	Peaceful Dove	Camera, incidental	-	-	-	-
-	LC	Coraciidae	*Eurystomus orientalis*	Dollarbird	Incidental	-	-	-	-
-	LC	Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	Incidental	-	-	-	-
-	LC	Corcoracidae	*Struthidea cinerea*	Apostlebird	Camera, incidental	-	-	-	-
-	LC	Corvidae	*Corvus orru*	Torresian Crow	Camera, incidental	-	X	X	-
-	LC	Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	Incidental	X	-	-	-
-	LC	Cuculidae	*Centropus phasianinus*	Pheasant Coucal	Incidental	-	-	-	-
-	LC	Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	Incidental	-	-	X	-
-	LC	Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	Incidental	-	-	-	-
-	LC	Estrildidae	*Neochmia temporalis*	Red-browed Finch	Incidental	-	-	-	-
-	LC	Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	Incidental	-	-	X	-
-	LC	Estrildidae	*Taeniopygia guttata*	Zebra Finch	Incidental	-	-	-	-
-	LC	Falconidae	*Falco berigora*	Brown Falcon	Incidental	-	-	-	-
-	LC	Gruidae	*Antigone rubicunda*	Brolga	Incidental	-	-	-	-
-	LC	Hirundinidae	*Petrochelidon nigricans*	Tree Martin	Incidental	-	-	-	-
-	LC	Locustellidae	*Cincloramphus cruralis*	Brown Songlark	Incidental	-	-	-	-
-	LC	Maluridae	*Malurus lamberti*	Variegated Fairywren	Incidental	X	-	-	-
-	LC	Maluridae	*Malurus leucopterus*	White-winged Fairywren	Incidental	-	-	-	X
-	LC	Maluridae	*Malurus melanocephalus*	Red-backed Fairywren	Incidental	-	-	-	-
-	LC	Maluridae	*Malurus cyaneus*	Superb Fairywren	Incidental	-	-	-	-
-	LC	Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	Incidental	-	-	-	-
-	LC	Meliphagidae	*Lichmera indistincta*	Brown Honeyeater	Incidental	-	-	-	-
-	LC	Meliphagidae	*Manorina flavigula*	Yellow-throated Miner	Incidental	-	-	-	-
-	LC	Meliphagidae	*Manorina melanocephala*	Noisy Miner	Incidental	X	-	-	-
-	LC	Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	Incidental	-	-	-	-
-	LC	Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	Incidental	-	-	-	-
-	LC	Meliphagidae	*Philemon buceroides*	Helmeted Friarbird	Incidental	-	-	-	-
-	LC	Meliphagidae	*Philemon citreogularis*	Little Friarbird	Incidental	-	-	-	-
-	LC	Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	Incidental	-	-	-	-
-	LC	Meropidae	*Merops ornatus*	Rainbow Bee-eater	Incidental	-	-	-	-
-	LC	Monarchidae	*Grallina cyanoleuca*	Magpie-lark	Camera, incidental	-	-	-	X
-	LC	Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	Incidental	-	X	-	-
-	LC	Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	Incidental	-	-	-	-
-	LC	Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	Incidental	-	-	-	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites			
EPBC	NC					Site 1	Site 2	Site 3	Site 4
-	LC	Pardalotidae	*Pardalotus striatus*	Striated Pardalote	Incidental	-	-	-	-
-	LC	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	Camera, incidental	-	-	-	-
-	LC	Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	Incidental	-	-	-	-
-	LC	Psittaculidae	*Psephotus haematonotus*	Red-rumped Parrot	Incidental	-	-	-	-
-	LC	Psittaculidae	*Aprosmictus erythropterus*	Red-winged Parrot	Incidental	-	-	-	-
-	LC	Psittaculidae	*Parvipsitta pusilla*	Little Lorikeet	Incidental	-	-	-	-
-	LC	Psittaculidae	*Platycercus adscitus*	Pale-headed Rosella	Incidental	-	-	-	X
-	LC	Psittaculidae	*Trichoglossus moluccanus*	Rainbow Lorikeet	Incidental	-	-	-	-
-	LC	Ptilonorhynchidae	*Chlamydera maculata*	Spotted Bowerbird	Camera, incidental	-	-	-	-
-	LC	Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	Incidental	-	-	-	-
-	LC	Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	Camera, incidental	-	-	-	-
-	*	Sturnidae	*Acridotheres tristis*	Common Myna	Incidental	-	-	-	-
-	LC	Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill	Incidental	-	-	-	-
-	LC	Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	Camera, incidental	-	-	-	-
MAMMALS									
-	*	Bovidae	*Bos taurus*	Domestic Cow	Incidental	-	-	-	-
-	LC	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	Bat detector	X	X	X	X
-	*	Equidae	*Equus caballus*	Horse	Incidental	-	-	-	-
-	*	Leporidae	*Lepus europaeus*	European Brown Hare	Incidental	-	-	-	-
-	LC	Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	Incidental, spotlighting	-	-	-	-
-	LC	Macropodidae	*Wallabia bicolor*	Swamp Wallaby	Incidental	-	X	-	-
-	LC	Macropodidae	*Notamacropus parryi*	Whiptail Wallaby	Incidental	-	-	-	-
-	LC	Macropodidae	*Notamacropus rufogriseus*	Red-necked Wallaby	Incidental	-	X	X	-
-	LC	Molossidae	*Austronomus australis*	White-striped Freetail Bat	Bat detector	X	X	X	X
-	LC	Molossidae	*Chaerephon jobensis*	Northern Freetail Bat	Bat detector	X	X	X	X
-	LC	Molossidae	*Mormopterus (Ozimops) lumsdenae*	Northern Free-tailed Bat	Bat detector	X	X	X	X
-	LC	Molossidae	*Mormopterus (Ozimops) ridei*	Eastern Free-tailed Bat	Bat detector	X	X	X	X
-	*	Muridae	*Mus musculus*	House Mouse	Pitfall, Elliot trap	-	X	-	-
-	LC	Muridae	*Pseudomys desertor*	Desert Mouse	Pitfall, Elliot trap	-	X	X	X
-	LC	Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	Camera trap	-	-	X	-
-	LC	Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	Spotlighting	X	X	X	X
-	LC	Potoroidae	*Aepyprymnus rufescens*	Rufous Bettong	Camera trap	-	-	X	X
E	E	Pseudocheiridae	*Petauroides armillatus*	Central Greater Glider	Spotlighting	-	-	-	-
-	LC	Pteropodidae	*Pteropus scapulatus*	Little Red Flying-fox	Spotlighting, incidental	-	-	-	-
-	*	Suidae	*Sus scrofa*	Feral Pig	Incidental	-	-	-	-
-	LC	Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	Harp trap	-	-	-	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites			
EPBC	NC					Site 1	Site 2	Site 3	Site 4
-	LC	Vespertilionidae	*Nyctophilus sp.*	Long-eared Bats	Bat detector	X	X	X	X
-	LC	Vespertilionidae	*Scotorepens balstoni*	Inland Broad-nosed Bat	Bat detector	-	X	-	X
-	LC	Vespertilionidae	*Scotorepens greyii*	Little Broad-nosed Bat	Bat detector	X	X	X	X
-	LC	Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	Bat detector	-	X	-	-
-	LC	Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	Bat detector	X	X	X	X
-	LC	Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	Bat detector, harp trap	-	X	X	-
-	LC	Vespertilionidae	*Chalinolobus nigrogriseus*	Hoary Wattled Bat	Bat detector	X	X	X	X
-	LC	Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	Bat detector, harp trap	X	X	X	X
REPTILES									
-	LC	Diplodactylidae	*Oedura sp.*	Velvet Gecko	Spotlighting	-	-	-	-
-	LC	Gekkonidae	*Gehyra dubia*	Dubious Dtella	Spotlighting	-	-	-	-
-	LC	Scincidae	*Carlia sp.*	Rainbow Skink	Incidental	-	-	-	-
-	LC	Scincidae	*Cryptoblepharus sp.*	Snake-eyed Skink	Incidental	-	-	-	X
-	LC	Scincidae	*Lerista punctatovittata*	Eastern Robust Slider	Pitfall	X	-	X	-
-	LC	Scincidae	*Lerista timida*	Timid Slider	Pitfall	-	-	X	X
-	LC	Scincidae	*Lygisaurus foliorum*	Tree-base Litter Skink	Pitfall, funnel trap	-	X	-	X
-	LC	Scincidae	*Morethia boulengeri*	South-eastern Morethia Skink	Pitfall	-	-	X	-
-	LC	Varanidae	*Varanus varius*	Lace Monitor	Camera, incidental	-	-	-	-

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Special Least Concern (SLC), Migratory (M), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed. '*' indicates a non-native species.

[2] Method of detection: spotlighting, pitfall, Elliot, funnel, cage trap, incidental (includes active search and bird survey), camera trap, harp trap, bat detector.

C.4 Fauna species recorded during the 2023 pre-wet season survey

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites		
EPBC	NC					Site 5	Site 6	Site 7
AMPHIBIANS								
-	*	Bufonidae	*Rhinella marina*	Cane Toad	Spotlighting	-	X	X
-	LC	Hylidae	*Cyclorana alboguttata*	Striped Burrowing Frog	Spotlighting	-	-	-
-	LC	Hylidae	*Litoria caerulea*	Green Tree Frog	Spotlighting/Funnel trap	-	X	X
-	LC	Hylidae	*Litoria latopalmata*	Broad-palmed Rocket Frog	Pitfall trap	-	-	-
-	LC	Hylidae	*Litoria peronii*	Peron's Tree Frog	Spotlighting	-	-	-
-	LC	Limnodynastidae	*Limnodynastes fletcheri*	Barking Frog	Pitfall trap	-	X	-
-	LC	Limnodynastidae	*Limnodynastes salmini*	Salmon Striped Frog	Pitfall trap	-	X	-
-	LC	Limnodynastidae	*Limnodynastes tasmaniensis*	Spotted Marsh Frog	Spotlighting/Pitfall trap/Funnel	X	X	X
-	LC	Limnodynastidae	*Platyplectrum ornatum*	Ornate Burrowing Frog	Pitfall trap	-	X	-
-	LC	Limnodynastidae	*Limnodynastes convexiusculus*	Marbled frog	Pitfall trap	-	X	-
-	LC	Myobatrachidae	*Uperoleia rugosa*	Chubby Gungan	Pitfall trap	-	X	-
BIRDS								
-	LC	Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	Incidental	-	-	-
-	LC	Acanthizidae	*Smicrornis brevirostris*	Weebill	Incidental	-	X	-
-	LC	Acanthizidae	*Acanthiza nana*	Yellow Thornbill	Incidental	-	-	X
-	LC	Acanthizidae	*Gerygone olivacea*	White-throated Gerygone	Incidental	X	-	-
-	LC	Accipitridae	*Aquila audax*	Wedge-tailed Eagle	Incidental	-	-	-
-	LC	Accipitridae	*Haliastur sphenurus*	Whistling Kite	Incidental	X	-	X
-	LC	Accipitridae	*Elanus axillaris*	Black-shouldered Kite	Incidental	-	-	-
-	LC	Accipitridae	*Milvus migrans*	Black Kite	Incidental	-	-	X
-	LC	Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	Incidental	-	-	-
-	LC	Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	Incidental/Camera trap	X	X	-
-	LC	Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher	Incidental	-	-	X
-	LC	Anatidae	*Anas gracilis*	Grey Teal	Incidental	-	-	-
-	LC	Anatidae	*Anas superciliosa*	Pacific Black Duck	Incidental	-	-	-
-	LC	Anatidae	*Chenonetta jubata*	Australian Wood Duck	Incidental	-	-	-
-	LC	Anatidae	*Dendrocygna eytoni*	Plumed Whistling Duck	Incidental	-	-	-
-	LC	Anatidae	*Aythya australis*	Hardhead	Incidental	-	-	-
-	LC	Anhingidae	*Anhinga novaehollandiae*	Australasian Darter	Incidental	-	-	-
M	SLC	Apodidae	*Apus pacificus*	Fork-tailed Swift	Incidental	-	-	-
-	LC	Ardeidae	*Ardea intermedia*	Intermediate Egret	Incidental	-	X	-
-	LC	Ardeidae	*Ardea pacifica*	White-necked Heron	Incidental	-	X	-
-	LC	Ardeidae	*Egretta novaehollandiae*	White-faced Heron	Incidental	-	-	-
-	LC	Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	Incidental	X	X	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites		
EPBC	NC					Site 5	Site 6	Site 7
-	LC	Artamidae	*Cracticus torquatus*	Grey Butcherbird	Incidental	-	-	X
-	LC	Artamidae	*Gymnorhina tibicen*	Australian Magpie	Incidental	X	X	X
-	LC	Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	Incidental	-	-	-
-	LC	Artamidae	*Strepera graculina*	Pied Currawong	Incidental	-	-	-
-	LC	Cacatuidae	*Cacatua galerita*	Sulfur-crested Cockatoo	Incidental	X	X	-
V	V	Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy Black-cockatoo (eastern)	Incidental	-	-	-
-	LC	Cacatuidae	*Eolophus roseicapilla*	Galah	Incidental	-	X	-
-	LC	Cacatuidae	*Nymphicus hollandicus*	Cockatiel	Incidental	-	-	-
-	LC	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckooshrike	Incidental	X	-	-
-	LC	Casuariidae	*Dromaius novaehollandiae*	Emu	Incidental	-	-	-
-	LC	Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	Incidental	-	-	-
-	LC	Charadriidae	*Vanellus miles*	Masked Lapwing	Incidental	-	-	-
-	LC	Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	Incidental	-	-	-
-	LC	Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	Incidental	-	-	-
-	LC	Columbidae	*Ocyphaps lophotes*	Crested Pigeon	Incidental	X	-	-
-	LC	Columbidae	*Geopelia placida*	Peaceful Dove	Incidental	-	-	-
-	LC	Coraciidae	*Eurystomus orientalis*	Dollarbird	Incidental	-	X	X
-	LC	Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	Incidental	-	-	-
-	LC	Corcoracidae	*Struthidea cinerea*	Apostlebird	Incidental/Camera trap	-	-	-
-	LC	Corvidae	*Corvus orru*	Torresian Crow	Incidental	X	X	X
-	LC	Cuculidae	*Cacomantis pallidus*	Pallid Cuckoo	Incidental	-	-	-
-	LC	Cuculidae	*Centropus phasianinus*	Pheasant Coucal	Incidental	-	-	-
-	LC	Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	Incidental	X	-	-
-	LC	Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	Incidental	-	-	-
-	LC	Eurostopodidae	*Eurostopodus argus*	Spotted Nightjar	Incidental	-	-	-
-	LC	Falconidae	*Falco berigora*	Brown Falcon	Incidental	-	-	-
-	LC	Falconidae	*Falco cenchroides*	Nankeen Kestrel	Incidental	-	-	-
-	LC	Falconidae	*Falco longipennis*	Australian Hobby	Incidental	-	-	-
-	LC	Gruidae	*Antigone rubicunda*	Brolga	Incidental	-	-	-
-	LC	Hirundinidae	*Hirundo neoxena*	Welcome Swallow	Incidental	-	-	-
-	LC	Hirundinidae	*Cheramoeca leucosterna*	White-backed Swallow	Incidental	-	-	-
-	LC	Locustellidae	*Cincloramphus cruralis*	Brown Songlark	Incidental	-	-	-
-	LC	Maluridae	*Malurus cyaneus*	Superb Fairywren	Incidental	-	X	X
-	LC	Maluridae	*Malurus lamberti*	Varigated Fairywren	Incidental	-	X	-
-	LC	Maluridae	*Malurus leucopterus*	White-winged Fairywren	Incidental	-	-	-
-	LC	Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	Incidental	-	-	X

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites		
EPBC	NC					Site 5	Site 6	Site 7
-	LC	Meliphagidae	*Gavicalis virescens*	Singing Honeyeater	Incidental	-	-	X
-	LC	Meliphagidae	*Lichmera indistincta*	Brown Honeyeater	Incidental	X	-	-
-	LC	Meliphagidae	*Manorina melanocephala*	Noisy Miner	Incidental	-	-	-
-	LC	Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	Incidental	-	X	X
-	LC	Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	Incidental	-	-	-
-	LC	Meliphagidae	*Manorina flavigula*	Yellow -throated Miner	Incidental	-	-	-
-	LC	Meliphagidae	*Melithreptus albogularis*	White-throated Honeyeater	Incidental	-	-	X
-	LC	Meliphagidae	*Philemon citreogularis*	Little Friarbird	Incidental	X	-	-
-	LC	Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	Incidental	-	-	-
-	LC	Monarchidae	*Grallina cyanoleuca*	Magpie-lark	Incidental	X	X	-
-	LC	Monarchidae	*Myiagra inquieta*	Restless Flycatcher	Incidental	-	-	-
-	LC	Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	Incidental	-	-	-
-	LC	Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	Incidental	-	-	-
-	LC	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird	Incidental	X	-	-
-	LC	Otididae	*Ardeotis australis*	Bustard	Incidental	-	-	-
-	LC	Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	Incidental	-	-	X
-	LC	Pardalotidae	*Pardalotus striatus*	Striated Pardalote	Incidental	-	X	X
-	LC	Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	Incidental	-	-	-
-	LC	Phasianidae	*Synoicus ypsilophorus*	Brown Quail	Incidental	-	-	-
-	LC	Podargidae	*Podargus strigoides*	Tawny Frogmouth	Incidental/Spotlighting	-	X	-
-	LC	Podicipedidae	*Podiceps cristatus*	Great-crested Grebe	Incidental	-	-	-
-	LC	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	Incidental	-	-	-
-	LC	Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	Incidental	-	-	-
-	LC	Psittaculidae	*Barnardius zonarius*	Australian Ringneck	Incidental	-	-	-
-	LC	Psittaculidae	*Psephotus haematonotus*	Red-rumped Parrot	Incidental	-	-	-
-	LC	Psittaculidae	*Aprosmictus erythropterus*	Red-winged Parrot	Incidental	-	X	-
-	LC	Psittaculidae	*Platycercus adscitus*	Pale-headed Rosella	Incidental	-	X	-
-	LC	Psittaculidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	Incidental	-	-	-
-	LC	Psittaculidae	*Trichoglossus moluccanus*	Rainbow Lorikeet	Incidental	-	-	-
-	LC	Ptilonorhynchidae	*Chlamydera maculata*	Spotted Bowerbird	Incidental/Camera trap	-	-	X
-	LC	Rallidae	*Fulica atra*	Eurasian Coot	Incidental	-	-	-
-	LC	Recurvirostridae	*Himantopus leucocephalus*	Pied Stilt	Incidental	-	-	-
-	LC	Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	Incidental	-	X	-
-	LC	Strigidae	*Ninox boobook*	Southern Boobook	Incidental	-	-	-
-	*	Sturnidae	*Acridotheres tristis*	Common Myna	Incidental	-	-	-
-	LC	Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	Incidental	-	-	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites		
EPBC	NC					Site 5	Site 6	Site 7
-	LC	Tytonidae	*Tyto javanica*	Eastern Barn Owl	Incidental	-	-	-
MAMMALS								
-	*	Bovidae	*Bos taurus*	Domestic Cow	Incidental	-	-	-
-	*	Canidae	*Canis lupus dingo*	Dingo	Camera trap	X	-	-
-	LC	Dasyuridae	*Sminthopsis macroura*	Striped-faced Dunnart	Pitfall trap	-	X	-
-	LC	Dasyuridae	*Sminthopsis murina*	Common Dunnart	Elliot trap	-	X	X
-	LC	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	Bat detector	X	X	X
-	*	Felidae	*Felis catus*	Feral Cat	Incidental	-	-	-
-	*	Leporidae	*Lepus europaeus*	European Brown Hare	Incidental/Camera trap	-	-	-
-	*	Leporidae	*Oryctolagus cuniculus*	Rabbit	Incidental	-	-	-
-	LC	Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	Incidental	X	-	-
-	LC	Macropodidae	*Osphranter rufus*	Red Kangaroo	Incidental	-	-	-
-	LC	Macropodidae	*Wallabia bicolor*	Swamp Wallaby	Incidental/Camera trap	-	-	-
-	LC	Macropodidae	*Notamacropus rufogriseus*	Red-necked Wallably	Camera trap	X	-	-
-	LC	Miniopteridae	*Miniopterus orianae oceanensis*	Eastern Bent-wing Bat	Bat detector	-	-	X
-	LC	Molossidae	*Austronomus australis*	White-striped Freetail Bat	Bat detector	X	X	X
-	LC	Molossidae	*Chaerephon jobensis*	Northern Freetail Bat	Bat detector	X	-	X
-	LC	Molossidae	*Mormopterus (Ozimops) lumsdenae*	Northern Free-tailed Bat	Bat detector	X	X	X
-	LC	Molossidae	*Mormopterus (Ozimops) ridei*	Eastern Free-tailed Bat	Bat detector	X	X	X
-	*	Muridae	*Mus musculus*	House Mouse	Elliot trap	-	X	-
-	LC	Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot	Camera trap	X	X	-
-	LC	Petauridae	*Petaurus breviceps sensu lato*	Sugar Gliders	Spotlighting	-	-	-
-	LC	Petauridae	*Petaurus norfolcensis*	Squirrel Glider	Spotlighting	-	-	-
-	LC	Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	Spotlighting/Camera trap	X	X	-
E	E	Phascolarctidae	*Phascolarctos cinereus*	Koala	Incidental	-	-	-
-	LC	Potoroidae	*Aepyprymnus rufescens*	Rufous Bettong	Spotlighting/Camera trap	X	-	X
E	V	Pseudocheiridae	*Petauroides armillatus*	Central Greater Glider	Spotlighting	-	X	-
-	*	Suidae	*Sus scrofa*	Feral Pig	Incidental	-	-	-
-	SLC	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echindna	Camera trap	-	X	-
-	LC	Vespertilionidae	*Nyctophilus sp.*	Long-eared Bats	Bat detector	X	X	X
-	LC	Vespertilionidae	*Scotorepens balstoni*	Inland Broad-nosed Bat	Bat detector	X	X	X
-	LC	Vespertilionidae	*Scotorepens greyii*	Little Broad-nosed Bat	Bat detector	X	X	X
-	LC	Vespertilionidae	*Vespadelus baverstocki*	Inland Forest Bat	Bat detector	X*	X*	X*
-	LC	Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	Bat detector	-	-	X
-	LC	Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	Bat detector	X	X	X
-	LC	Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat	Bat detector	X	X	-

Status[1]		Family	Scientific name	Common name	Method of detection[2]	Fauna sites		
EPBC	NC					Site 5	Site 6	Site 7
-	LC	Vespertilionidae	*Chalinolobus nigrogriseus*	Hoary Wattled Bat	Bat detector	X*	X*	X*
-	LC	Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	Bat detector	X	X	X
REPTILES								
-	LC	Agamidae	*Pogona barbata*	Bearded Dragon	Camera trap	-	-	X
-	LC	Chelidae	*Chelodina expansa*	Broad-shelled River Turtle	Incidental	-	-	-
-	LC	Colubridae	*Tropidonophis mairii*	Keelback	Incidental	-	-	-
-	LC	Elapidae	*Cryptophis nigrescens*	Eastern Small-eyed Snake	Spotlighting/Incidental	-	-	-
-	LC	Elapidae	*Pseudonaja textilis*	Eastern Brown	Incidental	-	-	-
-	LC	Gekkonidae	*Gehyra dubia*	Dubious dtella	Spotlighting	-	-	-
-	LC	Gekkonidae	*Gehyra sp.*	Web-toed Geckos	Spotlighting	-	X	X
-	LC	Gekkonidae	*Heteronotia binoei*	Bynoes gecko	Funnel	-	X	-
-	LC	Scincidae	*Carlia munda*	Shaded Litter Rainbow Skink	Incidental	-	-	-
-	LC	Scincidae	*Carlia sp.*	Rainbow Skink	Incidental	-	-	-
-	LC	Scincidae	*Cryptoblepharus sp.*	Snake-eyed Skink	Incidental	-	-	-
-	LC	Scincidae	*Ctenotus robustus sensu lato*	Eastern Striped Skink	Incidental	-	-	-
-	LC	Scincidae	*Lygisaurus foliorum*	Tree-base Litter Skink	Incidental	-	-	-
-	LC	Scincidae	*Menetia greyii*	Common Dwarf Skink	Incidental	-	-	-
-	LC	Scincidae	*Morethia boulengeri*	South-eastern Morethia Skink	Incidental	-	-	-
-	LC	Scincidae	*Tiliqua rugosa*	Shingle-back	Elliot trap/Camera trap	-	-	X
-	LC	Scincidae	*Morethia sp.*	Firetail Skink	Funnel	X	-	-
-	LC	Typhlopidae	*Anilios proximus*	Blind Snake	Spotlighting	-	-	-
-	LC	Varanidae	*Varanas varius*	Lace Monitor	Camera trap	X	-	-
-	LC	Varanidae	*Varanus panoptes*	Yellow-Spotted Monitor	Incidental	-	-	-

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Special Least Concern (SLC), Migratory (M), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed. '*' indicates a non-native species.

[2] Method of detection: spotlighting, pitfall, Elliot, funnel, cage trap, incidental (includes active search and bird survey), camera trap, harp trap, bat detector.

Appendix D Ground-truthed Regional Ecosystems

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

D.1 Descriptions, floristic composition and structure of ground-truthed REs within the study area

RE description and status [1]	Field description	Ground-truthed floristic composition/structure [2]	Representative photographs
RE 11.3.2 **VM class**: Of concern **BD status**: Of concern **EPBC Act**: Endangered Structural code: Woodland **REDD description**: 11.3.2: *Eucalyptus populnea* woodland on alluvial plains.	**Vegetation community**: *Eucalyptus populnea* dominated grassy woodland on alluvial plans. Shrubs sparse and ground layer generally dominated by native species. **Crown cover**: Tree layer: sparse Shrub layer: very sparse Ground layer: sparse **Landform**: Occurs on alluvial floodplain deposits adjacent to the larger watercourses. **Soils**: Clays or hard pedal yellow duplex soils.	**Tree layer 1 (height 10–15m):** *Eucalyptus populnea* (D), *Eucalyptus melanophloia* (A) **Tree layer 2 (height 5–7m):** *Eucalyptus populnea* (D) **Shrub layer 1 (height 2–3.5m):** *Eremophila mitchelli* (D), *Geijera parviflora* (S), *Acacia salicina* (S) **Ground layer (0-0.75):** *Themeda triandra* (D), *Cenchrus ciliaris** (S), *Heteropogon contortus* (S), *Sida hackettiana* (S), *Abutilon* sp.(A), *Glycine* sp. (A), *Brunoniella australis* (A), *Boerhavia domini* (A), *Indigofera linifolia* (A), *Cymbopogon obtectus* (A)	
RE 11.3.25 **VM class**: Least concern **BD status**: Of concern **EPBC Act**: not listed Structural code: Woodland **REDD description**: 11.3.25: *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	**Vegetation community**: Riparian community dominated with *Eucalyptus tereticornis,* with *Casuarina cunninghamiana* and other Eucalypt spp. **Crown cover**: Tree layer: sparse Shrub layer: very sparse Ground layer: mid-dense **Landform**: Occurs on alluvial deposits on watercourses/drainage lines. **Soils**: Clay, sand, gravel and silt.	**Tree layer 1 (height 20–25m):** *Eucalyptus tereticornis* (D), *Casuarina cunninghamiana* (S), *Eucalyptus populnea* (S), *Eucalyptus melanophloia* (A), *Angophora floribunda* (A), *Casuarina cristata* (A) **Tree layer 2 (height 7.5–12m):** *Eremophila mitchelli* (D), *Acacia salicina* (S) **Shrub layer 1 (height 2–4m):** *Geijera parviflora* (D), *Psydrax odorata* (S) **Ground layer (0-1.5):** *Cenchrus ciliaris** (C), *Megathyrsus maximus** (C), *Cynodon dactylon** (S), *Xanthium occidentale** (S), *Sida hackettiana* (S), *Bidens bipinnata** (A), *Verbena bonariensis* (A).	
RE 11.9.2 **VM class**: Least concern **BD status**: No concern at present **EPBC Act**: not listed Structural code: Woodland **REDD description**: 11.9.2: *Eucalyptus melanophloia +/- E. orgadophila* woodland to open woodland on fine-	**Vegetation community**: *Eucalyptus melanophloia* or *Eucalyptus orgadophila* dominated woodland. Shrubs sparse and ground layer generally dominated by non-native species. **Crown cover**: Tree layer: very sparse/sparse Shrub layer: sparse Ground layer: mid-dense **Landform**: Undulating sedimentary plains. **Soils**: Soils are grey cracking clay soils.	**Tree layer 1 (height 12–17m):** *Eucalyptus melanophloia* (D), *Eucalyptus orgadophila* (D), *Eucalyptus populnea* (A) **Tree layer 2 (height 7–9m):** *Eucalyptus melanophloia* (D), *Callitris glaucophylla* (S), *Acacia excelsa* (S) **Shrub layer 1 (height 2–4m):** *Geijera parviflora* (D), *Psydrax odorata* (S), *Acacia excelsa* (S) **Ground layer (0-1):** *Megathyrsus maximus** (C), *Cenchrus ciliaris** (C), *Erigeron bonariensis** (S), *Evolvulus alsinoides* (A), *Boerhavia domini* (A), *Eragrostis leptostachya* (A).	

RE description and status [1]	Field description	Ground-truthed floristic composition/structure [2]	Representative photographs
grained sedimentary rocks.			
RE 11.9.5 **VM class**: Endangered **BD status**: Endangered **EPBC Act**: Endangered **Structural code**: Open forest **REDD description**: 11.9.5: *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks.	**Vegetation community**: *Acacia harpophylla* and/or *Casuarina cristata* dominated woodland. Shrubs sparse and ground layer generally dominated by non-native species. **Crown cover**: Tree layer: mid-dense Shrub layer: sparse Ground layer: mid-dense **Landform**: Undulating sedimentary plains. **Soils**: Soils are grey cracking clay soils.	**Tree layer 1 (height 10–13m):** *Acacia harpophylla* (C), *Casuarina cristata* (C), *Eucalyptus populnea* (A) **Tree layer 2 (height 5.5–7.5m):** *Acacia harpophylla* (C), *Casuarina cristata* (C), *Eremophila mitchelli* (S) **Shrub layer 1 (height 1–3m):** *Geijera parviflora* (D), *Acacia harpophylla* (S), *Casuarina cristata* (S), *Citrus glauca* (S), *Atalaya hemiglauca* (S), *Alectryon diversifolius* (A), *Santalum lanceolatum* (A), *Psydrax odorata* (A) **Ground layer (0-1):** *Cenchrus ciliaris** (D), *Sporobolus* sp. (S), *Paspalidium caespitosum* (S), *Atriplex leptocarpa* (A), *Enchylaena tomentosa* (A), *Einadia nutans* (A), *Bryophyllum delagoense** (A).	
RE 11.9.7 **VM class**: Of concern **BD status**: Of concern **EPBC Act**: not listed **Structural code**: Woodland **REDD description**: 11.9.7: *Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks.	**Vegetation community**: *Eucalyptus populnea* dominated woodland. Shrubs mid-dense and dominated with *Eremophila mitchelli* and ground layer generally dominated by non-native species. **Crown cover**: Tree layer: sparse Shrub layer: mid-dense Ground layer: sparse **Landform**: Undulating sedimentary plains. **Soils**: Soils are grey cracking clay soils.	**Tree layer 1 (height 12–16m):** *Eucalyptus populnea* (D), *Eucalyptus melanophloia* (S), *Callitris glaucophylla* (S) **Tree layer 2 (height 7–10m):** *Eucalyptus populnea* (D), *Callitris glaucophylla* (S), *Acacia harpophylla* (A) **Shrub layer 1 (height 1–4m):** *Eremophila mitchelli* (D), Alstonia constricta (S), *Geijera parviflora* (S), *Alectryon diversifolius* (A), *Eucalyptus populnea* (A) **Ground layer (0-0.75):** *Cenchrus ciliaris** (D), *Megathyrsus maximus** (S), *Erigeron bonariensis** (S).	
RE 11.9.10 **VM class**: Of concern **BD status**: Endangered **EPBC Act**: not listed **Structural code**: Open forest **REDD description**: 11.9.10: *Eucalyptus populnea* open forest with a secondary tree layer of *Acacia*	**Vegetation community**: *Eucalyptus populnea* dominated woodland with *Acacia harpophylla* and/or *Casuarina cristata*. Shrubs sparse and ground layer generally dominated by non-native species. **Crown cover**: Tree layer: mid-dense Shrub layer: sparse Ground layer: sparse **Landform**: Undulating sedimentary plains. **Soils**: Soils are grey cracking clay soils.	**Tree layer 1 (height 10–14m):** *Eucalyptus populnea* (D), *Acacia harpophylla* (S), *Casuarina cristata* (S) **Tree layer 1 (height 5–8m):** *Eucalyptus populnea* (C) *Casuarina cristata* (C), *Acacia salicina* (A) **Shrub layer 1 (height 1–2m):** Citrus glauca (D), *Vachellia farnesiana** (S), *Carissa ovata* (A), *Geijera parviflora* (A), *Eremophila mitchelli* (A) **Ground layer (0-0.5):** *Cynodon dactylon** (D), *Cenchrus ciliaris** (S), *Aristida sp* (S), *Xanthium occidentale** (S), *Leptochloa sp.* (A).	

RE description and status [1]	Field description	Ground-truthed floristic composition/structure [2]	Representative photographs
harpophylla and sometimes *Casuarina cristata* on fine-grained sedimentary rocks.			

[1] VM class = least concern (LC), of concern (OC) or endangered (E) under the Vegetation Management Act 1999.

BD status = no concern at present (NC), of concern (OC) or endangered (E) Biodiversity Status according to the Queensland Department of Environment and Science.

EPBC Act = Vulnerable, Endangered or Critically Endangered threatened ecological community (TEC) status under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

[2] Relative dominance of each species = dominant (D), co-dominant (C), sub-dominant (S) or associated (A). '*' indicates a non-native species.

Appendix E Flora Survey Trigger Map

Terrestrial Ecology Technical Report

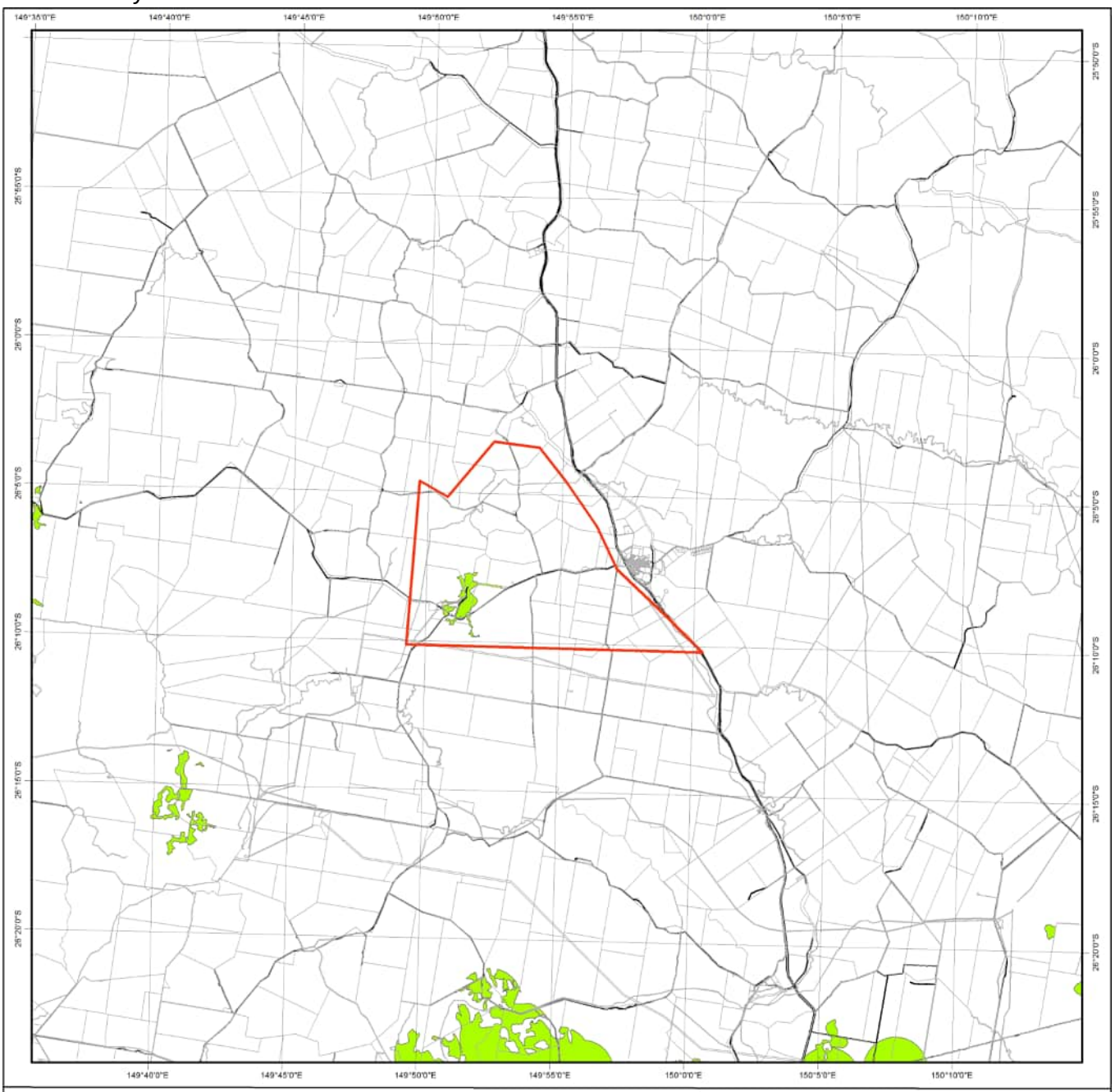
Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

12/12/2023 14:36:39
Custom Geometry



Protected Plants Flora Survey Trigger Map

Legend

- polygon
- High risk area
- Other land parcel boundaries
- Freeways / motorways / highways
- Secondary roads / streets

N

0 2,400 4,800 7,200 9,600 12,000 m

This product is projected into:
GDA 1994 Queensland Albers

This map shows areas where particular provisions of the Nature Conservation Act 1992 apply to the clearing of protected plants.

Land parcel boundaries are provided as locational aid only.

This map is produced at a scale relevant to the size of the area selected and should be printed as A4 size in portrait orientation.

For further information or assistance with interpretation of this product, please contact the Department of Environment and Science at palm@des.qld.gov.au

Disclaimer:
While every care is taken to ensure the accuracy of the data used to generate this product, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damages) and costs which might be incurred as a consequence of reliance on the data, or as a result of the data being inaccurate or incomplete in any way and for any reason.

© The State of Queensland (Department of Environment and Science), 2023

Protected plants flora survey trigger map

The protected plants flora survey trigger map identifies 'high risk areas' where threatened and near threatened plants are known to exist or are likely to exist. Under the *Nature Conservation Act 1992* (the Act) it is an offence to clear protected plants that are 'in the wild' unless you are authorised or the clearing is exempt, for more information see section 89 of the Act.

Please see the Department of Environment and Science webpage on the clearing of protected plants for information on what exemptions may apply in your circumstances, whether you may need to undertake a flora survey, and whether you may need a protected plants clearing permit.

Updates to the data informing the flora survey trigger map

The flora survey trigger map will be reviewed, and updated if necessary, at least every 12 months to ensure the map reflects the most up-to-date and accurate data available.

Species information

Please note that flora survey trigger maps do not identify species associated with 'high risk areas'. While some species information may be publicly available, for example via the Queensland Spatial Catalogue, the Department of Environment and Science does not provide species information on request. Regardless of whether species information is available for a particular high risk area, clearing plants in a high risk area may require a flora survey and/or clearing permit. Please see the Department of Environment and Science webpage on the clearing of protected plants for more information.

Appendix F Likelihood of Occurrence

Terrestrial Ecology Technical Report

Wandoan Coal Project

Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00200

12 June 2024

F.1 Likelihood of occurrence assessments for conservation significant flora species identified in database searches

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
E	E	Acanthaceae	*Xerothamnella herbacea*	-		x		0	This is a sparse, sprawling, perennial herb that grows to a height of 30 cm. This species is known from two sites northeast of Chinchilla, a single record from near Theodore and a record near Yelarbon east of Goondiwindi, Queensland. This species occurs in Brigalow dominated communities in shaded situations, often in leaf litter and is associated with gilgais. Soils are heavy, grey to dark brown clays. Three of the four known populations occur in cleared areas or non-remnant vegetation (DEWHA, 2008).	**Moderate** – No records occur within 30 km of the study area and the nearest known population is to the east of the Barakula State Forest (DCCEEW, 2023). The study area is within the modelled distribution of this species, and potentially suitable (but degraded habitat) is present.	DEWHA (2008). Approved Conservation Advice for *Xerothamnella herbacea*. Canberra: Department of the Environment, Water, Heritage and the Arts. DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
E	E	Apocynaceae	*Vincetoxicum forsteri* *(syn Tylophora linearis)*	-		x		0	This vine species has rarely been recorded (ALA, 2023), and occurs in dry scrub, open forests and woodlands associated with a range of canopy species, including *Melaleuca*, *Eucalyptus*, *Callitris*, and *Casuarina* spp. (DEWHA, 2008).	**Low** - Degraded but suitable habitat occurs in the study area for this species (e.g., woodlands with suitable canopy species), however, the study area is outside the species known or predicted range and there are no records within 30km.	ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/. DEWHA (2008). Approved Conservation Advice for *Tylophora linearis*. Canberra: Department of the Environment, Water, Heritage and the Arts.
E	LC	Brassicaceae	*Lepidium monoplocoides*	Winged Pepper-cress		x		0	This species primarily occurs in New South Wales and Victoria, with very few, scattered records in South Australia and Queensland (ALA, 2023). There are only two records of this species within Queensland, which occur within the vicinity of Yelarbon and are from 2005 and 2011 (ALA, 2023). This species is known to prefer mallee scrub in semi-arid areas. It occurs in seasonally moist to water-logged areas with heavy, fertile soils and a mean annual rainfall of around 300-500mm. The predominant vegetation is usually an open-woodland dominated by *Allocasuarina leuhmannii* and/or eucalypts, particularly *Eucalyptus largiflorens* or *Eucalyptus populnea*. The ground layer of the surrounding woodland is dominated by tussock grasses, but the seasonally waterlogged sites preferred by this species also support a variety of moisture dependent herbs. This species is also known from riparian woodland (DCCEEW, 2023; Mavromihalis, 2010).	**Low** – The nearest records of this species are ~270 km south of the study area. Due to an absence of local records the study area not occurring within an area known to contain a population of this species, and the degraded nature of habitats in the study area, this species is considered to have a low likelihood of occurring.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Mavromihalis, J. (2010). National Recovery Plan for the Winged Peppercress *Lepidium monoplocoides*. Department of Sustainability and Environment, Melbourne.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Leguminosae	*Acacia curranii*	Curly-bark Wattle		x	x	0	This species is known from three small populations, one of which occurs in Queensland near Wandoan (DCCEEW, 2023). This population is small and spread over a 20 km distance in Gurulmundi State Forest (ALA, 2023). Suitable habitat for the species includes rocky outcrops of isolated hills and ranges in diverse scrub (DCCEEW, 2023; DEWHA, 2008).	**Low** - The study area lacks suitable habitat (e.g., rocky outcrops in diverse scrub) and falls outside the species' mapped distribution. No records occur within 30 km of the study area.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/. DEWHA (2008). Approved Conservation Advice for *Acacia curranii* (Curly-bark Wattle). Canberra: Department of the Environment, Water, Heritage and the Arts.
V	V	Poaceae	*Arthraxon hispidus*	Hairy-joint Grass		x	x	0	This annual slender tufted creeping grass roots at the nodes, has erect to semi-erect stems and reddish to purplish leaves with long white hairs around the edge, broad at the base and tapering abruptly to a sharp point. This species has a wide distribution overseas from tropical Africa to Asia. Within Australia, this species has been recorded from scattered locations throughout Queensland and on the northern tablelands and north coast of New South Wales. Within Queensland, this species occurs north to Port Douglas and west to disjunct occurrences around mound springs in Carnarvon National Park, however most occurrences are from Noosa southwards. This species is found in or on the edges of rainforest, wet eucalypt forest, freshwater springs on coastal foreshores dunes, in shaded gullies, on creek banks and on sandy alluvium in creek beds in open forests (DCCEEW, 2023; DEWHA, 2008).	**Low** - No records occur within 30 km of the study area, and the study area occurs outside the species' modelled distribution. Although suitable habitat is present (i.e., creek banks in open forests), the ground layer is generally degraded by cattle grazing and weed species.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DEWHA (2008). Approved Conservation Advice for *Arthraxon hispidus* (Hairy-joint Grass). Canberra: Department of the Environment, Water, Heritage and the Arts.
V	LC	Poaceae	*Dichanthium setosum*	Bluegrass		x		0	This species is an upright perennial grass less than 1m tall, with densely clustered hairy flowers which appear along the stalk in a cylinder shape. Flowering for this species occurs during summer. In Queensland this species has been recorded from Leichardt, Morton, North Kennedy, and Port Curtis and is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil (DCCEEW, 2023). Queensland records of this species are sparse and scattered, with the highest density being recorded in the Springsure to Mount Moffatt area (ALA, 2023). The highest proportion of records of this species occur within New South Wales (ALA, 2023). This species is often found in moderately disturbed areas such as cleared woodland, grassy roadsides remnants and highly disturbed pastures (DCCEEW, 2023). Known threats to this species include heaving gazing by cattle, clearing of habitat for pasture improvement and cropping, and invasion by introduced grasses (DCCEEW, 2023, DEWHA, 2008).	**Low** – The nearest population of this species occurs ~200 km to the northwest of the study area in Carnarvon National Park (ALA, 2023); no records occur within 30 km of the study area. Additionally, habitat values for this species within the study area are likely to be degraded due to existing land uses.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/. DEWHA (2008). Approved Conservation Advice for *Dichanthium setosum*. Canberra: Department of the Environment, Water, Heritage and the Arts.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
-	NT	Poaceae	*Digitaria porrecta*	-	x		x	2	This species has a clustered distribution throughout the Brigalow Belt in QLD and NSW. In Queensland, there are isolated records in the Nebo district and near Rolleston, however most records are close to Toowoomba. It occurs in tussock grassland and open eucalypt woodland, associated with Eucalyptus populnea and *Eucalyptus tereticornis* on cracking clay soils (DES, 2023). This species occurs in grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying basaltic geology. It grows on dark and fine textured soils with some degree of seasonal cracking. It also persists in disturbed habitats, such as fallow paddocks, however its capability to maintain a viable population may be reduced as the clearing of grasslands for agriculture and trampling and grazing by livestock are known threats. Other known threats include habitat fragmentation, fire and physical disturbance by machinery and urban expansion. Potential threats include competition from introduced grasses (TSSC, 2013).	**Low** – The nearest population of this species occurs ~160 km to the southeast of the study area (ALA, 2023). Potentially suitable habitat for this species occurs within the study area, however it is likely to be degraded existing land uses and weed species.	DES (2023). Species Profile Database. Department of Environment and Science, Brisbane. TSSC (2013). Commonwealth Listing Advice on *Digitaria porrecta* (Finger Panic Grass). Threatened Species Scientific Committee. Canberra: Department of the Environment.
V	E	Poaceae	*Homopholis belsonii*	Belson's Panic	x	x	x	2	The distribution of this perennial grass species is throughout the southern Brigalow Belt, growing dry woodland on basaltic, poor-quality soils. Land clearing and pasture modification for agriculture currently pose a threat to the species (DEWHA, 2008b).	**Present** - This species is known to occur within the study area (ALA, 2023); two historical records occur within 30 km of the study area.	DEWHA (2008). Approved Conservation Advice for *Homopholis belsonii*. Canberra: Department of the Environment, Water, Heritage and the Arts. ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/.
V	V	Santalaceae	*Thesium australe*	Austral Toadflax		x		0	This species is a hairless, yellowish-green perennial herb with slender wiry stems up to 40 cm tall and tiny white flowers. This species occurs sporadically between the Bunya Mountains in south-east Queensland to north-east Victoria. This species is semi-parasitic species on the roots of a range of grass species, most notably on Kangaroo Grass (*Themeda triandra*). This species is known to occur in shrubland, grassland and woodland, often on damp sites (DCCEEW, 2023b). This species was considered extinct in Queensland prior to the mid-1980s. Collections since the 1990s have been made from Kumbia, Glen Rock Regional Park, Carnarvon National Park, Crows Nest, Clifton, Warwick, Greenmount, Cambooya, Dalby, The Bunya Mountains, Blackbutt and Imbil (ALA, 2023). Key threats to this species are: lack of fire/disturbance, existing and intensified grazing by livestock, native feral herbivores, residential, infrastructure and agricultural development, and weed invasion (DoE, 2013).	**Low** – The nearest contemporary (post 1980) record of this species occurs ~150 km to the southeast of the study area (ALA, 2023). Existing grazing within the study area is likely to degrade habitat quality for this species. Based on an absence of local records and impacted habitat values, this species is considered to have a low likelihood of occurring within the study area.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DoE (2013). Approved Conservation Advice for *Thesium australe* (Austral Toadflax). Canberra: Department of the Environment. ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/.
V	V	Surianaceae	*Cadellia pentastylis*	Ooline	x	x	x	6	This species has a scattered distribution on the western slopes of the Great Dividing Range, occurring in vine thickets and sclerophyll vegetation at altitudes greater than 300 m above sea level (asl) (DEWHA, 2008c). Land clearing and inappropriate fire regimes are among the current threats to this species (DEWHA, 2008c).	**Moderate** - Suitable habitat appears to be present (e.g., sclerophyll vegetation ~300m asl) and the study area is within the species' distribution. Further survey may be required.	DEWHA (2008). Approved Conservation Advice for *Cadellia pentastylis* (Ooline). Canberra: Department of the Environment, Water, Heritage and the Arts.

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed.

[2] 10km search radius for EPBC Act Protected Matters Report (PM) records; 30km search radius for WildNet database (WN) records. Review of additional Atlas of Living Australia records (ALA) in proximity to the study area. Species assessed during the PBA 2008 and 2009 EIS (PBA).

F.2 Likelihood of occurrence assessments for conservation significant fauna species identified in database searches

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
BIRDS											
V	V	Acanthizidae	*Aphelocephala leucopsis*	Southern Whiteface		x		0	This species occurs across most of mainland Australia south of the tropics, from the north-eastern edge of the Western Australian wheatbelt, east to the Great Dividing Range. In Queensland, the species is largely confined to the south-west of the Mitchell Grass Downs, the far southern Brigalow Belt, and along the southern border. This sedentary species occupies a wide range of eucalypt or *Acacia* spp. open woodlands and shrublands, typically with a shrubby understorey, on ranges, foothills, lowlands, and plains. Ideal habitat for the species is that which is relatively undisturbed, with a low tree density and high ground layer density for foraging (DCCEEW, 2023). This species may move into regions outside of their normal distribution during drought years in search of favourable conditions (DCCEEW, 2023).	**Low** - There is potentially suitable but degraded habitat in the study area; however, there are no records of this species within 30 km of the site. The study area is outside the core range of this species.	DCCEEW (2023). Conservation Advice for *Aphelocephala leucopsis* (Southern Whiteface). Canberra: Department of Climate Change, Energy, the Environment and Water.
E	E	Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk		x	x	0	This species prefers a mosaic of forests and woodland types, particularly near riverine systems and permanent water sources and high densities of prey species (DCCEEW, 2023). The home range in northern Australia has been reported up to 200 km^2, with indications it may be even larger (Aumann & Baker-Gabb, 1991).	**Low** - The study area contains mainly unsuitable habitat for this species largely due to the cleared landscape, i.e., the study area lacks a mosaic of forests and woodland types and permanent water sources. The study area falls outside the species' core range. There are no known records of this species within 30 km of the study area.	DCCEEW (2023). Conservation Advice for *Erythrotriorchis radiatus* (Red Goshawk). Canberra: Department of Climate Change, Energy, the Environment and Water. Aumann, T. & D. Baker-Gabb (1991). RAOU Report 75. A Management Plan for the Red Goshawk. RAOU. Royal Australasian Ornithologists Union, Melbourne.
M	SL	Apodidae	*Apus pacificus*	Fork-tailed Swift	x		x	4	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia. This species is known to utilise cliffs and beaches and to hunt above various habitat types including rainforest and open forests ahead of storm fronts (Higgins 1999). The species is an insectivorous, non-breeding visitor to Australia and forages aerially over effectively any landscape and habitat type in its known range (DoE, 2015).	**Present** - this species was recorded during the 2023 post-wet season survey. A flock of Fork-tailed Swifts were observed foraging in the air above Wolleebee Creek.	Higgins, PJ (Ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird. Oxford University Press, Melbourne. DoE (2015a). Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act. Canberra: Department of the Environment.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V, M	V	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	x	x	x	3	This species is widespread during the non-breeding season in eastern and south-eastern Australia. In Queensland it occurs in coastal regions, extending inland to the western slopes of the Great Dividing Range and occasionally onto the adjacent inland plains (DCCEEW, 2023; TSSC, 2019). This species is mostly aerial, occurring at heights of 1m to 1000m above ground (Coventry, 1989; Tarburton, 1993). They occur over most habitat types, being recorded most often above wooded areas such as open forests and rainforest (Higgins, 1999).	**Moderate** - This species has a moderate likelihood of occurring over the entire study area and using airspace as foraging habitat; however, vegetation is highly modified but there are no barriers to suitability. There are known records for this species within 30 km of the study area.	DCCEEW (2023). Species Profile and Threats Database. Department of Climate Change, Energy, the Environment and Water. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Coventry, P. (1989). Comments on airborne sightings of White-throated Needletails *Hirundapus caudacutus*. Australian Bird Watcher. 13:36-37. Tarburton, M. K. (1993). Radiotracking a White-throated Needletail to roost. Emu. 93:121--124. Higgins, P. J. (ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume Four - Parrots to Dollarbird. Melbourne: Oxford University Press. TSSC (2019). Conservation Advice *Hirundapus caudacutus* White-throated Needletail. Threatened Species Scientific Committee Canberra: Department of the Environment and Energy.
V	V	Cacatuidae	*Calyptorhynchus lathami lathami*	Glossy Black-cockatoo (eastern)	x	x	x	1	This subspecies is uncommon across a broad distribution in south-eastern Australia, occurring from Mitchell in central southern Queensland to East Gippsland, Victoria. The species feeds almost exclusively on the seeds of Casuarina and Allocasuarina spp. (she-oaks), with nine known food tree species in these genera. Glossy Black-cockatoos have strong preferences for individual trees, apparently based on size, weight and nutritional content of seeds (DCCEEW, 2022). In lowland SEQ the species appears to prefer Black She-oak (DCCEEW, 2022). Breeding habitat consists of large eucalypt trees with hollows that are importantly: >8 m above ground, in branches of >30 cm diameter and vertical to 45°, and with a minimum entrance diameter of >15 cm (DCCEEW, 2022).	**Present** - the species is known to occur in the study area and suitable habitat is present on site, i.e., habitat which includes food trees (*Allocasuarina* spp. and *Casuarina* spp.) as well as trees with hollows for nesting (particularly *Eucalyptus tereticornis*).	DCCEEW. (2022). Conservation Advice for *Calyptorhynchus lathami lathami* (South-eastern Glossy Black-cockatoo). Canberra: Department of Climate Change, Energy, the Environment and Water.
E	V	Cacatuidae	*Lophochroa leadbeateri*	Major Mitchell's Cockatoo			x	0	This species typically inhabits arid to semi-arid woodlands with *Acacia aneura*, *Callitris gracili*s, *Casuarina cristata*, mallee and box eucalypts (DCCEEW, 2023). The species makes use of suitably-sized hollows in mature, tall trees relative to the surrounding woodland for nesting and requires closely situated fresh water (DCCEEW, 2023).	**Low** - although suitable foraging habitat occurs in the study area (containing *Callitris* sp. and *Casuarina cristata*), the study area occurs well outside the mapped distribution for the species and there are no records of the species within 30 km of the study area.	DCCEEW. (2023). Conservation Advice for *Lophochroa leadbeateri leadbeateri* (eastern Major Mitchell's cockatoo). Canberra: Department of Climate Change, Energy, the Environment and Water.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (south-eastern)		x	x	0	The Brown Treecreeper is distributed in south-east Australia; in Queensland, the species distribution extends from the NSW border north to Mundubbera and inland as far west as St George (DCCEEW, 2023). The species typically occurs in undisturbed open eucalypt forests and woodlands with sparse shrub and ground layers, spending a large proportion of time foraging on the ground (DCCEEW, 2023).	**Low** - study area occurs outside the species' core range and there are no records of the species within 30 km of the study area. The study area is moderately to highly degraded and most woodlands contain shrub/ground layers which are densely vegetated by introduced pasture grasses, and therefore not preferred by the species.	DCCEEW. (2023). Conservation Advice for *Climacteris picumnus* victoriae (brown treecreeper (south-eastern)). Canberra: Department of Climate Change, Energy, the Environment and Water.
V	V	Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (southern subspecies)	x	x	x	1	The Squatter Pigeon (southern) is widely distributed throughout Queensland, with possible habitat occurring coastally from the NSW border north to Townsville, and extending inland as far as Charleville and Hughenden (TSSC, 2015). The species occupies woodlands and grasslands with sparse, patchy groundcover that facilitates movement and foraging for the mainly ground-dwelling species. Agricultural habitat modification, including associated water storage for cattle, incidentally provides the species with suitable habitat (TSSC, 2015); however, land clearing and introduction of pasture grasses has resulted in severe population decline in the south of its range.	**Moderate** - the species is known to occur in the study area and suitable habitat is present on site, i.e., modified due to cattle grazing with a number of dams and cattle troughs throughout the study area.	TSSC (2015). Conservation Advice *Geophaps scripta scripta* (squatter pigeon (southern)). Threatened Species Scientific Committee. Canberra: Department of the Environment, Water, Heritage, and the Arts.
M	SL	Cuculidae	*Cuculus optatus*	Oriental Cuckoo		x		0	The Oriental Cuckoo is a spring/summer, non-breeding migrant to Australia. It occurs primarily in coastal habitats with a preference for the edges of rainforests or ecotones between forest types, where it gleans invertebrates from loose-barked trees such as Melaleucas (DoE, 2015).	**Low** - Potentially suitable habitat occurs in the study area, but the species is rarely recorded in dry environs and habitats in the study area are largely very degraded. No records occur within 30 km of the study area.	DoE (2015). Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act. Canberra: Department of the Environment.
E	E	Estrildidae	*Neochmia ruficauda ruficauda*	Star Finch		x	x	0	The southern Star Finch is generally considered extinct, having undergone a severe contraction in range as a result of habitat alteration and loss due to agriculture (DCCEEW, 2023). This subspecies is believed to have occurred from Bowen QLD west to beyond Winton and south to near Wowan (DCCEEW, 2023). This species occurred mainly in grasslands and grassy woodlands and relied on regular access to fresh water. It also occurs in cleared or suburban areas such as along roadsides and in towns (DCCEEW, 2023).	**Low** - study area occurs outside the species' distribution and there are no records of the species within 30km of the study area. Habitat in the study area is sub-optimal (i.e., disturbed woodlands and no grasslands) and natural water sources are ephemeral.	DCCEEW (2023). Species Profile and Threats Database. Department of Climate Change, Energy, the Environment and Water. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DEWHA (2008). Approved Conservation Advice for *Neochmia ruficauda ruficauda* (Star Finch (eastern)). Department of the Environment, Water, Heritage and the Arts. Canberra: Department of the Environment, Water, Heritage and the Arts.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Estrildidae	*Stagonopleura guttata*	Diamond Firetail		x	x	0	This species occurs on the south-east mainland of Australia from South-east Queensland to the Eyre Peninsula in South Australia to ~300km inland from the sea. Historically, the distribution of this species extended to north Queensland to inland of Cardwell and this species has disappeared from many of the more settled parts of New South Wales, the Australian Capital Territory and Victoria. Preferred habitat for this species is eucalypt, Acacia or Casuarina woodlands, open forests and other lightly timbered habitats, including farmland and grassland with scattered trees. They prefer areas with relatively low tree density, few large logs, and little litter cover but high grass cover (DCCEEW, 2023).	**Low** - The study area is outside of the core-range of this species and there are no records occur within 30kms. Habitats within the study area are degraded, and there is a lack of native ground cover species for foraging.	DCCEEW (2023). Conservation Advice for *Stagonopleura guttata* (diamond firetail). Canberra: Department of Climate Change, Energy, the Environment and Water.
V	V	Falconidae	*Falco hypoleucos*	Grey Falcon		x	x	0	This species is sparsely distributed across a large area of Australia, however, is considered rare or nomadic across much of its range. Throughout its distribution, this species has been recorded to prefer lightly timbered country, especially stony plains and lightly timbered Acacia scrublands (Morcombe, 2003). However, it has also been recorded to occur around inland wooded watercourses (Garnett *et al.*, 2011). The presence of this species in an area and modelled habitat suitability are both highly variable between seasons and years (Garnett & Baker, 2021; TSSC, 2020).	**Low** - no records occur within 30 km of the study area, This species is highly mobile. No resources or habitats of importance for this species occur in the study area.	Morcombe, M. (2003). Field guide to Australian birds. Steve Parish Publishing Pty Ltd. Garnett, S. T., Szabo, J. & Dutson, G. (2011). The Action Plan for Australian Birds 2010. CSIRO Publishing. Garnet, S. T. & Baker, G. B. (2021). The Action Plan for Australian Birds 2020. CSIRO Publishing. TSSC (2020). Conservation Advice *Falco hypoleucos* Grey Falcon. Threatened Species Scientific Committee Canberra: Department of Agriculture, Water and the Environment.
V	V	Meliphagidae	*Grantiella picta*	Painted Honeyeater		x	x	0	This species is highly nomadic and occurs predominantly west of the Great Dividing Range (Rowland, 2012). The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe, with which its breeding season is closely matched (Rowland, 2012). The Painted Honeyeater mostly occurs in woodland habitats that have an abundance of mistletoe. These woodlands are usually dominated by Acacia spp. (e.g., *Acacia harpophylla*, *Acacia pendula* and *Acacia aneura*), Belah (*Casuarina cristata*) and Bull-oak (*Allocasuarina luehmannii*). Riparian eucalypt woodlands (e.g., River Red Gum) are also utilised, particularly those affiliated with acacia shrubs (Rowland, 2012; DoE, 2015).	**Moderate** - no records occur within 30 km of the study area, however it is within the species' core range and suitable foraging habitat is present (a range of woodland habitats) and includes a moderate abundance of mistletoe for feeding.	DoE (2015). Conservation Advice *Grantiella picta* painted honeyeater. Canberra: Department of the Environment. Rowland, J. (2012). Painted honeyeater, *Grantiella picta*. Targeted species survey guidelines. Brisbane: Queensland Herbarium, Department of Science, Information Technology and Innovation.
M	SL	Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher			x	0	In Queensland this species is widespread in the southeast and a regular visitor further north (DoE, 2015). The main habitat for this species includes dense eucalypt forests near wetlands or watercourses, while wintering birds in Queensland will use rainforest, mangroves and Melaleuca swamps (DoE, 2015).	**Moderate** - the study area occurs outside the species' core range but patches of modelled core range are near the site, and there are nearby records. Habitat is sub-optimal due to clearing for agriculture and does not include densely-vegetated eucalypt forests.	DoE (2015). Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act. Canberra: Department of the Environment.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
M	SL	Motacillidae	*Motacilla flava*	Yellow Wagtail		x		0	This species is a rare but regular migrant to coastal areas in Australia (Morcombe, 2003). It typically inhabits open habitats, often near water and occasionally on drier inland plains and edges of mangroves (Morcombe, 2003).	**Low** - the study area occurs outside the species' core range but within its non-core range. The species is not commonly observed inland and no records occur within 30kms of the study area. Habitat is present but sub-optimal.	Morcombe, M. (2003). Field guide to Australian birds. Steve Parish Publishing Pty Ltd.
M	SL	Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail		x		0	This species occurs in coastal and near coastal districts of northern and eastern Australia. In Queensland there are breeding populations from the New South Wales border north to the Cairns-Atherton region, and they overwinter farther north in Cape York Peninsula and Papua New Guinea. The species inhabits wet sclerophyll, subtropical and temperate rainforests. Occasionally the species is seen in secondary regrowth following disturbance in forests (DCCEEW, 2023).	**Low** - no records occur within 30kms of the study area, however the study area falls within the species non-core range. Suitable habitat (wet sclerophyll forest and rainforest) is absent from the study area.	DCCEEW (2023). Species Profile and Threats Database. Department of Climate Change, Energy, the Environment and Water. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
E	E	Rostratulidae	*Rostratula australis*	Australian Painted Snipe		x	x	0	This species has been recorded at wetland sites throughout much of Australia but is most common in the eastern states. The Australian Painted Snipe is a distinct species but can be hard to detect due to its cryptic and crepuscular behaviour. This species typically occurs in shallow freshwater wetlands and other permanently or temporarily inundated areas, particularly where rank tussocks of grasses, sedges, rushes or reeds are present (DCCEEW, 2023; DSEWPC, 2013; Morcombe, 2003).	**Moderate** - no records occur within 30 km of the study area, however sub-optimal habitat is present for this elusive species (i.e., wetlands with densely-vegetated edges) and the study area is within the species' core range.	DCCEEW (2023). Species Profile and Threats Database. Department of Climate Change, Energy, the Environment and Water. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DSEWPC (2013). Approved Conservation Advice for *Rostratula australis* (Australian painted snipe). Canberra: Department of Sustainability, Environment, Water, Population and Communities Morcombe, M. (2003). Field guide to Australian birds. Steve Parish Publishing Pty Ltd.
M	SL	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper		x		0	This species has a widespread but patchy distribution along all coastlines and in inland parts of Australia. Within this broad distribution this species can be found in coastal and inland wetlands with varying levels of salinity (DCCEEW, 2023). However, this species is most commonly found in muddy or rocky shores of estuaries, deltas of streams, banks upstream, lakes, pools, billabongs, reservoirs, and dams (DCCEEW, 2023).	**Low** - the study area occurs outside the species' core range but within its non-core range. The species is not commonly observed inland and no records occur within 30 kms of the study area. Habitat is present but sub-optimal.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
M	SL	Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper		x		0	This species occurs around the entire coast of Australia outside its breeding season, where it is found in a broad range of permanent or ephemeral water bodies, primarily brackish (DCCEEW, 2023). It prefers muddy edges of shallow fresh or brackish wetlands, and use flooded paddocks, sedge lands and other ephemeral wetlands.	**Low** - the study area occurs outside the species' core range but within its non-core range. The species is not commonly observed inland and no records occur within 30 kms of the study area. Habitat is present but sub-optimal.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
CE, M	CE	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper		x		0	This species occurs along the coasts of Australia and is quite widespread inland, with scattered records occurring in the Gulf of Carpentaria, with wide spread records along the coast south of Cairns (DoE, 2015). This species mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets, lagoons and also around non-tidal swamps, lakes, and lagoons near the coast, foraging on mudflats and nearby shallow water (DoE, 2015). This species typically inhabits intertidal mudflats in sheltered coastal areas, however have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains as well as around floodplains (Higgins & Davies, 1996).	**Low** - the study area occurs outside the species' core range but within its non-core range. The species is not commonly observed inland and no records occur within 30 kms of the study area. Habitat is present but sub-optimal.	DoE (2015). Conservation Advice *Calidris ferruginea* curlew sandpiper. Canberra: Department of the Environment. Higgins, P.J. & Davies, S.J.J.F., (eds) (1996). Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press.
M	SL	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper		x		0	Most records of this species are around the coasts of Australia or within south-eastern Australia (ALA, 2023). This species prefers shallow wetlands (fresh and marine) and tends not to utilise small or ephemeral water bodies (Menkhorst *et al.*, 2017; DCCEEW, 2023).	**Low** - the study area occurs outside the species' core range but within its non-core range. The species is not commonly observed inland and no records occur within 30 kms of the study area. Habitat is present but sub-optimal.	ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/.
M	SL	Scolopacidae	*Gallinago hardwickii*	Latham's snipe			x	0	This species is distributed along the east coast of Australia from Cape York Peninsula south to south-eastern Australia. It occurs in permanent and ephemeral wetlands with low to dense vegetation up to 2000 m above sea level (DCCEEW, 2023). This species is known to occur close to humans and human activity (i.e., near roads, railways, airfields, commercial or industrial complexes) (DCCEEW, 2023). Though it is described as utilising areas of permanent or temporary inundation, including streams in a wide range of habitat types, literature and records indicate that it does not occur in dense, closed-canopy rainforest and vine forest (DCCEEW, 2023).	**Moderate** - the study area occurs outside the species' core range but within its non-core range. No records of this elusive species occur within 30kms of the study area, but due to its elusive behaviour and presence of several large livestock dams and wetlands the species may occur on site and go undetected. Habitat is present but sub-optimal.	DCCEEW (2023). Species Profile and Threats Database. Department of Climate Change, Energy, the Environment and Water. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
V	V	Turnicidae	*Turnix melanogaster*	Black-breasted Button-quail		x	x	0	This species is generally associated with south-east Queensland vine thickets with closed canopies and deep leaf litter for foraging and nesting (TSSC, 2015). In the Brigalow Belt, the species prefers habitats with thick scrub provided by the introduced weed Lantana camara (TSSC, 2015). Habitat loss and habitat degradation from livestock as well as predation by introduced species are among the main threats to this species (TSSC, 2015).	**Low** - no species records occur within 30km of the study area and no suitable habitat occurs on site (i.e., dense vine thickets with deep leaf litter).	Threatened Species Scientific Committee (2015). Conservation Advice *Turnix melanogaster* black-breasted button-quail. Canberra: Department of the Environment.
INVERTEBRATES											
E	V	Camaenidae	*Adclarkia cameroni*	Brigalow Woodland Snail		x		0	This woodland snail species has a relatively small extent of occurrence (approximately 28,000km2) and a highly fragmented distribution (TSSC, 2016). The species occurs in Brigalow or Coolabah - black box woodland under logs and leaf litter (TSSC, 2016a). Therefore land clearing and habitat disturbance are among the largest threats to the species (TSSC, 2016).	**Moderate** - the study area occurs outside the species' core range but within its non-core range. No records of this species occur within 30 kms of the study area. Habitat is present but sub-optimal.	TSSC (2016). Conservation Advice *Adclarkia cameroni* brigalow woodland snail. Threatened Species Scientific Committee. Canberra: Department of the Environment and Energy.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
E	E	Camaenidae	*Adclarkia dulacca*	Dulacca Woodland Snail		x		0	This woodland snail species has a small extent of occurrence (approximately 8,000 km^2) and a severely fragmented distribution (TSSC, 2016). The species occurs in brigalow woodland on clay/loam soil, lancewood woodlands on ridges, and gum-topped eucalypt woodland (TSSC, 2016). Microhabitat requirements include coarse woody debris, logs, and loose bark at the base of trees. Therefore land clearing and habitat disturbance are among the largest threats to the species (TSSC, 2016).	**Moderate** - the study area occurs outside the species' core range but within its non-core range. No records of this species occur within 30 kms of the study area. Habitat is present but sub-optimal.	TSSC (2016). Conservation Advice *Adclarkia dulacca* Dulacca woodland snail. Threatened Species Scientific Committee. Canberra: Department of the Environment and Energy.
MAMMALS											
E	LC	Dasyuridae	*Dasyurus hallucatus*	Northern Quoll		x	x	0	Across its range the Northern Quoll utilises a wide variety of habitats; in Queensland it occupies a diversity of habitats including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. However, habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes, and are close to water (DCCEEW, 2023; TSSC, 2005).	**Low** - the study area occurs outside the species' core range but within its non-core range. No records of this species occur within 30 kms of the study area. Suitable denning habitat is absent from the study area.	Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). Species Profile and Threats Database. Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. TSSC (2005). Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*). Threatened Species Scientific Committee, Canberra.
V	E	Megadermatidae	*Macroderma gigas*	Ghost Bat		x		0	The distribution of this species is discontinuous across Australia with two ranges in Queensland: coastal and near-coastal eastern Queensland, from Cape York to near Rockhampton, and western Queensland (TSSC, 2016; Hourigan, 2011). It has been recorded hunting in rainforest, deciduous vine thicket, open woodland, spinifex, black soil and grassland habitats. Ghost Bats roost in caves, boulder piles, shallow escarpments and mines, and have very specific roosting requirements with respect to temperature and humidity (Van Dyck *et al.*, 2013). Contemporary genetic studies show that the entire species is dependent upon relatively few regional breeding sites. Although this species may disperse widely, females rarely move from their natal roost and individuals have been recorded travelling 12km from a daytime roost to forage (Baker & Gynther, 2023).	**Low** - the study area occurs outside the species' distribution and there are no records within 30 kms of the study area. Roosting habitat (e.g., caves, boulder piles, or mine shafts) are not known to occur in the study area.	TSSC. (2016). Conservation Advice *Macroderma gigas* ghost bat. Canberra: Department of the Environment. Hourigan, C. (2011). Ghost bat, *Macroderma gigas*. Targeted species survey guidelines. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane. Van Dyck, S., Gynther, I., & Baker, A. (2013). Field companion to the mammals of Australia. Sydney, Australia: New Holland Publishers. Baker, A. M. & Gynther, I. C. (2023). Strahan's Mammals of Australia. Fourth Edition. Sydney, Australia: New Holland Publishers.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Petauridae	*Petaurus australis australis*	Yellow-bellied Glider (southern subspecies)	x	x	x	9	This sub-species is found at altitudes ranging from sea level to 1400 m above sea level and has a widespread but patchy distribution from eastern Queensland to far south-eastern South Australia (DAWE, 2022). Isolated sub-populations occur both coastally and inland in the Blackdown and Canarvon Ranges of central Queensland. Eucalypt woodlands and forests, including both wet and dry sclerophyll forests, are preferred by the sub-species (DAWE, 2022). Population presence and density is determined by important features such as old-growth forest with hollow-bearing trees (DAWE, 2022) and winter-flowering and smooth-barked eucalypts (Woinarski *et al.*, 2014). Individuals have a low dispersal capacity over spaces larger than their gliding distance. The maximum gliding distance may be up to 120-140 m (DAWE, 2022).	**Moderate** - records of this species are mostly restricted to large patches of remnant vegetation and ranges, or along large watercourses. Nine records occur within 30 km of the study area, and suitable habitat (i.e., riparian woodlands with hollow-bearing species such as *E. tereticornis*) is present, although degraded.	DAWE (2022). Conservation Advice for *Petaurus australis australis* (yellow-bellied glider (south-eastern)). Canberra: Department of Agriculture, Water and the Environment. Woinarski JCZ, Burbidge AA & Harrison PL. (2014) The Action Plan for Australian Mammals 2012. CSIRO publishing, Collingwood.
E	E	Phascolarctidae	*Phascolarctos cinereus*	Koala	x	x	x	7	This species range includes the eastern half of Queensland in sclerophyll forest and woodland (Menkhorst & Knight, 2011). Although widespread, suitable feed species and leaf moisture are the primary determinants of habitat suitability and populations are in decline due to a wide range of threats (DAWE, 2022).	**Present** - this species, including evidence such as scratches, was recorded during the 2023 pre-wet season survey (DPM Envirosciences, pers.comm.) and observed during the 2024 post-wet season survey. Suitable habitat occurs in the study area along watercourses.	Menkhorst, P.& Knight, F. (2011). A Field Guide to the Mammals of Australia—Third Edition. Oxford University Press. Department of Agriculture, Water and the Environment. (2022). Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory.
E	E	Pseudocheiridae	*Petauroides armillatus (syn Petauroides volans)*	Central Greater Glider	x	x	x	1	This nocturnal, solitary species occurs along the east coast of Australia from Proserpine, Queensland and south to central Victoria at a range of elevations (DCCEEW, 2022). In Queensland, its distribution extends west of the Great Dividing Range and is strongly associated with tall eucalypt forests and woodlands with an abundance of den trees with suitably sized hollows (DCCEEW, 2022).	**Present** - this species was recorded during the 2023 pre-wet season survey and 2024 post-wet season survey. Suitable habitat occurs in the study area along watercourses.	DCCEEW. (2022). Conservation Advice for *Petauroides volans* (greater glider (southern and central)). Canberra: Department of Climate Change, Energy, the Environment and Water.
-	SL	Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	x		x	15	This solitary species is widely distributed across Australia, and individuals have large home ranges which are often shared with other individuals (ALA, 2023). They are commonly observed in woodlands or forests with a high abundance of fallen logs, and are a keystone species due to their role in the ecosystem of reworking soil through their digging activity (ALA, 2023).	**Present** - This species has previously been recorded in the study area. Suitable habitat occurs throughout the study area, including non-remnant areas with adequate ground cover/habitat features (e.g., fallen logs), and 15 records occur within 30 km of the study area.	ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/. DES (2023). Species Profile Database. Department of Environment and Science, Brisbane.
E	V	Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat		x	x	0	The distribution of this species is not well known and mainly occurs in NSW (DCCEEW, 2023). Suitable habitat consists of heavily canopied forest in close proximity to landscape features such as sandstone, rhyolite, trachyte and basalt outcrops for roosting (DCCEEW, 2023).	**Low** - no suitable habitat occurs in the study area (e.g., heavily canopied forest in close proximity to outcrops) and there are no records within 30 km of the study area.	DCCEEW (2023). Conservation Advice for *Chalinolobus dwyeri* (large-eared pied bat). Canberra: Department of Climate Change, Energy, the Environment and Water.

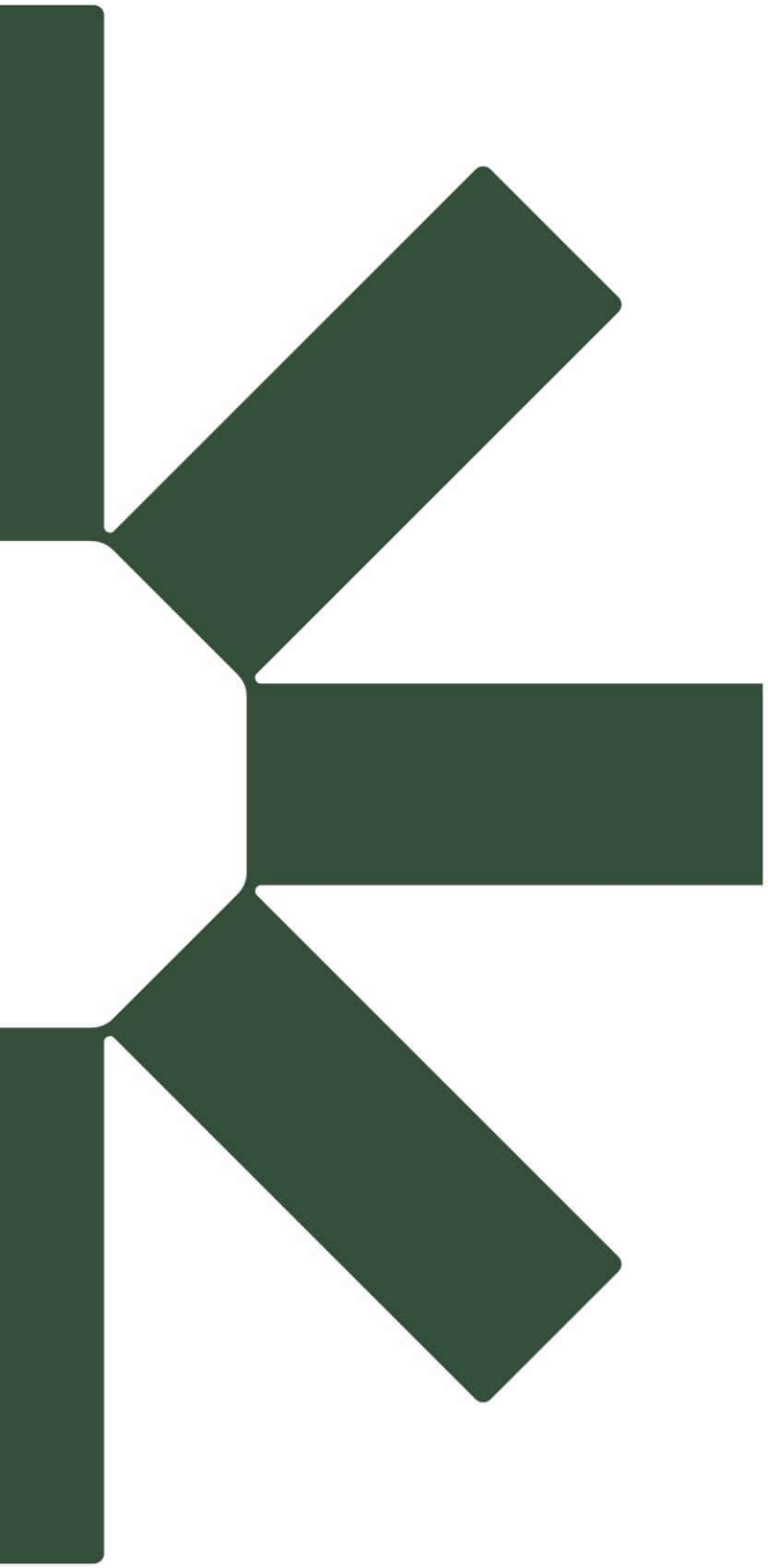
Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Vespertilionidae	*Nyctophilus corbeni (syn Nyctophilus timoriensis)*	Corben's Long-eared Bat		x	x	0	This species most commonly occurs within the Murray-Darling Basin, occurring in woodland on slopes and plains dominated by box, ironbark, and cypress pine (TSSC, 2015). The species roosts in tree hollows, under bark, and in tree crevices (TSSC, 2015).	**Moderate** - suitable but degraded habitat is present in the study area (i.e., box, ironbark, and cypress pine woodlands on plains with some decorticating bark and hollows for roosting), and the study area is within mapped distribution of the species.	TSSC (2015). Conservation Advice *Nyctophilus corbeni* south-eastern long-eared bat. Threatened Species Scientific Committee. Canberra: Department of the Environment.
REPTILES											
-	NT	Diplodactylidae	*Strophurus taenicauda*	Golden-tailed Gecko	x		x	12	This species is a nocturnal, arboreal gecko which occurs only in the Brigalow Belt Bioregion (Pavey, Vanderduys, and Raghu, 2021). It prefers woodland or forest which is dominated by *Acacia harpophylla*, *Casuarina cristata*, and/or *Callitris glaucophylla* (Pavey, Vanderduys, and Raghu, 2021). *Strophurus taenicauda* presence and abundance is dependent upon on the density of trees in the habitat, particularly of these tree species (Pavey, Vanderduys, and Raghu, 2021). Leaf litter, and presence of dead trees and small live trees are also important habitat features for this species (Pavey, Vanderduys, and Raghu, 2021).	**Present** - this species was recorded during field surveys in 2008. Suitable habitat is present in the study area, including non-remnant areas with adequate ground cover/habitat features (e.g., fallen logs), and 12 records exist within 30 km of the study area.	Pavey, C.R., Vanderduys, E., and Raghu, S. (2021). The golden-tailed gecko: a disturbance-tolerant species in a fragmenting environment. Wildlife Research 48: pp. 643-653. doi: 10.1071/WR20115.
-	V	Elapidae	*Acanthophis antarcticus*	Common Death Adder			x	0	This venomous species is an sedentary, terrestrial ambush hunter which relies on dense leaf litter, low foliage or loose sand for concealment/camouflage (DES, 2023). The species occurs in well-drained woodlands, shrublands, grasslands, and heathlands which possess these habitat features (DES, 2023). Its diet varies during its lifecycle and includes frogs, reptiles, mammals and birds. The main threats to the species are its attempted predation on Cane Toads (*Rhinella marina*), road kills, and habitat loss by land clearing and agricultural practices (DES, 2023).	**Moderate** - suitable but degraded habitat is present in the study area (e.g., with low foliage and loose sand), and the study area is within mapped distribution of the species. No records occur within 30 km of the study area.	DES (2023). Species Profile Database. Department of Environment and Science, Brisbane.
V	V	Elapidae	*Furina dunmalli*	Dunmall's Snake		x	x	0	In Queensland, this species is distributed throughout the Brigalow Belt, on black, cracking alluvial clay and clay loam 200-500 m above sea level. It occupies various eucalypt or Acacia woodlands, generally dominated by *A. harpophylla* and other *Acacia spp*., *Callitris sp*., *Allocasuarina luehmannii*, *C. citriodora*, *E. crebra*, and *E. melanophloia*. It feeds on small skins and geckos (DCCEEW, 2023). Given the cryptic nature and detection difficulty of the species, important habitat for the species is considered to be a surrogate for "important population" (DCCEEW, 2023), and this includes forests or woodlands within the Known/Likely-to-occur distribution (DSEWPC, 2011; DoE, 2014).	**Moderate** - suitable but degraded habitat present in the study area (e.g., *A. harpophylla* and *Callitris* sp. woodlands), and study area is within mapped distribution of the species. No records occur within 30 km of the study area, however this species is cryptic. The study area occurs outside, but within 40 km of its "Likely-to-occur" distribution.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DoE (2014). Approved Conservation Advice for *Furina dunmallii* (Dunmall's Snake). Canberra: Department of the Environment. DSEWPC (2011). Survey guidelines for Australia's threatened reptiles. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
E	E	Elapidae	*Hemiaspis damelii*	Grey Snake		x	x	0	Within Queensland, most records of this species occur along the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt from Goondiwini and Dalby west to Glenmorgan, on the Darling Downs and western Lockyer Valley, near Rockhampton on the central Queensland coast, and on the Darling Riverine Plains near Currawinga in south-western Queensland (DCCEEW, 2022). This species prefers habitats associated with brigalow and Belah woodlands on heavy, dark brown to black cracking clay soils, particularly in association with water bodies, areas with small gullies and ditches, and floodplain environments where the species shelters beneath logs, rocks and soil cracks. Key habitat attributes for this species are the floodplains and ephemeral wetlands that provide breeding habitat for the amphibian species that are its main prey, the presence of the amphibians themselves, and the heavy clay soils that provide cracks and crevices that the species usus in its hunting strategy and for shelter. (DCCEEW, 2022).	**Moderate** - suitable habitat occurs in the study area (*A. harpophylla* or *C. cristata* on heavy, cracking soils, with suitable habitat features, e.g., fallen logs) and the study area occurs within the core range of the species, but there are no records within 30 km.	DCCEEW (2022). Conservation Advice for *Hemiaspis damelii* (grey snake). Canberra: Department of Climate Change, Energy, the Environment and Water.
V	V	Pygopodidae	*Delma torquata*	Adorned Delma		x	x	0	This species has a coastal central to south-east Queensland distribution which extends west to Charleville (DCCEEW, 2023), occurring in eucalypt-dominated woodlands and open forests on Land Zones 3, 9, and 10 with suitable micro-habitats (exposed rocky outcrops) (DCCEEW, 2023). The ground cover is predominantly native grasses. Agricultural land clearing and habitat degradation by the removal of microhabitat features are among the greatest threats to this species (DCCEEW, 2023; DEWHA, 2008).	**Low** - No records occur within 30 km of the study area. The study area is within the known range of the species and Habitat within the study area is degraded and microhabitat features are absent.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DEWHA (2008). Approved Conservation Advice for *Delma torquata* (Collared Delma). Canberra: Department of the Environment, Water, Heritage and the Arts. ALA (2023). Atlas of Living Australia. Available from: https://www.ala.org.au/.
V	E	Scincidae	*Anomalopus mackayi*	Five-clawed Worm-skink		x	x	0	This species is known from a small area abutting the western edge of the Great Dividing Range, in north-eastern New South Wales and south-eastern Queensland. Within Queensland, records of this species are localised around the Dalby to Warwick area. This species prefers lower slopes of slight rises in grassy White Box woodland, open woodland and River Red Gum-Coolibah-Bimble Box woodland. Preferred woodland generally occurs on red-black to black clay-loam soils where this species lives in permanent deep tunnel-like burrows and deep soil cracks, uses fallen logs and timber as sheltering sites on the surface (DAWE, 2008). Given the cryptic nature and detection difficulty of the species, important habitat for the species is considered to be a surrogate for "important population" (DCCEEW, 2023), and this includes woodlands on alluvial, cracking clay soil in riparian zones and floodplains within its Known/Likely-to-occur distribution (DSEWPC, 2011).	**Low** - No records occur within 160 km of the study area. The study area is outside of this species' known distribution. Suitable habitat for this species is not present.	DAWE. (2008). Approved Conservation Advice for *Anomalopus mackayi* (Five-clawed Worm-skink). Canberra: Department of Agriculture, Water and the Environment. DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DSEWPC (2011). Survey guidelines for Australia's threatened reptiles. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Status[1]		Family	Scientific name	Common name	Source[2]			WN records	Ecology	Likelihood of occurrence	References
EPBC	NC				WN	PM	PBA				
V	V	Scincidae	*Egernia rugosa*	Yakka Skink		x	x	0	The known distribution of this species extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt, Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula biogeographical regions. This species is known to occur in open dry sclerophyll forest, woodland and scrub. The core habitat of this species is within the mulga lands and Brigalow Belt South bioregions. It is most commonly found in cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. This species often takes refuge in large hollow logs and has been known to excavate deep burrow systems, sometimes under dense ground vegetation. In cleared habitat, it can persist where there are shelter sites such as raked log piles, deep gullies, tunnel erosion/sinkholes and rabbit warrens (DCCEEW, 2023; DoE, 2014).	**Moderate** - the study area is within the species' non-core range and sub-optimal/degraded habitat occurs within the study area (e.g., fallen logs and deep gullies). No records occur within 30 km of the study area.	DCCEEW (2023). Species Profile and Threats Database. Australian Government Department of Climate Change, Energy, the Environment and Water Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DoE (2014). Approved Conservation Advice for *Egernia rugosa* (Yakka Skink). Canberra: Department of the Environment.

[1] Status: NC = Queensland Nature Conservation Act 1992; EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Categories include: Least Concern (LC), Special Least Concern (SLC), Migratory (M), Near Threatened (NT), Vulnerable (V), Endangered (E) or Critically Endangered (CE). '-' indicates not listed.

[2] 10km search radius for EPBC Act Protected Matters Report (PM) records; 30km search radius for WildNet database (WN) records. Review of additional Atlas of Living Australia records (ALA) in proximity to the study area. Species assessed during the PBA 2008 and 2009 EIS (PBA).



Making Sustainability Happen

DPM ENVIROSCIENCES

Wandoan Mine Project – Progressive Rehabilitation and Closure Plan – Terrestrial Groundwater-Dependent Ecosystem Assessment

July 2024

Wandoan Mine Project
Progressive Rehabilitation and Closure Plan
Terrestrial Groundwater-Dependent Ecosystem Assessment

22 July 2024

Prepared for:
SLR Consulting Australia Pty Ltd
ABN: 29 001 584 612
21 River Street, Mackay QLD 4740

Prepared by:
DPM Envirosciences Pty Ltd
ABN: 54 602 226 460
12 Lauren Drive, Buderim QLD 4556
PO Box 1298, Mooloolaba QLD 4557

DPM Ref: DPM22007_RPT_22Jul2024.docx

DISTRIBUTION

Wandoan Mine Project – Progressive Rehabilitation and Closure Plan – Terrestrial Groundwater-Dependent Ecosystem Assessment

22 July 2024

Copies	Recipient	Copies	Recipient
1 ecopy	**Brad Radloff** **Technical Director, Environmental Assessment & Management** **SLR Consulting**		
1 ecopy	DPM Files		

This document was prepared for the sole use of SLR Consulting Pty Ltd and their client Glencore Coal Assets Australia (Glencore), the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of DPM Enviroscences Pty Ltd.

By

DPM Enviroscences Pty Ltd
ABN: 54 602 226 460
PO Box 1298 Mooloolaba QLD 4557

David Moore
Principal Environmental Scientist

Deanna Bayliss
Senior Ecologist and GIS analyst, EcoGIS

"This page has been left blank intentionally"

EXECUTIVE SUMMARY

Glencore Coal Assets Australia (GCAA) is preparing a Progressive Rehabilitation and Closure Plan (PRCP) for the Wandoan Coal Mine Project (the Project). DPM Enviros ciences Pty Ltd (DPM Enviros ciences) has been commissioned by GCAA to undertake an assessment of terrestrial groundwater-dependent ecosystems (GDEs) to support the PRCP.

The Project is an open cut coal project approved under the *Environmental Protection Act 1994.* The Project was issued with environmental approvals by State and Commonwealth Governments between 2011 and 2013, with Mining Leases (MLs) 50229, 50230 and 50231 (the Project area) subsequently granted in 2017. The Project has remained undeveloped since being granted the tenement in 2017.

Field verification of State-mapped and remotely sensed terrestrial GDEs confirmed that trees within a narrow corridor of riparian vegetation on the bed and banks of Blackant, Frank, Halfway, Juandah, Mud (including Toms Gully), Wandoan and Woleebee creeks are known to intercept groundwater in dry conditions and are therefore terrestrial GDEs. The riparian vegetation of Horse Creek to the west of the Project area also contains terrestrial GDEs, as confirmed by Shell QGC and their consultants during GDE condition monitoring (DPM Enviros ciences 2023). All field-verified terrestrial GDEs of the Project area and surrounds (including Horse Creek) are regional ecosystem 11.3.25 (*Eucalyptus tereticornis* dominated woodland fringing drainage lines).

The waterways and riparian vegetation of the Project area and surrounds are subject to continuous natural wetting and drying cycles. The terrestrial GDE components of these riparian communities most likely have a facultative nature, accessing available moisture in the soil or sediments following rainfall, and accessing groundwater in the alluvial aquifer on occasion. Similarly, the riparian vegetation on the bed and lower banks may intermittently use the surface expression of groundwater during occasional periods of flow contribution from adjacent/underlying alluvium following prolonged rainfall or after flood events. Under these conditions, recharged alluvium may drain to the watercourses as the hydraulic gradient reverses; the result of which may sustain surface or shallow sub-surface flow for short periods (days, weeks or months) depending on the sequence of rainfall events.

The vegetation comprising terrestrial GDEs of the Project area and surrounds would likely persist without groundwater input yet is known to utilise groundwater on occasion (episodic or opportunistic terrestrial GDEs, not obligate terrestrial GDEs). These vegetation communities form known and potential habitat for the Endangered (under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Queensland *Nature Conservation Act 1992*) folivorous species koala (*Phascolarctos cinereus*) and greater glider (*Petauroides volans*) and likely provide higher nutrient and leaf moisture levels than surrounding vegetation unable to access groundwater in drier times. Consequently, the terrestrial GDEs of the Project area and surrounds are attributed a High Ecological Value (Category 1 sensitive environmental area) in accordance with the criteria adopted for this Project.

GCAA should manage the post-mining landform of the approved Project by avoiding and minimising direct impacts (clearing) as far as practicable. GCAA should also continue to monitor the groundwater quality in the alluvium post closure where there are mapped terrestrial GDEs.

CONTENTS

EXECUTIVE SUMMARY ..... **III**
1 INTRODUCTION **3**
1.1 Scope of work 3
2 PROJECT DESCRIPTION **6**
3 BACKGROUND **8**
3.1 Hydrology 8
3.2 Local hydrostratigraphy 9
3.3 Terrestrial GDEs of the Project area 11
3.3.1 Remote sensing analysis 13
3.3.2 Field verification of terrestrial GDEs 16
3.3.3 Depth to groundwater 19
3.3.4 Soil water potential in bore drilling samples 21
3.3.5 Conceptual understanding 22
3.3.6 Ecological value of terrestrial GDEs 25
4 CONCLUSION **26**
5 REFERENCES **27**

FIGURES

Figure 1 Regional context 4
Figure 2 Project area 5
Figure 3 Final landform 7
Figure 4 Flow volume statistics and observations for Juandah Creek at Windamere (DRDMW station 130344A) 8
Figure 5 Surface geology 10
Figure 6 State-mapped potential terrestrial groundwater-dependent ecosystems 12
Figure 7 Treed locations showing above-average greenness (NDVI) 14
Figure 8 NDVI and rainfall correlation analysis 15
Figure 9 Pre-dawn leaf water potential and soil water potential (1 and 2 m depth) measurements at target sites 17
Figure 10 Field-verified terrestrial groundwater-dependent ecosystems 18
Figure 11 Depth to water at start of post-closure (KCB 2024) 20
Figure 12 Soil water potential in bore drilling samples collected 5 bores in November 2023 21
Figure 13 Conceptual ecohydrological model for alluvia in the mid catchment during wetter months (Queensland Government 2015). 24
Figure 14 Conceptual ecohydrological model for alluvia in the mid catchment during drier months (Queensland Government 2015). 24

PLATES

Plate 1 Likely terrestrial GDE comprising riparian vegetation on Woleebee Ck, 19 June 2022 . 23
Plate 2 Threatened folivorous species opportunistically observed in terrestrial GDEs of the Project area 25

Acronyms

Acronym	Description
CSG	Coal Seam Gas
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
DCCEEW	The Commonwealth Department of Climate Change, Environment, Energy and Water
DES	The former Queensland Department of Environment and Science (now DESI)
DESI	The Queensland Department of Environment, Science and Innovation
DoR	The Queensland Department of Resources
DRDMW	The Queensland Department of Regional Development, Manufacturing and Water
E	Endangered (threatened species conservation status)
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GDE	Groundwater-Dependent Ecosystem
KCB	KCB Australia Pty Ltd
mAHD	Metres above (or below) the Australian Height Datum
mbgl	Metres Below Ground Level
ML	Mining Lease
NC Act	Queensland *Nature Conservation Act 1992*
NDVI	Normalised Difference Vegetation Index
PRCP	Progressive Rehabilitation and Closure Plan
The Bureau	Bureau of Meteorology
USGS	United States Geological Survey Center for Earth Resources Observation and Science

Definitions

Term	Description
Analysis Area	An area extending 5 kilometres beyond the Project area, used for the remote sensing analysis of potential groundwater-dependent ecosystems.
Ephemeral waterways	Waterways that flow for short periods of time following rain events.
Groundwater-Dependent Ecosystem	Groundwater-Dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. They may be 100% dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas.
Intermittent waterways	Waterways with seasonal flow during certain times of the year when smaller upstream waters are flowing and/or when groundwater provides enough water for stream flow.
Project area	Wandoan Coal Mine Mining Leases 50230, 502131 and 50229 in the Western Downs Region, Queensland.
Stygofauna	Stygofauna are aquatic fauna that live part or all their lives in groundwater systems such as aquifers or underground caves. Stygofauna are found in aquifers and caves, inhabiting the water filled pore spaces, voids, cracks and fissures.
Waterway	Waterways include riverine systems, watercourses, waterways or drainage lines identified in Queensland Wetlands Map, *Fisheries Act 1994*, Queensland Waterways for Waterway Barrier Works map or DoR Watercourse identification map (*Water Act 2000*).

1 INTRODUCTION

Glencore Coal Assets Australia (GCAA) is preparing a Progressive Rehabilitation and Closure Plan (PRCP) for the Wandoan Coal Mine Project (the Project). DPM Enviros ciences Pty Ltd (DPM Enviros ciences) has been commissioned by SLR Consulting Pty Ltd (SLR), on behalf of its client Glencore Coal Assets Australia (GCAA), to undertake an assessment of terrestrial groundwater-dependent ecosystems (GDEs) to support the PRCP.

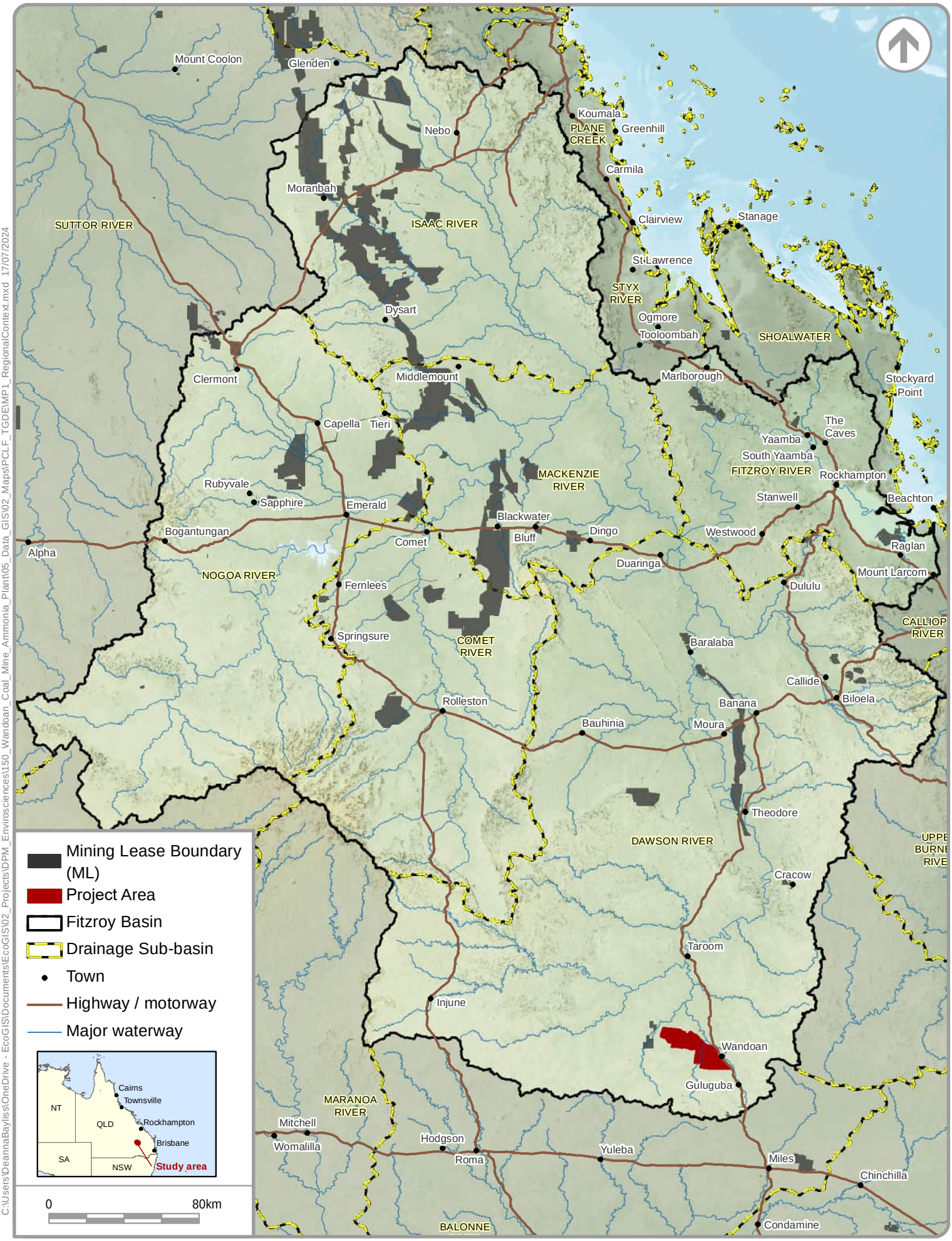
The Project is an open cut coal mine approved under the *Environmental Protection Act 1994*. The Project was issued with environmental approvals by State and Commonwealth Governments between 2011 and 2013, with the Mining Leases (MLs) 50230, 502131 and 50229 subsequently granted in 2017. However, the Project has remained undeveloped since being granted the tenement in 2017.

The approved Project includes 16 mining pits, including the Woleebee Creek and Woleebee North pits that would have required diversion and open cut mining of their natural flow path, including complete removal of the riparian vegetation at these pit locations. However, GCAA has scaled back the approved Project to avoid these direct impacts to Woleebee and Wandoan creeks. The existing extent of terrestrial GDEs within and surrounding the Project area has recently been assessed by DPM Enviros ciences on behalf of GCAA and is presented in this report as background information.

1.1 Scope of work

The scope of work for this terrestrial GDE assessment included presenting the background information on terrestrial GDEs of the Project area.

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. © State of Queensland (Department of Resources) 2022.
DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Envioscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



C:\Users\DeannaBayliss\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDE\MP1_RegionalContext.mxd 17/07/2024

REGIONAL CONTEXT

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 1

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2021.. DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviroscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

C:\Users\DeannaBaylis\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\3150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEMP2_ProjectArea.mxd 17/07/2024

PROJECT AREA

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 2

2 PROJECT DESCRIPTION

The Project is planned to include the following components:

- open cut mining of 16 areas;
- waste rock/overburden storages within and adjacent to the open pits;
- raw and mine affected water storages;
- Mining Infrastructure Area (MIA); and
- Coal Handling and Processing Plan (CHPP).

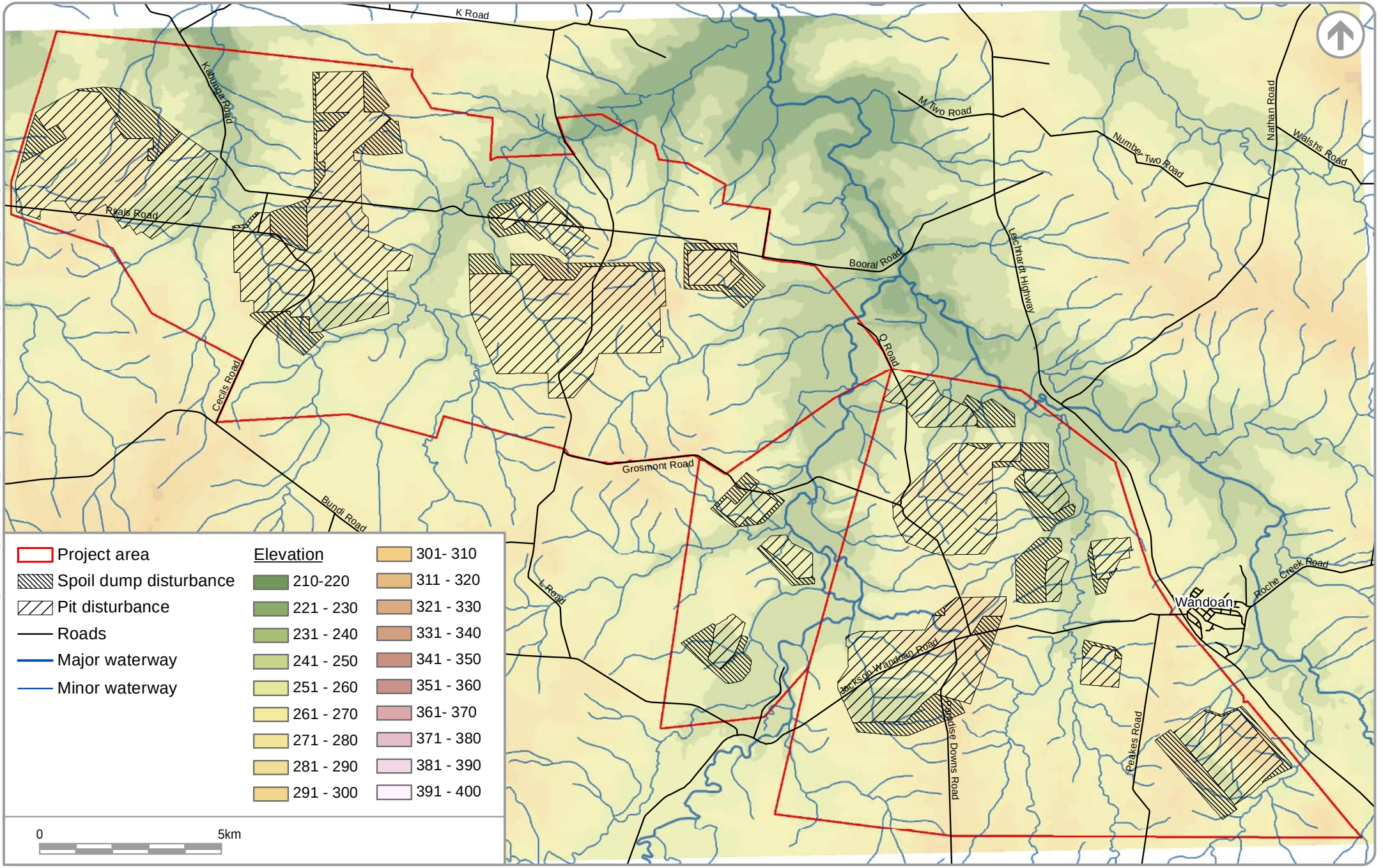
The Project is to be operated in accordance with Environmental Authority (EA) EPML00297613 – Wandoan Coal Mine, with the latest version issued by the Department of Environment and Science (DES) on 2 December 2022 (DES 2022).

Approved mining activities target the Upper Juandah Coal Measures (Kogan, Upper Macalister, Lower Macalister and Wambo coal seams) of the Walloon Coal Measures, with mining planned over a 75-year mine life.

The proposed final landform for the Project area is shown on Figure 3. The waste rock/spoil removed during mining activities will be used to backfill the mined areas. The geochemical characteristics of the backfill material has been described by RGS. Based on their sampling and characterisation, there is a low risk of acid generation and a high factor of safety with respect to potential Acid Mine Drainage (RGS 2023, cited in KCB 2024). The backfilled material is expected to have a higher salt content than the adjoining natural / in-situ regolith and rock. No residual pit lakes are planned.

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. . DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviosciences shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

C:\Users\DeannaBaylies\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEIMP3_FinalLandform.mxd 17/07/2024



FINAL LANDFORM

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 3

3 BACKGROUND

3.1 Hydrology

The Project area is located within the upper Dawson River drainage sub-basin of the greater Fitzroy Basin. Juandah and Woleebee creeks are the main waterways bisecting the Project Area. Other smaller, named waterways include Blackant, Frank, Halfway, Mount Organ, Mud, One Arm Man, Spring, Two Mile and Wandoan creeks, and Log Hut and Toms gullies. All waterways of the Project Area drain to Juandah Creek, which flows in a general northern direction to its confluence with the Dawson River near Taroom (Figure 1). The Dawson River converges with the Mackenzie River to form the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea south-east of Rockhampton near Port Alma.

Historical flow monitoring data (1974-2023) for Juandah Creek at Windamere (Department of Regional Development, Manufacturing and Water [DRDMW] monitoring station 130344A), located 1.8 km downstream of the confluence of Juandah and Woleebee creeks, approximately 2 km north-east of the Project Area, provides an indication of the local flow regime (Figure 4). Flow within Juandah Creek is intermittent, with higher flows typically encountered from November to February, although on average incurs at least some flow in each month of the year. The smaller waterways of the Project Area are expected to be ephemeral, experiencing flow for relatively short duration following rainfall and runoff in the catchment. Stream flows across the Project area are expected to be highly variable, with channels typically drying during winter to early spring when rainfall and runoff is historically low. Surface water flows are more likely in the wetter months from November to February in an average year (Figure 4).

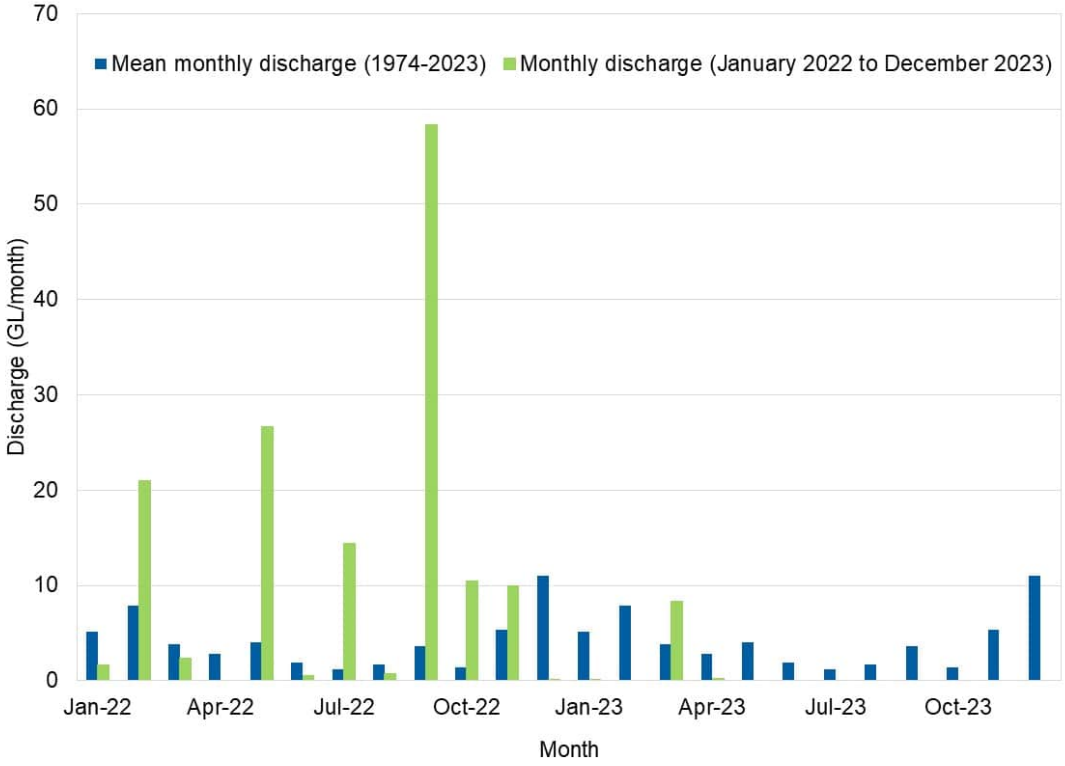


Figure 4 Flow volume statistics and observations for Juandah Creek at Windamere (DRDMW station 130344A)

3.2 Local hydrostratigraphy

The Project is situated in an area where Springbok Sandstone outcrops, with the Walloon Coal Measures outcropping to the north of the Project area. Hydrostratigraphic units relevant to the Project area include (KCB 2024):

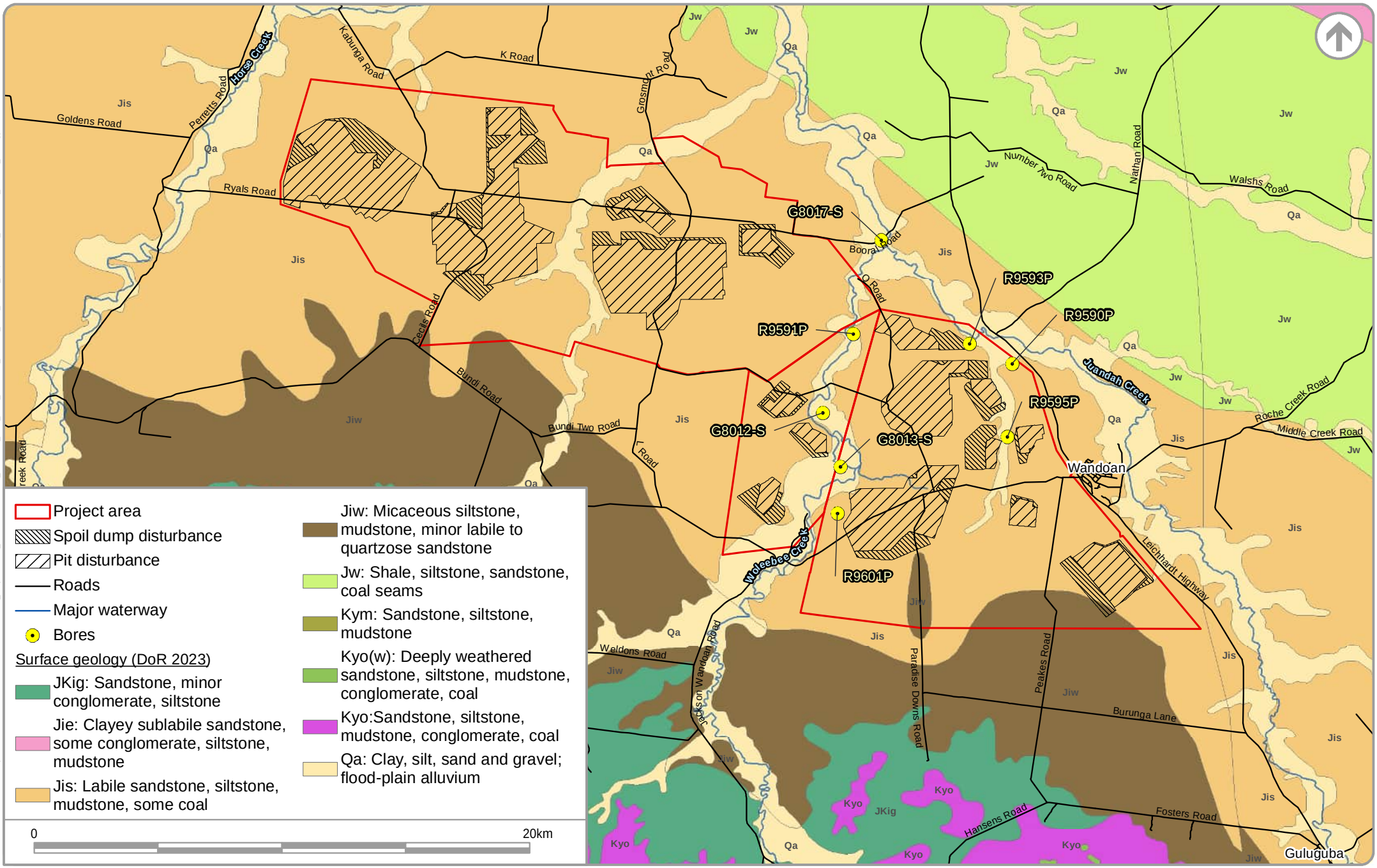
- Quaternary-age alluvium, associated with the watercourses and floodplains;
- Springbok Sandstone; and
- Walloon Coal Measures.

Units deeper than the Walloon Coal Measures are at depths greater than 400 m, with mining targeting depths of around 70 m (KCB 2024).

KCB (2024) conducted a desktop assessment and determined alluvium thickness to be up to 17.4 m (to the north of the Project), with thickness in the MLs between 1 and 10.5 m. A drilling program was completed in late-2023 with bores installed within the alluvium recorded as dry, with no groundwater intersected or static water level measured after drilling (KCB 2024). Three bores monitored by Glencore (G8012-S, G8013-S and G8017-S [Figure 5]) have currently or historically had groundwater within the bore column (KCB 2024). The saturated thickness of the alluvium ranges between 2 and 2.8 m at G8013-S, located to the south of the Woleebee North pit, with a logged alluvium thickness of 11.5 m (URS 2010, cited in KCB 2024) at this location. The saturated thickness of the alluvium at G8012-S, located on the northern edge of the proposed Woleebee North pit, ranges between 1.2 and 2 m, with a logged alluvium thickness of 8.9 m (KCB 2024).

Terrestrial GDEs field verified within the Project area comprise narrow strips of riparian vegetation confined to the alluvium (Section 3.3.2). Quaternary-age alluvium within and surrounding the Project area is associated with Juandah, Horse, Woleebee, Wandoan and Frank creeks, and Mud Creek / Tom's Gully (DoR 2023, Figure 6). Field observations indicate that the surface sediments are dominated by sand, silt/clay and gravel, respectively (DPM Enviroscences 2024).

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2021.. DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviosciences shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



SURFACE GEOLOGY

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 5

3.3 Terrestrial GDEs of the Project area

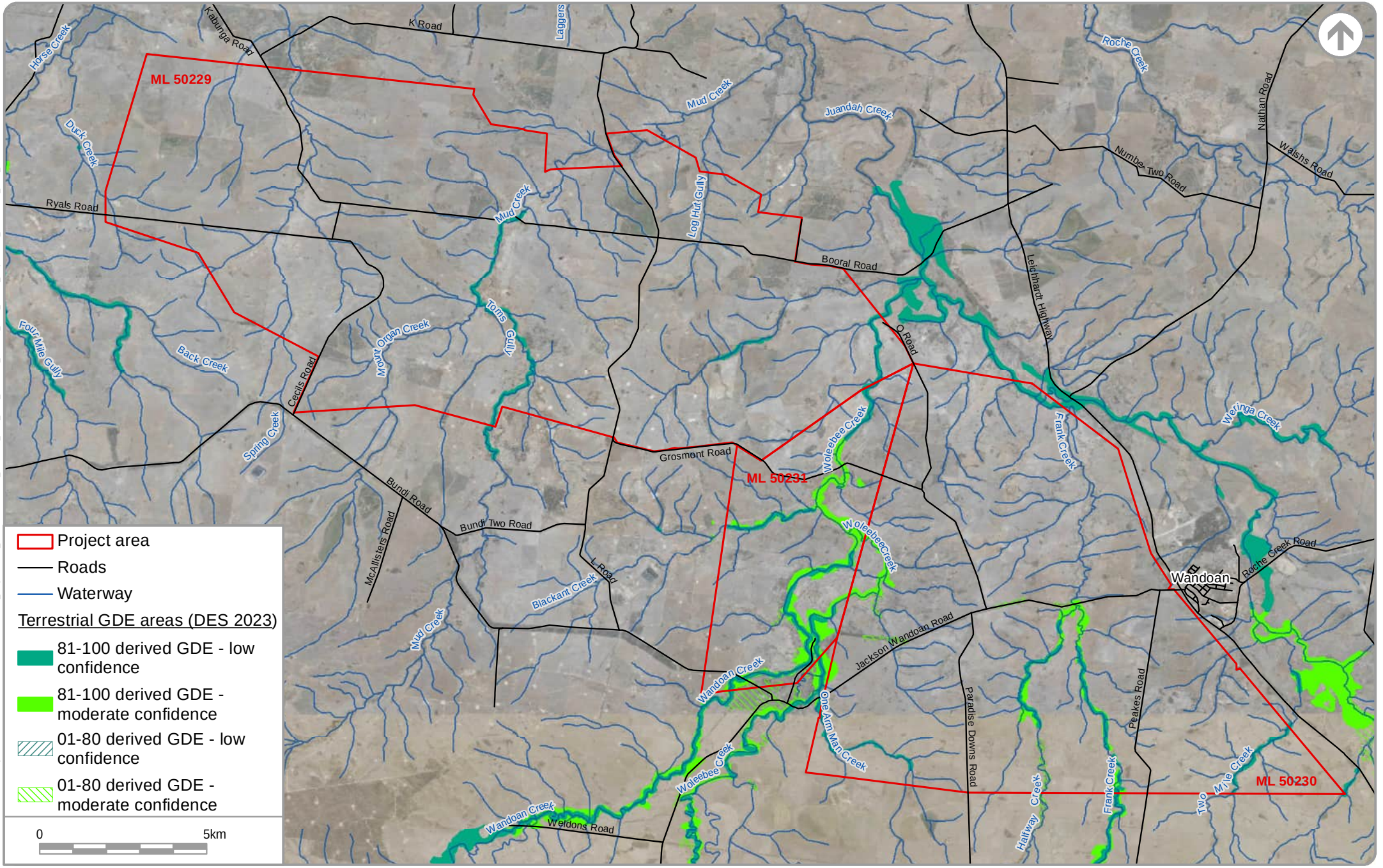
Terrestrial GDEs of the Project were identified as part of the Aquatic Ecology and Groundwater-Dependent Ecosystems Baseline Survey Report for the Wandoan Coal Project (DPM Enviros ciences 2014). The following sections summarise the findings relevant to this terrestrial GDE Assessment for the PRCP.State-mapped terrestrial GDEs

Desktop mapping of potential GDEs throughout Queensland (DES 2023c) shows no 'known' terrestrial GDEs within the Project area and 5 km buffer. However, a number of 'derived' terrestrial GDEs of varying confidence levels are identified in the State mapping (DES 2023a), based on expert knowledge of the landscape and available spatial datasets. The State mapping for the Project area and surrounds (Figure 6) identifies potential terrestrial GDEs of varying confidence, separated into polygons where the potential GDE makes up >80% of the mapped polygon, and those where the potential GDE makes up <80% of the mapped polygon (Figure 6), including:

- State-mapped 'moderate confidence' derived terrestrial GDEs:
  - treed REs on alluvia overlying sandstone ranges with fresh, intermittent groundwater connectivity regime; and
  - riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent groundwater connectivity regime.
- State-mapped 'low confidence' derived terrestrial GDEs:
  - treed REs on alluvial aquifers with fresh, intermittent groundwater connectivity regime;
  - treed REs within 50 m of a third order or greater channel on Springbok Sandstone with fresh, intermittent flow; and
  - riverine wetlands within 50 m of a third order or greater channel on Springbok Sandstone with fresh, intermittent flow.

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2021.. DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviroscience shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

C:\Users\DeannaBaylis\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\3150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEMP6_GDE_Terrestrial.mxd 17/07/2024



STATE-MAPPED TERRESTRIAL GROUNDWATER-DEPENDENT ECOSYSTEMS

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 6

3.3.1 Remote sensing analysis

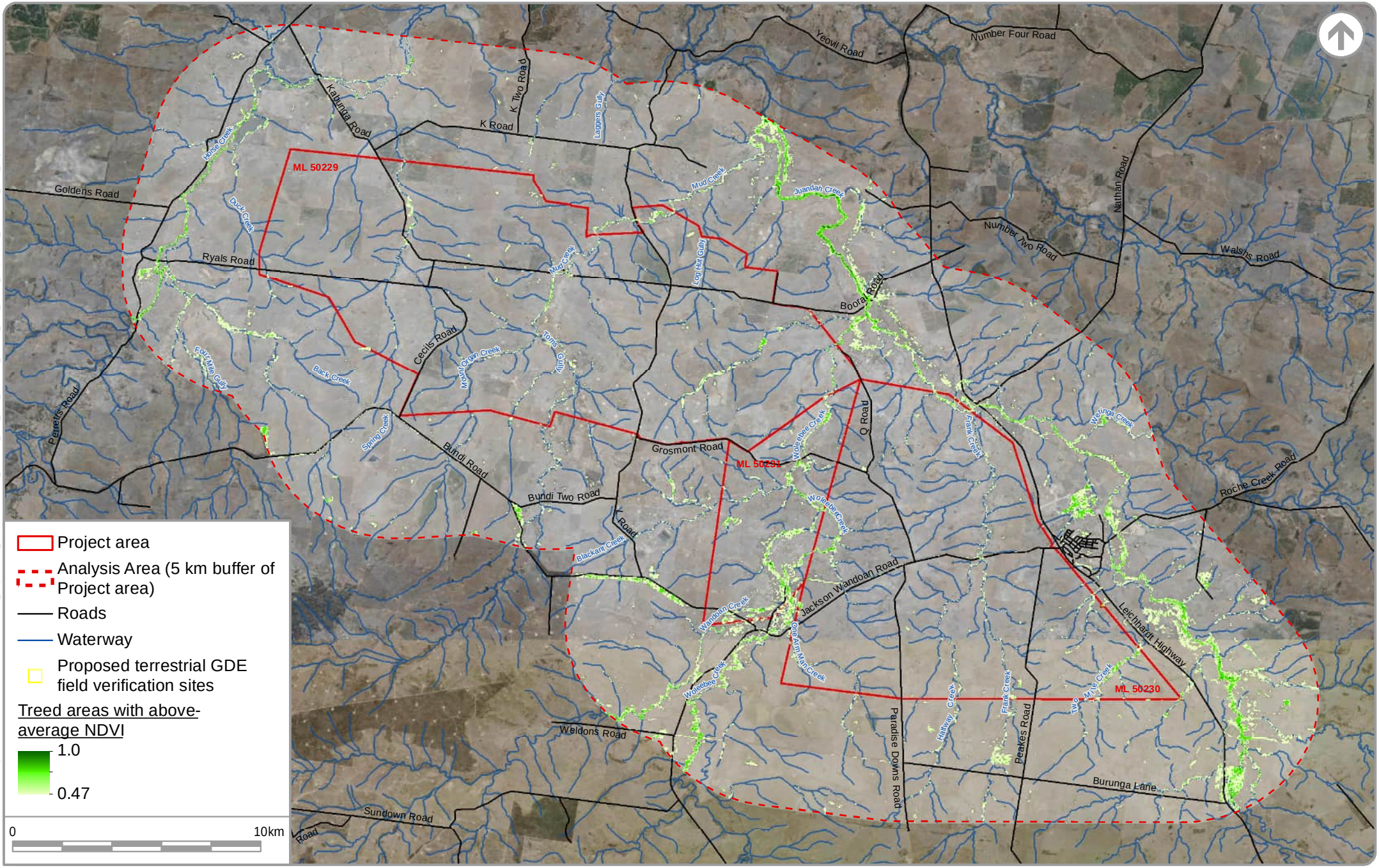
Desktop remote sensing analysis was undertaken in 2022, incorporating Normalised Difference Vegetation Index (NDVI) consistent with the *Australian groundwater-dependent ecosystems toolbox part 2: assessment tools* (Richardson et al. 2011). NDVI is a remotely sensed spectral vegetation index that is used to assess vegetation condition by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). NDVI is used to quantify vegetation 'greenness' and has been utilised in studies to assess vegetation density and changes in plant health (United States Geological Survey [USGS] 2022a; NSW DPI 2016). NDVI ranges from -1 to +1, with negative values typically indicating water, values close to zero indicating highly stressed or no vegetation, and values close to +1 indicating dense green leaves.

NDVI was used to assess the potential presence of GDEs within the Study Area based on the notion that GDEs are expected to remain relatively greener than vegetation that is unable to access groundwater throughout periods of low to no rainfall. Vegetation communities that have access to groundwater are likely to record stable NDVI values through drier periods compared to communities that are reliant on surface water (NSW DPI 2016). Based on methods adapted from NSW DPI (2016), the correlation between NDVI and rainfall was analysed across dry events to identify areas of poor correlation, inferring the potential presence of a GDE. Locations where there is a higher correlation between rainfall and NDVI are less likely to be accessing groundwater.

Above-average NDVI across the Analysis Period is shown in Figure 7. The output of the above-average NDVI/rainfall correlation analysis is presented on Figure 8. There is a concentration of pixels showing a poor NDVI/rainfall correlation, and therefore higher potential of being a GDE, along Juandah, Wandoan and Woleebee creeks, and to a lesser extent Halfway, Frank and Two Mile creeks, which coincides with potential State-mapped terrestrial GDEs (DES 2020c; Figure 8).

Additional locations, mostly along unnamed tributaries of Juandah and Two Mile creeks, that are not identified as potential GDEs by the State (DES 2023), also returned poor NDVI/rainfall correlations and warranted further field investigation. The results from the correlation analysis were used to focus the terrestrial GDE field verification effort to locations with a higher likelihood to be GDEs. This included State-mapped terrestrial GDEs as well as additional areas identified by the NDVI/rainfall correlation analysis (Figure 8).

Data sources: Qld Government 2024, DPM Envirosciences 2024, Glencore 2024. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2021.. DPM Envirosciences does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Envirosciences shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



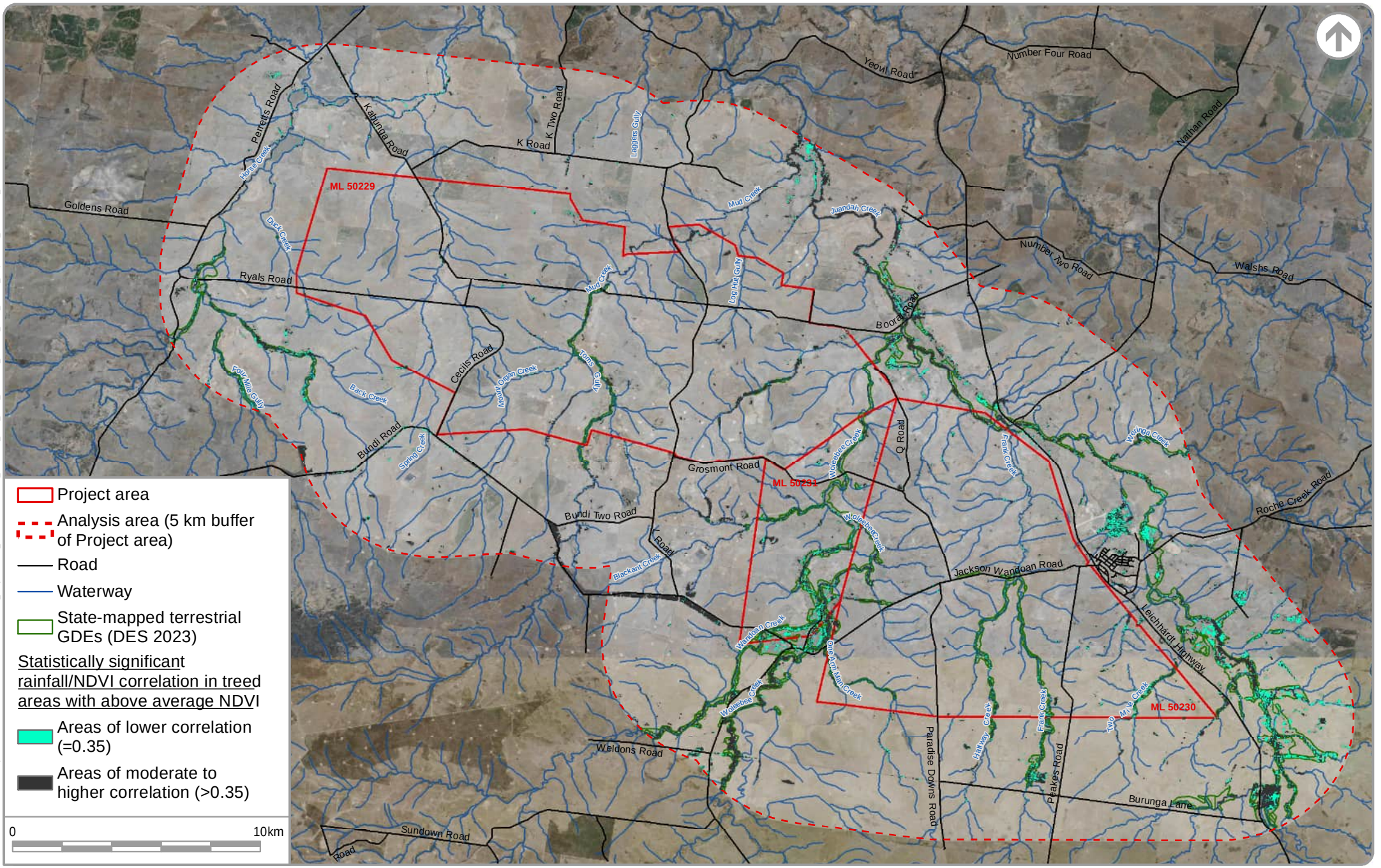
TREED LOCATIONS SHOWING ABOVE-AVERAGE GREENNESS (NDVI)

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 7

C:\Users\DeannaBaylis\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Envirosciences\150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEIMP7_NDVI_AvgGreen.mxd 17/07/2024

Data sources: Qld Government 2024, DPM Enviroscience 2024, Glencore 2024. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2021.. DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviosciences shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



C:\Users\DeannaBaylies\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEIMP8_NDVI.mxd 17/07/2024

DPM ENVIROSCIENCES

NDVI AND RAINFALL CORRELATION ANALYSIS

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 8

3.3.2 Field verification of terrestrial GDEs

Leaf Water Potential (LWP) measurements of 0.00 to -0.55 MPa were used in the baseline assessment to indicate trees that were accessing water (ranging from fresh to slightly saline) in either the soil profile or water table at the time of assessment (DPM Enviros ciences 2024). LWP measurements of <-0.55 MPa (i.e. more negative than -0.55 MPa) were used to indicate trees that were unlikely to be accessing water in either the soil profile or the water table (Figure 9), or that may have been accessing a moderately saline to saline water source.

The raw data relating to pre-dawn LWP and Soil Water Potential (SWP) measurements is provided in DPM Enviros ciences (2024) and summarised in Figure 9. Figure 10 depicts field-verified terrestrial GDEs within the Project area and immediate surrounds.

DPM Enviros ciences' remote sensing analysis and subsequent field verification of these areas and State-mapped terrestrial GDEs confirmed that trees within a narrow corridor of riparian vegetation on the bed and banks of Blackant, Frank, Halfway, Horse, Juandah, Mud (including Toms Gully), Wandoan and Woleebee creeks are known to intercept groundwater in dry conditions and are therefore terrestrial GDEs (Figure 10). All field-verified terrestrial GDEs were RE 11.3.25 (*Eucalyptus tereticornis* dominated woodland fringing drainage lines), although not all RE 11.3.25 within the Project area is terrestrial GDE. Most sampled trees on adjoining floodplains, which comprised commonly of tight clays on old alluvial deposits, were shown not to be intercepting groundwater at the time of assessment.

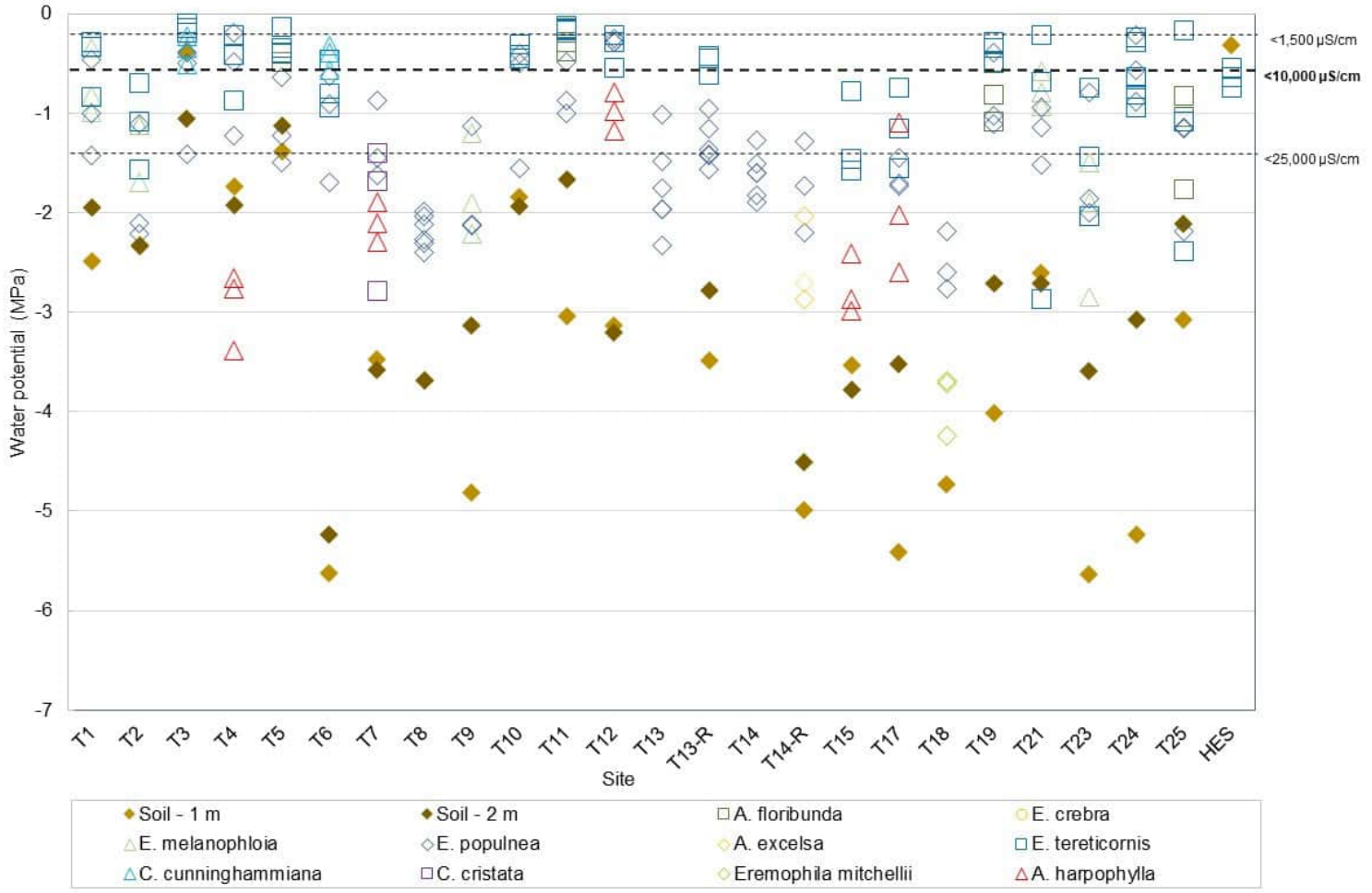
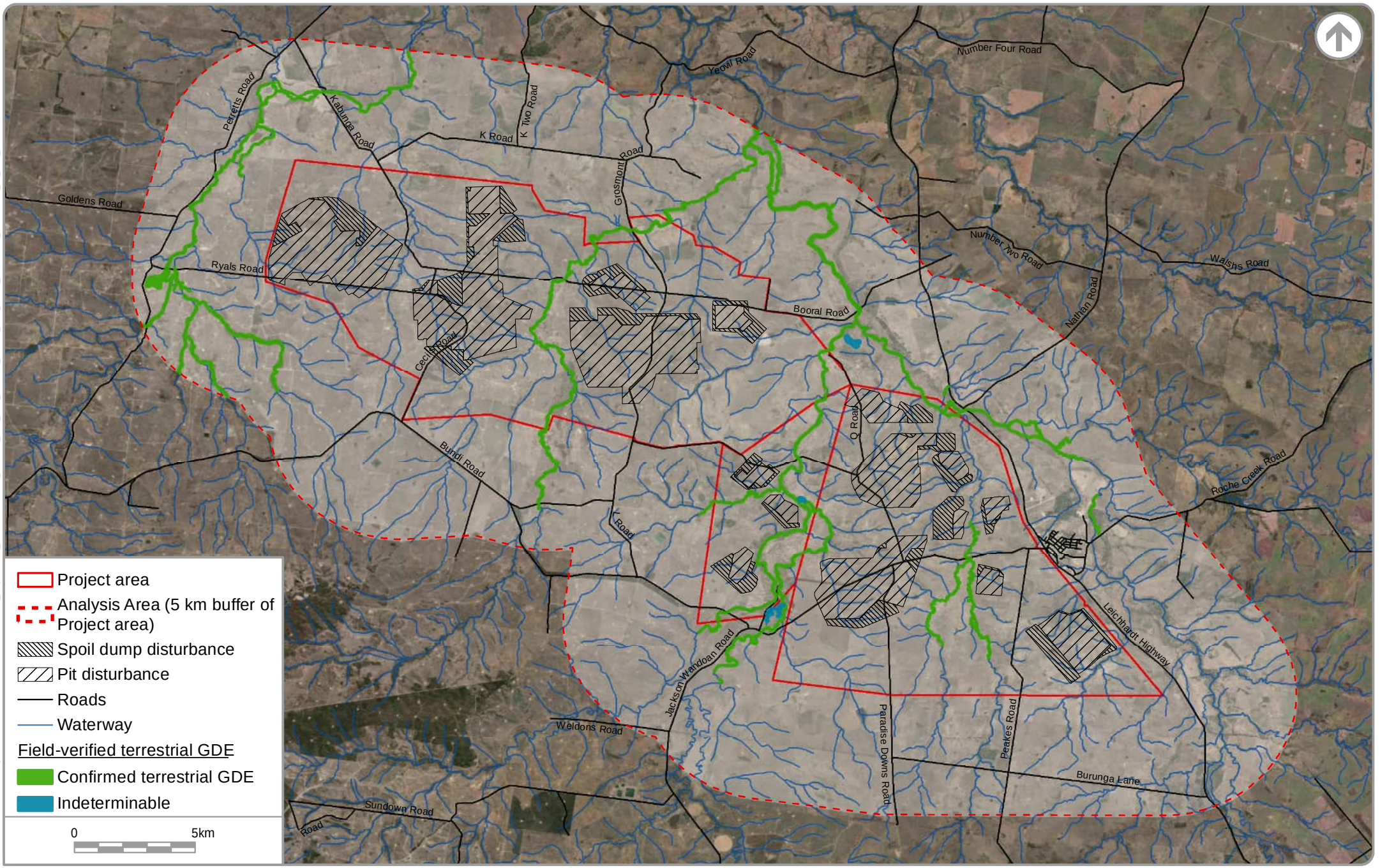


Figure 9 Pre-dawn leaf water potential and soil water potential (1 and 2 m depth) measurements at target sites

Note: Dashed lines indicate expected LWP value for trees in equilibrium with saturated moisture sources expected at 1,500 µS/cm, 10,000 µS/cm and 25,000 µS/cm (DPM Enviroscences 2024).

Data sources: Qld Government 2022, DPM Enviroscience 2022, Glencore 2022. Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. DPM Enviroscience does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.DPM Enviosciences shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

C:\Users\DeannaBaylies\OneDrive - EcoGIS\Documents\EcoGIS\02_Projects\DPM_Enviroscience\3150_Wandoan_Coal_Mine_Ammonia_Plant\05_Data_GIS\02_Maps\PCLF_TGDEIMP10_FV_GDE_Terrestrial.mxd 17/07/2024



FIELD-VERIFIED TERRESTRIAL GROUNDWATER-DEPENDENT ECOSYSTEMS

Wandoan Mine Project PRCP - Terrestrial GDE Assessment

FIGURE 10

3.3.3 Depth to groundwater

Vegetation generally uses 3 sources of water depending on availability, comprising: recent rainfall stored in the upper soil profile (soil water); stream water, relevant to some riparian species; or groundwater. The ability of trees to access available groundwater when soil water or stream water is unavailable depends on the rooting depth of the species and other variables such as geology, soil type and salinity.

Observations of riparian vegetation at aquatic survey sites on Blackant, Frank, Halfway, Juandah, Wandoan and Woleebee creeks (DPM Enviros ciences 2024) indicate that the riparian vegetation is dominated by forest red gum (*Eucalyptus tereticornis*), being a species known to access groundwater on occasion (Doody, Hancock and Pritchard 2018), although its presence alone does not necessarily indicate a GDE. From excavation in 20-year-old plantation forests of forest red gum (*E. tereticornis*), Kallarackal and Somen (1998) found that roots were traceable to depths of 9.3 mbgl. River red gum (*E. camaldulensis*), which has very similar characteristics to forest red gum, is known to access water tables as deep as 6 m (Orellana et al. 2012) and 9 to 10 mbgl (Colloff 2014), although Hill and Hore (2009, cited in OGIA 2019) inferred a capacity for rooting depths of at least 50 mbgl. Cunningham et al. (2011) demonstrated increased dieback of *E. camaldulensis* with increasing groundwater depth, particularly at depths below 10 mbgl. Canadell et al. (1996) determined generalised maximum rooting depths for 11 different ecosystems, including a maximum rooting depth of 9.5 mbgl for sclerophyll forest. Orellana et al. (2012) found that poplar gum (*Eucalyptus platyphylla*), Clarkson's bloodwood (*Corymbia clarksoniana*) and broad-leaved paperbark (*Melaleuca viridiflora*) were shown to access groundwater to a depth reaching 10 mbgl.

As a rule of thumb for treed ecosystems, groundwater use is considered to be of lesser importance, but still possible, at depth to water of 10-20 mbgl, and is unlikely to be used by treed ecosystems when deeper than 20 mbgl (Eamus et al. 2006, cited in OGIA 2019).

The maximum rooting depth of tree species is likely to be variable across the Project area and there are likely numerous exceptions to the adopted rule. However, 10 mbgl has been adopted as the threshold indicating areas of remnant or regrowth treed vegetation with greater potential to be accessing groundwater on occasion.

KCB (2024) has modelled and presented depth to water data for the end of mining (start of post-closure) (Figure 11), which indicates a water table at or shallower than 10 metres below ground level (mbgl) on Juandah, Wandoan and Woleebee creeks, and on the lower reaches of Frank and Mud creeks (each being where terrestrial GDEs have been field-verified). The water table at the start of post-closure (KCB 2024) is mapped deeper than 20 mbgl on Blackant and Halfway creeks, and in the upper reaches of Frank and Mud creeks (each being where terrestrial GDEs have been field-verified) implying that groundwater levels at that point in time may be too deep for trees to access groundwater at these locations. KCB (2024) predicted groundwater levels to reach post-closure equilibrium within approximately 50 years after mining activities have ended. The depth of the water table in the alluvial aquifer at that point in time is likely to determine the potential extent of surviving terrestrial GDEs at that point in time.

KCBs modelling does not extend to the adjoining Horse Creek, being a terrestrial GDE west of the approved Turkey Hill pit (Figure 15) that is monitored by Shell QGC (DPM Enviros ciences 2023).

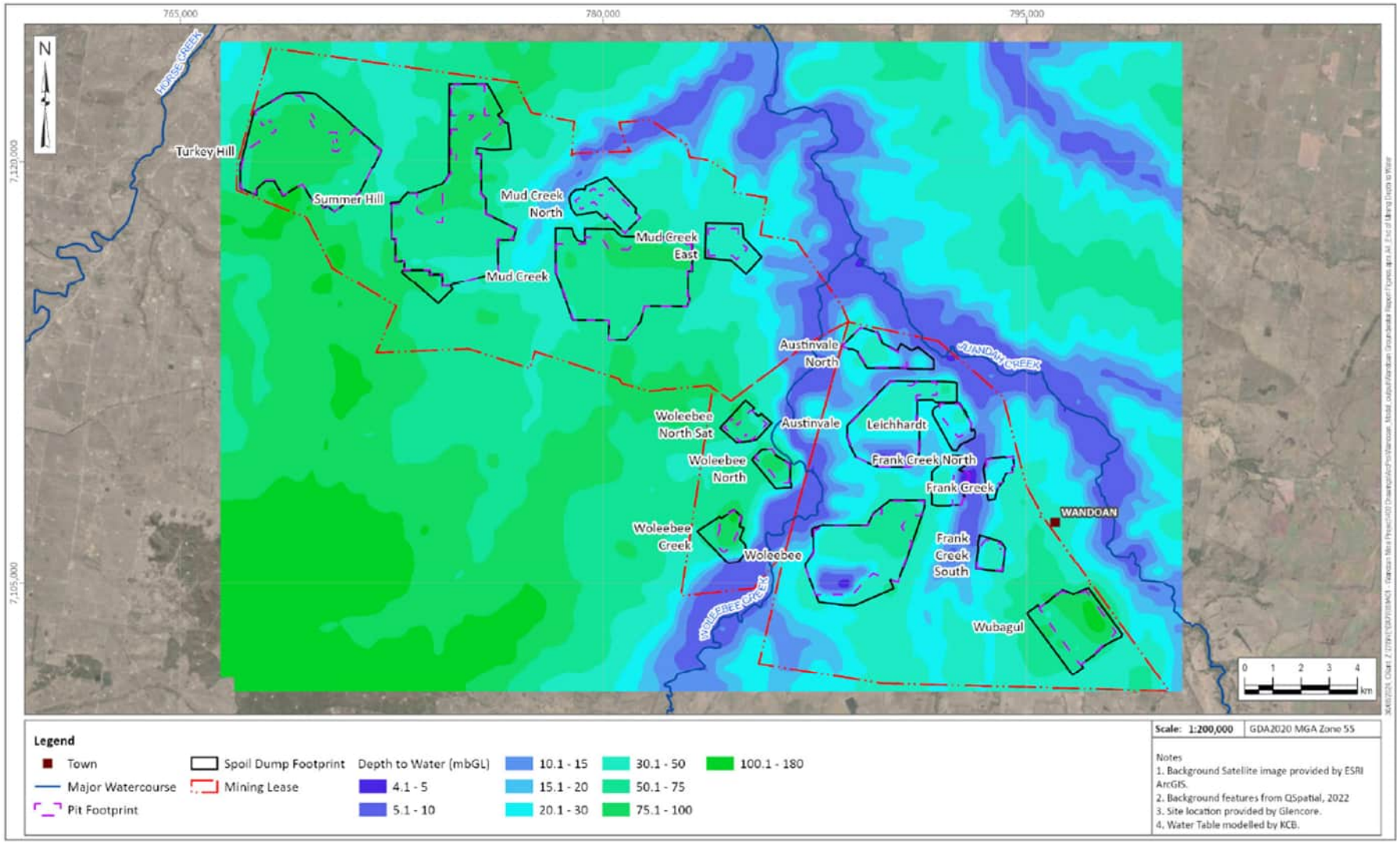


Figure 11 Depth to water at start of post-closure (KCB 2024)

3.3.4 Soil water potential in bore drilling samples

The SWP data indicates that no saturated samples were intercepted in the top 20 m of the profile at any of the 5 bores sampled, with SWP ranging from -1.68 to -96.62 MPa (Figure 12); whereas SWP closer to ≥-0.55 MPa would be expected in samples with a fresh to slightly saline saturated source of moisture, and SWP closer to >-1.4 MPa would be expected in samples with a moderately saline to saline saturated source of moisture (DPM Enviroscences 2024). Bore logs indicate that groundwater was intersected at between 22 and 24 mbgl in 3 of these 5 bores, and that the other 2 bores were dry.

Figure 12 presents the results of the analysis of SWP samples collected during the drilling of 5 bores (DPM Enviroscences 2024). The locations of these bores are identified on Figure 5.

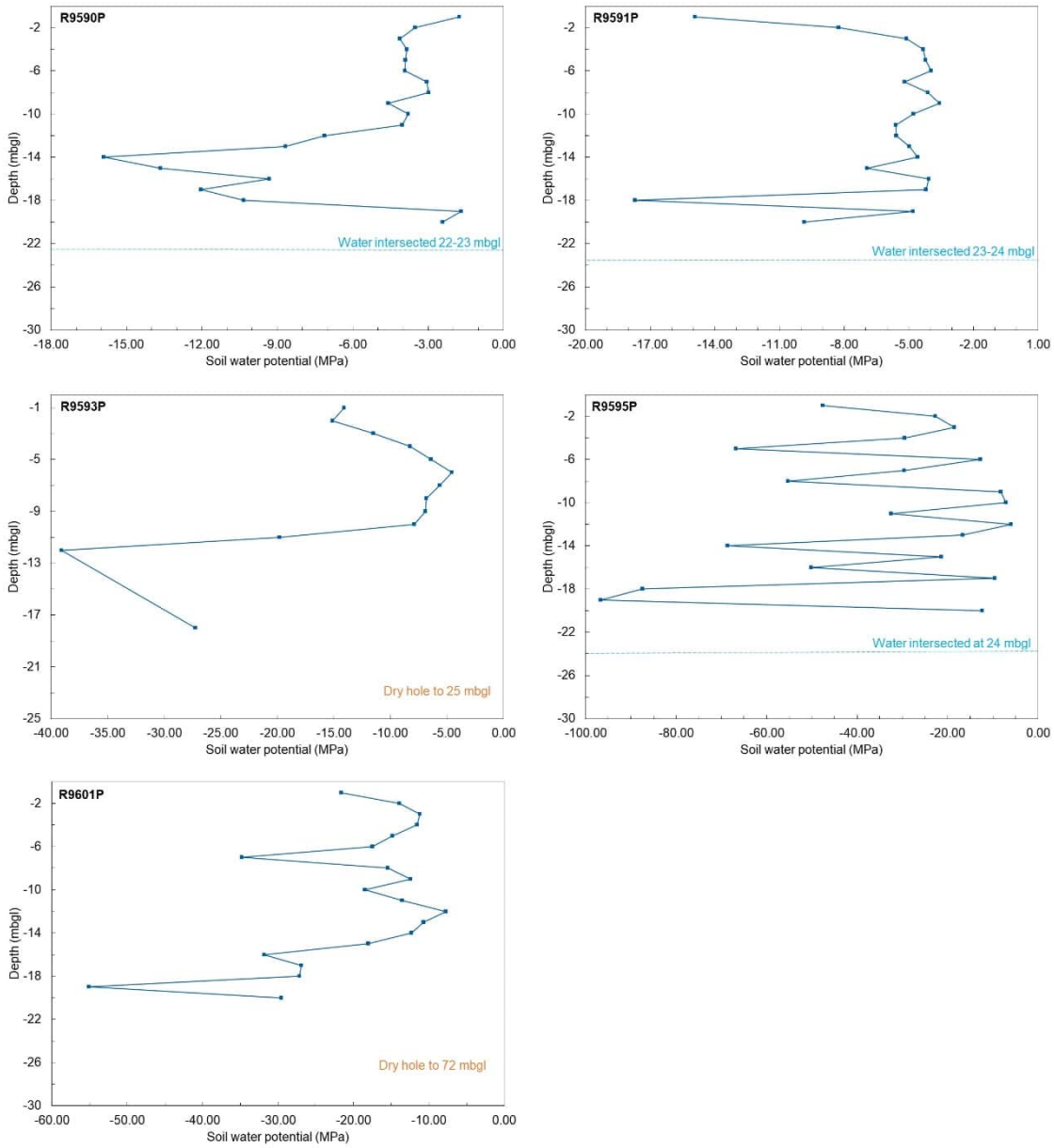


Figure 12 Soil water potential in bore drilling samples collected 5 bores in November 2023

Each of these 5 bores are positioned on a floodplain. It is unlikely that trees in the vicinity of these locations would be utilising groundwater, given the lack of available moisture (very low water potential; water tightly held) in samples collected from the top 20 m of the profile. Instead, trees in the vicinity of these locations are more likely to rely on soil water in the surface layers following rainfall infiltration.

The findings of the SWP analysis of the drilling samples complement the other methods being used to assess terrestrial GDEs, providing further evidence that saturated sources of water are unlikely to be available for vegetation positioned beyond the bed and banks of waterways within the Project area and surrounds (Figure 10).

3.3.5 Conceptual understanding

Multiple lines of evidence suggest that the riparian vegetation of Blackant, Frank, Halfway, Horse, Juandah, Mud (including Toms Gully), Wandoan and Woleebee creeks, each comprising RE 11.3.25, likely form terrestrial GDEs. Given this vegetation is subject to continuous natural wetting and drying cycles, these riparian communities most likely have a facultative nature, accessing available moisture in the soil following rainfall, and accessing groundwater in the alluvial aquifer on occasion. Similarly, the riparian vegetation on the bed and lower banks may intermittently use the surface expression of groundwater during occasional periods of flow contribution from adjacent/underlying alluvium following prolonged rainfall or after flood events. Under these conditions, recharged alluvium may drain to the watercourses as the hydraulic gradient reverses, the result of which may sustain surface or shallow sub-surface flow for short periods (days, weeks or months) depending on the sequence of rainfall events. It is likely that terrestrial GDEs along Blackant, Frank, Halfway, Horse, Juandah, Mud (including Toms Gully), Wandoan and Woleebee creeks would be both facultative and opportunistic, utilising small inputs of groundwater on occasion, but likely persisting without this input.

Plate 1 Likely terrestrial GDE comprising riparian vegetation on Woleebee Ck, 19 June 2022

The terrestrial GDEs of the Project area are aligned with the mid catchment conceptual ecohydrological models for alluvia available through Wetland*Info* (Queensland Government 2015) (Figure 13 and Figure 14), which shows how riparian vegetation may depend on the subsurface presence of groundwater within the capillary zone for some or all of its water requirements.

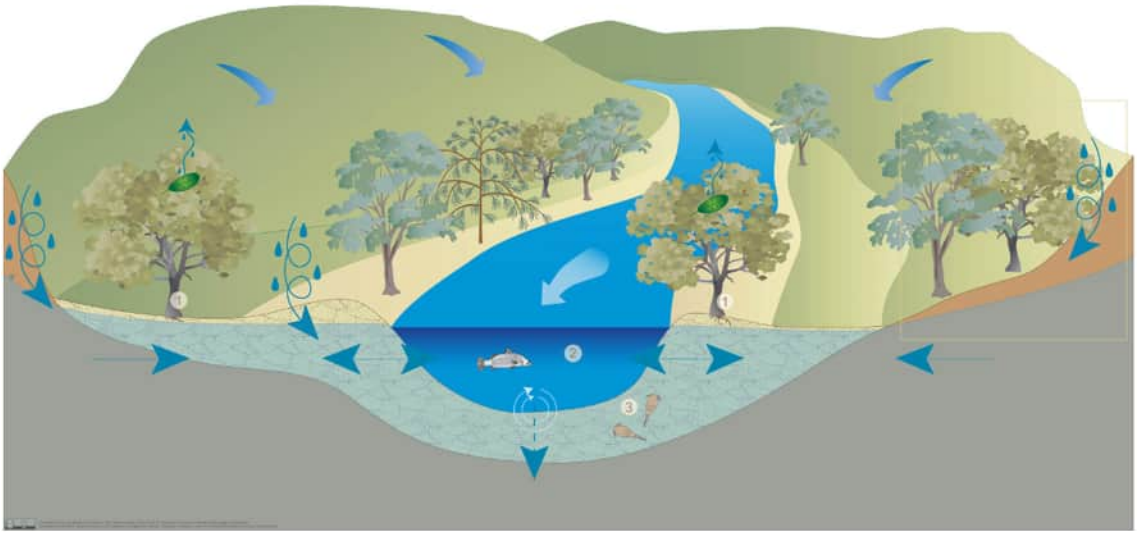


Figure 13 Conceptual ecohydrological model for alluvia in the mid catchment during wetter months (Queensland Government 2015).

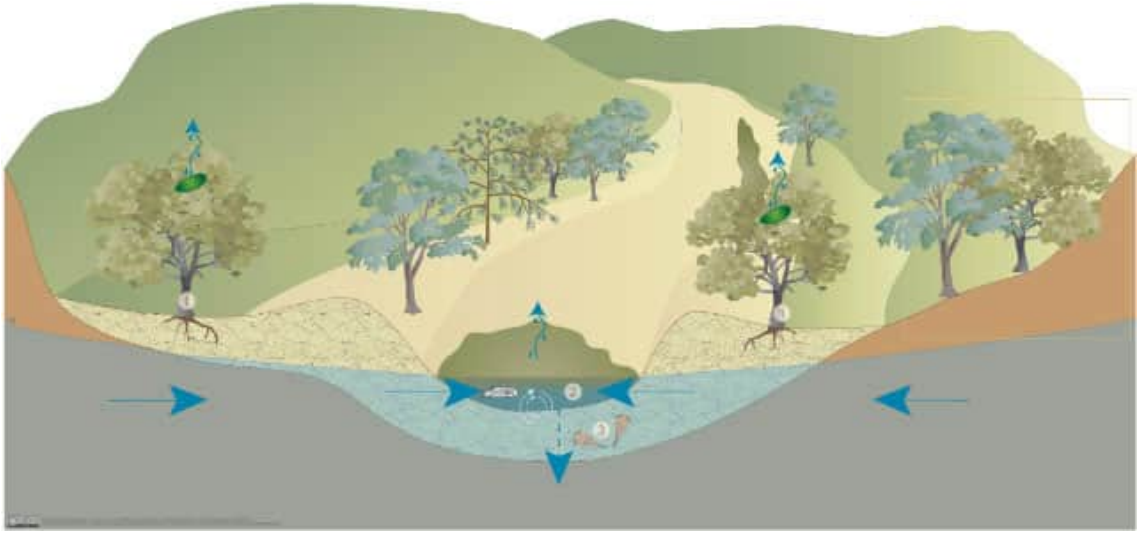


Figure 14 Conceptual ecohydrological model for alluvia in the mid catchment during drier months (Queensland Government 2015).

3.3.6 Ecological value of terrestrial GDEs

The terrestrial GDEs of the Project area and surrounds, including the riparian vegetation of Blackant, Frank, Halfway, Horse, Juandah, Mud (including Tom's Gully), Wandoan and Woleebee creeks, would likely exist without groundwater input, but are known to utilise groundwater on occasion (episodic or opportunistic terrestrial GDEs, not obligate terrestrial GDEs). Notwithstanding, these vegetation communities form known or potential habitat for the Endangered (EBPC Act and NC Act) folivorous species koala (*Phascolarctos cinereus*) and central greater glider (*Petauroides armillatus*) (each observed during terrestrial GDE field surveys [Plate 2]) and likely provide higher leaf moisture content and nutritional value than surrounding vegetation not able to access groundwater in drier times.

Accordingly, the terrestrial GDEs of the Project area and surrounds are attributed a High Ecological Value (Category 1 sensitive environmental area) in accordance with the *Risk Assessment Guidelines for Groundwater-dependent Ecosystems* (Serov, Kuginis and Williams 2012), as referred to in the *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody, Hancock and Pritchard 2019).

Koala in TGDE on Woleebee Creek, 25/10/2024

Koala and joey in TGDE on Mud Creek, 24/10/2024

Greater glider beside Woleebee Creek, 22/08/2024

Greater glider beside Woleebee Creek, 22/08/2024

Plate 2 Threatened folivorous species opportunistically observed in terrestrial GDEs of the Project area

4 CONCLUSION

This terrestrial GDE assessment aims to broadly assess the terrestrial GDEs surrounding the Wandoan Coal Mine final landform.

Field verification of State-mapped and remotely sensed terrestrial GDEs confirmed that trees within a narrow corridor of riparian vegetation on the bed and banks of Blackant, Frank, Halfway, Juandah, Mud (including Toms Gully), Wandoan and Woleebee creeks are known to intercept groundwater in dry conditions and are therefore terrestrial GDEs (DPM Enviros ciences 2024). The riparian vegetation of Horse Creek to the west of the Project area also contains terrestrial GDEs, as confirmed by Shell QGC and their consultants during GDE condition monitoring (DPM Enviros ciences 2023). All field-verified terrestrial GDEs of the Project area and surrounds (including Horse Creek) are RE 11.3.25 (*Eucalyptus tereticornis* dominated woodland fringing drainage lines).

The waterways and riparian vegetation of the Project area and surrounds are subject to continuous natural wetting and drying cycles. The terrestrial GDE components of these riparian communities most likely have a facultative nature, accessing available moisture in the soil or sediments following rainfall, and accessing groundwater in the alluvial aquifer on occasion. Similarly, the riparian vegetation on the bed and lower banks may intermittently use the surface expression of groundwater during occasional periods of flow contribution from adjacent/underlying alluvium following prolonged rainfall or after flood events. Under these conditions, recharged alluvium may drain to the watercourses as the hydraulic gradient reverses; the result of which may sustain surface or shallow sub-surface flow for short periods (days, weeks or months) depending on the sequence of rainfall events.

The vegetation comprising terrestrial GDEs of the Project area and surrounds would likely persist without groundwater input yet is known to utilise groundwater on occasion (episodic or opportunistic terrestrial GDEs, not obligate terrestrial GDEs) during drier conditions. These vegetation communities form known and potential habitat for the Endangered (EBPC Act and NC Act) folivorous species koala (*Phascolarctos cinereus*) and greater glider (*Petauroides volans*) and likely provide higher nutrient and leaf moisture content than surrounding vegetation unable to access groundwater in drier times. Consequently, the terrestrial GDEs of the Project area and surrounds are attributed a High Ecological Value (Category 1 sensitive environmental area) in accordance with the criteria adopted for this Project.

GCAA should manage the post-mining landform of the approved Project by avoiding and minimising direct impacts (clearing) as far as practicable. The approved Project includes 16 mining pits, including the Woleebee Creek and Woleebee North pits that would have required diversion and open cut mining of their natural flow path, including complete removal of the riparian vegetation at these pit locations. However, GCAA has scaled back the approved Project to avoid these direct impacts to Woleebee and Wandoan creeks. GCAA should also continue to monitor the groundwater quality in the alluvium post closure where there are mapped terrestrial GDEs. If groundwater monitoring identifies significant changes to groundwater quality in the alluvium, then additional management measures should be reviewed including a GDE Management Plan. The GDE Management Plan may include corrective actions and reporting protocols.

5 REFERENCES

Bureau of Meteorology (the Bureau) 2024a, Taroom Post Office 35070, available: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=122&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=035070, accessed: 5 January 2024.

Bureau of Meteorology (the Bureau) 2024b, Woleebee Nevasa station 35081, available: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=035081, accessed: 5 January 2024.

Canadell J, Jackson RB, Ehlringer JR, Mooney HA, Sala OE and Schulze E-D 1996, Maximum rooting depth of vegetation types at the global scale. *Oecologia*, 108, 583-595.

Colloff M 2014, *Flooded Forest and Desert Creek: Ecology and History of the River Red Gum*. CSIRO Publishing, Collingwood.

Cunningham SC, Thomson JR, Mac Nally R, Read J and Baker PJ 2011, Groundwater change forecasts widespread forest dieback across an extensive floodplain system, *Freshwater Biology*, 56, 1494-1508.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2022, National Forest and Sparse Woody Vegetation Data - version 5.0 – 2020 release, Australian Government, available: https://data.gov.au/data/dataset/national-forest-and-sparse-woody-vegetation-data-version-5-2020-release

Department of Environment and Science (DES) 2022, Environmental authority EPML00297613 – Wandoan Coal Mine. Queensland Government, Emerald.

Department of Environment and Science (DES) 2023, Mapping data – *Queensland Groundwater Dependent Ecosystems and Potential GDE Aquifer Mapping 2018 Version 1.5.1*. Queensland Government, Brisbane.

Department of Regional Development, Manufacturing and Water (DRDMW) 2024, 130344A Juandah Creek at Windamere, 5 January 2024, available https://water-monitoring.information.qld.gov.au/

Department of Resources (DoR) 2022, *Remnant regional ecosystem map*, version 12.2. State of Queensland, Brisbane.

Department of Resources (DoR) 2023, Mapping data – *Detailed Surface Geology of Queensland*. Queensland Government, Brisbane.

Doody TM, Hancock PJ and Pritchard JL 2018 (draft for consultation), Assessing Groundwater-Dependent Ecosystems: IESC Information Guidelines Explanatory Note. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

Doody TM, Hancock PJ, Pritchard JL 2019, *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems*. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

DPM Envirosciences Pty Ltd (DPM Envirosciences) 2021, *Aquatic Ecology and Groundwater-Dependent Ecosystem Assessment – Valeria Project*. Prepared for Valeria Coal Holdings Pty Ltd.

DPM Envirosciences Pty Ltd (DPM Envirosciences) 2023, *2023 BioCondition Monitoring Report, Groundwater-Dependent Ecosystems, Surat North Project Area*. Prepared for CDM Smith Australia Pty Ltd and their client Shell QGC Pty Ltd.

DPM Enviros ciences Pty Ltd (DPM Enviros ciences) 2024, Wandoan Coal Project – Aquatic Ecology and Groundwater-Dependent Ecosystems – Baseline Survey Report. Prepared for SLR Consulting Pty Ltd and their client Glencore Coal Assets Australia Pty Ltd.

Kallarackal J and Somen CK 1998, Water relations and rooting depths of selected eucalypt species. Kerala Forest Research Institute (KFRI) Research Report 136. KFRI, Peechi, Thrissur, India.

KCB Australia Pty Ltd (KCB) 2024, Wandoan Mine Project – Progressive Rehabilitation and Closure Plan – Groundwater Assessment Report – Draft, prepared for Glencore Coal Assets Australia Pty Ltd.

NSW Department of Primary Industries (NSW DPI) 2016, *Methods for the identification of high probability groundwater dependent vegetation ecosystems*. NSW DPI, available: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/151894/High-Probability-GDE-method-report.pdf

Office of Groundwater Impact Assessment (OGIA), Department of Natural Resources, Mines and Energy 2019, Technical summary: terrestrial groundwater-dependent ecosystems in the Surat Cumulative Management Area. OGIA, available: https://www.rdmw.qld.gov.au/__data/assets/pdf_file/0005/1449014/terrestrial-groundwater-ecosystems-surat-cma.pdf

Orellana F, Verma P, Loheide II SP and Daly E 2012, Monitoring and modelling water-vegetation interactions in groundwater-dependent ecosystems, *Reviews of Geophysics*, 50, RG3003.

Richardson S, Irvine E, Froend R, Boon P, Barber S and Bonneville B 2011, *Australian groundwater-dependent ecosystems toolbox part 2: assessment tools*, Waterlines report, National Water Commission, Canberra.

Serov P, Kuginis L and Williams JP 2012, *Risk assessment guidelines for groundwater dependent ecosystems, Volume 1—The conceptual framework*. NSW Department of Primary Industries, Office of Water, Sydney, available: http://archive.water.nsw.gov.au/__data/assets/pdf_file/0005/547682/gde_risk_assessment_guidelines_volume_1_final_accessible.pdf accessed November 2018

United States Geological Survey Center for Earth Resources Observation and Science (USGS) 2022a, Landsat Normalized Difference Vegetation Index, Landsat Missions 2022, available: https://www.usgs.gov/landsat-missions/landsat-normalized-difference-vegetation-index

United States Geological Survey Center for Earth Resources Observation and Science (USGS) 2022b, Landsat Spectral Indices products, United State Geological Survey, Earth Explorer, Landsat Missions 2022 United States Department of the Interior, available: https://earthexplorer.usgs.gov/z

United State Geological Survey Center for Earth Resources Observation and Science (USGS) 2022c, Landsat 8 Quality Assessment Band Pixel Value Interpretations, Landsat Missions 2022, United State Geological Survey, available: https://www.usgs.gov/media/images/landsat-8-quality-assessment-band-pixel-value-interpretations

Mining Lease	Land identifier	Land usage	Finalised
ML 50229	LOT 37 ON FT575 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 34 ON FT480 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 34 ON FT490 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 35 ON FT575 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 35 ON FT987 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 36 ON FT493 FREEHOLD	Permit	07-05-2014
ML 50229	LOT 1 ON RL5110 ROAD LICENSE	Permit	20-11-2013
ML 50229	LOT 1 ON RL5111 ROAD LICENSE	Permit	20-11-2013
ML 50229	LOT 20 ON FT464 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 21 ON FT493 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 59 ON FT556 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 53 ON FT505 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 54 ON FT504 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 55 ON FT503 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 55 ON FT826 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 58 ON FT556 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 39 ON FT503 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 40 ON FT503 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 48 ON FT573 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 51 ON FT507 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 28 ON FT467 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 29 ON FT467 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 30 ON FT468 FREEHOLD	Permit	20-11-2013
ML 50229	LOT 30 ON FT491 FREEHOLD	Permit	20-11-2013
ML 50229	KABUNGA ROAD	Permit	20-12-2012
ML 50229	BOORAL ROAD	Permit	20-12-2012
ML 50229	RYALS ROAD	Permit	20-12-2012
ML 50229	CECILS ROAD	Permit	20-12-2012
ML 50229	GROSMONT ROAD	Permit	20-12-2012
ML 50229	Q ROAD	Permit	20-12-2012
ML 50229	MARKWELLS ROAD	Permit	20-12-2012

Mining Lease	Land identifier	Land usage	Finalised
ML 50229	LOT 18 ON SP127560 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 2 ON SP210618 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 4 ON FT758 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 36 ON FT575 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 25 ON FT481 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 29 ON FT490 FREEHOLD	Permit	10-09-2012
ML 50229	LOT 72 ON FT590 FREEHOLD	Permit	29-08-2012
ML 50229	LOT 52 ON FT830 FREEHOLD	Permit	24-05-2011
ML 50229	LOT 71 ON FT503 UNALLOCATED STATE LAND	Permit	25-02-2010
ML50230	T 87 ON FT325 FREEHOLD	Permit	20-11-2013
ML50230	LOT 88 ON FT911 FREEHOLD	Permit	20-11-2013
ML50230	LOT 89 ON FT910 FREEHOLD	Permit	20-11-2013
ML50230	LOT 9 ON FT246 FREEHOLD	Permit	20-11-2013
ML50230	LOT 62 ON FT218 FREEHOLD	Permit	20-11-2013
ML50230	LOT 68 ON FT246 FREEHOLD	Permit	20-11-2013
ML50230	LOT 69 ON FT246 FREEHOLD	Permit	20-11-2013
ML50230	LOT 7 ON FT912 FREEHOLD	Permit	20-11-2013
ML50230	LOT 48 ON FT573 FREEHOLD	Permit	20-11-2013
ML50230	LOT 49 ON FT826 FREEHOLD	Permit	20-11-2013
ML50230	LOT 6 ON FT432 FREEHOLD	Permit	20-11-2013
ML50230	LOT 42 ON FT348 FREEHOLD	Permit	20-11-2013
ML50230	LOT 43 ON SP108598 FREEHOLD	Permit	20-11-2013
ML50230	LOT 115 ON FT452 FREEHOLD	Permit	20-11-2013
ML50230	LOT 116 ON FT452 FREEHOLD	Permit	20-11-2013
ML50230	LOT 118 ON FT452 FREEHOLD	Permit	20-11-2013
ML50230	LOT 2 ON FT418 FREEHOLD	Permit	20-11-2013
ML50230	LOT 110 ON FT487 PERPETUAL LEASE	Permit	20-11-2013
ML50230	LOT 111 ON FT487 PERPETUAL LEASE	Permit	20-11-2013
ML50230	LOT 114 ON FT884 FREEHOLD	Permit	20-11-2013
ML50230	ROAD RESERVE (JACKSON WANDOAN ROAD)	Permit	20-12-2012

Mining Lease	Land identifier	Land usage	Finalised
ML50230	GROSMONT ROAD	Permit	20-12-2012
ML50230	Q ROAD - Road Reserve	Permit	20-12-2012
ML50230	PARADISE DOWNS ROAD	Permit	20-12-2012
ML50230	PEAKES ROAD	Permit	20-12-2012
ML50230	UNNAMED ROAD	Permit	20-12-2012
ML50230	LOT 10 ON FT949 FREEHOLD	Permit	10-09-2012
ML50230	LOT 105 ON FT415 FREEHOLD	Permit	10-09-2012
ML50230	LOT 106 ON FT782 FREEHOLD	Permit	10-09-2012
ML50230	LOT 86 ON FT782 FREEHOLD	Permit	10-09-2012
ML50230	LOT 9 ON FT384 FREEHOLD	Permit	10-09-2012
ML50230	LOT 61 ON FT218 FREEHOLD	Permit	10-09-2012
ML50230	LOT 8 ON FT218 FREEHOLD	Permit	10-09-2012
ML50230	LOT 52 ON FT614 FREEHOLD	Permit	10-09-2012
ML50230	LOT 53 ON FT931 LAND LEASE	Permit	10-09-2012
ML50230	LOT 60 ON FT218 FREEHOLD	Permit	10-09-2012
ML50230	LOT 38 ON FT816 FREEHOLD	Permit	10-09-2012
ML50230	LOT 41 ON FT496 FREEHOLD	Permit	10-09-2012
ML50230	LOT 42 ON SP108598 FREEHOLD	Permit	10-09-2012
ML50230	LOT 43 ON FT348 FREEHOLD	Permit	10-09-2012
ML50230	LOT 156 ON FT931 FREEHOLD	Permit	10-09-2012
ML50230	LOT 3 ON FT695 FREEHOLD	Permit	10-09-2012
ML50230	LOT 109 ON FT915 FREEHOLD	Permit	10-09-2012
ML50230	LOT 112 ON FT825 FREEHOLD	Permit	10-09-2012
ML50230	LOT A ON AP18876 PERMIT TO OCCUPY 234248	Permit	28-02-2012
ML50230	LOT 113 ON FT488 SPECIAL LEASE 234539 (INDUSTRIAL PURPOSES)	Permit	28-02-2012
ML50231	LAND LEASE	Permit	20-11-2013
ML50231	LOT 48 ON FT573 FREEHOLD	Permit	20-11-2013
ML50231	LOT 49 ON FT826 FREEHOLD	Permit	20-11-2013
ML50231	LOT 50 ON FT573 FREEHOLD	Permit	20-11-2013
ML50231	LOT 52 ON FT614 FREEHOLD	Permit	20-11-2013

Mining Lease	Land identifier	Land usage	Finalised
ML50231	LOT 55 ON FT826 FREEHOLD	Permit	20-11-2013
ML50231	LOT A ON AAP18876 LAND LEASE	Permit	20-11-2013
ML50231	LOT 16 ON FT1012 FREEHOLD	Permit	20-11-2013
ML50231	LOT 41 ON FT496 FREEHOLD	Permit	20-11-2013
ML50231	LOT 43 ON FT495 FREEHOLD	Permit	20-11-2013
ML50231	LOT 44 ON FT495 FREEHOLD	Permit	20-11-2013
ML50231	LOT 45 ON FT497 FREEHOLD	Permit	20-11-2013
ML50231	LOT 34 ON FT490 FREEHOLD	Permit	24-06-2013
ML50231	GROSMONT ROAD	Permit	20-12-2012
ML50231	BUNDI ROAD	Permit	20-12-2012
ML50231	V ROAD	Permit	20-12-2012
ML50231	UNALLOCATED STATE LAND (WANDOAN CREEK)	Permit	10-09-2012
ML50231	UNALLOCATED STATE LAND (WOLEEBEE CREEK)	Permit	10-09-2012

WANDOAN
COAL PROJECT

GLENCORE

27 September 2024

Department of Environment, Science and Innovation
Coal Business Centre
PO Box 3028
Emerald QLD 4720
Via email - CRMining@des.qld.gov.au

Dear Department of Environment, Science and Innovation,

RE: Landowner statement for retention of infrastructure on land underlying the Wandoan Coal Project Mining Leases.

The Wandoan Coal Project (WCP) is a joint venture (WJV) between Glencore's Wandoan Holdings Pty Limited (WHL) (87.5% ownership) and SCAP Wandoan Pty Ltd (12.5% ownership). WJV is the Environmental Authority (EA) holder of EPML00297613 and the associated Mining Leases (MLs) 50229, 50230 and 50231. WHL is the owner **(the Landowner)** of freehold Lots underlying MLs listed in **Attachment 1 (the Land)**. There are freehold Lots underlying the WCP MLs that are not owned by the WJV and there is currently no infrastructure proposed to remain on those Lots.

Provided below is a statement made by WHL as the Landowner to retain ownership of current and future planned infrastructure located on the Land.

Landowner Statement
The Landowner seeks to retain, and agrees to accept responsibility for the infrastructure established by mining resource activities on MLs 50229, 50230 and 50231 described in **Table 1** below, that is proposed to remain on-site for agricultural purposes following the cessation of mining, and in particular, rehabilitation activities.

The Landowner seeks to retain the infrastructure as they are assets that will be used to support ongoing agricultural activities as an approved post-mining land use and will provide a benefit and improvement to the use of the Land following the cessation of mining activities, as set out in **Table 1** below.

State of infrastructure upon transfer
The Landowner acknowledges and agrees that ownership and ongoing responsibility for the infrastructure, including maintenance of that infrastructure, the infrastructure will be transferred after cessation of mining.

The Landowner also acknowledges and agrees that the infrastructure will be transferred in an acceptable state that is consistent with the achievement of the approved post-mining land use and is safe to humans and wildlife, non-polluting and stable.

Table 1: Infrastructure to be Retained by WHL as the Landowner

Item	Purpose of retention	Benefit of retention
Clean water storages.	Stock watering and/or crop irrigation for grazing activities.	A source of clean water is essential for grazing activities and trucking in clean water can be very costly.
Roads, tracks and remediated haul roads including associated infrastructure i.e. crossings, culverts etc.	Accessibility for grazing activities.	Utilising existing access roads removes the need to construct additional infrastructure and create additional disturbance through rehabilitated areas.
Built infrastructure including repurposed buildings and sheds.	Supports ancillary activities for grazing activities.	Utilising existing infrastructure such as sheds, administrative buildings and facilities removes the need to construct additional buildings and create additional disturbance through rehabilitated areas.
Water bores.	Access to groundwater for grazing activities.	A source of clean water is essential for grazing activities and trucking in clean water can be very costly. This water can also be used for topping up water storages and for fire management.
Essential infrastructure including power lines, water supply pipelines, fencing, fire breaks.	Essential services and infrastructure for property management and grazing activities.	Utilising existing services removes the need to construct additional infrastructure and create additional disturbance through rehabilitated areas.

Landowner Statement Approval

By signing this statement WHL, as the owner of the Land, agrees to accept ownership of and responsibility for the infrastructure described in **Table 1** on the terms set out above.

Wandoan Holdings Pty Limited
Signature:

Name: Michael Adamski
Position: Financial Controller

Contact

Should you have any queries regarding this landowner statement, please contact Melissa Brunner on 0419 357 531 or melissa.brunner@glencore.com.au.

Yours sincerely,

Scott Elliott
Project Director

Coal Assets Australia, GLENCORE
M: +61 439 631 371
E: scott.elliott@glencore.com.au
W: www.glencore.com

Attachment 1: Lot/Plan for land owned by WHL which underlies MLs 50229, 50230 and 50231.

105FT415	28FT467	4FT758	88FT911
106FT782	29FT467	50FT573	89FT910
109FT915	29FT490	51FT507	8FT218
10FT949	2FT418	52FT614	9FT246
110FT487	2SP210618	53FT505	9SP312433
111FT487	30FT468	53FT931	AAP18876
112FT825	30FT491	54FT504	AAP21184
113FT488	36FT575	55FT503	
114FT884	38FT816	55FT826	
115FT452	3FT695	58FT556	
116FT452	41FT496	59FT556	
118FT452	42FT348	60FT218	
156FT931	42SP108598	61FT218	
16FT1012	43FT348	62FT218	
18SP127560	43FT495	68FT246	
1RL5111	43SP108598	69FT246	
1SP277385	44FT495	6FT432	
20FT464	45FT497	7FT912	
21FT493	48FT573	86FT782	
25FT481	49FT826	87FT325	

COAL ASSETS AUSTRALIA

GLENCORE

Community Consultation Plan

Wandoan Coal Project

Number: Community Consultation Plan
Owner: Bronwen Morrison

Status: Final
Version: Rev 2

Effective: 01/12/2025
Review: 01/12/2027

Uncontrolled unless viewed on the intranet

Table of Contents

1. Introduction 2
1.1 Purpose 2
1.2 Scope 2
1.3 Objectives 2
2. Community Context 3
2.1 Project Description 3
2.2 Community Profile 3
3. Community and Stakeholders 4
4. Engagement Techniques 5
4.1 Historical Consultation Methods 7
4.2 Existing Consultation Methods 7
5. Consultation Plan 9
6. Community Consultation Register 12
Appendix A - Community Consultation Register 13

1. Introduction

1.1 Purpose

The purpose of this Community Consultation Plan (CC Plan) is to document historic and proposed community and stakeholder consultation by Wandoan Holdings Pty Limited and SCAP Wandoan Pty Ltd (Wandoan Joint Venture (WJV)) regarding rehabilitation and closure aspects of the Wandoan Coal Project (WCP). The CC Plan supports the Progressive Rehabilitation and Closure Plan (PRCP) and meets the requirements of section 126C(1)(c)(iii) and (iv) of the *Environmental Protection Act 1994* (EP Act).

1.2 Scope

The CC Plan includes the following:

- Objectives of consultation;
- Identification of community and stakeholders;
- Consultation methodologies and engagement techniques;
- Scope of information to be consulted on frequency; and
- A Consultation Register including historic community consultation.

The CC Plan applies to WCP mining leases (MLs) 50229, 50230 and 50231 to which Environmental Authority (EA) EPML00297613 applies. The CC Plan is regularly reviewed to enure it remains current and effective.

1.3 Objectives

The objectives of the mine closure and rehabilitation consultation process are to achieve the following:

- Identify, inform and engage the community on rehabilitation and closure of the WCP;
- Provide ongoing consultation throughout the life of mine to communicate mine planning, progressive rehabilitation, socio-economic and environmental impacts of mine closure;
- Collaborate with the community to identify mine closure opportunities and constraints;
- Reinforce relationships between WCP and the community; and
- Provide opportunities for the community to provide comments and feedback.

2. Community Context

2.1 Project Description

The WCP is an approved greenfield open-cut coal mine, located in the Western Downs region of Queensland. WCP is owned by the WJV.

The WCP was issued environmental approvals by State and Commonwealth Governments between 2011 and 2013, with the MLs subsequently granted in 2017. The WCP has subsequently remained undeveloped.

The WCP is located within Western Downs Regional Council Local Government Area, approximately 300 kilometres (km) southeast of Emerald and 250 km southwest of Gladstone. The ML areas extend approximately 34 km in an east-west direction and 22 km in a north-south direction over roughly 30,068 hectares (ha).

2.2 Community Profile

The WCP is located directly west of the township of Wandoan. The township is located approximately halfway between Taroom and Miles and is the centre for the local cattle industry. The town's economy is based on agriculture, including cattle grazing. Coal mining and CSG production are established industries within the region. The Surat Basin itself is a key area for CSG production and development and hosts numerous coal mining projects.

Wandoan is serviced with a library and community centre, community swimming pool, veterinary surgeon, fire brigade, police station, hotel/motel, official post office, 3-day-a-week coach bus service and a state school from prep to year 10. Medical services available in the town include an out-patient clinic, with a doctor available twice a week and a nurse available on week days, an ambulance service and a chemist.

The census shows that as of 2021, 666 residents lived in Wandoan, with 54% working full or part time. At this time, the majority of workers were employed as labourers, technicians and trade workers or machinery operations and drivers.

Wandoan is supported by additional services in the township of Taroom (located 60 km to the north with a population under 900) which has a small private hospital including an emergency department, private aircraft airport, and second state school from prep to year 10. Wandoan is also supported by Miles (located 70 km to the south with a population under 1,500) wich has a hospital service (including emergency and surgical), medical and dental practices, primary and high school and a range of retail, agricultural and domestic services.

3. Community and Stakeholders

The Department of Environmen, Science and Innovation (DESI) information sheet *Community Consultation for Progressive Rehabilitation and Closure Plan* (version 1.0, 01 Nov 2019) was used to assist in identifying community members and stakeholders relevant to mine closure for the PRCP. The information sheet highlights that members of the community must have a genuine interest in the underlying, adjacent or surrounding land where the mine is located and provides following examples of genuine interest:

- Direct impact interest (e.g. underlying and adjacent landholders);
- Cultural interest (e.g. Indigenous communities, Traditional Owners including Native Title holders);
- Heritage interest (e.g. State or Local government or relevant community groups);
- Environmental interest (e.g. State or Local government or relevant community groups);
- Recreational interest (e.g. community groups);
- Land use interest (e.g. overlapping tenure holders, agricultural entities or Local government); or
- Health interest (e.g. State or Local government, community groups).

Based on this, the community/stakeholders to be engaged as part of the PRCP are identified in Table 1.

Table 1 Relevant Community/Stakeholders

Category	Stakeholders	Interest in the Land
Local Community	Wandoan township - residents and businesses.	Direct impact, recreational, i.e. live and/or work in Wandoan.
WCP Community Reference Group	Established community group involving key local stakeholders including: • Regional Council; • representative from local community; • special interest groups; and • Non-Governmental Origanisations (NGOs).	Direct impact, recreational, i.e. live and/or work in Wandoan.
Traditional Owners	Iman People.	Cultural heritage and direct impact, recreational, land use – live and or work in the region.
Neighbouring landholders	Neighbouring landholders adjacent to the MLs.	Direct impact – adjacent landholders.
Local Government	Western Downs Regional Council	Land use interest.
State Government	• Department of Environment, Science and Innovation; and • Department of Resources.	Environment impacts and resource longevity.

4. Engagement Techniques

The International Association for Public Participation (2018) designed a spectrum of public participation which can be used to assist with the selection of the level of participation defining the community's role in the process (refer Figure 1). The Methods Matrix (IAP2) is a tool for selecting methods to match the community consultation needs (refer Table 2).

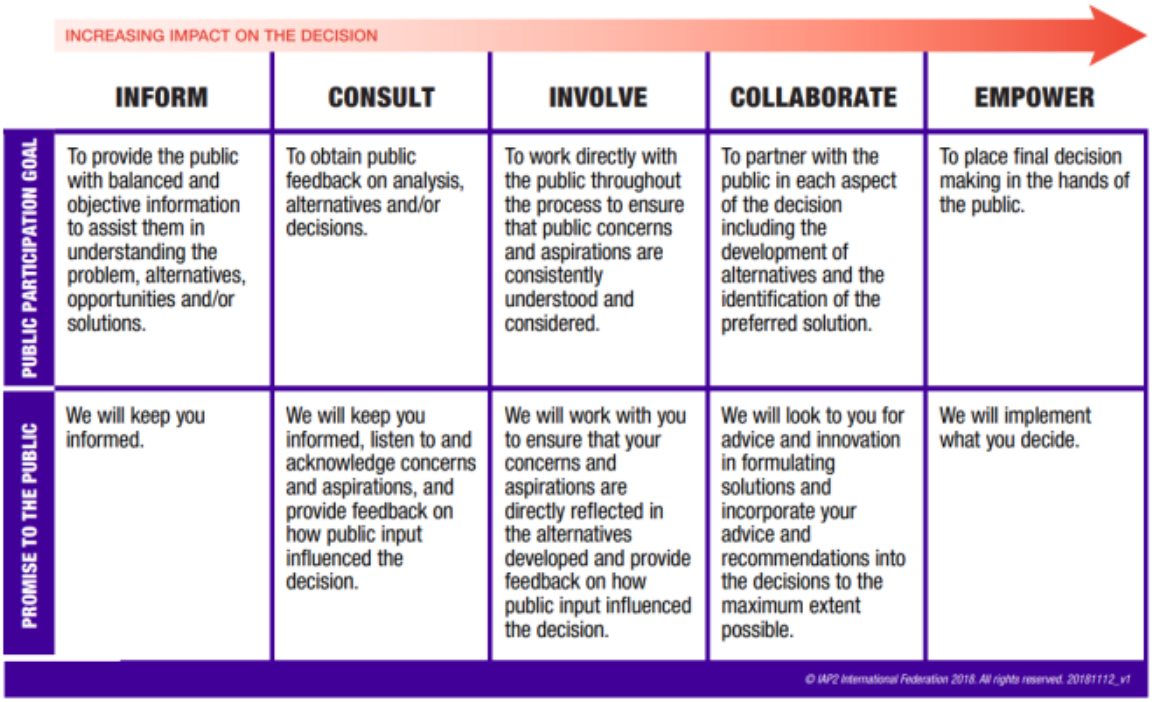


Figure 1 Spectrum of Public Participation (IAP2, 2018)

Table 2 Methods Matrix (IAP2)

Engagement and Communication Technique	Description	Level of Engagement				
		Inform	Consult	Involve	Collaborate	Empower
Field office, shop front	A staffed office or shop front located at or near a project site/operation where stakeholders can get information, ask questions or share concerns.	X	X			
Web sites	Information repository, but can include comments platforms, hosted chat times.	X	X			
Central information contacts	Designated person who serves as a single point of contact for enquires.	X				
Telephone hotlines	Toll-free, publicised telephone number to call to seek info, ask question, submit.	X	X			
Fairs, Community Events	Central event with activities to provide information or raise awareness.	X	X			
Newsletters, Fact Sheets, Reports, Direct Mailing	Written material directly mailed, either physically or electronically, and/or shared.	X				
Comment forms	Forms given to people to complete and return.		X			
Public meetings	Organised large group meeting usually to make a presentation and give the public an opportunity to ask questions and give comments.	X	X			
Open days, tours and field trips	Opportunities for stakeholders to learn about or see a particular topic by going on a field trip.		X	X	X	
Workshops	Public forum where participants work in small groups on defined assignments.		X	X	X	

4.1 Historical Consultation Methods

Community consultation was undertaken by WCP for the WCP environmental approvals process in preparing an Environmental Impact Statement (EIS). The consultation methods outlined below were used during the EIS process and may be reinstated to support the WCP should development occur.

WCP Community Reference Group

A Community Reference Group (CRG) was formed by the WCP in 2007, composed of representatives from local community, including the local council, chamber of commerce and the local state school. The CRG represented the interests of local community groups and organisations in and around Wandoan. The purpose of the CRG meetings was to update the community about project progress and to provide an opportunity for CRG members to discuss any issues raised by the community. The CRG would meet several times a year during times of project activity. The CRG meetings ceased in 2016 and will be reinstated if the WCP is developed.

WCP Newsletter

The WCP newsletter was a community-based newsletter managed by the WCP team. The newsletter featured community stories, events, local businesses and updates on community initiatives. The newsletter was also utilised to provide general information about the project and its activities, as well as communicating key project milestones. The newsletter was distributed to all stakeholders and the communities of Wandoan, Taroom, Miles and other surrounding towns. Distribution of the newsletter ceased in 2013 when the WCP went on hold.

Community Workshops

Workshops were held by the WCP for the communities of Wandoan, Taroom and Miles. The workshops provided information about the project to community members and also enabled community members to provide feedback, discuss their perceptions and voice any concerns regarding the project.

4.2 Existing Consultation Methods

The consultation forums and processes outlined below have been used to inform the community of mine closure and rehabilitation planning for the development of the WCP PRCP. The consultation undertaken at this time is considered appropriate due to the greenfield nature of the mine site, with further engagement with stakeholders relating to mine rehabilitation and closure planned for when development of the WCP commences and through the life of the mine.

WCP Office (located in Wandoan)

The WCP Office (in the township of Wandoan) has been open since the WCP EIS process was undertaken and the Glencore office staff are known and respected members of the community. The WCP office is a place where the local community can engage with the WCP and seek any information, advice or clarification required.

WCP Website

The WCP website is supported and managed by Glencore and provides useful information to the community and public. The website provides relevant information about the project and its facilities, including community investment and the latest project news.

Window on Wandoan

The Window on Wandoan (WoW) is published monthly by the Wandoan Community Commerce and Industry Association (WCCIA) and is available online, from multiple businesses within Wandoan and can also be delivered to members of the community. The newsletter features community stories, events, local businesses and updates on community initiatives. An article was published in the WoW on 5 March 2024 outlining the requirements of the PRCP process for WCP and to seek comment. The article detailed the statutory requirements for a PRCP, what a PRCP is and what it contains and the key information regarding the WCP PRCP. A link to the PRCP public register was also provided to enable the community to read the WCP PRCP post submission to DESI. The community was provided an update on 5 September 2024 with a subsequent article published in the WoW outlining that the site design for closure had been updated.

Information Letter

Letters were sent on 1 March 2024 to the private landowners on the MLs, WJV's licensees, Traditional Owners and the Western Downs Regional Council to advise them of the PRCP process for WCP and to seek comment. The letter detailed the statutory requirements for a PRCP, what a PRCP is and what it contains and the key information regarding the WCP PRCP. A link to the PRCP public register was also provided to enable these stakeholders to read the WCP PRCP post submission to DESI. Key stakeholders were informed by way of letter on 02 September 2024 that updates to the PRCP had been made to ensure the PRCP aligns with current regulatory approvals.

5. Consultation Plan

As the WCP remains undeveloped, consultation is undertaken as required. If the WCP is developed, the WCP will undertake consultation and engagement relating to rehabilitation and mine closure to inform, consult, involve, collaborate and empower the community where appropriate as well as indentify risks and opportunities.

The PRCP Guideline requires mines to plan for when and how consultation should occur in the future, including in the following circumstances:

1. Significant mine planning changes result in the delay of rehabilitation or relinquishment;
2. Changes are made to approved post-mining land uses and non-use management areas;
3. When new areas of disturbance are proposed;
4. Significant changes are made to rehabilitation methodologies;
5. Large legislative changes impact or influence rehabilitation and closure; and
6. When there may be opportunities for collaboration on rehabilitation objectives.

Information and feedback from any consultation or engagement will be considered on a case-by-case basis. In some instances, options for change may be limited—particularly where regulatory requirements mandate specific actions.

Any complaints will be documented and recorded in the Consultation Manager and escalated to the WCP Site Senior Executive.

As of December 2025, WCP remains a greenfield project with commencement date for operations to still be confirmed, thus, no further community consultation has been undertaken. Community Consultation processes will recommence if the status of WCP changes.

The consultation level, engagement techniques, frequency of engagement, information to be communicated and how feedback will be incorporated for each stakeholder identified above is outlined in Table 3. If the WCP is developed, the techniques and frequency of consultation outlined in Table 3 shall be reassessed accordingly.

Table 3 Community Consultation Plan

Category	Stakeholders	Level of Engagement	Engagement Techniques	Frequency	Information to be communicated
Local Community	Wandoan township – residents and businesses.	• Inform; and • Consult.	Community events.	As required.	• Post mining land uses, mine progression and rehabilitation schedule; • Mine closure implications for workers; • Opportunities in rehabilitation and closure; • Updates on closure progress; and • Community investment and positive legacy projects.
			WCP Website.	Ongoing	
			Site tours.	As required.	
			Newsletters.	Quarterly.	
			Factsheets.	Quarterly.	
			Reactive engagement – telephone hotline, briefings, etc.	As required.	
Wandoan Community Reference Group (CRG)	CRG of WCP stakeholders, representing local community, special interest groups, government organisations and NGOs as relevant.	• Inform; • Consult; and • Involve.	Community events.	As required.	• Post mining land uses, mine progression and rehabilitation schedule; • LOM implications for workers and community; • Opportunities in rehabilitation and closure; • Updates on closure progress; and • Community investment and positive legacy projects.
			WCP Website.	Ongoing.	
			Site tours.	Annually.	
			Newsletters.	Quarterly.	
			CRG Meetings.	Annually or more frequently as required.	
			Reactive engagement – telephone hotlines, briefings, etc.	As required.	
Traditional Owners	Iman People.	• Inform; and • Consult.	WCP Website.	Ongoing.	• Post mining land uses, mine progression and rehabilitation schedule; • Opportunities for Indigenous employment, training and development in rehabilitation and closure; and
			Cultural heritage- related meetings.	As required.	

Category	Stakeholders	Level of Engagement	Engagement Techniques	Frequency	Information to be communicated
					• Cultural heritage management.
Neighbouring and underlying landholders	Neighbouring landholders adjacent to the MLs and private landowners under the MLs.	• Inform; • Consult; and • Involve.	Neighbours day.	Annually.	• Environmental and social performance of rehabilitation and mine closure including success stories ; • Community investment; • Expected mine life and potential implications for the local community; • Post mining land uses, mine progression and rehabilitation schedule; and • Future cattle agistment opportunities.
			WCP website.	Ongoing.	
			One to One meetings	As required.	
			Site visits.	As required.	
			Reactive engagement – telephone hotlines, briefings, etc.	As required.	
State Government	• Department of Environment, Science and Innovation. • Department of Resources.	• Inform; • Consult; and • Involve.	Tours and field visits.	As required.	• Compliance with environmental and regional planning approvals; • Potential cumulative impacts; • Expected Life of Mine and potential implications for all stakeholders; and • Environmental and social performance.
			Meetings.	As required.	
			Ongoing advisory group meetings and updates.	As required.	
Local Government	Western Downs Regional Council.	• Inform; • Consult; and • Involve.	WCP Website.	All year round.	• Alignment with Western Downs Regional Council plans for the region; • Environmental and social impact performance of rehabilitation and mine closure; • Expected mine life and potential implications for the local community; • Legacy projects and investment; and • Infrastructure retention.
			Meetings.	As required.	
			Tours and field trips.	As required.	
			Briefings.	As required.	

Uncontrolled unless viewed on the intranet

6. Community Consultation Register

A record of all closure and rehabilitation consultation undertaken for WCP must be kept in the Community Consultation Register. The register records the following information:

- Consultation date(s);
- Stakeholder or community member name(s);
- Consultation method;
- Information provided;
- Issues raised by stakeholders/community;
- How issues have been or are intended to be considered;
- Any decisions/outcomes of the consultation; and
- Any commitments made.

A copy of the register is provided as Appendix A.

Appendix A - Community Consultation Register

Date	Community Group	Consultation Type/Method	Information Provided	Issues Raised related to rehabilitation and closure	How issues have been considered	Outcomes of engagement	Commitments
July 2007 to April 2008	Local Communities (Wandoan, Miles and Taroom).	Community information workshops.	Provided an overview of the WCP, updated project status and a forum for community members to voice questions or concerns regarding the project.	• The rehabilitation process; • Examples of succeful mine rehabilitation works; • Examples of progressive rehabilitation; • True land productivity once rehabilitation occurs; • The need to take photographic records of the region for benchmarking the rehabilitation process; • Rehabilitation of the mine should operations not continue to be viable; and • The importance of rehabilitation during and after operations.	The issues raised during consultation through the WCP EIS process will be revisited during community consultation on mine rehabilitation and closure if the WCP is developed.	N/A	Engage with the community on mine rehabilitation and closure throughout mine life.
October 2007 to September 2008	Wandoan CRG.	Meetings.	Provided information on the proposed mine and associated infrastructure.	• The rehabilitation process for the mine site; and • The need for rehabilitation plans to be in place before mining commences.	The issues raised during consultation through the WCP EIS process will be revisited during community consultation on mine rehabilitation and closure if the WCP is developed.	N/A	Engage with the community on mine rehabilitation and closure throughout mine life.
August 2008	Local community members.	Site tour.	Tour of bulk sample pit and associated rehabilitation areas.	• Enabled local community members to view small scale rehabilitation to understand rehabilitation techniques and efforts.	The community was able to view rehabilitation efforts and understand the techniques utilised in mine rehabilitation.	Community members were able to better understand mine site rehabilitation.	N/A
December 2008 to April 2009	Local residents of Wandoan, Miles and Taroom.	Community information workshops.	Provided an overview of the WCP, updated project status and a forum for community members to voice questions or concerns regarding the project.	• Discussion of the potential post mining landform and the rehabilitation of the site.	The issues raised during consultation through the WCP EIS process will be revisited during community consultation on mine rehabilitation and closure if the WCP is developed.	N/A	Engage with the community on mine rehabilitation and closure throughout mine life.
September 2011	Community members.	Email Invitation.	Invitation to community members to attend a rehabilitation information site tour of Xstrata Coal NSW sites.	• A visit to Xstrata Coal Hunter valley sites to enable community members to view mine site rehabilitation.	N/A	N/A	N/A
October 2011	Community member.	Email correspondence	Thank you and outcomes for the Hunter Valley trip from a community member.	• The group thought the rehabilitation was better than expected and in some cases quite impressive; • Community members thought Xstrata was making a concerted effort in terms of rehabilitation; and • Following the trip a number of the community members indicated they were interested in being involved in advising on the technical aspects of the rehabilitation program for the WCP. They felt their considerable expertise on local soils, pasture and conditions can only help achieve better rehabilitation results.	The issues raised during consultation through the WCP EIS process will be revisited during community consultation on mine rehabilitation and closure if the WCP is developed..	Community members were able to gain a better understanding of mine site rehabilitation and how a post mining landform is formed.	Engage with the community on mine rehabilitation and closure throughout mine life.
November 2011	Community member.	Letter.	Thank you letter from the Hunter Valley Trip from a community member.	• The community member indicated that they believed the Wandoan country can be returned to grazing and farming land by putting a layer of clay soils under the top soil during rehabilitation to keep the moisture	The issues raised during consultation through the WCP EIS process will be revisited during community	Community members were able to gain a	Engage with the community on mine rehabilitation and

Date	Community Group	Consultation Type/Method	Information Provided	Issues Raised related to rehabilitation and closure	How issues have been considered	Outcomes of engagement	Commitments
				in the surface root zone otherwise the moisture will just disappear into the sandstone.	consultation on mine rehabilitation and closure if the WCP is developed..	better understanding of mine site rehabilitation and how a post mining landform is formed.	closure throughout mine life.
November 2011	WCP CRG.	Meeting.	Feedback from site tour undertaken at Xstrata's New South Wales Sites.	• The Mount Owen Mine was a Forestry Lease prior to mining and has been successfully returned to forestry. A community member said the pasture was as good a stand of grass as you'd get anywhere – Rhodes Grass as well as Medics and Lucerne; • The community member also encouraged Xstrata to undertake grazing trials on their rehabilitated land. They were concerned about the steepness of some sites but overall was surprised by the results of rehabilitation; • Community members appreciated the trip and praised the rehabilitation efforts; • Local community members have voiced that they want to be involved in the rehabilitation process; and • Community members have requested to visit Rolleston to view their Rehabilitation.	The issues raised during consultation through the WCP EIS process will be revisited during community consultation on mine rehabilitation and closure if the WCP is developed..	Community members were able to gain a better understanding of mine site rehabilitation and how a post mining landform is formed.	Engage with the community on mine rehabilitation and closure throughout mine life.
March 2024	Wandoan Community – Local town, residents and businesses.	Newsletter acticle in March 2024 Window on Wandoan (WoW) Newsletter.	An article was published in the WoW newsletter outlining the requirements of the PRCP process.	• The article detailed the statutory requirements for a PRCP, what a PRCP is and what it contains and the key information regarding the WCP PRCP. A link to the PRCP public register was also provided to enable the local community to read the PRCP post submission.	The community were made aware of works being undertaken for the PRCP and requirement for the PRCP. The community were given the opportunity to contact the WCP if they had comments or questions relating to the PRCP process or the project more generally.	Community members were made aware of the statutory requirements for a PRCP and why works were being undertaken for the WCP.	Engage with the community on mine rehabilitation and closure throughout mine life.
March 2024	Underlying landowners, licensees of WJV land, Traditional Owners and local council	Letter.	A letter was sent to the underlying landowners, WJV licensees, Traditional Owners and the local council to advise them that the WCP is developing a PRCP.	• The letter detailed the statutory requirements for a transitional PRCP, what a PRCP is and what it contains and the key information regarding the WCP PRCP. A link to the PRCP public register was also provided to enable these stakeholders to read the PRCP post submission.	Underlying landowners, licensees, Traditional Owners and the local council were made aware of studies being undertaken for the PRCP and requirement for the PRCP. These stakeholders were given the opportunity to contact WJV if they had comments or questions relating to the PRCP process or the project more generally.	Stakeholders were made aware of the statutory requirements for a PRCP and why works were being undertaken for the WCP.	Engage with landowners, Traditional Owners and local council on progressive rehabilitation and closure planning over the life of mine.
Sept 2024	Wandoan Community – Local town, residents and businesses.	Newsletter acticle in September 2024 Window on Wandoan (WoW) Newsletter.	An article was published in the WoW newsletter outlining updates to the PRCP process.	• The article reiterated the statutory requirements for a transitional PRCP and the requirement for a PRCP regardless of whether the WCP is developed. The article advised of updates to the PRCP to align with current regulatory approvals. A link to the PRCP public register was also provided to enable the local community to read the PRCP post submission.	The community were made aware that updates to the development of the PRCP had occurred. The community was given the opportunity to contact WJV if they had comments or questions relating to the PRCP process or the project more generally.	Community members were made aware of updates to the PRCP to align with current regulatory approvals.	Engage with the community on mine rehabilitation and closure throughout mine life.
Sept 2024	Underlying landowners, licensees of WJV land, Traditional	Letter.	A letter was sent to the underlying landowners, WJV licensees, Traditional Owners and the local council to advise	• The letter reiterated the statutory requirements for a transitional PRCP and the requirement for a PRCP regardless of whether the WCP is developed. The letter advised of updates to the PRCP to align with current regulatory approvals. A link to the PRCP public register was also	Underlying landowners, licensees, Traditional Owners and the local council were made aware that updates to the development of the PRCP had occurred. These stakeholders were given the opportunity to contact	Stakeholders were made aware of updates to the PRCP to align with	Engage with landowners, Traditional Owners and local council on progressive

Date	Community Group	Consultation Type/Method	Information Provided	Issues Raised related to rehabilitation and closure	How issues have been considered	Outcomes of engagement	Commitments
	Owners and local council		them updates to the PRCP process had occurred.	provided to enable these stakeholders to read the PRCP post submission.	WJV if they had comments or questions relating to the PRCP process or the project more generally.	current regulatory approvals.	rehabilitation and closure planning over the life of mine.
Ongoing	Community Members.	WCP website.	The WCP website is supported and managed by Glencore and provides useful project information to the community.	• The WCP website has been updated to include information on the PRCP inlcuding statutory approvals process. • If the WCP is developed, the website will be updated accordingly to provide information on rehabitlation and closure planning as well as any changes to the PRCP.	N/A	N/A	Update WCP website as required.

GLENCORE

Klohn Crippen Berger

Wandoan Holdings Pty Ltd

Wandoan Coal Project

Progressive Rehabilitation and Closure Plan

Groundwater Assessment - RFI Update

Final Report

ISO 9001 14001 45001

14D70080A12

December 2025

4 December 2025

Wandoan Holdings Pty Ltd
Email: Melissa Brunner@Glencore.com.au

Melissa Brunner
PRCP and Approvals Coordinator (Wandoan)

Dear Melissa:

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan
Groundwater Assessment Report – Final (Updated)

Klohn Crippen Berger is pleased to provide this updated groundwater assessment report for the Wandoan Coal Project Progressive Rehabilitation and Closure Plan. The report has been updated to address the DETSI request for information. Should you have any queries, please do not hesitate to contact the undersigned.

Yours truly,

KLOHN CRIPPEN BERGER

Claire Kent, MSc, RPGeo
Senior Hydrogeologist, Associate

KCB Australia Pty Ltd.
Level 3, 150 Mary St ▪ Brisbane QLD 4000 ▪ Australia
t +617.3004.0244 ▪ www.klohn.com

EXECUTIVE SUMMARY

Klohn Crippen Berger (KCB) was commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) to undertake a groundwater assessment to support a Progressive Rehabilitation and Closure Plan (PRCP) for the Wandoan Coal Project (the Project), located on mining leases (ML) 50229, 50230 and 50231. This groundwater assessment has been prepared to address the requirements of Sections 3.1, 3.6.1 and 3.6.3 of the PRCP Guideline (ESR/2019/4964 v3). The Project is assumed to commence in 2031 with mining of 16 open cut areas across three MLs. The target for mining is the Upper Juandah Coal Measures of the Walloon Coal Measures, in the Surat Basin. The Life of Mine (LoM) is projected to be 75-years.

A calibrated 3D numerical groundwater model was developed as part of the assessment to predict post-mining groundwater conditions and potential influences on the groundwater system, based on the proposed final landform for the Project. The numerical model also considered the influence of coal seam gas (CSG) operations in the vicinity of the Project.

During LoM operations, the numerical groundwater model predicts drawdown to occur in the vicinity of each of the voids associated with mining, with the exception of Mud Creek, Summer Hill and Turkey Hill voids (the western ML), where groundwater levels are predicted to have already been impacted by CSG operations. Groundwater levels in the vicinity of voids mined earlier in the proposed mining sequence would show recovery prior to the start of post-closure.

Through the mining period, the sixteen open cut areas will progressively be backfilled with overburden material (sourced from the mined open cut areas) and the final landform established will be in place by post-closure (in year 75). Groundwater levels are predicted to reach post-closure equilibrium within ~50 years after mining activities have ended. No permanent groundwater-derived pit lakes are predicted to develop during post-closure, with groundwater predicted to be below the surface of the final landform in the base case simulations.

During post-closure, several areas of localised mounded groundwater (relative to pre-mining conditions) are predicted to occur in the areas with overburden emplacement facilities. This may result in shallower groundwater in these areas of lower topography. The Project is located adjacent to three major watercourses: Horse Creek, Juandah Creek and Woleebee Creek which are considered to be the main receptors for Project-influenced groundwater in the post-closure period. Groundwater is not predicted to discharge to surface within the creeks (i.e., not expected to daylight) during operations or after closure. For the alluvium and watercourses, increased salinity (if any) is not expected to be significant as the seepage chemistry (RGS 2024) and run-off water chemistry (KCB 2024) is of low to moderate salinity, inferred flow rates of seepage are low and any potential evapoconcentration that could occur would be expected to be seasonally diluted by fresh rainfall recharge and/or run-off. The electrical conductivity (EC) values predicted from the run-off and seepage are also expected to be within a similar magnitude to natural water quality measured in the alluvium.

An adaptive management approach will be undertaken for the operational and post-closure period, with additional groundwater and surface water monitoring and updates to the numerical groundwater model. As the understanding is refined through the LoM, and the monitoring and refined model results are reviewed, the Proponent will progressively review management and mitigation measures as part of their adaptive management for post-closure.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

CLARIFICATIONS REGARDING THIS REPORT VII

1 INTRODUCTION 1
1.1 Report Structure 1
1.2 Relevant Legislation and Guidelines 3
1.3 PRCP Guideline 4
1.4 Environmental Authority 6

2 PROJECT DESCRIPTION 7
2.1 Closure Plan 9

3 EXISTING ENVIRONMENT 12
3.1 Climate 12
3.2 Topography and Drainage 13
3.2.1 Catchment and Topography 13
3.2.2 Watercourses 15
3.2.3 Streamflow 16
3.3 Other Resource Development Projects 18
3.4 Environmental Values 22

4 HYDROGEOLOGICAL CONCEPTUALISATION 24
4.1 Regional Geology 24
4.2 Regional Hydrostratigraphy 26
4.3 Local Hydrostratigraphy 29
4.3.1 Hydrostratigraphic Units 29
4.3.2 Alluvium 32
4.3.3 Structures 32
4.4 Aquifer / Aquitard Properties 33
4.5 Groundwater Recharge 35
4.6 Groundwater Levels and Flow 36
4.6.1 Regional Groundwater Flow 36
4.6.2 Groundwater Contours 36
4.6.3 Monitoring Bores 38
4.6.4 Groundwater Elevation 41
4.6.5 Interconnectivity 42
4.7 Groundwater Chemistry 44
4.8 Springs 46
4.8.1 Vent Springs 46
4.8.2 Watercourse Springs 46
4.9 Existing Third-Party Groundwater Users 49
4.10 Hydrogeological Conceptual Model Summary 51

TABLE OF CONTENTS
(continued)

5 NUMERICAL GROUNDWATER MODEL 53
5.1 Modelling Overview 53
5.2 Model Construction 53
5.3 Model Calibration 55
5.4 Model Predictions 57
5.4.1 Life of Mine Simulation 57
5.4.2 Post-Closure Simulation 57
6 IMPACT ASSESSMENT 59
6.1 Post-Closure Groundwater Levels 59
6.1.1 Groundwater Level Recovery 59
6.1.2 Flow Directions and Velocity 66
6.2 Post-Closure Groundwater Chemistry 67
6.3 Potential Impacts to EVs 68
6.4 Adaptive Management, Monitoring and Mitigation 69
7 CONCLUSION 70
8 CLOSING 71
REFERENCES 72

List of Tables

Table 1.1 PRCP Groundwater Requirements 5
Table 1.2 Table W9 in EA 6
Table 3.1 Climate Statistics for -26.10 Latitude and 149.90 Longitude (SILO 2024) 12
Table 3.2 Groundwater and Surface Water EVs for the Upper Dawson River Sub-Basin (Environmental Protection (Water) Policy 2009. Dawson River Sub-Basin Environmental Values and Water Quality Objectives Basin No. 130 (Part), Including All Waters of the Dawson River Sub-Basin except the Callide Creek Catchment 2011) 23
Table 4.1 OGIA Calculated Recharge Rates (OGIA 2016a) 35
Table 4.2 UWIR Watercourse Spring Details 46
Table 6.1 Flow Directions and Travel Times 67

List of Figures

Figure 1.1 Project Location 2
Figure 2.1 Mining Sequence Used for PRCP Assessment 8
Figure 2.2 Reprofiled Void Depressions (Provided by SLR) 9
Figure 2.3 Topography of Final Landform 11
Figure 3.1 Daily Rainfall and CRD Trend for SILO Location (Latitude -26.10, Longitude 149.90) (SILO 2024) 13

TABLE OF CONTENTS
(continued)

Figure 3.2 Project Area Topography 14
Figure 3.3 Project Area Drainage 15
Figure 3.4 Photograph of Mud Creek (Near Southern Boundary of ML50229) 16
Figure 3.5 Annual Streamflow – Juandah Creek at Windemere (130344A)....17
Figure 3.6 Monthly Streamflow – Juandah Creek at Windemere (130344A) 17
Figure 3.7 Daily Streamflow – Juandah Creek at Windemere (130344A) 18
Figure 3.8 Typical CSG Water and Gas Extraction Profile (OGIA 2021b)....19
Figure 3.9 Location of the Project and Other Developments 20
Figure 3.10 QGC Northern Development Area Future Development Plan (2021 Block Production Summary) (CDM Smith 2022) 21
Figure 4.1 Mapped Surface Geology 25
Figure 4.2 Regional Hydrostratigraphy (after OGIA 2021c) 27
Figure 4.3 Stratigraphy of the WCM (Hamilton et al. 2014) 28
Figure 4.4 Indicative Hydrogeological Section – North-South 31
Figure 4.5 Alluvium Thickness (see Figure 4.1 for Geology Legend) 32
Figure 4.6 Hydraulic Conductivity Values for Surat Basin Units (OGIA 2019a) 34
Figure 4.7 Inferred Groundwater Table Contours 2022....37
Figure 4.8 GCAA Monitoring Bores 39
Figure 4.9 GWDB and CSG Monitoring Bores....40
Figure 4.10 G8012-S Groundwater Elevation and CRD Trend (Base of Creek at 236 mAHD) 41
Figure 4.11 Upper Juandah Coal Measures – GCAA Monitoring Bores....42
Figure 4.12 RN160722 Groundwater Elevation 43
Figure 4.13 RN160853 Groundwater Elevation 43
Figure 4.14 Piper and Durov Diagram 45
Figure 4.15 Location of Watercourse Springs 48
Figure 4.16 Location and Status of Registered Bores (see Figure 4.1 for Geology Legend)....50
Figure 4.17 Water Supply Bores with Dominant Aquifer Indicated (Data Provided by OGIA)...51
Figure 5.1 Model Domain....54
Figure 5.2 Groundwater Table Contours (mAHD) for Start and End of Calibration (1995 and 2022) 56
Figure 6.1 Pre-mining Groundwater Level Elevations (December 2022)....61
Figure 6.2 End of Operations/Start of Post-Closure (Assumed Year 2105) Groundwater Level Elevation (mAHD)....62
Figure 6.3 Depth to Water at Start of Post-Closure 63
Figure 6.4 Groundwater Level Elevation (mAHD) – 10, 50, 100 and 500 Years Post-Closure ..64
Figure 6.5 Depth to Water – 500 Years Post-Closure....65

TABLE OF CONTENTS
(continued)

List of Appendices

Appendix I Bore Register
Appendix II Groundwater Levels
Appendix III Groundwater Chemistry
Appendix IV Numerical Groundwater Model
Appendix V Post-Closure Landform Sections
Appendix IV DETSI RFI

Table of Abbreviations

AMD	Acid Mine Drainage
ANC	Acid Neutralisation Capacity
CHPP	Coal handling and preparation plant
CMA	Cumulative Management Area
CRD	Cumulative rainfall departure
CSG	Coal seam gas
DCCEEW	Department of Climate Change, Energy, Environment and Water
DETSI	Department of Environment, Tourism, Science and Innovation
DST	Drill stem tests
EA	Environmental Authority
EC	Electrical conductivity
ERA	Environmentally relevant activity
EV	Environmental Values
GAB	Great Artesian Basin
GCAA	Glencore Coal Assets Australia
GHB	General Head Boundaries
LoM	Life of Mine
MIA	Mine infrastructure area
ML	Mining leases
NAF	Non-Acid Forming
OGIA	Office of Groundwater Impact Assessment
PMLU	Post-mining land use
PRCP	Progressive Rehabilitation and Closure Plan
QWC	Queensland Water Commission
S&D	Stock and domestic
TDS	Total dissolved solids
UWIR	Underground Water Impact Report
WCM	Walloon Coal Measures
WQO	Water quality objectives

CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of KCB Australia Pty Ltd (KCB). The report has been prepared for the use of Wandoan Holdings Pty Ltd (Client) for the specific application to the Wandoan Coal Project and may be published or disclosed by the Client to Queensland Department of Environment, Science, Tourism and Innovation.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered; however, the use of this report will be at the user's sole risk absolutely and in all respects, and KCB makes no warranty, express or implied. This report may not be relied upon by any person other than the Client or DETSI without KCB's written consent.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The Executive Summary is a selection of key elements of the report. It does not include details needed for the proper application of the findings and recommendations in the report.
3. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
4. The report is based on information provided to KCB by the Client or by other parties on behalf of the Client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
5. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
6. This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

1 INTRODUCTION

Klohn Crippen Berger (KCB) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) to undertake a groundwater assessment to support a Progressive Rehabilitation and Closure Plan (PRCP) for the Wandoan Coal Project (the Project).

The groundwater assessment has been prepared to address the requirements of Sections 3.1, 3.6.1 and 3.6.3 of the PRCP Guideline (Queensland Government 2024).

The Project is approved under Environmental Authority (EA) EPML00297613 on mining leases (ML) 50229, 50230 and 50231, to the west and northwest of Wandoan (Figure 1.1). Since grant of the tenement in 2017 the Project has remained undeveloped.

The Project requires a PRCP to be developed and was issued a notice by the Department of Environment, Science and Innovation (DETSI) for a transitional PRCP prepared in accordance with the PRCP Guideline to be delivered by the September 27, 2024. A groundwater assessment was prepared by KCB to support the PRCP.

After submission of the PRCP (Reference No. A-PRCP-NEW-100732384) to DETSI in September 2024, DETSI issued an RFI in May 2025. This report has been updated to provide additional information as requested by the DETSI in the RFI related to groundwater. The RFI items, response and where they are addressed in the report is included in Appendix VI. This report retains all content in the groundwater assessment (KCB 2024b) and has been revised only to address the RFI.

1.1 Report Structure

This report is structured as follows:

- Section 1: Introduction
- Section 2: Relevant Legislation and Guidelines
- Section 3: Project Description
- Section 4: Existing Environment
- Section 5: Hydrogeological Conceptualisation
- Section 6: Numerical Groundwater Model Overview
- Section 7: Impact Assessment
- Section 8: Conclusion

The main report is supported by the following appendices:

- Appendix I: Monitoring Bore Register
- Appendix II: Groundwater Elevation Hydrographs
- Appendix III: Groundwater Chemistry Graphs
- Appendix IV: Numerical Groundwater Model
- Appendix V: Post-Closure Landform Cross Sections
- Appendix VI: DETSI RFI Response

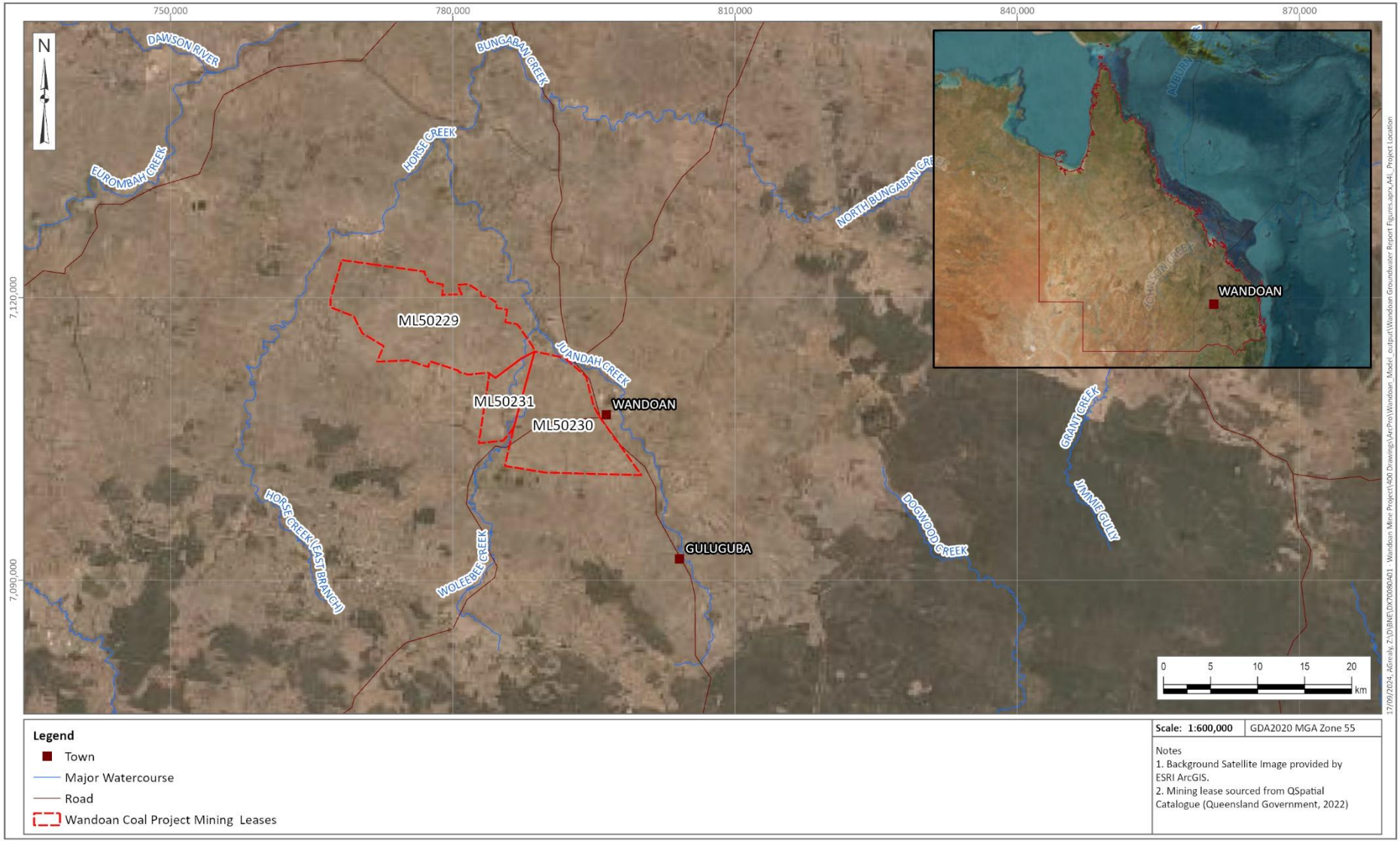


Figure 1.1 Project Location

1.2 Relevant Legislation and Guidelines

The following regulations, guidelines and requirements are relevant to this hydrogeological assessment, prepared to support the Project PRCP.

- The *Environmental Protection Act 1994* (EP Act) (Environmental Protection Act 1994 2022) aims to protect Queensland's environment while allowing for ecologically sustainable development. To conduct an environmentally relevant activity (ERA), an EA is required.
- The Queensland *Water Act 2000* (Water Act) (Water Act 2000 2024) aims to advance sustainable management and efficient use of resources by establishing a system for planning and allocation, and use of water. The *Water Act 2000* provides for the management of the impacts on underground water caused by the exercise of underground water rights by resource tenure holders. The Act also outlines the requirements for make good agreements, associated with the impacts to underground water. Chapter 3 of the *Water Act 2000* has a stated purpose to provide for the management of impacts on underground water caused by the exercise of underground water rights by resource tenure holders. To achieve the stated purpose, a regulatory framework is provided which requires:
  - Resource tenure holders to monitor and assess the impacts of the exercise of underground water rights on water bores and to enter into make good agreements with the owners of the groundwater bores as necessary.
  - The preparation of Underground Water Impact Report (UWIR) that establish underground water obligations, including obligations to monitor and manage impacts on aquifers and springs; and
  - Managing the cumulative impacts of the activities of two or more resource tenure holders' underground water rights on underground water.

  Under this regulatory framework, where there is an area of concentrated development, a Cumulative Management Area (CMA) can be declared. The Project is located within the Surat CMA, which was declared in 2011. The Office of Groundwater Impact Assessment (OGIA) was established under the *Water Act 2000* and is responsible for predicting regional impacts on water pressures in aquifers; developing water monitoring and spring management strategies; and assigning responsibility to individual petroleum tenure holders for implementing specific parts of the strategies within CMAs. These predictions, strategies and responsibilities are set out in the Surat CMA UWIR, prepared and maintained by OGIA.

  The Surat CMA UWIR was first published by Queensland Water Commission (QWC) in 2012 (QWC 2012a) to assess the cumulative impacts to the Surat and southern Bowen Basin, as a result of the expansion of CSG production by multiple, adjacent developers. There have been several updates to the Surat CMA UWIR since 2012, published by the OGIA (OGIA 2019a; 2022). Further discussion on the neighbouring operations is provided in Section 3.3.
- The Mined Land Rehabilitation Policy 2017 (MLR Policy) (State of Queensland 2021) ensures land disturbed by mining is rehabilitated to a stable, environmentally safe

condition for approved post-mining land use (PMLU). The policy includes binding milestones for progressive rehabilitation.

- The PRCP Guideline (ESR/2019/4964) (Queensland Government 2024) helps applicants develop a PRCP, aligning with the EP Act and the MLR Policy using best practices and industry standards.

1.3 PRCP Guideline

DETSI published the PRCP Guideline to assist applicants in developing a PRCP. The guideline includes several requirements for groundwater assessments within Sections 3.1, 3.6.1 and 3.6.3, which are addressed this report (Table 1.1).

Table 1.1 PRCP Groundwater Requirements

Inclusions	Comment
Section 3.1: Baseline Information: Groundwater levels and properties.	▪ Baseline information with relevance to hydrogeology and consideration of impacts to groundwater included in this report, generally Sections 3 and 4, with supporting data provided in appendices.
Section 3.6.1: General rehabilitation practices: Hydrogeology.	
Assess the hydrogeology of the site and all connected strata and develop a conceptual model of the mine site's groundwater systems.	▪ Included in this report Sections 3 and 4.
The hydrogeological assessment should include the following steps: ▪ determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards; ▪ locating groundwater recharge and discharge locations locally and regionally; ▪ groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs); ▪ current and potential future uses of groundwater including existing groundwater extraction bores; ▪ groundwater flow direction and velocity, including field tests to determine hydraulic conductivity; ▪ the development of potentiometric mapping and hydrostratigraphic cross sections; ▪ groundwater modelling to determine contaminant transport and potential changes to groundwater level from dewatering or waste storage.	▪ Hydrogeological conceptual model included in this report Sections 3 and 4. ▪ Numerical groundwater model discussed in Section 5, with supporting information in Appendix IV. ▪ Prediction of water quality undertaken by RGS (2024), with discussion in this report related to groundwater impacts.
Section 3.6.1: General rehabilitation practices: Water Management	
The rehabilitation planning part must include a description of the following: ▪ a description of the contaminants that pose a risk to environmental values of the receiving environment; ▪ source, pathway and fate of contaminants that have the potential to impact environmental values; ▪ infiltration and seepage intervention and collection controls; ▪ surface water diversions and long-term management requirements; ▪ dewatering requirements; ▪ ongoing water management and reduction requirements (i.e. treatment).	▪ Description of contaminants discussed in RGS 2024, as well as in relation to the groundwater environment in Section 6. ▪ Adaptive management strategy included in Section 6.4. ▪ Items related to surface water management not included in this groundwater report.
Section 3.6.3: Voids	
▪ groundwater modelling to determine whether the void is acting as a sink or a source for groundwater. ▪ a water balance study including an assessment of void surface and groundwater interactions such as: ♦ groundwater lowering/reduction in hydraulic head (from new voids) (e.g. caves/karst systems); ♦ cones of depression and associated impacts; ♦ the drainage and flooding behaviours of surface waters in the vicinity of the void; ♦ the potential extent of flooding and implications of interactions with the void; ♦ a conceptual model that incorporates all projected inflows, outflows, and recharge rates; ♦ water storage and long-term water balance; ♦ each of the major water fluxes into and out of the void; ♦ the sources of surface water within the mine catchment that are likely to influence the water quality in the void.	▪ Numerical groundwater modelling included in Section 5 and Appendix IV. ▪ Water balance study completed as part of PRCP and reported separately to this report.

1.4 Environmental Authority

The requirements for groundwater are detailed in the Project EA EPML00297613 (DES 2022) as follows:

- W41: A groundwater monitoring program must be designed and implemented as described in Table W9 and the locations shown in Figure W1 of the EA.
- W42: The holder of the environmental authority must, when requested by the administering authority, submit within 30 days an assessment report on the results of the groundwater monitoring program. The assessment must address whether the environmental values are being protected with reference to water quality parameters in Table W9, and any other monitoring data obtained, and state the basis on which the conclusions are drawn. If necessary, corrective and mitigation measures taken should be described.
- W43: Groundwater monitoring bores must be constructed and operated in accordance with methods prescribed in the latest edition of the Land and Water Biodiversity Committee, 2003 Minimum Construction Requirements for Water Bores in Australia.

Table 1.2 Table W9 in EA

Monitoring Sites	Parameter	Frequency	Purpose
WMB1-D WMB1-S WMB2 WMB3-D WMB3-S G8011D G8012D G8013D G8018D	Water level	Every 12 hours – electronic loggers	Detect drawdown in shallow coal seam aquifer and any mine induced variation in groundwater quality
	pH, EC, TDS (lab), cations, anions, Sulfate, selected metals (Al, Ba, Fe, As, Cd, Cr, Co, Cu, Ni, Li, Sr, Zn, Bo, Mn)	Every 3 months	
G8010S G8011S G8012S G8013S G8016S G8017S	Water level	Every 12 hours - electronic loggers	Determine baseline hydrochemistry and groundwater level variation in alluvium aquifer (minimum 12 months)
	pH, EC, TDS (lab), cations, anions, Sulfate, selected metals (Al, Ba, Fe, As, Cd, Cr, Co, Cu, Ni, Li, Sr, Zn, Bo, Mn)	3 months	

*EC – electrical conductivity, TDS – total dissolved solids

2 PROJECT DESCRIPTION

The mine plan supporting the PRCP contains 16 open cut mining pits designed to meet current approval conditions with:

- Disturbance areas within the approved pit, overburden emplacement, haul road, access roads and tracks and dam and infrastructure footprints.
- A coal handling and preparation plant (CHPP) with associated coal handling, tailings dewatering facilities, ROM stockpiles and a rail loop.
- A mine infrastructure area (MIA) that includes workshops, washdown facilities, service bays, administration offices, bathhouses and a power plant.
- Raw and mine affected water storages.
- Pit backfilling in eight pits to be free draining with no depressions.
- Reprofiled void depressions in the remaining eight pits to ≥ 5 m above the long-term groundwater level with ephemeral non-permanent surface water bodies in the base.
- Dry stacking methods and encapsulation with overburden emplacements for tailings, rejects and materials with spontaneous combustion risk disposal.
- Overburden emplacements.

The PRCP mining schedule has been developed in 2023 and used as a basis for the numerical groundwater model to support the PRCP (Figure 2.1). Mining targets the Upper Juandah Coal Measures (Kogan, Upper Macalister, Lower Macalister and Wambo coal seams) of the Walloon Coal Measures (Section 4.1) with mining planned over a 75-year mine life.

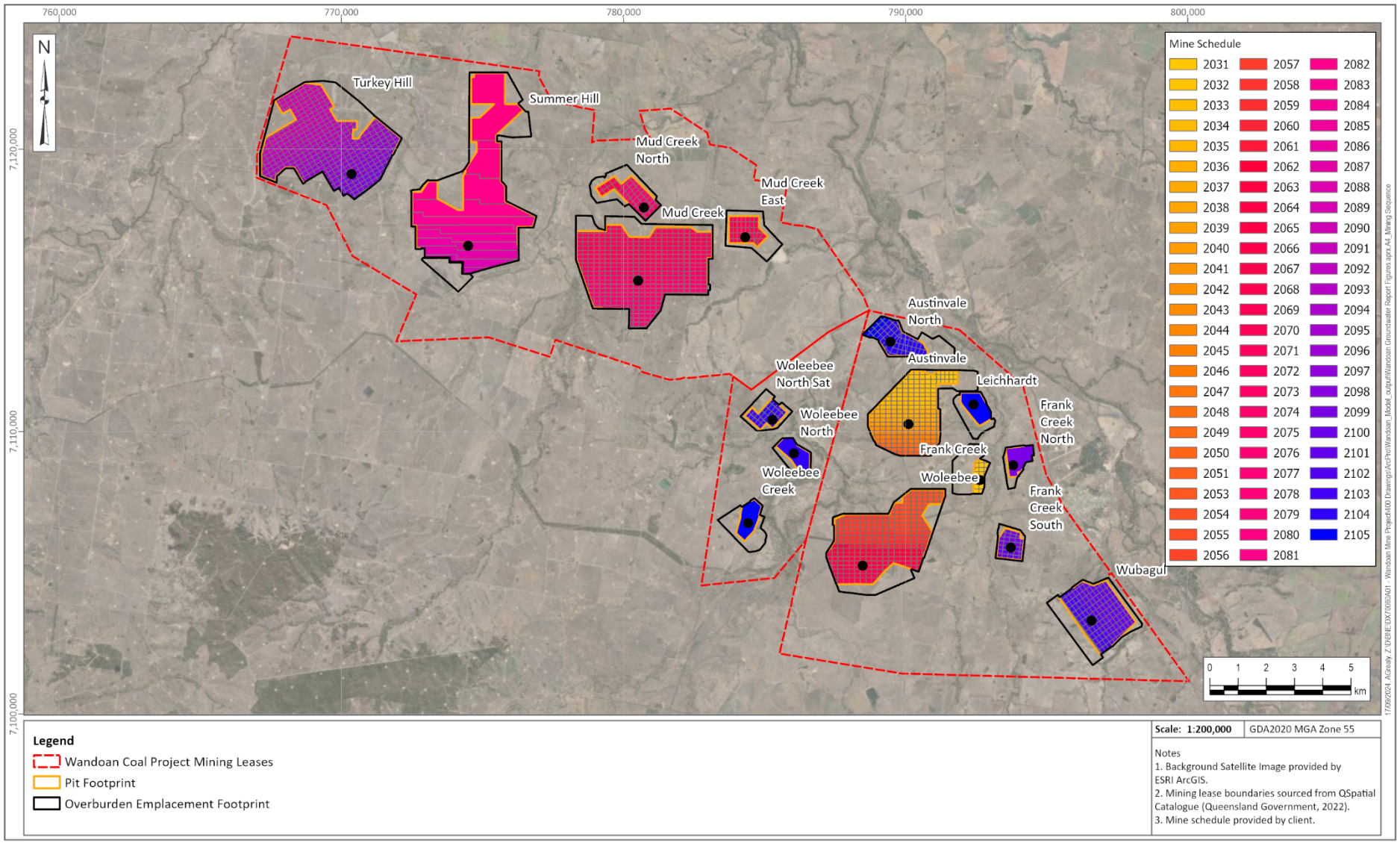


Figure 2.1 Mining Sequence Used for PRCP Assessment

2.1 Closure Plan

The mined pits will be progressively backfilled with spoil material during mining operations. Each mining pit is planned to be backfilled with spoil to at least 5 m above the predicted post-closure groundwater level, with only shallow surface depressions to remain.

As such, shallow reshaped mining pit depressed landforms (herein referred to a reprofiled void depressions) are planned to remain at closure. The reprofiled void depressions will have no groundwater as opposed to deep final voids with base levels below the groundwater (i.e., sinks) and pit lakes (as traditionally expected to remain at closure for open cut mining pits). The planned reprofiled void depressions and associated waterbodies are shown in Figure 2.2 (highlighted in green box) with the traditional final void and pit lakes presented for comparison.

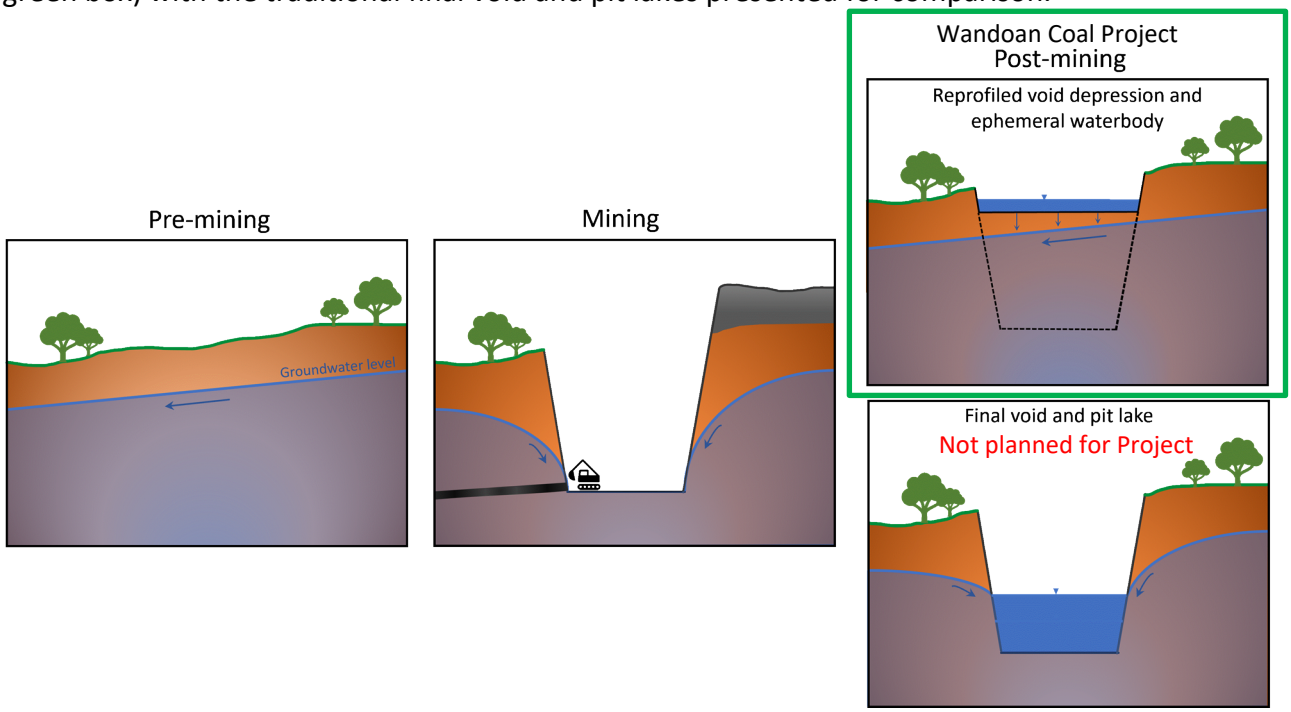


Figure 2.2 Reprofiled Void Depressions (Provided by SLR)

Key features of the reprofiled void depressions, as defined by the Proponent, include:

- Highwalls retained where the material is competent / unweathered, with slopes less than 214% (EA condition).
- Highwall weathered zones battered back to less than or equal to 22% (based on erosion studies) and revegetated to native bushland (EA PMLU) with grazing as a management tool where safety permits.
- Voids are to be backfilled to approximately 5 m above predicted post-closure groundwater levels.
- Low walls left will be reshaped to less than 22% and will be geotechnically stable with appropriate erosion rates.
- PMLU for the low walls and reprofiled void depressions is grazing with cattle to access the void water of stock drinking quality (less than 4,000 mg/L for total dissolved solids (TDS)).

The final landform surface, prepared by the Proponent (GCAA 2024), is presented in Figure 2.3 and features the final landforms of the 16 mining areas. Reprofiled void depressions are planned for eight of the 16 mining areas (i.e., Summer Hill, Mud Creek, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul). The remaining eight mining areas (Turkey Hill, Mud Creek North, Mud Creek East, Woleebee North, Austinvale North, Leichhardt, Frank Creek North and Frank Creek South) will be reshaped to form free draining landforms.

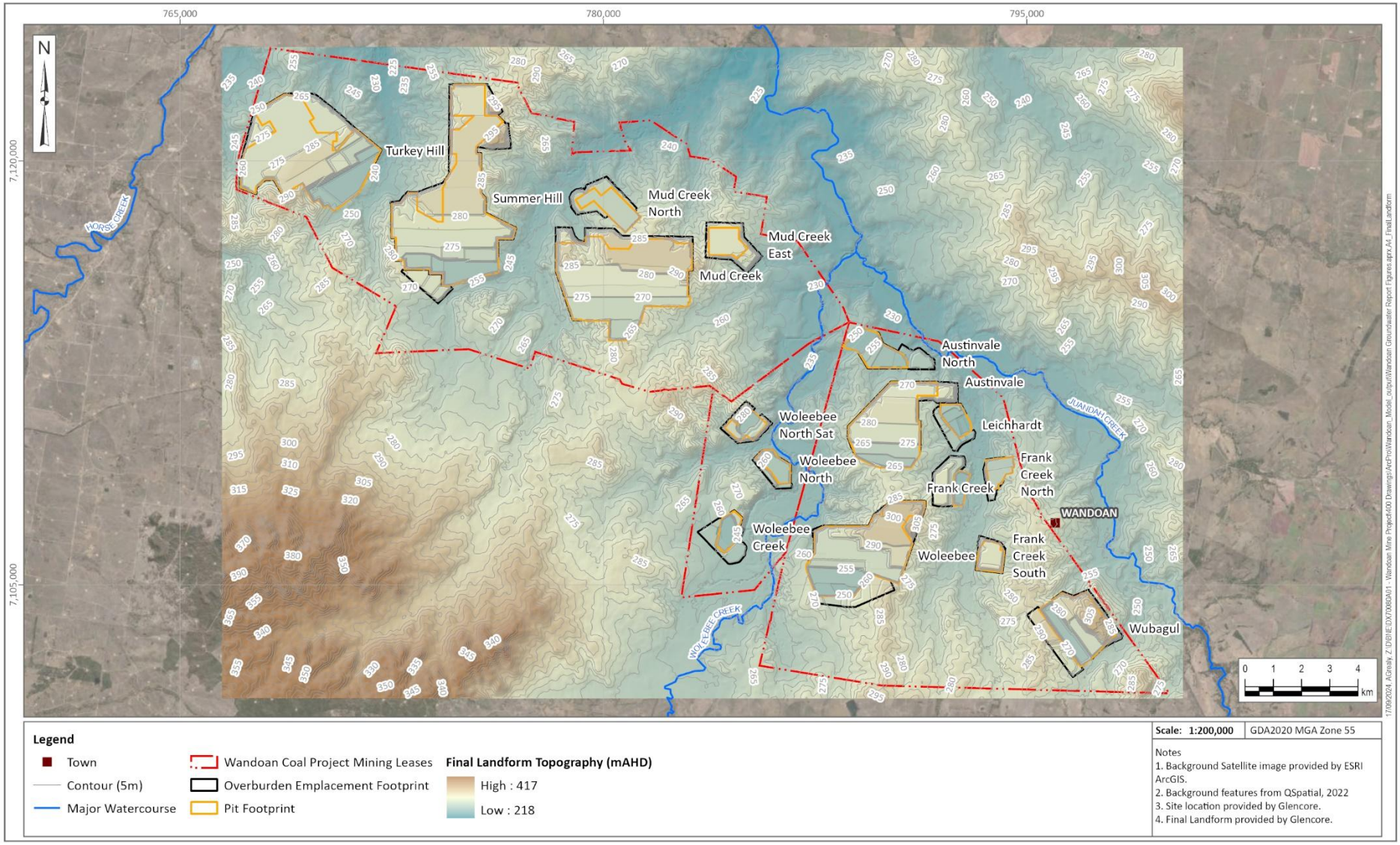


Figure 2.3 Topography of Final Landform

3 EXISTING ENVIRONMENT

3.1 Climate

The assessment area is classified under the modified Köppen classification system (BOM 2005) as subtropical with no dry season.

Climate statistics for the Project was obtained from the SILO database (2024) for a location central to the three MLs (-26.10 latitude, 149.90 longitude). SILO is an enhanced synthetic climate database that provides daily time series data for point locations and comprises actual station records augmented by interpolated estimates where observed data are missing.

Mean maximum temperatures range between 33.7°C in summer and 20.2°C in winter. Mean minimum temperatures range between 20.1°C in summer and 4.3°C in winter. Daily evaporation rates are generally high and exceed rainfall throughout the year. The highest rainfall occurs during December to February, with the lowest rainfall occurring during April to September.

Table 3.1 Climate Statistics for -26.10 Latitude and 149.90 Longitude (SILO 2024)

Month	Mean Monthly Rainfall (mm)	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Mean Monthly Evaporation (mm)
Period of Record	*1889 to 2024*	*1889 to 2024*	*1889 to 2024*	*1889 to 2024*
January	90.6	20.1	33.7	238.4
February	77.9	19.7	32.8	190.7
March	60.5	17.6	31.2	188.6
April	33.1	13.2	28.1	140.0
May	35.9	8.7	24.0	99.4
June	36.3	5.7	20.7	75.0
July	31.5	4.3	20.2	81.7
August	26.4	5.6	22.5	112.8
September	32.3	9.5	26.2	158.2
October	54.4	13.7	29.5	201.6
November	71.4	16.9	31.8	216.6
December	87.1	18.9	33.4	238.9
Annual	**635.4**	**12.8**	**27.8**	**1,934.8**

Note: SILO Point Data (Accessed 19 July 2024).

Synthetic rainfall data were used to analyse rainfall trends due to incomplete rainfall data for the Project area (SILO 2024).

Figure 5.2 presents daily rainfall between 1955 and 2023, as well as a cumulative rainfall departure (CRD) trend for the same period. CRD trends represent a running deviation of long-term actual rainfall against the overall average. This provides season-scale identification of trends (wet / dry) as well as longer term (e.g., decadal) deviation from average conditions. CRDs are useful for correlating rainfall events to aquifer responses. Observations from the CRD trend include:

- The overall rainfall trend is characterised by the cycle between the wet and dry seasons, with annual fluctuations of approximately 150 mm evident across the record.

- The trend shows a period of increasing rainfall between 1960 and 1986, a decline to below average conditions between 1986 and 1994, an increasing period to 1999 and a declining period to 2009.
- Between 2010 and 2012, a series of large rainfall events dominate the record, resulting in above average rainfall conditions, which is followed by a period of decline to 2020. Since 2020, the record indicates that rainfall has increased (with a recent seasonal decrease to 2023).

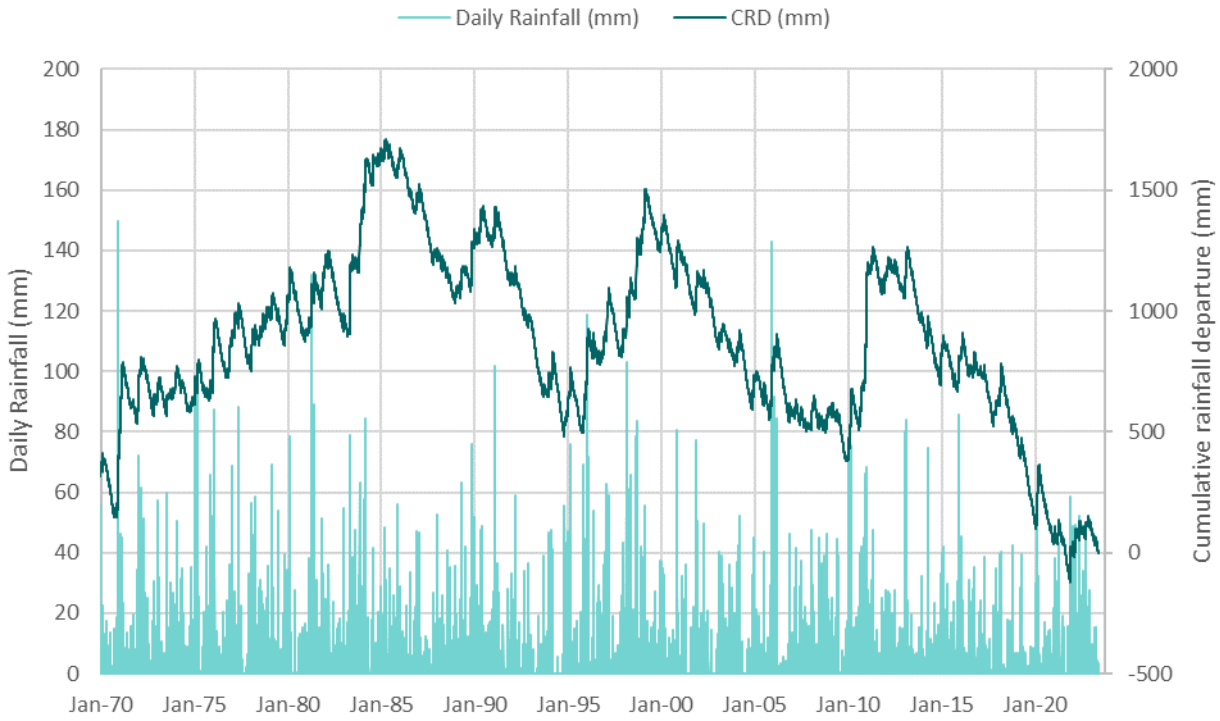


Figure 3.1 Daily Rainfall and CRD Trend for SILO Location (Latitude -26.10, Longitude 149.90) (SILO 2024)

3.2 Topography and Drainage

3.2.1 Catchment and Topography

The Project is in the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. The Fitzroy River Basin is the second largest externally drained basin in Australia and the largest on the east coast. Covering an area of 150,000 km^2, the basin contains several significant tributaries, including the Nogoa, Comet, Mackenzie, and Dawson Rivers. The basin discharges into the Coral Sea east of Rockhampton.

The Maranoa-Balonne Rivers sub-basin, which is part of the Condamine River Basin, is located to the south of the Project. The Maranoa-Balonne Rivers sub-basin contains several significant tributaries including the Balonne and Maranoa Rivers which drains southwest into NSW.

The topography of the Project area is presented in Figure 3.2. Elevations across the area range between 300 mAHD and 250 mAHD, with topographic highs to the south of the Project area. The natural flow path of drainage features through the Project area is towards the north.

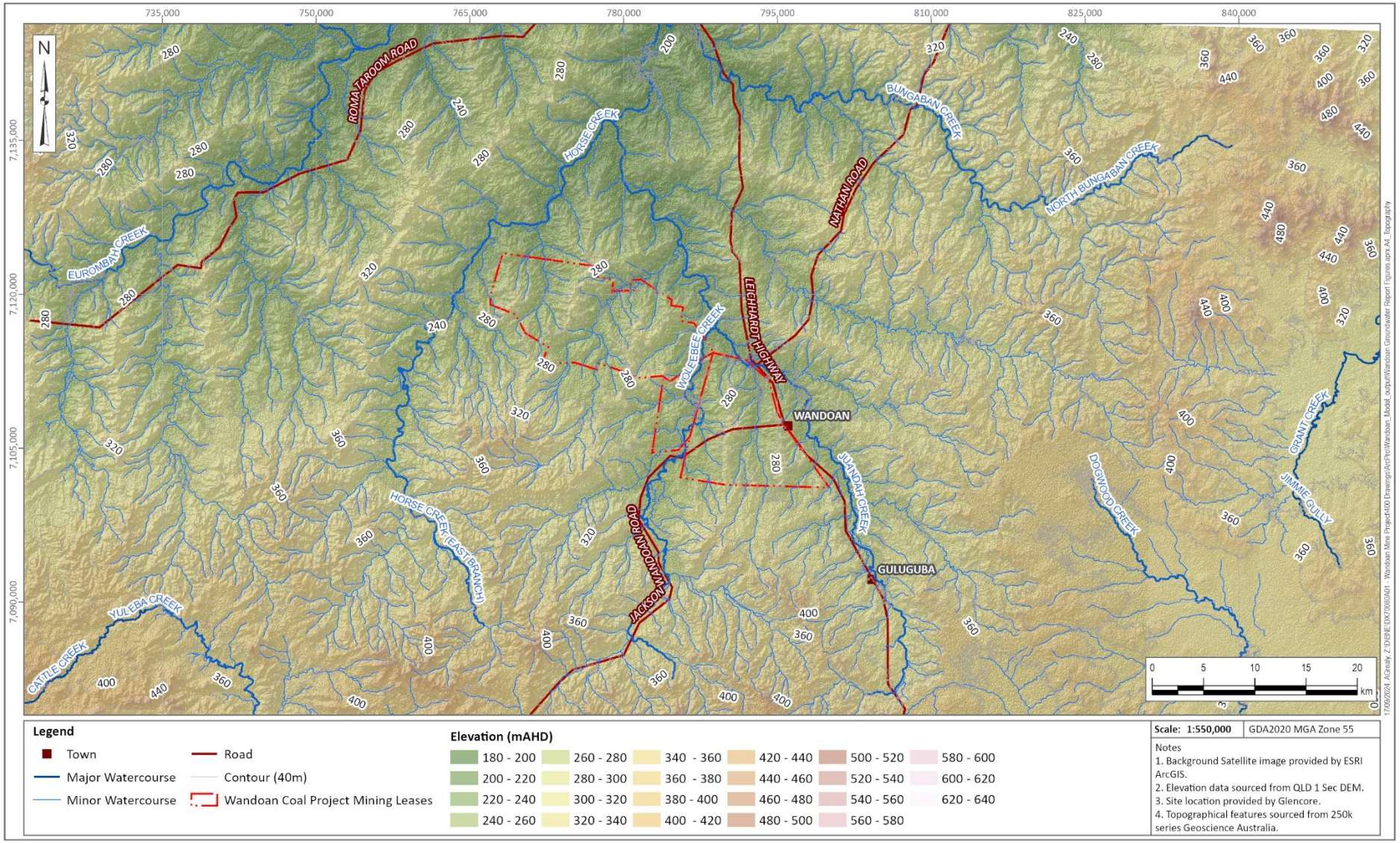


Figure 3.2 Project Area Topography

3.2.2 Watercourses

Key watercourses (as shown on Figure 3.3) within the vicinity of the Project include:

- Juandah Creek, which flows from the southwest of the Project, towards the north to join the Dawson River, 3 km south of Taroom. Juandah Creek is joined by Woleebee Creek, Horse Creek (from the south), and Bungaban Creek from the east before joining the Dawson River.
- Woleebee Creek, which flows north from its headwaters through the MLs to join Juandah Creek to the northeast.
- Horse Creek flows in a north-easterly direction on the western side of ML50229, to join Juandah Creek in the north, before joining the Dawson River.

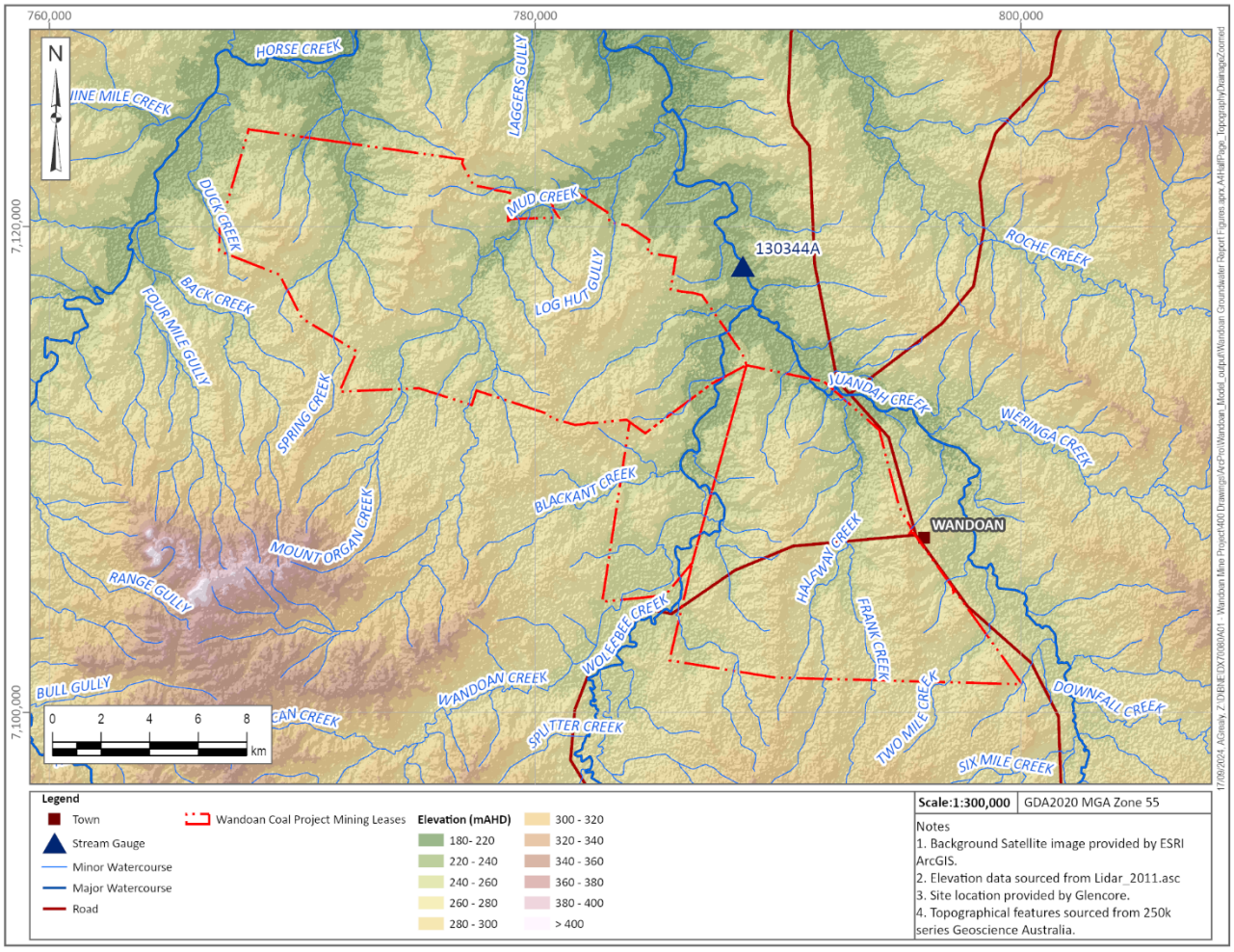


Figure 3.3 Project Area Drainage

Minor watercourses and drainage features are present throughout the Project area, as tributaries of the major watercourses described above. A photograph of Mud Creek is shown on Figure 3.4 and highlights the minor nature of these watercourses.

Watercourses across the Project area are characteristically ephemeral, which is a consequence of the watercourses being in the upper most reaches of the catchments with limited run-off area,

and seasonal rainfall. Ephemeral watercourses will typically only experience surface water flow during or immediately after heavy or sustained rainfall events (i.e., summer wet season). Following periods of flow, surface water will persist in the form of non-flowing, disconnected pools separated by dry / exposed stream bed.

Areas of Woleebee Creek to the south of the Project area have been mapped as a gaining stream by OGIA. Further discussion on these areas is provided in Section 4.8.

Figure 3.4 Photograph of Mud Creek (Near Southern Boundary of ML50229)

3.2.3 Streamflow

A government stream gauge (130344A) is located within the vicinity of the Project, on Juandah Creek at Windermere, downstream of the confluence between Woleebee and Juandah Creeks (Figure 3.3). The stream gauge catchment is approximately 1,657 km^2, with data available since 1974.

Calendar year, monthly and daily streamflow volumes for Juandah Creek at Windemere are presented in Figure 3.5 to Figure 3.7. Review of streamflow volumes indicated:

- Most of the streamflow occurs during high rainfall months of December to March, with the highest mean monthly streamflow volumes occurring in December.
- When streamflow was evident, mean volumes were consistently higher than the median and 75th percentile of non-exceedance volumes due to large events.
- Flow was ephemeral with no flow for several months in the dry season (at least 50% of the time). There are also several stream gauges within the Project area, with height data available for a limited timeframe. Available height data shows a similar ephemeral flow regime to the downstream government gauge.

- Low to no flow months shown in the monthly streamflow figures were also captured in the daily streamflow with approximately 80% of daily flow recorded with less than 0.1 ML/d and no flow for 78% of the time.

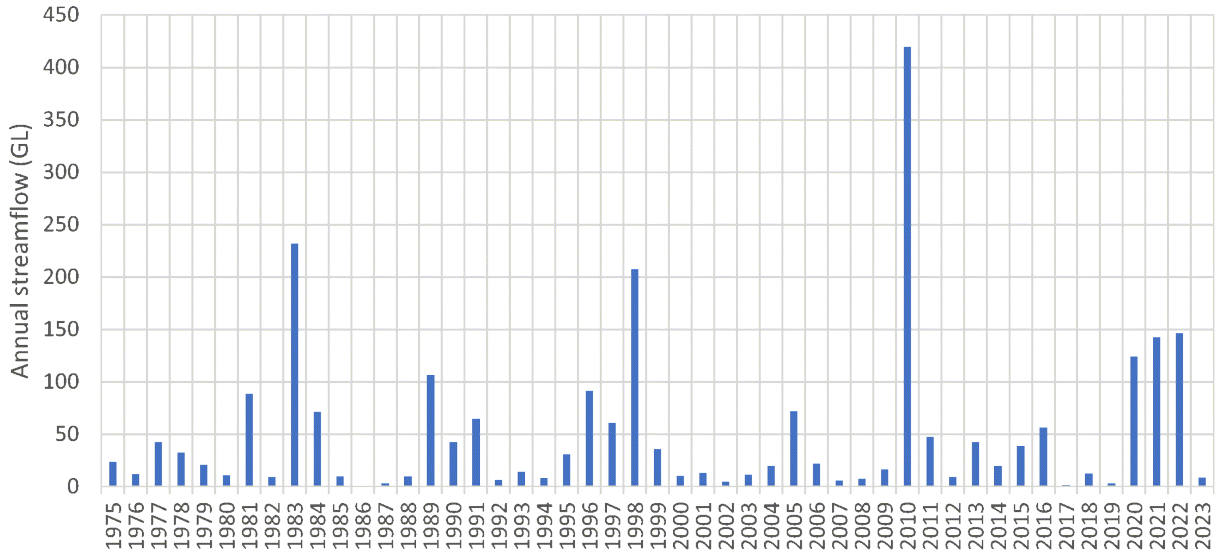


Figure 3.5 Annual Streamflow – Juandah Creek at Windemere (130344A)

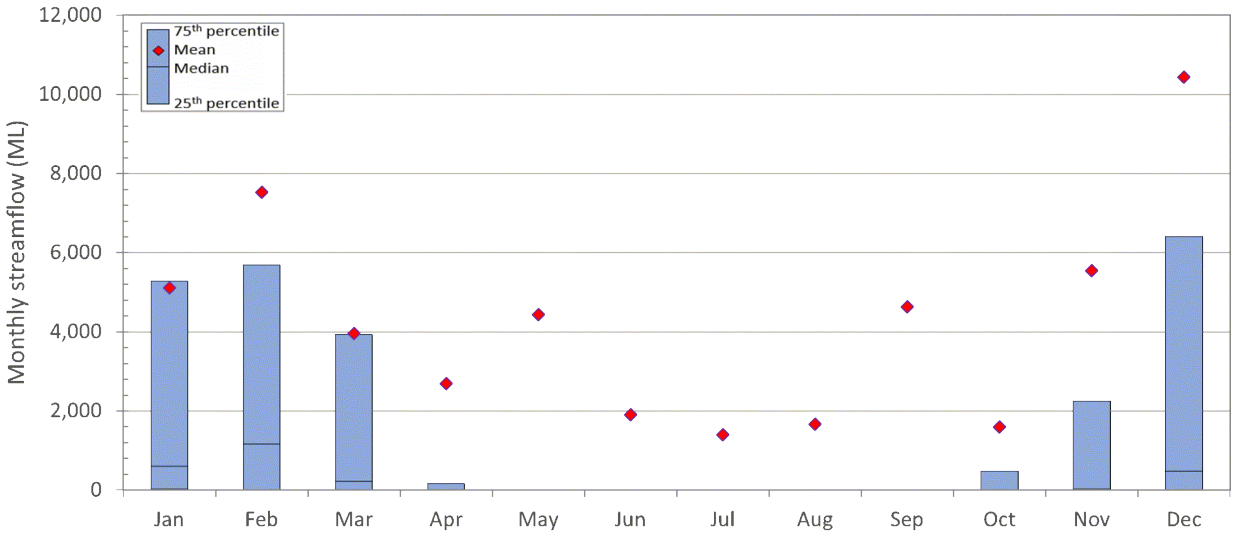


Figure 3.6 Monthly Streamflow – Juandah Creek at Windemere (130344A)

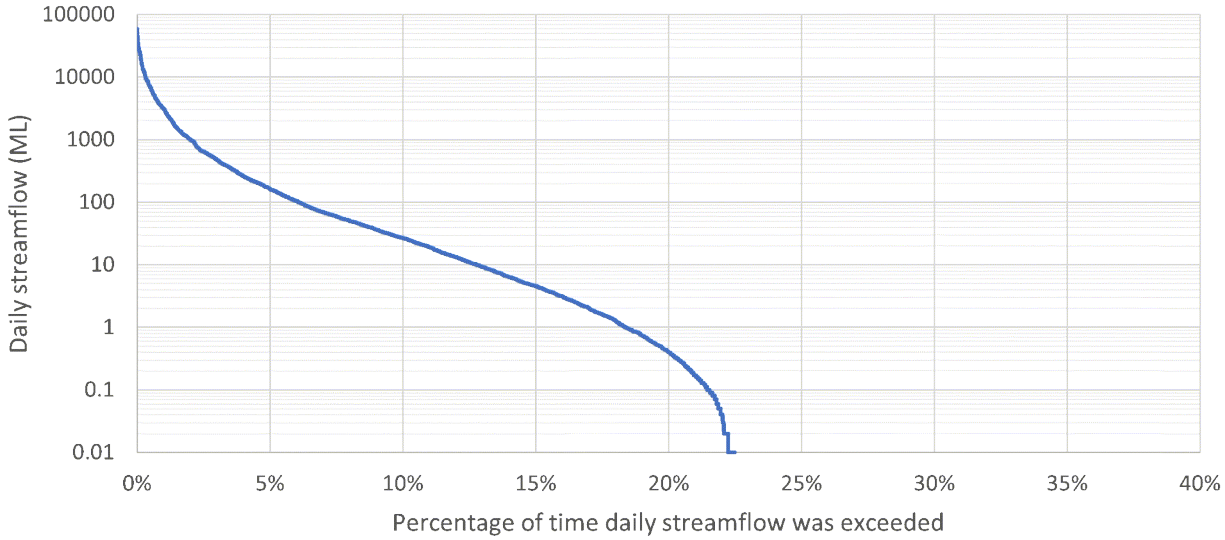


Figure 3.7 Daily Streamflow – Juandah Creek at Windemere (130344A)

3.3 Other Resource Development Projects

The Project is located in an area of concentrated resource development, mainly related to CSG extraction. As discussed in Section 1.2, the Project is located in the Surat CMA, which was established due to the concentrated development by multiple, adjacent operators.

CSG (Petroleum Leases)

Petroleum leases (PLs) can occur overlapping with MLs. This occurs in the vicinity of the Project, with PLs granted to QGC, Senex and Origin overlapping or in the immediate area, as shown in Figure 3.9.

OGIA (2021b) provides the following description in relation to CSG extraction:

> *"CSG is extracted by drilling a well into the coal formation and pumping groundwater out of the well to depressurise the formation. The volume of water that needs to be pumped to achieve the pressure reduction varies from well to well and is highly dependent on the geology intersected by the well. To produce gas, the water pressure in the well is reduced to 35–120 psi, which is equivalent to 25–80 m head of water. Once the desired pressure is reached, pumping continues at the rate necessary to maintain the pressure, until gas production becomes uneconomical. Initially, as shown in Figure 3.8, groundwater alone is extracted, but as the pressure drops, more and more gas is released and extracted together with water, leading to an increasing ratio of gas to water over time. The flow of water and gas together is known as 'dual-phase flow'* (Morad et al. 2008)*"*

Typically, CSG production wells are operated for 25 to 30 years.

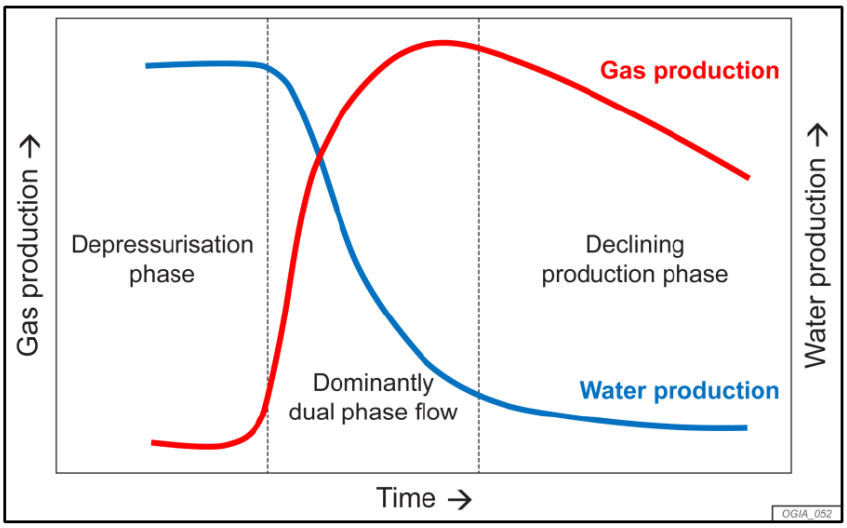


Figure 3.8 Typical CSG Water and Gas Extraction Profile (OGIA 2021b)

The target for CSG production in the vicinity of the Project is the Walloon Coal Measures, within the Surat Basin, which is also planned for mining in the Project. CSG water and gas extraction also occurs to the east of the Project area, targeting the deeper Baralaba Coal Measures, part of the underlying Bowen Basin (OGIA 2021b). Further discussion on the geological sequence is provided in Section 4.1.

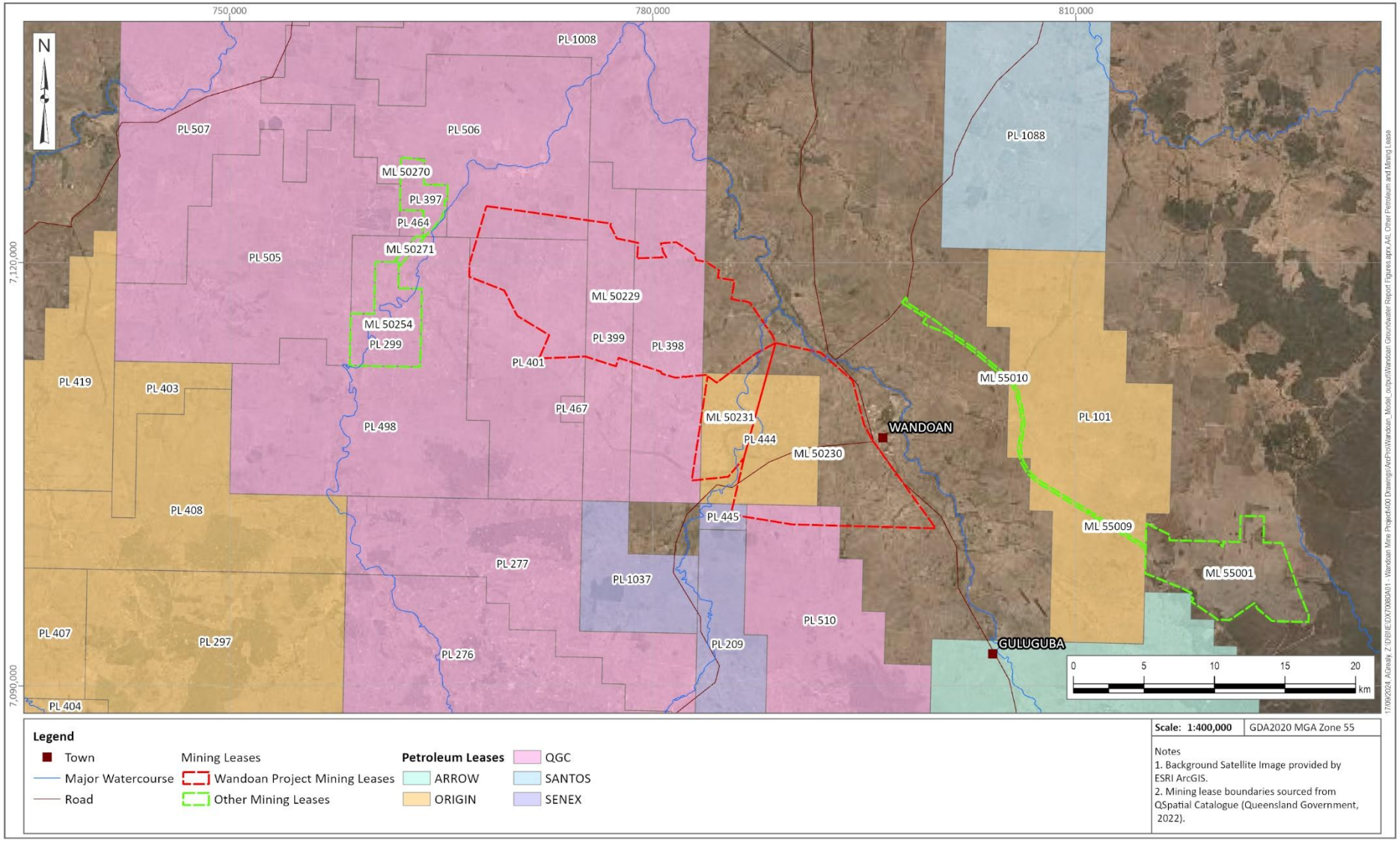


Figure 3.9 Location of the Project and Other Developments

Further discussion related to each of the CSG fields in the vicinity is summarised by individual operators:

QGC

QGC operate their Northern Development Area in the immediate vicinity of the Project, with the area overlapping with the western portion of ML50229. CSG production in the area commenced in 2004, with planned commencement up to 2028, as shown in Figure 3.10. OGIA report that the production cessation in this area is planned between 2050 and 2069 (OGIA 2021b).

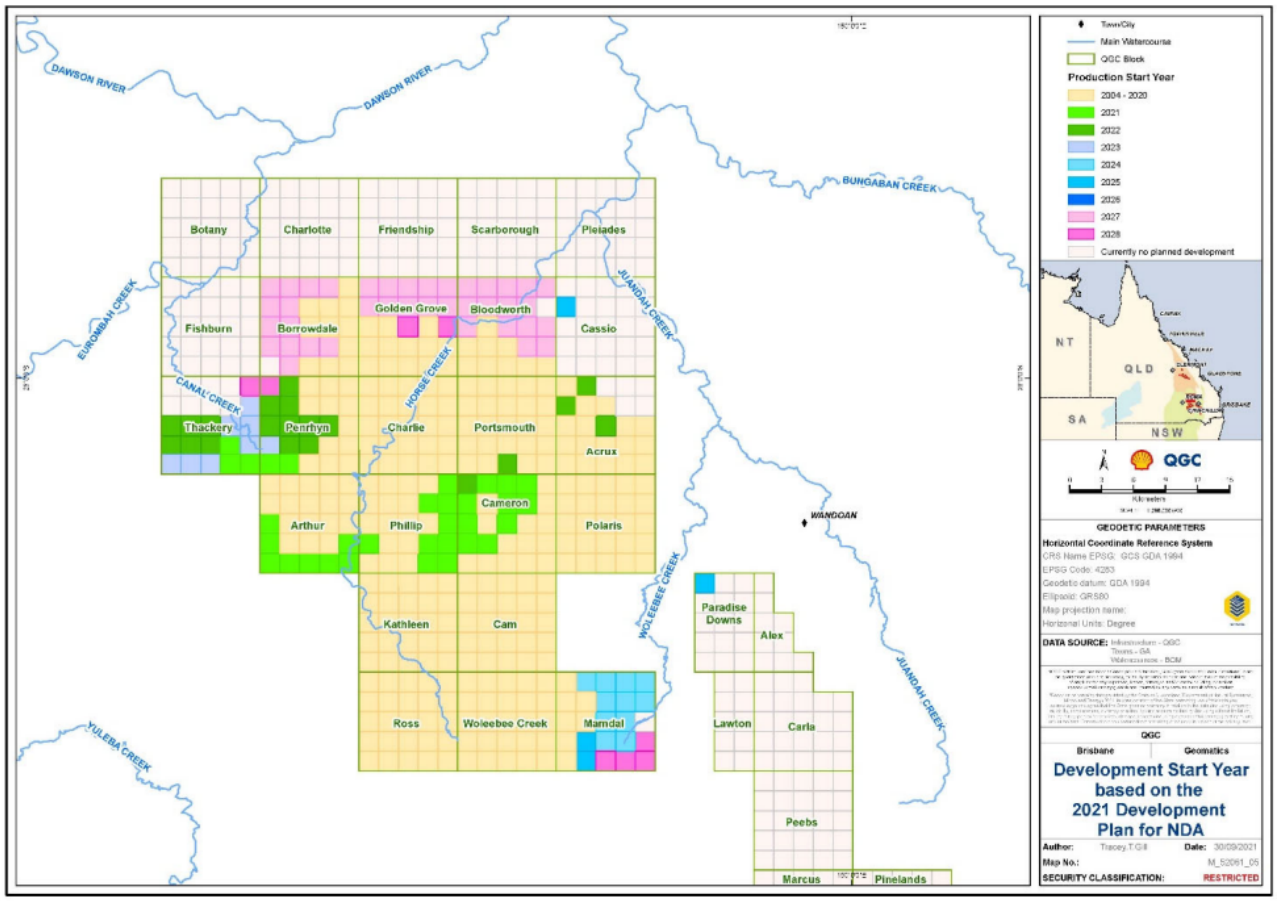


Figure 3.10 QGC Northern Development Area Future Development Plan (2021 Block Production Summary) (CDM Smith 2022)

Senex

Senex operate their Project Atlas tenure to the south of the Project area, located between the QGC tenures. The Project was approved in 2018. 23 CSG production wells were operating in this area (as at 2020), with an additional 98 reported to be planned (OGIA 2021b). Cessation of production in this area is indicated as between 2060 and 2069 (OGIA 2021b).

A referral has been submitted by Senex to the federal government for an expansion of the Project (Atlas Stage 3). The Department of Climate Change, Energy, Environment and Water (DCCEEW) website indicates that the project will include up to 151 CSG wells, with the life expectancy of each CSG well being between 15 and 25 years (DCCEEW 2023). The Project has been approved in July 2024 and is planned to commence towards the end of 2024.

Origin

The tenure underlying ML50230 and ML52031 (PL444) is attributed to Origin Energy. The 2021 UWIR (OGIA 2021b) does not indicate any planned commencement of CSG on these PLs.

Mining Leases

There are two other MLs in proximity to the Project but neither of these are currently operating or have development underway.

3.4 Environmental Values

Under the *Environmental Protection Act 1994* (EP Act 1994), the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019) is established as subordinate legislation to achieve the object of the Act in relation to Queensland waters.

The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* is achieved by identifying environmental values (EVs) and management goals for Queensland waters; stating water quality guidelines and water quality objectives to enhance or protect the EVs; providing a framework for making consistent, equitable and informed decisions about Queensland waters; and monitoring and reporting on the condition of Queensland waters.

The *Environmental Protection Act 1994* defines an EV as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an EV under an Environmental Protection policy or regulation.

The Project is in the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. EVs and water quality objectives (WQOs) have been defined for the sub-basin under the E*nvironmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP).* Table 3.2 presents the EVs for groundwater and surface water for the Project area. The Project area is also defined as being located in a saline groundwater chemistry zone.

The EPP provides WQOs to support and protect the various EVs identified for waters within the Dawson River sub-basin. The WQOs are provided for various water types associated with the EVs.

Table 3.2 Groundwater and Surface Water EVs for the Upper Dawson River Sub-Basin (Environmental Protection (Water) Policy 2009. Dawson River Sub-Basin Environmental Values and Water Quality Objectives Basin No. 130 (Part), Including All Waters of the Dawson River Sub-Basin except the Callide Creek Catchment 2011)

Water	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking Water	Industrial Use	Cultural And Spiritual
Groundwater - Taroom area	✓	✓	✓	✓			✓		✓	✓	✓	✓
Surface water – southern tributaries	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓

4 HYDROGEOLOGICAL CONCEPTUALISATION

4.1 Regional Geology

The Project is within the geographical extent of the Surat Basin, a basin of Jurassic- Cretaceous age, which is underlain by the Permo-Triassic Bowen Basin. Cenozoic-age formations are present overlying the Surat Basin formations and in the vicinity of watercourses. The surface geological map within the vicinity of the Project is shown in Figure 4.1.

Cenozoic-age formations cover much of the Surat Basin and generally comprise unconsolidated alluvial sediments, which have been deposited along pre-existing watercourses (OGIA 2021c).

The Surat Basin underlies approximately 180,000 km^2 of southeast Queensland. This basin is connected to the Eromanga Basin to the west, the Clarence-Moreton Basin to the east, and the Mulgildie Basin to the northeast (KCB 2016). The Surat Basin is bounded to the northeast by the Auburn Arch and to the southeast by the Texas Block. The northern margin of the basin has been exposed and extensively eroded. Basin sediments generally dip southwest (OGIA 2016a). Maximum sediment thickness of the Surat Basin is approximately 2,500 m, which occurs in the Mimosa Syncline that is delineated on the western boundary of ML50229.

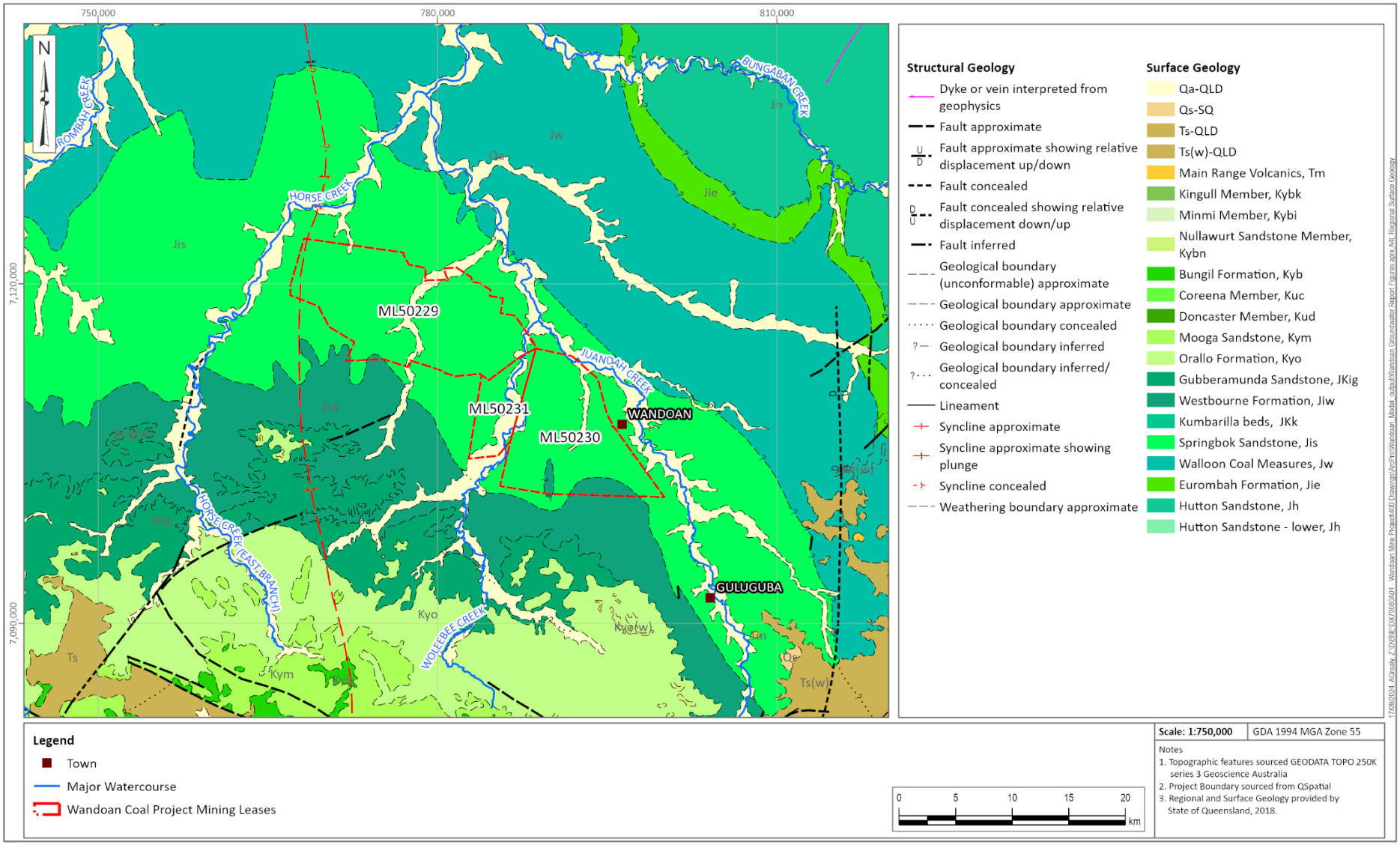


Figure 4.1 Mapped Surface Geology

4.2 Regional Hydrostratigraphy

The Surat Basin forms part of the Great Artesian Basin (GAB), which comprises several aquifers and confining aquitards. Aquifers of the Surat Basin are a significant source of water used for stock, public water, and domestic supply. The hydrostratigraphy of the Surat and Bowen Basin is presented in Figure 4.2, sourced from the 2021 Surat CMA UWIR. A summary of each of the hydrostratigraphic units within the Surat Basin, which are relevant to this assessment is provided below (from oldest to youngest).

Precipice Sandstone ***Regional Aquifer***

The Precipice Sandstone is the basal unit of the Surat Basin overlying the Moolayember Formation and sedimentary sequences of the Bowen Basin. Lower and upper subunits are recognised. This is often separated by a siltstone or shale unit. The layers with the coarsest grain sizes were deposited by transverse bars in a braided stream system and the finer grain sized sediments were deposited in a lower energy fluviatile meandering system (Martin 1981). The lower subunit, also known as the Precipice Braided Stream Facies (or Precipice BSF), consists of white, fine to very coarse-grained, in part pebbly, thin to very thickly bedded, porous, quartz-rich sandstone with a white clay matrix (Exon 1976).

Hutton Sandstone ***Partial and Tight Aquifer***

The Hutton Sandstone was deposited in a non-marine environment by meandering streams on a broad floodplain (Exon 1976) and consists mainly of sandstone with interbedded siltstone, shale, minor mudstone, and coal. The sandstone is white to light grey, fine to medium-grained, well sorted, generally quartz-rich, partly porous with some pebble bands, shale, and siltstone clasts in the lower part. Siltstones and shales are light to dark grey, micaceous, carbonaceous and commonly interlaminated with very fine-grained sandstone (Green 1997). It is highly heterogeneous, with sand bodies limited in vertical and lateral extent.

Durabilla (Eurombah) Formation ***Tight Aquitard***

The Durabilla Formation, often referred to as the Eurombah Formation, conformably overlies the Hutton Sandstone. The depositional environment for this unit was fluvial with periods of rapid sedimentation. It is often difficult to differentiate the Durabilla Formation from the Walloon Coal Measures (WCM). It is more restricted in extent than either the Hutton Sandstone or the WCM (Green 1997). The Durabilla Formation is considered an aquitard, consisting of siltstone, mudstone and fine to medium-grained poorly sorted sandstone, with almost no coal and consequently, little permeability (OGIA 2016b).

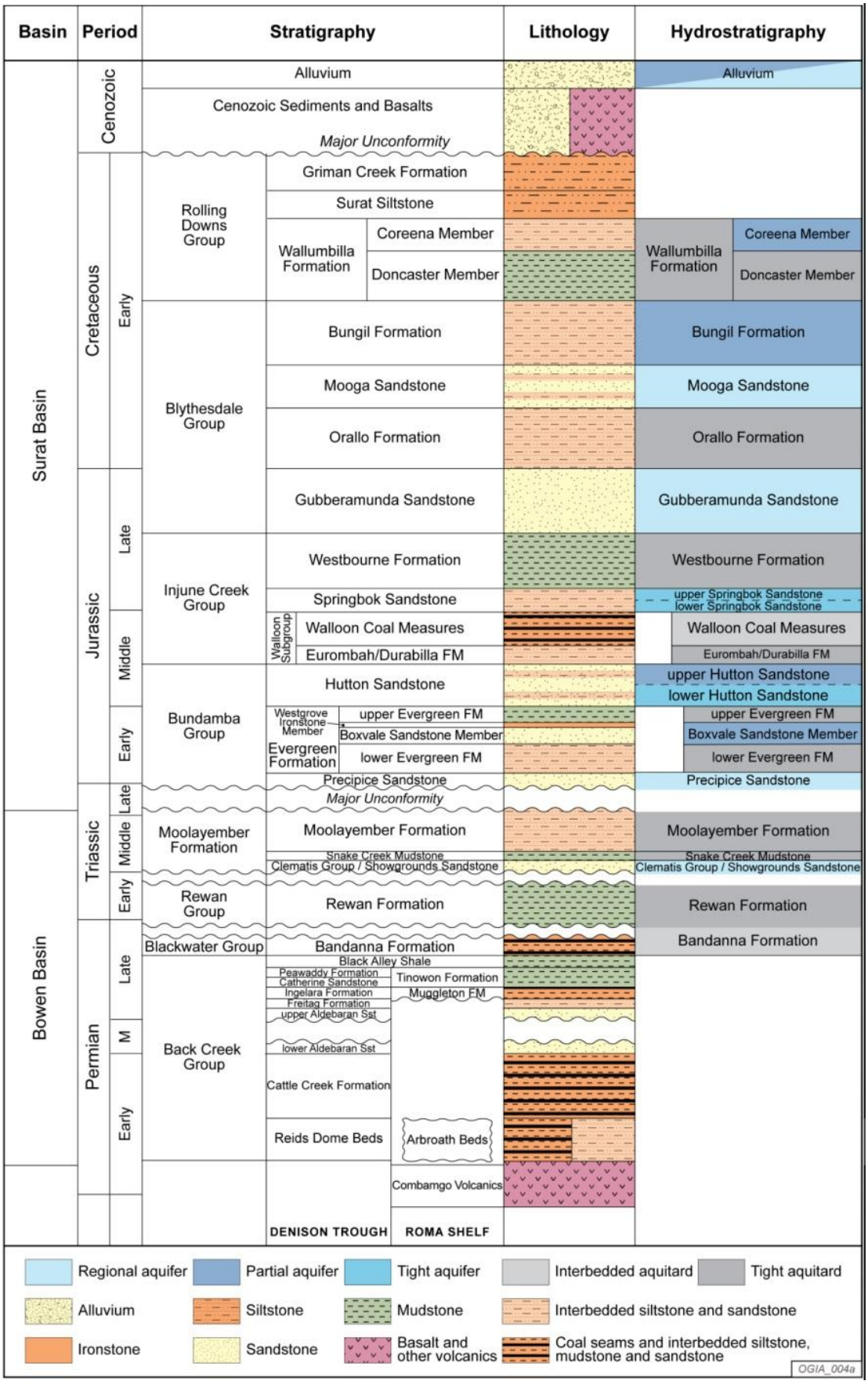


Figure 4.2 Regional Hydrostratigraphy (after OGIA 2021c)

Walloon Coal Measures *Productive Coal Seam and Interbedded Aquitard*

The WCM is the target formation for the mining operations of the Project, and for CSG extraction in the vicinity of the Project. This formation conformably overlies the Durabilla Formation. It was deposited in a low-energy meander-belt river system, with the coal layers deposited mainly in an overbank environment (Exon 1976). The WCM consists of very fine to medium-grained argillaceous sandstone, siltstone, mudstone, and coal with minor calcareous sandstone, impure limestone, and ironstone (Swarbrick 1973). Typically, the coal layers are positioned in the upper half to three-quarters of the coal measures, with mudstone, siltstone, and lithic sandstone dominant in the lower part.

The stratigraphy of the WCM is shown in Figure 4.3. The coal seams to be mined as part of the Project are within the Upper Juandah Coal Measures and include the Kogan, Macalister Upper, Macalister Lower and Wambo coal seams.

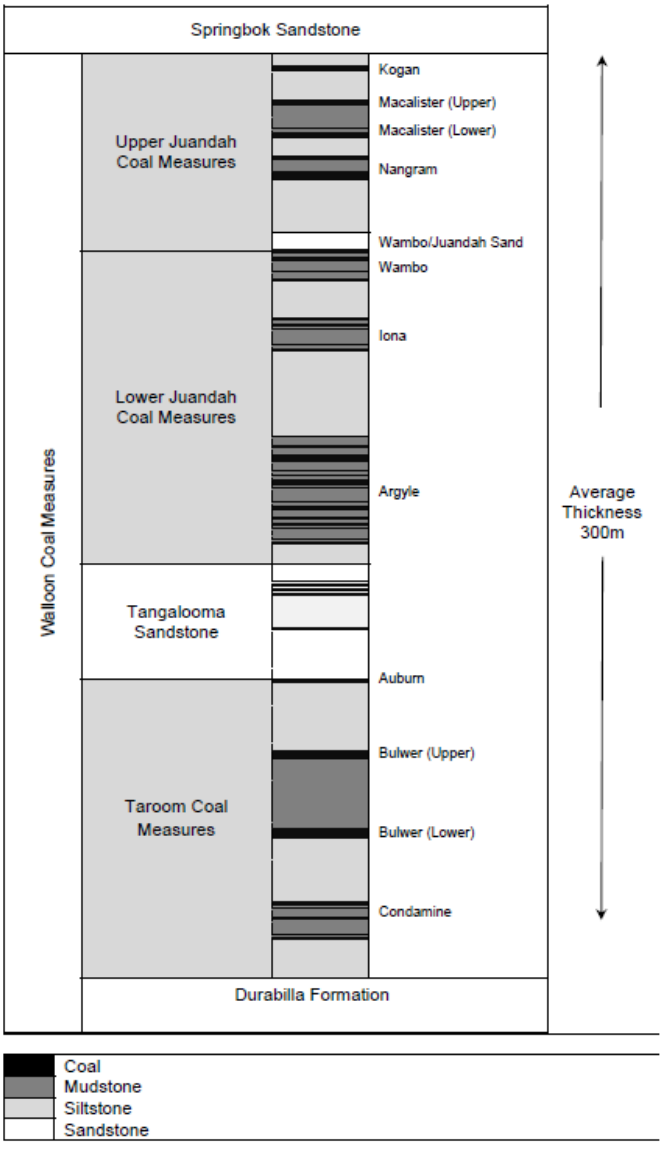


Figure 4.3 Stratigraphy of the WCM (Hamilton et al. 2014)

Springbok Sandstone ***Tight Aquifer***

The Springbok Sandstone overlies the WCM. It was deposited by streams and includes overbank and swamp deposits in the upper part of the unit which indicates streams becoming less energetic with time (Exon 1976). The Springbok Sandstone consists mostly of feldspathic sandstones, commonly with calcareous cement (Green 1997). At the basin scale, the sandstones range from very fine to coarse-grained, although some very coarse-grained, poorly sorted pebbly beds also occur. Minor interbedded siltstones, mudstones, and thin coal seams are also present, primarily in the upper part of the unit. Within the GAB, the Springbok Sandstone is considered a usable water source, however it is highly variable in hydraulic properties and yield across the basin. The Springbok Sandstone also has a very high content of mudstone and siltstone at many locations with very low permeability (OGIA 2016b).

Westbourne Formation ***Aquitard***

The Westbourne Formation conformably overlies the Springbok Sandstone. It was deposited in an environment with characteristics consistent with a low-energy, lacustrine deltaic (Green 1997). Westbourne Formation comprises predominately siltstone layers with thick interbeds of fine to medium-grained sandstone and minor mudstone. Small coal fragments, lenses and lamina are common throughout the formation. Within the GAB sequence, the Westbourne Formation is considered an aquitard.

Gubberamunda Sandstone ***Aquifer***

Regionally, the Gubberamunda Sandstone conformably overlies the Westbourne Formation, but locally is disconformable, particularly around the margins of the basin (Green 1997). It was deposited by braided and meandering stream systems draining surrounding highlands (Exon 1976). Consistent with a fluvial depositional environment, repeated packages of siltstone and fine to coarse sandstone were deposited. Deposits of carbonaceous shale along with minor coal fragments are typically present. Within the GAB, the Gubberamunda Sandstone is considered a usable aquifer.

4.3 Local Hydrostratigraphy

4.3.1 Hydrostratigraphic Units

The Project is situated in an area where Springbok Sandstone outcrops, with the WCM outcropping to the north of the Project area. Relevant hydrostratigraphic units to the Project area include Quaternary-age alluvium, associated with the watercourses and flood plains, the Springbok Sandstone, and WCM. Units deeper than the WCM are at depths greater than 400 m, with mining reaching depths of up to 70 m. Impacts on deeper units such as the Hutton and Precipice Sandstone are considered unlikely from the post-closure period because of the relative depths of these units compared to the base of the mining operations. The Hutton Sandstone is estimated to be at ~550 m depth and Precipice Sandstone at ~900m depth Similarly, the upper units, such as the Westbourne Formation occur at least 10 km to the south of the Project area, and as such are considered unlikely to be influenced during the post-closure period and not discussed further.

A cross section, oriented North-South, through the Project area, is shown in Figure 4.4. The cross sections were prepared using the geological model surfaces developed for the numerical groundwater model (Appendix IV). The final landform and maximum depth of the pits is also shown. The sections highlight the WCM units (Upper Juandah, Lower Juandah and Taroom Coal Measures) have a combined thickness in excess of 400 m, as well as the units dipping towards the south. Mapping of the coal seams has been undertaken by Glencore Coal Assets Australia (GCAA) on behalf of the Proponent for resource estimation. The resource estimation mapping indicates that the Springbok Sandstone is thin or absent across the majority of the Project area.

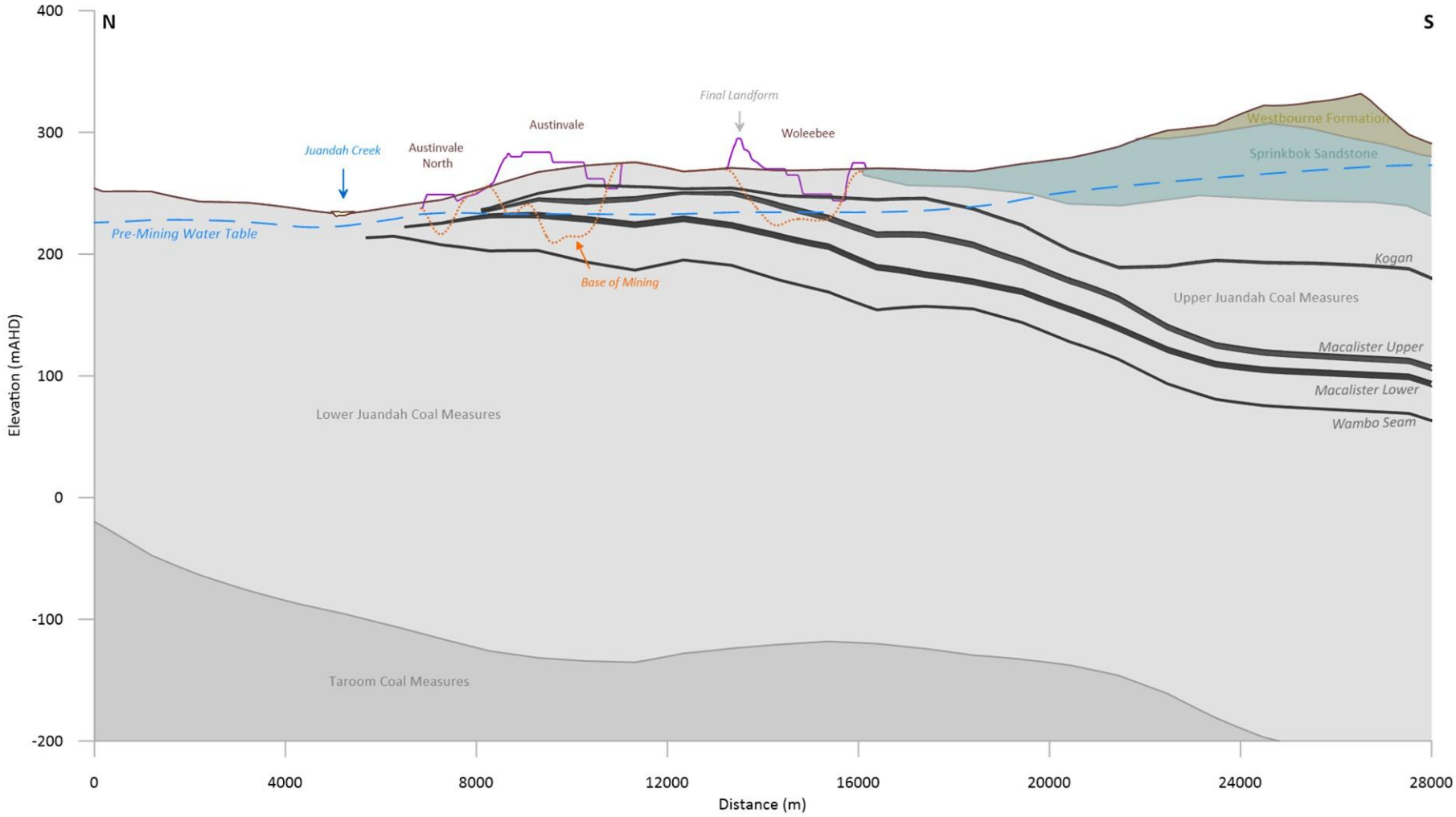


Figure 4.4 Indicative Hydrogeological Section – North-South

4.3.2 Alluvium

Quaternary-age alluvium is mapped within the Project area and is associated with Juandah Creek, Woleebee Creek, Frank Creek and Mud Creek, as shown on Figure 4.5. Alluvial sediments are typically weathered geological products of bedrock lithotypes that have been transported along watercourses and deposited by fluvial actions. Alluvial sediments typically comprise sand, silt, clay and gravel deposited in a fining upwards fluvial sequence (CDM Smith 2022).

Data for alluvium thickness was compiled from four sources (Groundwater Database (GWDB), QGC, Senex and GCAA), as presented on Figure 4.5. The data shows alluvium thicknesses interpreted up to 17.4 m (to the north of the Project), with thickness directly in the MLs between 1 and 10.5 m. A drilling program was completed by GCAA in late-2023, with bores installed within the alluvium recorded as dry, with no groundwater intersected or static water level measured after drilling. Further discussion of the alluvium groundwater levels is provided in Section 4.6.

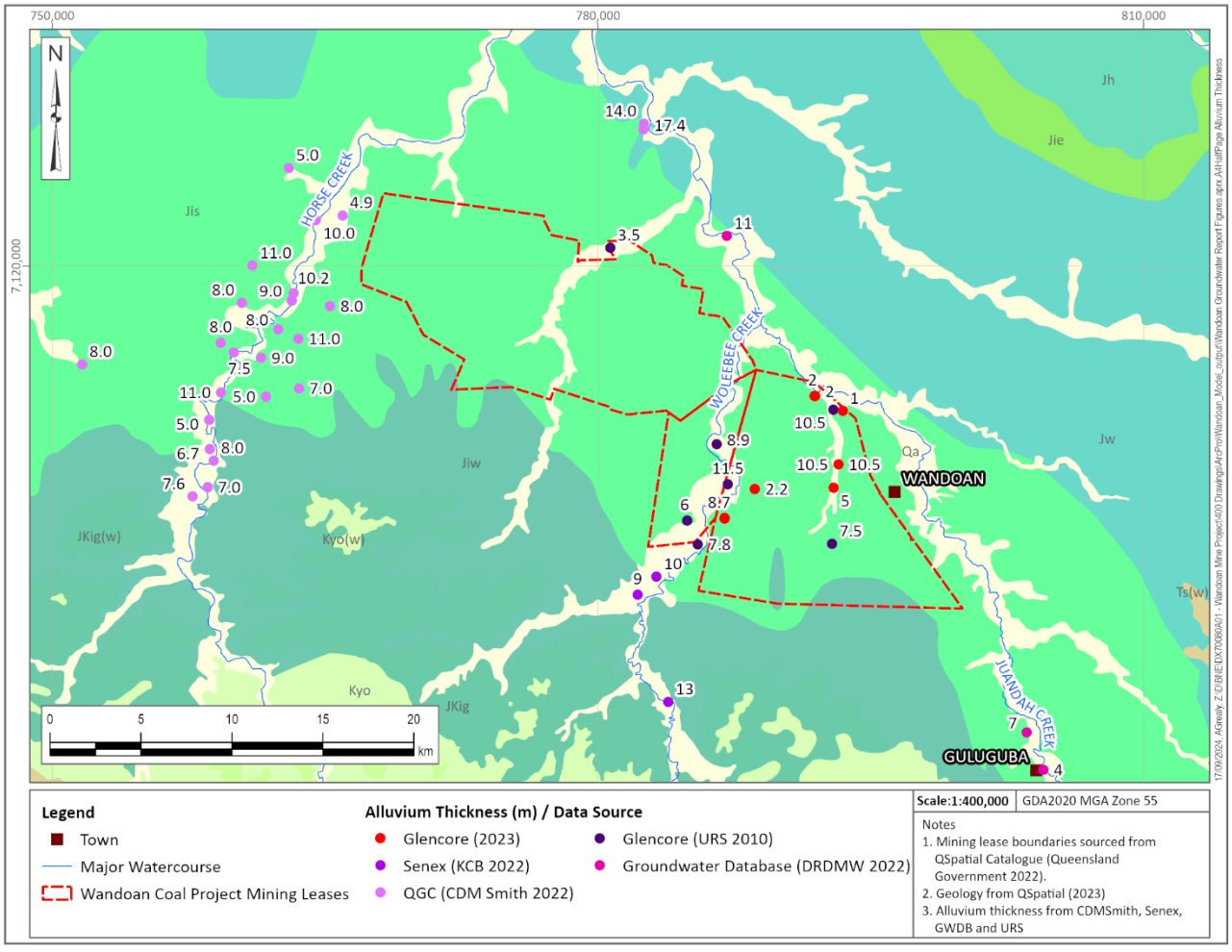


Figure 4.5 Alluvium Thickness (see Figure 4.1 for Geology Legend)

4.3.3 Structures

There are no mapped major geological structures (e.g., faults) within Project MLs. The nearest major structure is the Mimosa Syncline that is delineated on the western boundary of ML50229, and the closest fault is the Burunga Fault located approximately 17 km east of Wandoan.

However, there were 20 vertical faults identified through exploration drilling on the MLs and the displacement is between 15 m – 30 m (GCAA 2018).

4.4 Aquifer / Aquitard Properties

A number of hydraulic tests, to determine hydraulic parameters, have been conducted across the Surat Basin on formations overlying and underlying the WCM.

OGIA (2019b) presented a range of hydraulic conductivity estimates from core, drill stem tests (DSTs), and pumping tests within the Surat CMA. Those values are provided on Figure 4.6. The data was compiled from a range of sources including the Queensland Groundwater Database (GWDB), Queensland Petroleum Exploration Database (QPED), GAB Water Resource Assessment (Smerdon et al. 2012) and public domain sourced investigations undertaken by other CSG proponents including QGC, APLNG and Arrow Energy.

Ranges of horizontal permeability values from these tests, together with model calibrated values indicate that the Gubberamunda and Precipice Sandstones have the highest hydraulic conductivity values for consolidated formations in the Surat CMA (Figure 4.6) (OGIA 2019a)[1]. Based on the data presented in OGIA (2019b), hydraulic conductivity values for the WCM range between 10^{-12} and 10^{+1} m/day. The values are likely influenced by the lithology tested as well as the test method.

Limited site-specific hydraulic parameter values are available for the alluvium, which is likely a function of the geometry of the alluvium (i.e., thin) and with the alluvium being largely unsaturated. Two slug tests were conducted on Woleebee Creek alluvium in 2009, with the reported values being 0.001 and 0.26 m/day (URS 2010). A hydraulic conductivity of between 0.2 and 1.4 m/d was reported for the alluvium associated with Horse Creek (AGE 2012), to the west of the Project.

[1] The 2019 Surat UWIR has been superseded by the 2022 Surat UWIR, however the hydraulic conductivity values referenced in this report are provided in the 2019 UWIR report (and are the same as those used in the 2021 Surat UWIR groundwater model).

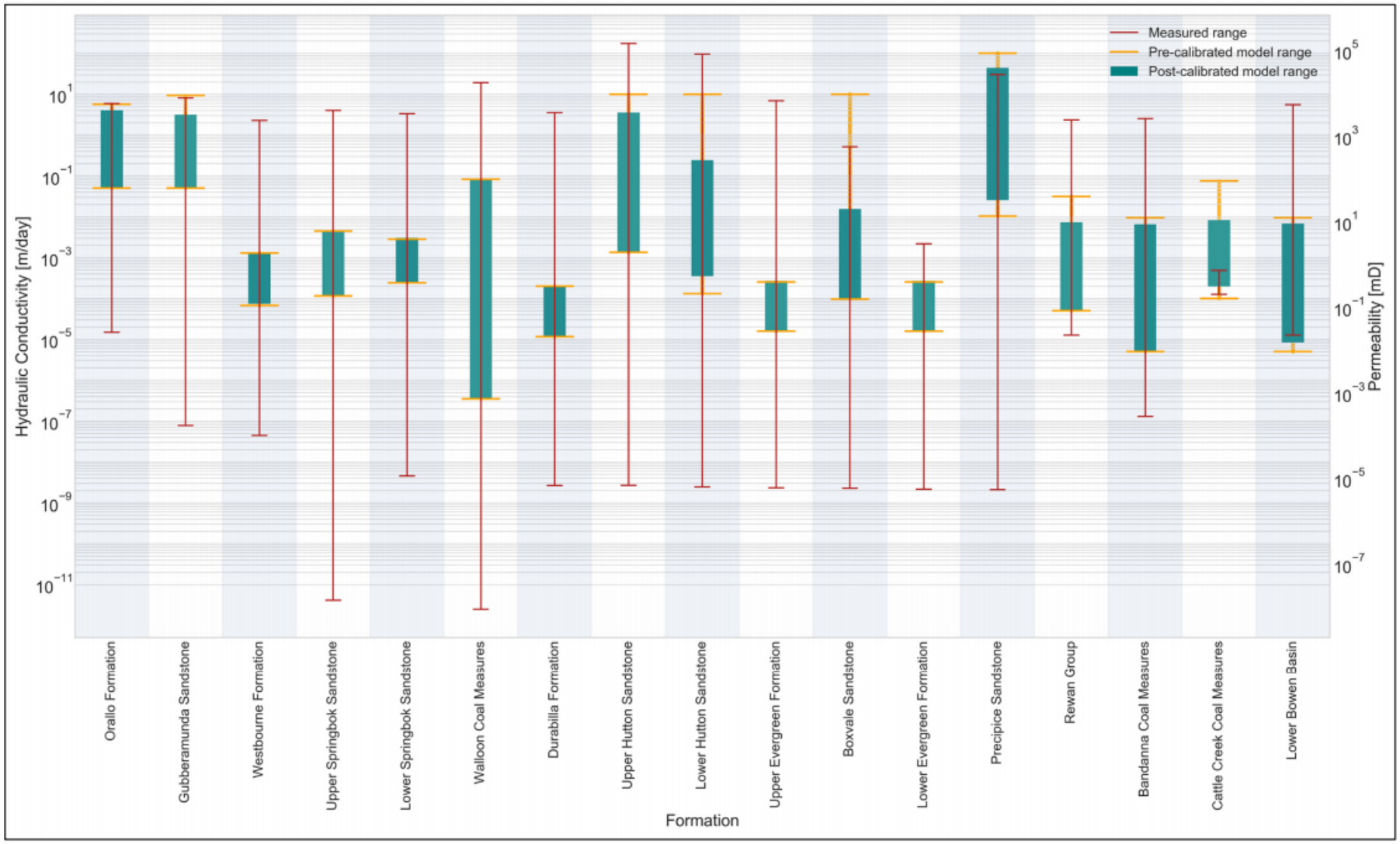


Figure 4.6 Hydraulic Conductivity Values for Surat Basin Units (OGIA 2019a)

4.5 Groundwater Recharge

Groundwater recharge processes within the Surat Basin are summarised in the *Hydrogeological Conceptualisation Report for the Surat Cumulative Management Area* (OGIA 2016a) and based on Kellett et al. (2003b), and *Regional flow systems and potentiometry in Queensland's Surat and Southern Bowen Basins* (OGIA 2021a). Key processes of recharge include localised recharge, preferential pathway flow and diffuse recharge:

- Localised recharge occurs beneath drainage features including rivers, creeks, and alluvial and tertiary groundwater systems where there is sufficient saturation and hydraulic head to allow water to infiltrate into aquifers. Areas of localised recharge are considered limited in extent in the GAB (Kellett et al. 2003b).
- Preferential pathway flow arises from changes in permeability within aquifers and in overlying regolith, providing conduits for water to infiltrate. Zones of higher permeability may include fissures, faults, joints, tree roots and high-permeability beds within individual formations and along bedding planes (Kellett et al. 2003b; Sucklow et al. 2016). This mechanism is considered the dominant recharge process in the GAB (Kellett et al. 2003b).
- Diffuse discharge is the process by which rainfall infiltrates directly though outcropping aquifers. This is expected to occur within all outcrop areas and therefore this process applies to the largest spatial extent (Kellett et al. 2003b).

Within the vicinity of the Project, groundwater recharge is likely to occur as a result of localised recharge occurring beneath watercourses and alluvial systems where sufficient saturation and hydraulic head allows water to infiltrate into surficial aquifers.

Recharge will also occur as diffuse recharge with rainfall infiltrating directly through outcropping aquifers, such as the Springbok Sandstone which outcrops across the majority of the MLs.

Long-term average recharge rates were estimated by OGIA using the chloride mass balance recharge method (OGIA 2016a). The rates are presented in Table 4.1. OGIA used three methods to estimate recharge. Method 1 had no adjustments to the mean annual rainfall for potential run-off or chloride (Cl) removal by crops and pasture. For method 2 adjustments were made to the amount of rainfall due to potential run-off. For method 3 adjustments were made to the amount of rainfall due to potential run-off and also reduced Cl accession due to removal of Cl from the field via grazing and cropping systems.

Table 4.1 OGIA Calculated Recharge Rates (OGIA 2016a)

Hydrostratigraphic Unit	Number of Bores	Method 1 Calculated Recharge (mm/yr.)	Method 2 Calculated Recharge (mm/yr.)	Method 3 Calculated Recharge (mm/yr.)
Alluvium	6,646	14.3	11.0	8.4
Gubberamunda Sandstone	193	5.8	5.2	3.9
Westbourne Formation	47	3.2	2.9	2.2
Springbok Sandstone	85	5.0	4.3	3.2
Walloon Coal Measures	530	7.4	5.7	4.3
Durabilla Formation	147	6.4	5.2	3.9
Hutton Sandstone	733	8.7	6.8	5.1

OGIA (2019a) indicates that the recharge estimates in 2016 (OGIA 2016c) were based on a relatively small concentration data set, which might not reflect the attributions in some aquifers (units). For example, *"more than 50% of the available chloride data for samples taken from the Precipice Sandstone assessed by OGIA suggest recharge of more than 30 mm/yr, which tends to confirm that this is not a realistic upper bound for this aquifer"* (OGIA 2019a).

Other studies relevant to the Project report recharge ranges between 0 - 2.5 mm/year (Kellett et al. 2003a), 1 - 30.0 mm/year (QWC 2012b), 0.01 - 1.8 mm/year (Wohling et al. 2012) and 0 - 5.55 mm/year (QGC 2016).

4.6 Groundwater Levels and Flow

4.6.1 Regional Groundwater Flow

Basin scale groundwater flow within the Surat Basin is typically north to south from northern outcrop areas. Groundwater also tends to flow towards the north (towards Taroom) on the northern side of the Great Dividing Range with groundwater discharging into the Dawson River catchment (OGIA 2016b; 2021a). South of the range, groundwater flow is generally southward, broadly consistent with the dip of the formation (OGIA 2021a).

Groundwater movement is slow in the GAB with flow velocities estimated at 1 to 5 m/yr. (Habermehl 1980). Generally, groundwater flow and movement occurs as sub-horizontal flow, with limited vertical leakage across formations, where pressure differences may exist (OGIA 2016b). Local groundwater flow conditions may be different from regional flow conditions with potential steeper gradients and increased velocities in response to hydraulic stresses such as groundwater abstraction. Potential groundwater users within the Project area are discussed in Section 4.9, and if evident within groundwater monitoring data, local responses are noted.

4.6.2 Groundwater Contours

The inferred groundwater flow direction is shown in Figure 4.7. The figure presents the groundwater table elevation using the available data for 2022. The groundwater contours indicate that groundwater elevations are highest to the south-southeast of the Project. The general inferred groundwater flow is towards the north and east. Directly within the Project area the flow is from the southwest to northeast. Limited localised influence of CSG activities is evident in the water table contours.

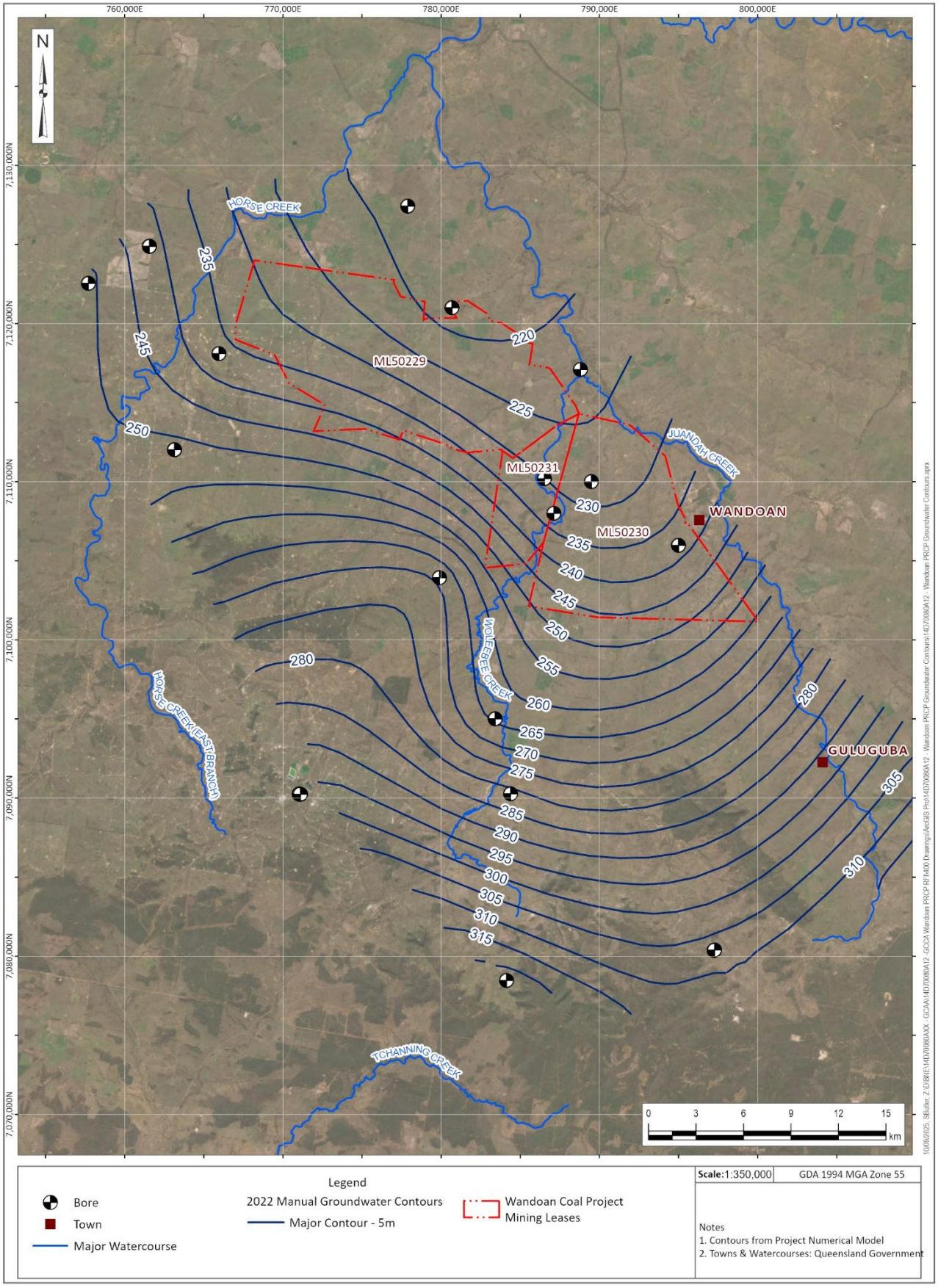


Figure 4.7 Inferred Groundwater Table Contours 2022

4.6.3 Monitoring Bores

GCAA monitors a network of bores within the Project area on behalf of the Proponent. Figure 4.8 shows the location of the GCAA monitoring bores.

An additional 20 bores were installed at the end of 2023, early 2024 to supplement the existing network. The additional monitoring bores were installed on the eastern side of the Project area as the first mining is planned to commence in the east, with later mining planned to occur in the west. Additional monitoring on the western side of the Project area will be planned and installed as mining progresses. The first available data from the additional monitoring bores was available in early 2024. Due to the timing of the drilling program, and time frame for the development of numerical model to support the PRCP, the data from the additional monitoring bores was not available for incorporation into the numerical model, which was started in early 2023.

Existing GCAA monitoring bores were also visited in March 2023 to verify the bore surface infrastructure, document the visible bore construction details and collect information on screen interval using a bore camera. Details of the GCAA monitoring bores (current and historical) are provided in Appendix I.

Monitoring data was also obtained from QGC and Senex to support conceptualisation and numerical groundwater model calibration.

There are also numerous monitoring bores which have been installed as part of the Surat CMA UWIR and other programs, such as the CSG Online or CSG Net programs, which are coordinated by the Queensland Government. The location of these bores is shown on Figure 4.9. It should be noted that some of the monitoring bore data was not available at the time of reporting for all bores indicated in the GWDB, potentially due to recent installation, or the frequency of data entry into the GWDB. The assigned formation for the monitoring bores was provided by OGIA.

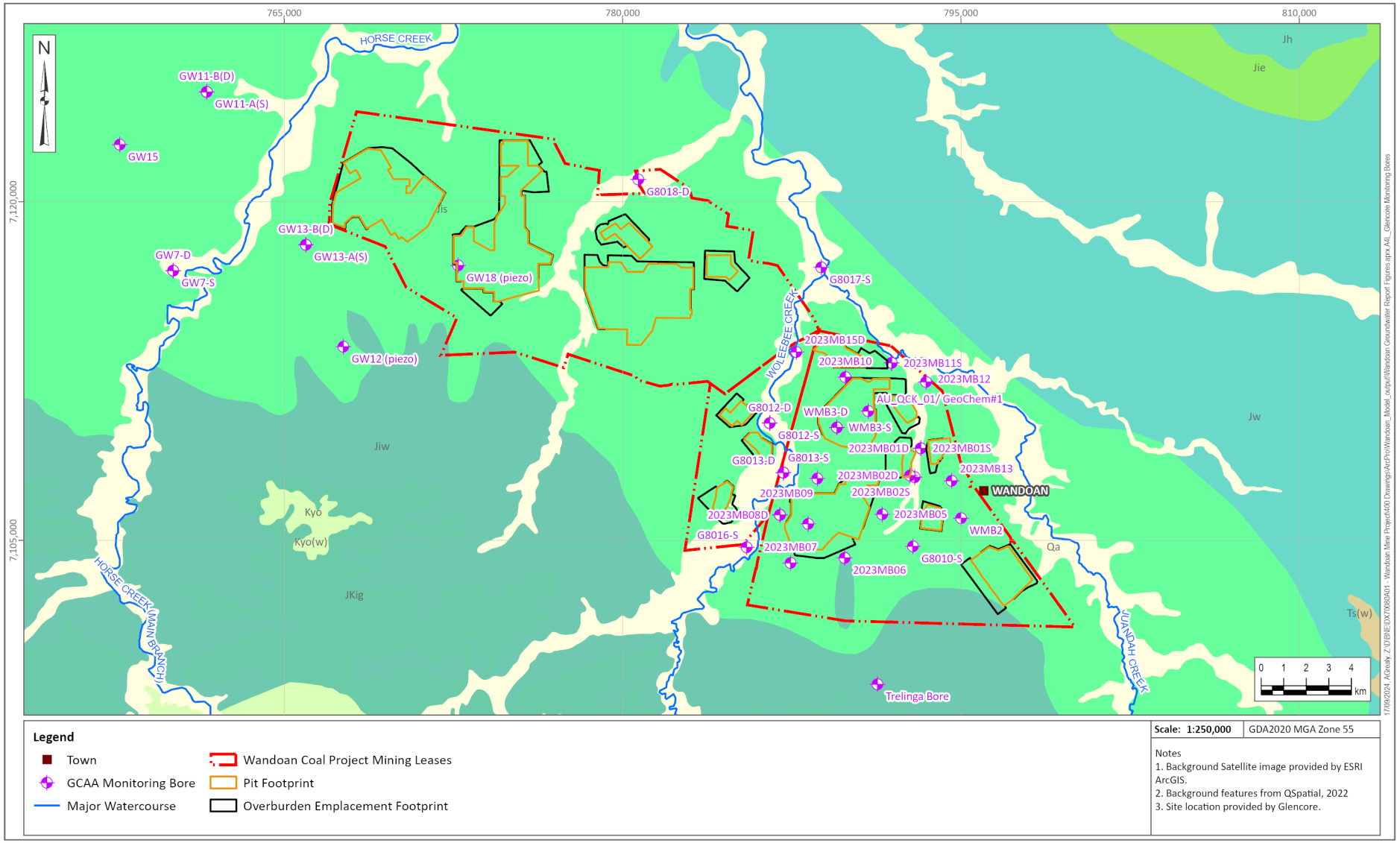


Figure 4.8 GCAA Monitoring Bores

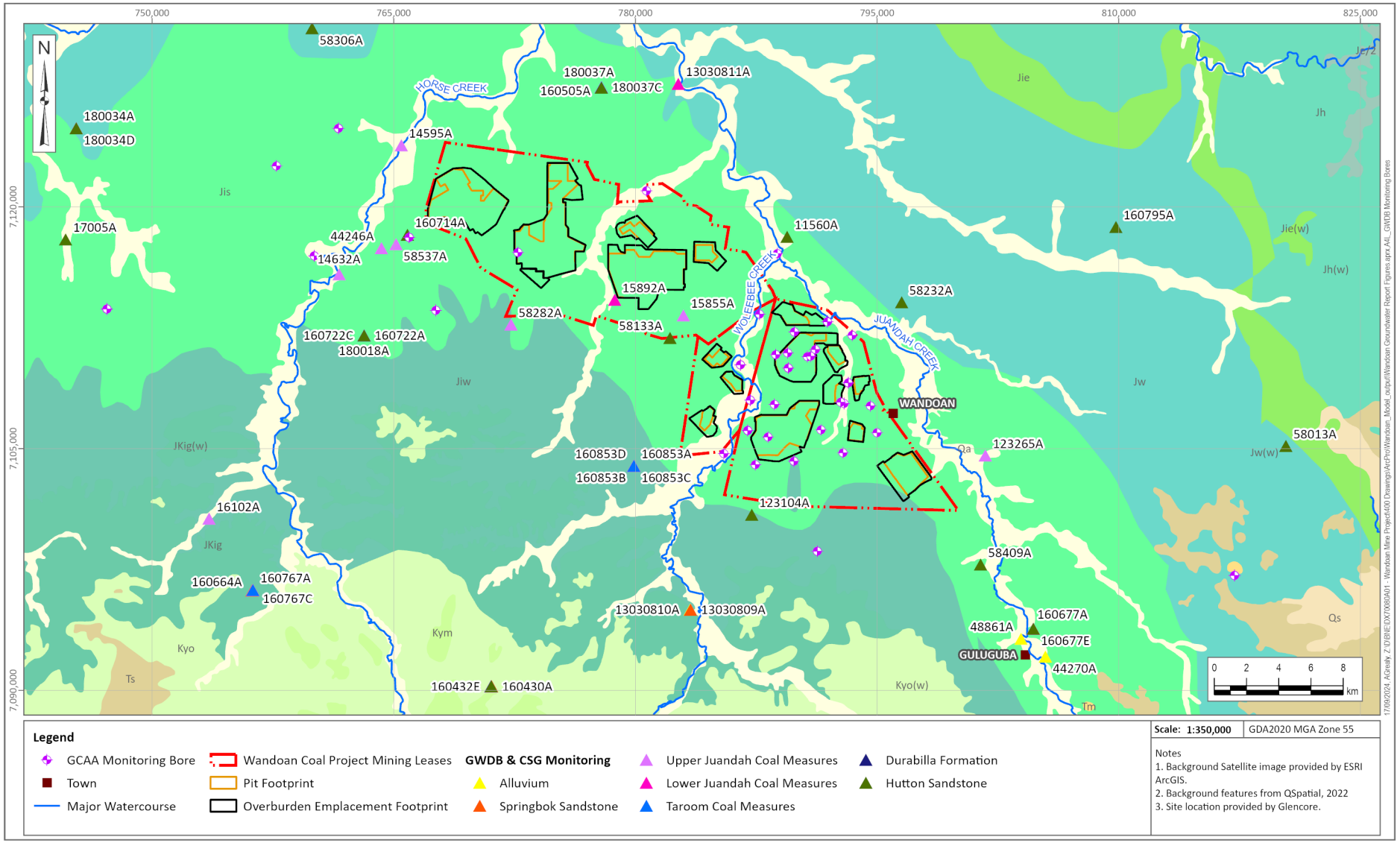


Figure 4.9 GWDB and CSG Monitoring Bores

4.6.4 Groundwater Elevation

Groundwater elevation time series data for each formation and individual hydrographs is provided in Appendix II. The key hydrostratigraphic units relevant to the Project are the alluvium, Springbok Sandstone, which overlies the WCM to the south of the Project area, and the WCM upper units, specifically the Upper Juandah Coal Measures, which is the target for mining.

Alluvium:

The majority of the bores monitoring the alluvium have persistently been dry since installation. Only three bores monitored by GCAA (G8012-S, G8013-S and G8017-S) have currently or historically had groundwater within the bore column. The responses at G8012-S and G8013-S, located on Woleebee Creek alluvium, show a strong correlation with the CRD trend (Figure 3.1). The saturated thickness of the alluvium ranges between 2 and 2.8 m at G8013-S, located to the south of the Woleebee North pit, with a logged alluvium thickness of 11.5 m (URS 2010) at this location. The saturated thickness of the alluvium at G8012-S, located on the northern edge of the assumed Woleebee North pit, ranges between 1.2 and 2 m, with a logged alluvium thickness of 8.9 m. The creek bed elevation near G8012-S is 236 mAHD.

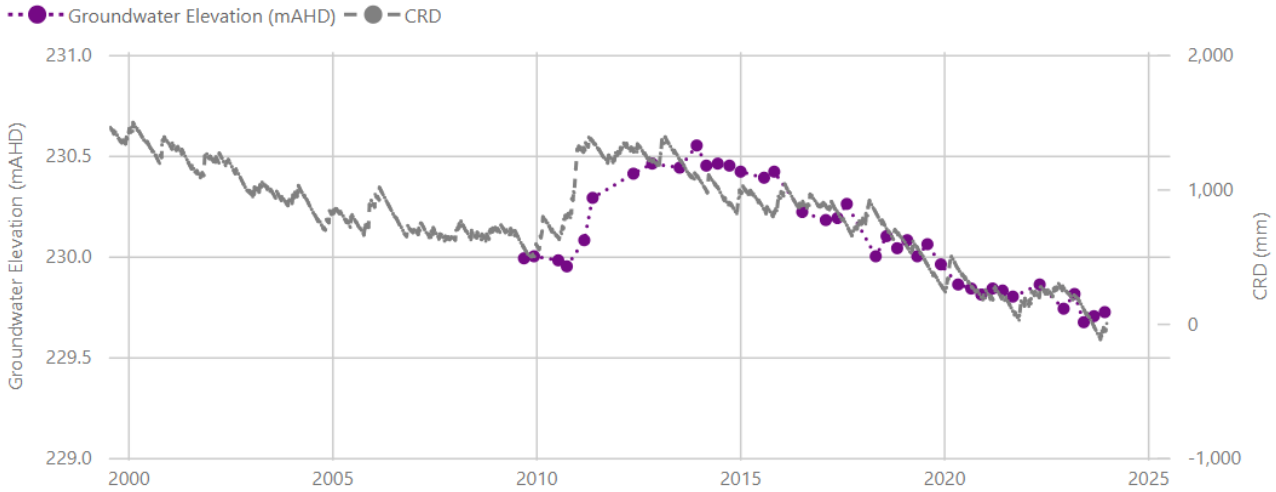


Figure 4.10 G8012-S Groundwater Elevation and CRD Trend (Base of Creek at 236 mAHD)

Springbok Sandstone:

Monitoring in the Springbok Sandstone occurs at bores installed for monitoring CSG, with elevations ranging between 320 and 240 mAHD (Appendix II). Elevations are highest towards the south, where the unit is confined by the overlying Westbourne Formation and Gubberamunda Sandstone. The Springbok Sandstone groundwater levels have shown a rising trend in recent years. OGIA (OGIA 2021c) suggests that this is related to upwards gas migration associated with CSG extraction.

WCM:

The groundwater levels in the Upper Juandah Coal Measures in the Project MLs range between 217 and 244 mAHD and do not currently show an influence from CSG depressurisation (Figure 4.11), however, monitoring to the south of the Project shows a decline in groundwater levels[2] of ~150 m (Appendix II).

In the Project area, the Upper Juandah monitoring bores show a similar trend to the Springbok Sandstone, with an increase in groundwater elevations indicated in the monitoring record.

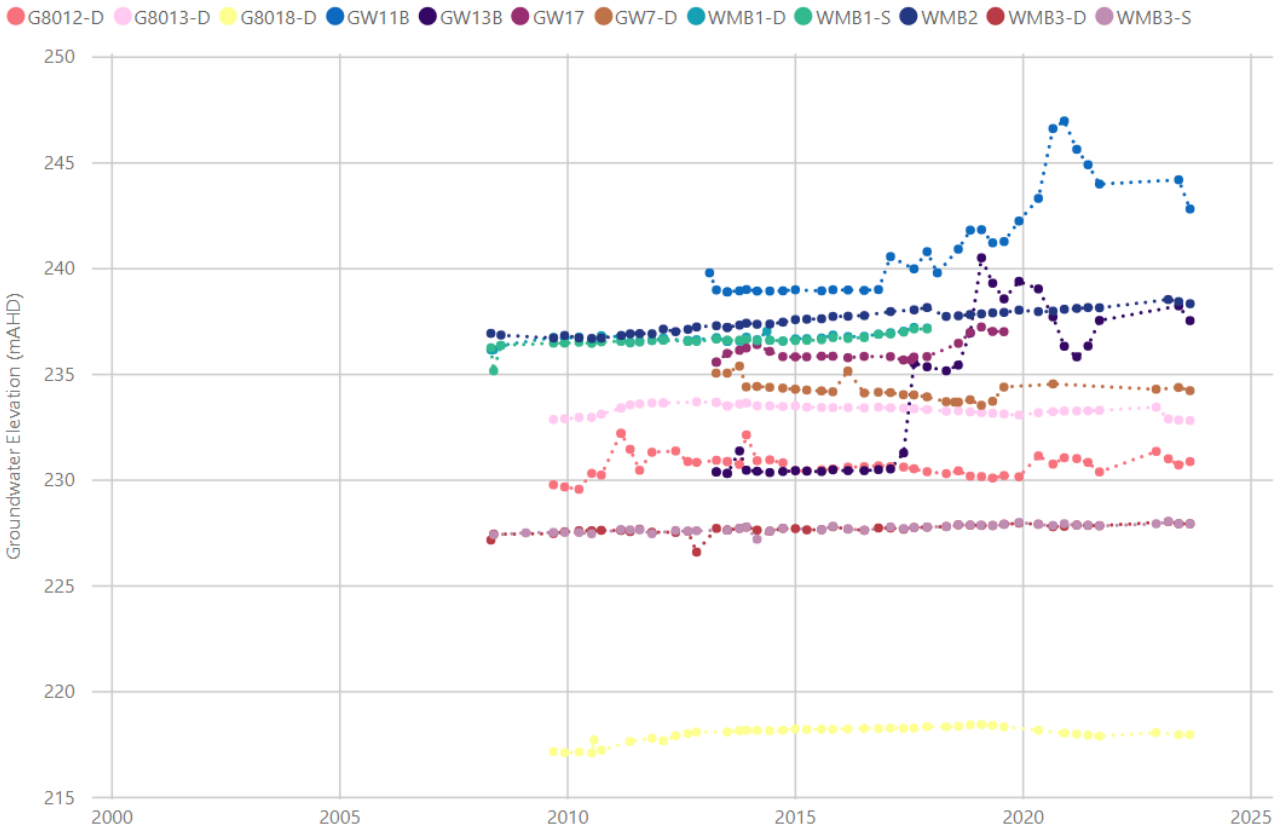


Figure 4.11 Upper Juandah Coal Measures – GCAA Monitoring Bores

Data for the Lower Juandah was sourced from the GWDB and shows declines in groundwater elevation of ~450 m associated with CSG depressurisation (Appendix II). RN160853B is located south of MLs and has a decline of 200 m for the period of record (2015 to 2023).

4.6.5 Interconnectivity

As the area surrounding the Project has significant CSG development there are several locations with multi-level monitoring, since CSG generally targets the deeper coal seams (Lower Juandah and Taroom) for CSG extraction, and there is a potential to impact shallower hydrostratigraphic units. Two locations provide useful information to support the conceptualisation of the interconnectivity (RN160722 and RN160853), as shown in Figure 4.12 and Figure 4.13.

[2] Note that data has been extracted from the GWDB and cannot be verified for accuracy. Where data is considered unreliable it has been excluded based on professional hydrogeological judgement.

The graphs highlight the depressurisation within the Taroom Coal Measures, with limited propagation of drawdown or influence on overlying/underlying units at RN160722. At RN160853, drawdown has occurred through the WCM units, with stable water levels and limited connectivity with the overlying Springbok Sandstone. Further responses are provided in Appendix II and show the variability in responses in the area, which may be related to the timing of CSG development in those areas.

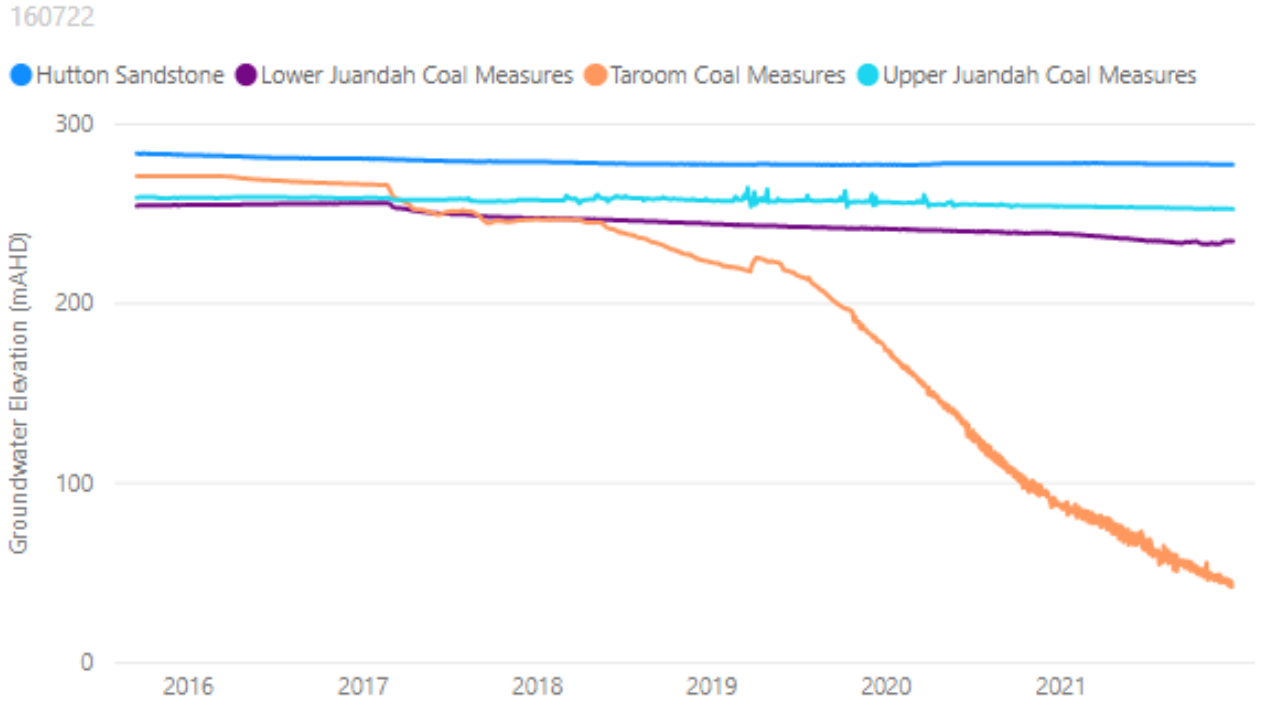


Figure 4.12 RN160722 Groundwater Elevation

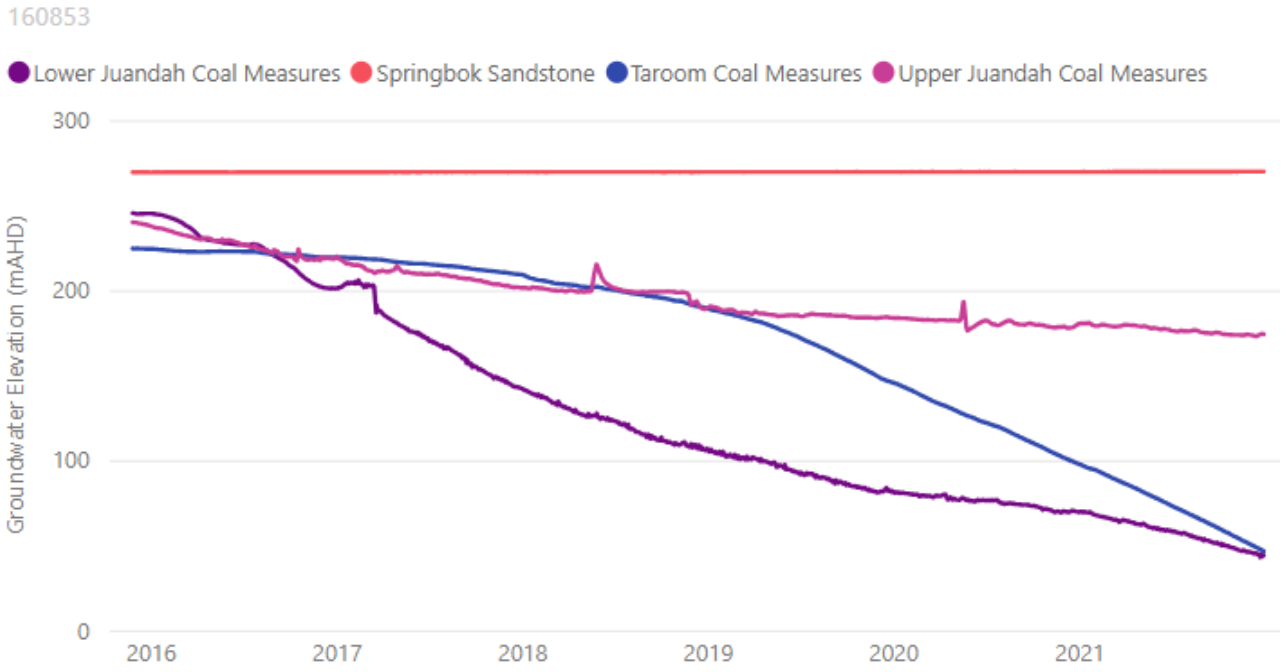


Figure 4.13 RN160853 Groundwater Elevation

4.7 Groundwater Chemistry

Groundwater chemistry within the Surat Basin was considered using information provided in the Hydrogeological Conceptualisation Report which supports the Surat CMA UWIR (OGIA 2016a):

- The Springbok Sandstone is characterised as fresh to brackish water quality, with a mean TDS of ~1,000 mg/L (ranging between 200 and 7,000 mg/L).
- The WCM is characterised as fresh to saline groundwater and TDS ranges from 30 to 18,000 mg/L, with a mean TDS of around 3,000 mg/L.

Hydrochemical data is available for the GCAA monitoring bores. Figure 4.14 presents a Piper and Durov Diagram for each relevant hydrostratigraphic unit. The majority of the samples reflect either sodium-chloride or sodium-bicarbonate water types, including the limited number of alluvium samples that show a similar signature to the underlying Upper Juandah Coal Measures.

Appendix III provides the available time series chemistry data for indicator analytes / contaminants of concern associated with coal mining (pH, electrical conductivity (EC) and sulfate). Appendix III also includes tabulated statistics for dissolved metals and other analytes. The baseline data shows that the analytes have relatively stable trends, with EC ranging between 4500 µS/cm and 27,000 µS/cm (equivalent TDS estimated 2,925 mg/L and 17,550 mg/L) for the Upper Juandah Coal Measures and pH values between 8.1 and 6.2 pH units. Limited time series data is available for the alluvium as the bores were dry most of the time, or with insufficient water column to collect a sample. From the available historical data, the EC has ranged between ~3,000 and 20,000 µS/cm (based on 14 samples at two bores).

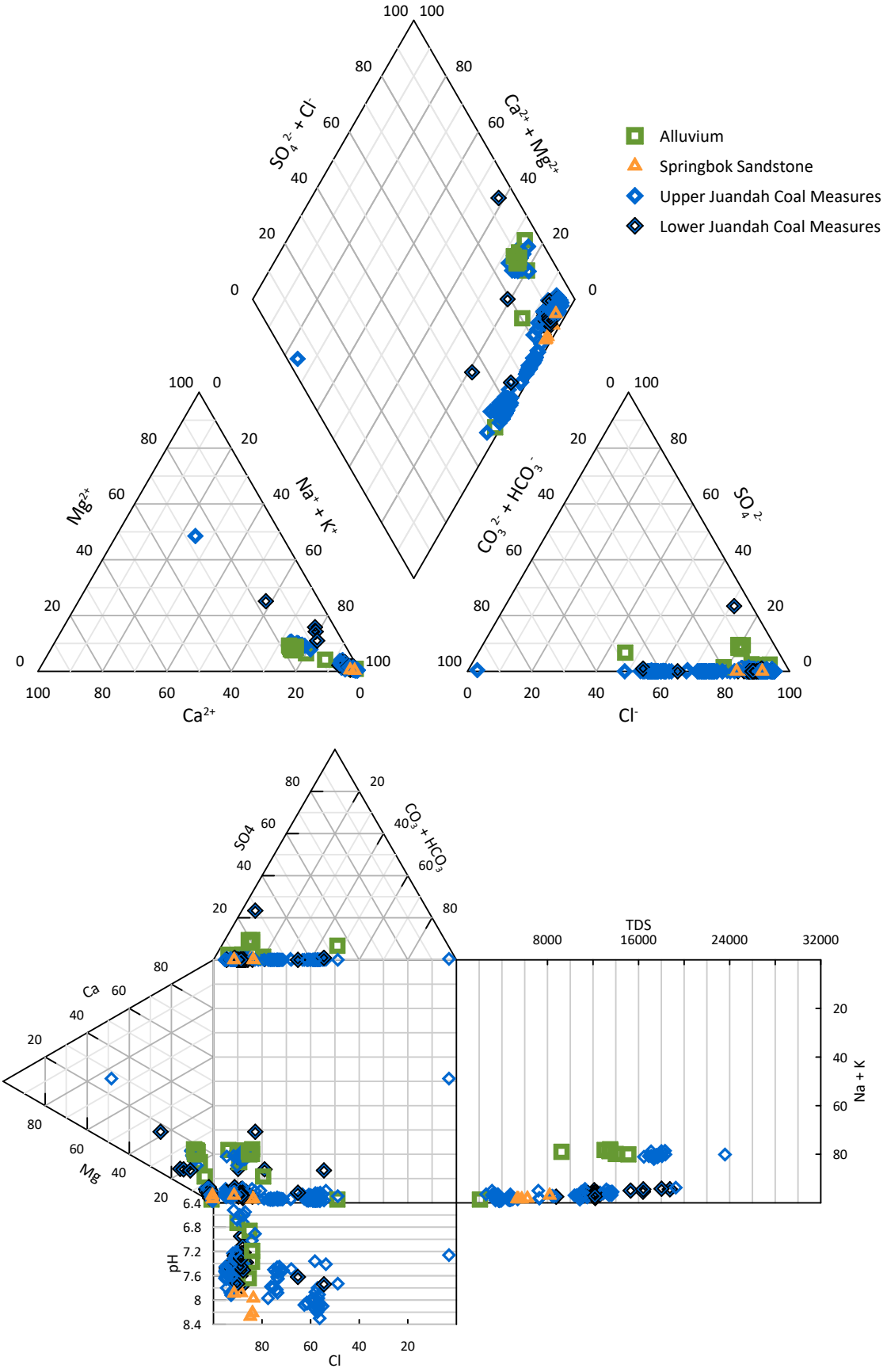


Figure 4.14 Piper and Durov Diagram

4.8 Springs

4.8.1 Vent Springs

There are no spring vents or complexes within the vicinity of the Project.

4.8.2 Watercourse Springs

Baseflow-fed reaches of watercourses, or watercourse springs, are sections of a watercourse where groundwater from an aquifer enters the stream through the streambed (OGIA 2021c). A report published by OGIA in 2017 re-maps potential gaining streams (or baseflow-fed reaches, watercourse springs) within the Surat CMA (OGIA 2017). This report identified sections of Woleebee Creek and Juandah Creek as potentially gaining streams. OGIA have re-mapped watercourse springs within the Surat CMA for the 2021 UWIR report (OGIA 2021c). These locations are shown on Figure 4.15 with the details of the springs in the area summarised in Table 4.2.

Table 4.2 UWIR Watercourse Spring Details

Site Number	Name	Source Aquifer
W164	Yuleba Creek	Mooga Sandstone
W204	Downfall Creek	Alluvium
W76	Horse Creek East Branch	Gubberamunda Sandstone
W281	Woleebee Creek	Alluvium/Orallo Formation
W200	Woleebee Creek	-
W280	Woleebee Creek	Alluvium/Gubberamunda
W279	Woleebee Creek	Alluvium
W221	Juandah Creek	Alluvium
W271	Frank Creek	Alluvium

OGIA has identified three potential watercourse springs present within the Project area associated with Woleebee Creek. These watercourse springs are identified as being associated with the alluvium, Gubberamunda Sandstone, and the Orallo Formation. These are noted as springs of interest but are not currently affected or listed as mitigation sites (OGIA 2021c).

Reaches of Woleebee Creek were assessed by Senex Energy within PL1037, which is located to the south of the Project area (KCB 2018c). The following observations were made regarding Woleebee Creek as a gaining stream:

- The assessment was conducted during the dry season and no flow was observed within the areas surveyed.
- Pools of water were encountered in the lower reaches of Woleebee Creek (within the PL). The pools were assessed to be rainfall-derived surface water based on the turbid appearance and the field measured EC was 547 µS/cm.
- Based on the difference between the field water quality measured at Woleebee Creek pools, field observations and groundwater elevation monitoring data from the alluvium and Gubberamunda Sandstone, it is considered unlikely that Woleebee Creek is a baseflow-fed reach. (i.e., it is a losing stream).

Senex's verification program considered it unlikely that Woleebee Creek is a baseflow-fed reach. This aligns with the assessment undertaken by CDM Smith for QGC's Northern Development Area, which concluded the ephemeral creeks feeding Juandah Creek (which includes Woleebee Creek) are not 'gaining' from alluvial groundwater (CDM Smith 2021). Both these studies and observations support the conceptualisation based on the available data for the Project area and alluvium monitoring bores, that the alluvium is unlikely to provide baseflow to the creeks. The data for G8012-S shows that the groundwater level has been below the nearby creek invert for the full period of record.

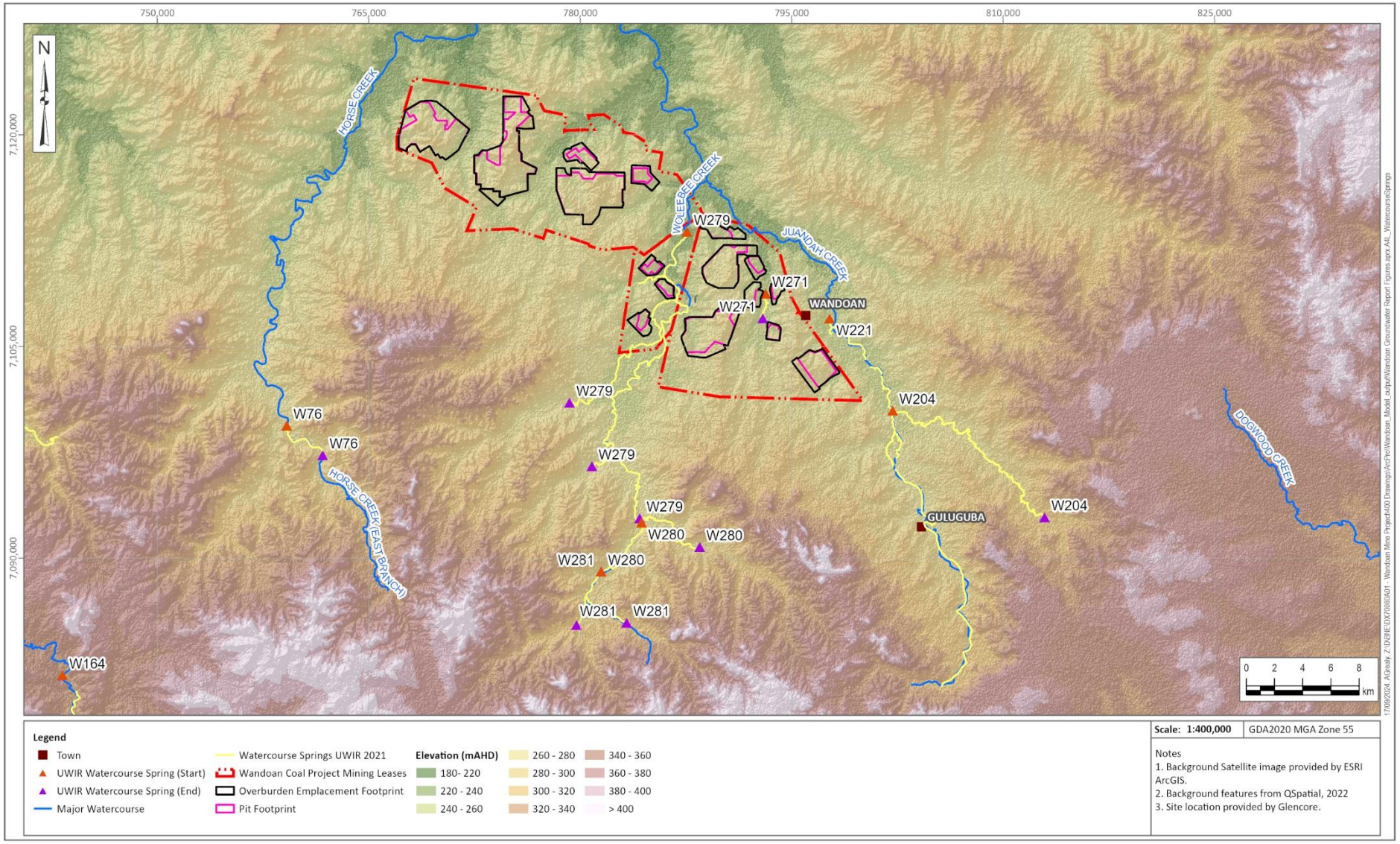


Figure 4.15 Location of Watercourse Springs

4.9 Existing Third-Party Groundwater Users

Figure 4.16 shows the location of bores registered in the GWDB and their status. The purpose of the bores includes monitoring bores, water supply bores, or bores for exploratory / investigation purposes.

The Project is located in an area where groundwater is abstracted for water supply purposes, which include stock and domestic (S&D), town water supply, irrigation and industrial purposes. Often such bores are drilled until a depth is reached where a suitable yield for the intended purpose is encountered and this is often the first aquifer unit. Figure 4.17 shows the attributed aquifer (dominant formation) for each of the bores assigned as a water supply bore by OGIA. The figure highlights bores to the south abstracting groundwater from the Gubberamunda Sandstone, and Hutton Sandstone to the northwest of the Project.

As part of the Surat CMA UWIR (OGIA 2021c), OGIA provided estimates of groundwater abstraction from each of the Surat Basin formations. The highest abstraction in the Surat CMA is estimated from the Hutton Sandstone, followed by the Gubberamunda Sandstone.

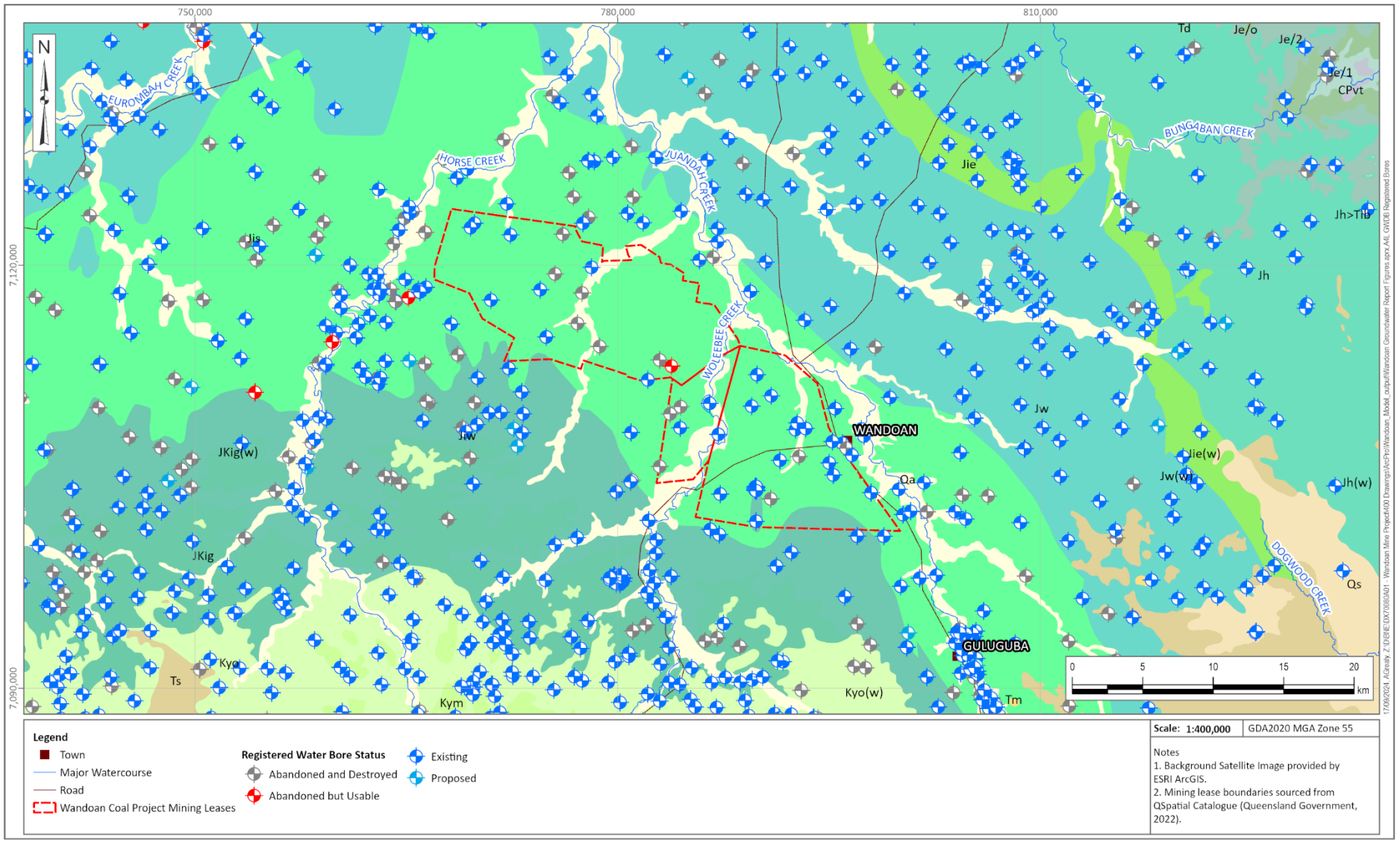


Figure 4.16 Location and Status of Registered Bores (see Figure 4.1 for Geology Legend)

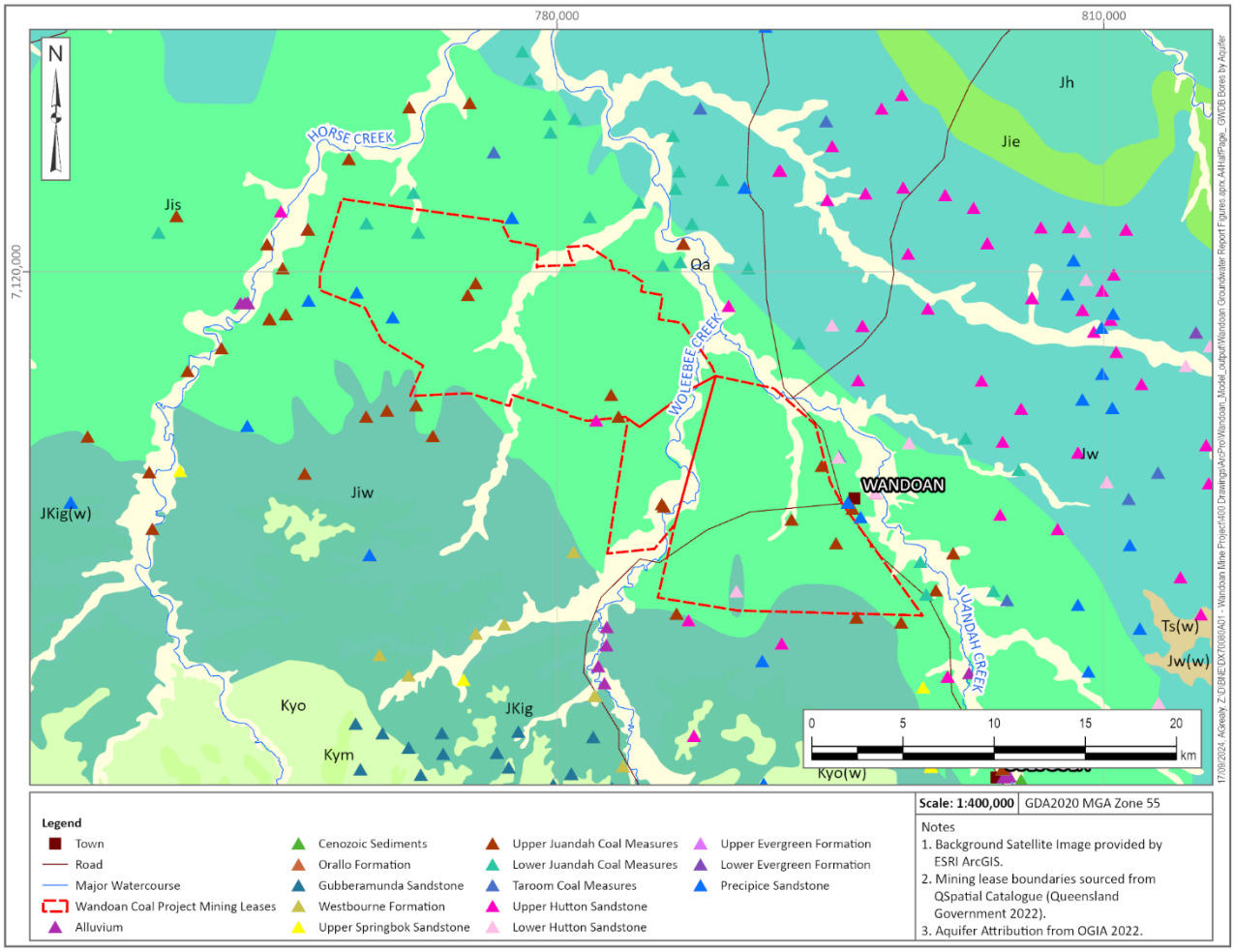


Figure 4.17 Water Supply Bores with Dominant Aquifer Indicated (Data Provided by OGIA)

4.10 Hydrogeological Conceptual Model Summary

The hydrogeological conceptual model has been summarised to support the development of the numerical model and for the context of the PRCP in the post-closure environment, using the source-pathway-receptor approach:

- Mining for the Project targets the Kogan, Upper Macalister, Lower Macalister and Wambo coal seams of the WCM across 16 individual mining areas through open cut methods. Overburden is removed prior to the coal and stored adjacent to the voids. Progressive backfilling is planned with backfill comprising the waste rock material that has been removed to facilitate mining. The geochemical characteristics of the waste rock are reported by RGS (2023) to be NAF, and low reactivity resulting in water quality expected to be low salinity (median EC 592 µS/cm).
- Other resource activities, which have the potential to interact/influence the Project through operations and post-closure, are related to CSG developments that extract gas from deeper formations. Depressurisation occurs to facilitate the gas extraction, which will cause drawdown in the vicinity of the Project MLs through the operational period. CSG extraction is expected to have ceased, and groundwater level recovery associated with CSG is expected to have commenced as the Project enters the post-closure period.

- The surface geology within the Project MLs comprises the Springbok Sandstone and the Upper Juandah Coal Measures of the WCM. Deeper units include the Lower Juandah Coal Measures of the WCM, Taroom Coal Measures and Durabilla Formation. GAB aquifers, Hutton Sandstone and Precipice Sandstone are present underlying the Project; however, these units are at depths greater than 500 m from surface in the Project area, and are therefore unlikely to have any interaction or be impacted on by the shallow Project activities where the mining depths are in the range of 70 m.
- Quaternary-age alluvium is present associated with Woleebee, Juandah and Mud Creeks. The alluvium ranges between 1.0 and 17.5 m (based on drilling records), and is generally unsaturated, with the exception of a localised area in Woleebee Creek.
- Typically, surface water flow is ephemeral (associated with rainfall events) with no flow for several months in the dry season. Due to the depth to groundwater and surface water flow records, watercourses are not considered to receive baseflow.
- Groundwater levels within the Project MLs have been relatively stable, or increasing, through the available period of record, with limited drawdown influence from CSG. Groundwater levels monitoring for CSG developments show drawdown occurring in deeper units, however, limited propagation of drawdown has occurred to the upper units over the period where data is available.
- Groundwater supply bores are present within the Project MLs with uses including S&D, town supply, irrigation and industrial purposes. Most of the bores are abstracting water from the Hutton Sandstone to the north and Gubberamunda Sandstone to the south with some abstraction from the WCM. Typically, groundwater bores are drilled to the first suitable water and screened across that unit, and therefore generally the screen unit corresponds with the aquifer.

5 NUMERICAL GROUNDWATER MODEL

The numerical model is described in detail in Appendix IV, with a summary of key aspects provided in the following sections.

5.1 Modelling Overview

A numerical groundwater model has been constructed to support the PRCP to predict changes in groundwater levels and flow into closure and for the post-closure period.

The objectives of the modelling include:

- Addressing the requirements of state legislation and guidelines in relation to groundwater assessment and predictions for closure.
- Predicting groundwater conditions associated with the final landforms for post-closure.
- Identification of the potential risk areas where groundwater impact mitigation / control measures may be required.

The model domain is required to focus on the Project, but with sufficient distance outside of the Project to simulate the full extent of drawdown, pit recovery, and permit inclusion of boundary conditions.

The numerical groundwater model has been constructed and simulated with consideration of the Australian Groundwater Modelling Guidelines (Barnett et al. 2012a) and the requirements of the PRCP Guideline (Queensland Government 2024).

5.2 Model Construction

The 3D numerical groundwater flow model was developed using the MODFLOW-USG platform to represent the conceptual hydrogeological model described in Section 4.10.

The model domain is shown in Figure 5.1. The area of the model extent is approximately 4,200 km^2. The model boundaries are aligned with sub-catchment divides, where a local groundwater divide, within the shallow groundwater systems is inferred. The external model boundaries are represented using General Head Boundaries (GHB). These boundaries represent regional groundwater levels at the model extents and provide/control groundwater flux to/from the model domain representative of regional groundwater flow conditions.

The model was constructed with 16 layers to adequately represent the hydrostratigraphic units within the model domain. The model uses drain cells to simulate the open cut mining and GHB to consider the influence of CSG development.

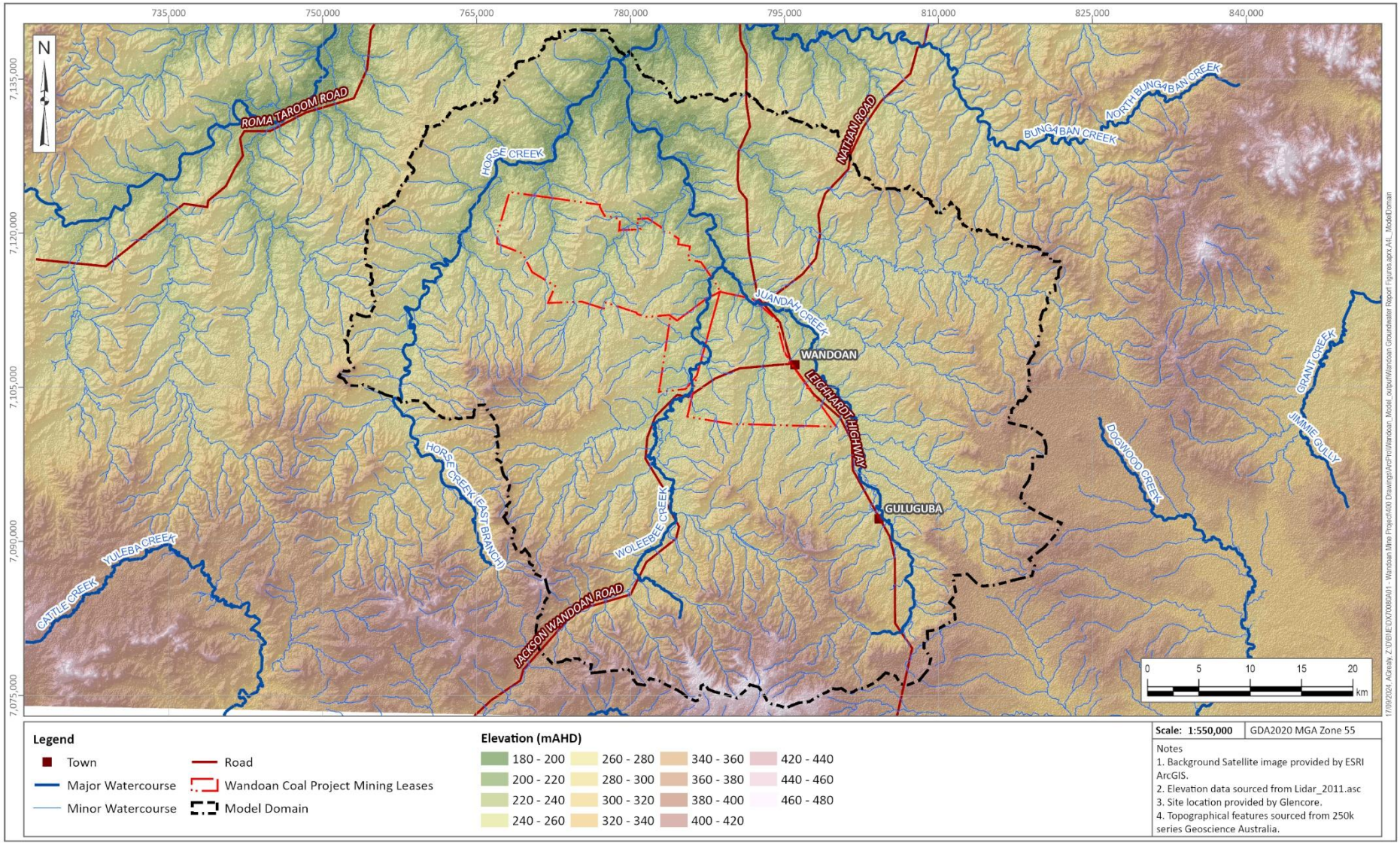


Figure 5.1 Model Domain

5.3 Model Calibration

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012b) were used to frame the calibration process.

The model was calibrated in steady state for data prior to 1995 and in transient for the period between January 1995 and December 2022 comprising seasonal/quarterly stress period from 1995 to 2014, and monthly stress periods from 2015 to 2022.

Figure 5.2 presents the groundwater table contours extracted from the numerical groundwater model for the start and end of the calibration period (1995 and 2022). The 2022 contours show that the general flow directions are similar to the inferred groundwater contours, presented in Figure 4.7, with increased resolution associated with the model output as the inferred contours are largely controlled by the spatial distribution of monitoring data.

Comparison of the groundwater table contours between 1995 and 2022 shows that about 30 to 40 m drawdown occurred in the southwest of the model domain during this period, which is attributed to CSG development in the area.

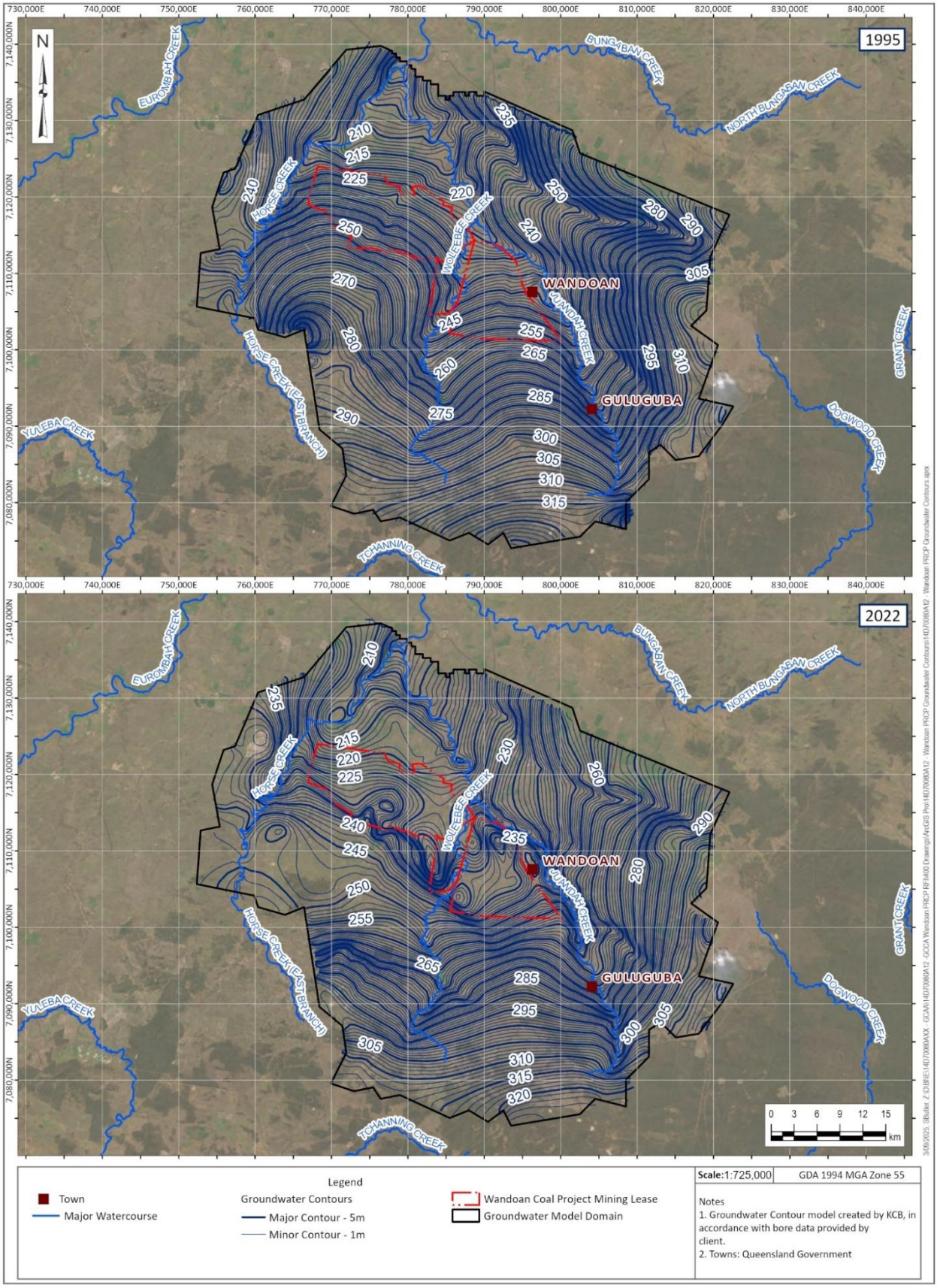


Figure 5.2 Groundwater Table Contours (mAHD) for Start and End of Calibration (1995 and 2022)

5.4 Model Predictions

Following calibration, the model run was extended to encompass the future potential 75-year operation period (Life of Mine (LoM) simulation) followed by a period of time for post-closure recovery (post-closure simulation) as follows:

- LoM simulation:
  - Pre-mining period from January 2023 to December 2030.
  - Life of Mine (LoM) period[3] for 75 years between January 2031 and December 2105, with annual stress periods.
- Post-closure simulation:
  - 500 years from 2106 to 2606, with annual stress periods.

5.4.1 Life of Mine Simulation

A predictive simulation was carried out until 2105, assuming an operational start date of January 2031, using the calibrated transient model as the starting point of the simulation.

The simulation comprised annual stress periods to align with the available mining schedule starting at the final time step of the transient calibration. Average annual historical rainfall and evaporation were used for the predictions. All other boundary conditions were carried over from the transient calibration model. Mining was simulated with drains with reference head towards the base of the void, and material properties modified as backfill is placed through mining.

GHBs were retained in the model to simulate the ongoing influence of CSG impact during the operational period using the same methodology as used for calibration. From the OGIA data, most CSG operations cease around 2050 to 2070, therefore the system and associated drawdown predictions begin recovering.

Results of the LoM simulation are provided in Appendix IV, with discussion in Section 6.

5.4.2 Post-Closure Simulation

The simulation of post-closure groundwater conditions was undertaken to assess recovery of the system after mining has ceased, with the upper most surface reflecting the proposed post-closure landform/ design, as described in Section 2.1 and shown in Figure 2.3, and material properties within the mined open cut pits reflecting the backfilled overburden emplacement material.

The recharge and evapotranspiration rates were extended from the LoM model for each zone of the model. A recharge rate (10% of rainfall) and evapotranspiration rate (same as alluvium unit) were applied to the overburden emplacement areas across the mining area. Scenarios considering the sensitivity of the spoil recharge rate are included in Appendix IV.

All active drains that were used to simulate mine progression and dewatering were removed in the closure model to allow simulation of groundwater recovery. The GHBs representing CSG activities were removed in the post-closure simulation as the CSG activities were assumed to have ceased during the LoM (timing is based on information from the proponents and/or from OGIA).

[3] Life of Mine start and finish dates based on anticipated project timing provided by GCAA at the time of preparation of PRCP.

All other regional boundary conditions, such as drains along the watercourses, were retained for the post-closure simulations.

Results of the post-closure simulation are provided in Appendix IV, with discussion in Section 6.

6 IMPACT ASSESSMENT

6.1 Post-Closure Groundwater Levels

6.1.1 Groundwater Level Recovery

Hydrographs from the predictive modelling for each of the mined / backfilled open cut areas for the LoM and post-closure predictions are provided in Appendix IV. On all of the figures, the start of mining (assumed as 2031), groundwater elevation prior to commencement of mining and the base of the excavation have been indicated. The hydrographs provide the predicted groundwater recovery at each of the open cut pits after operations and through the post-closure period.

Figure 6.1 shows the groundwater table pre-mining (2022). Figure 6.2 shows the predicted water table at the end of mining / start of post-closure (assumed 2105 for modelling purposes). The figure shows lower groundwater elevations (darker blue colour) to the west and south of the Project area associated with CSG, and depressed groundwater associated with the pits that were mined later in the assumed mining schedule (e.g. Wubagul, Woleebee North).

Figure 6.3 shows the predicted depth to water for the same time period (start of post-closure), calculated using the final landform elevation and the 2105 water table elevations. The figure shows shallow groundwater in the vicinity of the watercourses, where the topography is lower and in the lowest areas of the backfilled open cut areas at end of mining. The depth to groundwater ranges between 4 m below ground level (mbGL) and extends up to 180 m towards the southwest.

Predicted post-closure water table maps are provided in Figure 6.4 for 10, 50, 100 and 500 years post-closure, with the associated depth to the water table at 500 years provided in Figure 6.5. These outputs have been prepared using the base case spoil recharge of 10%. Additional maps are included in Appendix IV for 5% and 1% spoil recharge scenarios. Appendix V provides sections through individual backfilled open cut pits and overburden emplacement.

The predictions for the post-closure period show:

- Groundwater elevations in the west of the Project area (Mud Creek, Mud Creek East, Mud Creek North, Turkey Hill and Summer Hill) are influenced by CSG activities, with CSG production ending around 2070 and groundwater levels starting to recover during the Project operational period.
- Recovery of groundwater levels for the majority of backfilled open cut pits occurs within 50 years from the cessation of mining.
- The depth to groundwater, once the groundwater levels have reached post-closure equilibrium (as illustrated by 500-years post-closure values), ranges between 1 and 150 mbGL across the wider Project area, with the deepest groundwater towards the southwest.
- No groundwater-driven residual pit lakes are predicted in the base case simulations, which uses the average annual rainfall for the modelled recharge, and 10% recharge on the spoils. There is a residual risk that during very wet years, ephemeral water bodies could rise in these areas. Since progressive backfill and rehabilitation will be undertaken, an

improved understanding of these risks should be developed during operations (including understanding site-specific recharge values).

- Shallow groundwater is predicted in proximity of several backfilled open cut areas, generally in areas where the overburden emplacements are located close to the watercourses, where there is lower topography and there is localised mounding associated with the overburden emplacements. These are highlighted further in the cross sections in Appendix V.
- The results of the sensitivity scenarios for spoil recharge show that, in general, the higher recharge scenarios results in a higher groundwater elevation, with lower recharge values the water table elevation is predicted to be lower with less localised mounding.

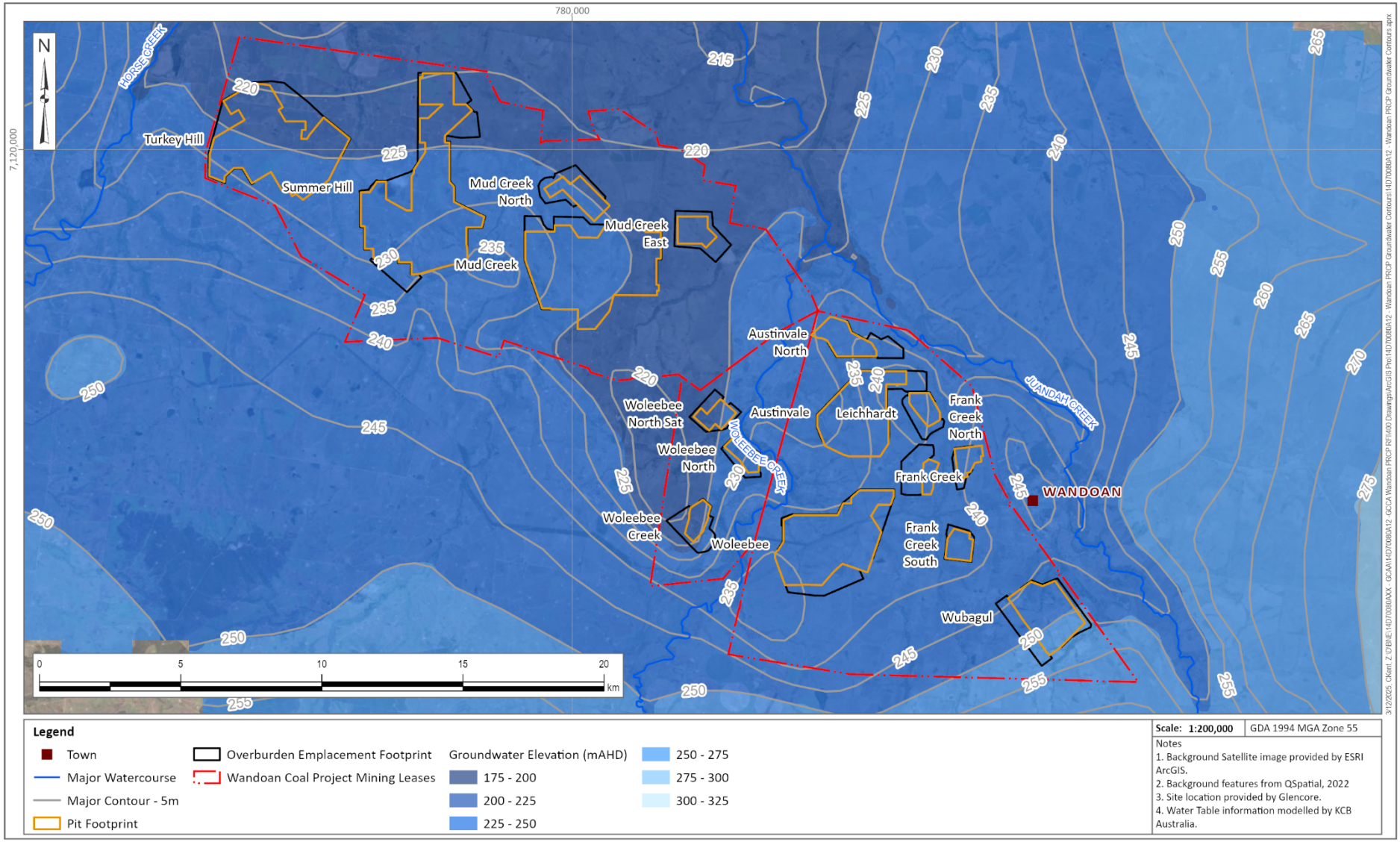


Figure 6.1 Pre-mining Groundwater Level Elevations (December 2022)

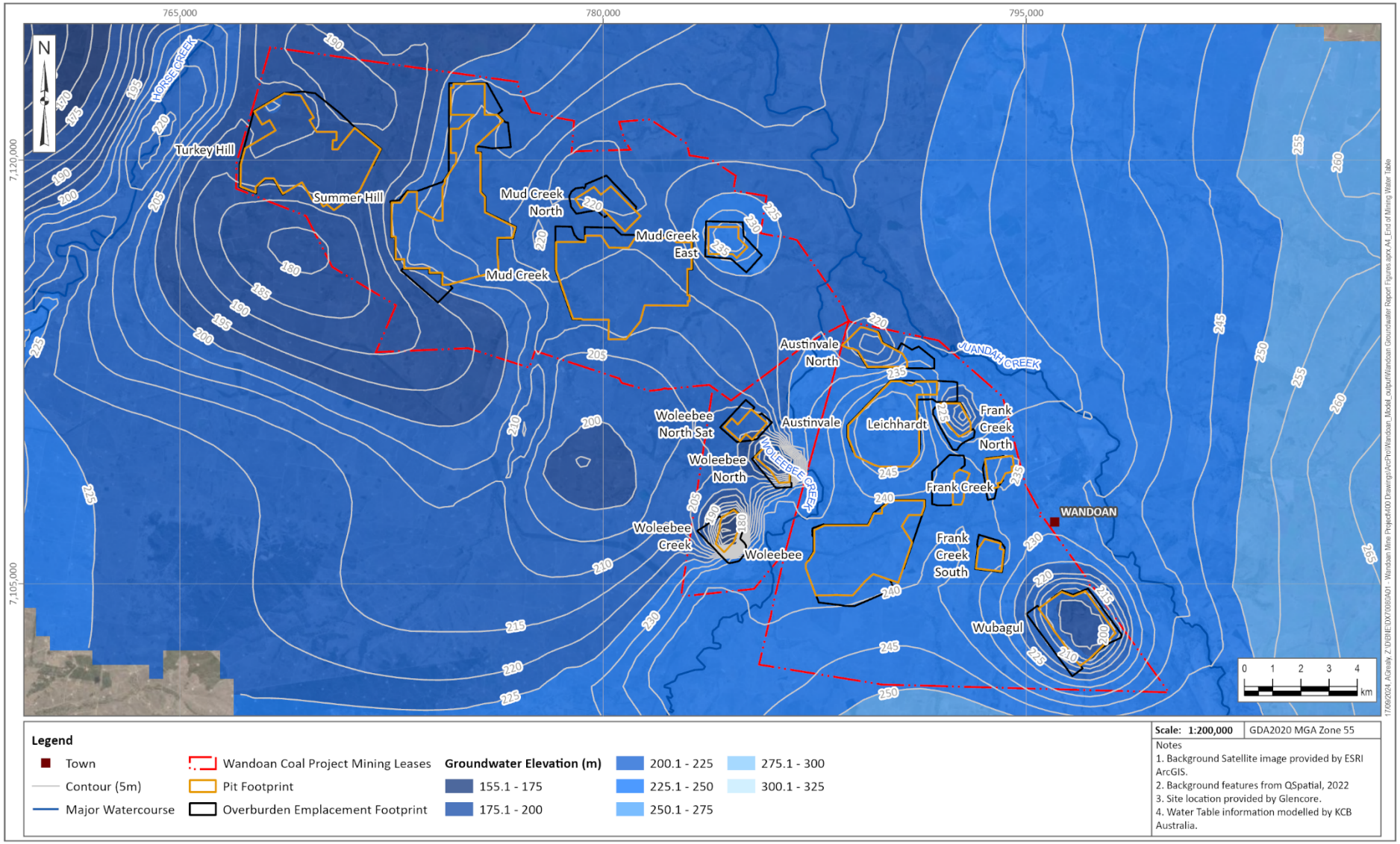


Figure 6.2 End of Operations/Start of Post-Closure (Assumed Year 2105) Groundwater Level Elevation (mAHD)

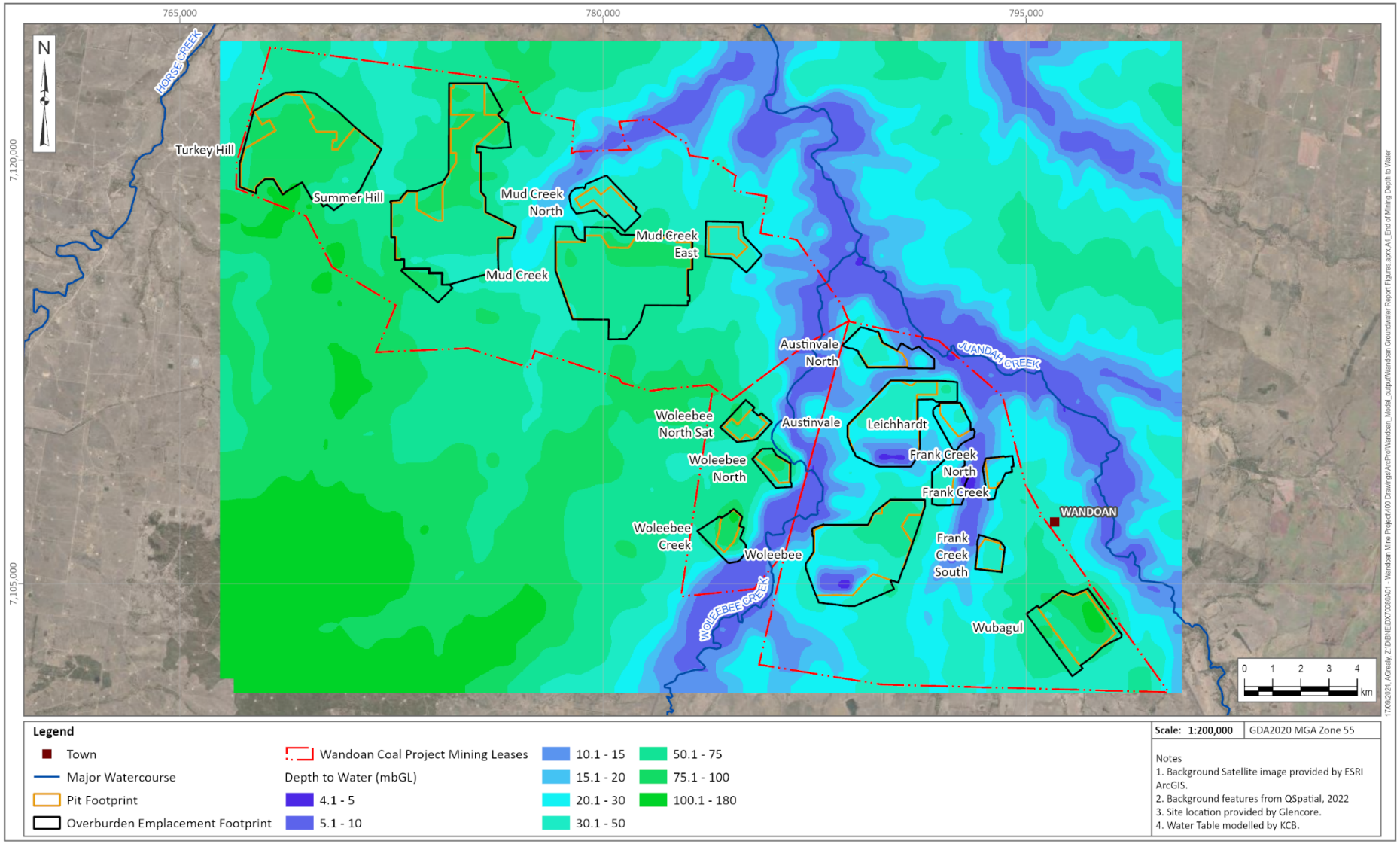


Figure 6.3 Depth to Water at Start of Post-Closure

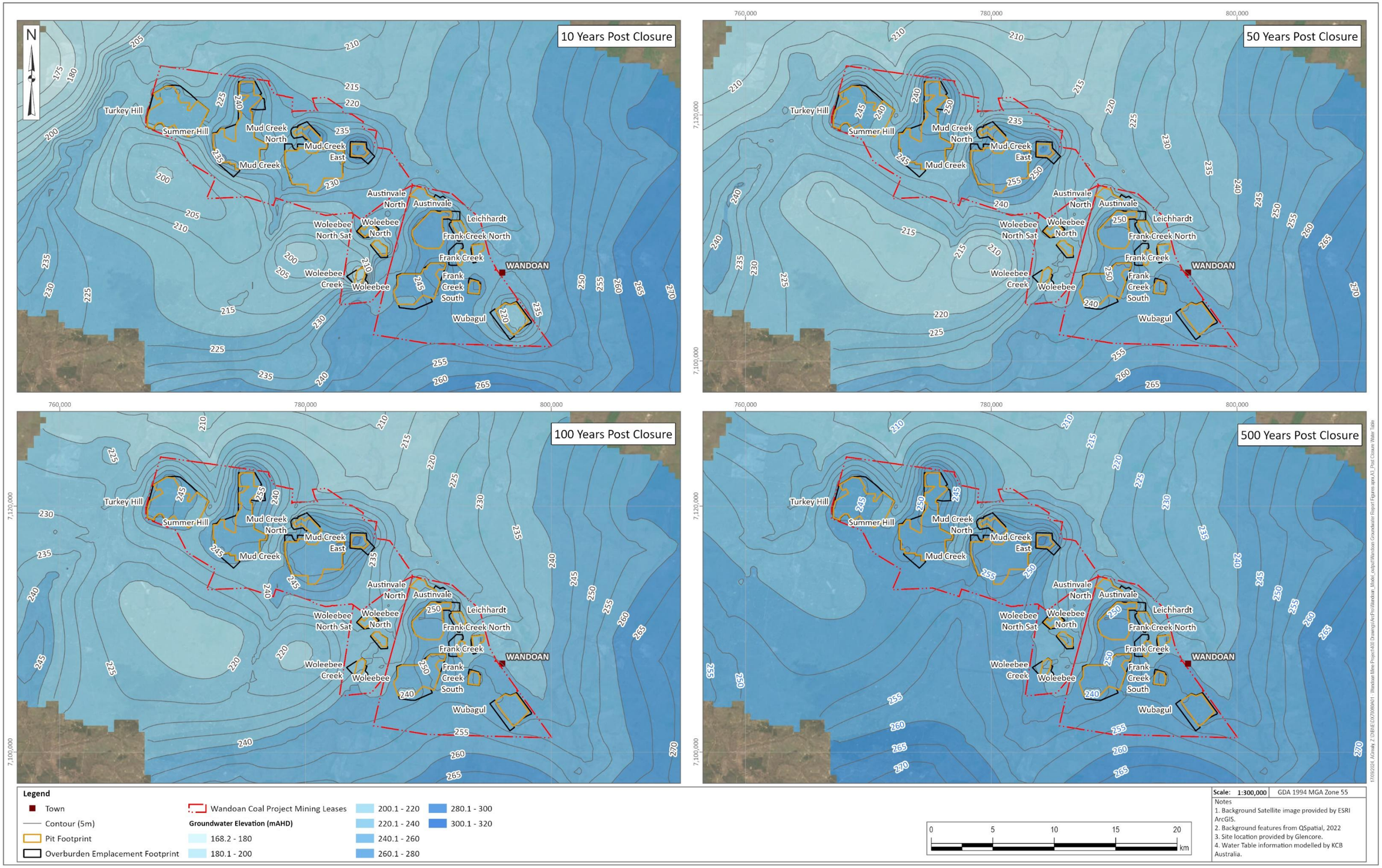


Figure 6.4 Groundwater Level Elevation (mAHD) – 10, 50, 100 and 500 Years Post-Closure

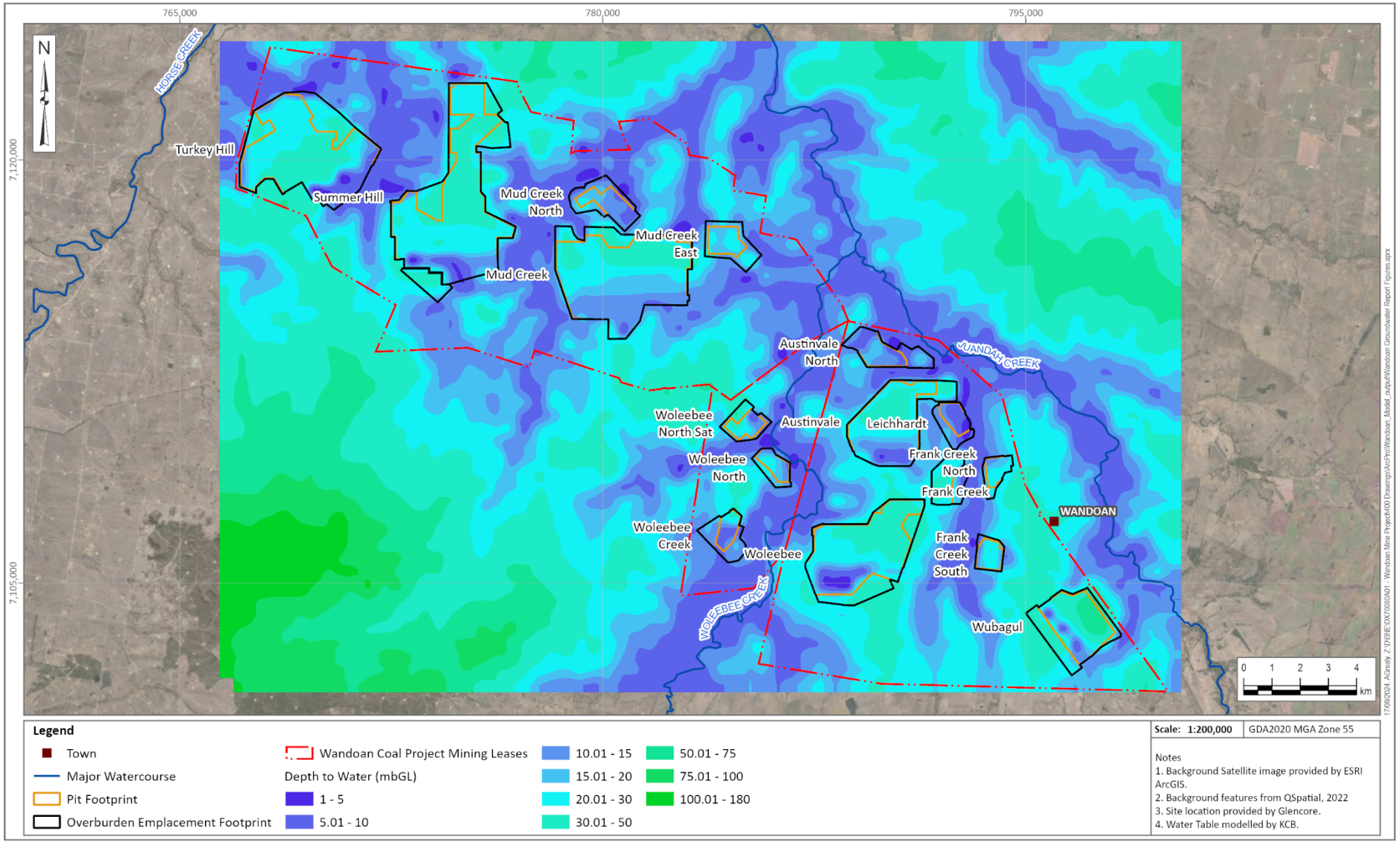


Figure 6.5 Depth to Water – 500 Years Post-Closure

6.1.2 Flow Directions and Velocity

Flow directions associated with the final landform can be interpreted from the re-equilibrated water table contours at 500 years post-closure, as shown in Figure 6.4. Table 6.1 provides a summary of the flow directions at 500 years post-closure. Due to the proximity of the Project to the watercourses, the receptors are considered to be the major watercourses. The table provides an indication of the nearest watercourse and the shortest distance to the watercourse in the direction of flow (interpreted from the water table contours).

Groundwater levels are not predicted to daylight (i.e. express above ground surface) in the base case groundwater model prediction, which uses the average annual rainfall for recharge. There are some areas, however, where the recovered water table is predicted to be higher than the base of the alluvium unit. The results of the sensitivity scenarios for spoil recharge show that, in general, the higher recharge scenarios results in a higher groundwater elevation. Therefore, the base case of 10% recharge is considered conservative, and with lower recharge values the water table elevation is predicted to be lower with less localised mounding and the water table may be below the base of the alluvium unit.

Average groundwater velocity and travel times from the overburden emplacement areas to the watercourses have been calculated. These estimates have been based on the post-closure groundwater contours and using Darcy's law, hydraulic conductivity for the weathered bedrock (0.25 m/day) and assumed effective porosities of 0.15 - 0.2 (to provide a range)[4]. The estimated results are included in Table 6.1 and indicate that such areas most likely to experience this are associated with Austinvale North, Austinvale and Woleebee North Satellite (Sat) and Woleebee North backfilled open cut areas and overburden emplacements.

[4] Note these values are in the higher range to provide a conservative estimate.

Table 6.1 Flow Directions and Travel Times

Backfilled Open Cut Area	Flow Direction 500 Years Post-Closure	Watercourse Receptor	Shortest Distance to Watercourse in Direction of Flow	Estimates of Travel Times from Overburden Emplacement to Receptor (Years)
Turkey Hill	Flow towards the north, west and east.	Horse Creek	3 km (west)	400-550
Summer Hill	Flow towards the north, west and east.	Horse Creek	5 km (northwest)	875-1200
Mud Creek	Flow towards southeast and north, combined flow with Mud Creek North and East.	Horse Creek	5.2 km (northeast)	870-1160
Mud Creek North	Flow towards the north.	Horse Creek	8.5 km (north)	550-750
Mud Creek East	Flow towards the north and east.	Horse Creek	3.4 km (northeast)	400-550
Woleebee North Sat	Flow towards the east.	Woleebee Creek	0.3 km (east)	150-200
Woleebee North	Flow towards the east.	Woleebee Creek	0.3 km (east)	150-200
Woleebee Creek	Flow towards the east.	Woleebee Creek	0.8 km (east)	1050-1400
Austinvale North	Flow towards the northeast.	Juandah Creek	0.4 km (northeast)	20-25
Austinvale	Flow towards the northeast.	Juandah Creek	1.1 km (northeast)	110-150
Leichhardt	Flow towards the northeast.	Juandah Creek	1.9 km (northeast)	750-990
Frank Creek	Flow towards the northeast.	Juandah Creek	3.3 km (northeast)	2500-3400
Frank Creek North	Flow towards the north.	Juandah Creek	3.1 km (north)	1300-1800
Frank Creek South	Flow towards the northeast.	Juandah Creek	5.6 km (northeast)	3000-4000
Wubagul	Flow towards the northeast.	Juandah Creek	1.9 km (northeast)	1200-1600

6.2 Post-Closure Groundwater Chemistry

Impacts associated with changing void water quality and seepage outflow from source or sink voids impacting groundwater are not relevant to this PRCP, as there are no residual groundwater-fed pit lakes associated with the Project.

Potential changes to groundwater chemistry may occur as a result of recharge through the overburden emplacement areas and groundwater residing within the reprofiled void depressions/backfilled areas, which may travel towards the receptors, which includes the creek systems, but also the alluvium unit which may provide groundwater contribution to surface water after high rainfall events, if groundwater elevation rise sufficiently.

RGS (2023) undertook extensive geochemical assessment of the anticipated overburden materials. These materials are shown to have a low risk of acid generation and a high factor of safety with respect to potential AMD and RGS indicate that “the materials are not expected to present any environmental issues associated with revegetation and rehabilitation”. Through leachate and kinetic testing, RGS have also indicated that concentration of major ions expected in surface run-off and seepage from overburden emplacement materials is likely to be dominated by sodium, chloride, sulfate and bicarbonate; with lower concentrations of other major ions and low trace metals/metalloids concentrations at the circumneutral to slightly alkaline pH of the seepage and run-off. This assessment had sample materials generating a leachate with an EC value less

than 1,000 µS/cm in both static leaching and kinetic testing. RGS concluded that dissolved metal/metalloid concentrations in surface run-off and seepage from bulk NAF materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources in the vicinity of the Project.

The potential for salinity was also considered in the catchment yield assessment that KCB completed for this Project (KCB 2024a). This assessment considers the overall water balance and the salinity from each type of land use. For the overburden emplacement materials, the modelling used the results from RGS geochemical assessment and also considered the impact of rehabilitation from similar open cut operations in the Surat and Bowen Basins. The results from this modelling also indicated that expected salinity variation associated with the Project should maintain salinity at levels that are comparable to current conditions (generally with TDS in the range of up to 500 mg/L except for selected areas where increased evaporation may occur). The catchment yield water balance model included the consideration of how TDS levels change within the reprofiled void depression waterbodies over time. In all reprofiled void depressions, as reported in the catchment yield assessment (KCB 2024a), TDS levels are expected to fluctuate dependent on the volume of water in each waterbody No net accumulation of salt over time was found in the modelling with seasonal and regular run-off dilution preventing longer term salinity build up.

There is limited baseline data for the alluvium groundwater quality in the vicinity of the Project, as the monitoring bores are frequently dry. From the available historical data, the EC has ranged between ~3,000 and 20,000 µS/cm (based on 14 samples at two bores). For alluvium (and watercourses) the range of increased salinity is not expected to be significant as the seepage and run-off water chemistry is of low to moderate salinity, inferred flow rates of seepage are low and any potential evapoconcentration that could occur would be expected to be seasonally diluted by fresh rainfall recharge and/or run-off. The EC values predicted from the run-off and seepage are also expected to be within a similar magnitude to natural water quality measured in the alluvium.

6.3 Potential Impacts to EVs

EVs defined by the EPP for the water systems are included in Section 3.4. The values to be protected include aquatic ecosystems, irrigation, farm supply, stock water, human consumers, primary recreation, visual recreation, drinking water, industrial use and cultural and spiritual values.

For values associated with groundwater abstraction and supply, the system recovers during the post-closure period and therefore a reduction (or drawdown) in groundwater levels and availability of supply is not anticipated after operations have ceased.

For the alluvium and watercourses, whilst the model predictions do not suggest expression of water into the creek at surface, there are areas where the 10% recharge case (which is conservative) suggest that the water table may be above the base of the alluvium unit. The range of increased salinity is not expected to be significant into the alluvium as the seepage and run-off water chemistry is of low to moderate salinity, inferred flow rates of seepage are low and any potential evapoconcentration that could occur would be expected to be seasonally diluted by fresh rainfall recharge and/or run-off. The EC values predicted from the run-off and seepage are also expected to be within a similar magnitude natural water quality measured in the alluvium.

6.4 Adaptive Management, Monitoring and Mitigation

Based on the potential impacts to EVs that have been identified, the following adaptive management approach is recommended through operations and closure:

- To further support the PRCP predictions as well as refinement of the hydrogeological understanding during operations, monitoring is recommended to continue under the EA framework, with baseline groundwater level and chemistry monitoring for at least two years prior to commencement of operations. Additional shallow monitoring to the west of the Project, between the mining areas and the watercourses is recommended to be installed in a staged approach (at least two years before the open cut pit is to be mined). Coupled seasonal surface water sampling is also recommended to understand baseline water quality within the watercourses.
- Update and refine the numerical model groundwater predictions (including post-closure scenarios), within the first five years of the operational period. The update is recommended to include calibration to the dewatering volumes and monitoring response to mining, which will assist in increasing the numerical model confidence and understanding of the groundwater system response.
- Collection of site-specific hydraulic properties, through pumping tests, will also provide further information to verify the model predictions and system response.
- The sensitivity scenarios on spoil recharge, included in Appendix IV, highlighted that in the majority of areas the lower recharge rate results in a lower water table elevation at the spoils. Once spoil placement commences, site-specific testing to obtain estimates of spoil recharge is recommended. The site-specific estimates will then assist with further refinement of the numerical model predictions for post-closure and further understanding of the risks to the receptors.
- Based on the monitoring and refined model results, progressively review management and mitigation measures for closure. Assessment of potential options is only recommended to be considered once the above monitoring and model refinement is undertaken (after five years of mining) and an improved understanding of the system response is available.

7 CONCLUSION

A calibrated 3D numerical groundwater model was used to provide projected post-mining groundwater conditions and potential influences on the groundwater system, based on the proposed final landform for the Project. The numerical model also considered the influence of CSG operations in the vicinity of the Project.

During LoM planned operations (assumed between 2031 and 2105 for assessment), the numerical groundwater model predicts drawdown to occur in the vicinity of each of the 16 open cut areas associated with mining, with the exception of open cut areas to the west of the Project (Mud Creek, Summer Hill and Turkey Hill), where groundwater levels are predicted to have already been impacted by CSG operations. Groundwater levels in the vicinity of open cut areas mined earlier in the sequence are shown to have experienced recovery prior to the completion of mining.

Through the mining period and by post-closure (2105), the open cut areas will be backfilled with overburden material and reshaped to represent the final landform design.

Groundwater levels are predicted to reach post-closure equilibrium within ~50 years after mining activities have ended with recovery of groundwater in the mining areas. Post-closure drawdown that exceeds the operating period is not anticipated and between mining and recovery, no new impacts to groundwater are anticipated. From the base-model predictions, no groundwater-fed pit lakes are predicted to develop during post-closure, with groundwater levels predicted to be below the surface of the final landform.

During post-closure, several areas of localised mounded groundwater are predicted to occur in the areas with overburden emplacements. This may result in shallower groundwater in these areas of lower topography. The Project is located adjacent to three major watercourses: Horse Creek, Juandah Creek and Woleebee Creek which are considered to be the main receptors for Project-influenced groundwater in the post-closure period. Groundwater is not predicted to express within the creeks. For the alluvium and watercourses, the range of increased salinity is not expected to be significant as the seepage and run-off water chemistry is of low to moderate salinity, inferred flow rates of seepage are low and any potential evapoconcentration that could occur would be expected to be seasonally diluted by fresh rainfall recharge and/or run-off. The EC values predicted from the run-off and seepage are also expected to be within a similar magnitude natural water quality measured in the alluvium.

An adaptive management approach is recommended through operations and closure, comprising a staged groundwater monitoring plan, seasonal surface water sampling, updates to hydrogeological and numerical model predictions as well as progressively reviewing management and mitigation measures for post-closure period.

8 CLOSING

We would like to thank you for the opportunity to work on this assignment. Should you have any questions, please do not hesitate to contact the undersigned.

KLOHN CRIPPEN BERGER

Claire Kent, MSc, RPGeo
Senior Hydrogeologist, Associate

REFERENCES

AGE. 2012. *Elimata Project Groundwater Assessment*. G1438/A. no. G1438/A. Prepared by Australasian Groundwater and Environmental Consultants Pty Ltd for Northern Energy Corporation. http://www.newhopegroup.com.au/files/files/projects/elimatta/12%20Appendix%20M%20-%20Groundwater%20Assessment.pdf.

Barnett, B, LR Townley, V E A Post, et al. 2012a. *Australian Groundwater Modelling Guidelines*. Waterlines Report. National Water Commission.

Barnett, B, LR Townley, V E A Post, et al. 2012b. *Australian Groundwater Modelling Guidelines*. Waterlines Report. National Water Commission.

BOM. 2005. *Climate Classification of Australia*. Australian Government Bureau of Meteorology. http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=kpngrp#maps.

CDM Smith. 2021. 'Northern Development Area - GDE Management Plan. QGC. October 2021'. Preprint.

CDM Smith. 2022. *QGC Northern Development Area – GDE Management Plan*. https://www.shell.com.au/about-us/projects-and-locations/qgc/environment/water-management/reports/_jcr_content/par/expandablelist_48b1/expandablesection_209680896.stream/1673230635251/a06426476b73286dd300b942924de4d746649776/cdm-smith-qgc-northern-development-area-gde-management-plan-rev.pdf.

DCCEEW. 2023. 'EPBC Act Public Portal'. July. https://epbcpublicportal.awe.gov.au/all-referrals/project-referral-summary/?id=19a5af33-1966-ed11-9561-00224818aa41.

DES. 2022. 'Environmental Authority Number: EPML00297613'. December.

Environmental Protection Act 1994 (2022). https://www.legislation.qld.gov.au/view/html/inforce/current/act-1994-062.

Environmental Protection (Water) Policy 2009. Dawson River Sub-Basin Environmental Values and Water Quality Objectives Basin No. 130 (Part), Including All Waters of the Dawson River Sub-Basin except the Callide Creek Catchment (2011).

Exon, NF. 1976. *Geology of the Surat Basin, Queensland*. Bulletin 166. Bureau of Mineral Resources, Geology and Geophysics.

GCAA. 2024. 'PRCP Final Landform (Revision C)'. May.

GCAA. 2018. *Model Release Report - WanMLsMDL449_2019 Model*.

Green. 1997. *The Surat and Bowen Basins, South-East Queensland*. Queensland Department of Mines and Energy.

Habermehl, MA. 1980. 'The Great Artesian Basin, Australia'. *BMR Journal of Australian Geology and Geophysics,* 5: 9–38.

Hamilton, SK, JS Esterle, and R Sliwa. 2014. 'Stratigraphic and Depositional Framework of the Walloon Subgroup, Eastern Surat Basin, Queensland'. *Australian Journal of Earth Sciences* 61 (8): 8.

KCB. 2016. *Hydrogeological Assessment of the Great Artesian Basin: Characterisation of Aquifer Groups - Surat Basin*. Prepared for the Queensland Government Department of Natural Resources and Mines. Klohn Crippen Berger Ltd.

KCB. 2018. 'Project Atlas - EA Amendment, Water Resources Assessment Report.' Preprint.

KCB. 2024a. *Wandoan Coal Project - Catchment Yield Study - Draft (Revision B)*.

KCB. 2024b. *Wandoan Coal Project - Progressive Rehabilitation and Closure Plan - Groundwater Assessment*.

Kellett, JR, TR Ransley, J Coram, et al. 2003a. *Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland*. NHT Project# 982713. no. NHT Project# 982713. Bureau of Rural Science, Natural Resources and Mines, Queensland.

Kellett, JR, TR Ransley, J Coram, et al. 2003b. *Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland*. NHT Project# 982713. Bureau of Rural Science, Natural Resources and Mines, Queensland.

Martin, KR. 1981. 'Deposition of the Precipice Sandstone and the Evolution of the Surat Basin in the Early Jurassic'. *The APEA Journal*, no. 21: 16–23.

Morad, K, R Mireault, and L Dean. 2008. *Reservoir Engineering for Geologists: Coalbed Methane Fundamentals. Reservoir Issues, 9, 22–26*.

OGIA. 2016a. *Hydrogeological Conceptualisation Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2016b. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2016c. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2017. *Identification of Gaining Streams in the Surat Cumulative Management Area; Hydrogeological Investigation Report*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2019a. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources, Mines and Energy.

OGIA. 2019b. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources, Mines and Energy.

OGIA. 2021a. 'Regional Flow Systems and Potentiometry in Queensland's Surat and Southern Bowen Basins'. Preprint.

OGIA. 2021b. *Status of Coal Seam Gas and Conventional Petroleum and Gas Development in the Surat CMA*. Office of Groundwater Impact Assessment.

OGIA. 2021c. 'Underground Water Impact Report 2021 for the Surat Cumulative Management Area. OGIA, Brisbane.' Preprint.

OGIA. 2022. *Underground Water Impact Report 2021 for the Surat Cumulative Management Area*.

QGC. 2016. *Surat North Development - CSG Water Monitoring and Management Plan for EPBC Referral 2013/7047, November 2016. QCLNG-BE99-WAT-RPT-000023*.

Queensland Government. 2024. 'Statutory Guideline - Progressive Rehabilitation and Closure Plan (PRC Plans), Version 3.01, September 2024'.

QWC. 2012a. *Underground Water Impact Report for the Surat Cumulative Management Area*. Tate of Queensland, Coal Seam Gas Water, Queensland Water Commission.

QWC. 2012b. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, Coal Seam Gas Water, Queensland Water Commission.

RGS. 2023. *Geochemical, Physical, and Spontaneous Combustion Assessment of Mine Materials from the Bulk Sample Pit: Wandoan Coal Project*.

SILO. 2024. *SILO Rainfall Data for Grid -26.10, 149.90. Queensland: Queensland Government. Https://Www.Longpaddock.Qld.Gov.Au/Silo/Point-Data/#responseTab2.Accessed 19 July 2024*.

Smerdon, BD, TR Ransley, BM Radke, and JR Kellett. 2012. *Water Resource Assessment for the Great Artesian Basin: A Report for the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment*.

State of Queensland. 2019. 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Subordinate Legislation 2019 No. 156. Made under the Environmental Protection Act 1994. Commences from 1 September 2019.' Preprint.

State of Queensland. 2020. 'Water Act. Https://Www.Legislation.Qld.Gov.Au/View/Pdf/Inforce/Current/Act-2000-034'.

State of Queensland. 2021. *Mined Land and Rehabilitation Policy*. https://environment.des.qld.gov.au/__data/assets/pdf_file/0035/87659/mined-land-rehabilitation-policy.pdf.

Sucklow, Axel, Andrew Taylor, Phil Davies, and Fred Leaney. 2016. *Geochemical Baseline Monitoring. Final Report*. Gas Industry Social and Environmental Research Alliance, CSIRO, Australia. https://gisera.org.au/wp-content/uploads/2012/06/Project-4-Geochemical-Baseline-Report-201602.pdf.

Swarbrick, CFJ. 1973. *Stratigraphy and Economic Potential of the Injune Creek Group in the Surat Basin*. Report 79. Geological Survey of Queensland.

URS. 2010. *Wandoan Project Hydrogeological Study Alluvium and Spoil Dump Assessment*. Prepared for Xstrata Coal Queensland Pty Ltd.

Water Act 2000 (2024). https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-2000-034.

Wohling, DL, AJ Love, SA Fulton, P Rousseau-Gueutin, and S De Ritter. 2012. *Groundwater Recharge, Hydrodynamics and Hydrochemistry of the Western Great Artesian Basin in South Australia and the Northern Territory, Report for the Project 'Allocating Water and Maintaining Springs in the Great Artesian Basin',*. National Water Commission.

APPENDIX I

Bore Register

Appendix I - Monitoring Bore Details

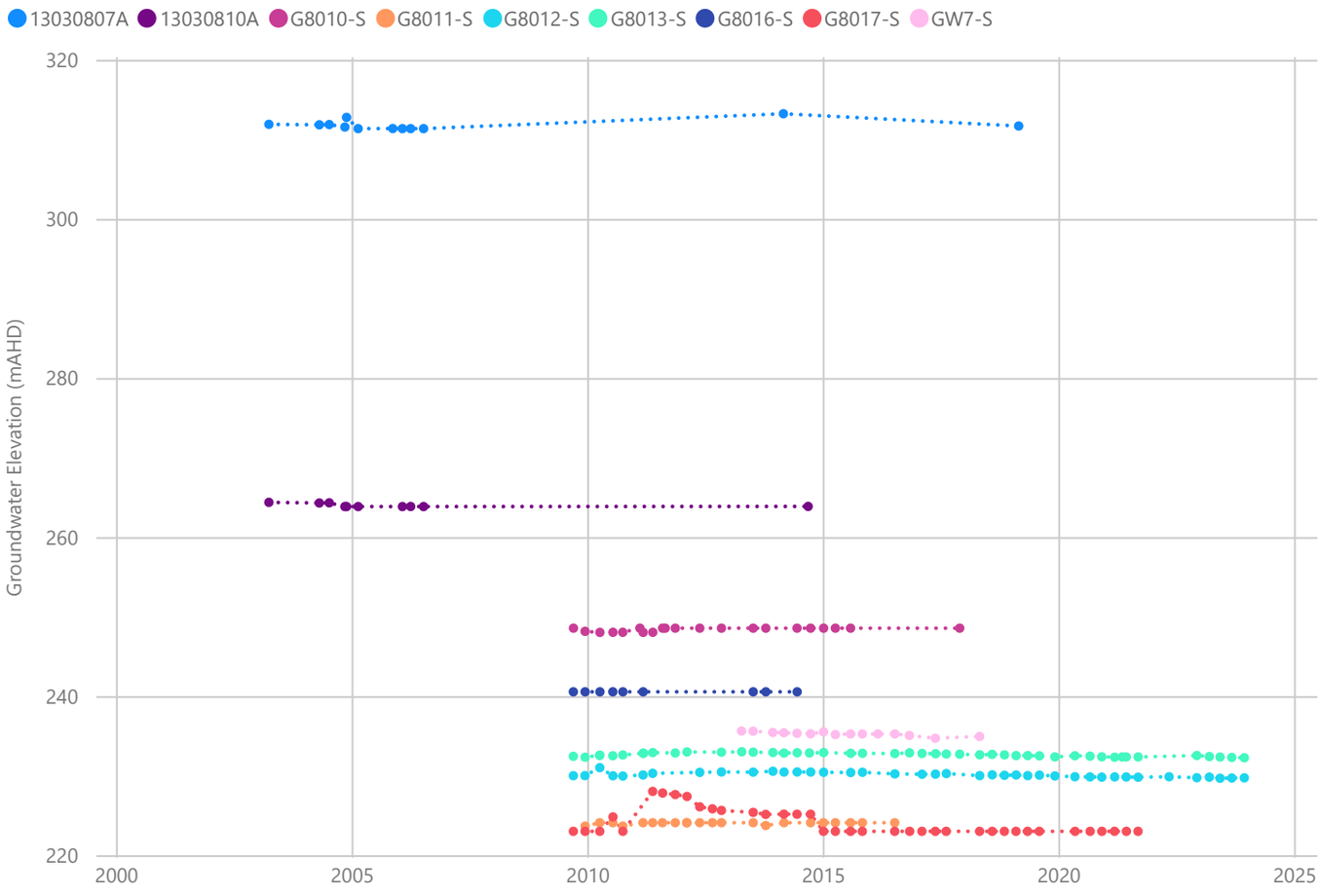
Table I-1 Monitoring Bore Details

Bore Name	EA/ Non-EA	Drilled Date	Easting (m)	Northing (m)	Elevation (mAHD)	Depth (mbGL)	Screen Interval (mbGL)	Screen Interval Geology	Records Available	Status
WMB1-S	EA	Apr-2008	786921	7106177	259.0	36.0	27.0 to 33.0	Kogan	58	Rehabilitated
WMB1-D	EA	Apr-2008	786921	7106177	259.0	88.0	46.0 to 57.0, 69.0 to 72.0, 78.0 to 84.0	Walloon Coal Measures	58	Rehabilitated
WMB2	EA	Apr-2008	795005	7105981	276.9	118.0	70.0 to 73.0	Macalister Lower	77	Operational
WMB3-S	EA	Apr-2008	789498	7110003	268.5	47.0	38.0 to 44.0	Macalister Upper	42	Operational
WMB3-D	EA	Apr-2008	789498	7110003	268.5	61.0	49.0 to 58.0	Wambo	74	Operational
G8010-S	EA	Apr-2009	792878	7104734	256.3	7.8	4.9 to 7.8	Alluvium	22	Unknown
G8011-D	EA	Apr-2009	792936	7112104	233.7	34.0	12.3 to 14.8, 20.9 to 24.0	Coal and Mudstone	13	Rehabilitated
G8011-S	EA	Apr-2009	792936	7112104	234.1	10.0	6.5 to 10.0	Alluvium	23	Rehabilitated
G8012-D	EA	Apr-2009	786527	7110194	237.9	31.9	16.1 to 19.1, 28.1 to 38.1	Coal and Siltstone	75	Operational
G8012-S	EA	Apr-2009	786527	7110194	237.5	9.1	6.0 to 9.0	Alluvium	38	Operational
G8013-D	EA	Apr-2009	787130	7108005	241.2	39.5	33.2 to 39.5	Siltstone and Coal	71	Operational
G8013-S	EA	Apr-2009	787130	7108005	241.2	12.0	9.0 to 12.0	Alluvium	42	Operational
G8016-S	EA	Apr-2009	785498	7104694	248.8	8.3	5.1 to 8.3	Alluvium	11	Unknown
G8017-S	EA	Apr-2009	788811	7117095	231.3	6.4	3.4 to 6.4	Alluvium	39	Unknown
G8018-D	EA	Apr-2009	780693	7120994	232.3	31.5	19.4 to 22.2, 28.6 to 31.5	Coal and Mudstone	41	Operational
GW7-S	Non-EA	Unknown	760073	7116952	Unknown	6.8	Unknown	Unknown	4	Operational
GW7-D	Non-EA	Unknown	760073	7116952	Unknown	11.0	Unknown	Unknown	17	Operational
GW8-S	Non-EA	Unknown	747202	7113658	Unknown	10.1	Unknown	Unknown	4	Operational
GW8-D	Non-EA	Unknown	747202	7113658	Unknown	11.2	Unknown	Unknown	16	Operational
GW11A	Non-EA	Unknown	761565	7124875	Unknown	16.1	Unknown	Unknown	25	Operational
GW11B	Non-EA	Unknown	761565	7124875	250.6	55.4	42.0 to 48.0	Unknown	52	Operational
GW12	Non-EA	Unknown	796051	7106705	Unknown	25.7	Unknown	Unknown	17	Operational
GW13A	Non-EA	Unknown	765957	7118100	Unknown	15.0	Unknown	Unknown	24	Operational
GW13B	Non-EA	Unknown	765957	7118100	257.7	43.6	36.5 to 42.5	Unknown	54	Operational
GW15	Non-EA	Unknown	757712	7122539	Unknown	35.3	Unknown	Unknown	28	Operational
GW17	Non-EA	Unknown	747202	7113658	266.7	73.6	Unknown	Unknown	26	Operational
GW18	Non-EA	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	16	Unknown
Trelinga	Non-EA	Unknown	791298	7098628	Unknown	1268.0	Unknown	Unknown	29	Operational
2023MB12	Non-EA	Nov-2023	793454	7112027	235.7	30.0	19.0 to 22.0	Wambo	2	Operational
2023MB15D	Non-EA	Nov-2023	787706	7113343	236.5	30.0	24.0 to 30.0	Wambo	2	Operational
2023MB10	Non-EA	Nov-2023	789875	7112240	249.8	40.0	34.0 to 40.0	Wambo	1	Operational
2023MB11D	Non-EA	Nov-2023	791924	7112863	235.5	25.0	19.0 to 25.0	Wambo	Dry	Operational
2023MB11S	Non-EA	Nov-2023	791929	7112863	235.2	3.0	1.0 to 3.0	Alluvium	Dry	Operational
2023MB01D	Non-EA	Nov-2023	793222	7109080	242.0	30.0	24.0 to 30.0	Macalister Upper and Macalister Lower	1	Operational
2023MB01S	Non-EA	Nov-2023	793223	7109084	242.2	11.0	5.0 to 11.0	Alluvium	Dry	Operational
2023MB07	Non-EA	Nov-2023	787452	7104006	269.1	62.0	56.0 to 62.0	Macalister Upper	2	Operational
2023MB02S	Non-EA	Nov-2023	792951	7107800	245.2	6.0	2.0 to 5.0	Alluvium	Dry	Operational
2023MB09	Non-EA	Nov-2023	788639	7107740	265.7	29.0	22.5 to 28.5	Sandstone	Dry	Operational
2023MB05	Non-EA	Nov-2023	791517	7106155	278.1	54.0	48.0 to 54.0	Macalister Upper	2	Operational
2023MB08D	Non-EA	Nov-2023	786974	7106128	260.7	82.0	76.0 to 82.0	Wambo	1	Operational
2023MB08S	Non-EA	Nov-2023	786974	7106124	261.0	10.0	3.7 to 9.7	Alluvium	Dry	Operational
2023MB13	Non-EA	Nov-2023	794590	7107644	276.8	36.0	30.0 to 36.0	Macalister Upper	2	Operational
2023MB16D	Non-EA	Dec-2023	817188	7097125	352.9	60.0	54.0 to 60.0	Sandstone	2	Operational
WL_QCK_03/ GeoChem#2	Non-EA	Dec-2023	788226	7105731		50.1	35.0 to 41.0	Macalister Upper and Macalister Lower	-	Operational
AU_QCK_01/ GeoChem#1	Non-EA	Dec-2023	790890	7110731		44.4	30.0 to 36.0	Wambo	-	Operational
2023MB06	Non-EA	Dec-2023	789847	7104224	290.7	57.0	51.0 to 57.0	Sandstone	1	Operational
2023MB02D	Non-EA	Dec-2023	792744	7107880	251.0	60.0	40.0 to 46.0	Wambo	2	Operational
2023MB16S	Non-EA	Dec-2023	817183	7097124	352.6	60.0	20.0 to 26.0	Sandstone	2	Operational

APPENDIX II

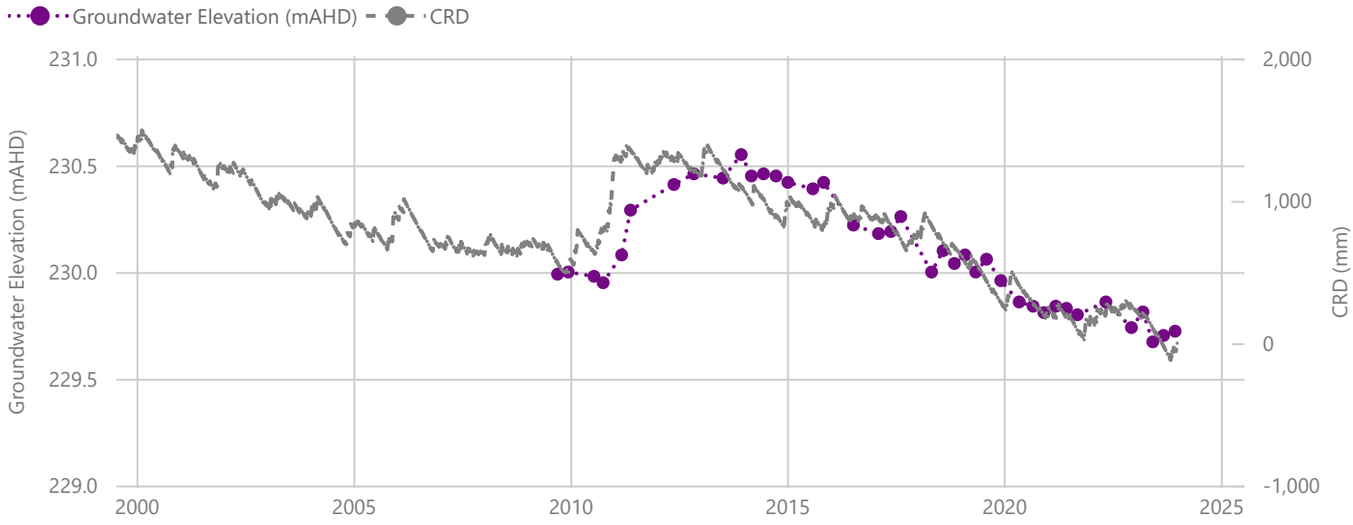
Groundwater Levels

Alluvium

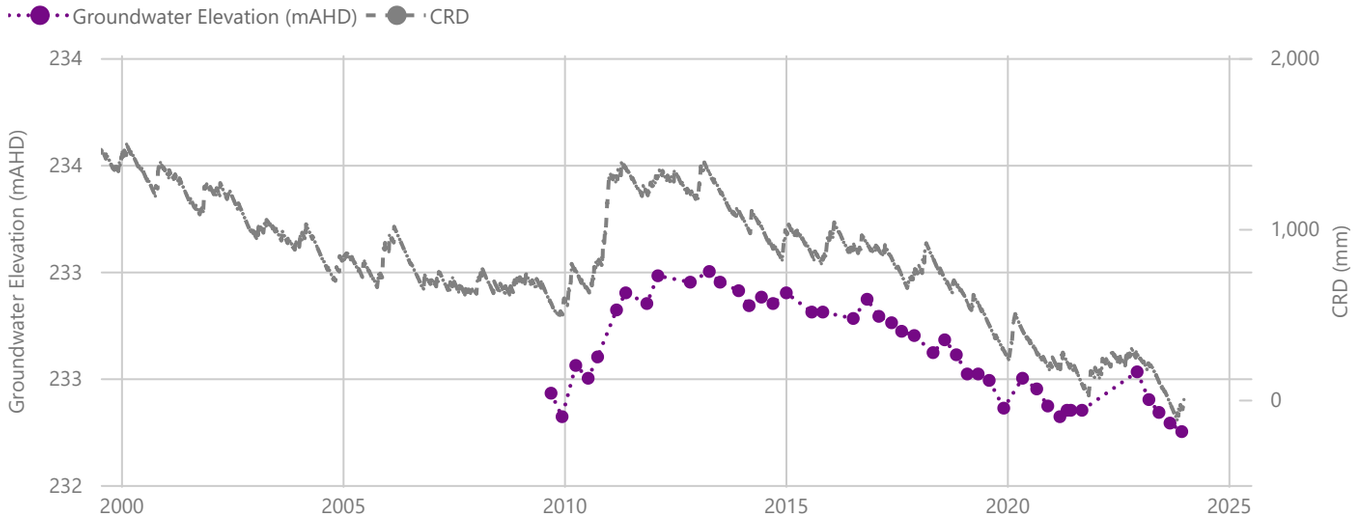

13030807A
13030810A
G8010-S
G8011-S
G8012-S
G8013-S
G8016-S
G8017-S
GW7-S
Groundwater Elevation (mAHD)
320
300
280
260
240
220
2000
2005
2010
2015
2020
2025

Alluvium

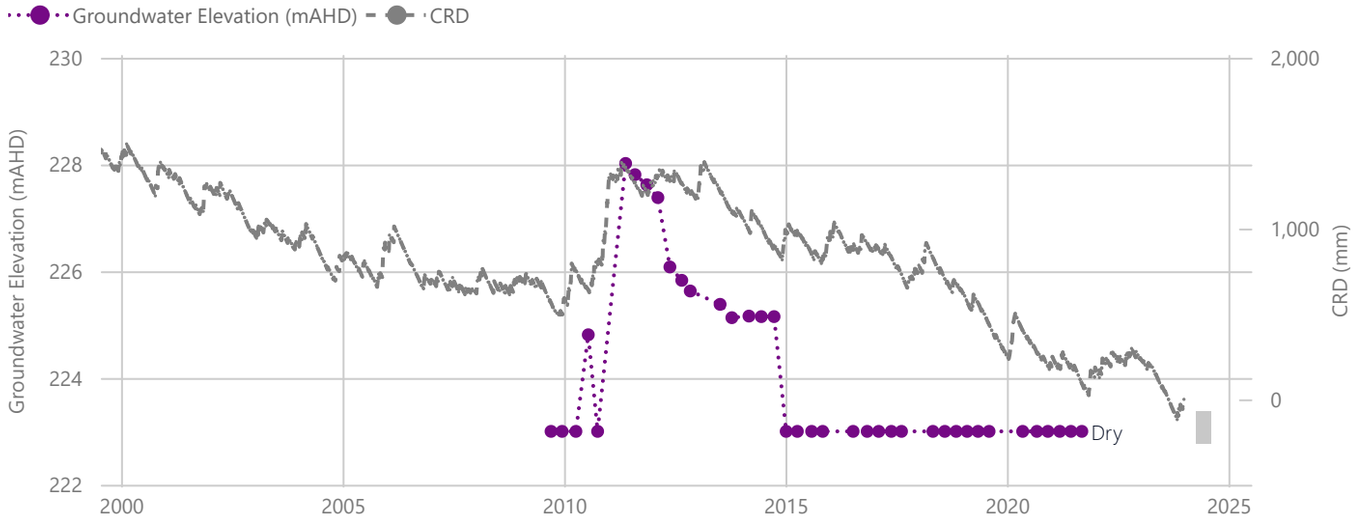
G8012-S



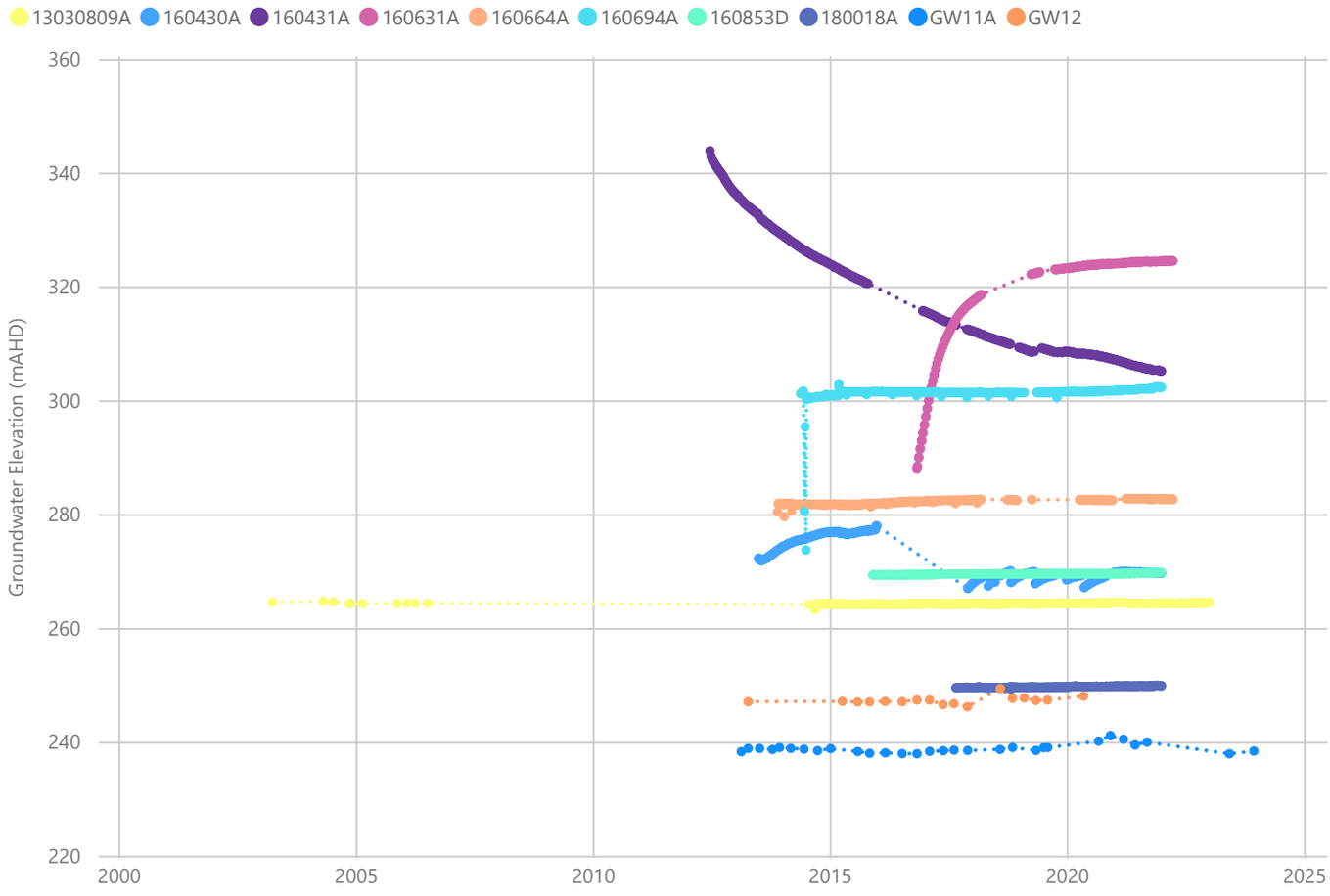
G8013-S



G8017-S

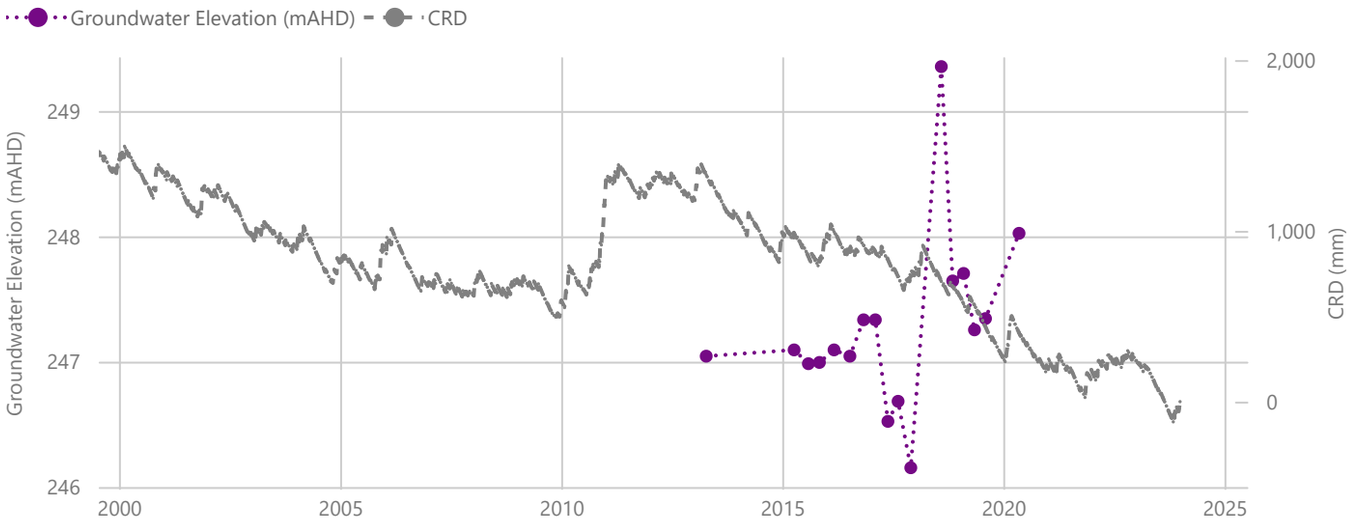


Springbok Sandstone

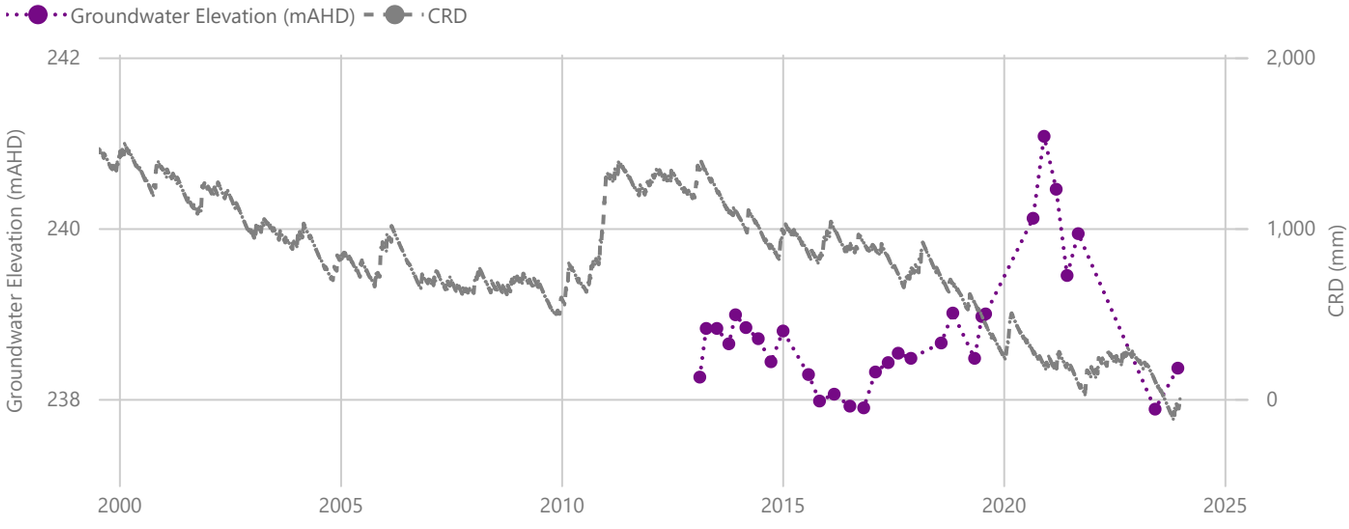


Springbok Sandstone

GW12

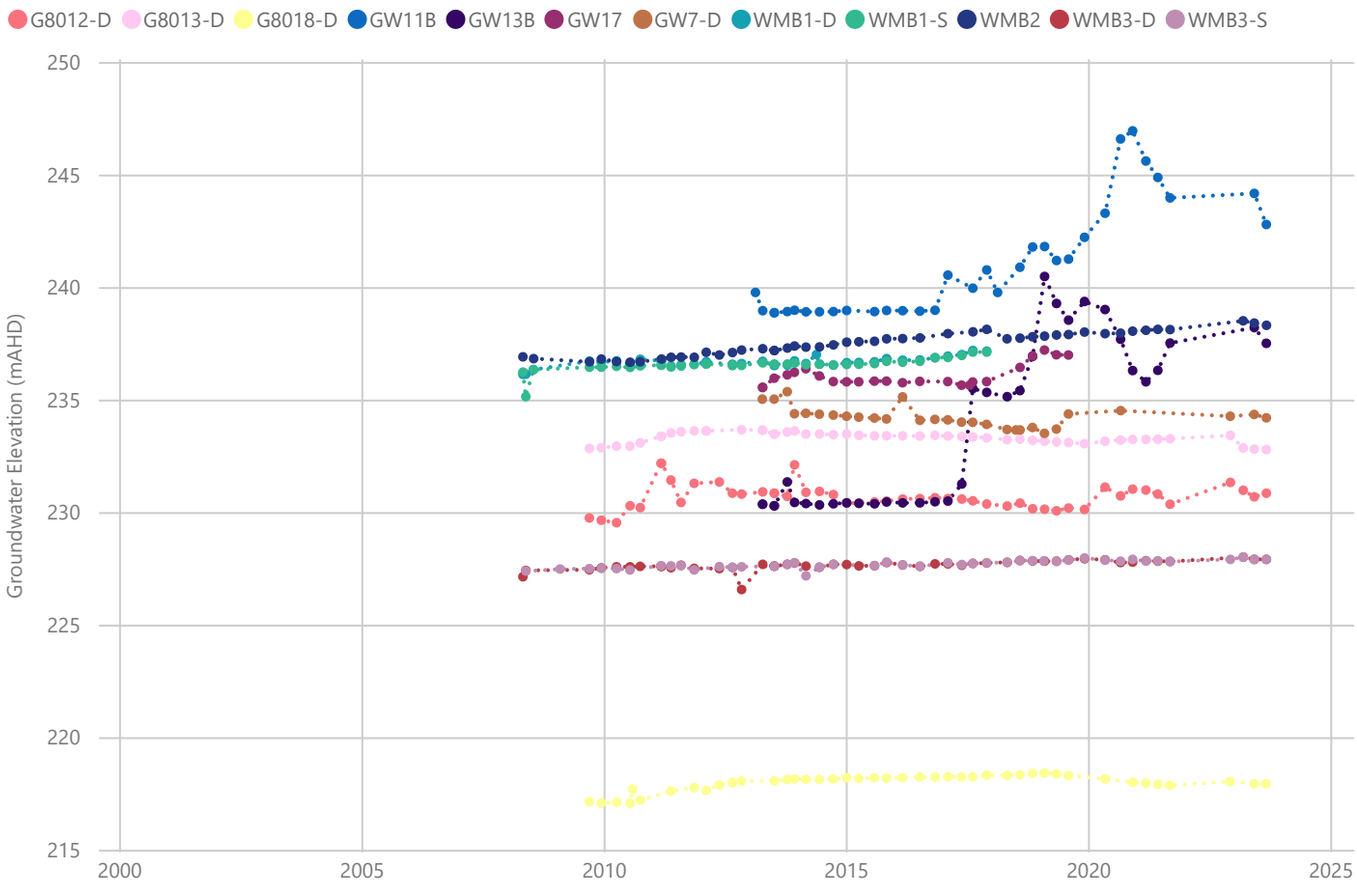


GW11A

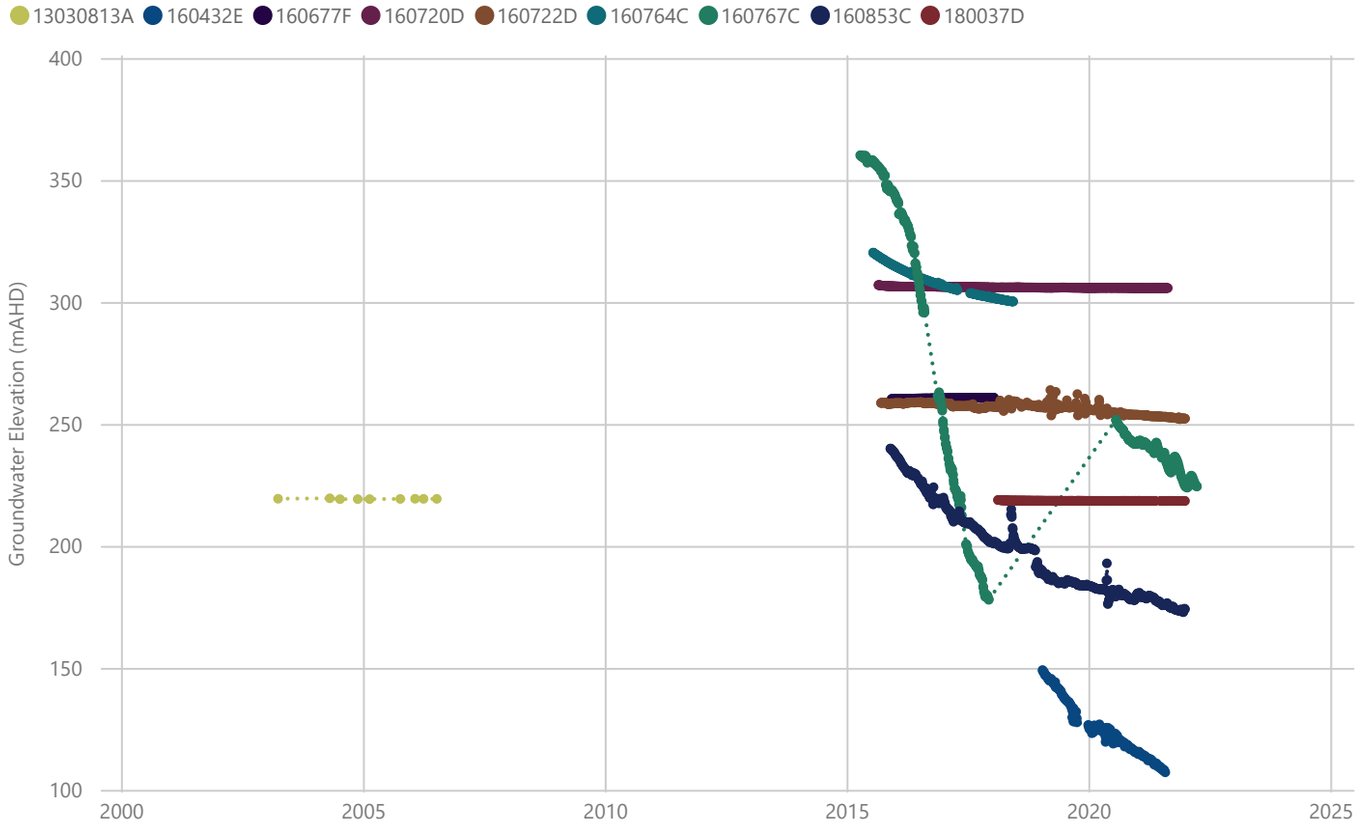


Upper Juandah Coal Measures

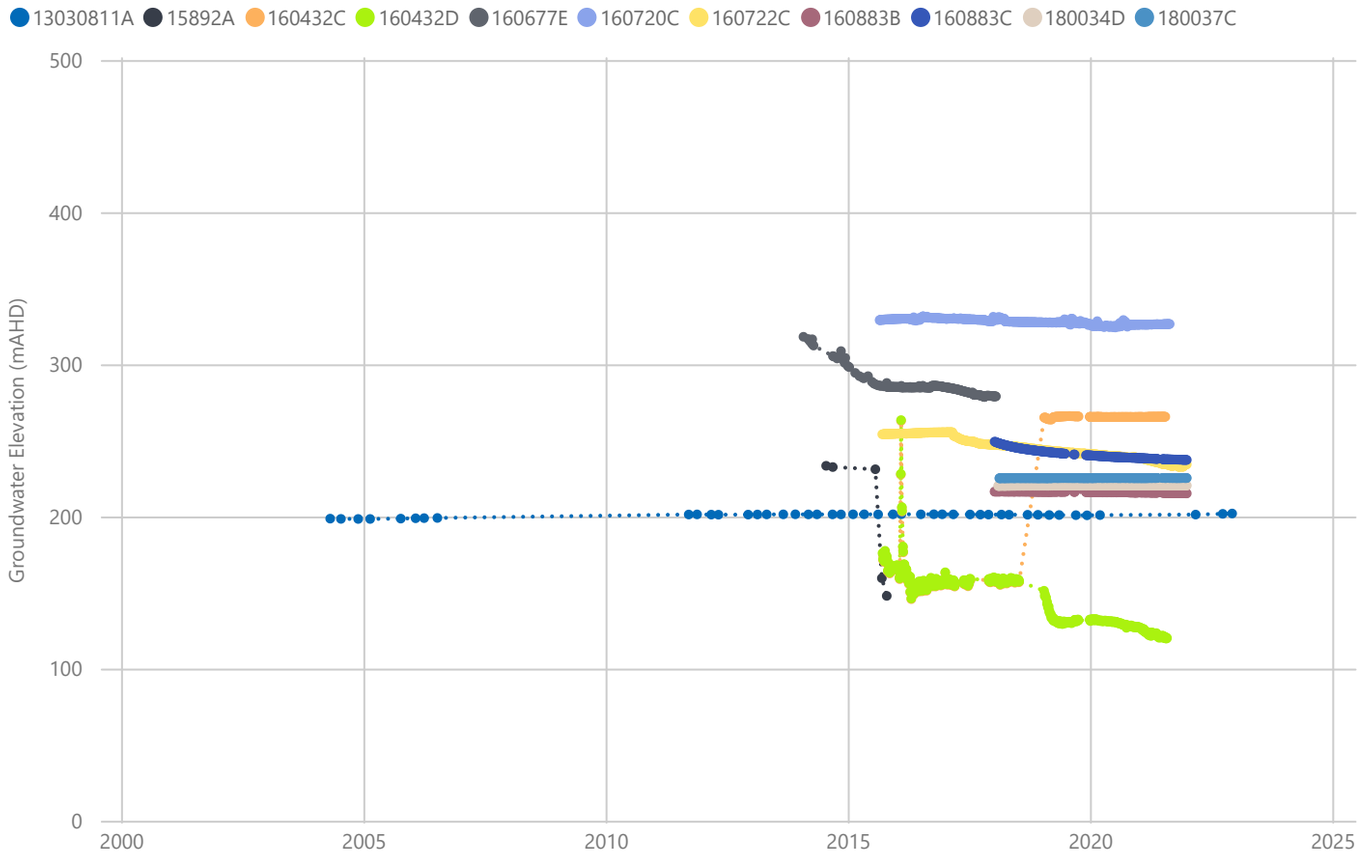
GCAA Monitoring Bores

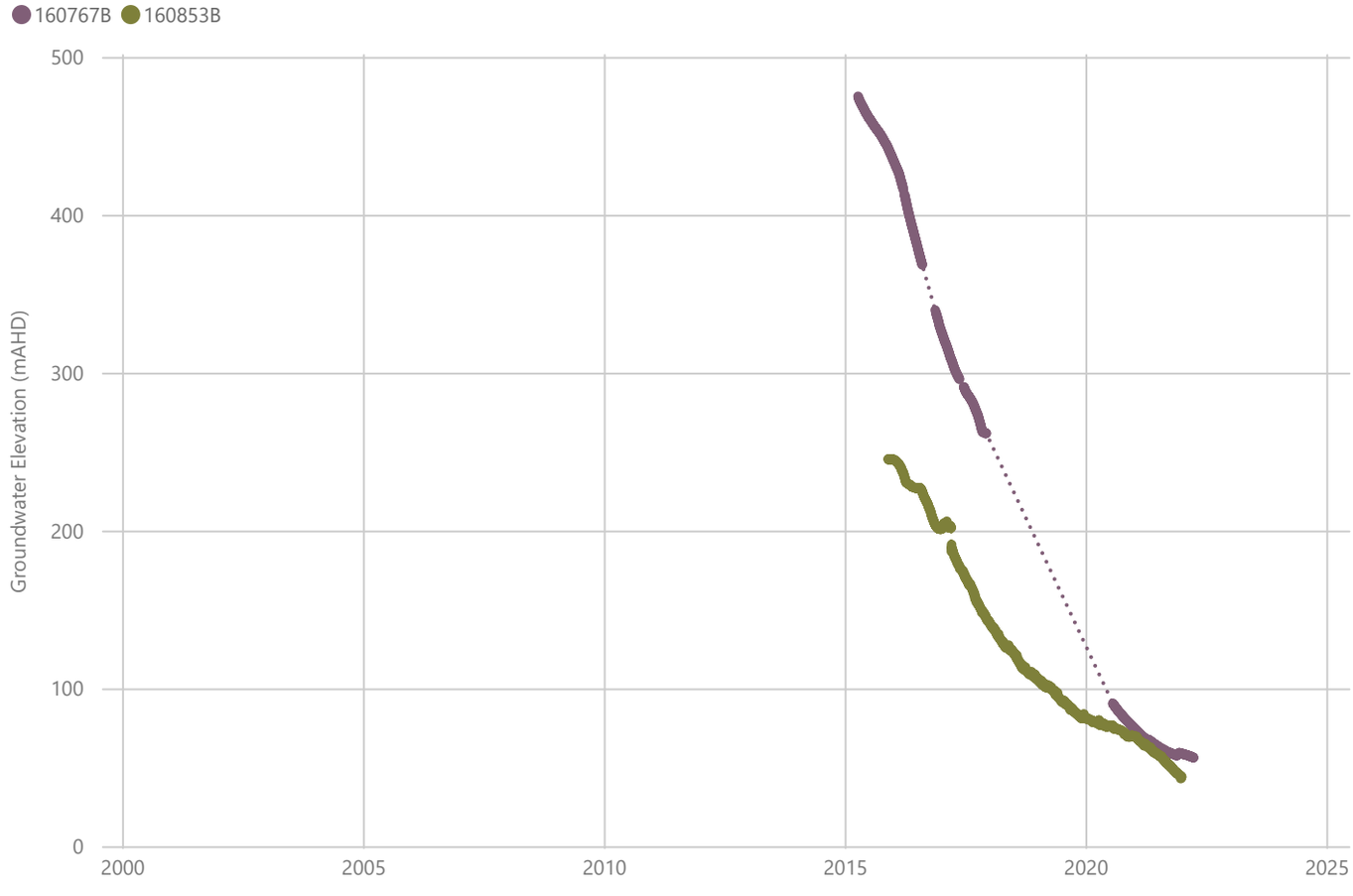


GWDB

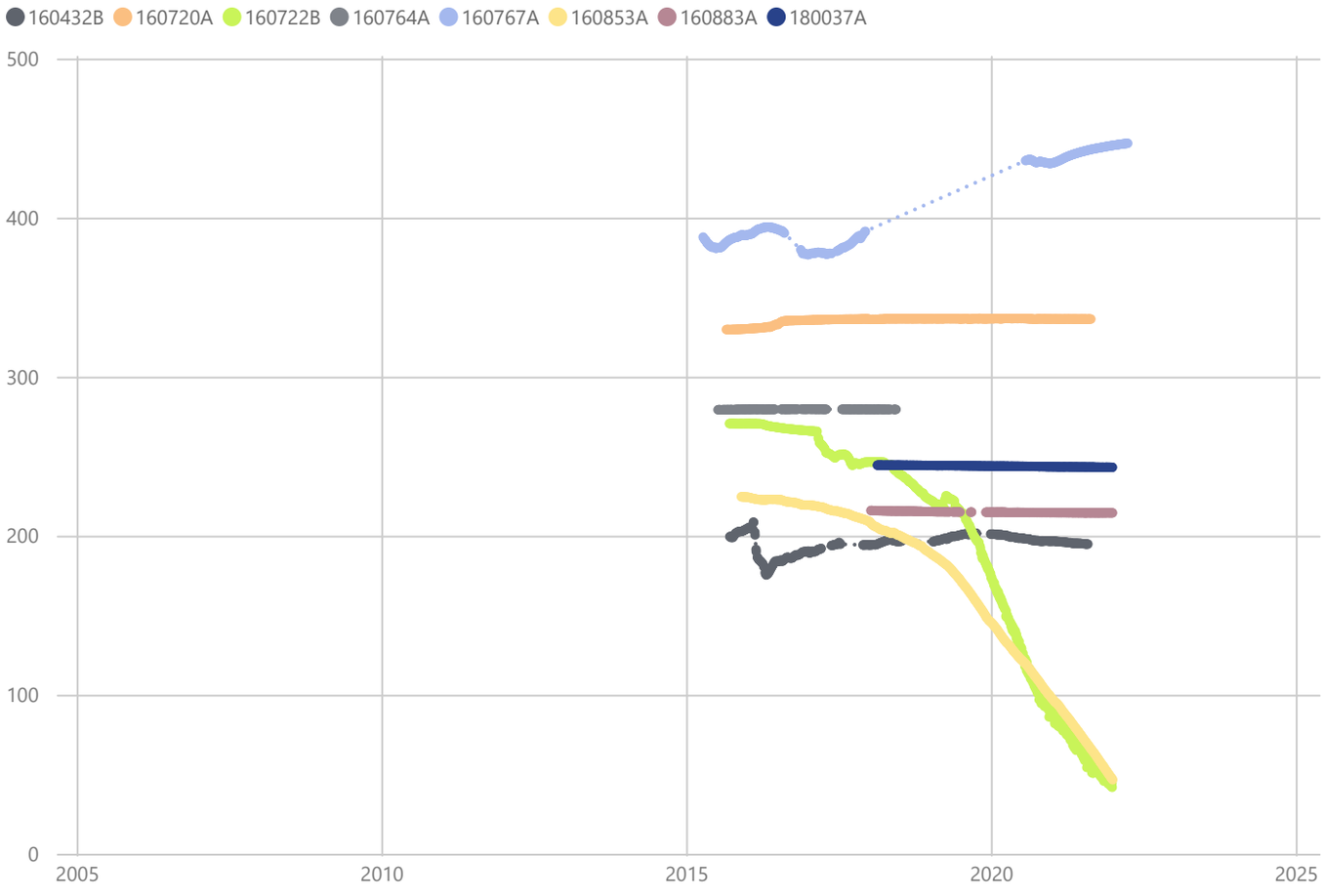


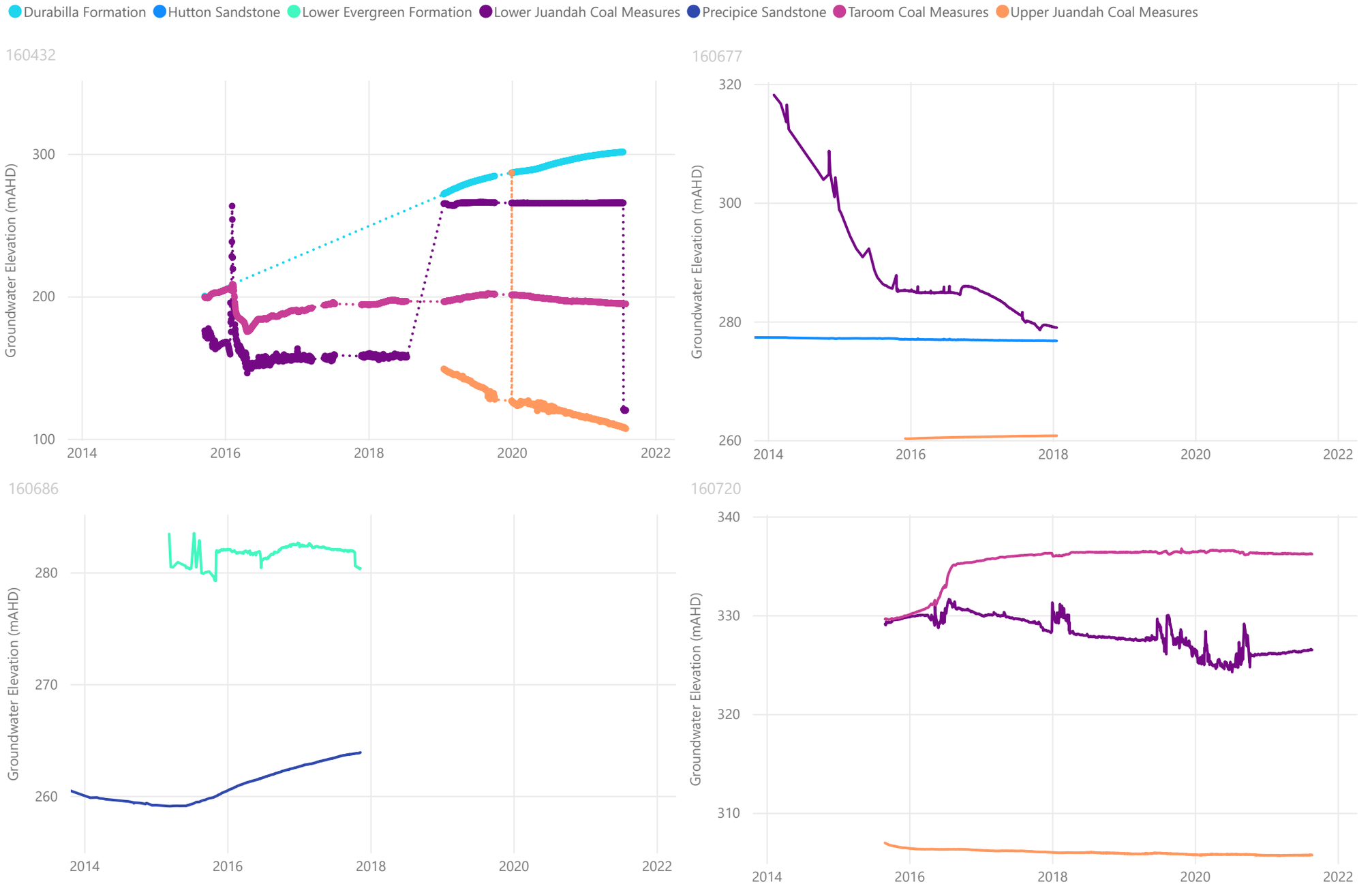
Lower Juandah Coal Measures

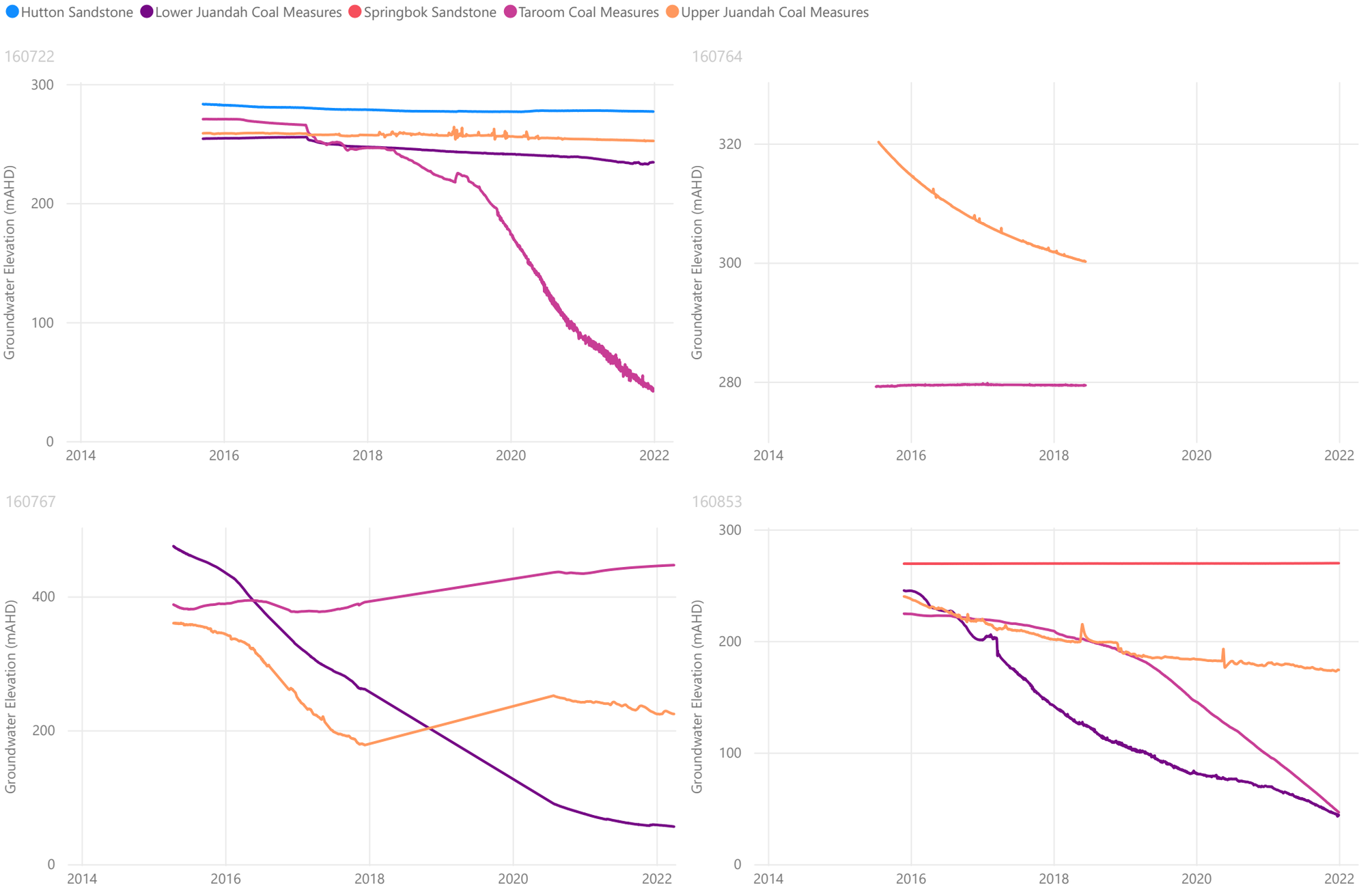


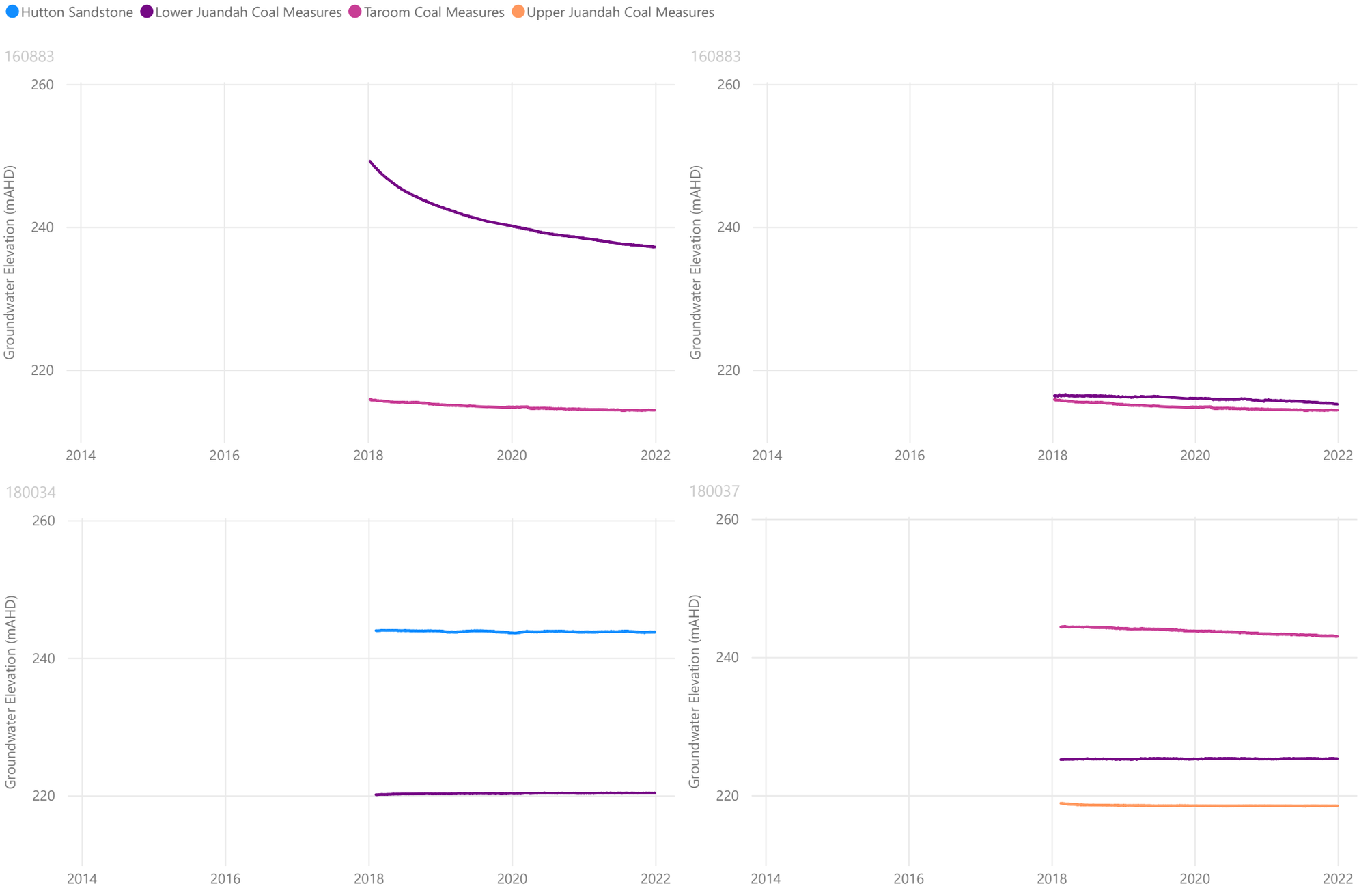


Taroom Coal Measures




Durabilla Formation
Hutton Sandstone
Lower Evergreen Formation
Lower Juandah Coal Measures
Precipice Sandstone
Taroom Coal Measures
Upper Juandah Coal Measures
160432
160677
160686
160720
Groundwater Elevation (mAHD)
2014
2016
2018
2020
2022


Hutton Sandstone
Lower Juandah Coal Measures
Springbok Sandstone
Taroom Coal Measures
Upper Juandah Coal Measures
160722
160764
160767
160853
Groundwater Elevation (mAHD)
0
100
200
300
280
320
400
2014
2016
2018
2020
2022


Hutton Sandstone
Lower Juandah Coal Measures
Taroom Coal Measures
Upper Juandah Coal Measures
160883
160883
180034
180037
Groundwater Elevation (mAHD)
260
240
220
2014
2016
2018
2020
2022

APPENDIX III

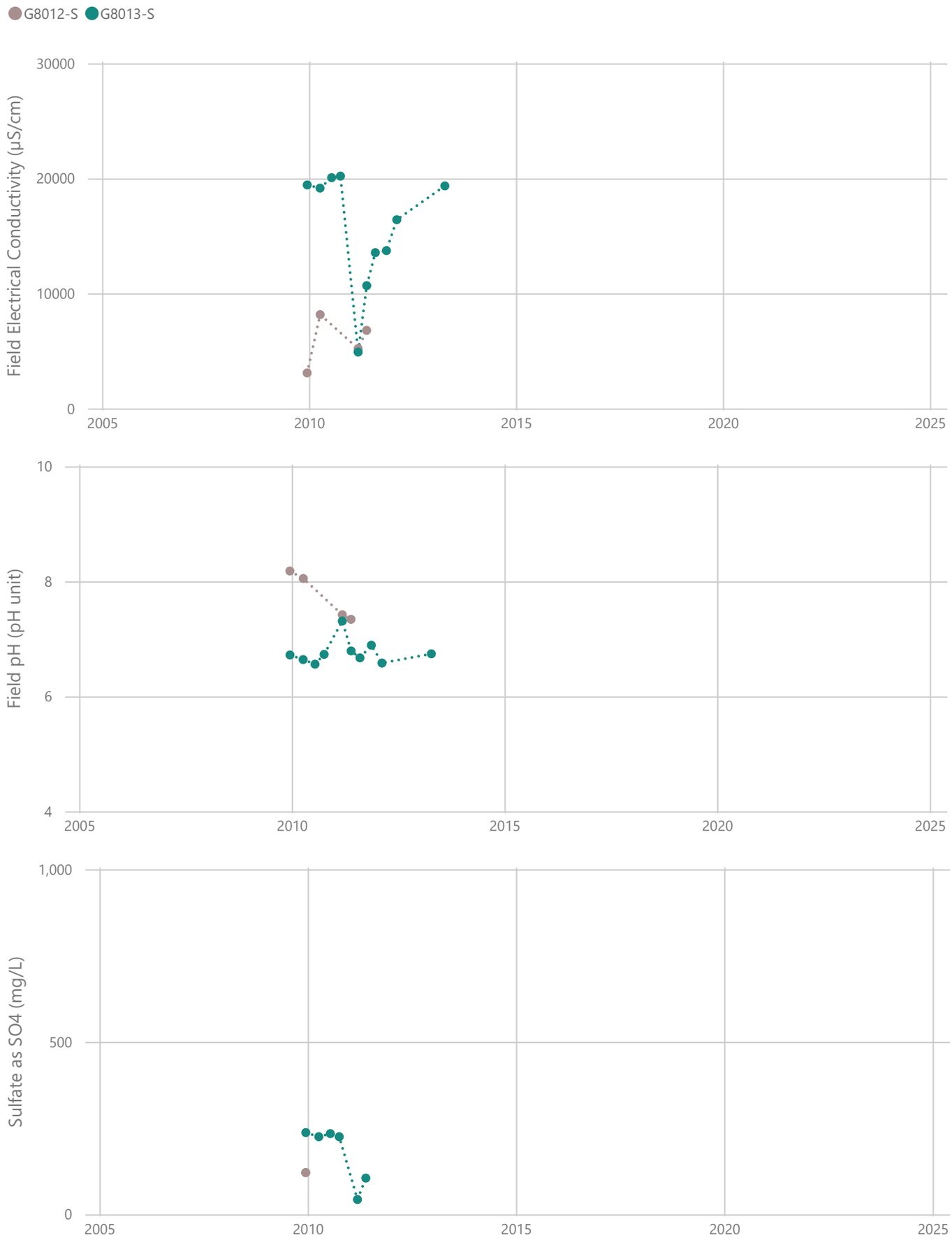
Groundwater Chemistry

Appendix III
Groundwater Chemistry

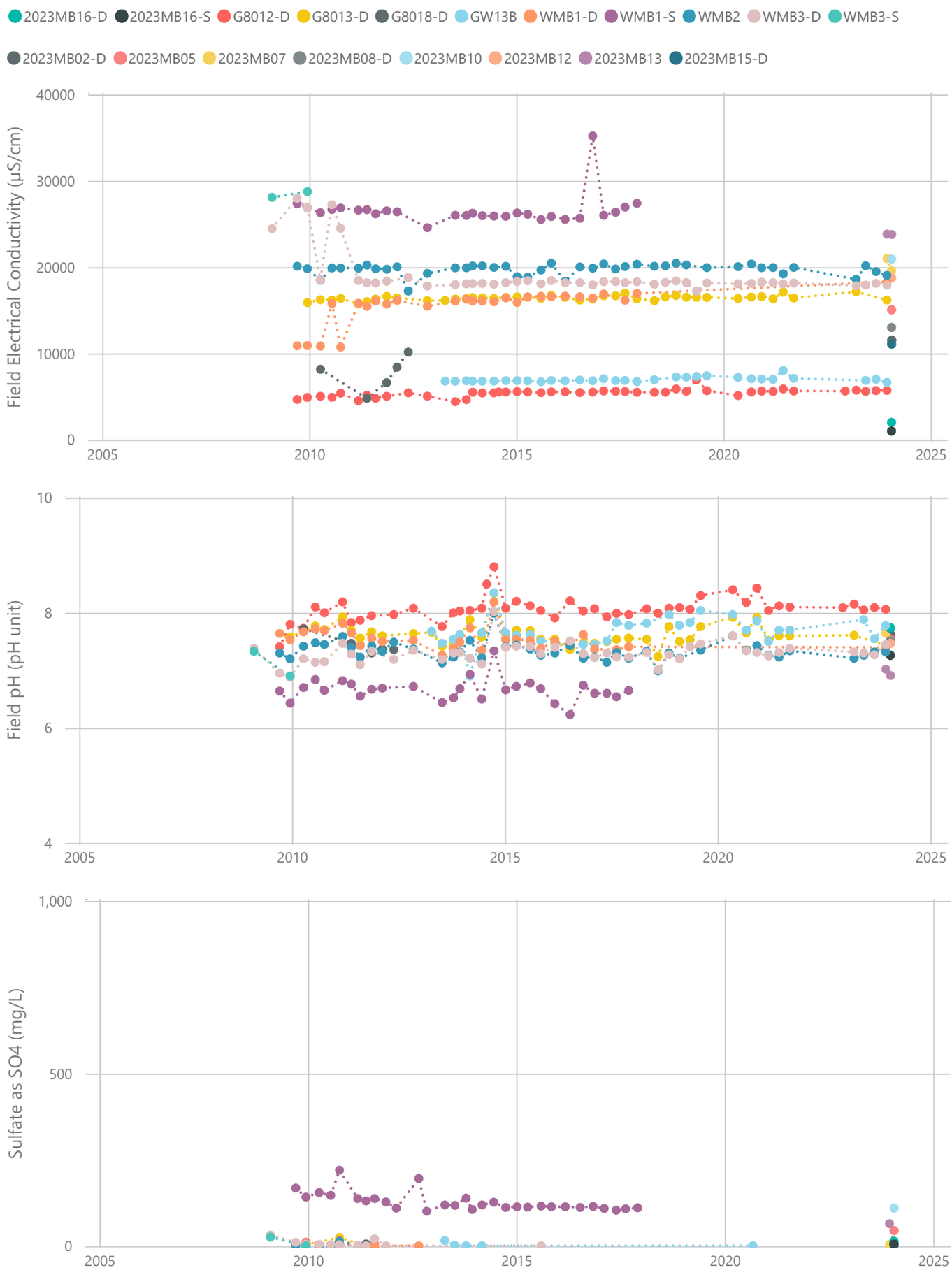
Analyte	Statistic	2023MB02-D	2023MB05	2023MB07	2023MB08-D	2023MB10	2023MB12	2023MB13	2023MB15-D	2023MB16-D	2023MB16-S	G8012-D	G8012-S	G8013-D	G8013-S	G8018-D	GW11B	GW13B	GW17	WMB1-D	WMB1-S	WMB2	WMB3-D	WMB3-S
Field Electrical Conductivity (µS/cm)	Count	1	1	2	1	1	1	2	1	1	1	47	4	42	10	5	33	32	1	29	28	45	46	2
	Max	11,539	15,064	21,001	13,007	20,930	18,767	23,826	11,073	2,004	1,002	6,962	8,158	17,154	20,200	10,155	18,906	8,025	15,098	18,303	35,207	20,460	27,981	28,757
	Min	11,539	15,064	19,585	13,007	20,930	18,767	23,788	11,073	2,004	1,002	4,414	3,087	15,738	4,902	4,802	16,510	6,646	15,098	10,740	24,574	17,234	17,239	28,091
	Average	11,539	15,064	20,293	13,007	20,930	18,767	23,807	11,073	2,004	1,002	5,426	5,810	16,428	15,745	7,630	16,966	6,978	15,098	15,552	26,571	19,764	19,036	28,424
Field pH (pH unit)	Count	1.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	47.00	4.00	42.00	10.00	5.00	33.00	32.00	1.00	29.00	28.00	45.00	46.00	2.00
	Max	7.62	7.54	7.64	7.51	7.27	7.47	7.02	7.73	7.74	7.26	8.80	8.18	8.34	7.31	7.72	8.24	8.35	7.98	8.19	7.34	7.99	8.02	7.33
	Min	7.62	7.54	7.50	7.51	7.27	7.47	6.91	7.73	7.74	7.26	7.41	7.34	7.24	6.56	7.30	0.47	6.90	7.98	7.26	6.23	6.99	6.88	6.90
	Average	7.62	7.54	7.57	7.51	7.27	7.47	6.97	7.73	7.74	7.26	8.06	7.75	7.63	6.76	7.44	7.35	7.68	7.98	7.54	6.66	7.34	7.30	7.12
Total Alkalinity as CaCO3 (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	1,080	229	217	376	385	220	928	233	270	542	664	359	601	388	293	198	476	227	561	758	456	721	654
	Min	1,080	229	199	376	385	220	828	233	270	542	264	359	237	201	293	166	247	227	327	272	328	380	474
	Average	1,080	229	208	376	385	220	878	233	270	542	573	359	270	303	293	180	397	227	401	639	391	484	564
Sulfate as SO4 (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	0.50	45.00	5.00	6.00	110.00	1.00	65.00	3.00	14.00	6.00	11.00	121.00	25.00	237.00	6.00	3.00	16.00	67.00	16.00	220.00	14.00	32.00	26.00
	Min	0.50	45.00	3.00	6.00	110.00	1.00	8.00	3.00	14.00	6.00	0.00	121.00	0.00	43.00	6.00	0.50	0.50	67.00	0.00	101.00	0.00	0.50	1.00
	Average	0.50	45.00	4.00	6.00	110.00	1.00	36.50	3.00	14.00	6.00	0.95	121.00	1.17	178.17	6.00	0.68	1.01	67.00	1.26	128.13	0.91	2.26	13.50
Dissolved Aluminium (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	5.00	5.00	5.00	5.00	5.00	5.00	25.00	5.00	5.00	5.00	20.00	5.00	20.00	5.00	0.00	20.00	30.00	5.00	140.00	30.00	20.00	240.00	5.00
	Min	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.00	5.00	0.00	0.00	0.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	5.00
	Average	5.00	5.00	5.00	5.00	5.00	5.00	15.00	5.00	5.00	5.00	5.42	5.00	5.34	4.17	0.00	5.61	7.08	5.00	10.97	6.50	5.63	14.06	5.00
Dissolved Arsenic (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	2.00	2.00	2.00	4.00	4.00	3.00	2.50	3.00	2.00	1.00	6.00	15.00	4.00	3.00	2.00	3.00	8.00	10.00	12.00	3.00	1.00	4.00	0.50
	Min	2.00	2.00	0.50	4.00	4.00	3.00	2.00	3.00	2.00	1.00	0.50	15.00	0.00	0.00	2.00	0.50	0.50	10.00	0.50	0.50	0.00	0.50	0.50
	Average	2.00	2.00	1.25	4.00	4.00	3.00	2.25	3.00	2.00	1.00	2.28	15.00	0.74	1.58	2.00	1.29	3.21	10.00	2.45	0.65	0.51	2.57	0.50
Dissolved Barium (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	2,430	3,590	8,620	3,660	3,460	7,870	7,220	2,590	242	216	4,120	5	5,060	1,100	1,520	5,770	4,260	3,430	5,480	784	7,300	9,980	5
	Min	2,430	3,590	8,020	3,660	3,460	7,870	5,760	2,590	242	216	5	5	5	5	1,520	3,910	323	3,430	5	5	5	5	5
	Average	2,430	3,590	8,320	3,660	3,460	7,870	6,490	2,590	242	216	689	5	3,932	500	1,520	4,831	709	3,430	4,169	590	5,619	4,840	5
Dissolved Boron (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	45		42	4	1	33	36	1	28	27	45	44	
	Max	260.00	260.00	180.00	160.00	220.00	120.00	340.00	120.00	25.00	60.00	170.00		200.00	210.00	110.00	160.00	210.00	270.00	200.00	260.00	240.00	230.00	
	Min	260.00	260.00	150.00	160.00	220.00	120.00	220.00	120.00	25.00	60.00	50.00		25.00	70.00	110.00	25.00	50.00	270.00	25.00	25.00	25.00	25.00	
	Average	260.00	260.00	165.00	160.00	220.00	120.00	280.00	120.00	25.00	60.00	125.11		132.02	130.00	110.00	107.73	138.61	270.00	125.18	161.30	150.56	141.36	
Dissolved Cadmium (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	0.05	0.10	0.10	0.20	0.10	0.05	0.25	0.05	0.05	0.40	600.00	200.00	600.00	1200.00	0.30	100.00	1000.00	0.01	600.00	700.00	400.00	600.00	100.00
	Min	0.05	0.10	0.05	0.20	0.10	0.05	0.05	0.05	0.05	0.40	0.00	200.00	0.00	0.60	0.30	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01
	Average	0.05	0.10	0.08	0.20	0.10	0.05	0.15	0.05	0.05	0.40	25.02	200.00	20.48	433.43	0.30	3.06	30.59	0.01	25.82	80.01	29.21	52.11	50.00
Dissolved Calcium (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	85.00	101.00	149.00	60.00	241.00	148.00	189.00	63.00	33.00	64.00	78.00	5.00	127.00	692.00	41.00	154.00	86.00	131.00	154.00	844.00	188.00	214.00	220.00
	Min	85.00	101.00	135.00	60.00	241.00	148.00	164.00	63.00	33.00	64.00	6.00	5.00	10.00	90.00	41.00	50.00	11.00	131.00	27.00	647.00	86.00	39.00	164.00
	Average	85.00	101.00	142.00	60.00	241.00	148.00	176.50	63.00	33.00	64.00	15.71	5.00	71.09	508.00	41.00	101.76	19.17	131.00	79.10	760.50	120.65	104.08	192.00
Dissolved Chloride (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	3,580	5,370	7,200	4,800	7,520	6,810	7,960	3,820	573	28	5,710	607	5,850	6,750	2,210	6,150	5,800	5,370	6,100	10,400	7,910	9,450	9,060
	Min	3,580	5,370	7,120	4,800	7,520	6,810	7,870	3,820	573	28	1,050	607	1,480	1,680	2,210	5,170	1,620	5,370	3,220	7,300	5,640	5,300	8,480
	Average	3,580	5,370	7,160	4,800	7,520	6,810	7,915	3,820	573	28	1,444	607	5,463	5,198	2,210	5,834	2,215	5,370	5,310	8,824	6,736	6,353	8,770
Dissolved Chromium (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	0.50	0.50	0.50	0.50	0.50	0.50	2.50	0.50	0.50	0.50	2.00	0.50	2.00	2.00	0.00	0.50	0.50	0.50	2.00	3.00	2.00	2.00	3.00
	Min	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.00	0.00	0.50	0.50	2.00
	Average	0.50	0.50	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.50	0.56	0.50	0.57	0.75	0.00	0.50	0.50	0.50	0.58	0.65	0.70	0.68	2.50
Dissolved Cobalt (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	45		42	4	1	33	36	1	28	27	45	44	
	Max	0.50	1.00	0.50	0.50	1.00	0.50	2.50	0.50	0.50	0.50	0.50		0.50	12.00	0.00	2.00	0.50	0.50	0.50	2.00	0.50	2.00	
	Min	0.50	1.00	0.50	0.50	1.00	0.50	1.00	0.50	0.50	0.50	0.00		0.00	0.50	0.00	0.50	0.50	0.50	0.00	0.50	0.00	0.00	
	Average	0.50	1.00	0.50	0.50	1.00	0.50	1.75	0.50	0.50	0.50	0.49		0.49	7.13	0.00	0.55	0.50	0.50	0.48	0.65	0.49	0.55	
Dissolved Copper (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	0.50	1.00	18.00	62.00	0.50	8.00	2.50	9.00	15.00	53.00	5.00	6.00	30.00	4.00	1.00	23.00	18.00	5.00	5.00	11.00	22.00	10.00	8.00

Analyte	Statistic	2023MB02-D	2023MB05	2023MB07	2023MB08-D	2023MB10	2023MB12	2023MB13	2023MB15-D	2023MB16-D	2023MB16-S	G8012-D	G8012-S	G8013-D	G8013-S	G8018-D	GW11B	GW13B	GW17	WMB1-D	WMB1-S	WMB2	WMB3-D	WMB3-S
	Min	0.50	1.00	0.50	62.00	0.50	8.00	0.50	9.00	15.00	53.00	0.00	6.00	0.00	2.00	1.00	0.50	0.50	5.00	0.00	0.00	0.00	0.00	4.00
	Average	0.50	1.00	9.25	62.00	0.50	8.00	1.50	9.00	15.00	53.00	2.40	6.00	2.88	3.00	1.00	2.94	2.58	5.00	3.03	3.68	3.22	2.77	6.00
Dissolved Iron (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	80.00	25.00	100.00	25.00	300.00	25.00	25.00	25.00	25.00	25.00	260.00	90.00	500.00	3770	0.00	890	410	25.00	1420	3760	990	5710	2280
	Min	80.00	25.00	25.00	25.00	300.00	25.00	25.00	25.00	25.00	25.00	0.00	90.00	0.00	0.00	0.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00	1560
	Average	80.00	25.00	62.50	25.00	300.00	25.00	25.00	25.00	25.00	25.00	60.10	90.00	300.34	2138.33	0.00	481.52	241.67	25.00	611.61	1854.3	594.79	1574.58	1920
Dissolved Lead (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	0.50	0.50	0.50	0.50	0.50	0.50	2.50	0.50	0.50	0.50	8.00	0.50	0.50	0.50	0.00	0.50	3.00	0.50	4.00	0.50	1.00	0.50	1.00
	Min	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.50	0.00	0.00	0.00	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.50
	Average	0.50	0.50	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.50	0.65	0.50	0.49	0.42	0.00	0.50	0.57	0.50	0.63	0.48	0.50	0.49	0.75
Dissolved Magnesium (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	23.00	23.00	36.00	25.00	59.00	53.00	91.00	8.00	28.00	70.00	24.00	3.00	38.00	223.00	16.00	28.00	23.00	13.00	56.00	344.00	47.00	109.00	117.00
	Min	23.00	23.00	33.00	25.00	59.00	53.00	80.00	8.00	28.00	70.00	2.00	3.00	4.00	26.00	16.00	23.00	3.00	13.00	13.00	240.00	34.00	30.00	113.00
	Average	23.00	23.00	34.50	25.00	59.00	53.00	85.50	8.00	28.00	70.00	5.60	3.00	23.73	152.33	16.00	26.03	4.94	13.00	29.45	295.70	41.77	41.06	115.00
Dissolved Manganese (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	76.00	189.00	88.00	36.00	406.00	76.00	236.00	34.00	37.00	23.00	911.00	48.00	68.00	3550.00	54.00	335.00	98.00	9.00	29.00	282.00	70.00	337.00	230.00
	Min	76.00	189.00	83.00	36.00	406.00	76.00	122.00	34.00	37.00	23.00	3.00	48.00	11.00	51.00	54.00	40.00	2.00	9.00	10.00	188.00	24.00	15.00	55.00
	Average	76.00	189.00	85.50	36.00	406.00	76.00	179.00	34.00	37.00	23.00	63.63	48.00	29.05	2150.17	54.00	76.06	36.42	9.00	19.81	229.87	35.67	46.25	142.50
Dissolved Nickel (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	4.00	3.00	1.00	2.00	4.00	1.00	2.50	0.50	1.00	3.00	6.00	21.00	7.00	46.00	11.00	15.00	7.00	4.00	15.00	32.00	16.00	28.00	4.00
	Min	4.00	3.00	0.50	2.00	4.00	1.00	0.50	0.50	1.00	3.00	0.00	21.00	0.00	1.00	11.00	0.50	0.50	4.00	0.00	0.50	0.50	0.50	2.00
	Average	4.00	3.00	0.75	2.00	4.00	1.00	1.50	0.50	1.00	3.00	1.57	21.00	1.81	12.00	11.00	4.03	1.94	4.00	2.44	3.97	3.31	6.17	3.00
Dissolved Potassium (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	12.00	14.00	16.00	14.00	20.00	18.00	21.00	10.00	4.00	2.00	12.00	3.00	18.00	32.00	6.00	16.00	13.00	12.00	19.00	51.00	23.00	36.00	31.00
	Min	12.00	14.00	15.00	14.00	20.00	18.00	19.00	10.00	4.00	2.00	4.00	3.00	5.00	11.00	6.00	11.00	4.00	12.00	11.00	24.00	13.00	13.00	30.00
	Average	12.00	14.00	15.50	14.00	20.00	18.00	20.00	10.00	4.00	2.00	4.92	3.00	13.11	22.33	6.00	12.58	5.25	12.00	14.52	35.47	16.21	16.60	30.50
Dissolved Sodium (mg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	2710.00	3490.00	4670.00	3300.00	4740.00	4590.00	5360.00	2530.00	389.00	66.00	3240.00	615.00	3990.00	3490.00	1470.00	3910.00	3330.00	3320	4230	5920	5360	6200	5260
	Min	2710.00	3490.00	4220.00	3300.00	4740.00	4590.00	4730.00	2530.00	389.00	66.00	906.00	615.00	1120.00	1020.00	1470.00	3110.00	1330.00	3320	2230	4000	3700	3390	5060
	Average	2710.00	3490.00	4445.00	3300.00	4740.00	4590.00	5045.00	2530.00	389.00	66.00	1177.65	615.00	3388.41	2685.00	1470.00	3457.58	1551.11	3320	3299	4530	4152	3930	5160
Dissolved Zinc (µg/L)	Count	1	1	2	1	1	1	2	1	1	1	48	1	44	6	1	33	36	1	31	30	48	48	2
	Max	91.00	224.00	79.00	275.00	284.00	60.00	81.00	40.00	31.00	119.00	87.00	6.00	60.00	33.00	6.00	148.00	130.00	2.50	53.00	982.00	138.00	467.00	28.00
	Min	91.00	224.00	56.00	275.00	284.00	60.00	12.50	40.00	31.00	119.00	0.00	6.00	0.00	2.50	6.00	2.50	2.50	2.50	0.00	8.00	0.00	2.50	23.00
	Average	91.00	224.00	67.50	275.00	284.00	60.00	46.75	40.00	31.00	119.00	17.32	6.00	15.73	13.92	6.00	24.56	21.18	2.50	14.71	67.80	26.01	83.82	25.50

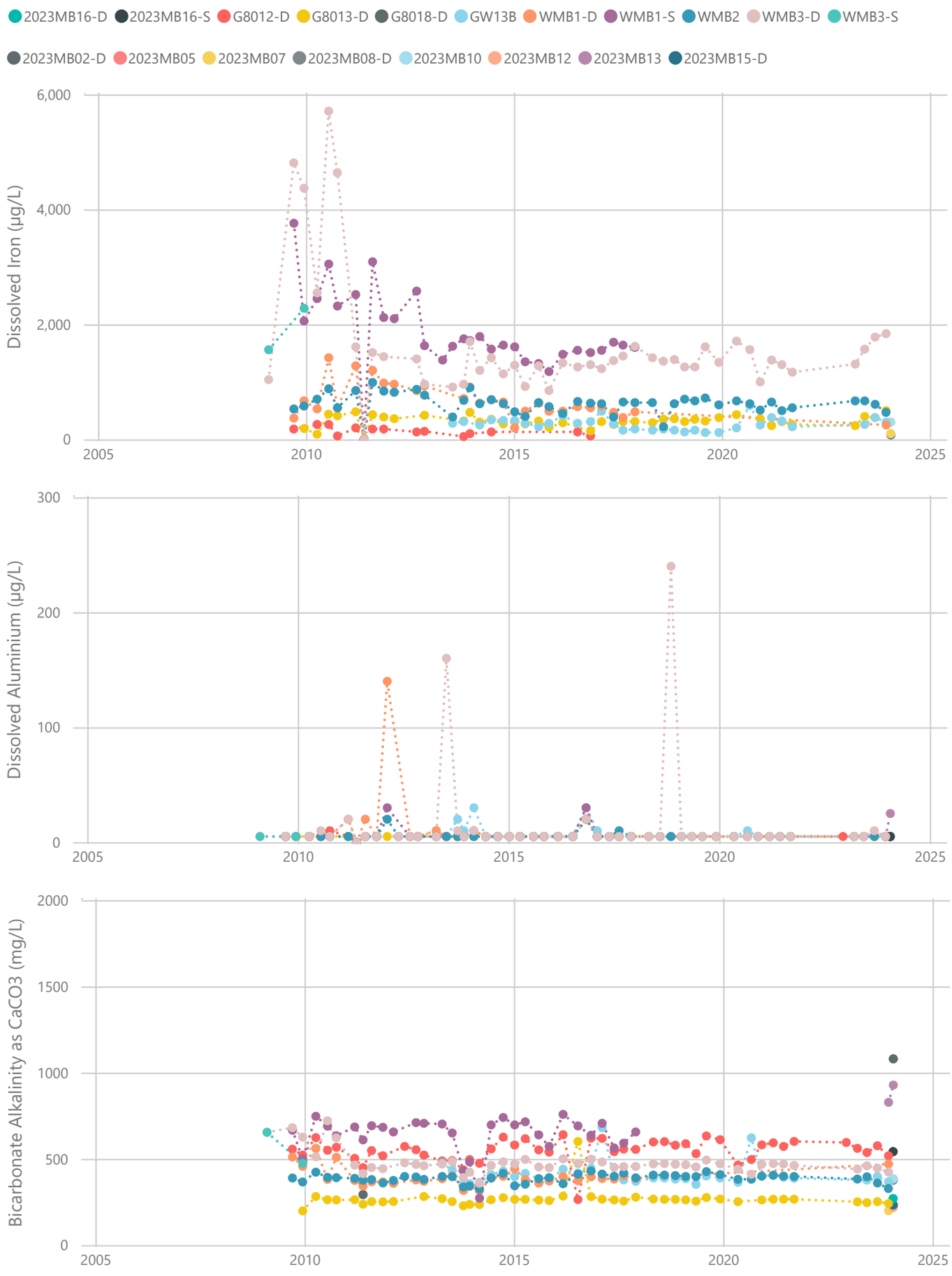
Alluvium


G8012-S
G8013-S
Field Electrical Conductivity (µS/cm)
30000
20000
10000
0
2005
2010
2015
2020
2025
Field pH (pH unit)
10
8
6
4
Sulfate as SO4 (mg/L)
1,000
500
0

Upper Juandah Coal Measures



Upper Juandah Coal Measures



APPENDIX IV

Numerical Groundwater Model

Appendix IV
Numerical Groundwater Model

IV-1 MODEL OBJECTIVES AND APPROACH

IV-1.1 Objectives

A numerical groundwater model has been constructed to support the Wandoan Holdings Pty Ltd (herein referred to as the Proponent) Wandoan Coal Project (the Project) Progressive Rehabilitation and Closure Plan (PRCP). The main objective was to develop a groundwater flow model for the Project that reasonably represents the groundwater system and can be used to predict changes in groundwater levels during closure and for the post-closure period and can be used for the PRCP.

The objectives of the modelling also include:

- Addressing the requirements of state legislation and guidelines in relation to groundwater assessment and predictions for closure.
- Predicting groundwater conditions in the vicinity of the final landforms for post-closure.
- Identifying potential risk areas where groundwater impact mitigation / control measures may be required after operations have ceased.

The model domain focused on the Project area, with sufficient distance outside of the Project to simulate the full extent of drawdown associated with mining, simulate post-mining recovery, and permit inclusion of appropriate boundary conditions.

IV-1.2 Approach

The numerical groundwater model has been constructed and simulated with consideration of the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) and the requirements of the PRCP Guideline (DES 2021).

IV-2 MODEL CONSTRUCTION

IV-2.1 Model Code

MODFLOW-USG was used as the modelling platform to simulate groundwater flow. MODFLOW-USG is a control volume finite difference (CVFD) code, which supports the construction of structured and unstructured model grids and contains robust solution methods and simulation capabilities, including the ability to handle complex, variably saturated / unsaturated flow.

IV-2.2 Units and Datum

The time unit for the model is days and the length unit is metres. The horizontal datum for the Project is GDA2020. The vertical datum is the Australian Height Datum (AHD) in metres.

IV-2.3 Model Domain Extent and Cells

The model domain is shown in Figure IV-2.1. The area of the model extent is approximately 4,200 km^2.

The model boundaries are aligned with sub-catchment divides, where a local groundwater divide, within the shallow groundwater systems is inferred. The external model boundaries are represented using the General Head Boundary (GHB) package of MODFLOW-USG. These boundaries represent regional groundwater levels at the model extents and provide/control groundwater flux to/from the model domain representative of regional groundwater flow conditions.

The numerical model uses a quadtree refinement approach to generate the unstructured mesh as shown in Figure IV-2.2. The range of model grid cell sizes is between 62.5 m and 500 m and the total number of active cells is 853,856. A rotation of the model domain by 25° to northwest was applied to the model grid to align with the proposed open cut mining orientation. The mesh/grid is refined in the areas associated with mining operations, watercourses and mapped alluvium.

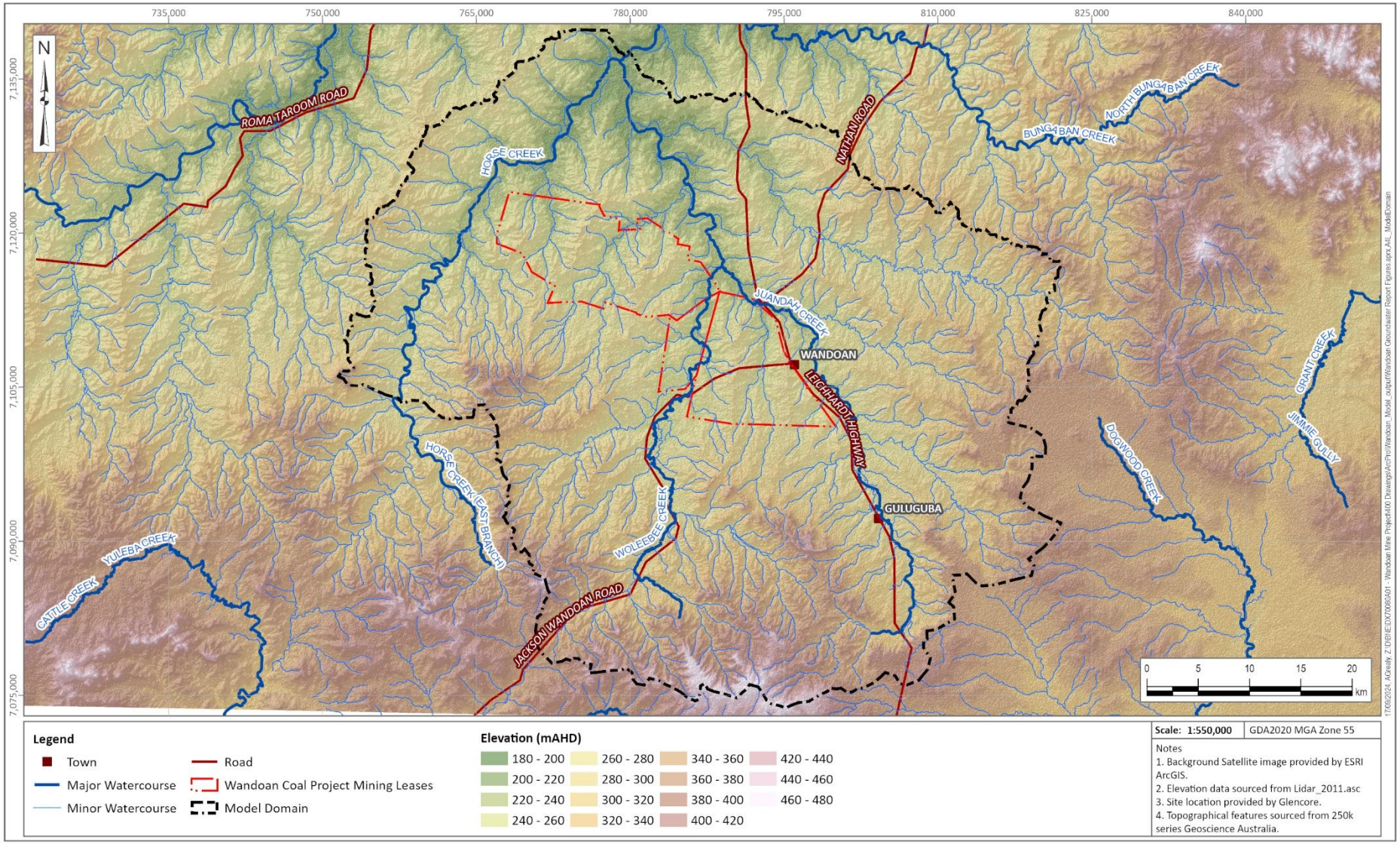


Figure IV-2.1 Model Domain

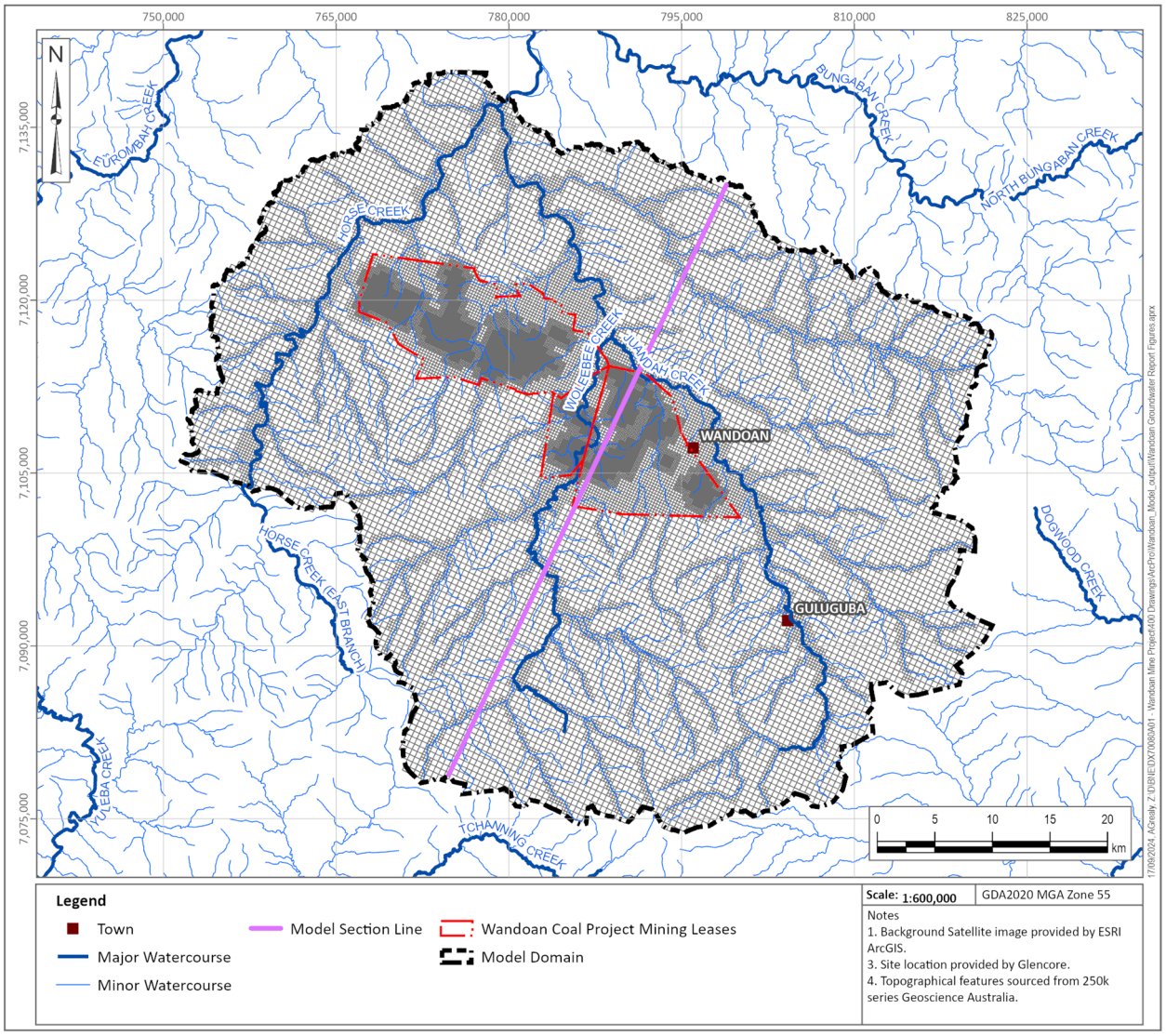


Figure IV-2.2 Unstructured Mesh

IV-2.4 Model Layering

The model was constructed with 16 layers to adequately represent the hydrostratigraphic units within the model domain. The model layers, the associated hydrostratigraphic units and the layer thicknesses are summarised in Table IV-2.1, with a cross section through the model layers shown in Figure IV-2.3 (location of section shown on Figure IV-2.2).

The model layering within the Project mining leases (MLs) is based on the Glencore Coal Assets Australia GCAA geological model, developed for resource definition (GCAA 2023). The Office of Groundwater Impact Assessment (OGIA) regional geological model was used for the area beyond the MLs, and to define the upper layers (above the coal seams) as these units are not included in the GCAA geological model.

The top surface of the model was constructed based on the Proponents 2022 LiDAR survey, while for the area outside of the MLs the Queensland one second digital elevation model (DEM) was adopted.

Table IV-2.1 Model Layers

Model Layer	Hydrogeological Unit	Thickness (m)
1	Quaternary alluvium	~3 – ~15
2	Weathered Surat Basin	1 – ~30
3	Shallow Surat Basin units (Gubberamunda Sandstone, Westbourne Formation)	1 – ~320
4	Springbok Sandstone	1 – ~325
5	Walloon Coal Measures - Overburden	1 – ~155
6	Walloon Coal Measures - Kogan	0.1 – ~15.2
7	Walloon Coal Measures - Interburden	1 – ~90
8	Walloon Coal Measures - Macalister Upper	0.1 – ~7.8
9	Walloon Coal Measures - Interburden	1 – ~50
10	Walloon Coal Measures - Macalister Lower	0.1 – ~20.4
11	Walloon Coal Measures - Interburden	1 – ~76
12	Walloon Coal Measures - Wambo	0.1 – ~4.7
13	Walloon Coal Measures - Lower Juandah Coal Measures	1 – ~160
14		1 – ~240
15	Walloon Coal Measures - Taroom Coal Measures	1 – ~183
16	Durabilla Formation	1 – ~138

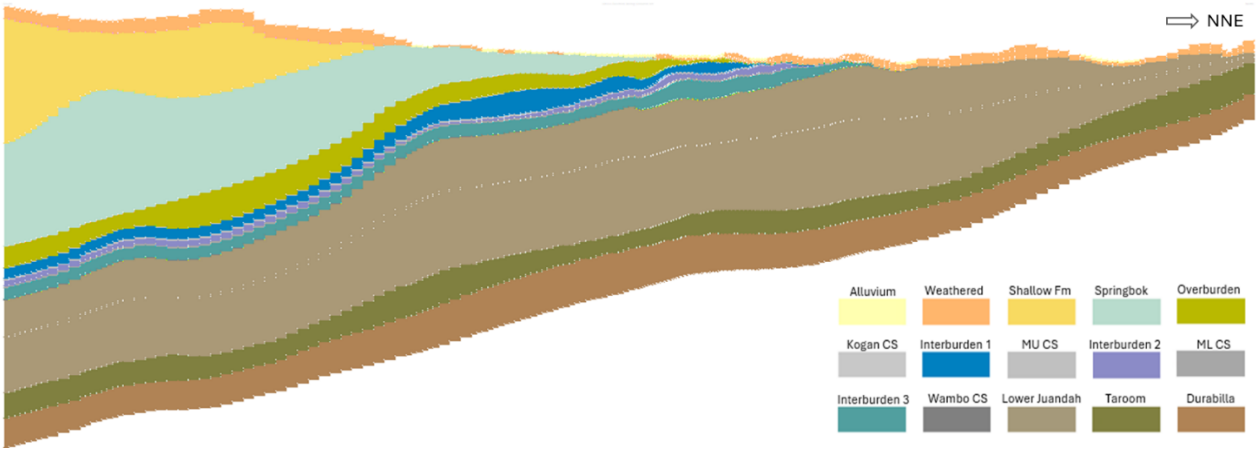


Figure IV-2.3 Cross Section of Model Layering

IV-2.5 Boundary Conditions

Boundary conditions are mathematical representation of the exchange of flow between the model and the external system that specify the dependent variable (head) or the derivative of the dependent variable (flux). The following sub-sections summarise the boundary conditions established in the model.

Recharge

Recharge across the model domain was assigned at surface and zoned to account for variable rates of recharge across the different geological units (outcrops). The numerical model only models saturated flow, therefore recharge is applied directly to the groundwater table. The top five layers of the model are set as unconfined, with layers six to sixteen as confined.

Recharge rates initially defined in the numerical model were based on the Surat CMA UWIR Hydrogeological Conceptualisation (OGIA 2016a) and a regional recharge investigation conducted for the previous UWIR in 2012 (QWC 2012). Recharge rates from relevant previous studies are summarised in Table IV-2.2. Rainfall data from the Wandoan Post Office weather station (35014) was used (BOM 2023b).

Table IV-2.2 Summary of Recharge in Adjacent Modelling Studies/Reports

Geological Units	OGIA CMB Model (2016a)	OGIA Surat Model (2019)		Other Adjacent Studies (All Units)
	Rate (mm/yr)	% of Rainfall	Rate (mm/yr)	Rate (mm/yr)
Alluvium	8.4 - 14.3	1.02%	3.28	0 - 2.5 (Kellett et al. 2003) 1 - 30.0 (QWC 2012) 0.01 - 1.8 (Wohling et al. 2012) 0 - 5.55 (QGC 2016)
Weathered Surat Basin	-	0.03% ~ 0.35%	0.2 - 1.7	
Springbok Sandstone	3.2 - 5.0	0.02%	0.1	
Upper Juandah	4.3 - 7.4	0.03%	0.2	
Lower Juandah	4.3 - 7.4	0.03%	0.2	

Evapotranspiration

Evapotranspiration (EVT) was applied to Layer 1 using the EVT package. Similar to recharge, evapotranspiration zones were defined for the surficial units. The evapotranspiration rate for each zone was calibrated with PEST in the range between 730 mm/annum and 10 mm/annum[1], which is the range of values from the OGIA model[2] (OGIA 2022). The average areal potential evapotranspiration map, which was based on a standard 30-year climatology from 1961-1990 (Chiew et al. 2002) was also used. An extinction depth between 1 m and 9 m was applied with consideration of the alluvium depth, the thickness of weathered units as well as values applied in the OGIA model (2022). The final rates and depths for each hydrogeological units were calibrated in the model and presented in the Section VI-3.5.6.

Drains

Drains (DRN) were included to represent the dewatering associated with mining of the open pits. The drains were assigned with head elevation equivalent to 0.1 m above the base of the coal seam layer within each active bench/panel. 0.1 m was selected to assist with model stability and model running times.

Watercourses across the model domain were also simulated using DRN boundaries. This allows groundwater to discharge into the drainage line where the head in the surrounding geological units is above the base of the creek due to rainfall recharge. Where the groundwater level in the hydrostratigraphic unit is below the base of the creek, a drain boundary setting does not contribute any flux to the groundwater system. This boundary condition has been applied to the drainage lines within the model domain due to the ephemeral nature of surface water drainage across the Project and the lack of surface water flow contribution to the underlying groundwater system.

[1] Note that this is the range of values used as the upper and lower bound for PEST. See Section VI-3.5.6 for actual values.
[2] The OGIA model is a regional model for the Surat Cumulative Management Area (CMA) which the Project is located within. The OGIA model was used as a reference for construction of this model as significant research and collation of data/properties has been completed by OGIA.

General Head

GHBs were applied around the perimeter of the model domain in steady state case (pre-coal seam gas (CSG)/mining) to establish regional groundwater flow conditions.

GHBs were also applied to represent the influence of CSG on the groundwater levels in the Walloon Coal Measures (WCM) in transient cases (calibration and prediction periods). These GHBs were applied to the deep coal seam layers, (where drawdown was predicted in the OGIA model as a result of the CSG development), within the model domain and at the south and west model domain boundary.

The GHBs allows the CSG development influence on the regional flow system to be replicated in the Project focus area (i.e. MLs) for each period during calibration and for the predictions. A reference head for these cells was specified using the OGIA model's predicted drawdown and the initial head to represent the period prior to CSG development was based on the initial steady state calibration.

Conductance values applied to the GHB cells were initially applied to be consistent with hydraulic conductivity values for each coal seam layer. These values were adjusted in calibration according to the monitoring data observed in the coal seam layers.

IV-2.6 Model Timing and Stress Periods

The model was simulated for the period between January 1995 and December 2022 to represent historical groundwater performance for calibration purposes. The period was discretised into seasonal/quarterly stress period from 1995 to 2014, and monthly stress periods from 2015 to 2022.

Following calibration, the model run was extended to encompass the future assumed operation period (Life of Mine (LoM) simulation) followed by a period of time for post-closure recovery (post-closure simulation).

The LoM simulation covered the pre-mining period from January 2023 to December 2030 and the assumed Life of Mine (LoM) which is planned for a 75-year period with an assumed start date of January 2031 and finishing in December 2105, with annual model stress periods. The post-closure simulation represents 500 years from 2106 to 2606, with annual stress periods (assuming mining starts in 2031 and occurs for 75 years).

IV-2.7 Initial Material Parameters

Table IV-2. summarises the hydraulic conductivity and storativity parameters from OGIA's regional groundwater model (OGIA 2022). The mid-values (mid-point between maximum and minimum in the parameter ranges reported by OGIA) were applied as the starting value for each parameter at the start of the steady state calibration.

Controls on the K_h/K_v ratios from OGIA modelling report (OGIA 2019; 2022) were adopted in the initial model set-up, whereby K_v was primarily less than K_h. This is typical for the sedimentary interbedded hydrogeological environment.

Table IV-2.3 Reference Hydraulic Parameters

Layer	Unit	Model Parameters*					
		Horizontal Conductivity (m/d)		Vertical Conductivity (m/d)		Ss	Sy
		Minimum	Maximum	Minimum	Maximum	1/m	-
1	Quaternary alluvium	$1.0x10^{-3}$	$1.0x10^{+1}$	$1.0x10^{-4}$	$1.0x10^{+0}$	$1.0x10^{-6}$ ~ $1.0x10^{-4}$	0.01 ~ 0.1
2	Weathered Surat Basin	$1.0x10^{-5}$	$1.0x10^{+1}$	$1.0x10^{-6}$	$1.0x10^{0}$	$7.3x10^{-7}$ ~ $1.6x10^{-5}$	0.01 ~ 0.1
3	Shallow Surat Basin units (Gubberamunda Sandstone, Westbourne Formation)	$1.0x10^{-7}$	1.0x100	$2.0x10^{-8}$	$1.0x10^{-1}$	$7.3x10^{-7}$ ~ $1.6x10^{-5}$	0.01 ~ 0.1
4	Springbok Sandstone	$3.0x10^{-6}$	$3.5x10^{-1}$	$3.0x10^{-8}$	$3.5x10^{-2}$	$3.8x10^{-7}$ ~ $1.0x10^{-5}$	0.01 ~ 0.1
5	Walloon Coal Measures - Overburden	$3.0x10^{-9}$	$1.0x10^{-1}$	$3.0x10^{-9}$	$1.0x10^{-3}$	$3.8x10^{-7}$ ~ $1.0x10^{-5}$	0.001 ~ 0.1
6	Walloon Coal Measures - Kogan	$1.0x10^{-5}$	$5.0x10^{-1}$	$1.0x10^{-7}$	$5.0x10^{-2}$	$2.2x10^{-7}$ ~ $1.7x10^{-5}$	0.001 ~ 0.1
7	Walloon Coal Measures - Interburden	$3.0x10^{-9}$	$1.0x10^{-1}$	$3.0x10^{-9}$	$1.0x10^{-3}$	$3.8x10^{-7}$ ~ $1.0x10^{-5}$	0.001 ~ 0.1
8	Walloon Coal Measures - Macalister Upper	$1.0x10^{-5}$	$5.0x10^{-1}$	$1.0x10^{-7}$	$5.0x10^{-2}$	$2.2x10^{-7}$ ~ $1.7x10^{-5}$	0.001 ~ 0.1
9	Walloon Coal Measures - Interburden	$3.0x10^{-9}$	$1.0x10^{-1}$	$3.0x10^{-9}$	$1.0x10^{-3}$	$3.8x10^{-7}$ ~ $1.0x10^{-5}$	0.001 ~ 0.1
10	Walloon Coal Measures - Macalister Lower	$1.0x10^{-5}$	$5.0x10^{-1}$	$1.0x10^{-7}$	$5.0x10^{-2}$	$2.2x10^{-7}$ ~ $1.7x10^{-5}$	0.001 ~ 0.1
11	Walloon Coal Measures - Interburden	$3.0x10^{-9}$	$1.0x10^{-1}$	$3.0x10^{-9}$	$1.0x10^{-3}$	$3.8x10^{-7}$ ~ $1.0x10^{-5}$	0.001 ~ 0.1
12	Walloon Coal Measures - Wambo	$1.0x10^{-5}$	$5.0x10^{-1}$	$1.0x10^{-7}$	$5.0x10^{-2}$	$2.2x10^{-7}$ ~ $1.7x10^{-5}$	0.001 ~ 0.1
13	Walloon Coal Measures - Lower Juandah Coal Measures	$3.0x10^{-9}$	$1.0x10^{-2}$	$3.0x10^{-10}$	$1.0x10^{-3}$	$3.0x10^{-7}$ ~ $1.0x10^{-4}$	0.001 ~ 0.1
14	Walloon Coal Measures - Lower Juandah Coal Measures	$3.0x10^{-9}$	$1.0x10^{-2}$	$3.0x10^{-10}$	$1.0x10^{-3}$	$3.0x10^{-7}$ ~ $1.0x10^{-4}$	0.001 ~ 0.1
15	Walloon Coal Measures - Taroom Coal Measures	$3.0x10^{-9}$	$1.0x10^{-2}$	$3.0x10^{-10}$	$1.0x10^{-3}$	$3.0x10^{-7}$ ~ $1.0x10^{-4}$	0.001 ~ 0.1
16	Durabilla Formation	$1.0x10^{-9}$	$1.0x10^{-2}$	$1.0x10^{-10}$	$1.0x10^{-3}$	$1.0x10^{-8}$ ~ $1.0x10^{-4}$	0.001 ~ 0.1

*Parameter values were mainly sourced from OGIA report and site investigation data

IV-3 MODEL CALIBRATION

Model calibration was performed to align the groundwater flow system in the numerical groundwater model with observations, through adjustment and optimisation of model parameters and boundary conditions within established data bounds. The calibrated model represents the starting condition for the transient predictive simulations.

IV-3.1 Calibration Overview

The calibration process included the development of a steady state (pre-CSG development) model which was calibrated using both automatic and calibration techniques, followed by transient calibration for the period where sufficient data was available.

The steady state model provides the initial conditions for the transient model calibration. The transient stage of model calibration included the period from 1995 to 2022. PEST++ was used to initially calibrate the model. Using PEST++ also allowed assessment of sensitivity of model calibration to various model parameters during the steady state calibration and transient calibration stages.

IV-3.2 Calibration Targets

Table IV-3.1 presents a summary of the calibration points by hydrostratigraphic unit. Figure IV-3.1 and Figure IV-3.2 presents the calibration targets used in the steady state and transient calibration models. Data provided by the Proponent, QGC and data from the groundwater database (GWDB) (DRDMW 2022) were used in the calibration.

Table IV-3.1 Summary of Calibration Points

Layer	Hydrostratigraphic Unit	Number of Calibration Points / Bores	
		Steady State	Transient
1	Quaternary alluvium	10	11
2	Weathered Surat Basin	1	2
3	Shallow Surat Basin units	7	9
4	Springbok Sandstone	3	6
5	Walloon Coal Measures - Overburden	0	0
6	Walloon Coal Measures - Kogan	7	8
7	Walloon Coal Measures - Interburden	0	0
8	Walloon Coal Measures - Macalister Upper	2	5
9	Walloon Coal Measures - Interburden	0	0
10	Walloon Coal Measures - Macalister Lower	1	4
11	Walloon Coal Measures - Interburden	0	0
12	Walloon Coal Measures - Wambo	0	5
13	Walloon Coal Measures - Lower Juandah Coal Measures	7	8
14	Walloon Coal Measures - Lower Juandah Coal Measures	0	2
15	Walloon Coal Measures - Taroom Coal Measures	1	5
16	Durabilla Formation	0	0
	Total	**39**	**65**

A total of 39 points were used in the steady state calibration. Limited data was available for the period prior to CSG development (before 1995); therefore, the data was selected, with consideration of:

- Regional bores to provide spatial distribution across the model domain and with data as close to 1995 as possible.
- Bores within the mining area with relatively static groundwater levels over a period of at least five years.

While the limited data will impact the overall confidence in the calibration, it is considered appropriate for the intended purpose of setting initial conditions for the transient model.

For the transient calibration period (1995 to 2022), groundwater levels from 65 bores[3] were used as calibration targets. 25,000 individual records were available from the 65 bores, with the majority of the records being high frequency monitoring data (daily measurements from QGC and GWDB). To align the dataset with the model timestep and stress periods (quarterly/monthly), the number of high frequency measurements was reduced, resulting in 2,618 records for calibration.

[3] Monitoring bores installed at the end of 2023/24 were not able to be used in the model calibration as the calibration commenced in mid-2023, and therefore bores had not been installed.

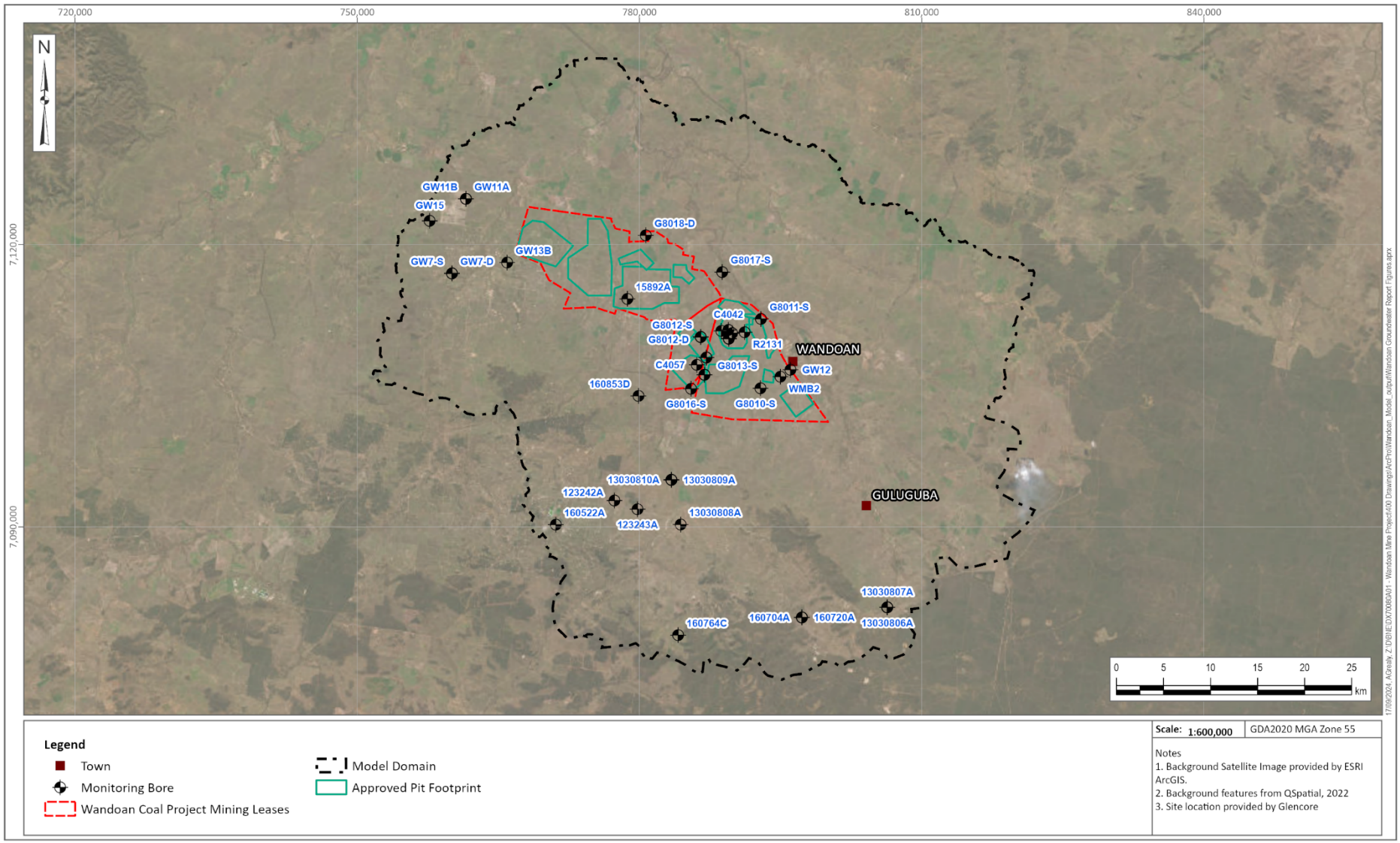


Figure IV-3.1 Steady State Calibration Points

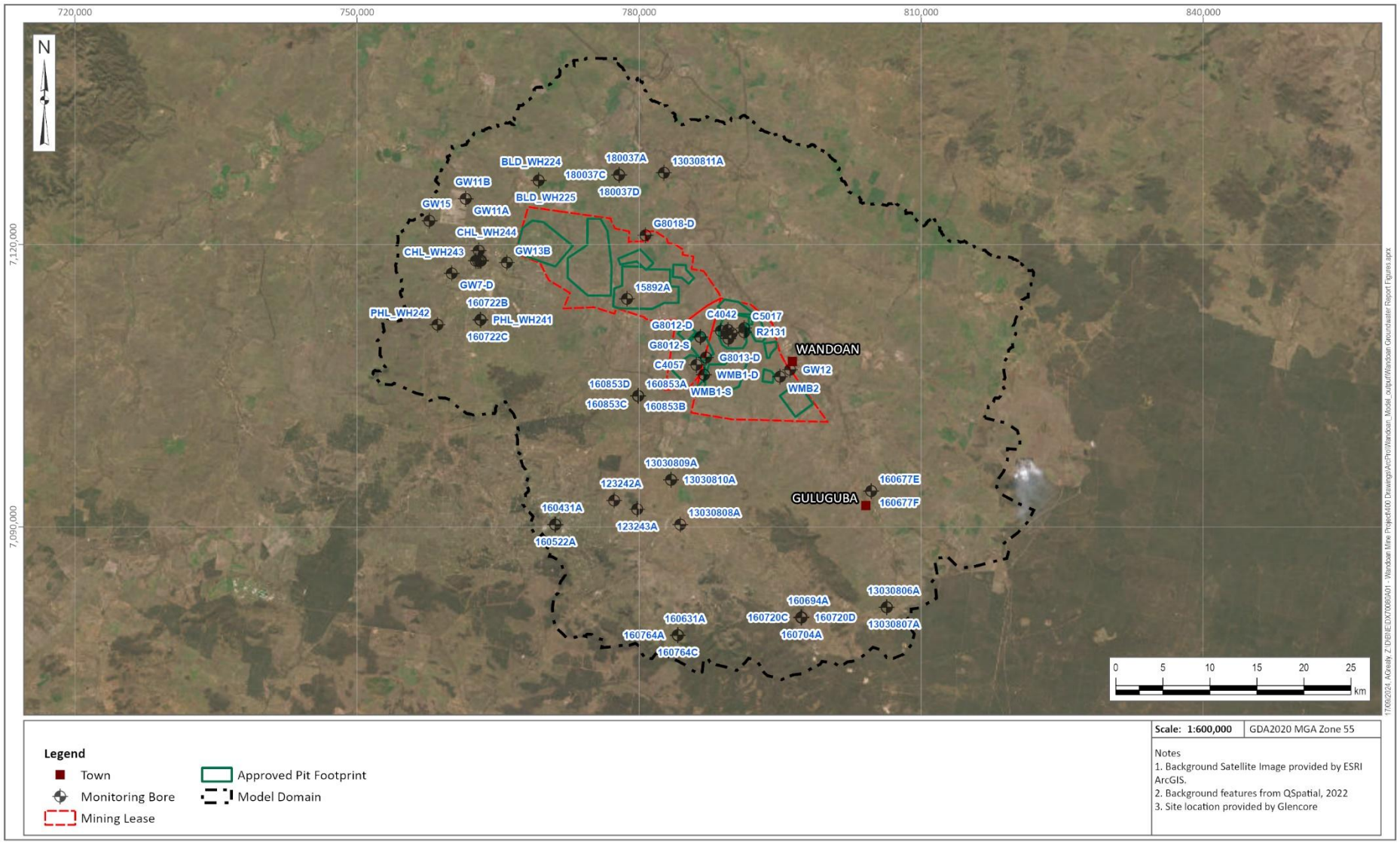


Figure IV-3.2 Transient Calibration Points

IV-3.3 Calibration Performance Metrics

The following performance metrics were used to assess the quality of the model calibration:

- The Mean Sum of Residual (MSR), Root Mean Squared (RMS) and Scaled Root Mean Squared (Scaled RMS) Error for the model-predicted versus observed hydraulic heads in both steady state and transient models.
- A scatterplot to show systematic/unsystematic nature and magnitude of over-prediction or under-prediction of hydraulic heads at all the calibration targets. A correlation coefficient was calculated to provide a numerical indication of the relationship between observed and computed heads.
- Hydrographs showing the observed and modelled groundwater level variations over time from transient calibration.
- Groundwater flow budget throughout the calibration process to confirm if the groundwater model has converged and the flow system is honouring the conceptual understanding.

These metrics align with the requirements of the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).

IV-3.4 Steady State Calibration

VI-3.4.1 Calibration Approach

The steady state calibration assumed that all hydraulic properties and drain / recharge / evapotranspiration values were able to be modified, within realistic / conceptual bounds, to achieve a better match with observed groundwater levels. Values were adjusted within the ranges discussed in Section IV-2.

VI-3.4.2 Calibration Statistics

A scatter plot of predicted versus observed hydraulic heads is presented in Figure IV-3.3. This figure shows 10 m error bounds, as well as the trend line. The graph highlights a general over-prediction at higher elevations and an under-prediction at lower elevations for the steady state model.

All modelled heads fall within the +/- 10 m error bounds. The calibration statistics from the steady state calibration are summarised in Table IV-3.2. The table shows the MSR error values for all the monitoring bores is less than 0.1 m, the RMS error is 5.2 m, the total SRMS value is less than 5%, and the correlation coefficient is higher than 98%: indicating a good agreement between the modelled and measured groundwater levels.

Table IV-3.2 Summary of Steady State Model Calibration

Statistical Metric	Calibration Results
MSR	0.02 (m)
RMS Error	5.2 (m)
Scaled RMS	4.6 (%)
Correlation Coefficient	98.8 (%)
Total calibration targets: 39	

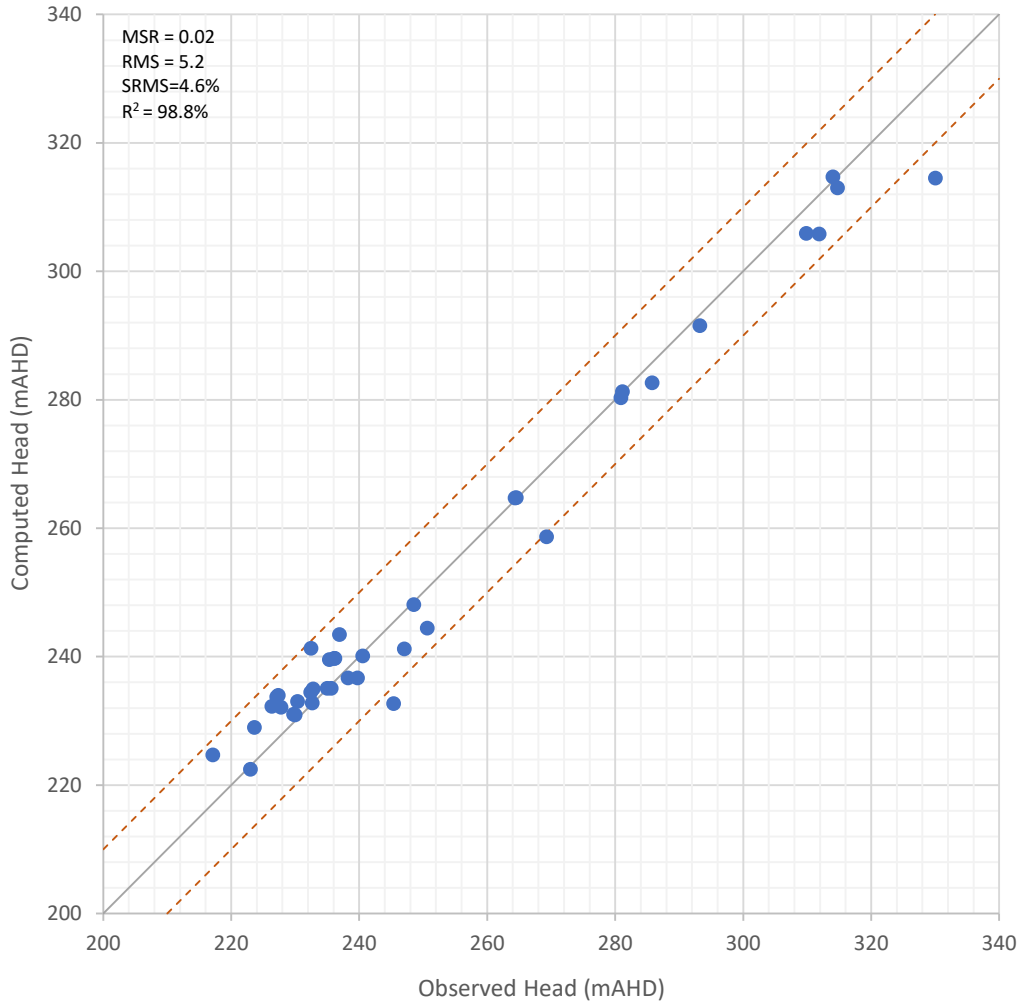


Figure IV-3.3 Steady State Calibration Results - Observed versus Predicted Heads

VI-3.4.3 Calibrated Water Budget

The modelled water balance and mass balance error for the steady state calibration simulation defines the difference between model inflows and model outflows. An error of 1%, or less, in a groundwater model water budget is typically considered acceptable for a regional groundwater system (Anderson and Woessner 1991). The water budget and mass balance error for the steady state calibration simulation is outlined in Table IV-3.3. The water balance error is 0.0% indicating that the model is stable and has an adequate level of accuracy for the simulation of groundwater flow. Recharge provides the most inflow to the model, with the highest outflow from river drains and evapotranspiration, mostly associated with the alluvium layer.

Table IV-3.3 Water Budget and Mass Balance Error for Steady State Simulation

Water Budget Item	Inflow (m^3/day)	Outflow (m^3/day)
Recharge	5,388.9	-
GHB Throughflow	985.1	80.1
Evapotranspiration	-	2,936.2
River Drain	-	3,330.7
Total	**6347.0**	**6347.0**
Mass Balance Error	**0.0%**	

IV-3.5 Transient Calibration

The transient model was set-up using the results and hydraulic properties / conditions established in the calibrated steady state model, as starting conditions.

The observed groundwater levels recorded over the 28 years (1995 to 2022), from 65 monitoring bores, were used in the calibration.

The main challenges and assumptions made for the transient calibration were:

- As the mine is yet to be developed, there is no operational mining data available to verify the groundwater response and pit/inflows associated with mining over the calibration period. Therefore, the water balance component can only be considered in relation to the groundwater flow system and model stability (i.e., no dewatering or open cut pit inflow rates available for calibration).
- Watercourses across the Project area are characteristically ephemeral and only experience surface water flow during or immediately after heavy rainfall events, and when the groundwater elevation within the alluvium is elevated to provide baseflow. Therefore, a high recharge rate around riverbanks (alluvium/quaternary sediments) and the watercourses was used to reasonably represent groundwater behaviour around the watercourse.
- The specific sequence of CSG operations was not available, with only secondary groundwater drawdown data from the OGIA regional model available. The OGIA data was used to apply GHBs in the transient calibration. GHBs represent the drawdown of groundwater levels in the WCM from the CSG development in transient cases (calibration and prediction periods). This boundary allows the drawdown and associated timing of drawdown predicted in the OGIA regional model to be replicated within the model. Note that drawdown was used with the steady state model head to create a reference head as specific groundwater elevations were not available from the OGIA model, which only provides drawdown.

VI-3.5.1 Calibration Approach

A transient calibration was conducted for the period January 1995 to December 2022. The period includes CSG operations, and recharge/discharge mechanisms on the groundwater system. The transient calibration used available time-variant data such as groundwater level records and drawdown from CSG development to be simulated in the groundwater model. Automatic calibration using PEST was initially implemented and provided a good calibration, however, manual adjustments (to parameter values) were made to further consider adjust the model in the vicinity of the Project site understanding and the localised trends of the groundwater response to

the CSG development. Adjustments through the manual calibration included hydraulic conductivity in shallow units, and the evapotranspiration depths for alluvium units. Further details on the adjustments during the calibration process are shown in Figure IV-3.11 to Figure IV-3.14.

A PEST++ sensitivity analysis in the transient model calibration was also undertaken to preliminarily assess the response of the model to varying hydraulic properties, recharge rates, and drain conductance and model run times.

VI-3.5.2 Calibration Statistics

Figure IV-3.4 presents the observed versus predicted heads for the transient calibration. Calibration is considered to be well fitted, with a MSR of -1.06 m, RMS of 7.4 m, SRMS of 2.5% and 98.9% of correlation coefficient between the observed and predicted heads. Minor outliers are evident in the calibration dataset. These were identified as attributed to uncertainty in the secondary drawdown data used from OGIA model, which may be related to predicted CSG development sequence in the OGIA model versus the actual or OGIA regional model uncertainty.

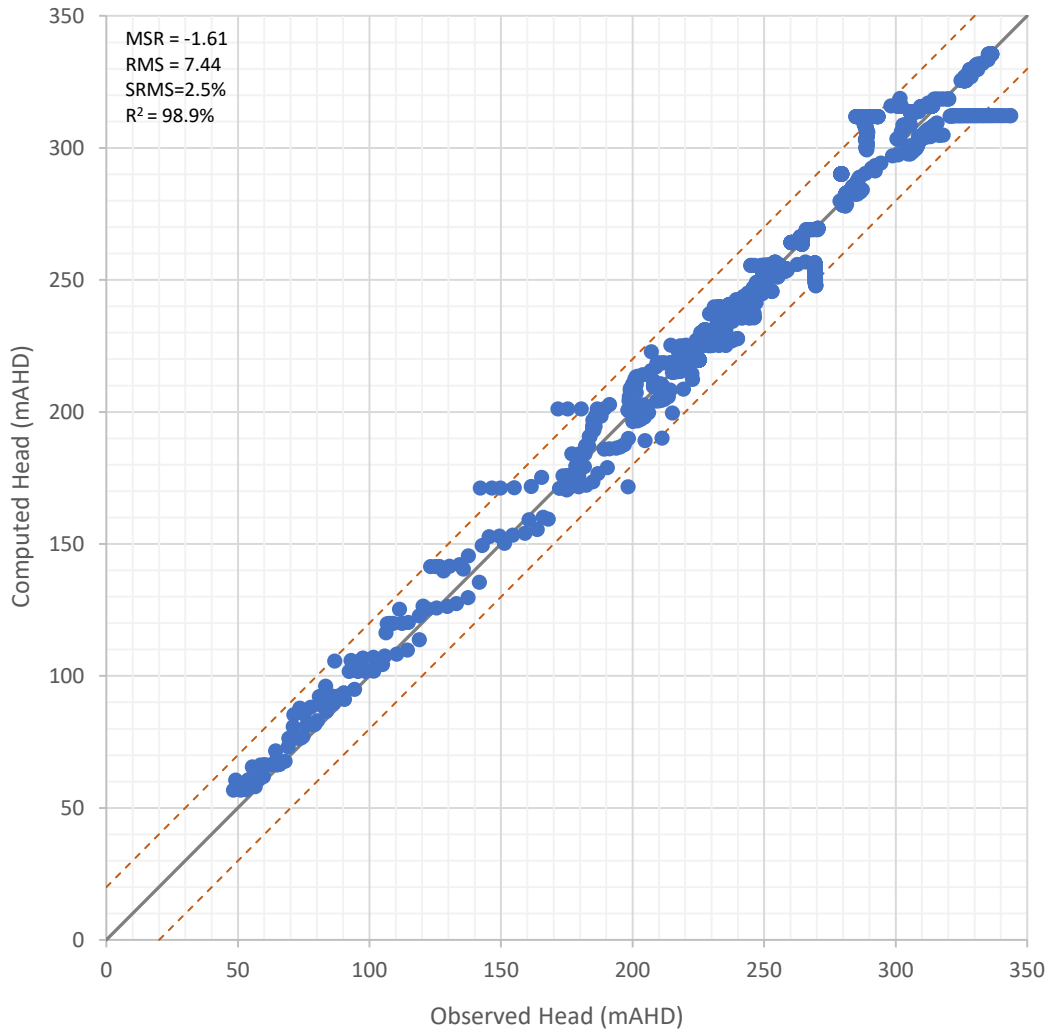


Figure IV-3.4 Transient Calibration Observed versus Computed Heads

VI-3.5.3 Calibrated Transient Hydrographs

Hydrographs showing measured versus predicted heads are provided Figure IV-3.5 to Figure IV-3.8. The following comments are made related to the transient calibration:

- 247 groundwater level records across 10 monitoring bores for the alluvium units were available for the calibration. A good trend calibration was achieved across all the shallow monitoring bores. A 1 to 3 m over-prediction in levels in the majority monitoring bores associated with the alluvium is evident, which may be related to the uncertainty in the depth/thickness of alluvium units.
- 834 groundwater level records across 23 bores screened within the Upper Juandah Coal Measures were available for calibration. A fair to good calibration was achieved for this unit, with slightly over/under-prediction of levels observed in GW8013, GW12 and WMB2 screened within the Kogan seam (Upper Juandah Coal Measures) in the southern Project area.
- A reasonable calibration for all the bores in Lower Juandah Coal Measures was achieved. The regional response of groundwater levels from CSG development was demonstrated in the bores 160677E, 160722C and 160853B.
- A fair agreement in calibration was achieved for all the bores in Taroom Coal Measures. The drawdown impact on groundwater levels associated with CSG development was well replicated at the bores 160722B and 160853A.

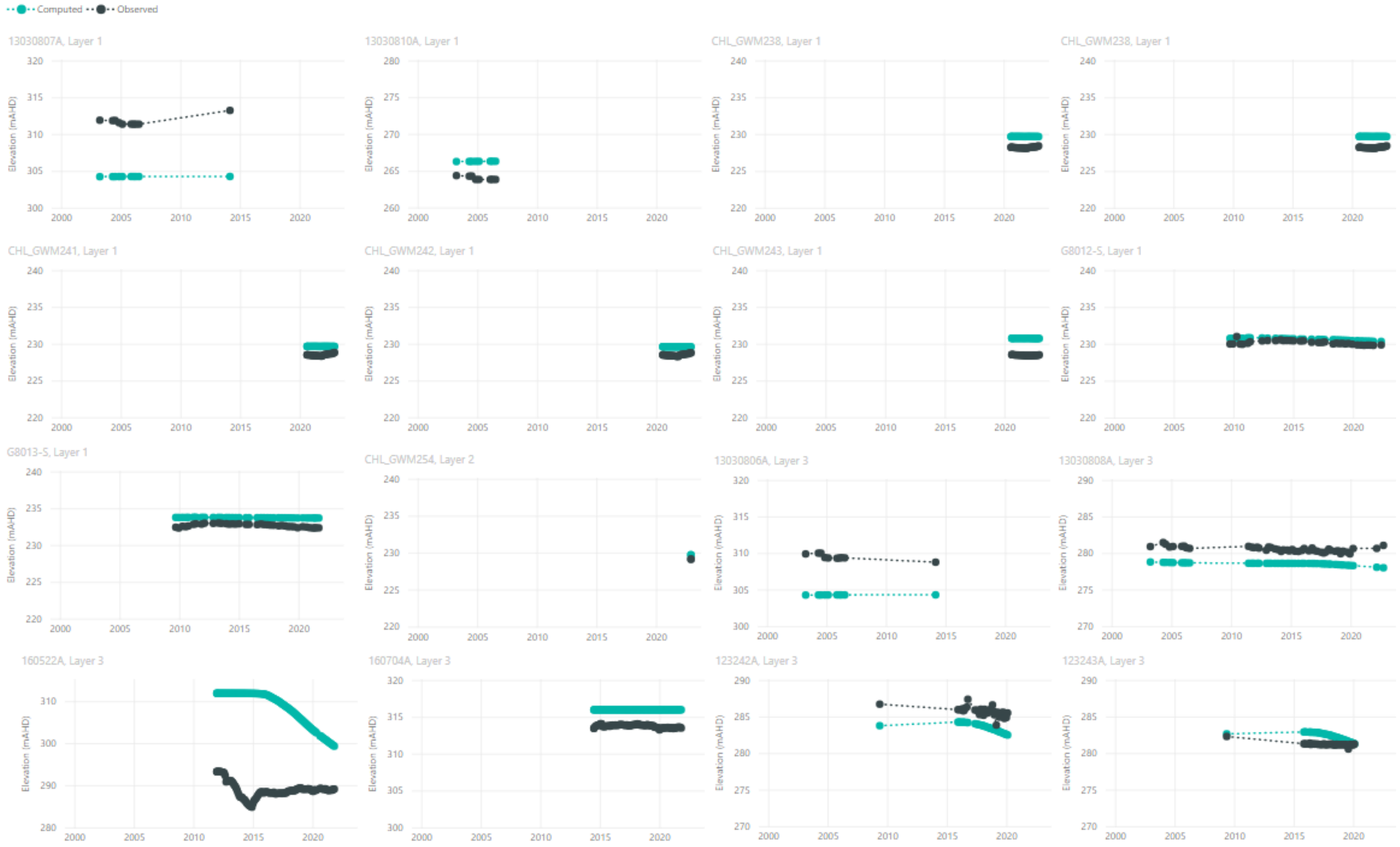


Figure IV-3.5 Transient Calibration Hydrographs – Layer 1, 2 and 3

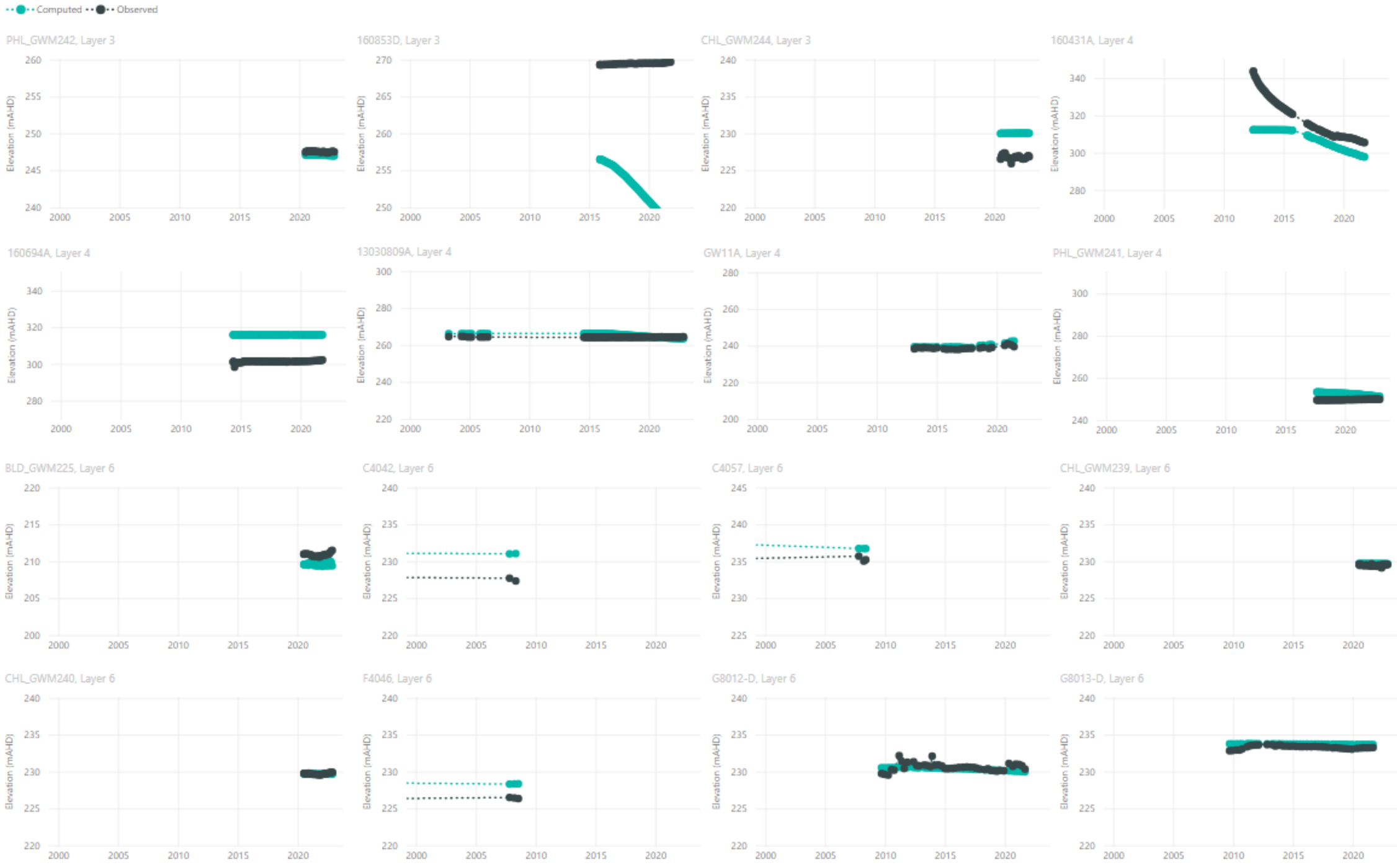


Figure IV-3.6 Transient Calibration Hydrographs – Layer 3, 4 and 6

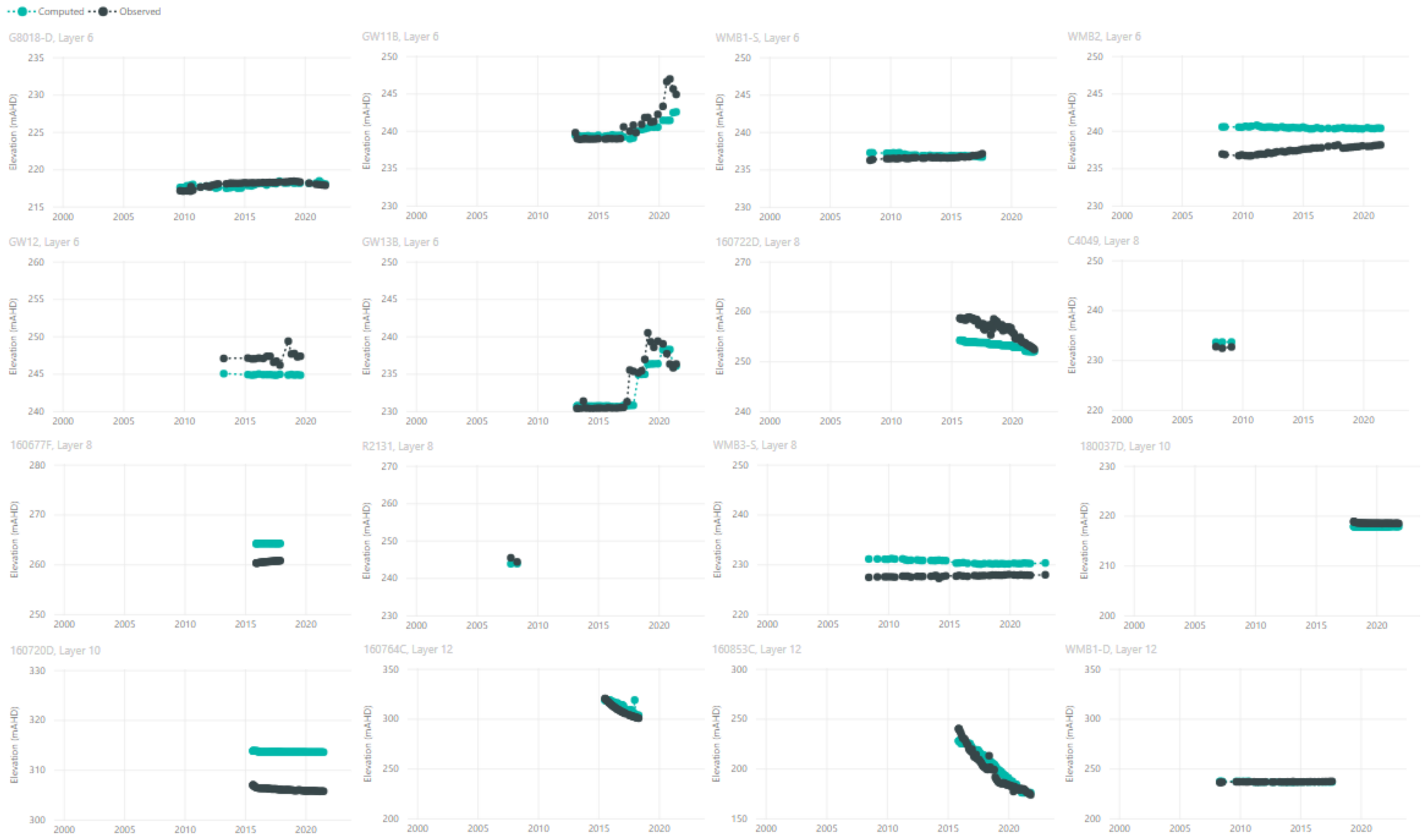


Figure IV-3.7 Transient Calibration Hydrographs – Layers 6, 8, 10 and 12

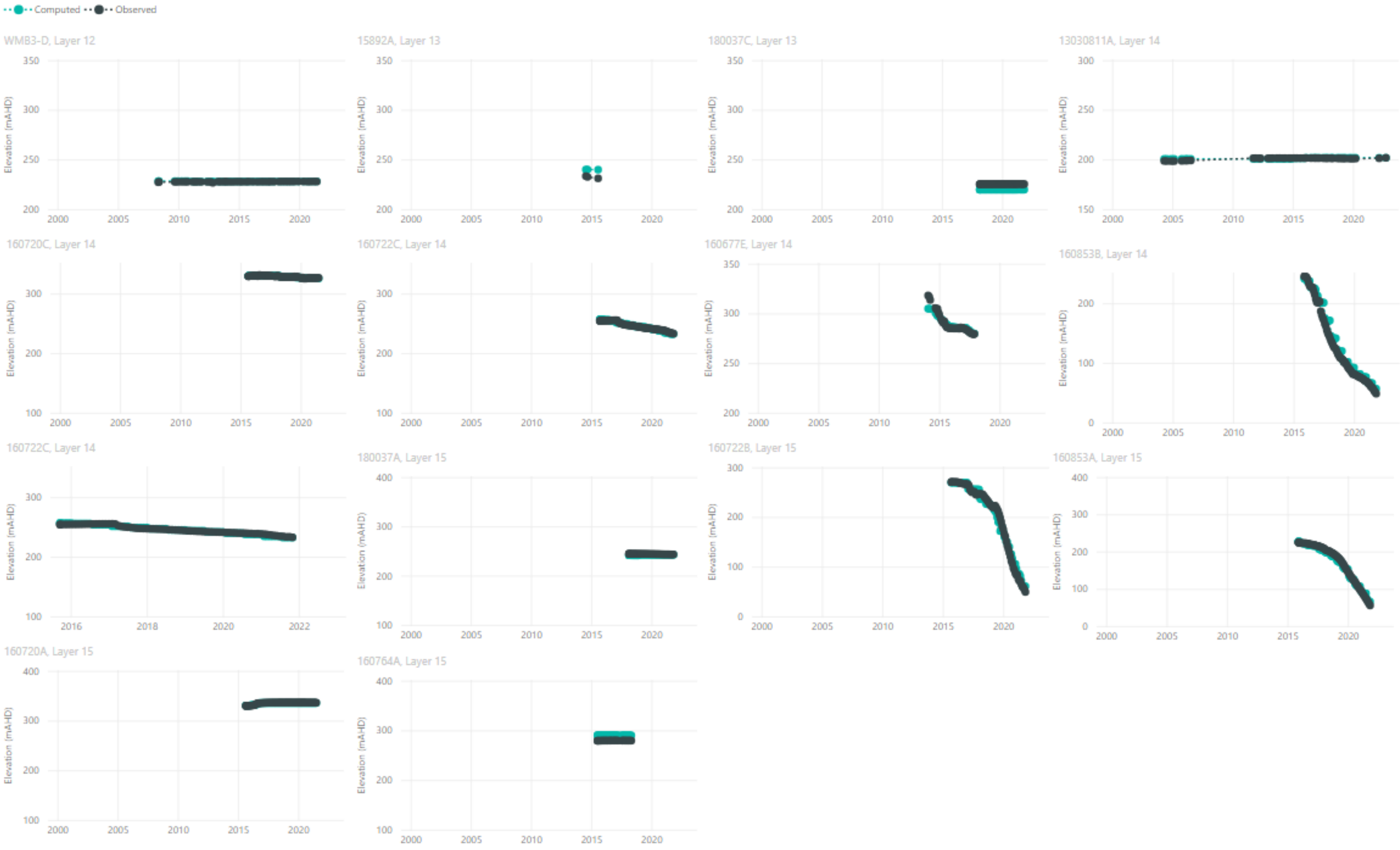


Figure IV-3.8 Transient Calibration Hydrographs – 12, 13, 14 and 15

VI-3.5.4 Calibrated Water Balance

The model-reported water budget for the transient calibration model is shown in Figure IV-3.10 and the water balance for the average of all stress periods is presented in Table IV-3.4. The water budget error is less than 1% at each stress period. This indicates that the net flow water balance and convergence of the numerical solution were achieved in transient calibration. Parameters applied to both the transient and steady state models were consistent.

Variation in the recharge and evapotranspiration is slightly apparent from the steady state model. This is related to the seasonality of the values applied and transient observation data available for calibration.

Key components of the water balance are related to storage and the GHB. These are related to the representation of CSG depressurisation in the model. The storage inflow represents the drawdown associated with CSG, while the GHB outflow represents the water extracted from the model for CSG. The GHB inflow is related to the flow at the model boundary.

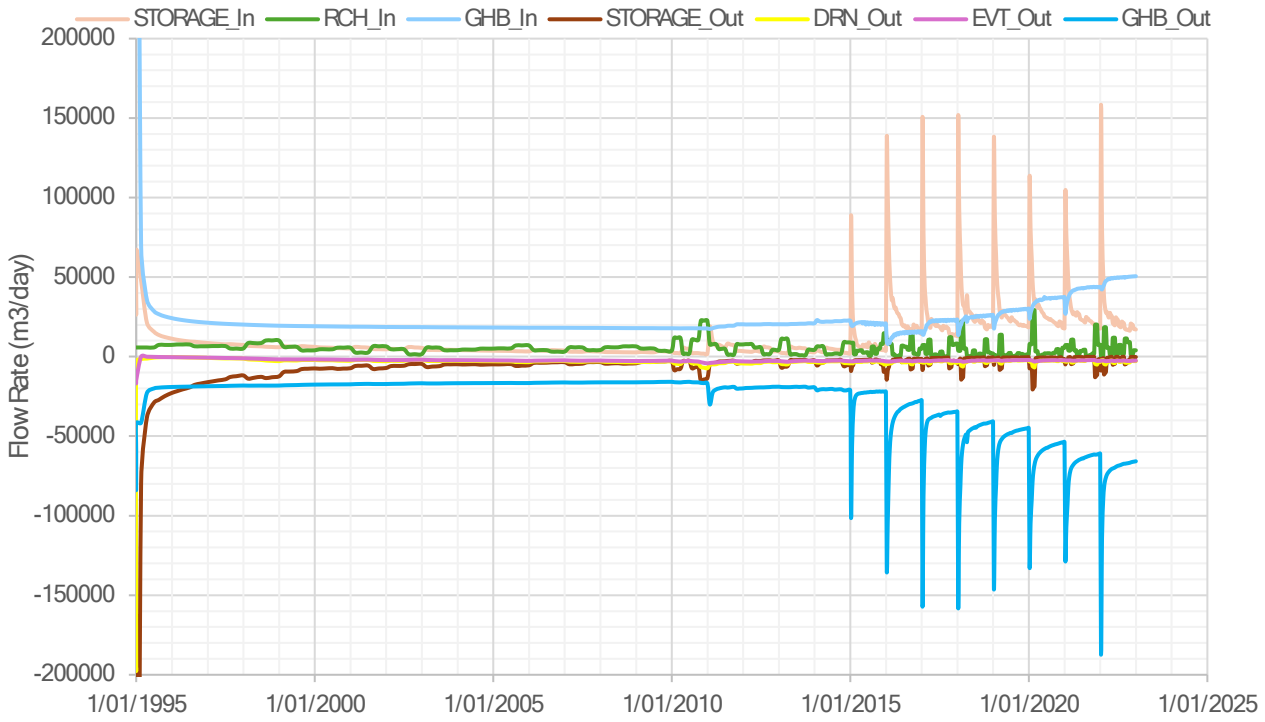


Figure IV-3.9 Transient Calibration Water Budget

Table IV-3.4 Water Budget and Mass Balance Error for Transient Simulation

Water Balance Item	Inflow From Boundary		Outflow From Boundary	
	Average Inflow Rate (m^3/day)	% of Total Inflow	Average Outflow Rate (m^3/day)	% of Total Outflow
Storage	19,494.2	38.6%	3,759.5	7.4%
River drain	-	-	3,188.9	6.3%
Recharge	5,067.6	10.0%	-	-
Evapotranspiration	-	-	2,523.5	5.0%
General head flow	25,911.7	51.3%	41,001.9	80.1%
TOTAL	50,473.6		50,473.6	
Total Net Flow	**$1.3x10^{-3}$**			**0.0%**

VI-3.5.5 Calibration Sensitivity

To understand the sensitivity of the calibrated parameters, a sensitivity analysis has been completed using PEST. The results of parameter sensitivity from the PEST model calibration are shown in Figure IV-3.10. These results highlight:

- The observations are highly sensitive to the conductance of GHB in Taroom and Upper Juandah Coal Measures. These units have the majority of the available monitoring data (~60% of target values) Although some modifications to the GHB conductance can be made, the GHB is governed by the OGIA model drawdown and initial heads, therefore there is limited opportunity to vary the conductance as part of the calibration process.
- Evapotranspiration extinction depth and recharge rates for alluvium, hydraulic conductivity (K_h and K_v) of the alluvium and drain conductance are also sensitive parameters.
- Hydraulic conductivities (K_x and K_z) and storativity of the weathered upper units are also sensitive parameters. Variation in those values influence head gradients in the shallow aquifers.
- The calibration results are less sensitive to parameters such as hydraulic conductivity of the interburden of Upper Juandah Coal Measures and deeper WCM units. This is due to the lack of available monitoring data in those units for PEST calibration.

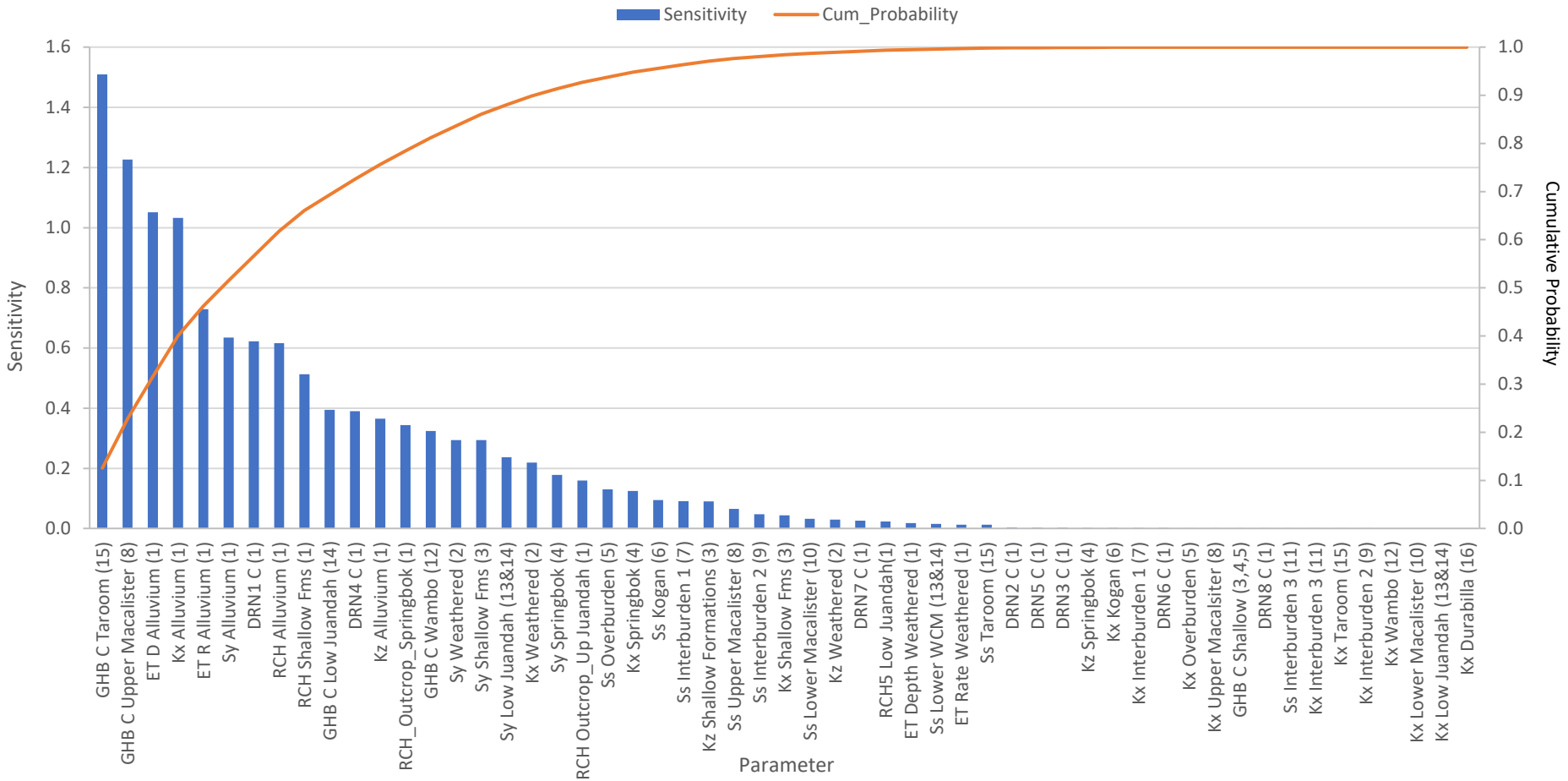


Figure IV-3.10 Sensitivity of Model Parameters (Model Layer in Brackets)

VI-3.5.6 Calibrated Model Parameters

An automated calibration was completed using PEST, followed by manual adjustment of key parameters (outlined below) to improve the calibration within the mining area of the model.

Table IV-2.3 (Section 0) presents the range of the model parameters that were used as upper and lower bounds in the automated transient calibration values. Figure IV-3.11 to Figure IV-3.14 present the upper and lower bound ranges as well as the PEST calibrated values, and the final calibrated values (manually adjusted after PEST).

Final values for the majority of parameters were similar to the PEST automated calibration values with the exception of recharge rates and evapotranspiration depths, which were adjusted by manual calibration following the PEST calibration.

The recharge rates that were initially adopted in the numerical model were consistent with the values adopted in the OGIA 2019 model[4]. These rates were constrained during the PEST calibration, (based on 95th and 5th percentiles of recharge rates). Following the PEST calibration, the recharge rates were further adjusted by manual calibration based on the local monitoring data in the vicinity of the proposed mining area and QGC monitoring data to further improve the transient calibration.

Table IV-3.5 presents the final calibrated parameters of hydraulic conductivities and storage; while Table IV-3.6 summarises the final recharge and evapotranspiration rates adjusted during the calibration. Both rates are presented as annual averages, with recharge varying seasonally/monthly in the model. Compared to the estimated recharge rates from the chloride mass balance approach presented in the main report sourced from OGIA (2016a), the calibrated rates provided in Table IV-3.6 are generally lower for most hydrostratigraphic units, however consistent with the OGIA 2019 numerical groundwater model. OGIA (2019) indicates that the recharge estimates for the previous CMA model (OGIA 2016b) were based on a smaller chloride concentration data set, which might not reflect the attributions in some aquifers (units). For example, *"more than 50% of the available chloride data for samples taken from the Precipice Sandstone assessed by OGIA suggest recharge of more than 30 mm/yr, which tends to confirm that this is not a realistic upper bound for this aquifer"*. The recharge rates shown in Table IV-3.6 are comparable to the calibrated values in the Springbok Sandstone and the WCM (Juandah) from the 2019 Surat CMA numerical model (OGIA 2019), which were provided in Table VI-2.2.

[4] Note that the 2019 model was superseded by the 2022 UWIR groundwater model and report. The same recharge parameters were used in both the 2019 and 2022 OGIA models, however the 2019 report is referenced as this report specifically discusses the adopted recharge rates and hydraulic conductivities.

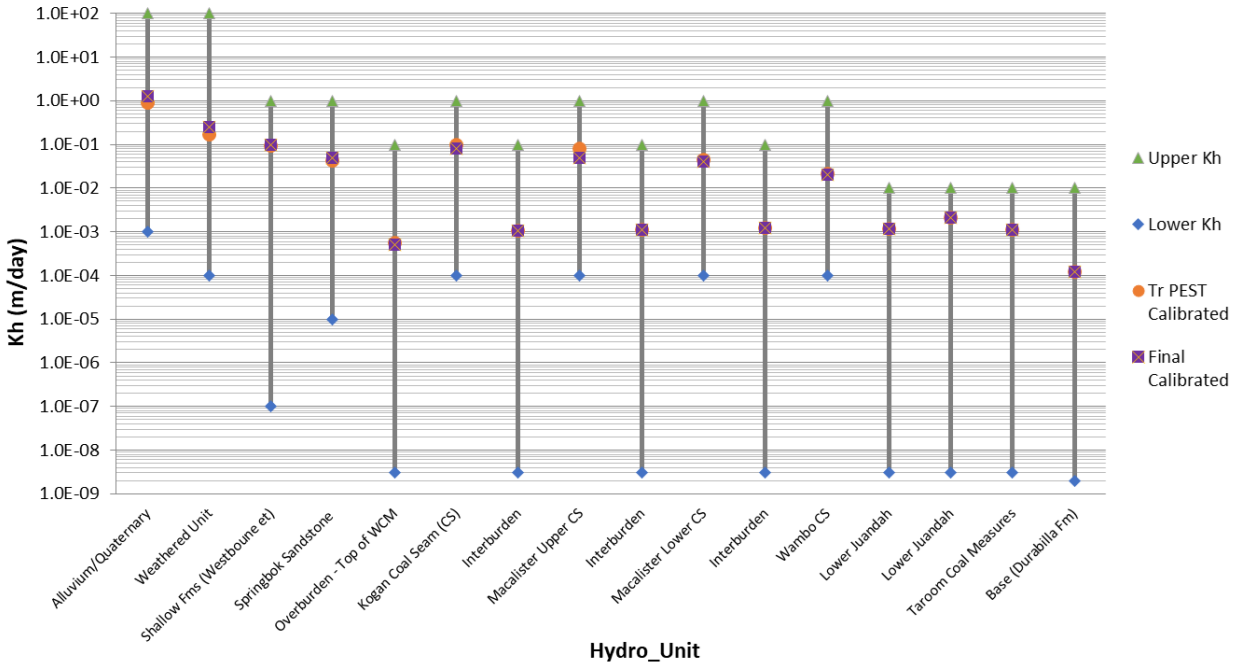


Figure IV-3.11 Horizontal Hydraulic Conductivity Range and Calibrated Values

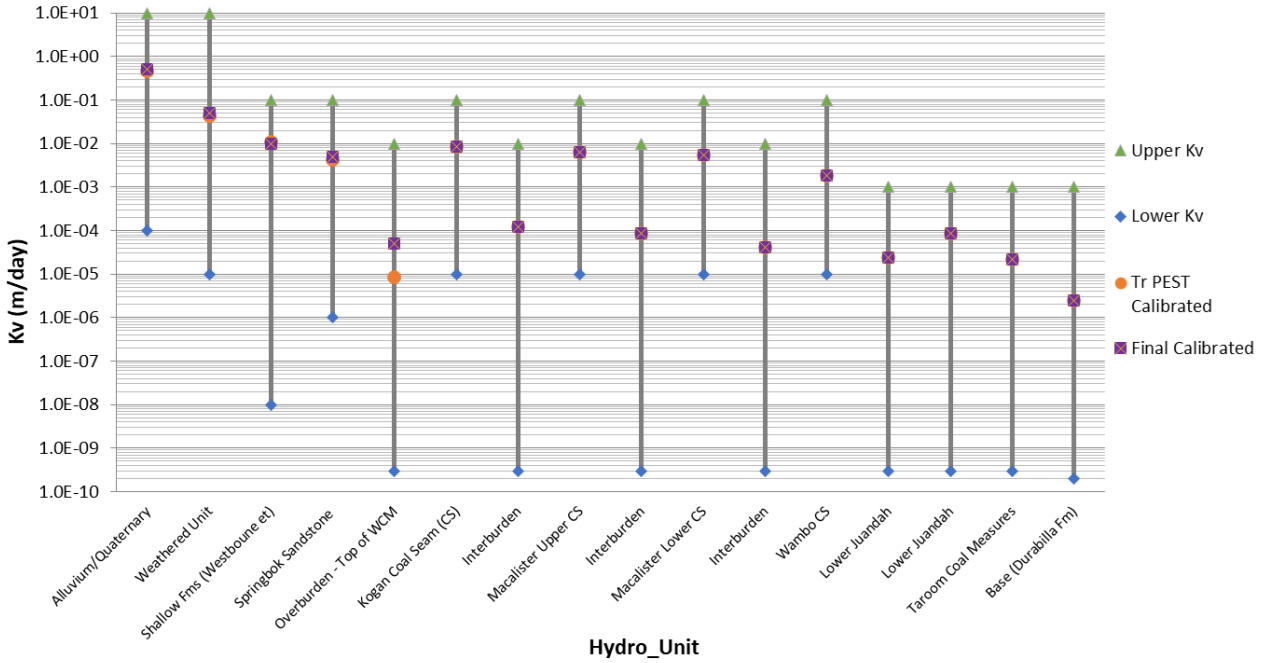


Figure IV-3.12 Vertical Hydraulic Conductivity Range and Calibrated Values

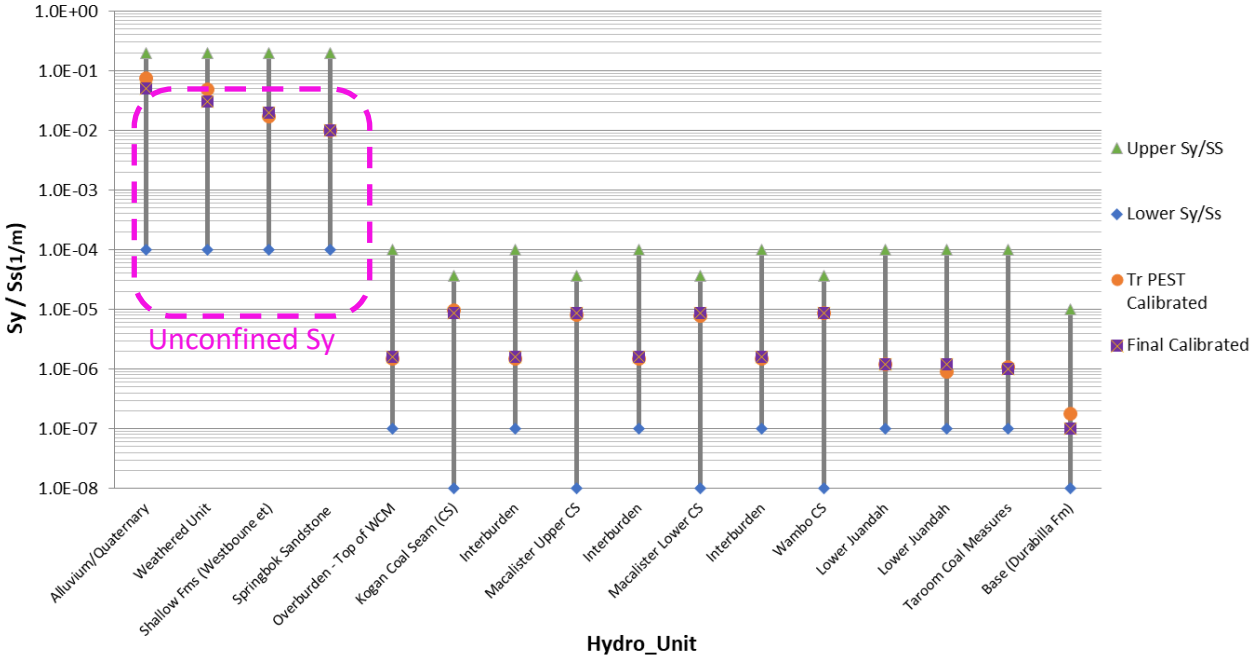


Figure IV-3.13 Storativity Range and Calibrated Values

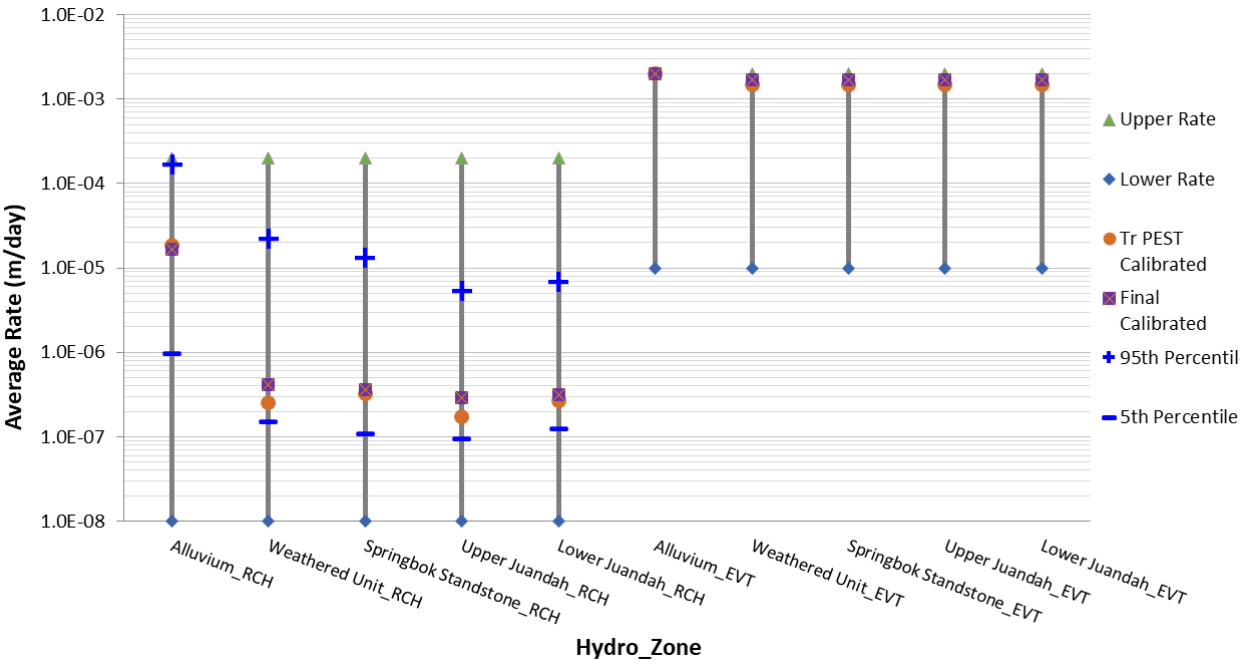


Figure IV-3.14 Recharge and Evaporation Ranges and Calibrated Values

Table IV-3.5 Calibrated Hydraulic Conductivity and Storage Parameters

Layer	Hydrostratigraphic Unit	Kh (m/d)	Kv (m/d)	Ratio (Kh/Kv)	Ss	Sy
1	Quaternary alluvium	1.25	0.50	2.5		0.05
2	Weathered Surat Basin	0.25	0.05	5.0		0.03
3	Shallow Surat Basin units (Gubberamunda Sandstone, Westbourne Formation)	0.100	1.2E-02	8.3		0.02
4	Springbok Sandstone	0.05	5.0E-03	10.0		0.01
5	Walloon Coal Measures - Overburden	5.0E-03	5.0E-04	10.0	1.6E-06	0.005
6	Walloon Coal Measures - Kogan	8.0E-02	8.7E-03	9.2	8.6E-06	0.05
7	Walloon Coal Measures - Interburden	1.0E-03	1.0E-04	10.0	1.6E-06	0.005
8	Walloon Coal Measures - Macalister Upper	5.0E-02	6.3E-03	7.9	8.6E-06	0.05
9	Walloon Coal Measures - Interburden	1.1E-03	8.8E-05	12.5	1.6E-06	0.005
10	Walloon Coal Measures - Macalister Lower	4.0E-02	4.5E-03	8.9	8.6E-06	0.05
11	Walloon Coal Measures - Interburden	1.2E-03	4.0E-05	30.0	1.6E-06	0.005
12	Walloon Coal Measures - Wambo	2.0E-02	1.8E-03	11.0	8.6E-06	0.05
13	Walloon Coal Measures - Lower Juandah Coal Measures	1.2E-03	2.4E-05	50.0	1.2E-06	0.002
14	Lower Juandah	2.1E-03	8.5E-05	24.7	1.2E-06	0.002
15	Walloon Coal Measures - Taroom Coal Measures	1.1E-03	2.2E-05	50.0	1.0E-06	0.002
16	Durabilla Formation	1.2E-04	2.5E-06	48.0	1.0E-07	0.001

Table IV-3.6 Calibrated Recharge and Evapotranspiration Rates

Zone	Hydrostratigraphic Unit	Calibrated Recharge		Calibrated Evapotranspiration	
		% of Rainfall	Rate (mm/yr)	Rate (m/d)	Extension Depth (m)
1	Alluvium	1.02%	6.26	2.0E-03	9
2	Weathered Surat Basin	0.03%	0.18	1.5E-03	5
3	Springbok Sandstone	0.02%	0.12	1.5E-03	5
4	Upper Juandah	0.02%	0.12	1.5E-03	7
5	Lower Juandah	0.02%	0.12	1.5E-03	4

VI-3.5.7 Calibration Confidence

Barnett et al. (2012) developed a system to classify the confidence level of groundwater flow models based on the adopted calibration process and the predictive capability of the model. Three classes of models were developed: Class 1, Class 2, and Class 3. A Class 3 model has the greatest confidence level, and a Class 1 model has the least. Factors that are considered when determining model confidence level are:

- Data availability.
- Calibration procedures.
- Consistency between calibration and predictive analyses; and
- Stresses applied on the model and associated simulation results.

The model outlined in this report is considered a Class 2 model based on the following:

- The local geological model used to support development of the groundwater model domain was constructed using site-specific geological data (resource definition geological model). 65 groundwater monitoring bores were used for transient calibration, with more than 60% of these monitoring bores within the Project area, or in the vicinity of Project area.
- Key calibration statistics (SMRS <5%; R^2 > 95%) were acceptable and meets agreed targets in transient model calibration.
- Detailed transient calibration was undertaken over a 28-year period, and the long-term trends were replicated in the major hydrostratigraphic units within and in the vicinity of the MLs.
- The transient calibration covered the most recent period (from year 1995 and 2022), and 65 monitoring bores and data observed over this period (mostly from 2003 to 2022) are used in the calibration.
- Regional predicted CSG drawdown (drawdown from OGIA regional model) was used for model calibration.
- Model parameters were calibrated within the ranges identified as part of the conceptualisation.
- Model water balance error is less than 0.01%.

The calibration model meets the criteria for a Class 2 model. The calibrated model is therefore deemed to be a suitable for assessing the dewatering, associated drawdown impacts and groundwater level recovery into closure from the Project.

IV-4 PREDICTIONS

IV-4.1 Predictions Overview

Simulations to support the PRCP included two stages:

1. Simulation of the period prior to mining from the end of the calibration period (2022) through 75 years of mining to the end of operations.
2. Simulation of post-closure for a period of 500 years.

IV-4.2 Life of Mine Simulation

VI-4.2.1 Model Set-Up

A predictive simulation was carried out for the LoM until the end of operations (75-year mine life) using the calibrated transient model. The period between January 2023 and December 2030 includes no mining, as mining is proposed to commence in January 2031. Figure IV-4.2 shows the assumed annual mine sequence used in the predictive scenarios.

The simulation comprised annual stress periods to align with the available mining schedule (Figure IV-4.2) starting at the final time step of the transient calibration.

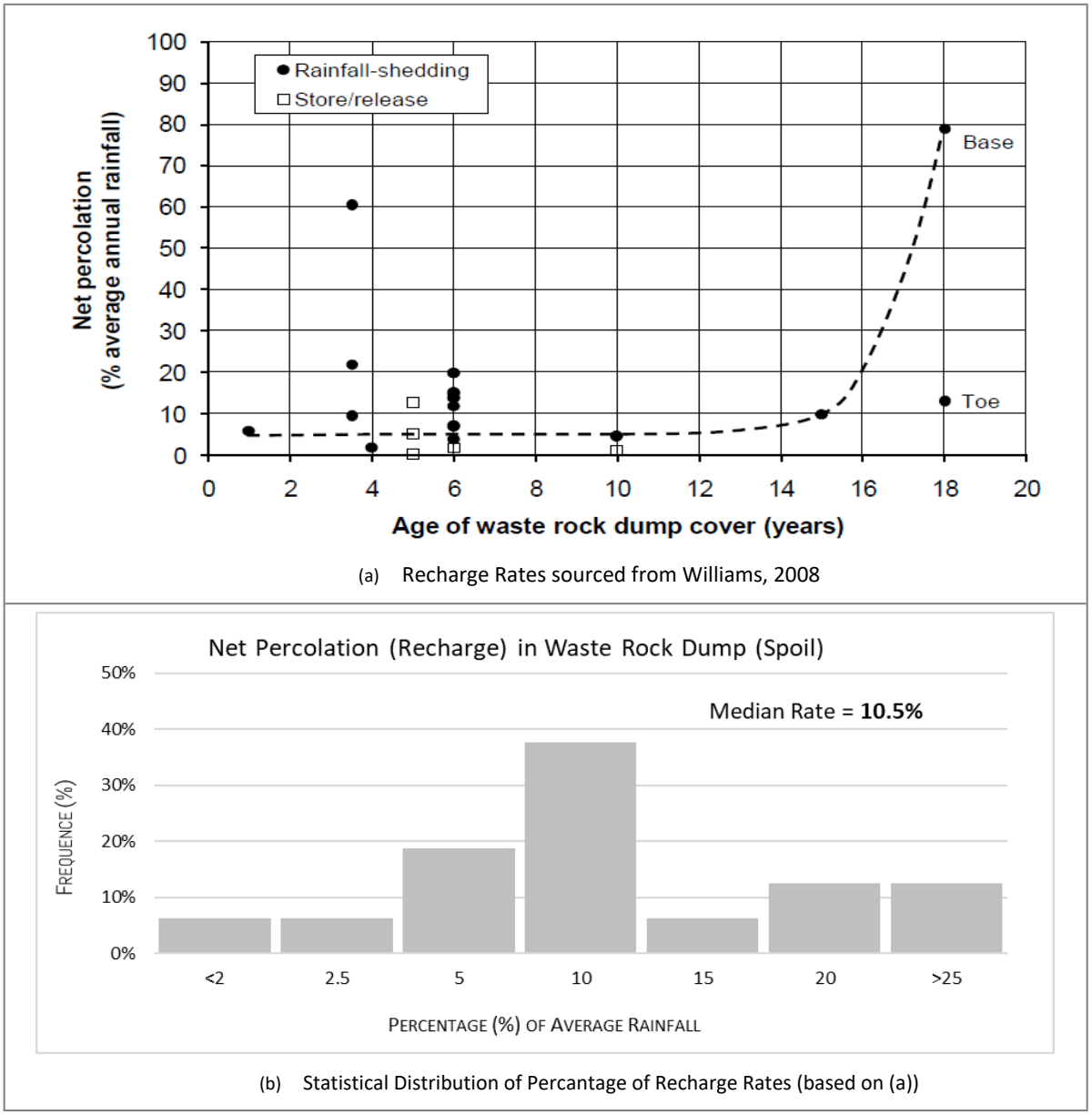
Simulation of the mining sequence for the predictive scenarios comprises the progressive assignment of Drain boundaries to represent open cut mining operation and the associated dewatering to permit mining. Drain cells were assigned to all layers above and the corresponding target coal seams. The reference drain elevation was assigned to correspond with the planned excavation elevation. The drain conductance was automatically calculated in terms of the hydraulic conductivity and the cell size for each drain.

GHBs were retained in the model to simulate the ongoing influence of CSG impact during the operational period. The same methodology as applied in the calibration was applied to predictions. From the OGIA data, the majority of CSG operations located in the model domain cease between 2050 to 2070, therefore the system commences recovery from CSG development during the period of model prediction.

The average annual recharge rates were applied to each zone of the model, consistent with the calibrated model zones, except for higher recharge and evapotranspiration rates being adopted to the spoil placed in-pit area after mining. All other boundary conditions were carried over from the transient calibration model.

Changes in hydraulic properties in the LoM model, to simulate the material property changes in open cut mining zones, were incorporated. The property change is represented using the MODFLOW-USG Time-Varying Materials (TVM) package, which varies hydraulic properties (K and S) for each layer in open cut zones to enhance hydraulic conductivity and storage values transferred from the natural ground conditions to the spoil properties, which have been placed in the mined area after mining.

For the backfilled spoil properties, a single hydraulic conductivity value (5 m/day) was applied to the spoil material, with a specific storage value of 0.05. No site-specific values are available, and therefore reference values have been sourced from literature (Fityus et al. 2022). The recharge rate for the spoils was also sourced from Williams (2008). The review indicated that recharge (net percolation) on the uncovered dumps, and store/release covers, ranges between 2% and 60% of average annual rainfall, depending on the cover type, spoil age, spoil material and depths of spoil. The distribution of recharge rates from Williams (2008) is presented in Figure IV-4.1 and indicates that the median recharge rate is ~10% of rainfall, which was adopted for the predictive simulations for this model. The evapotranspiration rate for the spoils, and cover, was 2×10^{-3} m/day, the same as the alluvium unit. Due to the uncertain nature of these properties, this was considered as part of sensitivity analysis.



(a) Recharge Rates sourced from Williams, 2008

(b) Statistical Distribution of Percantage of Recharge Rates (based on (a))

Figure IV-4.1 Spoil Recharge Rates (adapted from Williams 2008)

VI-4.2.2 Results

Error! Reference source not found. presents the groundwater elevation hydrograph for a central location within each of the open cut pit areas for the LoM scenario. The location of the hydrograph points is shown on **Error! Reference source not found.**

Figure IV-4. presents the predicted groundwater elevation (water table) for the end of operations in 2105. The influence of CSG is noted in the northwestern, and southwestern area of the figure, with some drawdown associated with pits mined later in the sequence. This is highlighted further on Figure IV-4.5, which shows the change in groundwater level between 2030 (pre-mining) and 2105 (start of post-closure). Blue shows areas which are predicted to have increased in level during the LoM period, with red/orange areas showing areas where residual drawdown remains at the end of the LoM period.

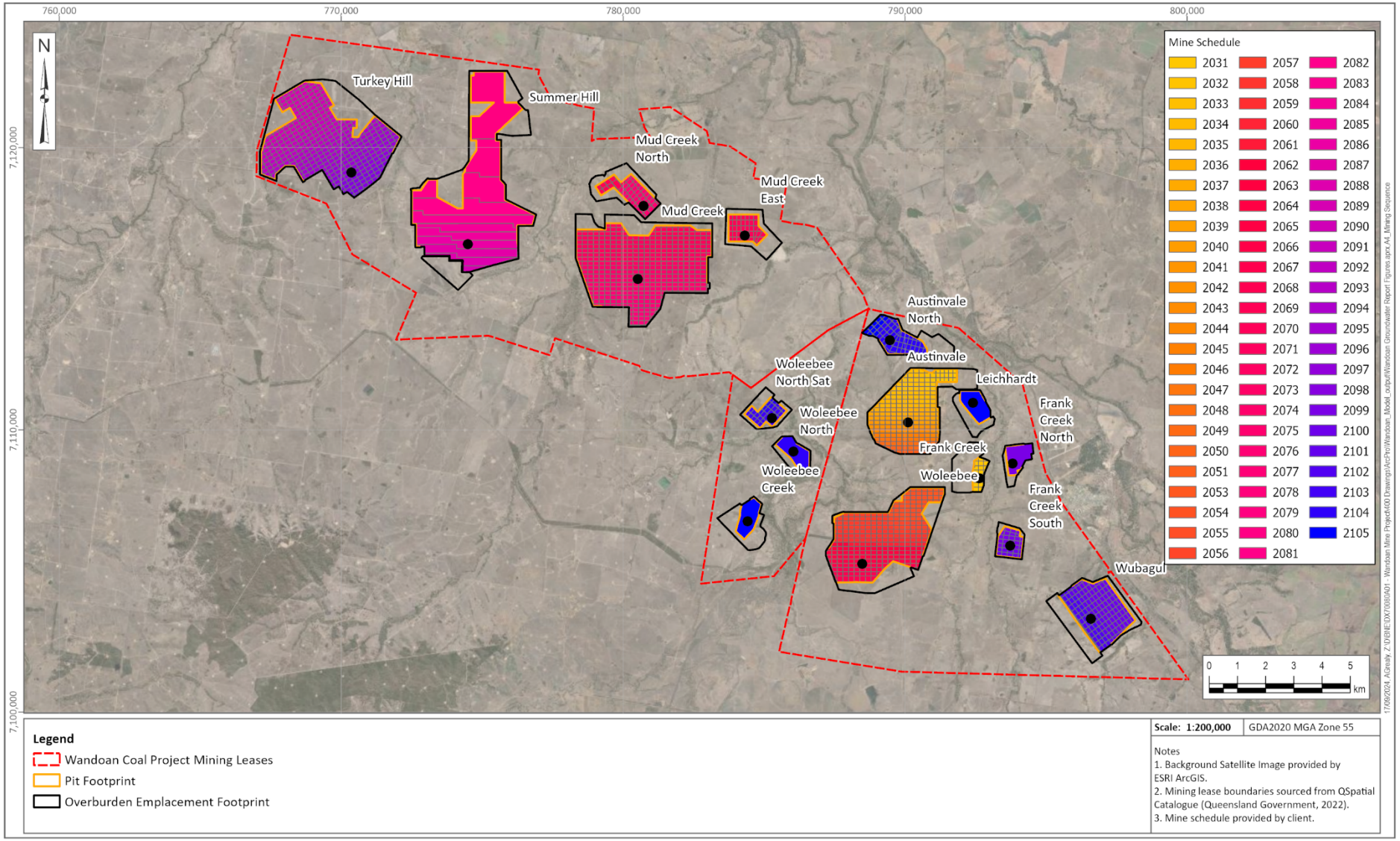


Figure IV-4.2 Mine Sequencing and Location of Points for Open Cut Pit Area Hydrographs

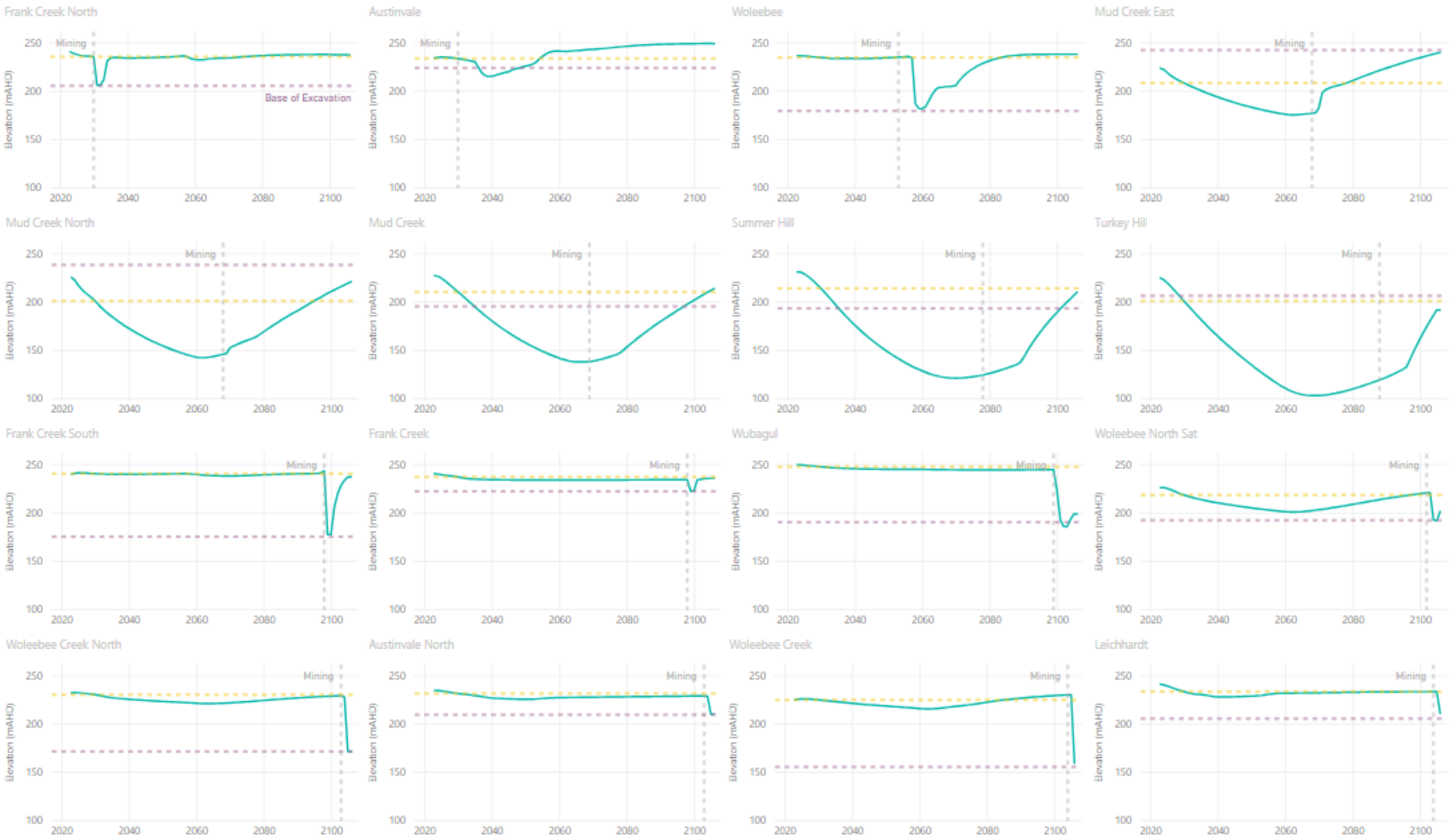


Figure IV-4.3 Individual Pit Hydrographs During Mining, with Assumed Start of Mining (Grey Dashed Line), Groundwater Elevation at Pit at Assumed Start of Project Mining (Yellow Dashed Line), and Base of Excavation (Purple)

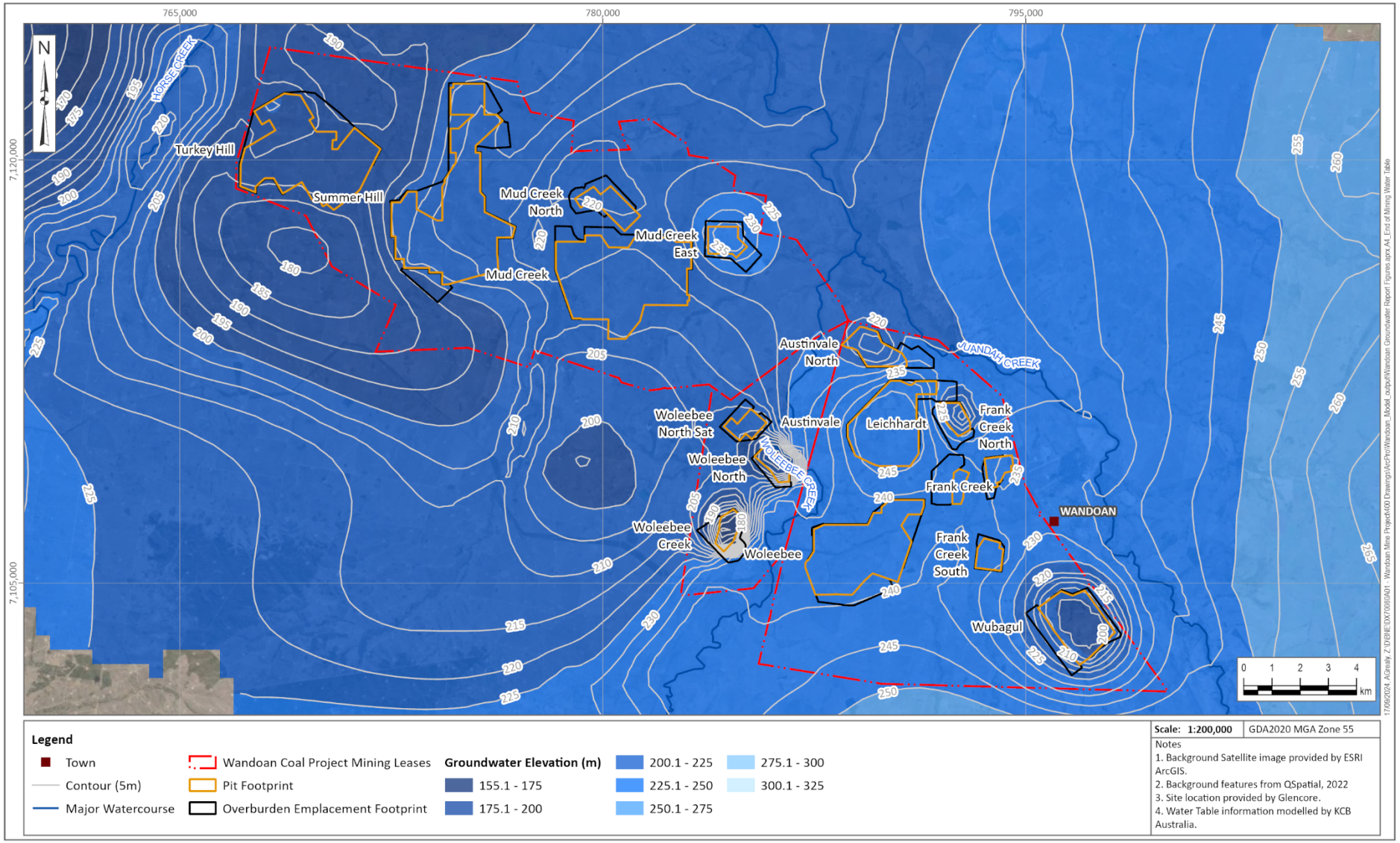


Figure IV-4.4 Assumed End of Operations Water Table Elevation (2105)

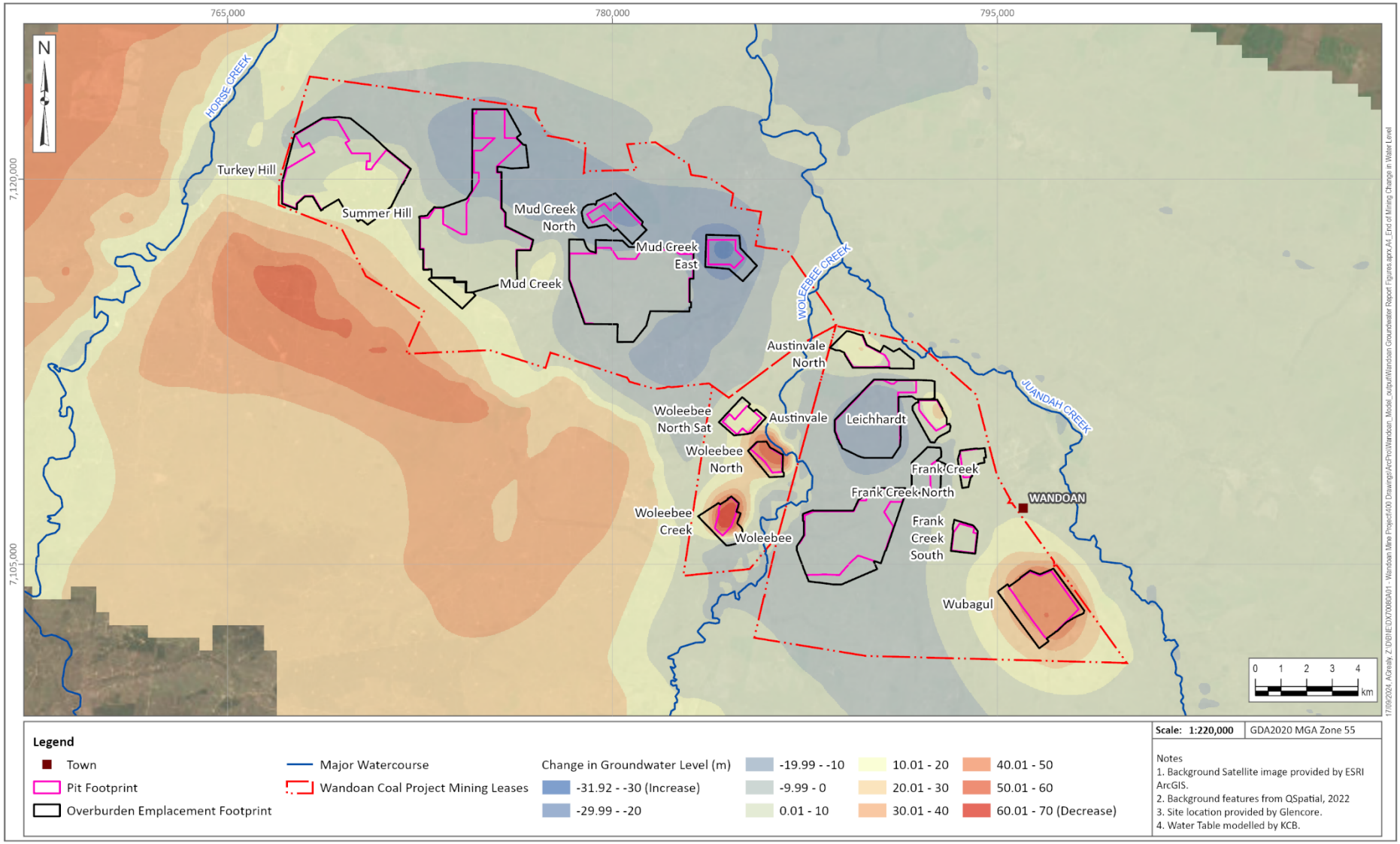


Figure IV-4.5 Change in Groundwater Level from Assumed Start of Mining (2031) and Assumed End of Mining (2105)

IV-4.3 Post-Closure

VI-4.3.1 Model Set-Up

The simulation of post-closure groundwater conditions was undertaken to assess recovery of the system after mining has ceased. The top surface of the model was updated to reflect the proposed post-closure landform topography, as shown in Figure IV-4.4. Properties for the backfilled open cut areas were progressively changed through the LoM simulation (using the TVM package). The post-closure landform has been designed so that there are no residual pit lakes within the backfilled residual void depressions, and that all open cut pits areas are backfilled above the water table by the end of the operational mining period (2105). The design water table considered the available historical water level data, as well as initial predictive scenarios of the model.

The recharge and evapotranspiration rates were extended from LoM model for each zone of the model. A recharge rate (10% of rainfall) and evapotranspiration rate (the rates and depths have used the approach that was applied to the alluvium units) are applied to the spoil across the mining area. Additional spoil recharge scenarios were also considered and are reported in Section VI-4.4.3.

All active drains that were used to simulate mine progression and dewatering were removed in the closure model to allow simulation of groundwater recovery. CSG activities are assumed to cease during the LoM simulation and the GHB boundary conditions that represent the impacts of CSG extraction are removed in the post-closure simulation. All other regional boundary conditions, such as drains along the watercourses, were retained from the end of the LoM model.

No additional contributions from surface water are included in the post-closure scenarios (surface water assessments have indicated that these occurrences would be transient).

VI-4.3.2 Results

The post-closure water table provided in Figure IV-4.5 for 10-, 50-, 100- and 500-years post-closure. Hydrographs for each of the open cut pits for the LoM and post-closure predictions are provided in Figure IV-4.6, with the assumed start of mining, groundwater elevation prior to commencement of mining (2031) and the base of the excavation indicated.

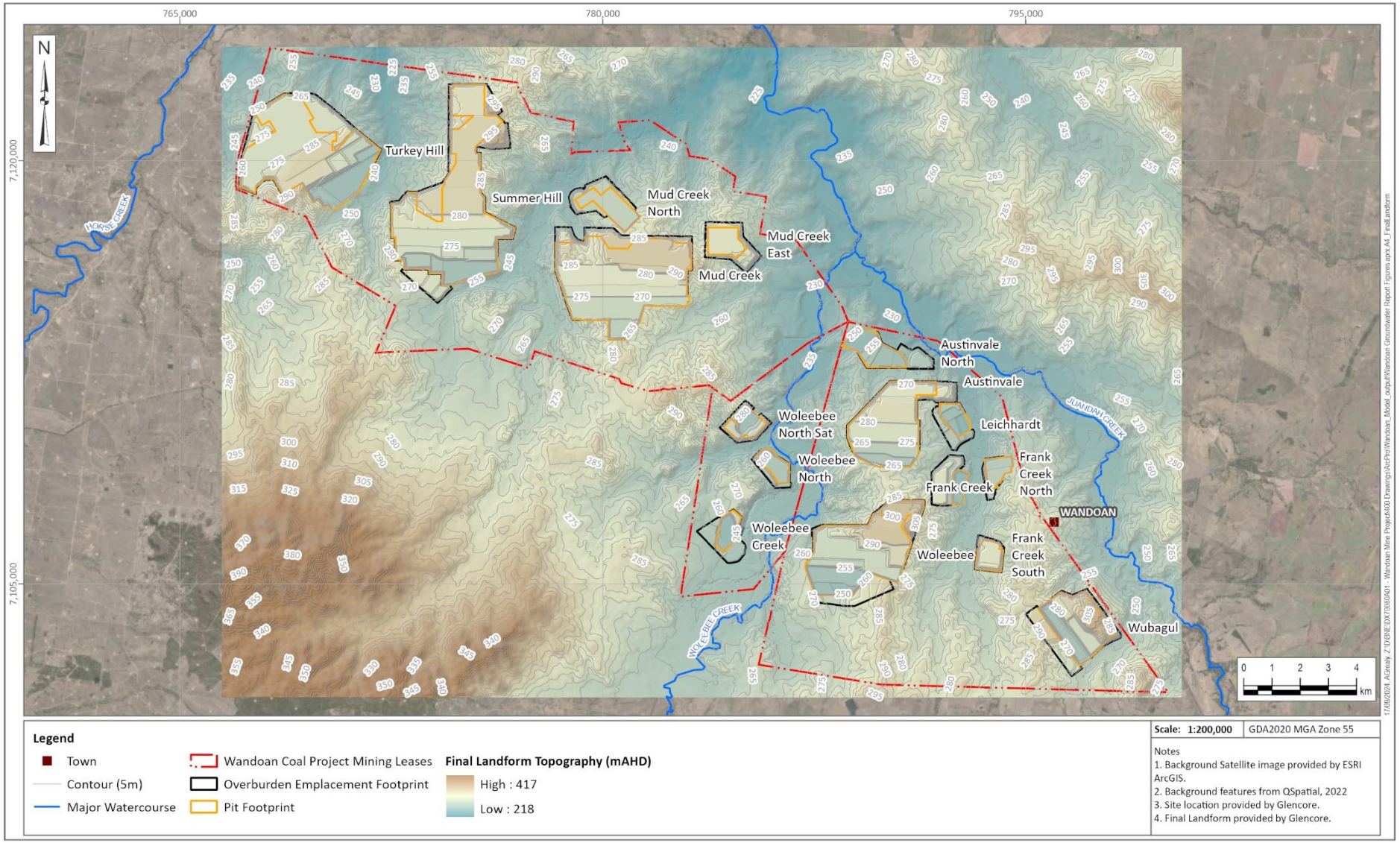


Figure IV-4.4 Final Landform

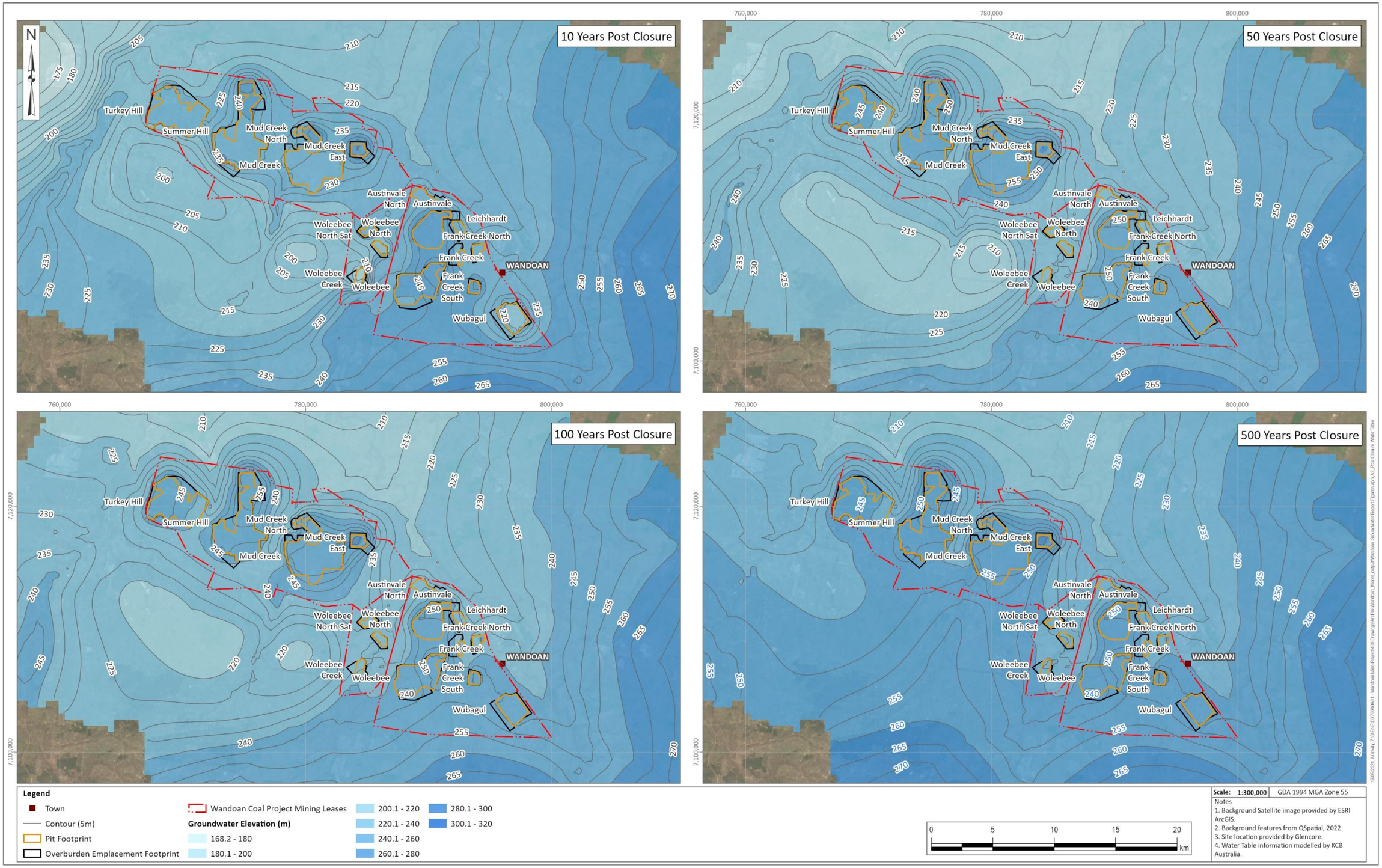


Figure IV-4.5 Water Table – 10-, 50-, 100- and 500-Years Post-Closure

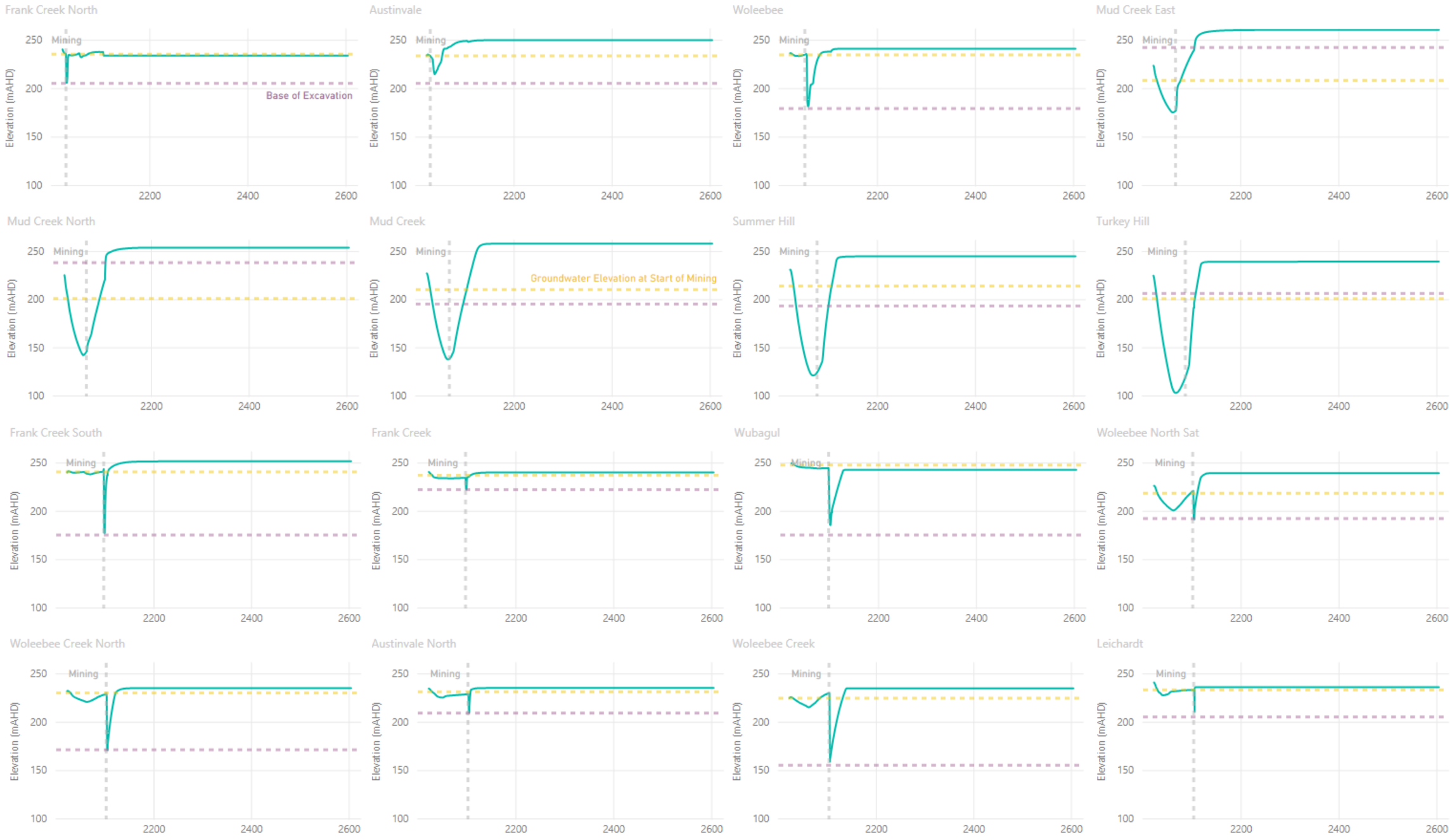


Figure IV-4.6 Backfilled Open Cut Pit (Residual Void Depression) Hydrographs During Mining and 500 Years Post-Closure with Assumed Start of Mining Indicated (Grey Dashed Line) and Groundwater Elevation at Backfilled Open Cut Pit at Start of Project Mining (Yellow Dashed Line) and Base of Excavation (Purple Dashed Line)

IV-4.4 Sensitivity Analysis

An initial sensitivity analysis of the model parameters was undertaken during calibration with PEST++ (Section I-3.5.5). Further sensitivity analysis included:

- Calibration model – Assessment of model parameters to allow comparison between the calibration metrics of the sensitivity scenarios and the metrics of the calibration model.
- Prediction model – Conducted on the prediction simulation to assess the variation in the system response to mining and.

Parameters considered to produce the greatest influence on model performance, and simulations, are mainly based on the model calibration and PEST++ results. Each scenario (or case) tested is listed in Table IV-4.1.

Table IV-4.1 Sensitivity Scenarios

Scenario	Content
Case 1	Alluvium K * 10
Case 2	Alluvium K / 10
Case 3	Units above WCM K in upper range
Case 4	Units above WCM K in lower range
Case 5	WCM K * 10
Case 6	WCM K / 10
Case 7	Backfilled spoil K * 10
Case 8	Backfilled spoil K / 10
Case 9	Recharge rate * 2
Case 10	Recharge rate / 2
Case 11	Storativity (alluvium and Upper Juandah) Sy * 5, Ss* 10
Case 12	Storativity (alluvium and Upper Juandah) Sy / 5, Ss/ 10
Case 13	Recharge rate * 10

VI-4.4.1 Sensitivity of the Calibration Model

The scenarios listed in Table IV-4.1, with the exception of cases 7 and 8 (prediction model only), were tested in the calibrated model to understand the impact on the calibration metrics. The results are summarised in Table IV-4.2. The results highlight:

- The calibrated model, used for predictions, continued to show the best statistical results.
- Changes in the hydraulic conductivity of the WCM coal seams resulted in the greatest influence to the calibration statistics (results in a lower correlation in calibration).
- Changes of alluvium hydraulic conductivity had the lowest influence to the calibration model.

Table IV-4.2 Comparison of Statistical Metrics in Sensitivity Models

Scenario	Change	SRMS (%)	Correlation R^2 (%)	Av. Residual (m)	Max. Residual (m)
Calibrated Model	NA	2.5%	98.9%	-1.1	29.5
Case 1	Alluvium K increase	2.6%	98.8%	-1.2	31.5
Case 2	Alluvium K decrease	2.7%	98.9%	-1.4	33.5

Scenario	Change	SRMS (%)	Correlation R^2 (%)	Av. Residual (m)	Max. Residual (m)
Case 3	Overburden K increase	2.9%	98.9%	-0.3	50.1
Case 4	Overburden K decrease	5.4%	98.8%	-1.4	36.6
Case 5	WCM K increase	5.7%	97.2%	-2.7	63.3
Case 6	WCM K decrease	6.4%	97.9%	-1.2	51.3
Case 9	Recharge increase (*2)	2.8%	98.4%	-1.2	31.6
Case 10	Recharge decrease	3.2%	97.8%	-1.3	33.1
Case 11	Storativity (alluvium and Upper Juandah) increase	3.0%	98.7%	-0.6	32.1
Case 12	Storativity (alluvium and Upper Juandah) decrease	4.2%	98.0%	-1.8	35.9
Case 13	Recharge increase (*10)	3.4%	97.8%	-1.7	33.3

Average residual presented rather than absolute average to highlight sensitivity during calibration.

VI-4.4.2 Sensitivity of the Prediction Model

To understand the sensitivity of the model and the impact on predictions, the twelve sensitivity scenarios listed Table IV-4.1 were also tested in the prediction model. Table IV-4.3 provides a summary of the results in the context of the impact on the post-closure recovery and modelled groundwater elevations at each of the backfilled open cut pits with reference to the base prediction model.

Table IV-4.3 Sensitivity Scenarios – Results Summary

Scenario	Content	Results Summary
Case 1	Alluvium K * 10	Limited change from base model predictions.
Case 2	Alluvium K / 10	Limited change from base model predictions.
Case 3	Units above WCM K in upper range	Limited change from base model predictions in general. Minor change to the rate of recovery (5 years longer) following mining of Woleebee Creek pit, which is located furthest south with the greatest thickness of units overlying the WCM.
Case 4	Units above WCM K in lower range	Increased drawdown predicted in pits impacted by CSG depressurisation. Recovery rate slower (+5 years) to similar groundwater elevations or higher than the base model.
Case 5	WCM K * 10	Results show increased interaction between the individual pits (drawdown at neighbouring pits) and a quicker recovery in post-closure. Groundwater elevations are lower in the majority of pits during post-closure.
Case 6	WCM K /10	Slower rate of recovery (up to 10 years) at some pits (e.g. Woleebee Creek, Wubagul), which are located furthest south where the WCM is deeper.
Case 7	Backfilled spoil K * 10	Increased rate of recovery in the majority of pits (i.e. quicker recovery to equilibrium). Some pits show lower groundwater elevations at equilibrium.
Case 8	Backfilled spoil K / 10	Increased rate of recovery in the majority of pits. Some pits show higher groundwater elevations at equilibrium.
Case 9	Recharge rate * 2	Increased rate of recovery in the majority of pits.
Case 10	Recharge rate / 2	Slower rate of recovery (up to 10 years) at some pits. Some pits show lower groundwater elevations at equilibrium.
Case 11	Storativity (alluvium and Upper Juandah) Sy *5, Ss*10	Influences the drawdown and recovery rates post-mining at some pits (e.g. Mud Creek, Summer Hill, Woleebee). Slower recovery post-mining and into closure.
Case 12	Storativity (alluvium and Upper Juandah) Sy /5, Ss/10	Influences interaction between pits (e.g. drawdown at neighbouring pits). Faster recovery into post-closure.

Figure IV-4.7 shows the hydrographs through the prediction model period and 100 years post-closure (all water levels recovered). The hydrographs also highlight the top of the final landform at the hydrograph point location. The graphs show that all water levels remain below the final landform for all sensitivity scenarios. Depending on the scenario and location of the open cut area within the model domain/project site, the predicted water levels vary over a 5 m range (i.e., there is not one consistent sensitivity scenario that produces the maximum water level or the minimum water level across the open cut areas).

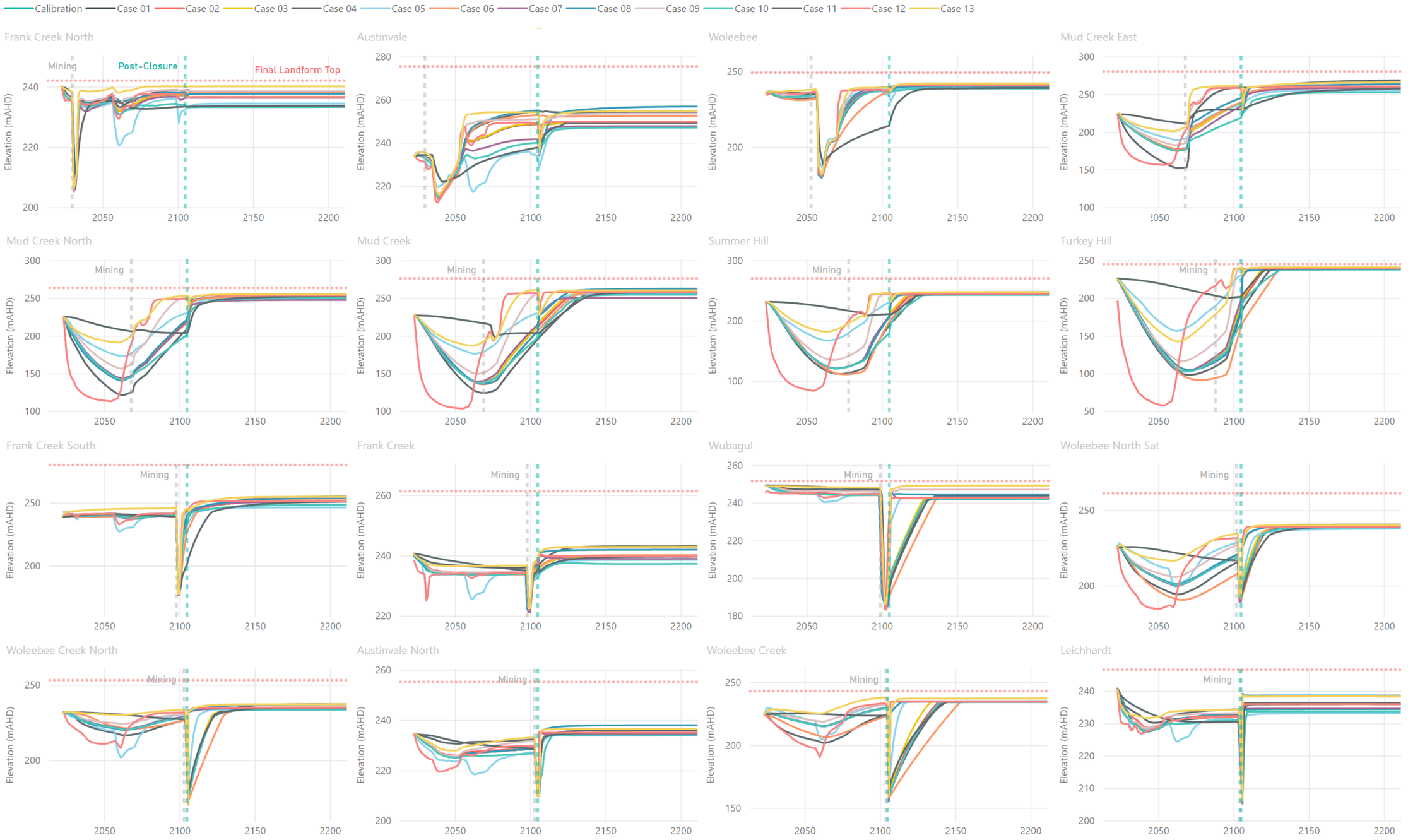


Figure IV-4.7 Open Cut Pit Hydrographs – Sensitivity Scenarios (Assumed Start of Mining – Grey Dashed Line, Start of Post-Closure – Green Dashed Line, Top of Final Landform (at Point) – Red Dotted Line)

VI-4.4.3 Spoil Recharge Sensitivity

To consider the influence of the spoil recharge on the model predictions, two additional scenarios have been considered. The base scenario used the median recharge rate presented by Williams (2008) as discussed in Section IV-4. The additional scenarios have adopted lower recharge rates with scenario 1 considering 5% and scenario 2 considering 1% of annual rainfall.

Figure VI-4.8 presents the groundwater table elevation of the two additional scenarios, as well as the base scenario (10% recharge) at each of the voids at 500 years post-closure. Figure IV-4.9 and Figure IV-4.10 present the groundwater table at four time periods (10 years, 50 years, 100 years and 500 years) into post-closure for the two spoil recharge sensitivity scenarios (10% scenario is presented in Figure IV-4.5).

The results show that, in general, the higher recharge scenarios results in a higher groundwater elevation. The greatest difference is at Mud Creek, Mud Creek East and Mud Creek North (which has the largest spoil footprint). These three voids/spoils are located in close proximity to each other. The difference between the recharge scenarios yields ~30 m elevation in 2506. The smallest difference between the scenarios is at Leichardt North (1.7 m), which has a small spoil footprint.

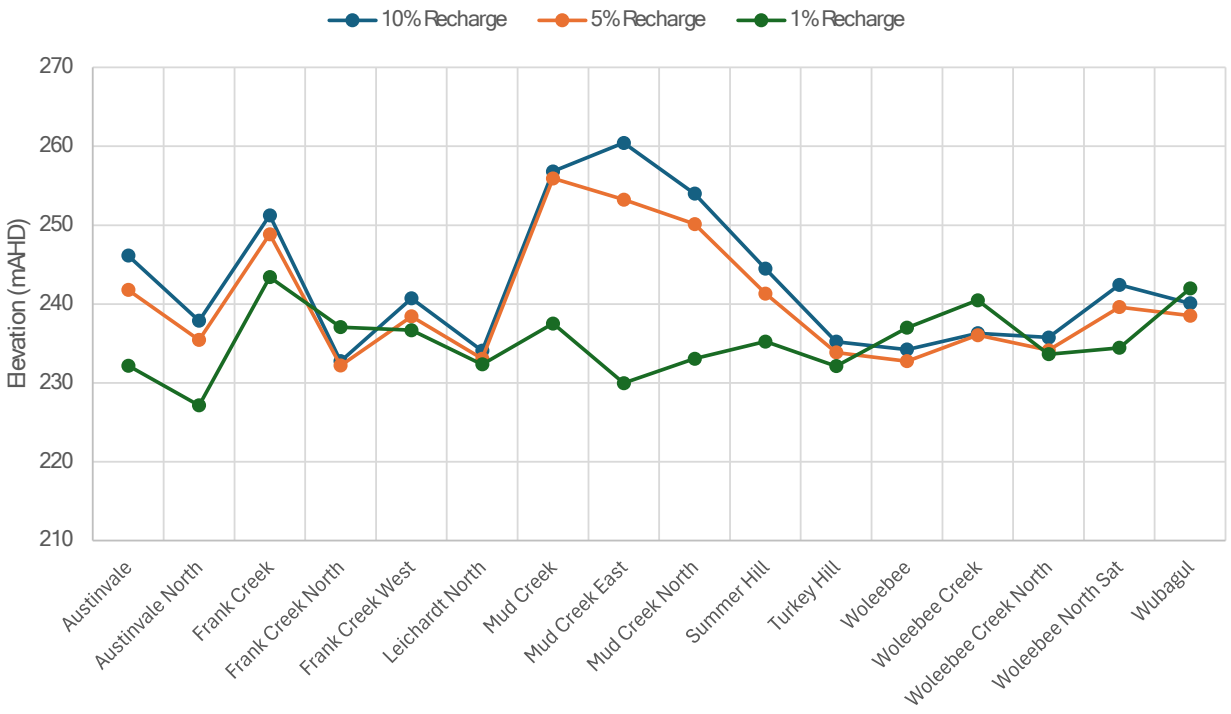


Figure VI-4.8 Sensitivity Results - Groundwater Table Elevation at 500 Years Post-Closure

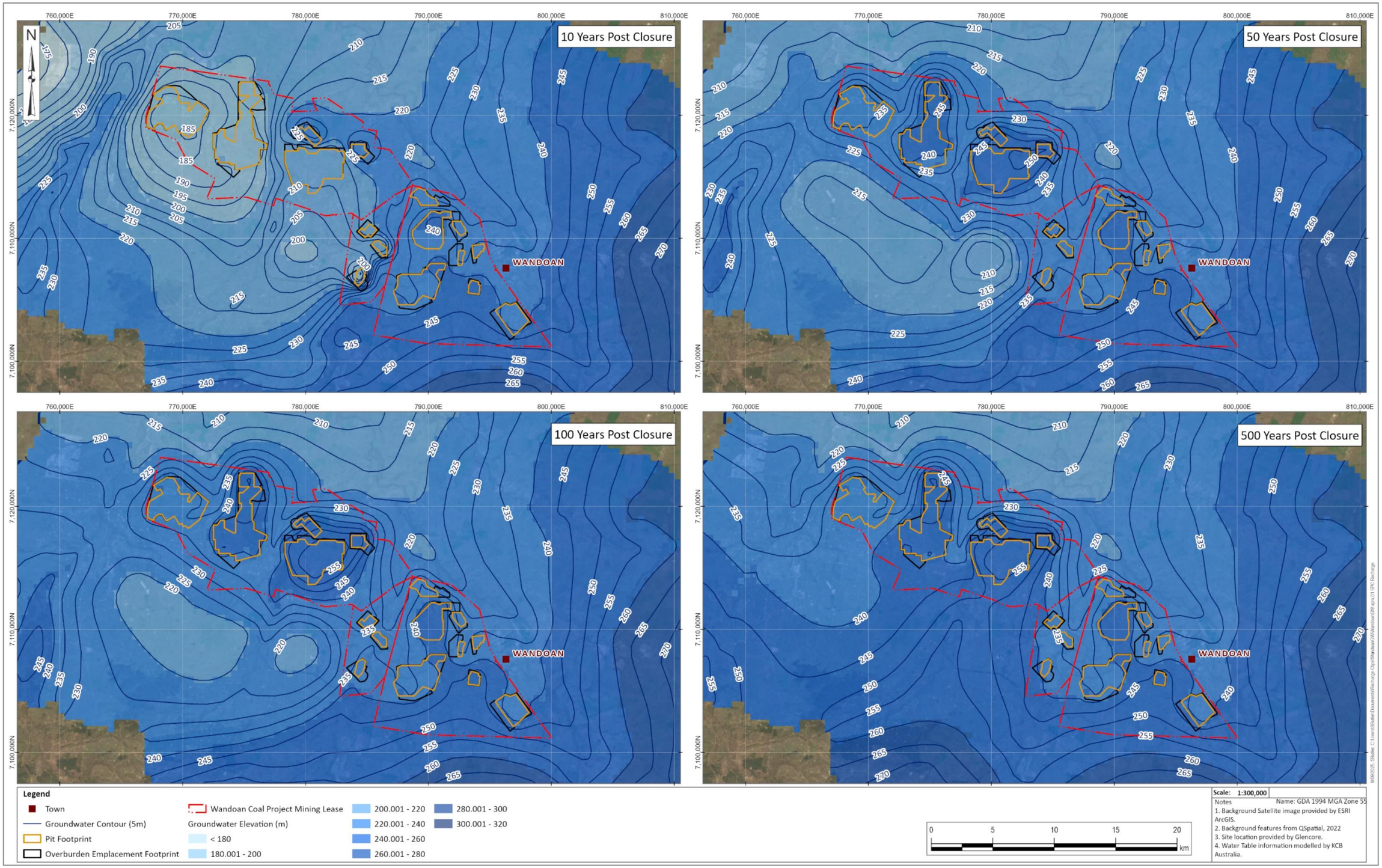


Figure IV-4.9 Scenario 1 (5% Recharge) Water Table – 10-, 50-, 100- and 500-Years Post-Closure

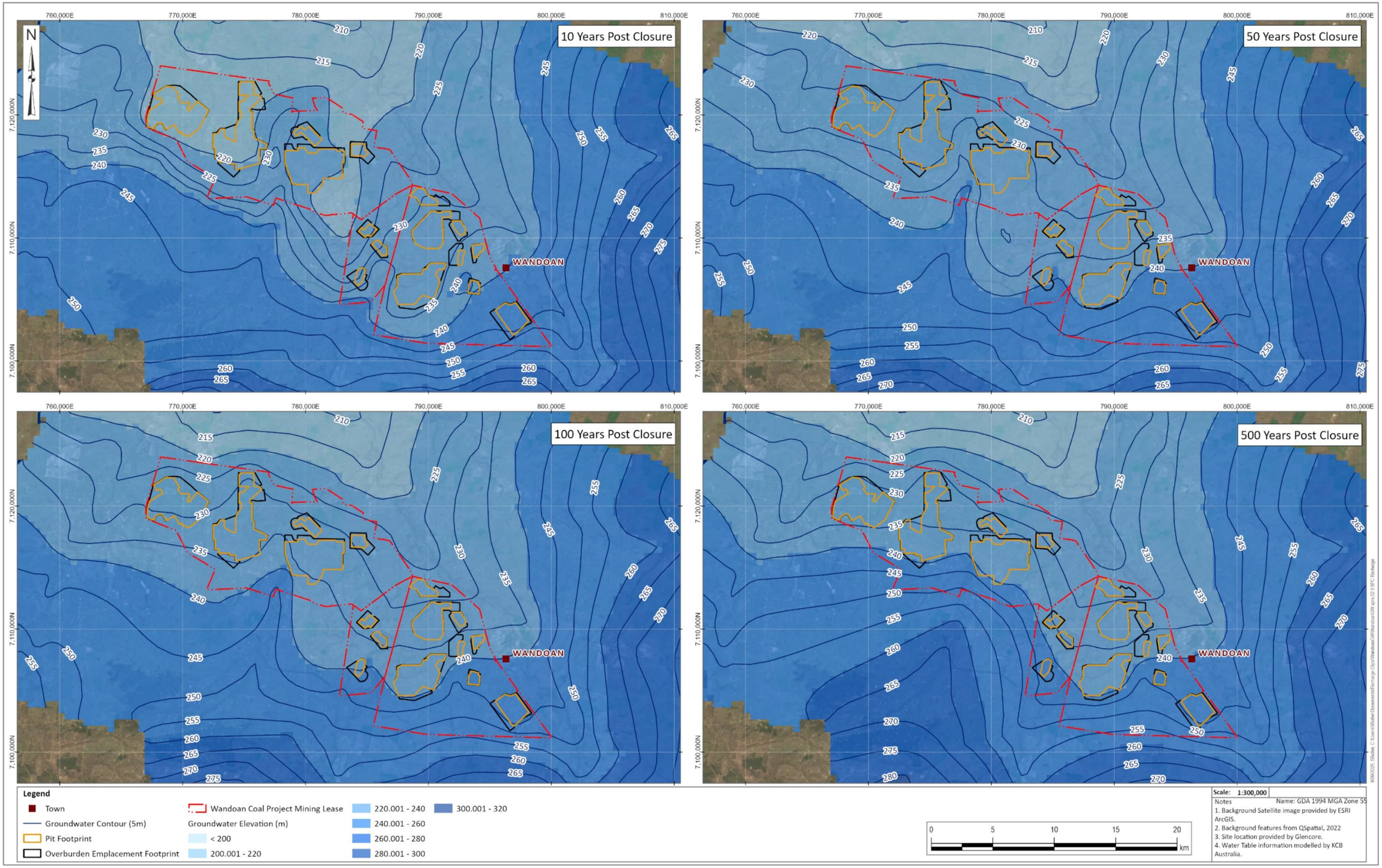


Figure IV-4.10 Scenario 1 (1% Recharge) Water Table – 10-, 50-, 100- and 500-Years Post-Closure

REFERENCES

Barnett, B, LR Townley, V E A Post, et al. 2012. *Australian Groundwater Modelling Guidelines*. Waterlines Report. National Water Commission.

BOM. 2023b. *Wandoan Post Office Climate Data, Site Number 35941. Australian Government Bureau of Meteorology. Http://Www.Bom.Gov.Au/.*

Chiew, Francis, QJ Wang, Fiona McConachy, Ross James, William Wright, and Graham deHoedt. 2002. 'EVAPOTRANSPIRATION MAPS FOR AUSTRALIA'. Paper presented Hydrology and Water Resources Symposium, Melbourne. (Melbourne), May 20.

DES. 2021. *Guideline: Progressive Rehabilitation and Closure Plans (PRC Plans)*. ESR/2019/4964; Version 2.00. no. ESR/2019/4964; Version 2.00. Queensland Government, Department of Environment and Science. https://environment.des.qld.gov.au/__data/assets/pdf_file/0026/95444/rs-gl-prc-plan.pdf.

DRDMW. 2022. *Queensland Groundwater Database: April 2022*. State of Queensland, Department of Regional Development, Manufacturing and Water.

Fityus, Stephen, Olivier Buzzi, and John Simmons. 2022. *Groundwater Pressures and Flows within Spoil Dumps*. ACARP Project C28038.

GCAA. 2023. *GCAA Resource Geological Model*.

Kellett, JR, TR Ransley, J Coram, et al. 2003. *Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland*. NHT Project# 982713. no. NHT Project# 982713. Bureau of Rural Science, Natural Resources and Mines, Queensland.

OGIA. 2016a. *Hydrogeological Conceptualisation Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2016b. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines.

OGIA. 2019. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, The Office of Groundwater Impact Assessment, Department of Natural Resources, Mines and Energy.

OGIA. 2022. *Underground Water Impact Report 2021 for the Surat Cumulative Management Area*.

QGC. 2016. *Surat North Development - CSG Water Monitoring and Management Plan for EPBC Referral 2013/7047, November 2016. QCLNG-BE99-WAT-RPT-000023*.

QWC. 2012. *Underground Water Impact Report for the Surat Cumulative Management Area*. State of Queensland, Coal Seam Gas Water, Queensland Water Commission.

Williams, David J. 2008. *The Influence of Climate on Seepage from Mine Waste Storages During Deposition and Post-Closure*. Mine Closure.

Wohling, DL, AJ Love, SA Fulton, P Rousseau-Gueutin, and S De Ritter. 2012. *Groundwater Recharge, Hydrodynamics and Hydrochemistry of the Western Great Artesian Basin in South Australia and the Northern Territory, Report for the Project 'Allocating Water and Maintaining Springs in the Great Artesian Basin',*. National Water Commission.

APPENDIX V

Post-Closure Sections

Appendix V
Post-Closure Cross Sections

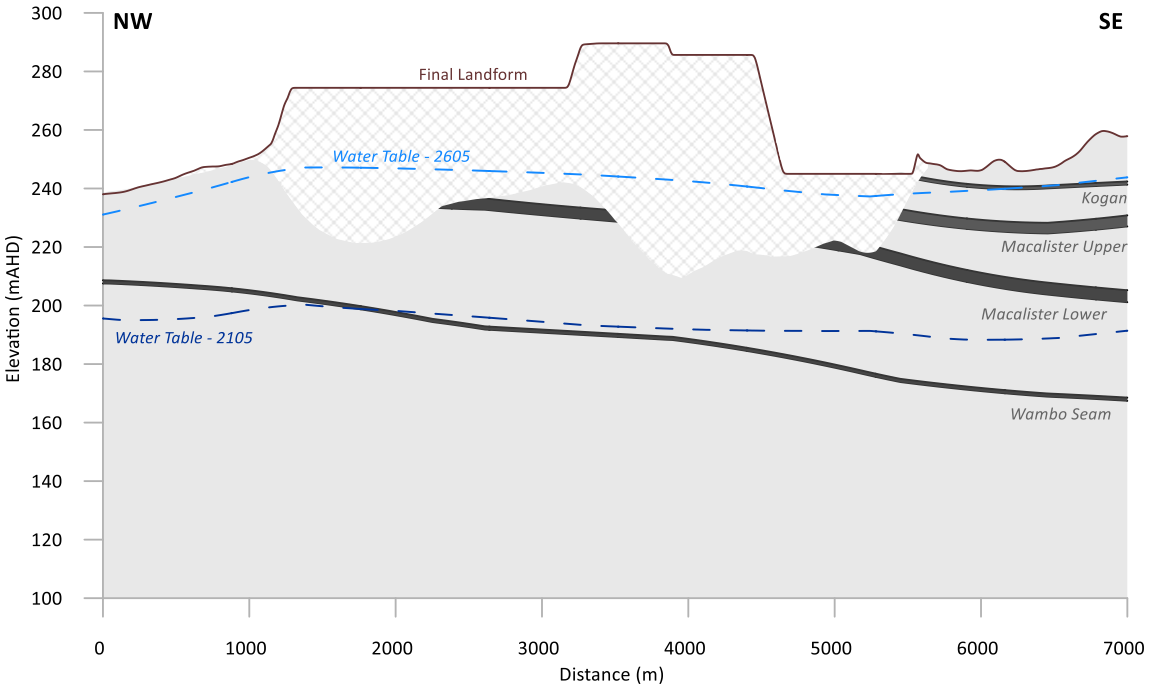


Figure V-1 Final Landform and Water Table - Turkey Hill

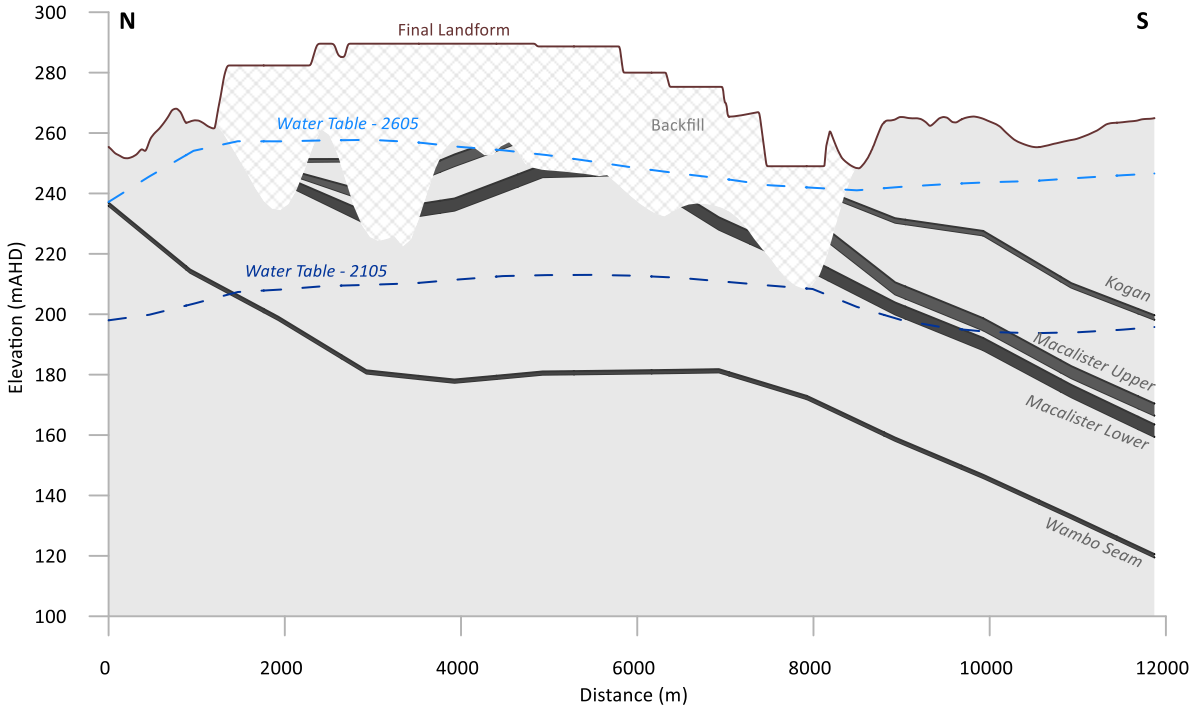


Figure V-2 Final Landform and Water Table – Summer Hill

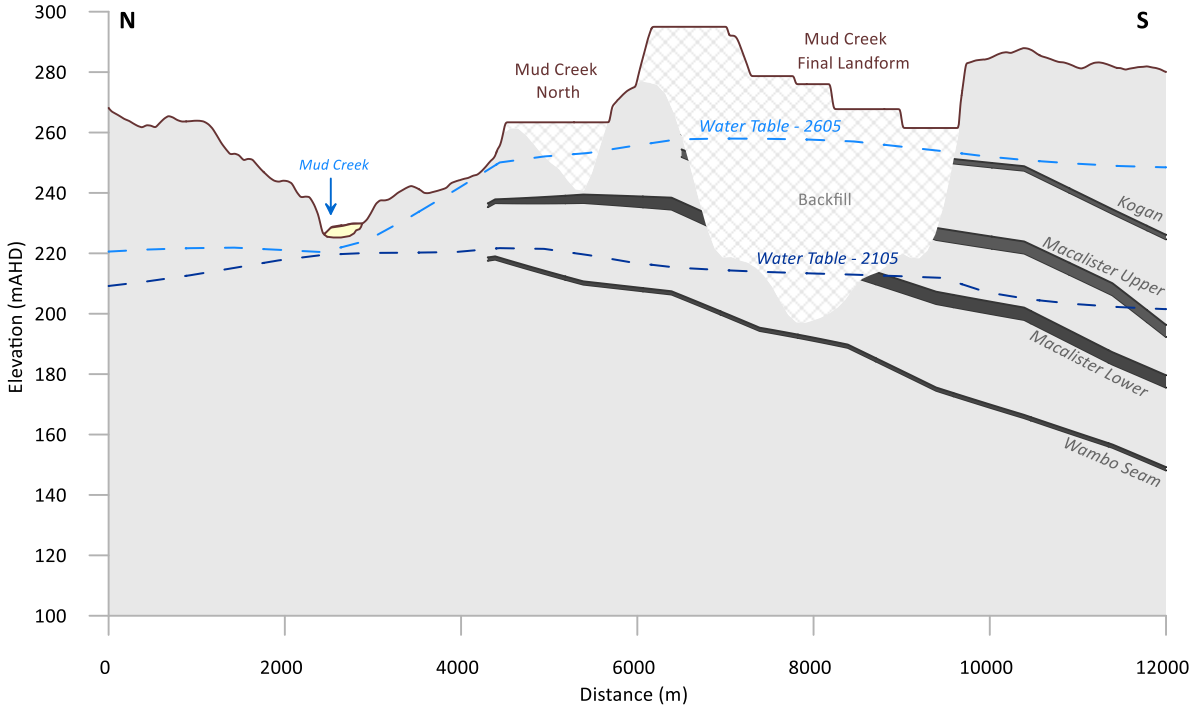


Figure V-3 Final Landform and Water Table – Mud Creek and Mud Creek North

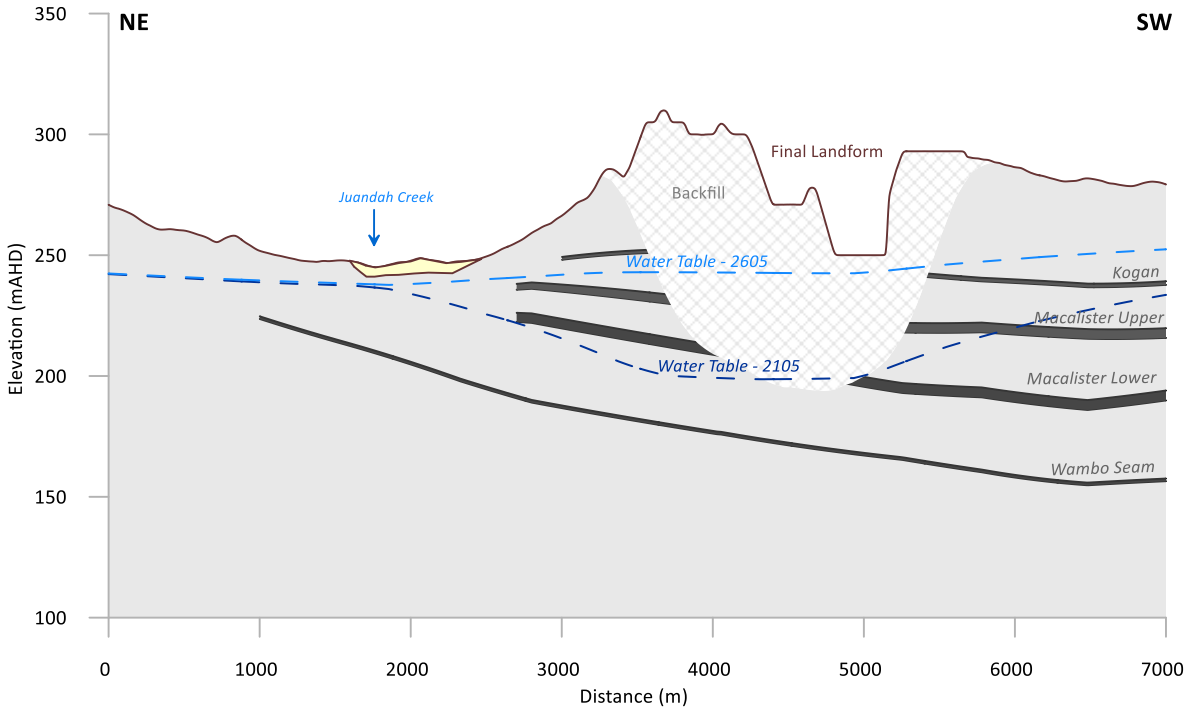


Figure V-4 Final Landform and Water Table – Wubagul

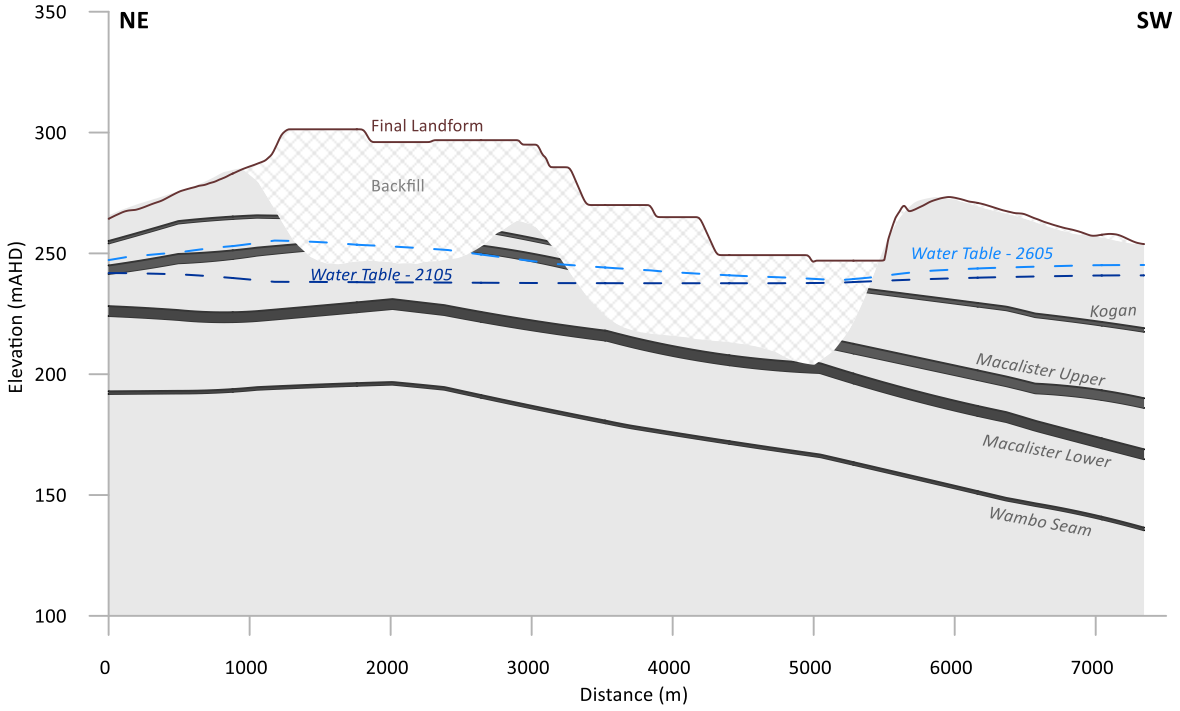


Figure V-5 Final Landform and Water Table – Woleebee

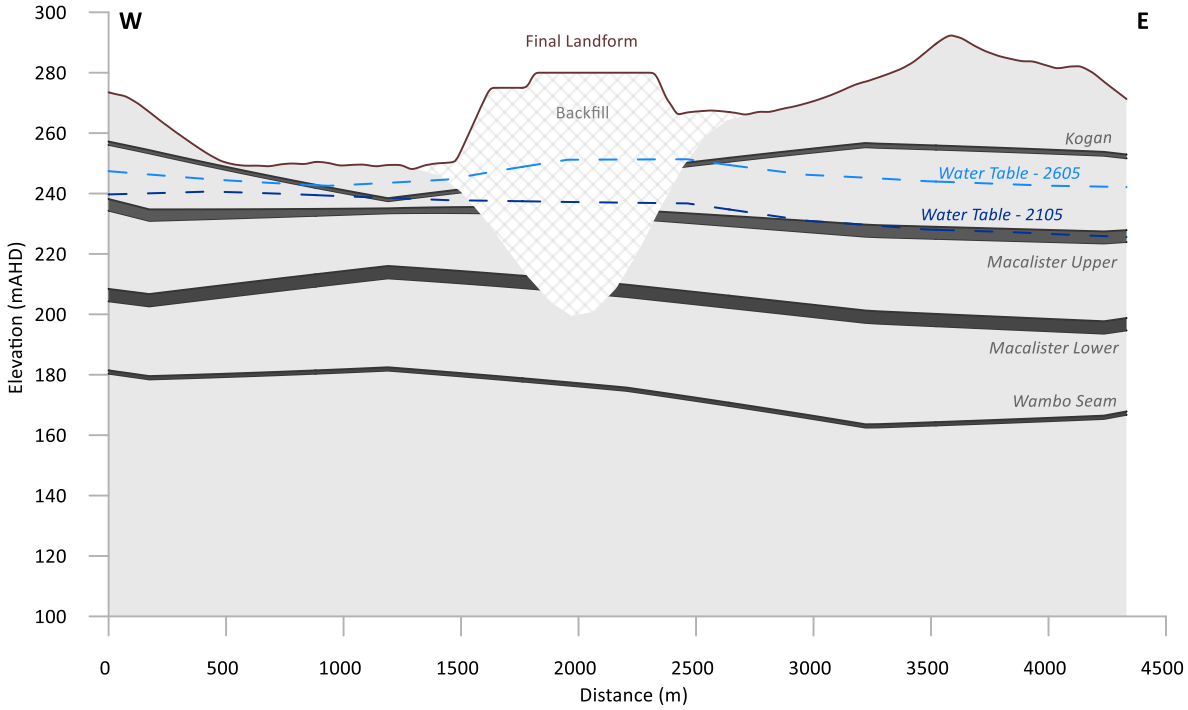


Figure V-6 Final Landform and Water Table – Frank Creek South

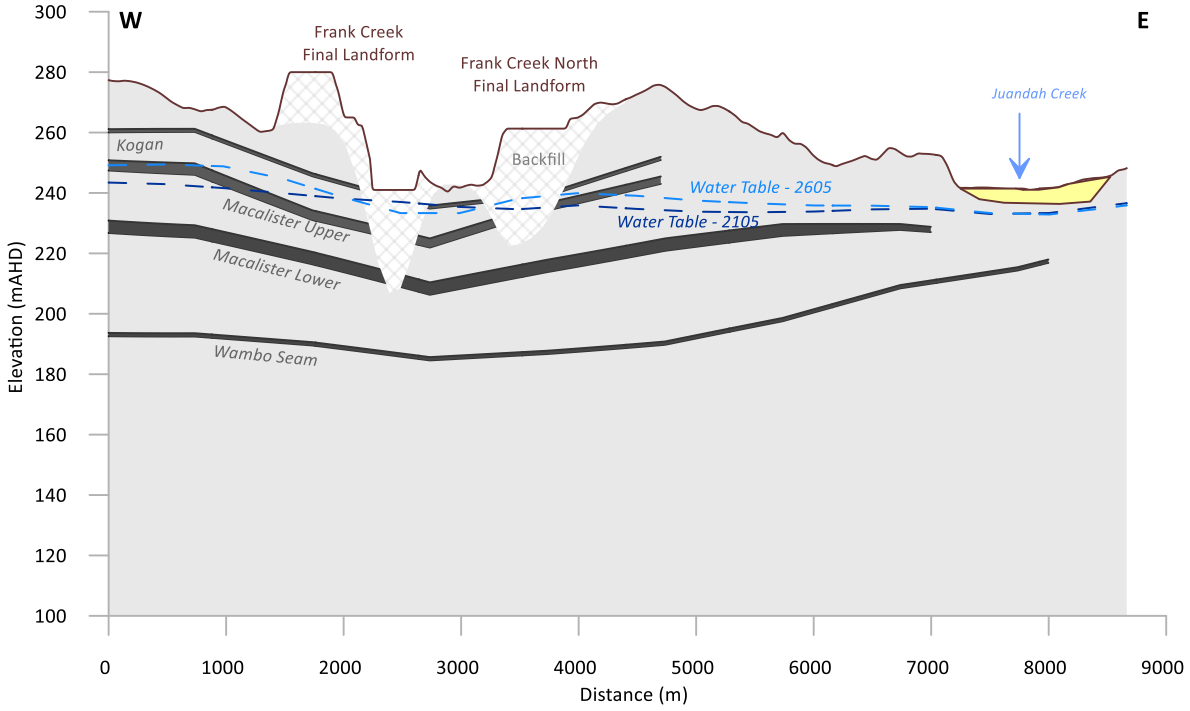


Figure V-7 Final Landform and Water Table – Frank Creek North

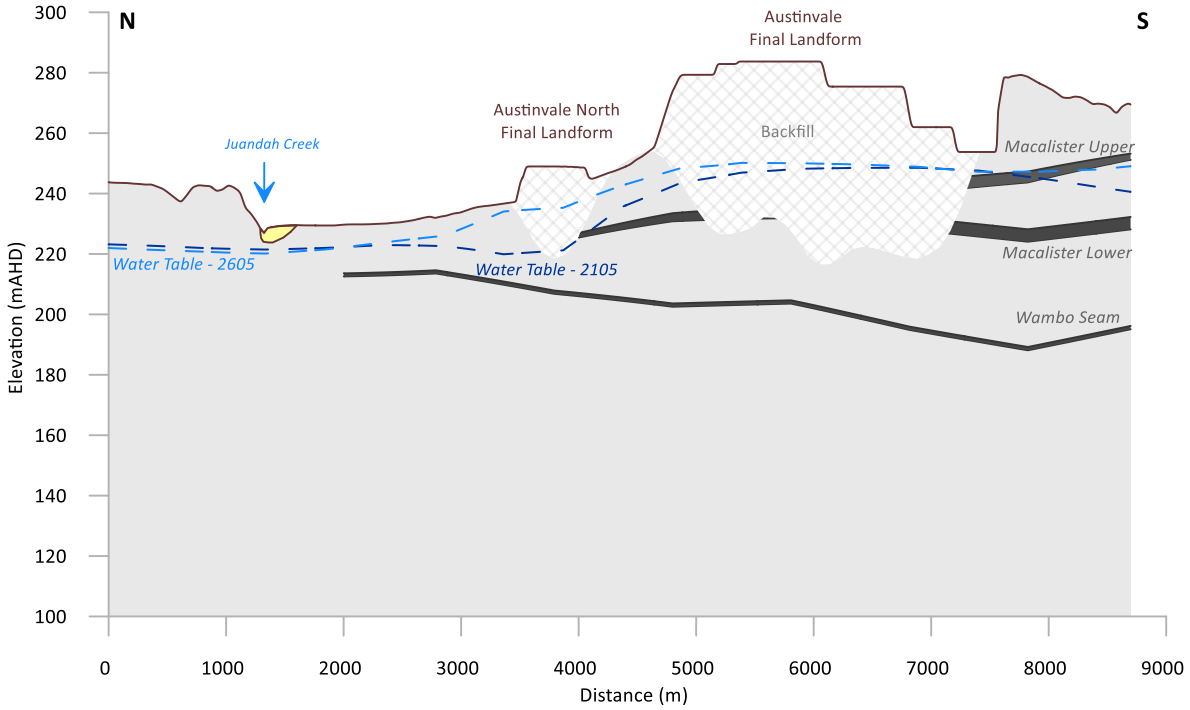


Figure V-8 Final Landform and Water Table – Austinvale and Austinvale North

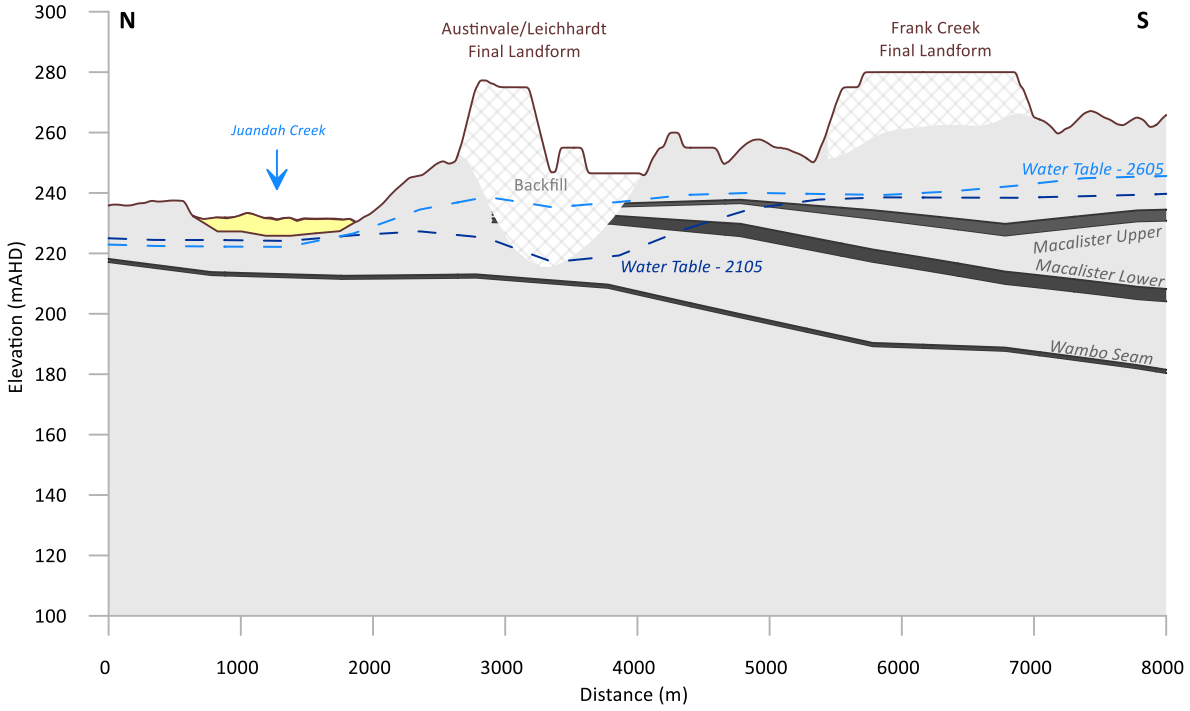


Figure V-9 Final Landform and Water Table – Austinvale / Leichhardt and Frank Creek

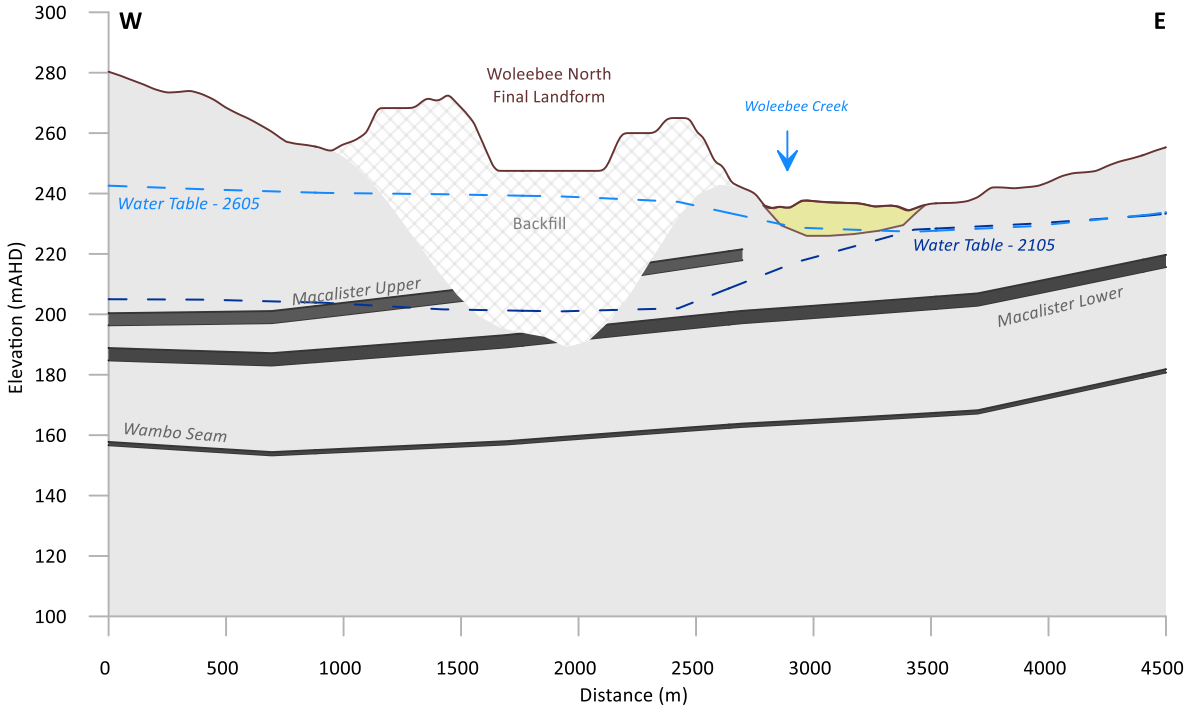


Figure V-10 Final Landform and Water Table – Woleebee North Sat

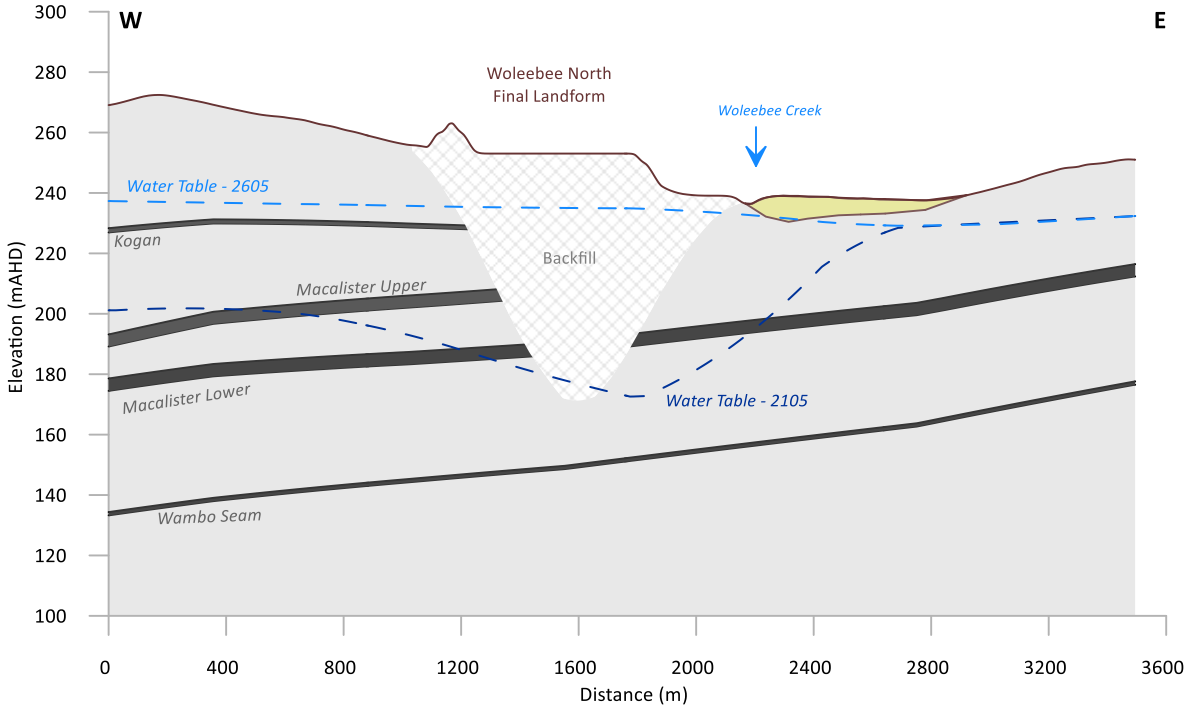


Figure V-11 Final Landform and Water Table – Woleebee North

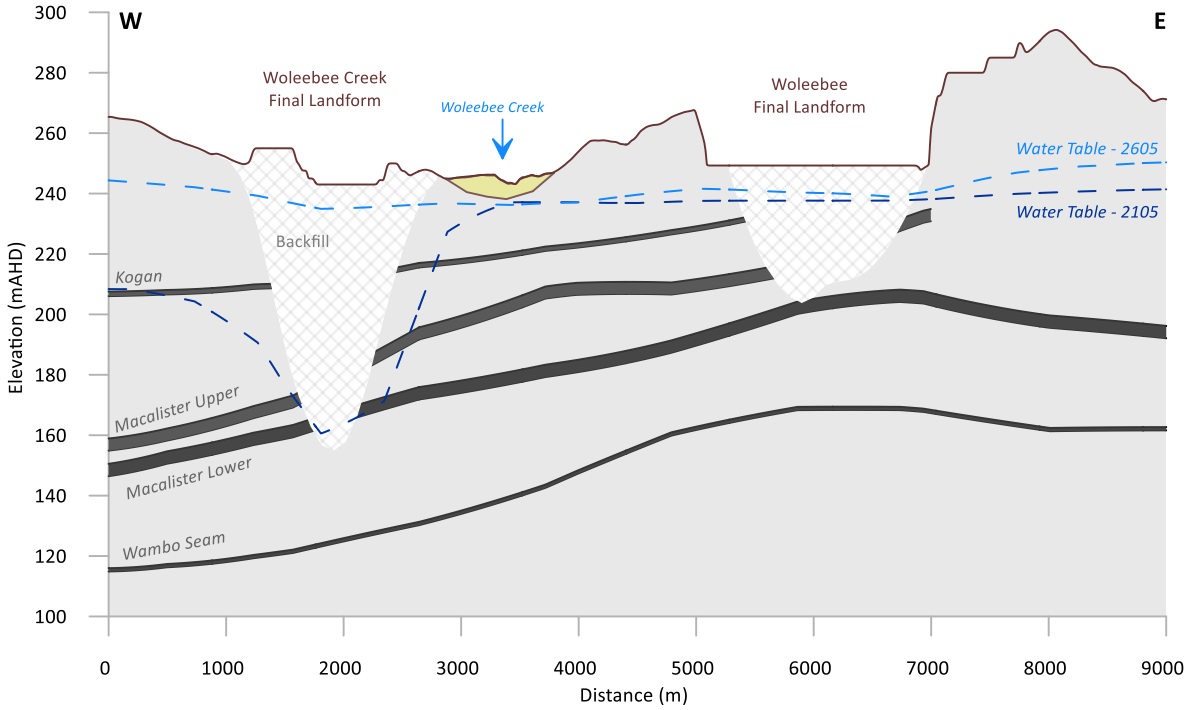


Figure V-12 Final Landform and Water Table – Woleebee Creek and Woleebee

APPENDIX VI

DETSI RFI

Appendix VI
DETSI Request for Information

VI-1 DETSI RFI

Following submission to DETSI in September 2024, a request for information (RFI) was received in May 2025. The RFI requested additional information to support the initial PRCP application (Reference No. A-PRCP-NEW-100732384). The RFI items related to groundwater are provided in Table VI-1.1. The table also provides response comments and identifies where the RFI has been addressed in the report.

Table VI-1.1 RFI Items Related to Groundwater Assessment

Item	PRCP plan / schedule	Issue	Required Information	Response
7	Groundwater levels and flow	Section 4.6.11 states: "*Local groundwater flow conditions may be different from regional flow conditions with potential steeper gradients and increased velocities in response to hydraulic stresses such as groundwater abstraction.*" It is noted that no groundwater contours are provided based on observed groundwater levels at the project site to support any discussion about groundwater flows. This is required as a basis for the conceptualisation of the groundwater system and to compare with simulated groundwater contours from the numerical groundwater model.	Provide groundwater level elevation contours for the major geologic units based on the observed groundwater levels at the project site to provide confidence in the modelled groundwater elevation contours and to understand the current groundwater flow directions.	▪ The statement referenced as the issue is included in the regional groundwater flow discussion to highlight that local conditions may be different. Responses at the local scale are discussed in Section 4.6.4. ▪ Inferred groundwater table contours for 2022 are provided and discussed in Section 4.6.2. The groundwater contours indicate that groundwater elevations are highest to the south-southeast of the Project. The general inferred groundwater flow is towards the north and east. Directly within the Project area the flow is from the southwest to northeast. Limited localised influence of CSG activities is evident in the water table contours. ▪ Numerical model generated contours for the calibration period are included in Section 5.3. extracted from the numerical groundwater model for the start and end of the calibration period (1995 and 2022). The 2022 contours show that the general flow directions are similar to the inferred groundwater contours, with increased resolution associated with the model output as the inferred contours are largely controlled by the spatial distribution of monitoring data.
8	Groundwater monitoring bores	Section 4.6.2 states: *"GCAA monitors a network of bores within the Project area on behalf of the Proponent, with additional bores installed in late-2023/24 to supplement the existing network."* Based on Table I-1 in Appendix 1 it appears that 20 bores were drilled in November/ December 2023. It is noted that the numerical model transient calibration period finishes in December 2022 indicating that water levels from the new bores were not used in the calibration of that model.	Provide advice as to whether the new bores drilled in November/ December 2023 were used in any way to support the groundwater report. If so, how the information from these bores was used.	▪ Clarification is included in Appendix IV and Section 4.6.3. ▪ An additional 20 bores were installed at the end of 2023, early 2024 to supplement the existing network. ▪ The first available data from the additional monitoring bores was available in early 2024. Due to the timing of the drilling program, and time frame for the development of numerical model to support the PRCP, the data from the additional monitoring bores was not available for incorporation into the numerical model. Work on the numerical model commenced in early 2023.

Item	PRCP plan / schedule	Issue	Required Information	Response
		Figure IV-3.2 (Transient Calibration Points) appears to confirm this. Additionally, strata details from the new bores appear likely to be unavailable for use in developing model layers. It is not clear if any information from the new bores has been used in any way to support the groundwater report. This information should be made clear to understand what data was available to support the groundwater assessment.		▪ Information from the new bores is recommended to be incorporated in any future numerical model updates (as recommended in Section 6.4 of the main report).
9	Location of groundwater monitoring bores	Figure 4.7 appears to indicate a large number of monitoring bores drilled on the eastern part of the project site but very few on the western part of the site. There is no discussion in the report as to why this spread of monitoring bores has been adopted.	Provide discussion as to: a) Why the majority of monitoring bores are located on the eastern side of the project. b) How has this impacted the assessment of groundwater conditions on the western part of the site.	▪ Clarification is included in Section 4.6.3. ▪ An additional 20 bores were installed at the end of 2023, early 2024 to supplement the existing network. The additional monitoring bores were installed on the eastern side of the Project area as the first mining is planned to commence in the east, with later mining planned to occur in the west. ▪ Additional monitoring on the western side of the Project area will be planned and installed as mining progresses. ▪ Existing monitoring bores and public domain information were used for the western side of the Project area. ▪ Refer to Section 6.4 regarding adaptive management approach through operations and closure.
10	Groundwater data	Section 4.6.3 Groundwater Data states "however, monitoring to the south of the Project shows a decline in groundwater levels1 of ~150 m (Appendix II)." A footnote to this comment states: *Note that data has been extracted from the GWDB and cannot be verified for accuracy. Some data is considered unreliable.*	Provide an update rehabilitation planning part that details: a) Whether the unreliable data referenced was VWP data. b) How any VWP data that was used in the groundwater	▪ The report has been updated to provide clarification in Section 4.6.3. ▪ The comment is related to groundwater database (GWDB) data, in general (not just VWP data), and that it is not possible to verify the accuracy of data contained in the database. ▪ Professional judgement was used to review and QA/QC the externally sourced data (as well as Glencore's own data) that was used to develop the hydrogeological conceptualisation

Item	PRCP plan / schedule	Issue	Required Information	Response
		It is noted that some data provided in the report appears to be referenced from Vibrating Wire Piezometers (VWPs). Is this the data that is considered unreliable? DETSI has concerns about the quality of data that is provided from some VWPs across a number of mining sites. It is unclear if any VWP data used in developing this groundwater assessment been verified.	assessment was verified for accuracy.	and understanding of the system, as well as the data used for numerical modelling. Where appropriate the data was excluded from the assessment. ▪ QA/QC processes include visual review of the monitoring data and comparison to other monitoring data (such as Glencore data or data used in the Surat CMA UWIR) which has a higher confidence, removal of outlier values, identification of values which may have telemetry issues, or have not been converted correctly.
11	Groundwater model predictions	The groundwater report provides no modelled groundwater elevation contours for the major geologic units at the start of the transient calibration in 1995 or at 2022 (end of calibration). These contours would provide the simulated impact of CSG activities during this period. The 2022 simulated groundwater elevation contours should be compared to the groundwater elevation contours developed based on observed data to determine how well the model is simulating actual groundwater level conditions and observed groundwater flow directions.	Provide modelled groundwater elevation contours for the start and end of the model calibration period to demonstrate model predicted impacts of CSG on groundwater levels, and to provide a comparison of modelled groundwater elevation contours with groundwater elevation contours developed using observed groundwater data. The latter will provide confidence in the groundwater modelling.	▪ Simulated groundwater table elevation contours are provided and discussed in Section 5.3. ▪ See item 7 response. ▪ Comparison of the groundwater table contours between 1995 and 2022 shows that about 30 to 40 m drawdown occurred in the southwest of the model domain during this period, which is attributed to CSG development in the area.
12	Post-closure groundwater levels	Section 6.1 states *"No groundwater-driven residual pit lakes are predicted in the base case simulations, which uses the average annual rainfall for the modelled recharge. However, there is a residual risk that during very wet years, that ephemeral water bodies could rise in these areas. Since progressive backfill and*	Given the uncertainties associated with final post mining groundwater levels and the residual risks associated with groundwater rising above ground level and into some	▪ Section 6.4 provides this information: ◆ To further support the PRCP predictions as well as refinement of the hydrogeological understanding during operations, monitoring is recommended to continue under the EA framework, with baseline groundwater level and chemistry monitoring for at least two years prior to commencement of operations. Additional shallow

Item	PRCP plan / schedule	Issue	Required Information	Response
		rehabilitation will be undertaken, an improved understanding of these risks should be developed during operations. Shallow groundwater is predicted in proximity of several backfilled open cut areas, generally in areas where the overburden emplacements are located close to the watercourses, where there is lower topography and there is localised mounding associated with the overburden emplacements." It is noted that post-mining groundwater levels are predicted to be close to the surface in some areas, as little as 1m is stated, and there is potential for higher groundwater levels in those wetter years which have not been modelled. It is stated that as progressive backfill and rehabilitation will be undertaken an improved understanding of these risks should be developed, but no discussion of what management options might be adopted should these risks be realised. There is no discussion of how future updated groundwater modelling will incorporate additional information that is acquired during mining and early backfilling operations and how this might be utilised in any alterations to the final landform.	depressions, provide an updated rehabilitation planning part that includes additional information on what steps will be taken in the future in regard to updated groundwater modelling and potential adjustment of final landform design.	monitoring to the west of the Project, between the mining areas and the watercourses is recommended to be installed in a staged approach (at least two years before the open cut pit is to be mined). Coupled seasonal surface water sampling is also recommended to understand baseline water quality within the watercourses. ♦ Update and refine the numerical model groundwater predictions (including post-closure scenarios), within the first five years of the operational period. The update is recommended to include calibration to the dewatering volumes and monitoring response to mining, which will assist in increasing the numerical model confidence and understanding of the groundwater system response. ♦ Collection of site-specific hydraulic properties, through pumping tests, will also provide further information to verify the model predictions and system response. ♦ The sensitivity scenarios on spoil recharge, included in Appendix IV, highlighted that in the majority of areas the lower recharge rate results in a lower water table elevation at the spoils. Once spoil placement commences, site-specific testing to obtain estimates of spoil recharge is recommended. The site-specific estimates will then assist with further refinement of the numerical model predictions for post-closure and further understanding of the risks to the receptors. ♦ Based on the monitoring and refined model results, progressively review management and mitigation measures for closure. Assessment of potential options is only recommended to be considered once the above monitoring and model refinement is undertaken (after five years of mining) and an improved understanding of the system response is available.

Item	PRCP plan / schedule	Issue	Required Information	Response
13	Flow direction and velocity	Section 6.1.2 of Flow Direction and Velocity and Table 6.1 appear to indicate groundwater flow from some of the backfilled pit spoil areas towards nearby watercourses. It is stated that: *Groundwater levels are not predicted to daylight (i.e. express above ground surface) in the base case groundwater model prediction, which uses the average annual rainfall for recharge.* Section 6.2 appears to indicate that the anticipated water quality within the spoil material will not *pose a significant risk to the quality of surface and groundwater resources in the vicinity of the Project.* However, despite this statement it is not clear if groundwater is predicted to drain into the creek beds that have been identified as receptors. For example, in periods immediately following high rainfall and high recharge in the alluvium, there may be potential for movement of alluvial groundwater back into the watercourse when stream flows finish. In the case of Woleebee North and Woleebee North Sat, Appendix V, Figures V-10 and V-11 appear to indicate that the final groundwater level will be above bed level in Woleebee Creek. But in 'section 7 Conclusion', it is stated 'Groundwater is not predicted to express within the creeks'. This statement appears to conflict with Figures V-10 and V-11 referenced above.	Review Sections 6.2, 7 and Appendix V and provide clarification as to whether groundwater from the backfilled areas is predicted to drain into nearby creeks and/or contribute to alluvial groundwater. Provide advice on how future monitoring of water quality in spoil areas will be conducted and the results incorporated into future decision making relating to final landform management to minimise movement of any poor-quality groundwater towards watercourses.	▪ Clarification is included in Section 6: ♦ Groundwater levels are not predicted to daylight (i.e. express above ground surface) in the base case groundwater model prediction, which uses the average annual rainfall for recharge. There are some areas, however where the recovered water table is predicted to be higher than the base of the alluvium unit. ▪ The statement in Section 7 refers to the daylight of water above ground surface, consistent with the statement in Section 6: ♦ Groundwater is not predicted to express within the creeks. For the alluvium and watercourses, the range of increased salinity is not expected to be significant as the seepage and run-off water chemistry is of low to moderate salinity, inferred flow rates of seepage are low and any potential evapoconcentration that could occur would be expected to be seasonally diluted by fresh rainfall recharge and/or run-off. The EC values predicted from the run-off and seepage are also expected to be within a similar magnitude natural water quality measured in the alluvium. See Item 12 for adaptive management and monitoring discussion which is included in Section 6.4. Additional monitoring should be considered once operations commence and there is additional information available to update the numerical groundwater model predictions.

Item	PRCP plan / schedule	Issue	Required Information	Response
		This issue should be clarified to confirm the final landform can achieve non-polluting.		
14	Calibrated model parameters	In figure I1-3.14 the lower bounds for recharge rates of 1x 10-8m/day (0.0036mm/yr) for all aquifers and the calibrated recharge rates for non-alluvial aquifers appear very low. The calibrated recharge rate for the Weathered Surat Basin being 4.49 x 10-7m/day (0.16mm/yr) and for the Springbok Sandstone being 3.56 x 10-7m/day (0.13mm/yr). In comparison the lowest OGIA rates referenced in Section 4, Table 4.1 of this report were 4.3mm/yr for the Walloon Coal Measure and 3.2mm/yr for the Springbok Sandstone. These values are much higher than those being used in the Wandoan numerical model. No justification is provided for these low bounds and low calibrated recharge rates. Information should be supplied to demonstrate that recharge rates applied in the modelling are within realistic boundaries to provide confidence in the modelling.	Provide an updated rehabilitation planning part that includes additional information to support the lower bounds used for the calibration of recharge rates and the final calibrated recharge rates in the non-alluvial aquifers in Table I1-3.14.	▪ Additional discussion is provided in Appendix IV-2.5, clarifying the recharge values adopted in the numerical groundwater model. ▪ The calibration approach and the calibrated recharge rates are consistent with the OGIA numerical groundwater modelled values (OGIA 2019).
15	Life of mine – model set-up – recharge to spoil	VI-4.2.1 Life of Mine - Model Set-Up – Recharge to spoil This section states: *Similarly, a reference recharge rate (10% of rainfall) and evapotranspiration rate (same as alluvium unit) was applied for the spoil sourced from Williams (2008).* It is noted that Williams (2008) is identified as: *Williams, David, J. 2008. 'The Influence of Climate on Seepage from Mine Waste Storages During Deposition and Post-Closure'. Mine Closure 2008.*	Provide additional advice as to how Williams (2008) supports the use of a recharge rate of 10% for the spoil in the numerical groundwater model. Provide advice as to why Williams (2008) was referenced in preference to Mackie (2009).	▪ Further information is provided in Section IV-4.2.1 in Appendix IV related to the recharge values adopted for the spoils. ▪ Additional modelling scenarios for 1% and 5% recharge scenarios are also included in Appendix IV, to consider the range of values quoted by DETSI. ▪ The sensitivity scenarios on spoil recharge, included in Appendix IV, highlighted that in the majority of areas the lower recharge rate results in a lower water table elevation at the spoils. Once spoil placement commences, site-specific testing to obtain estimates of spoil recharge is recommended. The site-specific estimates will then assist

Item	PRCP plan / schedule	Issue	Required Information	Response
		Typically, where localised data is not available, model reports have referenced Mackie (2009), and a recharge rate of between 1 and 5.5% of rainfall to be used on the spoil. DETSI have reviewed Williams (2008) and it is not clear what part of this report has been referenced to support a spoil recharge rate of 10%. The recharge rate applied to the spoil in the latter stages of mining and post-mining is potentially an important part of the water balance.		with further refinement of the numerical model predictions for post-closure and further understanding of the risks to the receptors.

Klohn Crippen Berger

Wandoan Holdings Pty Ltd

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan

Hydrologic and Hydraulic Modelling Study

ISO 9001 14001 45001

14D70080A12

December 2025

2 December 2025

Glencore Coal Assets Australia
On behalf of Wandoan Holdings Pty Ltd
Email: Melissa.Brunner@glencore.com.au

Melissa Brunner
PRCP and Approvals Coordinator (Wandoan)

Dear Melissa:

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan
Hydrologic and Hydraulic Modelling Study – Rev 5

KCB Australia Pty Ltd is pleased to provide Glencore Coal Assets Australia (on behalf of Wandoan Holdings Pty Ltd) with this hydrologic and hydraulic modelling report for the Wandoan Coal Project.

We would like to thank you for the opportunity to work on this assignment. Should you have any questions, please do not hesitate to contact the undersigned.

Revision 05 of this report has been updated to address the request for further information from the Department of Environment, Tourism, Science and Innovation (DETSI) dated 30th May 2025. Specifically, item 34 has been addressed in section 7.3.2 of this report and Appendix VIII.

Yours truly,

KCB AUSTRALIA PTY LTD.

Olivia Ciocca
Water Resources Engineer

OC and KB: LE

KCB Australia Pty Ltd.
Level 3, 150 Mary St ▪ Brisbane QLD 4000 ▪ Australia
t +617.3004.0244 ▪ www.klohn.com

Rev	Date	KCB			Proponent	SLR	Status	Revision description
		Author	Checked	Approved	Approved	Approved		
A	07/05/24	O. Ciocca	K. Bethune J. Heaslop	J. Heaslop	For approval			
B	29/05/24	O. Ciocca	K. Bethune J. Heaslop	J. Heaslop	For approval			
C	27/06/24	O. Ciocca	K. Bethune	K. Bethune	For approval			
0	01/8/24	O. Ciocca	K. Bethune	J. Heaslop	For use			
1	28/8/24	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with PMF
2	04/9/2024	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with client comments
3	16/9/2024	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with client comments
4	01/09/2025	O. Ciocca	K. Bethune	J. Heaslop	For approval			Updated for RFI
5	2/12/2025	O. Ciocca	K. Bethune	J. Heaslop	For approval			Updated for RFI

EXECUTIVE SUMMARY

This report outlines the design hydrological and hydraulic modelling undertaken to characterise the design flows and flood extents for the Project for the progressive rehabilitation and closure plan (PCRP). Modelling has been completed for the 1 in 1,000 annual exceedance probability (AEP) design event, as outlined in the Progressive Rehabilitation and Closure Plans guidelines (DETSI 2024).

PRCP hydrology and hydraulic modelling included the following:

- Rating curve assessment for the Juandah Creek at Windamere gauge with the re-rated curve adopted for this study.
- At-site flood frequency analysis (FFA) undertaken and compared to regional flood estimation techniques in Australia.
- Calibrated hydrologic model of Juandah Creek catchment to derive stream routing and loss parameters.
- Hydrology flow estimation for the 1 in 1,000 AEP flood event for Juandah, Mud and Spring Creek catchments.
- Hydraulic modelling of 1 in 1,000 AEP flood event to determine design flood extents with velocity and depth maps produced.
- Climate change sensitivity analysis completed for 1 in 1,000 AEP event with velocity and depth maps produced.

Key outcomes of the hydrology and hydraulic modelling included:

- Flood waters are not expected to ingress into the reprofiled void depressions and associated water storages for the 1 in 1,000 AEP event.
- The flood waters are not expected to reach the level of the out-of-pit-dump toes proposed as part of the final landforms for most pits. There are minor interactions (depths >0.5 m) between flood water and out-of-pit dump toes for Woleebee Creek, Woleebee North and Woleebee pit. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour). Erosion plots have been assessed in section 7.3.2. Other pits (Wubgal, Woleebee North Sat, Frank Creek South) have minimal interactions between flood water and out-of-pit dump toes (depths <0.5 m).
- Results of the climate change modelling indicated that the expected water depth and velocities are higher than the PRCP base case (without climate change). For Juandah Creek there was approximately 0.6 m of water depth difference, for Mud Creek there was approximately 0.2 m difference in water levels and for Spring Creek there was approximately a 0.1 m difference in water level.
- Climate change modelling results show that flood waters are not expected to ingress into the reprofiled void depressions or reach the toe of elevated dumps in the final landform in most pits. There are minor interactions between surface water and toes of the out-of-pit dumps for Woleebee Creek and Woleebee. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour).

Revision 05 has been updated to for RFI comments, refer to section 7.3.2 of this report and Appendix VIII.

TABLE OF CONTENTS

EXECUTIVE SUMMARY II

CLARIFICATIONS REGARDING THIS REPORT IX

1 INTRODUCTION 1
1.1 Project scope 1
1.2 Relevant legislation and guidelines 1
1.2.1 PRCP guideline 3
1.3 Report structure 5

2 PROJECT DESCRIPTION 6
2.1 Components 6
2.2 Closure plan 6
2.3 Existing drainage network 12

3 PROJECT DATA 13
3.1 Previous studies 13
3.2 Topographic data 13
3.3 Structures to remain 13
3.4 Streamflow 14
3.4.1 Stream gauge 14
3.4.2 Rating curve 17
3.5 Rainfall 18
3.5.1 Rainfall gauges 18

4 MODELLING APPROACH 19

5 HYDROLOGY – PARAMETER DERIVATION 20
5.1 Overview 20
5.2 Modelling approach 20
5.3 Model schematisation 21
5.4 Storm representation 21
5.5 Model calibration 23
5.6 Loss parameter derivation 24
5.7 Adopted calibration parameters 26

6 HYDROLOGY - DESIGN FLOOD 27
6.1 Overview 27
6.2 Hydrologic model schematisation 27
6.3 Runoff routing parameters 29
6.4 Design rainfall 29
6.5 Areal reduction factors 29
6.6 Temporal patterns 29
6.7 Spatial patterns 29
6.8 Losses 30

TABLE OF CONTENTS
(continued)

6.9 Design flows and representative event selection 30
7 HYDRAULIC MODELLING 31
7.1 Overview 31
7.2 Model setup 31
7.3 Model results 34
7.3.1 Risk analysis 38
7.3.2 Erosion at Woleebee Creek, Woleebee North and Woleebee North Satellite voids and dumps 38
7.4 Climate change 42
8 CONCLUSION 44
9 CLOSING 45
VERSION MANAGEMENT 45
REFERENCES 46

List of Tables

Table 1.1 PRCP void closure plan requirements 4
Table 2.1 Summary of reprofiled void depression physical characteristics 11
Table 3.1 Topographic data 13
Table 3.2 Stream gauge 14
Table 3.3 Rain gauges 18
Table 5.1 RORB catchment model parameters 21
Table 5.2 Calibration results 23
Table 5.3 Comparison of k_c to published data 24
Table 5.4 FFA calibrated losses 25
Table 5.5 Adopted RORB calibration model parameters 26
Table 6.1 RORB PRCP design model parameters 27
Table 6.2 Adopted runoff routing parameters 29
Table 6.3 Design temporal patterns 29
Table 6.4 Design losses 30
Table 6.5 Design flows (1 in 1000 AEP) 30
Table 7.1 Hydraulic model setup 31
Table 7.2 Water at toe dumps and height to reprofiled void depression 37
Table 7.3 Comparison of PRCP to existing (pre-mining) flood modelling 38
Table 7.4 Climate change inputs 43

List of Figures

Figure 1.1 Project location 2
Figure 2.1 Reprofiled void depression 7

TABLE OF CONTENTS
(continued)

Figure 2.2 EA approved pit and dump footprint 8
Figure 2.3 Pit and dump progressions over the life of mine 9
Figure 2.4 Final landform 10
Figure 3.1 Stream and rainfall gauge locations 15
Figure 3.2 Annual streamflow – Juandah Creek at Windemere (130344A) 16
Figure 3.3 Monthly streamflow – Juandah Creek at Windemere (130344A) 16
Figure 3.4 Daily streamflow – Juandah Creek at Windemere (130344A) 17
Figure 3.5 Rainfall gauges available record 18
Figure 5.1 Juandah Creek RORB model schematisation 22
Figure 5.2 RORB model mean flow derivation 24
Figure 5.3 FFA and RORB flood frequency comparison 26
Figure 6.1 RORB design model schematisation 28
Figure 7.1 TUFLOW Manning's n 32
Figure 7.2 TUFLOW design model schematisation 33
Figure 7.3 Reprofiled void area flood map 1 of 2 35
Figure 7.4 Reprofiled void area flood map 2 of 2 36
Figure 7.5 1 in 1,000 AEP velocity around Woleebee dumps and voids 40
Figure 7.6 1 in 1,000 AEP velocity profile around Woleebee Creek Dump 41
Figure 7.7 1 in 1,000 AEP velocity profile around Woleebee North Dump 41
Figure 7.8 1 in 1,000 AEP velocity profile around Woleebee North Satellite Dump 42

List of Appendices

Appendix I Survey extents
Appendix II Stream gauge rating curve
Appendix III Flood frequency analysis
Appendix IV RORB model calibration
Appendix V IFD data
Appendix VI Flood modelling maps
Appendix VII PMF modelling methodology and maps
Appendix VIII RFI Response

List of Acronyms

General terms

AEP	Annual exceedance probability
AHD	Australian height datum
ARF	Areal reduction factor
ARI	Average recurrence interval

TABLE OF CONTENTS
(continued)

ARR	Australian Rainfall and Runoff
Artificial feature	For land the subject of a PRCP schedule, means: a) a structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or b) a structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land is the relevant activities the subject of the PRCP schedule had not been carried out; or c) a feature forming part of the landform of the land, other than a natural landform, if the feature interferes with or affects – i. a relevant watercourse, or ii. the natural flow of water on the land (DETSI 2024)
AVM	Average variability method
BOM	Australian Government - Bureau of Meteorology
CHPP	Coal handling and preparation plant
CL	Continuing loss
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DETSI	Department of Environment, Tourism, Science and Innovation
DRDMW	Department of Regional Development, Manufacturing and Water
EA	Environmental authority under the *Environmental Protection Act 1994*
EIS	Environment impact statement
ERA	Environmentally relevant activity
EV	Environmental values
FFA	Flood frequency analysis
Flood plain modelling	For land the subject of a PRCP schedule, means modelling of the landform of the land: a) carried out under the ARR; and b) excluding any artificial features for the land. (Department of Environment and Science 2023)
GIS	Geographic information system
GPU	Graphics processing unit
GSDM	Generalised short duration method
GTSMR	Generalised tropical storm method
Haul Roads	Roads specifically for hauling coal across the mining lease
HPC	Heavily parallelised compute
IDW	Inverse distance weighting
IFD	Intensity frequency duration
IL	Initial loss
KCB	KCB Australia Pty Ltd
LOM	Life of mine
LP3	Log Pearson III distribution

TABLE OF CONTENTS
(continued)

MIA	Mine infrastructure area
ML	Mining lease under the *Mineral resources Act 1989*
Overburden emplacements	Final landform constructed from overburden removed for mining coal
PMF	Probable maximum flood
PMLU	Post-mining land use
PMP	Probable maximum precipitation
PMPF	Probable maximum precipitation flood
PRCP	Progressive rehabilitation and closure plan
Project area	Spatial extent associated with the ground disturbance areas
Reprofiled void depression	Reshaped mining pit depressed landforms
Ephemeral waterbodies	Waterbodies contained within reshaped reprofiled void depressions
ROM	Run of mine
RFFE	ARR 2019 regional flood frequency estimation technique
SEIS	Supplementary environmental impact statement
SGS	Sub grid sampling
SSP	Shared socioeconomic pathway
Strahler stream order	A method used to describe stream size based on the hierarchy of tributaries of the upstream network. (DETSI 2025)
The Proponent	Wandoan Holdings Pty Ltd
ToC	Table of contents
Watercourse	A watercourse as determined by the Department of Natural Resources and Energy under the *Water Act 2000*
Water year	1 September to 31 August, for the Dawson Valley Water Management Area. The Water Year starting in 2022 and ending in 2023 is the 2023 Water Year (BOM 2024)
WCP	Wandoan Coal Project

Legislation, policies and guidelines

EP Act	Environmental Protection Act 1994
EPP (WWB)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018
MLR Policy	Mined Land Rehabilitation Policy 2017
Water Act	Queensland Water Act 2000
WRP	Water resource plan

CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of KCB Australia Pty Ltd (KCB) and has been prepared for the exclusive use of Glencore Coal Assets Australia (Client) (on behalf of Wandoan Holdings Pty Ltd) for the specific application to the hydrologic and hydraulic modelling study for the Wandoan Coal Project. It may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
4. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
5. This report should not be relied upon as a final document for design, implementation and/or construction.
6. This report is electronically signed and sealed, and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

1 INTRODUCTION

KCB Australia Pty Ltd (KCB) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) to undertake surface water assessments to support the Wandoan Coal Project (the Project) progressive rehabilitation and closure plan (PRCP).

1.1 Project scope

The Project covers mining leases (ML) 50229, 50230 and 50231, to the west and northwest of Wandoan, as shown in Figure 1.1. The Project is an open cut coal mine authorised under environmental authority (EA) EPML00297613. However, since grant of the MLs in 2017, the Project has remained undeveloped.

The Project requires a PRCP to be developed. The hydrologic and hydraulic assessment for the PRCP is presented in this report. The report includes relevant legislative requirements and guidelines, background information and hydrologic and hydraulic modelling undertaken to characterise design flows and flood extents at the Project for the closure scenario.

1.2 Relevant legislation and guidelines

Regulations, guidelines and requirements relevant to the Project surface water assessments for closure include:

- The *Environmental Protection Act 1994* (EP Act) (State of Queensland 2025a) aims to protect Queensland's environment while allowing for ecologically sustainable development. To conduct an environmentally relevant activity (ERA), an environmental authority (EA) is required.
- The *Queensland Water Act 2000* (Water Act) (State of Queensland 2025b) aims to advance sustainable management and efficient use of resources by establishing a system for planning and allocation, and use of water. The act is enacted under the framework of catchment specific Water Resources Plans (WRPs) with the Project included in the Water Plan (Fitzroy Basin) 2011. The act includes criteria for determining watercourses and drainage features that require authorisation to interfere with the flow of water and overland flow, respectively.
- The *Mined Land Rehabilitation Policy 2017* (MLR Policy) (State of Queensland 2017) ensures land disturbed by mining is rehabilitated to a stable, environmentally safe condition for approved post-mining land use (PMLU). The policy includes binding milestones for progressive rehabilitation.
- The PRCP guideline (ESR/2019/4964) (DETSI 2024) helps applicants develop a PRCP, aligning with the EP Act and the MLR Policy using best practices and industry standards. This includes the information sheet *Voids in flood plains (ESR/2019/4966).*

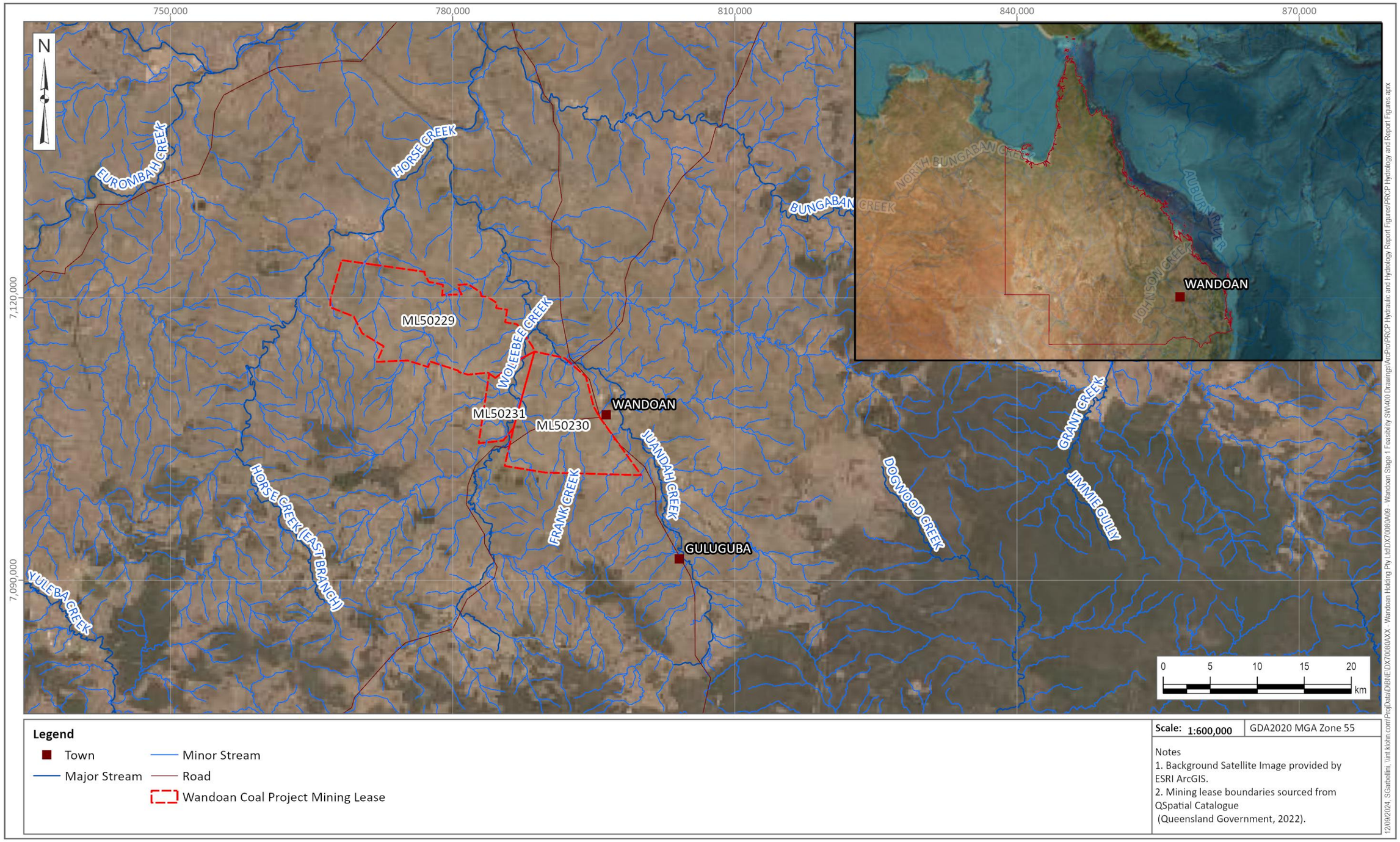


Figure 1.1 Project location

1.2.1 PRCP guideline

The requirements for flood modelling are detailed in the PRCP guideline (DETSI 2024) contained in:

- Section 3.4: Voids in flood plains;
- Section 3.6.1: General rehabilitation practices; and
- Section 3.6.3: Voids.

The specific requirements and comment on how they relate to this study are presented in Table 1.1.

Table 1.1 PRCP void closure plan requirements

Requirement	Comment
Section 3.4: Voids in flood plains	
The PRCP must include a flood plain model report developed by an appropriately qualified person that includes, but is not limited to:	KCB has developed a PRCP flood plain model which predicts flood levels for the Project for the 1 in 1,000 (or 0.1%) annual exceedance probability (AEP) event.
▪ Details of the data used to develop the model in accordance with section 4.13.3 of the Australian Rainfall and Runoff (ARR) (J. Ball et al. 2019).	▪ Refer to Sections 3, 5 and 6 of this report.
▪ Identification of all artificial features proposed or present with the tenure boundary.	▪ Refer to Section 3.3 of this report. ▪ In accordance with Section 4 of the DETSI Information Sheet – Voids in flood plains (DETSI 2025), flood modelling has been carried out excluding any artificial features. ▪ Definition of artificial feature presented in the list of acronyms in this report.
▪ Identification of all watercourses within the immediate catchment with the Strahler method of stream ordering applied.	▪ Refer to Section 2.3 of this report.
▪ Identification of any approved permanent watercourse diversion within the tenure boundaries and the relevant approval of the diversion.	▪ No permanent watercourse diversions are planned within the Project MLs.
▪ Consideration of how groundwater may impact the flood plain extent.	▪ Refer to KCB's PRCP groundwater assessment report (KCB 2025). Modelling results shows that expression of groundwater on the flood plain is not expected.
▪ A hydrologic model.	▪ A RORB hydrologic model has been developed as part of the PRCP hydrologic and hydraulic modelling study. ▪ Refer to Section 6 of this report.
▪ A hydraulic model.	▪ A TUFLOW hydraulic model has been developed as part of this PRCP hydrologic and hydraulic study. ▪ Carried out under ARR and excluded any artificial features of the land. ▪ Refer to Section 7 of this report.
▪ Model assumptions and limitations.	▪ Refer to Section 7.2 of this report.
▪ Model calibration and sensitivity analysis.	▪ Refer to Section 5.5 of this report.
▪ Spatial data outlining the extent of the flood plain.	▪ Flood extent for a 1 in 1,000 AEP event provided. ▪ Refer to Figure 2.4 of this report.
Section 3.6.1: General rehabilitation practices – flooding	
▪ The application must also assess the flooding susceptibility and influence across the site. If flooding is a consideration, develop a hydrologic model of the catchment and a hydraulic model of the proposed mining area.	▪ A RORB hydrologic model and TUFLOW hydraulic model have been developed as part of the PRCP hydrologic and hydraulic modelling study. ▪ Refer to Sections 6 and 7 of this report.
▪ Knowledge of flooding is integral to the rehabilitation planning process, including the placement and design of mine domains. ▪ When assessing flooding, you must at least: ♦ consider the location of domains in relation to potential flood levels; ♦ consider alteration of flow upstream and downstream; ♦ model flood levels (including probable maximum flood (PMF) levels) for a range of design storm events; and ♦ develop a flooding risk profile.	▪ Flood plain models have been developed which predict flood levels for the area prior to and during the Project. ▪ Flood levels for the 1 in 1,000 AEP event for the PRCP and climate change have been modelled. ▪ Flood levels for the PMF have been modelled. Refer to Appendix VII. ▪ Afflux has been determined based on existing flood profile. ▪ Flooding risk analysis has been completed. Refer to Section 7.3 of this report.
Section 3.6.3: Voids	
▪ If flood waters are likely to move over backfilled material, an assessment of the hydraulic properties must be conducted to assess whether instability may occur.	▪ Based on PRCP flood modelling, backfilled material is expected to remain outside the 1 in 1,000 AEP flood extent. ▪ Refer to Section 7.3 of this report for flood extent and location of backfilled materials.
▪ If flood waters are allowed to enter the void this may compromise the stability of the wall, which can increase the volume of floodwater entering the void.	▪ Based on PRCP flood modelling, all reprofiled void depressions are expected to remain outside the 1 in 1,000 AEP flood extent with no ingress of flood waters expected. ▪ Refer to Section 7.3 of this report for flood extent and location of reprofiled void depressions and associated waterbodies. ▪ Catchments contributing runoff to reprofiled void depressions have been minimised, where possible.

1.3 Report structure

The report structure is:

- Section 2: Project setting;
- Section 3: Flood assessment data (topography, rainfall, streamflow);
- Section 4: Modelling approach;
- Section 5: RORB hydrologic model calibration;
- Section 6: Rainfall estimates and hydrologic modelling outcomes; and
- Section 7: 1 in 1,000 AEP event design flood estimates for the Project.

2 PROJECT DESCRIPTION

2.1 Components

The Project includes:

- Open cut mining on ML50230 at the Leichhardt, Austinvale and Woleebee pits for the first 35 years of operation. Mine plans for these pits target the Upper Juandah Coal Measures (Kogan, Upper Macalister, Lower Macalister and Wambo coal seams).
- Open cut mining of all remaining pits for the final 35 years of the life of mine.
- Overburden emplacements adjacent to the open pits.
- Raw and mine affected water storages.
- Mine infrastructure area (MIA).
- Coal handling and preparation plant (CHPP).

The Project will be operated in accordance with EA EPML00297613, with the latest DETSI version taking effect on 2 December 2022 (DETSI 2022).

The approved pit disturbance areas for the Project are shown in Figure 2.2 along with the proposed mining scheduled shown in Figure 2.3.

2.2 Closure plan

The proposed final landform for the Project (as provided by the Proponent) is shown on Figure 2.4.

The mined pits will be progressively backfilled with spoil material during mining operations. Each mining pit will be backfilled with spoil to at least 5 m above the predicted post-closure groundwater level, with only shallow surface depressions to remain. This will reduce the number of voids remaining at closure from 16 to eight. It is also expected to prevent the ingress of saline groundwater into the remaining depressions and the associated decline of water quality (due to groundwater ingress) within the waterbodies which may form in the depressions. This has the potential to provide a water source for stock.

As such, shallow reshaped mining pit depressed landforms (herein referred to a reprofiled void depressions) are planned to remain at closure with no ingress of groundwater as opposed to deep final voids with base levels below the groundwater (i.e., sinks) and pit lakes (as traditionally expected to remain at closure for open cut mining pits). The planned reprofiled void depressions and associated waterbodies are depicted graphically in Figure 2.1 with the traditional final void and pit lakes presented for comparison.

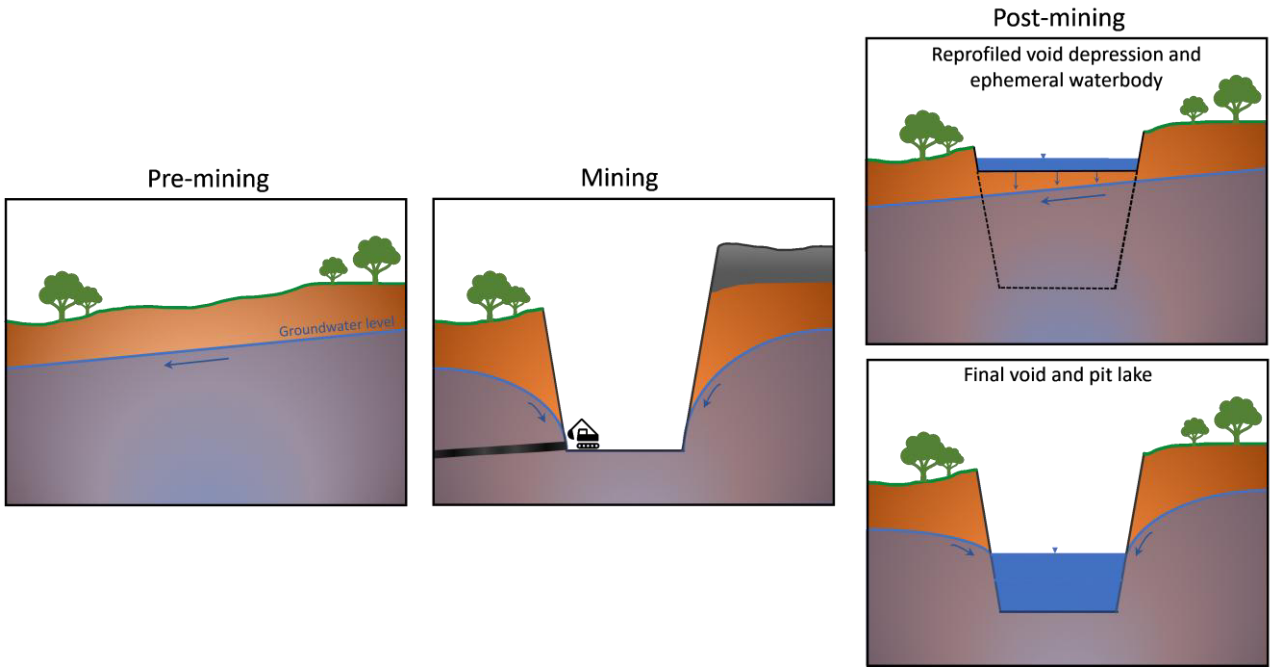


Figure 2.1 Reprofiled void depression

Key features of the reprofiled void depressions, as defined by the Proponent, include:

- Highwalls to remain where they comprise of material that is competent and unweathered, with slopes less than 214% (EA condition).
- Highwall weathered zone will be battered back to less than or equal to 22% (based on erosion studies) and revegetated to native bushland (EA PMLU) with grazing as a management tool where safety permits.
- Voids to be backfilled to be approximately 5 m above predicted post-closure groundwater levels.
- Low walls will be reshaped to less than 22% and will be geotechnically stable with appropriate erosion rates.
- PMLU for the low walls and reprofiled void depressions is grazing with cattle to access the void water of stock drinking quality (less than 4,000 mg/L for total dissolved solids (TDS)).

The final landform surface, prepared by the Proponent (GCAA 2024), is presented in Figure 2.4 and features the final landforms of the 16 mining areas. A summary of the physical characteristics of each mining area upon closure is provided in Table 2.1.

As shown in Figure 2.4 and Table 2.1, reprofiled void depressions are planned for eight of the mining areas (i.e., Summer Hill, Mud Creek, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul). The remaining eight mining areas (Turkey Hill, Mud Creek North, Mud Creek East, Woleebee North, Austinvale North, Leichhardt, Frank Creek North and Frank Creek South) will be reshaped to form free draining landforms.

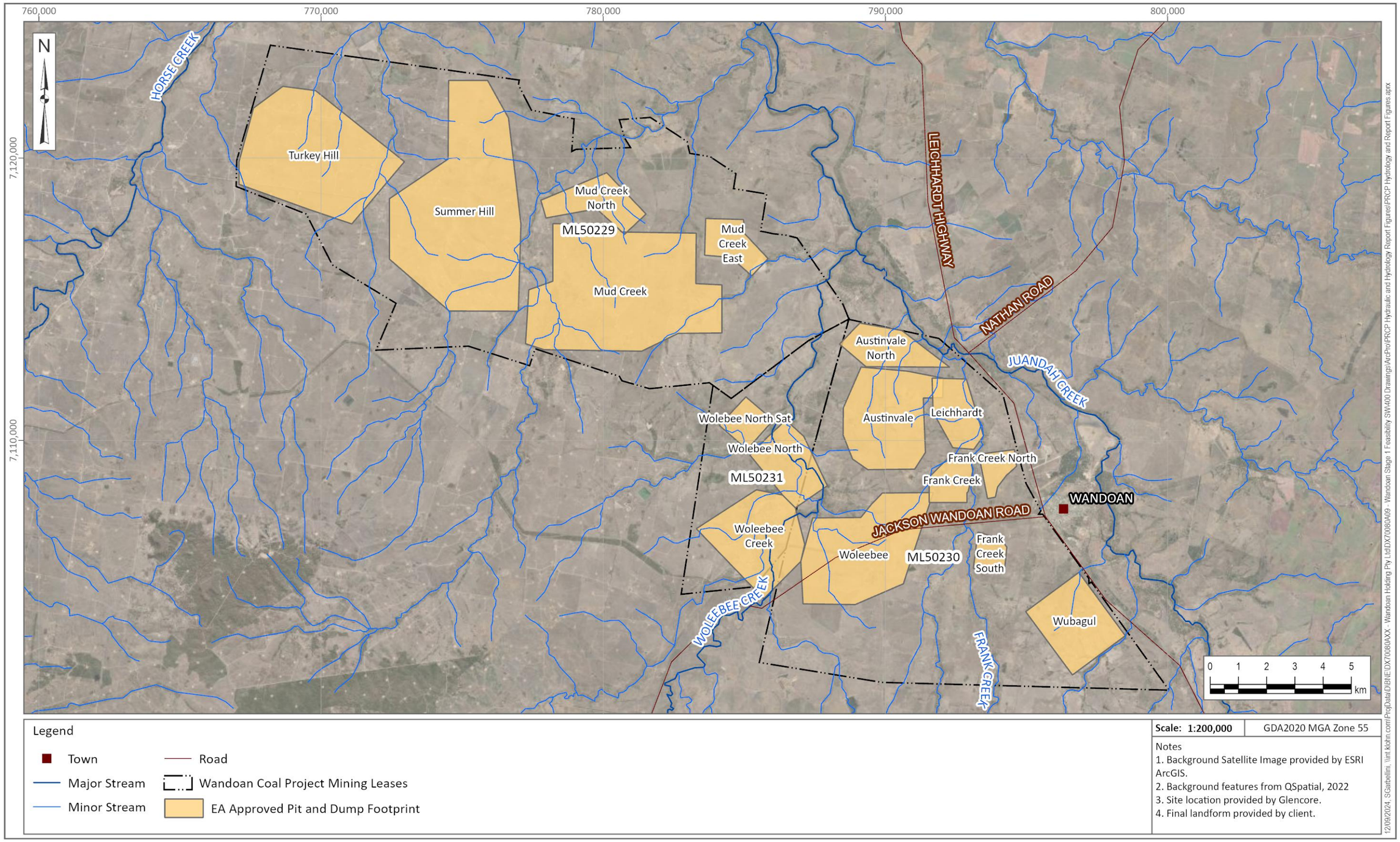


Figure 2.2 EA approved pit and dump footprint

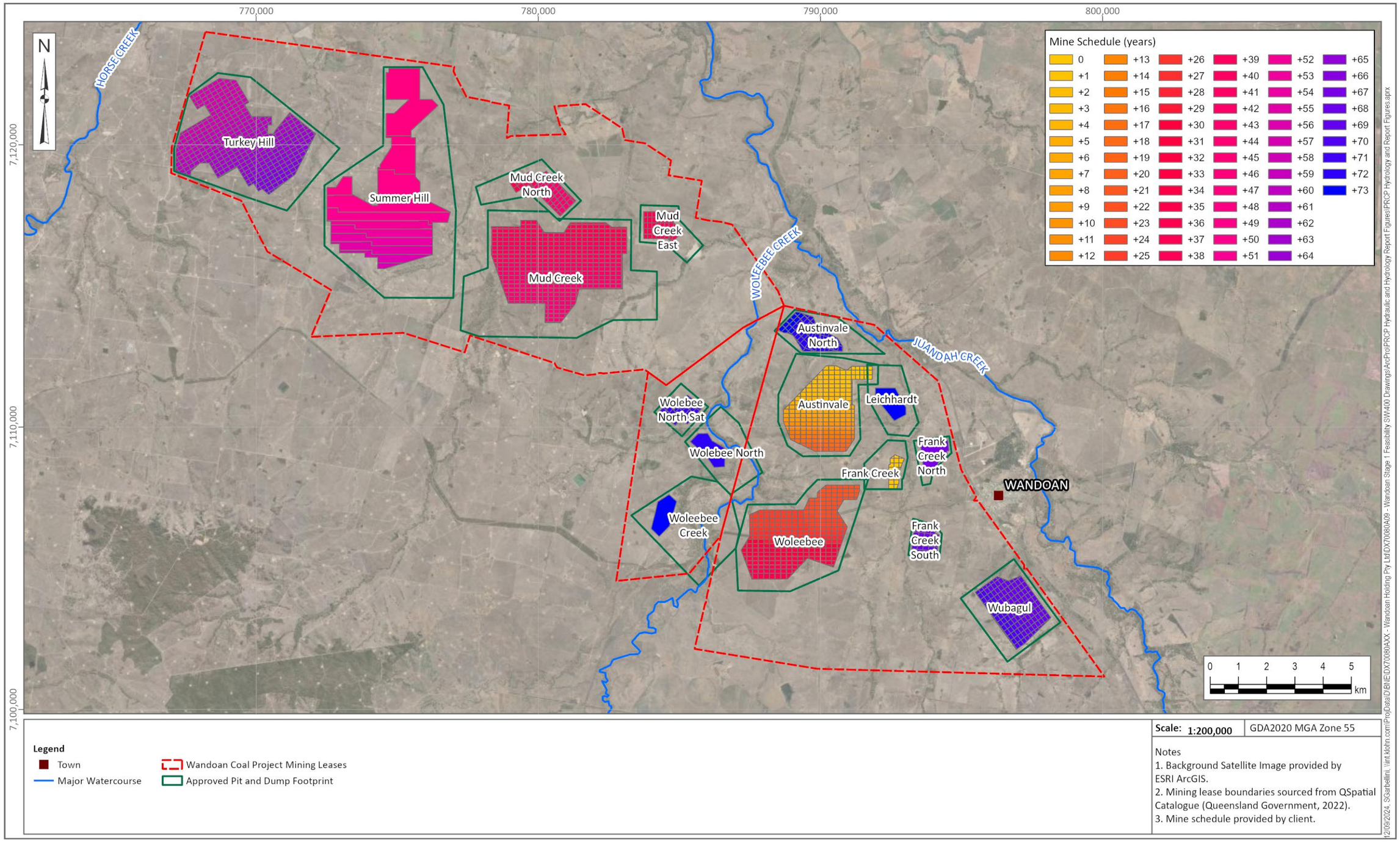


Figure 2.3 Pit and dump progressions over the life of mine

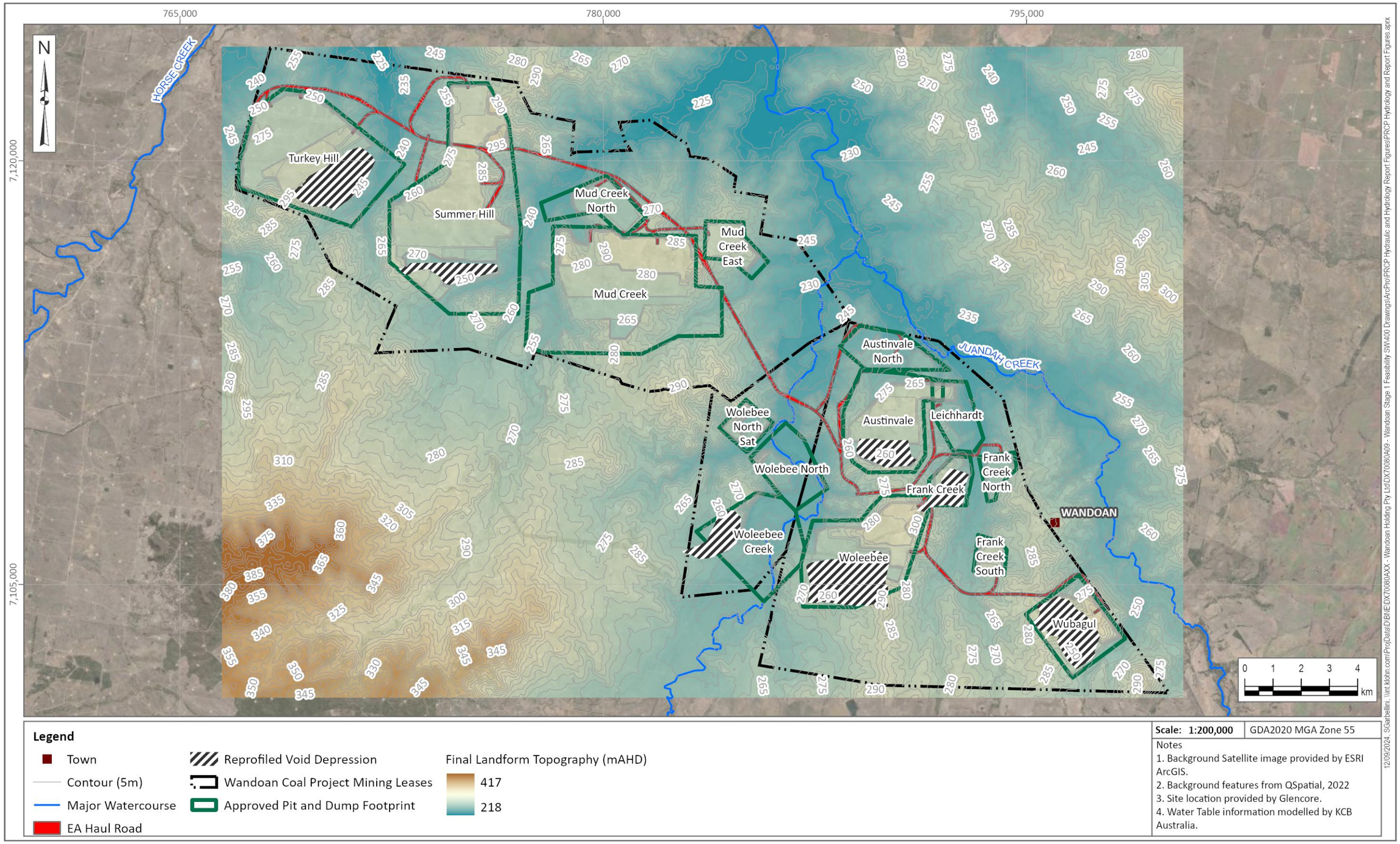


Figure 2.4 Final landform

Table 2.1 Summary of reprofiled void depression physical characteristics

Mining area	Closure date (year from start of mining)	Maximum storage capacity (GL)	Base surface area (ha)	Base level of depression (mAHD)	Crest level of depression (mAHD)	Outlet type	Receiving waterway	Reprofiled void depression
Turkey Hill	68	0	No depression			Free draining	Spring Creek	No
Mud Creek North	46	0	No depression			Free draining	Mud Creek	No
Mud Creek East	40	0	No depression			Free draining	Juandah Creek tributary	No
Woleebee North	74	0	No depression			Free draining	Woleebee Creek	No
Austinvale North	75	0	No depression			Free draining	Juandah Creek	No
Leichhardt	75	0	No depression			Free draining	Frank Creek	No
Frank Creek North	69	0	No depression			Free draining	Frank Creek	No
Frank Creek South	69	0	No depression			Free draining	Frank Creek	No
Summer Hill	59	3.6	104.1	249.0	252.2	Crest overflow	Mud Creek	Yes
Mud Creek	48	3.1	46.3	260.2	267.7	Crest overflow	Mud Creek	Yes
Woleebee North Satellite	73	1.4	22.9	247.5	253.2	Crest overflow	Woleebee Creek	Yes
Woleebee Creek	75	4.0	43.0	242.9	249.9	Crest overflow	Wandoan Creek	Yes
Woleebee	38	29.0	24.3	243.6	264.9	Crest overflow	Woleebee Creek	Yes
Austinvale	21	4.7	47.3	253.7	261.9	Crest overflow	Woleebee Creek	Yes
Frank Creek	1	1.4	13.6	241.0	246.1	Crest overflow	Frank Creek	Yes
Wubagul	72	9.3	85.5	250.0	259.9	Crest overflow	Two Mile Creek	Yes

2.3 Existing drainage network

The Project is in the Surat Basin, near the township of Wandoan.

The Project is in the Upper Dawson River sub-basin within the Fitzroy River Basin. The Fitzroy River Basin is Australia's second largest externally drained basin and the largest on the east coast. Covering an area of 150,000 km^2, the basin contains several significant tributaries, including the Nogoa, Comet, Mackenzie, and Dawson Rivers. The basin discharges into the Coral Sea east of Rockhampton.

Key streams (as shown on Figure 1.1) in the vicinity of the Project include:

- Juandah Creek: flows from the southeast of the MLs, towards the north to join the Dawson River, 3 km south of Taroom. Juandah Creek is joined by Woleebee Creek, Horse Creek from the south, and Bungaban Creek from the east before joining the Dawson River.
- Woleebee Creek: flows north from its headwaters through the MLs to join Juandah Creek to the northeast.
- Horse Creek: flows in a north-easterly direction on the western side of ML50229, to join Juandah Creek in the north, before joining the Dawson River.

Juandah and Woleebee Creeks are the main streams that run through the Projects MLs and are stream order five based on the Strahler system used to describe stream hierarchy. These creeks are named watercourses determined under the Water Act 2000.

Minor streams and drainage features are present throughout the Project area, as tributaries of the major streams described above.

There are several smaller named streams including Frank, Wandoan, Blackant, Mud Creeks (stream orders three to four), Mount Organ and Spring Creeks (stream order two to three) that run through the Project MLs. These named streams are mapped and defined as watercourses under the Water Act 2000. Halfway Creek (stream order three), Duck and Two Mile Creeks (stream orders two and three, respectively) and Tom's Gully (stream order one) are mapped drainage features under the Water Act 2000 along with several unnamed tributaries of Duck, Juandah, Spring and Woleebee Creeks.

Streams across the assessment area are ephemeral. This is a consequence of the watercourses being in a climate zone with seasonal rainfall and being in the upper reaches of the catchments, which means they have limited catchments. Ephemeral watercourses will typically only experience surface water flow during or immediately after heavy or sustained rainfall events (i.e., summer wet season). Following periods of flow, surface water will persist in the form of non-flowing, disconnected pools separated by dry / exposed stream beds.

3 PROJECT DATA

3.1 Previous studies

An environmental impact statement (EIS) and supplementary EIS (SEIS) were prepared for the Project in 2008/2009. The EIS and SEIS included assessment of regional flooding around the Project area. The hydrologic and hydraulic modelling presented in the EIS and SEIS has been considered in this report. It is noted that the previous modelling was undertaken using ARR87.

3.2 Topographic data

Topographic data includes data from inside and outside the Project ML boundaries, as presented in Table 3.1 in order of use to create the topographic surface. Areas where the Proponent-provided survey did not exist were supplemented with public data sources. Survey extents are presented in Appendix I.

Table 3.1 Topographic data

Rank	Filename	Cell size (m)	Projection	Vertical datum	Source
1	PRCP Updated Final Landform RevC 2024-05-16_Z_GDA2020	5	GDA 2020 MGA Zone 55	AHD	Proponent
2	LiDAR230815_GDA2020_Z55	1	GDA 2020 MGA Zone 55	AHD	Proponent
3	2011 Pre-Feasibility	5	GDA 1994 MGA Zone 55	AHD	Proponent
4	SRTM-derived 1 Second Digital Elevation model	30	GDA 2020 MGA Zone 55	AHD	ELVIS (Commonwealth of Australia (Geoscience Australia 2021)

3.3 Structures to remain

Features within the Project MLs expected to remain after closure include haul roads and water storages.

Haul roads:

- Several haul roads are expected to remain after closure and will be handed over to the landowners, as presented in Figure 7.1. Design of the haul road crossings for roads that will remain after closure results in the following flood modelling assumptions:
  - low-level crossing at a nominal elevation of 300 mm above the current surface;
  - no localised drainage; and
  - modelled as an impervious area.

Water storages:

- Several EA approved dams are also expected to remain after closure and will be handed over to the landowners for water storage (for reuse) as presented in Figure 7.1. These

dams were also modelled as impervious areas (i.e., assumed full under the 1 in 1,000 AEP flood event with rainfall reporting as runoff).

- Several reprofiled void depressions and associated ephemeral streams are expected to remain after closure as demonstrated by the final landform topography. Water balance modelling was undertaken to assess the potential for the reprofiled voids to fill and overflow into the regional watercourses. Outcomes of this assessment indicated that this is unlikely to occur. Accordingly, the catchment area for the reprofiled void depressions were removed from the regional watercourse catchments for the purpose of determining the post-mining 1 in 1,000 AEP flood extents.

All other artificial features (i.e., levees) will be decommissioned upon closure and have been removed for PRCP modelling.

3.4 Streamflow

3.4.1 Stream gauge

A stream gauge is located within the vicinity of the Project, on Juandah Creek, downstream of the confluence between Woleebee and Juandah Creeks (Figure 3.1). The catchment area reporting to the gauge is approximately 1,657 km^2. This stream gauge is operated by the Department of Local Government, Water and Volunteers (DLGWV) with details presented in Table 3.2.

Table 3.2 Stream gauge

Name	Gauge ID	Owner	Latitude	Longitude	Date range	Years of data collected
Juandah Creek at Windamere	130344A	DLGWV	-26.03	149.88	27/06/1974 to 20/03/2024	49.7

Annual, monthly, and daily streamflow recorded for Juandah Creek at Windemere are presented in Figure 3.2 to Figure 3.4. Review of streamflow volumes indicated that:

- Most of the streamflow occurs during high rainfall months of December to March, with the highest mean monthly streamflow occurring in December.
- When streamflow was evident, mean flows were consistently higher than the median and 75th percentile of non-exceedance flows.
- Flow was ephemeral with no flow for several months in the dry season (at least 50% of the time).
- Low to no flow months shown in the monthly streamflow figures were also captured in the daily streamflow with approximately 80% of daily flow recorded with less than 0.1 ML/d and no flow for 78% of the time.

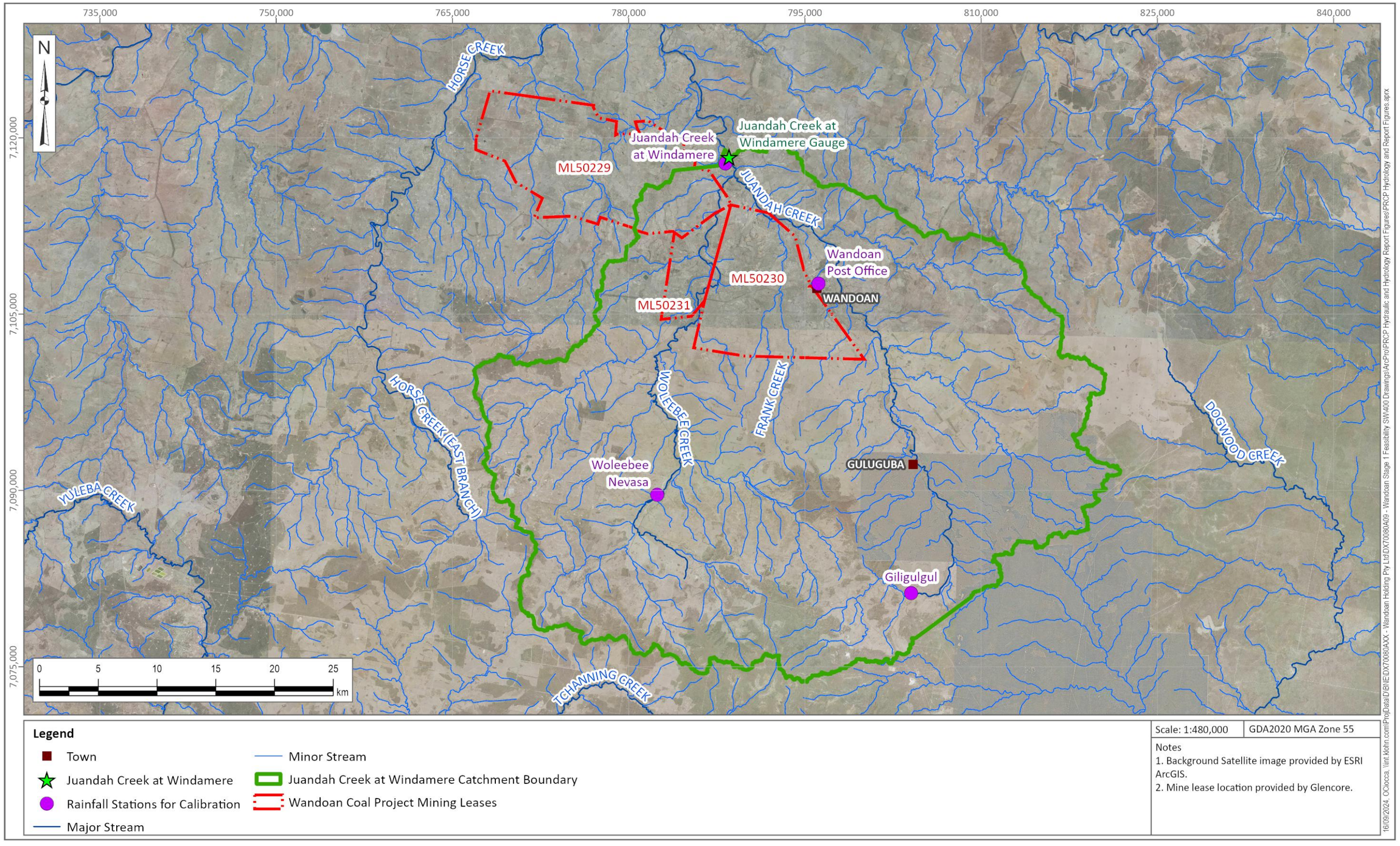


Figure 3.1 Stream and rainfall gauge locations

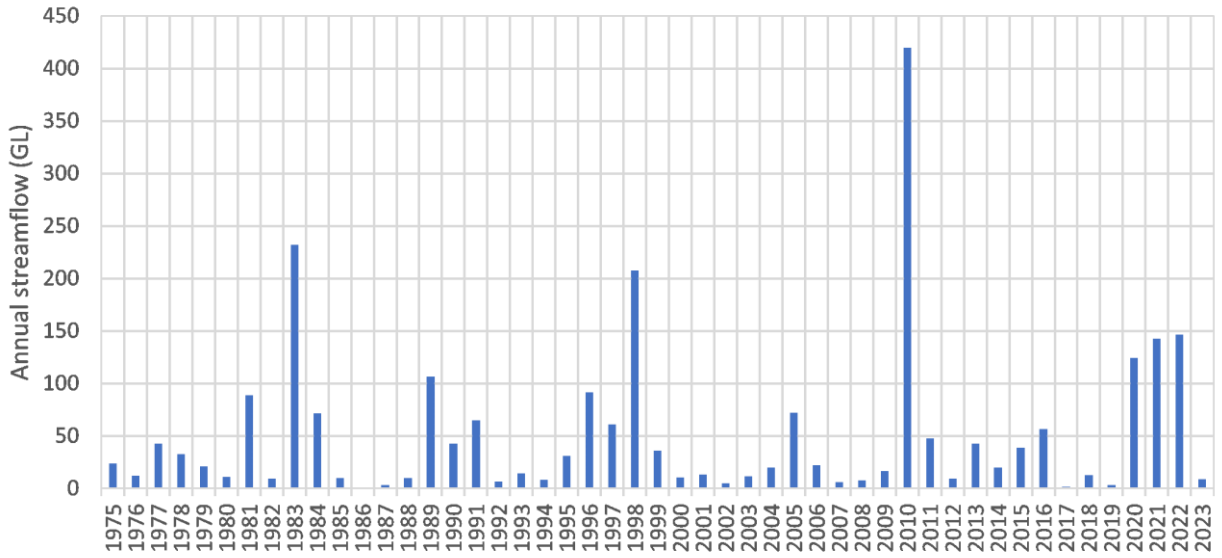


Figure 3.2 Annual streamflow – Juandah Creek at Windemere (130344A)

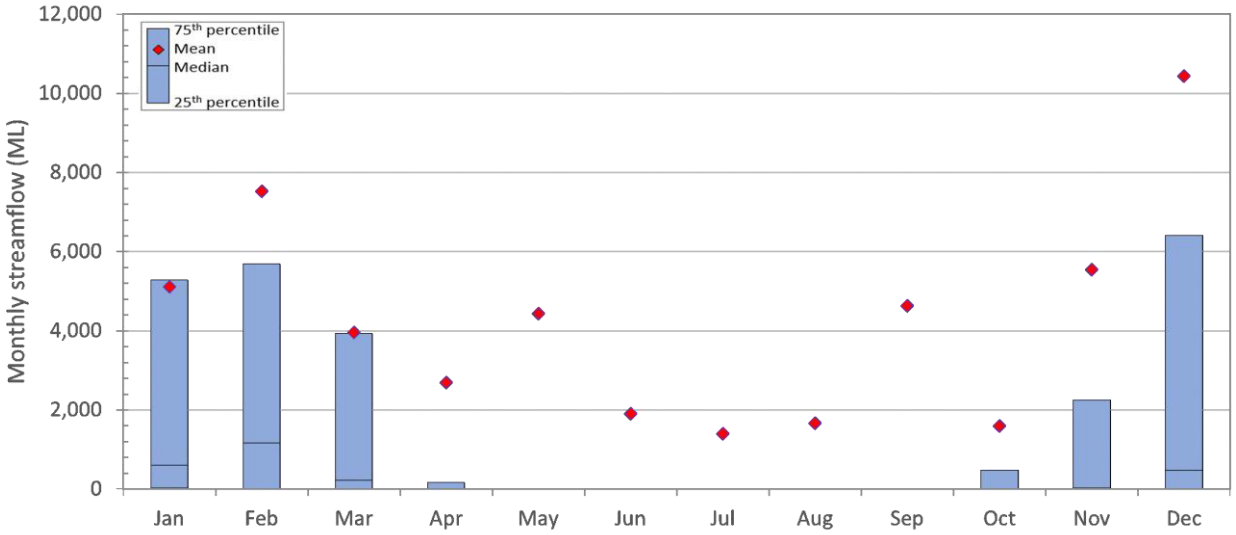


Figure 3.3 Monthly streamflow – Juandah Creek at Windemere (130344A)

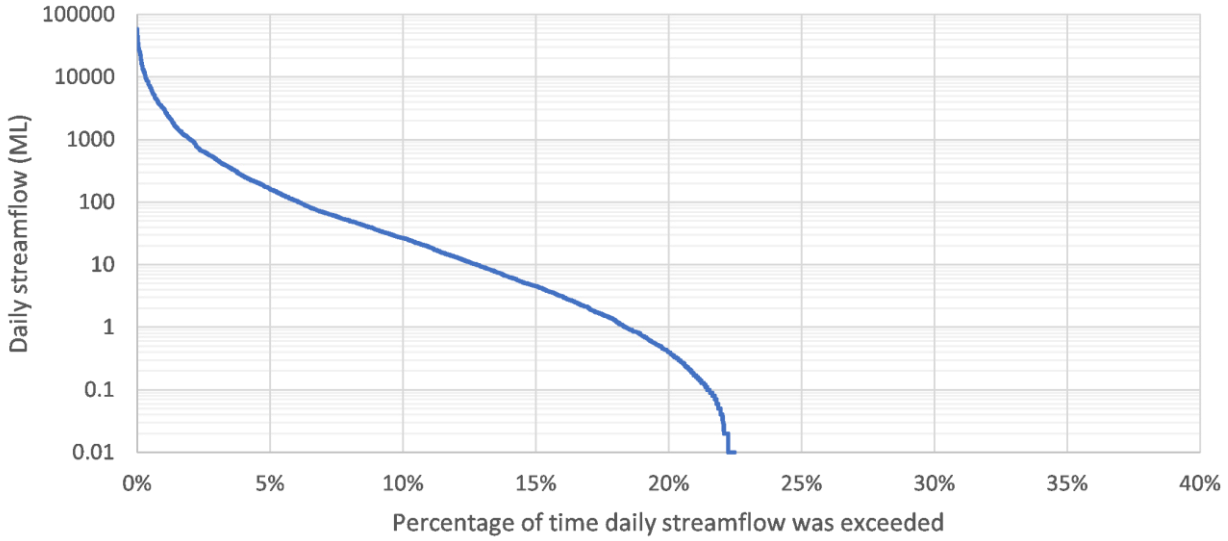


Figure 3.4 Daily streamflow – Juandah Creek at Windemere (130344A)

3.4.2 Rating curve

The rating curve for the Juandah Creek at Windemere stream gauge (valid from 13/05/2022 to date) and measured stream gauging obtained from the Bureau of Meteorology (BOM) Water Data Online portal (BOM 2023) are presented in Appendix II (Figure II.1). The gauge has been re-rated multiple times (22 in total) with the reason for re-rating unknown. However, it is likely a result of bed level changes following flood events or updates in the hydraulic modelling techniques used to derive the rating curves.

On review of the Bureau's rating curve and associated flow measurements, the maximum gauged level is within the channel. Several flood peaks have been recorded at levels where the flow is not confined to the channel. A TUFLOW two dimensional (2D) hydraulic model was developed for this Project to validate the Bureau's rating curve and extend the curve to account for 'out of channel' flows. The model was completed in 2023 and uses the 5 m cell size and the 2011 Pre-Feasibility LiDAR supplied by the Proponent which covers the gauge. The roughness coefficient (Manning's n) was selected based on photography and the wooded extent and foliage projective cover code layer for Queensland (Queensland Government 2015). To match the TUFLOW derived rating curve to gauged points, the Manning's n values within the creek channel were varied with outcomes shown in Appendix II (Figure II.2). The adopted TUFLOW derived rating curve had Manning's n values as follows:

- pasture and grass areas: 0.05 $s/m^{1/3}$;
- creek beds: 0.045 $s/m^{1/3}$;
- creek banks: 0.12 $s/m^{1/3}$; and
- heavily vegetated areas: 0.12 $s/m^{1/3}$.

Although there is agreement between the Bureau and TUFLOW ratings curves for flows within the creek channel, there is poor agreement between the two curves when the water level is above the stream banks. Potential reasons for the difference are that the rating curve could have been

extrapolated from gauged points and doesn't account for the topography of the flood plain, or if modelled using a different Manning's n for the flood plain. After review by third-party peer reviewers, the TUFLOW derived rating curve was adopted for the subsequent flood modelling. The TUFLOW derived rating curve has good agreement with measured water levels, inside the channel and outside of the banks.

3.5 Rainfall

3.5.1 Rainfall gauges

As shown in Figure 3.1, four rainfall gauges are located within the vicinity of the Project. Rainfall gauge records have been sourced from Bureau's Climate Data online, Bureau's paid pluviographic data or DRDMW with details of the records presented in Table 3.3 and Figure 3.5.

Each calibration event uses all available rainfall records for the event.

Table 3.3 Rain gauges

Name	Owner	Time Step	Latitude, Longitude	Available Record
Juandah Creek at Windamere (130344A)	DRDMW	Daily	-26.03, 149.88	1996 - 2023
Gilgulgul (3035029)	Bureau	Sub daily (6min)	-26.35, 150.04	1972 - 2017
Woleebee Nevasa (35081)	Bureau	Daily	-26.28, 149.82	1912 - 2023
Wandoan Post Office (35014)	Bureau	Daily	-26.12, 149.96	1955 - 2023

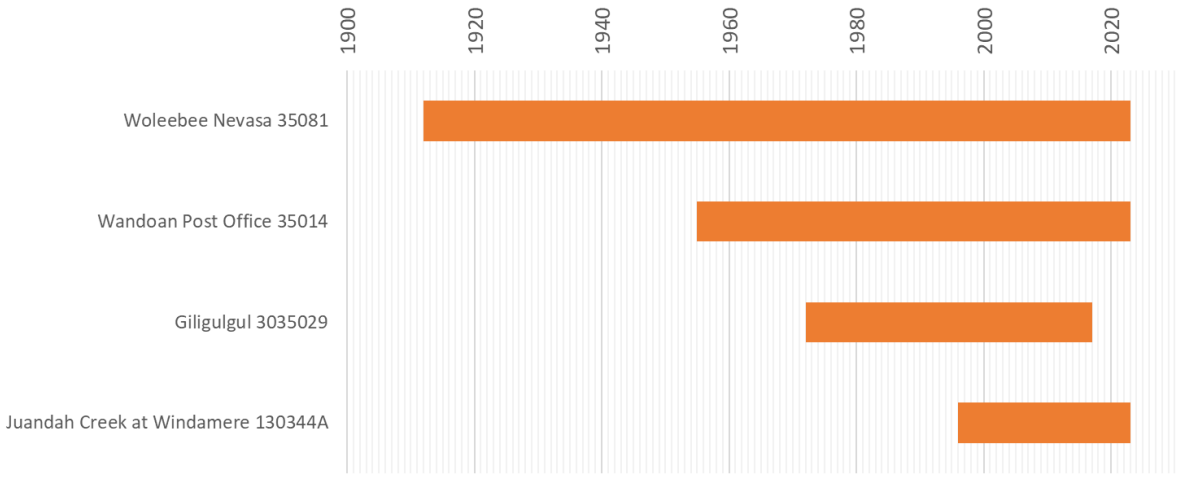


Figure 3.5 Rainfall gauges available record

4 MODELLING APPROACH

PRCP modelling undertaken to assess the flood behaviour in the Project area consisted of two key components:

- Hydrology – the simulation of rainfall – runoff processes to generate a series of hydrographs at respective sub-catchment outlets. Hydrologic modelling allowed for the rapid assessment of flood events and simulation of the propagation or attenuation of flood flows throughout the catchment. Hydrologic modelling was undertaken for:
  - parameter derivation (through RORB model calibration as presented in Section 5 and an at-site flood frequency analysis (FFA)); and
  - design flood hydrographs (for input into the hydraulic modelling as presented in Section 6).
- Hydraulics – the hydrodynamics of the flood flows through the Project included the simulation of flood level and extent, flow depths and velocities (as presented in Section 7). TUFLOW hydraulic modelling was used to gain an understanding of the flood behaviour/hazard across the Project site. Hydraulic modelling was undertaken for the PRCP case (for the 1 in 1,000 AEP event).

5 HYDROLOGY – PARAMETER DERIVATION

5.1 Overview

This section of the report outlines the outcomes of RORB calibration runs for the Juandah Creek at Windamere stream gauge assuming existing catchment conditions. Calibration to observed flood events has been undertaken to derive runoff routing parameters and inform the selection of design losses. To further inform the selection of losses, design runs have also been undertaken to compare and fit the flood frequency curves derived from RORB to the at-site FFA presented in Appendix III. A regional loss parameters set (IL = 36 mm and CL = 3.2 mm/hr) were used as a starting point and losses were calibrated from here.

This section along with Appendix IV (calibration results for gauged events) informs the selection of design parameters and the adopted design flood estimates which are discussed in Section 6.

5.2 Modelling approach

A hydrological model has been developed of the Juandah Creek catchment with upstream output locations at the Juandah Creek at Windamere stream gauge using the runoff routing software RORB version 6.45. RORB is a lumped runoff routing model used to calculated flood hydrographs from catchment, stream and rainfall inputs (HARC 2019).

Runoff routing models such as RORB rely on empirical parameters to convert rainfall into runoff and to route flow through a catchment. RORB uses two interrelated empirical routing parameters to adjust catchment response to rainfall: k_c, the principal model parameter that is related to the catchment response and average reach length; and m, a non-linearity parameter fixed at 0.8 in accordance with standard practice (Laurenson, E, M; Mein, R, G; Nathan, R, J 2010). RORB also includes an empirically based loss model to account for the affect that infiltration and other losses have on a flood hydrograph. An initial and continuing loss model has been used in this study for both calibration and design. This initial loss represents the antecedent conditions prior to the commencement of a storm and the continuing loss represents the average loss rate once the initial losses are satisfied (J. Ball et al. 2019).

The RORB model of the Juandah Creek at Windamere catchment has been calibrated to historic flood events recorded at the stream gauge. Parameters for the design flood hydrology model have been selected based on the outcomes of the calibration process along with fitting of the design model to the at-site FFAs presented Appendix III.

As noted in Section 3.4.2 there is poor agreement between the Bureau's rating curve and the TUFLOW derived rating curve, when the water level is above the stream banks.

Although there is agreement between the Bureau and TUFLOW ratings curves for flows within the creek channel, there is poor agreement between the two curves when the water level is above the stream banks. Previous calibrations completed in 2009 using the original rating curve, which has been found to underestimate flows in flood plains.

5.3 Model schematisation

A layout plan of the Juandah Creek RORB model is presented in Figure 5.1. The catchment boundary and subarea boundaries have been derived using available survey and the terrain analysis tools within HEC-HMS version 4.7. Some minor revisions were made to simplify the representation of the catchments (USACE 2021). The RORB model stream network has been derived in geographic information system (GIS) using available survey and aerial imagery.

Key RORB catchment model parameters are listed in Table 5.1.

Table 5.1 RORB catchment model parameters

Model parameter	Value
Catchment area	1,657 km^2
No. of sub-catchments	42
Sub-catchment areas	Average: 40 km^2 Minimum: 21 km^2 Maximum: 84 km^2
Average flow distance	36 km

5.4 Storm representation

Rainfall depths for the RORB model calibration scenarios have been derived for each sub-catchment from the rainfall gauging stations listed in Table 3.3. The temporal and spatial variation of rainfall across the catchment has been calculated using an inverse distance weighting (IDW) formula. The IDW formula estimates the amount of rainfall at each sub-catchment per model timestep based on the distance between the sub-catchment centroid and rain gauge.

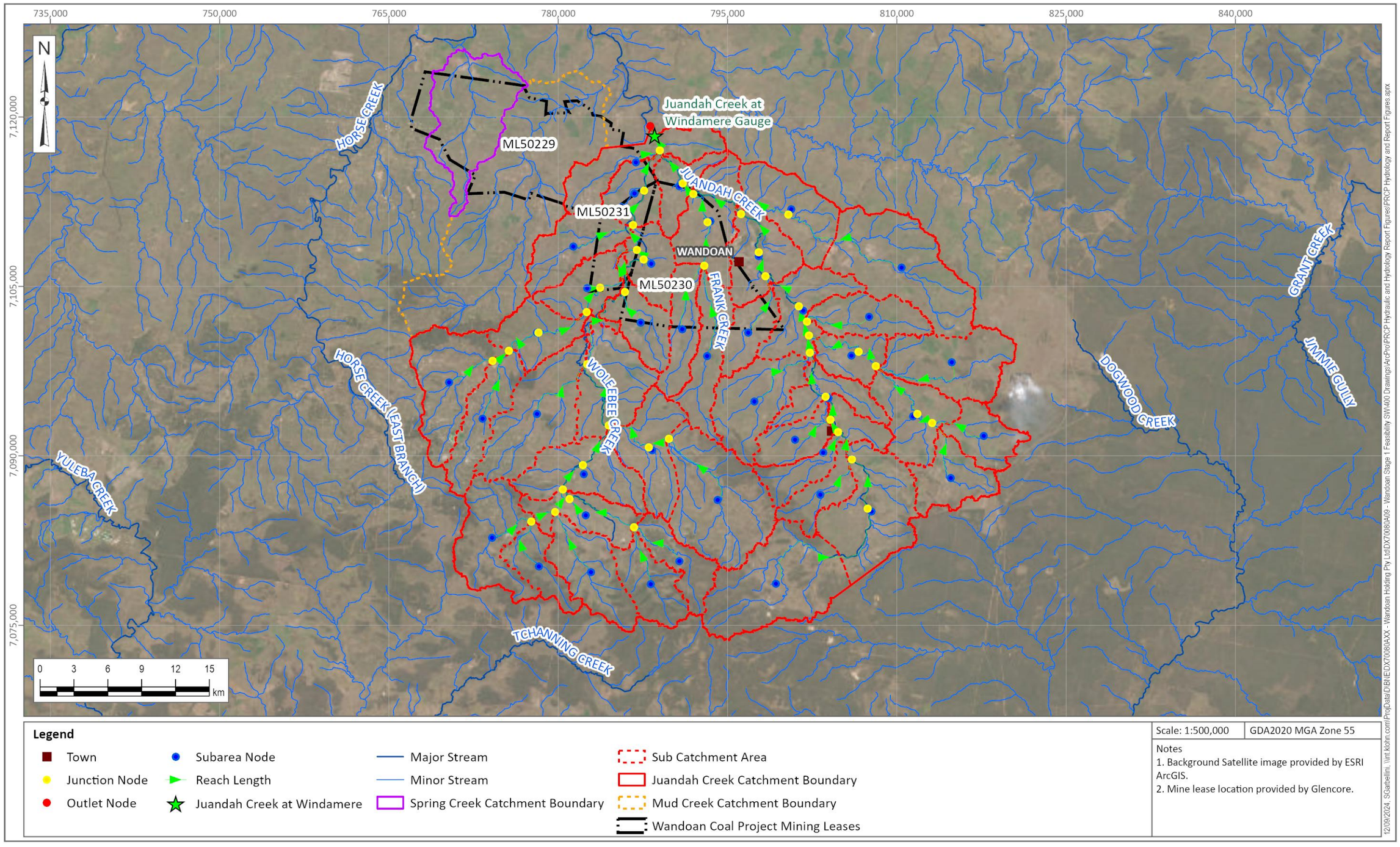


Figure 5.1 Juandah Creek RORB model schematisation

5.5 Model calibration

The model has been calibrated to five flood events recorded in the catchment. These events are December 2010. May 1983, February 1991, August 1998 and March 2010. Calibration results are presented in Table 5.2.

The calibrations have been performed in RORB as design event runs (design event runs are used to determine design hydrographs). The recorded flood hydrographs generally have a single defined peak; accordingly, a single burst has been used for all events. The calibration objectives adopted in order of priority were to achieve agreement between the modelled and recorded:

1. peak flow;
2. hydrograph shape (slope of the rising and falling limbs of the hydrograph) and the timing of the peak; and
3. volume.

Comparison of recorded and modelled hydrographs for the five historical flood events are presented in Appendix IV with good agreement between the recorded peak flow and modelled peak flow, with error in the range of ±5%. Additionally, review of the results presented in Appendix IV showed that reasonable agreement has also been achieved between the recorded and modelled hydrograph volumes, with volume error generally in the range of ±10.5%.

Calibrations which achieved a poor fit are likely the result of a combination of factors, including but not limited to:

- number and location of rainfall gauges within the catchment may not allow for adequate representation of spatial and temporal distributions where the rainfall intensity gradient of a given storm event is high (small intense storms over localised areas); and
- limitations and model error inherent to the RORB models.

Table 5.2 Calibration results

Event no.	Event	k_c (m=0.8)	Initial loss (IL) (mm)	Continuing loss (CL) (mm/hr)	Peak flow (modelled/recorded)	Volume error (%)
1	December 2010	46.0	36.0	0.0	1790 / 1869	-9.2%
2	May 1983	34.0	80.0	2.0	1628 / 1636	+4.3%
3	February 1991	36.0	110.0	4.0	1484 / 1518	+9.4%
4	August 1998	45.0	60.0	1.9	1470 / 1493	-10.5%
5	March 2010	40.0	60.0	1.1	951 / 958	-10.3%
Summary statistics						
Minimum		34.0	36.0	0.0		
Maximum		46.0	110.0	4.0		
Median		40.0	60.0	1.9		
Average		40.2	69.2	1.8		

Table 5.3 Comparison of k_c to published data

Event	k_c (m=0.8)	Regional (Weeks) (Weeks 1986)	Regional (Aus Wide Dyer) (Dyer 1995)
December 2010	46.0	44.8	40.7
May 1983	34.0		
February 1991	36.0		
August 1998	45.0		
March 2010	40.0		

From the calibration, a k_c value of 40 (median value) was adopted which is comparable to the Weeks and Dyer published values. Refer to Table 5.3.

5.6 Loss parameter derivation

The following modelling approach has been used for the loss parameter derivation.

Objective:

- The objective of rainfall-based event modelling through programs such as RORB, is to derive peak flows and design hydrographs for a given AEP. Rainfall data is used to simulate how water moved through the catchment during an event.

Loss values:

- Loss values were applied to the model to account for rainfall that is intercepted or infiltrated in the catchment.

Flood frequency comparison:

- Loss values derived were compared to the at-site flood frequency estimates to ensure the RORB model was consistent with recorded data. This approach is recommended by ARR where recorded data is available (J. Ball et al. 2019).

Loss parameters for Juandah Creek at Windemere gauge have been established by calibrating RORB design flood frequency curves to the at-site FFAs presented in Appendix III, for events up to the 1 in 100 AEP. The model does not extend beyond the 100 AEP as the flood frequency curve is extrapolated well beyond the observed data, and the model may therefore underestimate the uncertainty.

Figure 5.2 details the process in RORB to determine the mean flow for the FFA and loss parameter derivation.

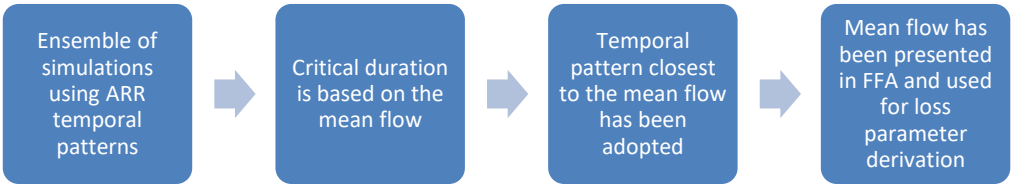


Figure 5.2 RORB model mean flow derivation

Specific inputs into the design RORB model used for derivation of design losses include:

- median k_c (of 40) derived from model calibration (refer to Section 5.5);
- ARR rainfall intensity frequency duration (IFD) data from Bureau;
- spatial distribution derived from ARR IFD data for the 1 in 50 AEP rainfall event at the centroid of each sub-catchment;
- ARR areal temporal patterns for the East Coast North region (the 1,000 km^2 set has been used);
- ARR areal reduction factors;
- ARR median pre-burst depths; and
- pre-burst temporal patterns from Jordan et al. (Jordan 2005) and Bureau (BOM 2006).

The above approach is consistent with the approach outlined for the derivation of design flood hydrographs presented in Section 6.

The resulting loss parameters are presented in Table 5.4. It has been assumed that the losses derived for the frequent and rare events are applicable for the 1 in 1,000 AEP event. As noted in ARR Book 8, the estimated of design loss values for very rare (1 in 1,000 AEP events) has to be based on observed rainfall, flood hydrographs and flood frequency data can be used to valid the derived loss values.

Table 5.4 FFA calibrated losses

Design event AEP	k_c (m=0.8)	IL (mm)	CL (mm/hr)
1 in 1,000	40	40	1.9

Review of the resulting loss parameters indicated that the values generally lie in the range of the losses derived from the model calibration. Constant losses have been adopted for all design events. Following that, the 1 in 1,000 AEP event required for this study was run using the adopted losses listed in Table 5.4.

The fit between the FFA calibrated loss (IL = 40 mm and CL = 1.9 mm/hr) and the at-site flood frequency curve is shown in Figure 5.3.

Figure 5.3 indicated that the above uniform loss parameters resulted in flood frequency curves that generally do not match the shape of the at-site flood frequency curve. The loss parameter sets over predict the peak flow for more frequent events and under predict the flow for rarer events. The fit between the uniform loss parameter sets and at-site FFA is reasonable between the 1 in 10 AEP and 1 in 20 AEP event.

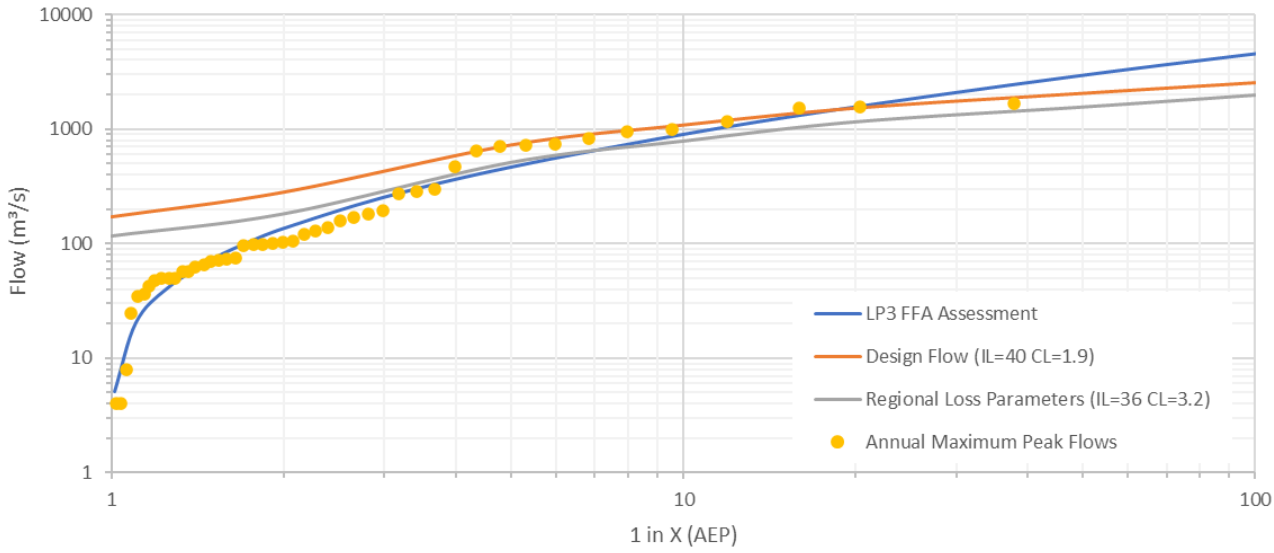


Figure 5.3 FFA and RORB flood frequency comparison

5.7 Adopted calibration parameters

Adopted RORB parameters for Juandah Creek, derived from the calibration process and FFA assessment, are presented in Table 5.5. The values will be scaled for the Mud Creek catchment and Spring Creek catchment based on average reach length.

Table 5.5 Adopted RORB calibration model parameters

Model parameter	Juandah Creek
k_c	40
m	0.8
IL	40 mm
CL	1.9 mm/hr

6 HYDROLOGY - DESIGN FLOOD

6.1 Overview

This section of the report outlines the selection of design hydrology parameters informed by the flood frequency analysis (Appendix III) and the RORB model calibration (Section 5).

Hydraulic modelling of the Project area has required the derivation of design flood hydrographs for the 1 in 1,000 AEP event, for three distinct catchments:

- Juandah Creek catchment:
  - catchment area of 1,645 km^2 which includes ML50230 and ML50231 and a portion of ML50229 (same as used for the Juandah Creek at Windamere gauge calibration);
  - catchment flows from the southern boundary of the Fitzroy Basin in a northerly direction; and
  - elevation range is from approximately 480 mAHD to 220 mAHD.
- Mud Creek catchment:
  - catchment area of 200 km^{2}which includes a portion of ML50229;
  - catchment flows from the southern boundary of the Fitzroy Basin in a northerly direction; and
  - elevation ranges from approximately 370 mAHD to 219 mAHD.
- Spring Creek catchment:
  - catchment area of 65 km^2 which includes and portion of ML50229;
  - catchment flows from the southern boundary of the Fitzroy Basin; and
  - elevation range from approximately 310 mAHD to 218 mAHD.

Catchment boundaries and the hydraulic model domain are presented in Figure 6.1. Design flood hydrographs for the Juandah, Mud and Spring Creeks have been estimated using RORB.

6.2 Hydrologic model schematisation

A schematisation of the Juandah Creek, Mud Creek and Spring Creek RORB design model layout is shown in Figure 6.1. The configuration of the Juandah Creek RORB design model is similar to the Juandah Creek calibration model, apart from catchment changes due to PRCP final landform surfaces (shown in Figure 2.4). Key RORB design model parameters are listed in Table 6.1.

Table 6.1 RORB PRCP design model parameters

Model parameter	Juandah Creek	Mud Creek	Spring Creek
Catchment area	1,645 km²	200 km²	65 km²
No. of sub-catchments	42	17	7
Sub-catchment area	Average: 39 km² Minimum: 20 km² Maximum: 84 km²	Average: 12 km² Minimum: 6 km² Maximum: 20 km²	Average: 9 km² Minimum: 6 km² Maximum: 11 km²
Average flow distance	36 km	18 km	7.2 km

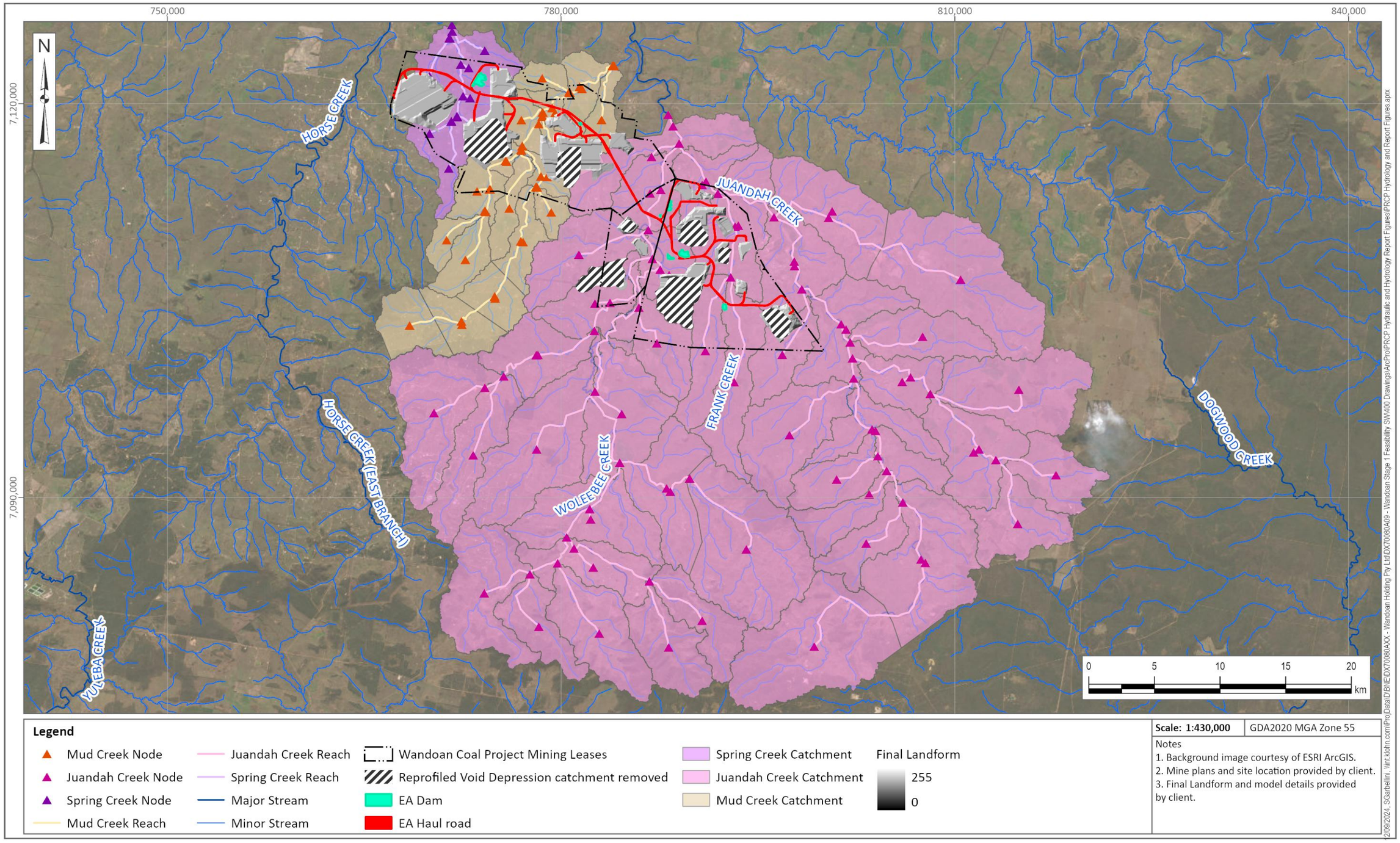


Figure 6.1 RORB design model schematisation

6.3 Runoff routing parameters

Adopted design runoff routing parameters are presented in Table 6.2. The median k_c for Juandah Creek catchment was determined through calibration, with k_c values for Mud and Spring Creek catchments scaled from the Juandah Creek catchment k_c using average reach length scaling. Average reach length scaling of k_c is the basis of some of the more modern regional relationships for k_c presented in ARR (J. Ball et al. 2019).

Table 6.2 Adopted runoff routing parameters

Model parameter	Juandah Creek	Mud Creek	Spring Creek
k_c	40	19.9	7.9
m	0.8	0.8	0.8

6.4 Design rainfall

Design rainfall information for the 1 in 1,000 AEP event has been sourced from the Bureau's 2016 design rainfall data system (BOM 2021). Areal weighted average point IFD for the Juandah Creek, Mud Creek and Spring Creek is presented in Appendix V.

6.5 Areal reduction factors

Areal reduction factors (ARF) for the catchments have been computed using the procedure outlined in ARR 2019 Book 2 Chapter 4 (Ball et al. 2019) for the 1 in 1,000 AEP event.

6.6 Temporal patterns

Representative temporal patterns for 1 in 1,000 AEP event have been selected for input into the hydraulic model using a rudimentary RORB model of the representative catchment.

The rudimentary RORB model uses the ARR design rainfall inputs for the three catchments with model outputs used for temporal pattern selection only. The temporal patterns which produced the flow closest to the mean outflow was selected as the representative temporal pattern for the hydraulic modelling input, with design temporal patterns presented in Table 6.3.

Table 6.3 Design temporal patterns

Event	Duration	Temporal pattern
1 in 1,000 AEP	Up to six hours	Generalised Short Duration Method (GSDM) and ensemble pattern from Jordan et al. (Jordan 2005)
	Six to 24 hours	Both 24-hour GTSMR areal patterns and longest duration GSDM patterns and ensemble pattern from Jordan et al. (Jordan 2005)
	24 hours and longer	Revised Generalised Tropical Storm Method (GTSMR) areal patterns (single and ensemble)

6.7 Spatial patterns

Spatial patterns adopted for the three catchments in the derivation of design floods are the GSTMR spatial patterns.

6.8 Losses

Losses within the RORB hydrologic model have been simulated using a storm approach for the 1 in 1,000 AEP event based on the calibration.

Design IL and CL adopted for all catchments are presented in Table 6.4.

Table 6.4 Design losses

Design event AEP	Storm IL (mm)	CL (mm/hr)
1 in 1,000 AEP	40	1.9

Pre-burst depths for the 1 in 1,000 AEP event have been derived through interpolation using the ARR datahub median pre-burst estimated value for the 1 in 1,000 AEP event and the probable maximum precipitation (PMP) rainfall event pre-burst estimates. The median pre-burst depths have been applied using a combination of pre-burst temporal patterns from Jordan (Jordan 2005) and Bureau's (BOM 2006).

6.9 Design flows and representative event selection

Design flows for Juandah, Mud and Spring Creeks are presented in Table 6.5. Ensemble mean design flows along with representative design events that have been selected for input into the hydraulic model are presented in the table below.

Table 6.5 Design flows (1 in 1000 AEP)

Catchment	RORB model output		Hydraulic model input	
	Ensemble mean flow (m^3/s)	Critical duration	Peak flow (m^3/s) (representative event)	Temporal pattern (representative event)
Juandah Creek	3,740	18 hours	3,379	GSTMR
Spring Creek	406	6 hours	404	Jordan DA74
Mud Creek	701	9 hours	708	GSTMR Average Variability Method

7 HYDRAULIC MODELLING

7.1 Overview

This section of the report outlines inputs and outcomes of the 2D TUFLOW hydraulic modelling of the Project area for the 1 in 1,000 AEP event. Sensitivity runs have been undertaken to assess the sensitivity of the outcomes to climate change.

7.2 Model setup

Key features relevant to the setup of the TUFLOW model are summarised in Table 7.1 and Figure 7.1. The hydraulic model extent, boundary conditions, hydraulic structures, computational grid size extent, calibration points and surface roughness classification zones are shown in Figure 7.1 and Figure 7.2.

Table 7.1 Hydraulic model setup

Item	Description
Software	TUFLOW Single Precision 2020-10-AD (latest release at the time of writing)
Solution scheme	TUFLOW heavily parallelised compute (HPC)
Hardware	Graphics processing unit (GPU)
Timestep	Variable, automatically selected to maintain model stability
Bathymetry	Survey data supplied by GCAA (see Section 3.2).
Bathymetry grid size	As per Table 3.1. Sub-grid sampling (SGS) of 5 m.
Computational cell size	10 m
Simulation time	Variable across the model runs. Checks have been undertaken to ensure that simulations capture the peak of the flood wave across the model domain.
Boundary conditions	Upstream: ▪ Inflow hydrographs at code boundary for catchments upstream of boundary. ▪ For catchments within code boundary, 2D source area polygons applied with hydrographs of individual catchment flow. ▪ For each catchment (Mud, Spring and Juandah Creeks), the maximum peak hydrograph for the event was used. Downstream: ▪ Rating curve based on normal depth. Placed at individual streams, perpendicular to the flow. The water surface slope to be selected through analysis stream slope immediately upstream and downstream of the outflow boundary.
Roughness	Hydraulic roughness has been represented across the model using Manning's n. Variable roughness zones have been delineated using the Australia wide vegetation layer developed by Gill et al. (Gill, T; Johansen, K; Phinn, S; Trevithick, R; Scarth, P; Armston, J 2017) and through review of aerial photography (Figure 7.1). Manning's n values have been selected from descriptions provided by Chow (Chow 1959) and model calibration (Section 5). Adopted Manning's n: ▪ pasture and grass areas: 0.05 $s/m^{1/3}$ ▪ creek beds: 0.045 $s/m^{1/3}$ ▪ creek banks: 0.12 $s/m^{1/3}$ ▪ heavily vegetated areas: 0.12 $s/m^{1/3}$ ▪ roads: 0.035 $s/m^{1/3}$; and ▪ dams: 0.02 $s/m^{1/3}$.
Structures	Roads remaining after closure have been modelled as low-level flood immunity crossings, nominally 300 mm above the surface (Section 3.3).

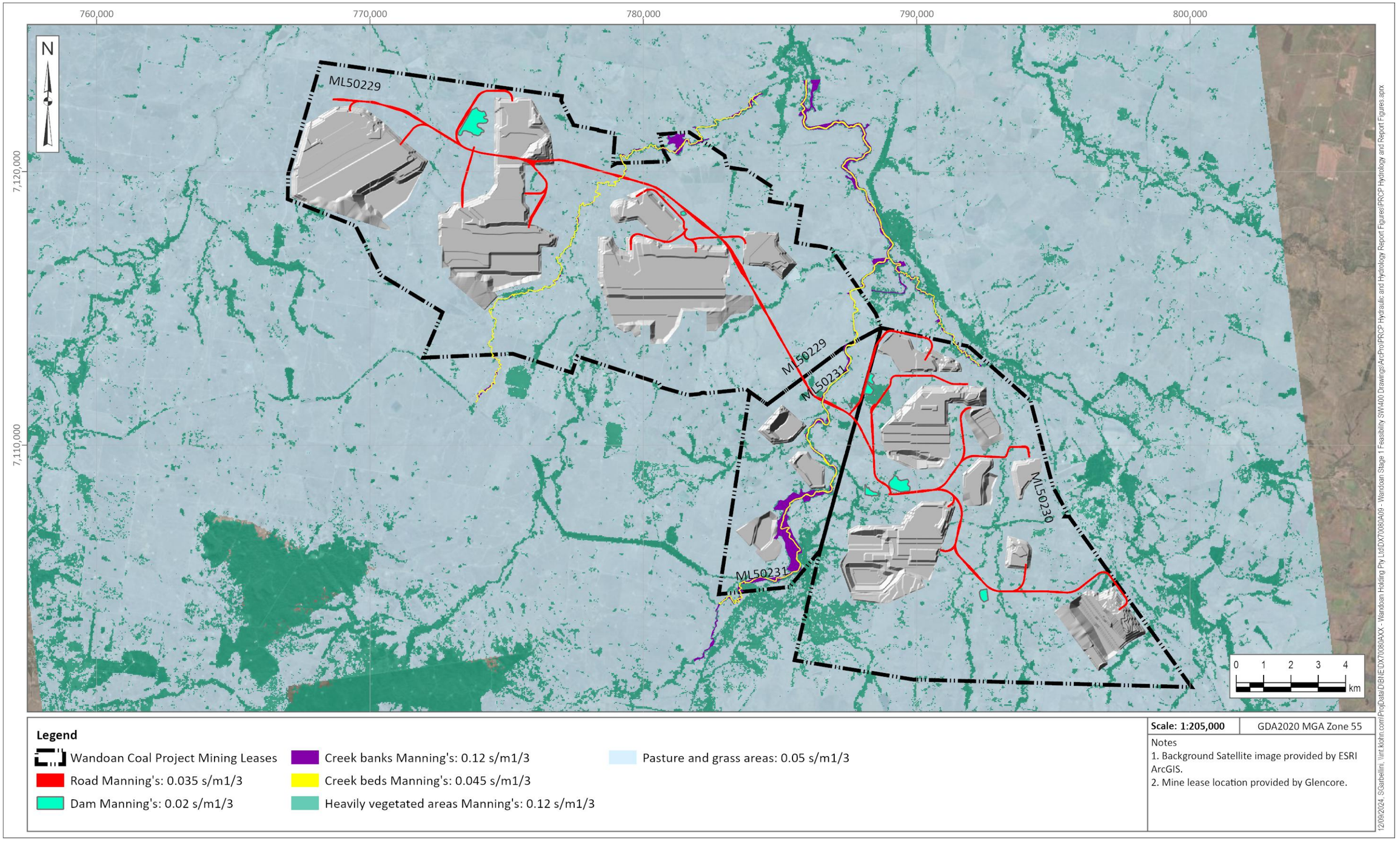


Figure 7.1 TUFLOW Manning's n

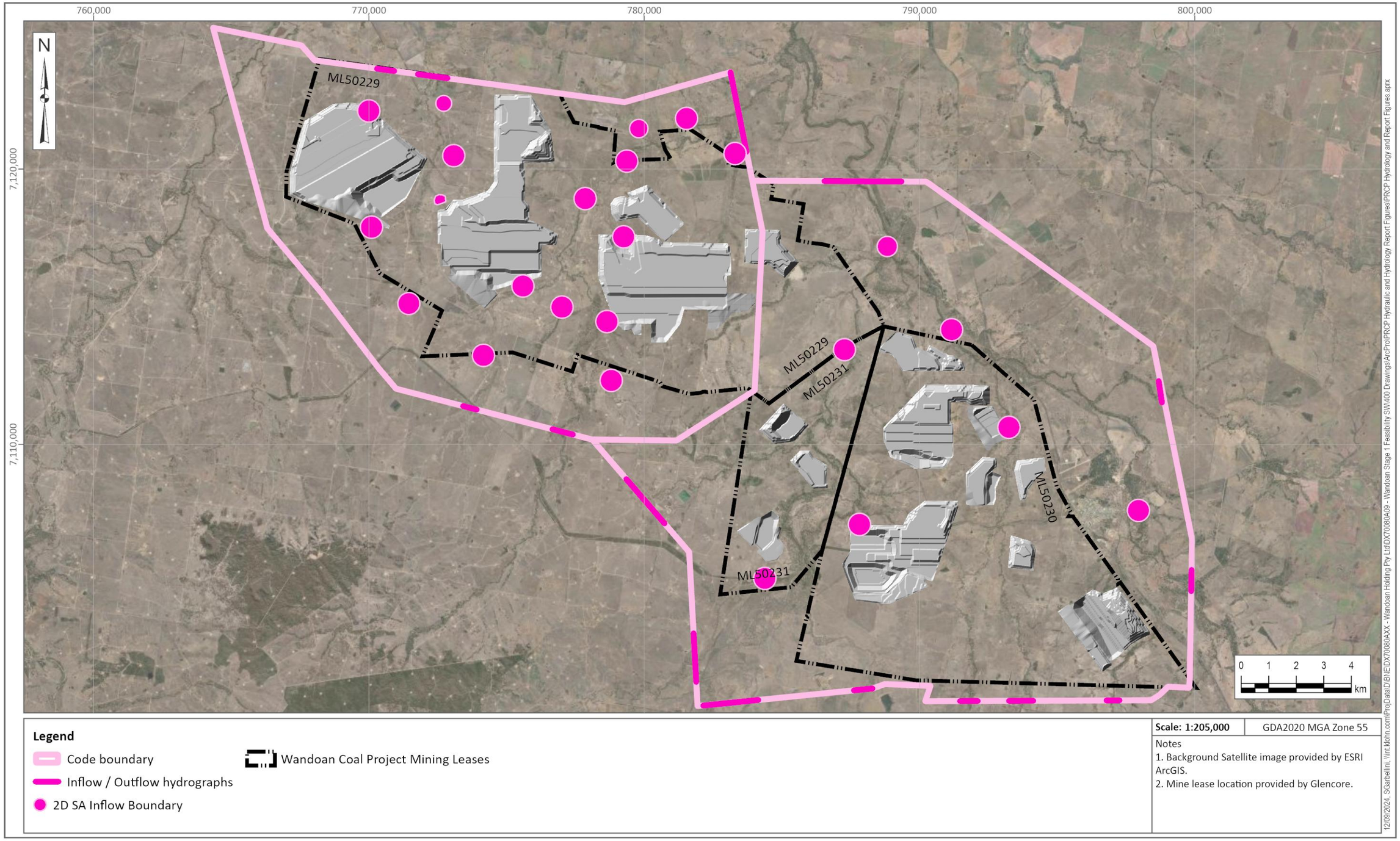


Figure 7.2 TUFLOW design model schematisation

7.3 Model results

Flood maps showing modelled flood depths, velocities, and flood extents for the 1 in 1,000 AEP design event are presented in Appendix VI. Figure 7.3 and Figure 7.4 shows the reprofiled void depression areas for the 1 in 1,000 AEP flood.

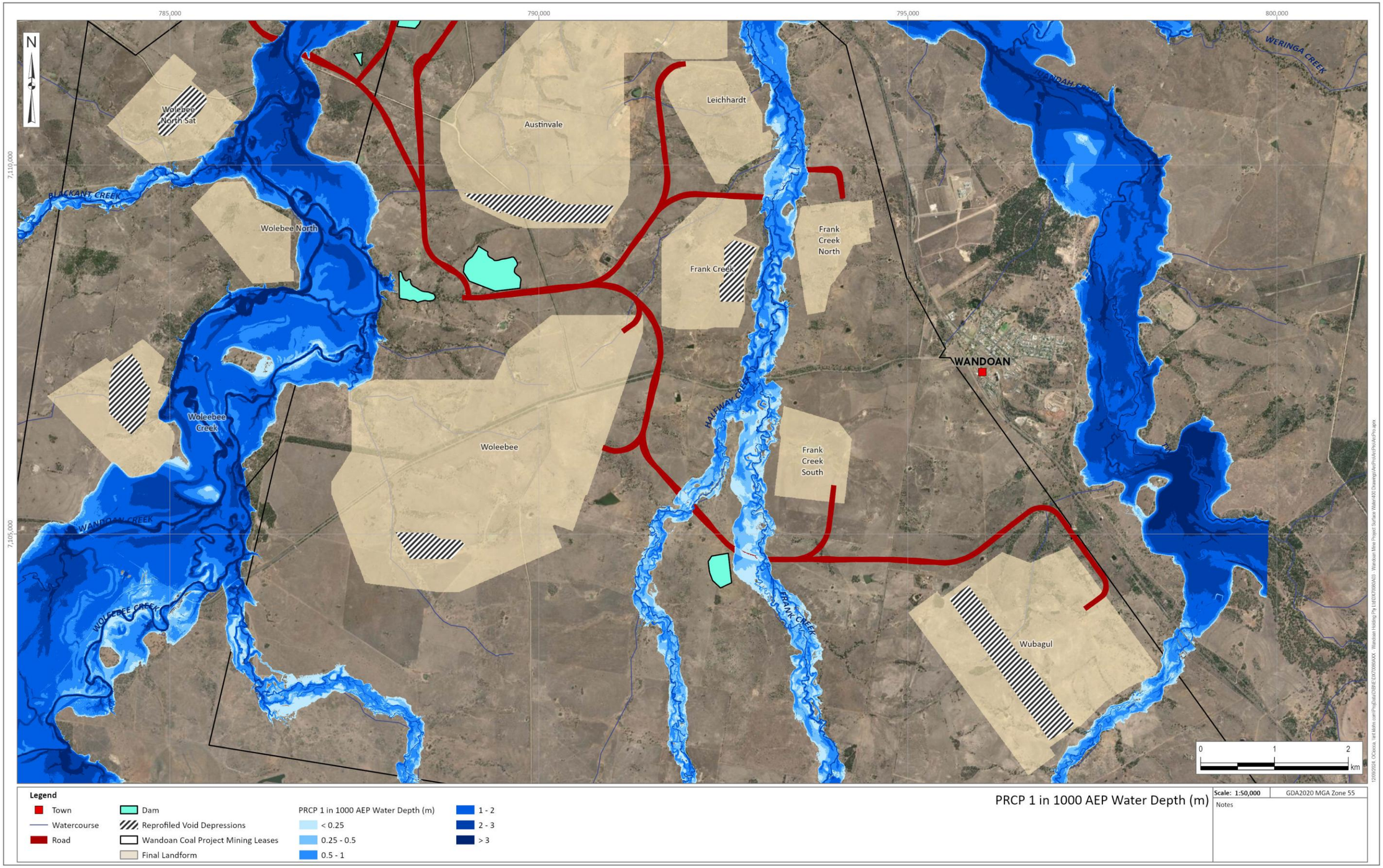


Figure 7.3 Reprofiled void area flood map 1 of 2

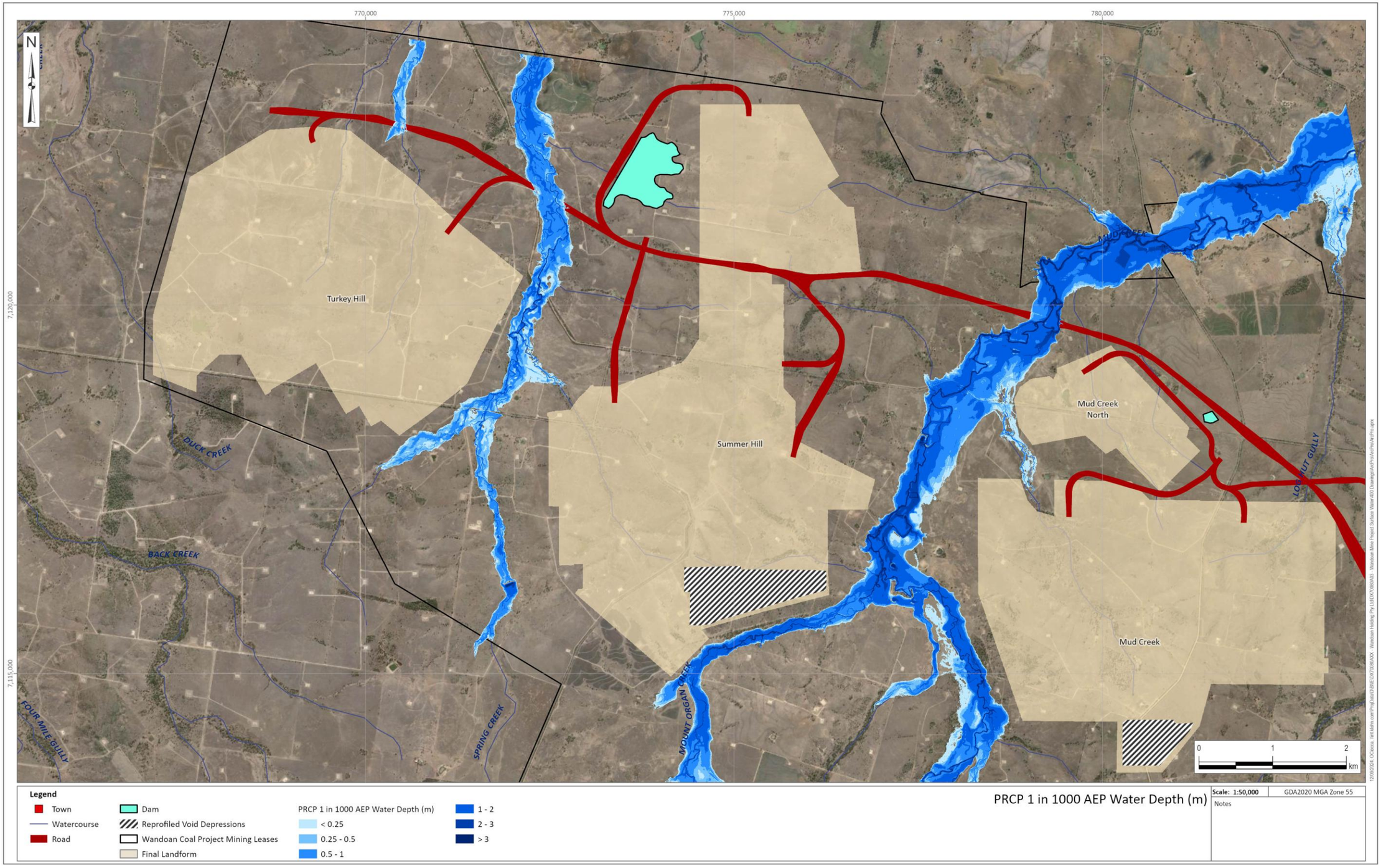


Figure 7.4 Reprofiled void area flood map 2 of 2

Flood model results indicated:

- Flood waters are not expected to ingress into the reprofiled void depressions and associated water storages for the 1 in 1,000 AEP event. Review of modelling outputs confirms that there are no voids within floodplains and no flow enters the catchment reporting to the reprofiled void depression (deactivated areas). Refer to Table 7.2 for overflow levels from reprofiled void depressions and corresponding 1 in 1,000 AEP flood level adjacent to the reprofiled void depressions.
- The flood waters are not expected to reach the level of the out-of-pit-dump toes proposed as part of the final landforms for most pits. There are minor interactions (depths >0.5 m) between flood water and out-of-pit dump toes for Woleebee Creek, Woleebee North and Woleebee pit. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour). Erosion plots have been assessed in section 7.3.2. Other pits (Wubgal, Woleebee North Sat, Frank Creek South) have minimal interactions between flood water and out-of-pit dump toes (depths <0.5 m). Flood water depths are presented in Table 7.2.
- Comparison of PRCP to existing (pre-mining) flood modelling is presented in Table 7.3.
- Flood waters are not expected to ingress reprofiled void depressions as there is minimum 1.3 m freeboard to inflow elevation for the void depressions (i.e., at a minimum, flood waters are 1.3 m lower than the inflow level of the reprofiled void depressions).

Table 7.2 Water at toe dumps and height to reprofiled void depression

Pit Name	Maximum Out-of-Pit Water Depth at toes (m)	Reprofiled Void Depression	Overflow Level from Reprofiled Void Depression (m)	Flood Level at Reprofiled Void Depression (m)	Freeboard to Reprofiled Void Depression (m)
Wubgal	0.42	Yes	259.9	258.6	1.3
Woleebee	1.86	Yes	264.9	247.6	17.3
Frank Creek	N/A	Yes	246.1	244.3	1.8
Austinvale	N/A	Yes	261.9	240.9	21
Woleebee Creek	2	Yes	249.9	246.8	3.1
Woleebee North Sat	0.48	Yes	253.2	239.8	13.4
Mud Creek	N/A	Yes	267.7	251.3	16.4
Summer Hill	N/A	Yes	252.2	243.8	8.4
Frank Creek South	0.11	No	N/A		
Frank Creek North	N/A	No	N/A		
Leichhardt	N/A	No	N/A		
Austinvale North	N/A	No	N/A		
Woleebee North	0.55	No	N/A		
Mud Creek East	N/A	No	N/A		
Mud Creek North	N/A	No	N/A		
Turkey Hill	N/A	No	N/A		

Table 7.3 Comparison of PRCP to existing (pre-mining) flood modelling

Streams	Flood depths	Flood velocities
Juandah Creek	▪ Downstream of the Project MLs, a decrease in the Juandah Creek water level up to 0.02 m. ▪ Adjacent to the Project, a slight increase of 0.05 m in water level due to impervious areas and inclusion of roads and dams.	▪ Downstream of the MLs, a 0 m/s to 0.02 m/s decrease of velocity is expected for Juandah Creek. ▪ Adjacent to the Project is expected to have a slight increase of 0.05 m/s in velocity because of the increase in impervious areas with the roads and dams and the inclusions of roads which are 300 mm above natural ground.
Mud Creek	▪ Decrease in water level in Mud Creek up to 0.02 m downstream of the Project MLs.	▪ Decrease in velocity in Mud Creek of up to 0.02 m/s downstream of the Project MLs.
Spring Creek	▪ There is a minor increase of water level of 0.02 m to 0.1 m expected downstream of Spring Creek because of the small catchment change from the final landform design from Mud Creek catchment to Spring Creek catchment.	▪ Minor increase of velocity of 0.02 m/s to 0.1 m/s expected downstream of Spring Creek because of the small catchment change from the final landform design from Mud Creek catchment to Spring Creek catchment.

7.3.1 Risk analysis

The final landform design has been developed to minimise voids and if voids exist, provide flood immunity up to the 0.1% AEP flood event. As shown in Table 7.2 the minimum freeboard of the 0.1% AEP flood level to voids is 1.3 m and ranges from 1.3 m to 17.3 m. The flood risk is considered to be low based on the final landform design.

7.3.2 Erosion at Woleebee Creek, Woleebee North and Woleebee North Satellite voids and dumps

Figure 7.5 details the 1 in 1,000 AEP velocity around the Woleebee Creek, Woleebee North and Woleebee North Satellite voids and dumps. No voids are impacted by ingress of flood water in the 1 in 1,000 AEP event. Figure 7.6 to Figure 7.8 shows detailed plots of the velocity at a 10m offset from the toe of the dumps. The maximum velocity ranges from 0.025 m/s to 0.82 m/s at a 10m offset from the toe of the dumps. For the toe of the dumps, scour will be mitigated through grassed vegetation of the final landforms. Vegetated landforms can withstand velocities of 1.2 m/s to 1.8 m/s (Fischenich 2001).

For the pre-mining catchment conditions, it is expected that naturally occurring processes would result in elevated sediment loads in the watercourse for the 1 in 1,000 AEP event. While modelling indicates that some small sections of the final landform dumps may be exposed to the 1 in 1,000 AEP flood waters, the potential for erosion from this interaction with the flood waters is not expected to significantly increase the background sediment load in the watercourse.

Scour protection is not designed for the PMF. The theoretical definition of PMP is the largest depth of precipitation for a given duration that is physically possible over a given size storm area, at a particular location at a certain time of year. The likelihood of a PMP event in the Juandah Creek is 1 in 603,500. The PMF is the maximum flood which a catchment could be reasonably expected to

generate. It represents a notional upper limit of flood magnitude and there is no AEP associated with such an event.

The PRCP guidelines state that voids in floodplains should be designed to withstand a 1 in 1,000 AEP event. The PMF is not used as a design criterion for the PRCP. PMF flood plain modelling is completed for information only and is not used to sized erosion protection.

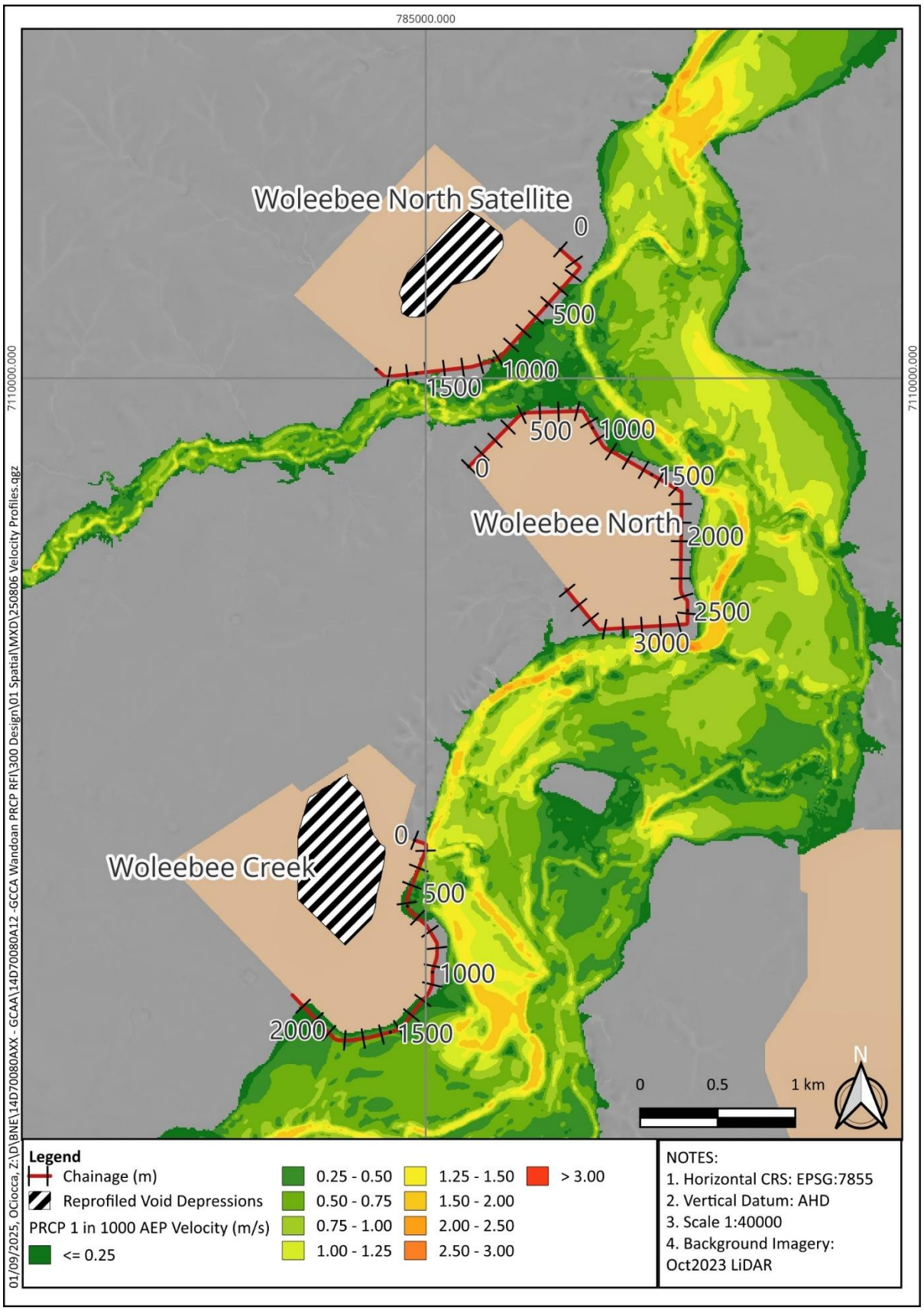


Figure 7.5 1 in 1,000 AEP velocity around Woleebee dumps and voids

Figure 7.6 1 in 1,000 AEP velocity profile around Woleebee Creek Dump

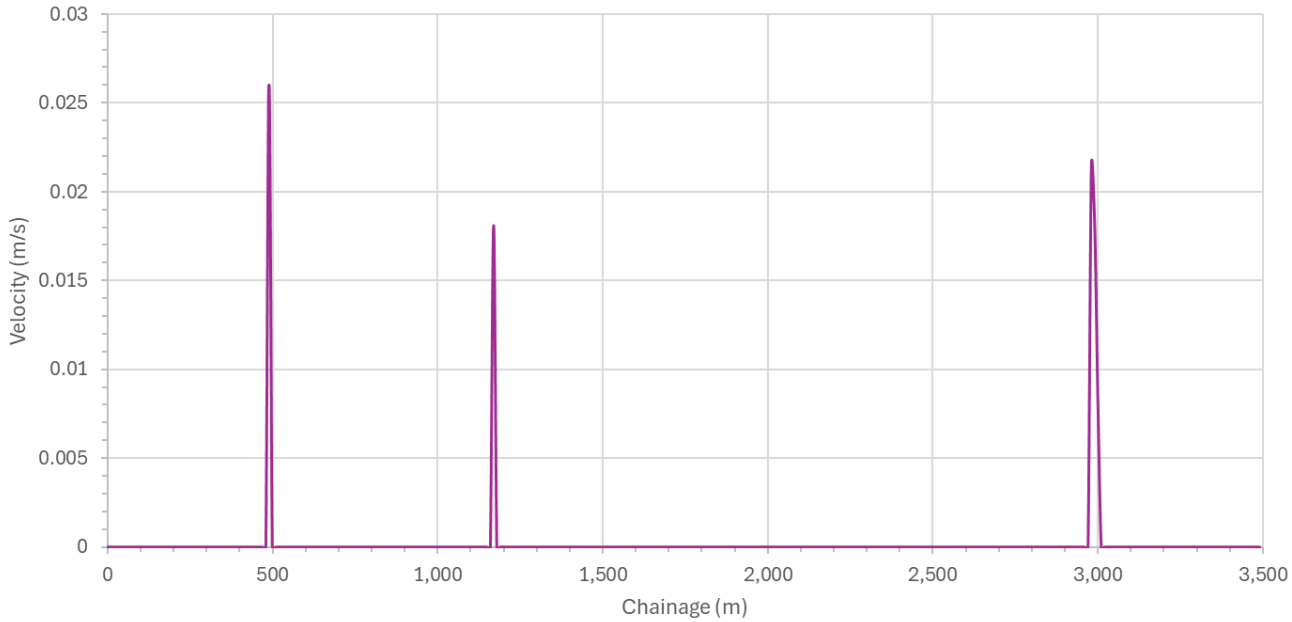


Figure 7.7 1 in 1,000 AEP velocity profile around Woleebee North Dump

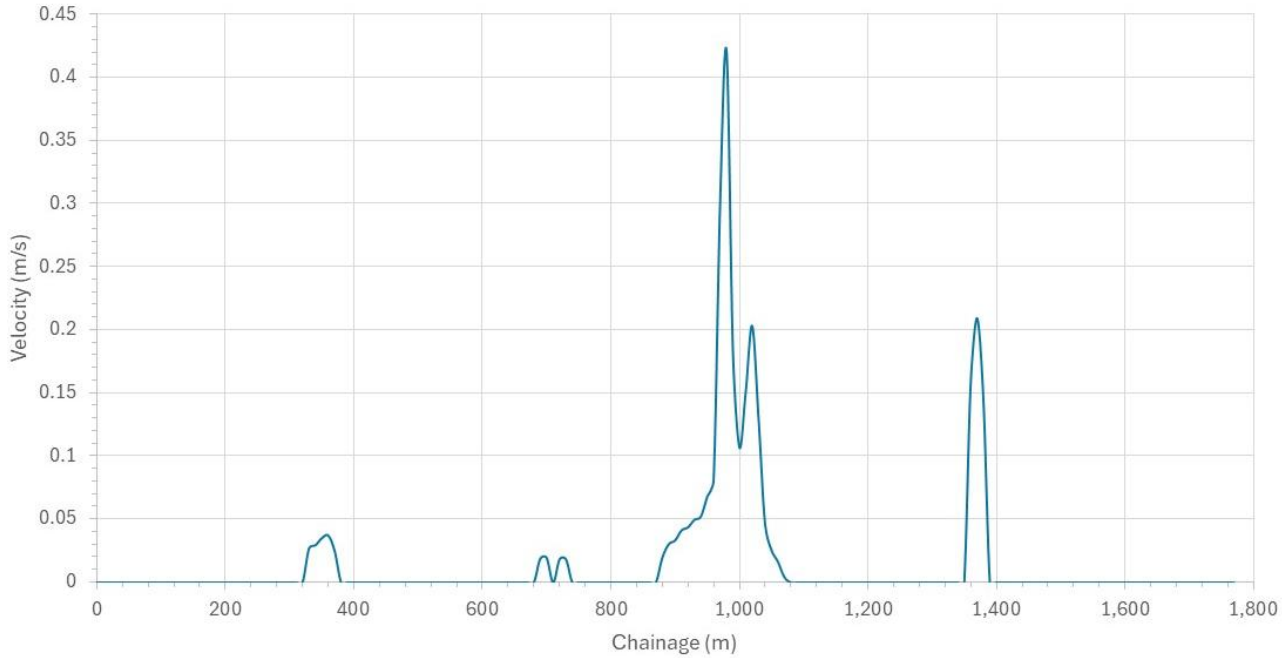


Figure 7.8 1 in 1,000 AEP velocity profile around Woleebee North Satellite Dump

7.4 Climate change

The recently released draft update to the *Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation* (DCCEEW 2023) provides guidance on the estimated impact of climate change upon extreme rainfall and flood risk. While it is acknowledged that the guidance is in draft, it is considered suitable for estimation of future flood impact given it is based on recent climatic science, projections and observations.

Through discussions with the third-party peer reviewers, the shared socioeconomic pathway (SSP) 2-4.5 (medium) with the long-term projected date of 2100 was adopted for this study. The median of published estimates has been used to factor event depths and losses.

The following parameters were used in the climate change assessment as per the draft update to the *Climate Change Considerations chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation*:

- long-term expected LoM (2081-2100);
- climate scenario of SSP2-4.5 (1.9 – 3.8), adopting a median of 2.7°C;
- extreme rainfall depth has been factored based on the East Coast region; and
- IL and CLs factored based on the East Coast region are applied.

Factored rainfall depth and losses used for each catchment for the climate change modelling are presented in Table 7.4.

The climate change factored rainfall depth for Juandah, Mud and Spring Creek is 24%, 28% and 29% respectively, higher than the original rainfall depths. The climate change factored initial loss for Juandah, Mud and Spring Creek is 18%, 20% and 2% respectively, higher than the original

initial loss. The climate change factored continuing loss for Juandah, Mud and Spring Creek is -4%, -1% and 2% respectively, compared to the original continuing loss.

Table 7.4 Climate change inputs

Item	Juandah Creek	Mud Creek	Spring Creek
Critical duration	18 hours	9 hours	6 hours
Factored rainfall depth (mm)	242.5	226.1	212.3
Factored IL (mm)	47	48	48.6
Factored CL (mm/hr)	2.6	2.7	2.7

Flood maps showing the flood extents derived for the 1 in 1,000 AEP climate change design event are presented in Appendix VI.

The results of the climate change modelling indicate that the expected water depth and velocities are higher than expected for the PRCP base case (i.e., non-climate change scenario). There is a 50 % increase in water level difference in the PRCP climate change case compared to PRCP base case for Juandah Creek. However, as with the PRCP base case, no ingress of flood water into the reprofiled void depressions or to the toe of elevated dumps in the final landform, are expected for most pits. There are minor interactions between surface water and out-of-pit dump toes for Woleebee Creek and Woleebee pit, as predicted for the PRCP base case. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour).

8 CONCLUSION

This report has outlined design hydrologic and hydraulic modelling undertaken to characterise design flows and flood extents for the PRCP design event (i.e., 1 in 1,000 AEP) for the Project.

The rating curve for Juandah Creek at Windamere has been re-rated based on a hydraulic model, adjusting roughness parameters to gauged points.

At-site FFA has been undertaken for the Juandah Creek at Windamere gauge downstream of the Project. The at-site FFA has been compared to various regional flood estimation techniques that are applicable to Australia.

A calibrated hydrologic model of the Juandah Creek catchment to the Juandah Creek at Windemere stream gauging station has been developed. A series of calibration runs have been performed within the RORB model to derive stream routing and loss parameters in the catchment upstream of the gauge. Design loss parameters for the catchments have been derived by fitting the RORB calibration model to the at-site FFA.

The calibrated routing and design loss parameters have been used in conjunction with ARR design rainfall information to derive the 1 in 1000 AEP flood event for the Juandah, Mud and Spring Creeks design catchments using RORB for input into the hydraulic model.

Hydraulic modelling has been undertaken in the 2D hydraulic modelling software TUFLOW to determine design flood extents in the Project MLs for the 1 in 1,000 AEP flood for the PRCP and a climate change scenario. The model outputs provide design flood extents, velocities and depths that may be expected throughout the modelled region based on the hydrological events considered in this study.

Key outcomes of the hydrology and hydraulic modelling include:

- Flood waters are not expected to ingress into the reprofiled void depressions and associated water storages for the 1 in 1000 AEP event.
- The flood waters are not expected to reach the level of the out-of-pit-dump toes proposed as part of the final landforms for most pits. There are minor interactions (depths >0.5 m) between flood water and out-of-pit dump toes for Woleebee Creek, Woleebee North and Woleebee pit. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour). Erosion plots have been assessed in section 7.3.2. Other pits (Wubgal, Woleebee North Sat, Frank Creek South) have minimal interactions between flood water and out-of-pit dump toes (depths <0.5 m).
- Results of the climate change modelling indicated that the expected water depth and velocities are higher than the PRCP base case.
- Climate change modelling results showed that flood waters are not expected to ingress into the reprofiled void depressions, or reach the toe of elevated dumps in the final landform in most pits. There are minor interactions between surface water and the out-of-pit dump toes for Woleebee Creek and Woleebee pit. However, velocities are less than 0.6 m/s (i.e., grass or vegetation cover should be adequate to reduce the risk of scour).

9 CLOSING

We would like to thank you for the opportunity to work on this hydrologic and hydraulic modelling study in support of the PRCP for the Project. Should you have any questions, please do not hesitate to contact the undersigned.

KCB AUSTRALIA PTY LTD.

Olivia Ciocca, RPEQ
Water Resources Engineer

VERSION MANAGEMENT

Rev	Date	KCB			Proponent	SLR	Status	Revision description
		Author	Checked	Approved	Approved	Approved		
A	07/05/24	O. Ciocca	K. Bethune J. Heaslop	J. Heaslop	For approval			
B	29/05/24	O. Ciocca	K. Bethune J. Heaslop	J. Heaslop	For approval			
C	27/06/24	O. Ciocca	K. Bethune	K. Bethune	For approval			
0	01/8/24	O. Ciocca	K. Bethune	J. Heaslop	For use			
1	28/8/24	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with PMF
2	04/9/2024	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with client comments
3	16/9/2024	O. Ciocca	K. Bethune	J. Heaslop	For use			Updated with client comments
4	01/09/2025	O. Ciocca	K. Bethune	J. Heaslop	For approval			Updated for RFI
5	02/12/2025	O. Ciocca	K. Bethune	J. Heaslop	For approval			Updated for RFI

REFERENCES

Ball et al. 2019. "Australian Rainfall and Runoff: A Guide to Flood Estimation." Commonwealth of Australia (Geoscience Australia). http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/.

Ball, J, M Babister, R Nathan, et al. 2019. "Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia."

BMT Commercial Australia Pty Ltd. 2023. "FLIKE."

BOM. 2003. "The Estimation of Probable Precipitation in Australia: Generalised Short-Duration Method."

BOM. 2005. "Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method."

BOM. 2006. "Guidebook to the Estimation of Probable Maximum Precipitation: GENERALISED SOUTHEAST AUSTRALIA METHOD."

BOM. 2023. "Juandah Creek at Windamere." http://www.bom.gov.au/waterdata/.

BOM. 2024. "Fitzroy: Geographic Information." http://www.bom.gov.au/water/nwa/2021/fitzroy/regiondescription/geographicinformation.shtml#:~:text=In%20the%20Fitzroy%20region%2C%20the,from%201%20October%E2%80%9330%20September.

Chow. 1959. "Manning's n Values." https://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm.

Commonwealth of Australia (Geoscience Australia. 2021. "Elvis - Elevation and Depth - Foundation Spatial Data."

DCCEEW. 2023. "Draft Update to the Climate Change Considerations Chapter in Australian Rainfall and Runoff: A Guide to Flood Estimation Book 1. Chapter 6. Climate Change Considerations." https://storage.googleapis.com/files-au-climate/climate-au/p/prj2aec7b7ec59ab390bffc6/public_assets/Draft%20update%20to%20the%20Climate%20Change%20Considerations%20chapter.pdf.

DETSI. 2022. "Environmental Authority Number: EPML00297613." December.

DETSI. 2024. "Guideline - Progressive Rehabilitation and Closure Plans (PRC Plans) ESR/2019/4964 Version 3.01." September 16.

DETSI. 2025. "Information Sheet - Environmental Protection Act 1994 - Voids in Flood Plains. ESR/2019/4966 Version 1.02." July 8.

Dyer. 1995. "Prediction Equations for the RORB Parameter Kc Based on Catchment Characteristics, Australian Journal of Water Resources, 1(1), 29-38."

GCAA. 2024. "PRCP Final Landform (Revision C)." May.

Gill, T; Johansen, K; Phinn, S; Trevithick, R; Scarth, P; Armston, J. 2017. "A Method for Mapping Australian Woody Vegetation Cover by Linking Continental-Scale Field Data and Long-Term Landsat Time Series."

HARC. 2019. "RORBwin." Hydrology and Risk Consulting.

Jordan. 2005. "Growth Curves and Temporal Patterns of Short Duration Design Storms for Extreme Events."

KCB. 2025. "Wandoan Coal Project - Progressive Rehabilitation and Closure Plan - Groundwater Assessment Report (Final)." December.

Laurenson, E, M; Mein, R, G; Nathan, R, J. 2010. “RORB Version 6 - Runoff Routing Program - User Manual.”

Queensland Government. 2015. “Wooded Extent and Foliage Projective Cover Code Layer - Queensland 2015.” https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={297D32FD-6713-4B6A-A150-B89593CEE046}.

State of Queensland. 2017. “Mined Land Rehabilitation Policy.”

State of Queensland. 2025a. “Environmental Protection Act 1994.” October. https://www.legislation.qld.gov.au/view/html/inforce/current/act-1994-062.

State of Queensland. 2025b. “Water Act 2000.” August. https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-2000-034.

USACE. 2021. “HEC-HMS.” https://www.hec.usace.army.mil/software/hec-hms/.

Weeks. 1986. “Flood Estimation by Runoff Routing - Model Applications in Queensland. Instn. Engrs. Australia, Civil Engg. Trans., CE28(2), 159-166.”

APPENDIX I

Survey extents

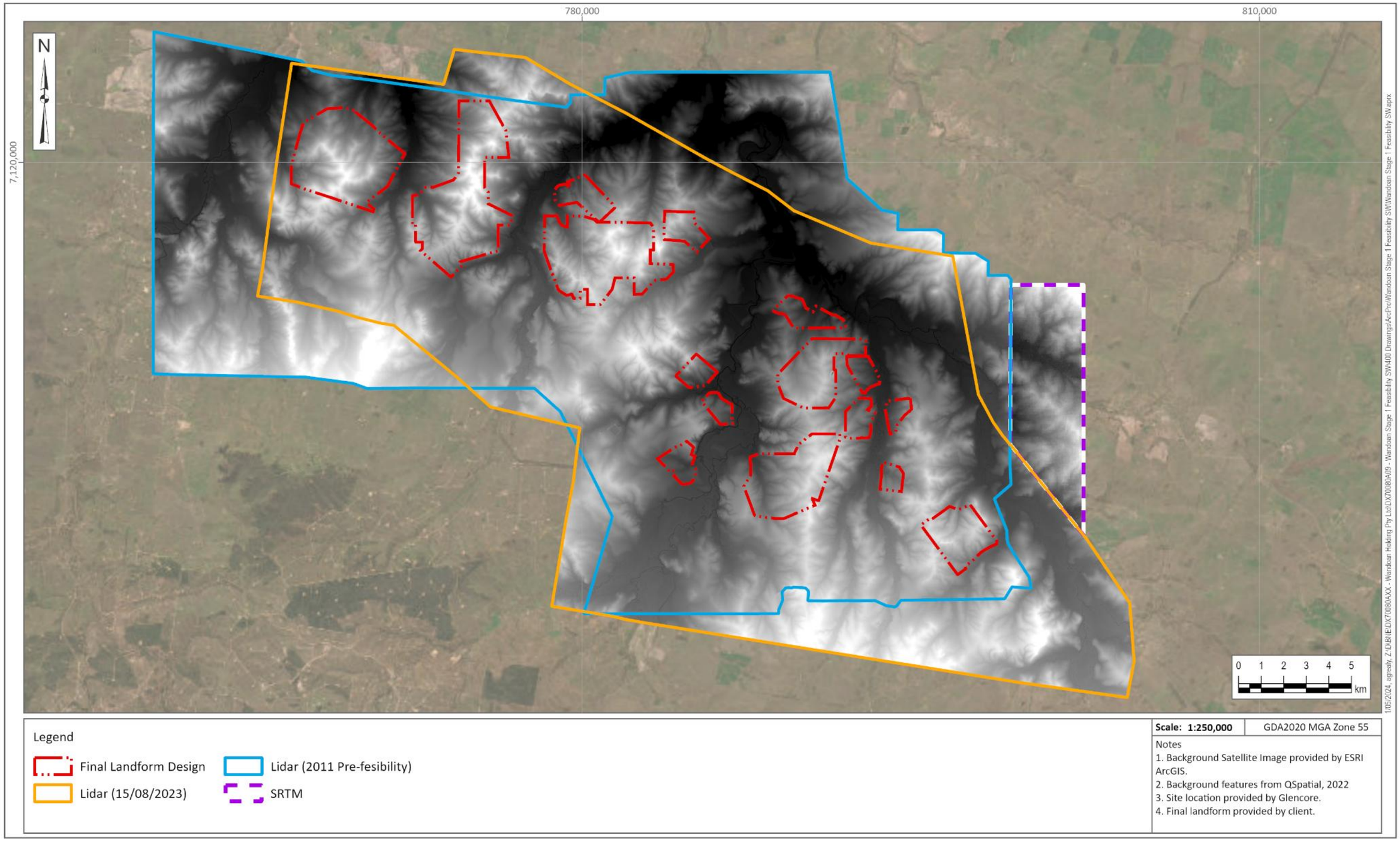


Figure I.1 Survey plan

APPENDIX II

Stream gauge rating curve

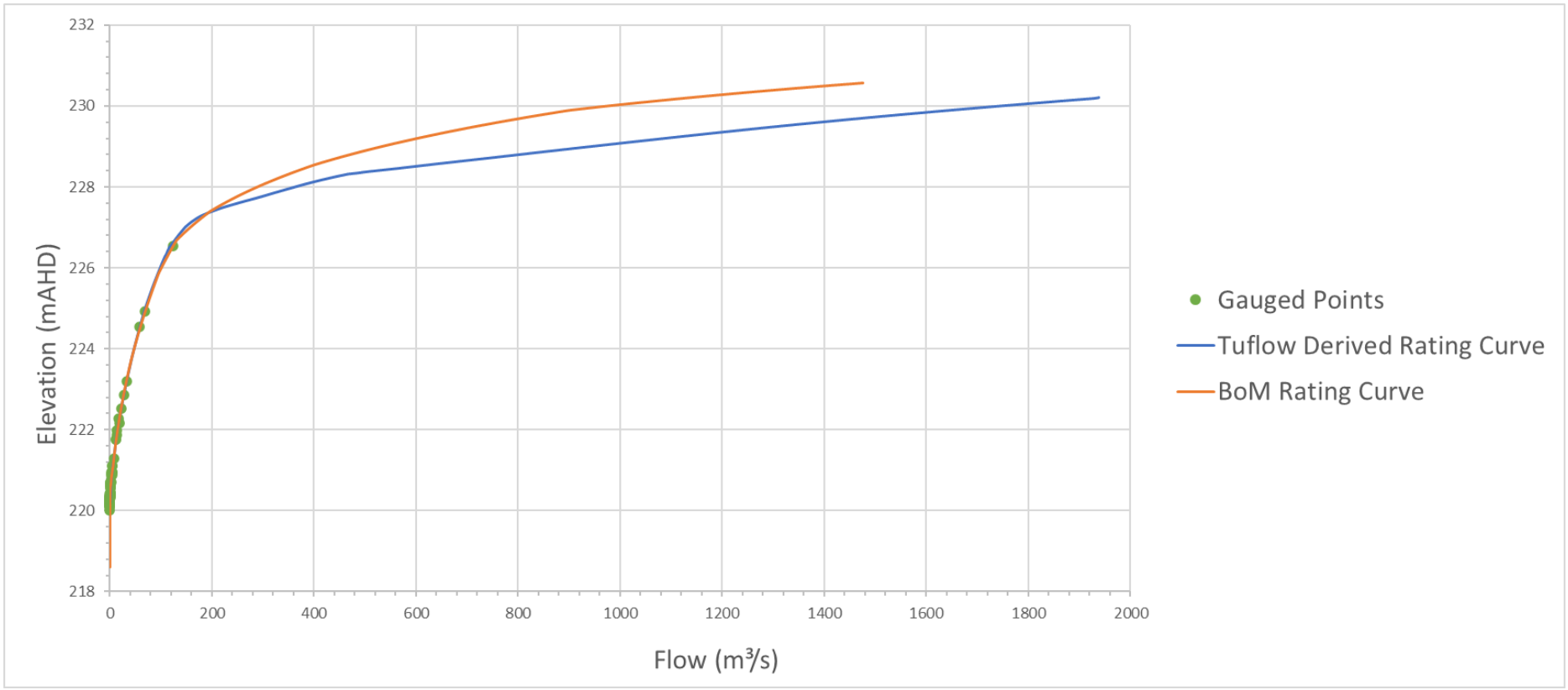


Figure II.1 Juandah Creek at Windamere – rating curves

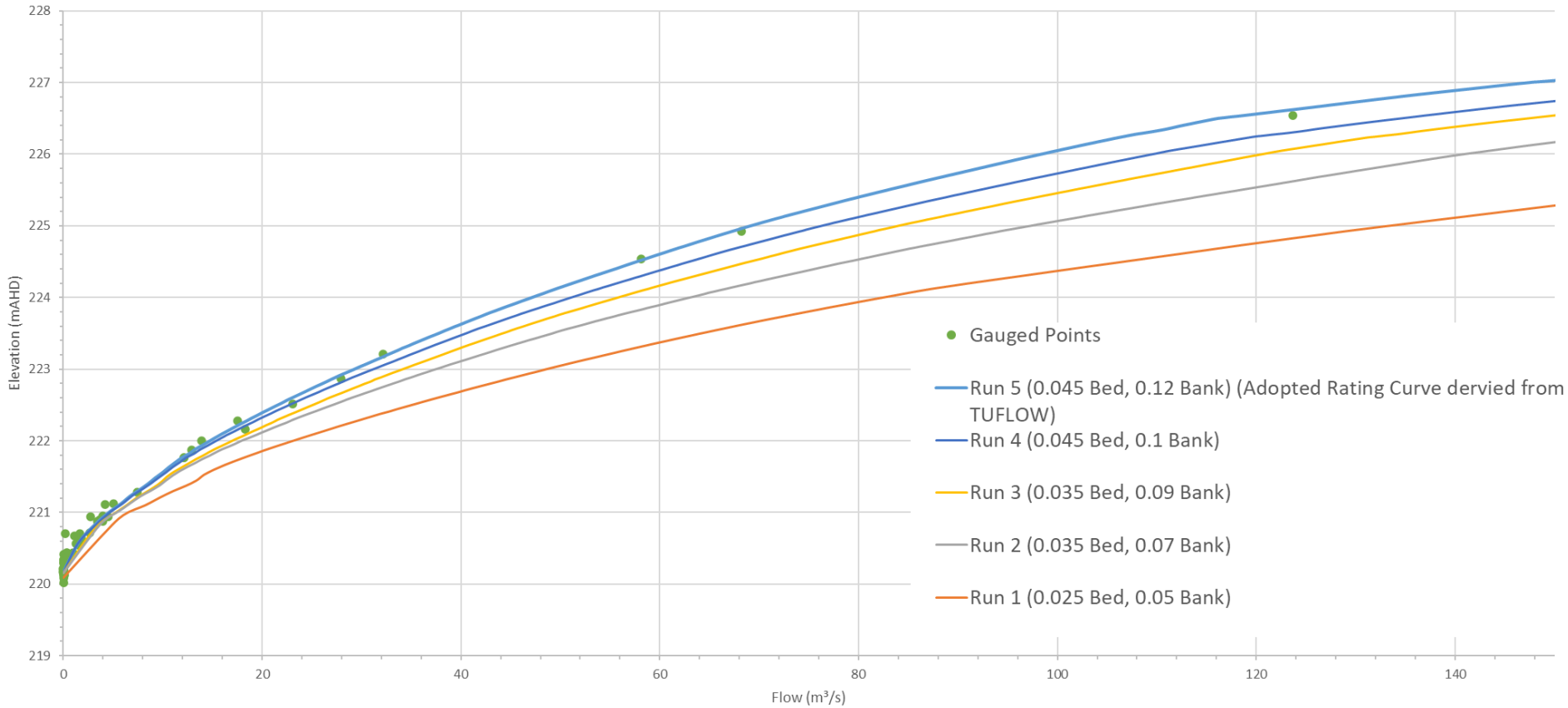


Figure II.2 Juandah Creek at Windamere – gauged points and TUFLOW model runs

APPENDIX III

Flood frequency analysis

FFA has been completed for the Juandah Creek at Windamere stream gauge using the software program FLIKE version 5.0.300.0 (BMT Commercial Australia Pty Ltd 2023). FLIKE is an extreme value analysis package that calculates the probability of flood events based on historical records and is recommended by ARR (J. Ball et al. 2019) for this type of analysis. The FFA curves computed for the stream gauge are presented in Figure III.1.

The FFAs used annual maximum series calculated for a water year running from 1 September to 31 August. This approach is most applicable to events rarer than a 1 in 10 AEP flood event, which are the events of most relevance in this study. Consideration of a peak over threshold series approach is recommended if events more frequent than a 1 in 10 AEP flood event are of interest in the future.

Annual maximums used in the FFAs are presented in Table III.1. Annual maximums have been sourced from daily maximum rainfall data recorded by DRDMW and sourced from BoM (BOM 2023) at the Windamere Gauge.

Adopted FFAs used a Log Pearson III (LP3) probability distribution which has been judged to provide the best fit of the probability models available within FLIKE. Goodness of fit has been judged visually. The inference method used for the FFAs is Bayesian inference with no prior information.

Table III.1 Juandah Creek at Windamere adopted annual maximum series

Water year	Date	Annual maximum flood peak (m^3/s)	Rank
1974	26/02/1975	72.00	32
1975	24/12/1975	137.36	21
1976	16/05/1977	737.52	9
1977	8/09/1978	127.67	22
1978	5/03/1979	69.43	33
1979	11/02/1980	121.11	23
1980	2/06/1981	645.14	12
1981	13/03/1982	65.36	34
1982	4/05/1983	1686.18	2
1983	28/07/1984	472.87	13
1984	1/11/1984	7.88	46
1985	24/10/1985	73.05	31
1986	8/01/1987	4.06	47
1987	6/01/1988	56.87	37
1988	26/04/1989	50.02	38
1989	22/04/1990	701.83	11
1990	9/02/1991	1557.58	3
1991	27/02/1992	102.67	25
1992	6/11/1992	4.06	48
1993	10/12/1993	157.65	20
1994	16/02/1995	169.03	19
1995	11/01/1996	1162.99	5
1996	7/03/1997	298.85	14
1997	29/08/1998	1532.26	4
1998	3/02/1999	270.19	16
1999	12/01/2000	35.02	44
2000	31/10/2000	42.14	42
2001	20/11/2001	106.04	24
2002	16/04/2003	97.36	28
2003	26/02/2004	63.16	35
2004	9/12/2004	100.06	26
2005	3/12/2005	721.18	10
2006	14/02/2007	47.72	41
2007	6/02/2008	57.16	36
2008	21/05/2009	49.51	40
2009	4/03/2010	990.12	6
2010	28/12/2010	1913.59	1
2011	17/12/2011	75.12	30
2012	28/01/2013	196.13	17
2013	29/03/2014	98.31	27
2014	29/01/2015	284.22	15
2015	22/09/2016	179.36	18
2016	17/01/2017	24.45	45
2017	22/02/2018	36.48	43
2018	1/04/2019	49.96	39
2019	24/02/2020	829.39	8
2020	25/03/2021	96.07	29
2021	29/11/2021	957.14	7

The ARR regional flood frequency estimation (RFFE) model has been applied to Juandah Creek at Windamere gauge catchment (total area of 1,657 km² calculated using available survey, visual confirmation and terrain analysis tools within HEC-HMS version 4.7 (USACE 2021)). Although the RFFE model is not strictly applicable as the catchment has an area greater than 1,000 km^2 (recommended upper bound of the methods applicability), results have been presented for comparative purposes.

There is a high degree of uncertainty associated with the regional method presented and the RFFE techniques have not been used directly in design. KCB considers that the design flood estimates generated in RORB and the at-site FFA to be more reliable than those generated by RFFE method.

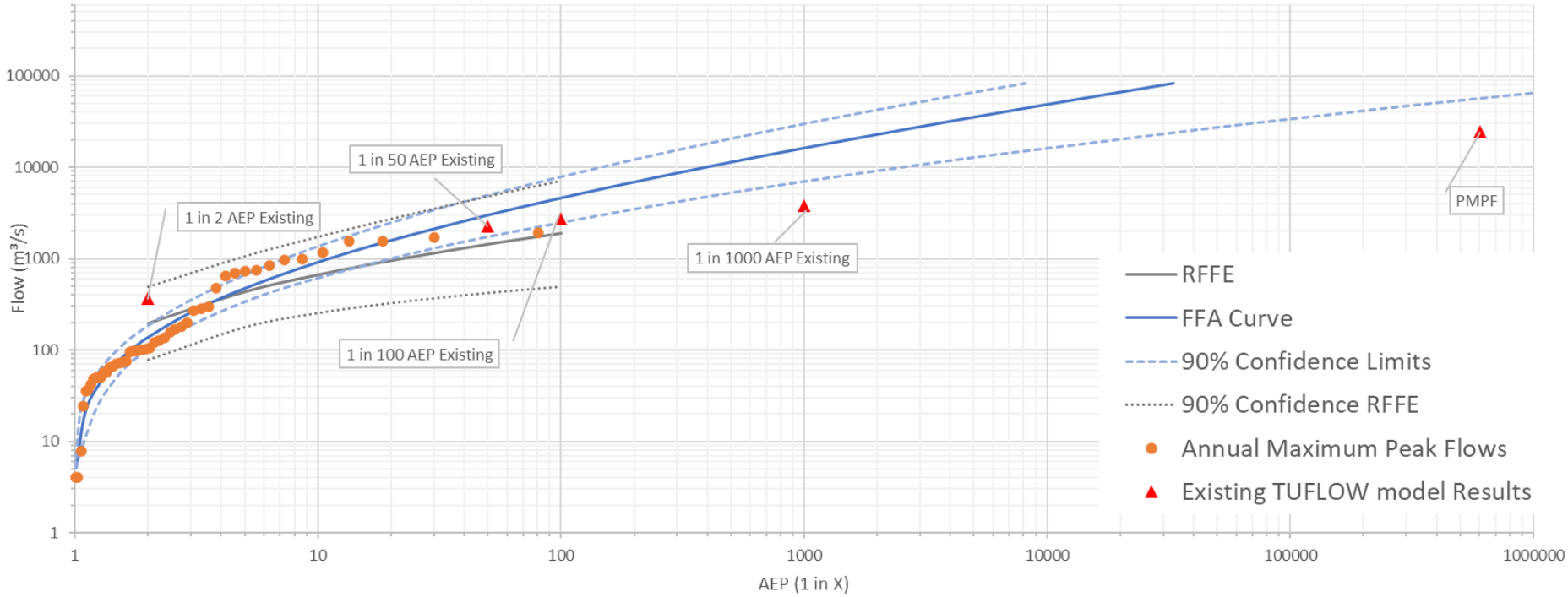


Figure III.1 Juandah Creek at Windamere - FFA sensitivity analysis

APPENDIX IV

RORB model calibration

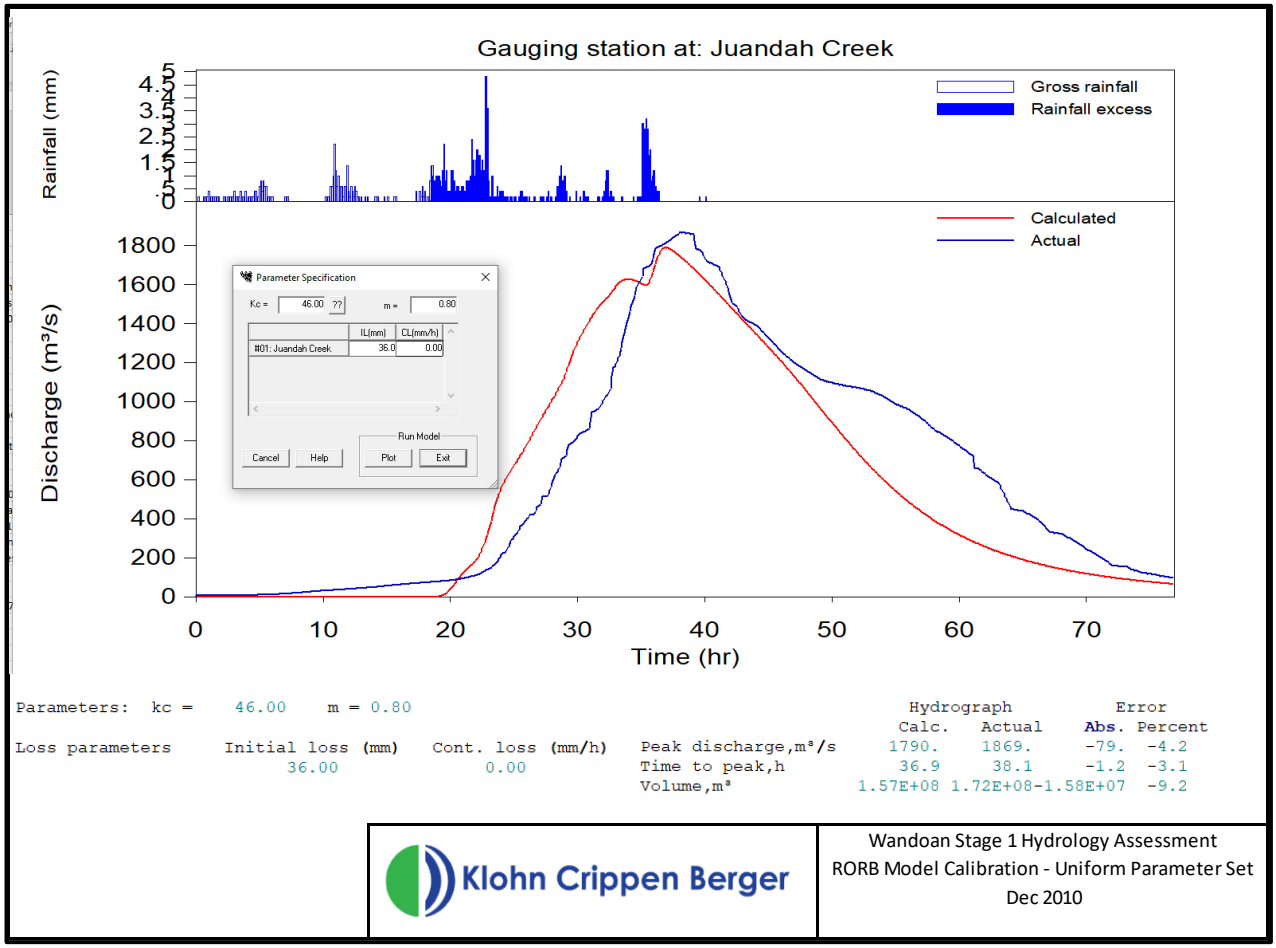


Figure IV.1 – December 2010 calibration

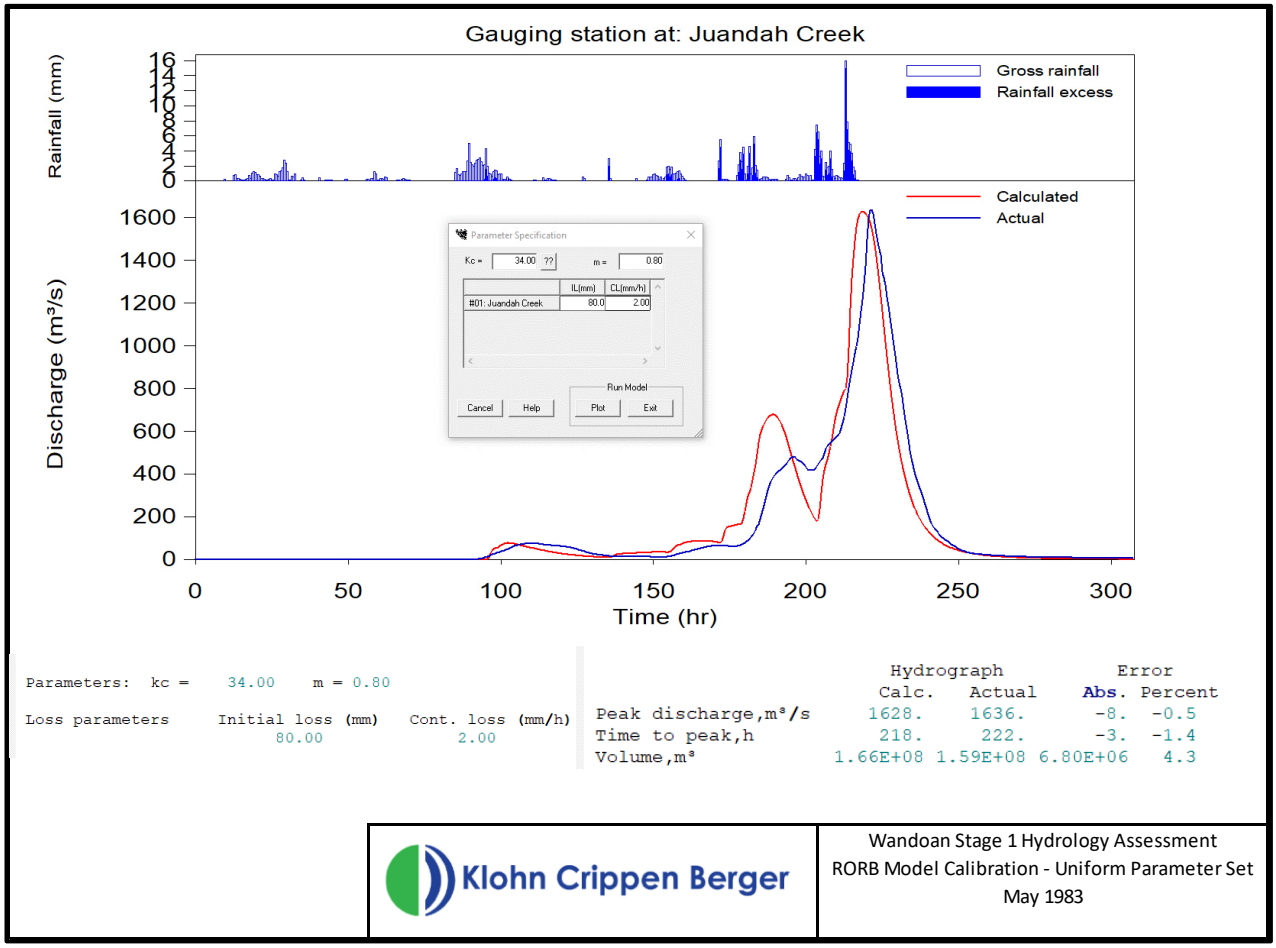


Figure IV.2 – May 1983 calibration

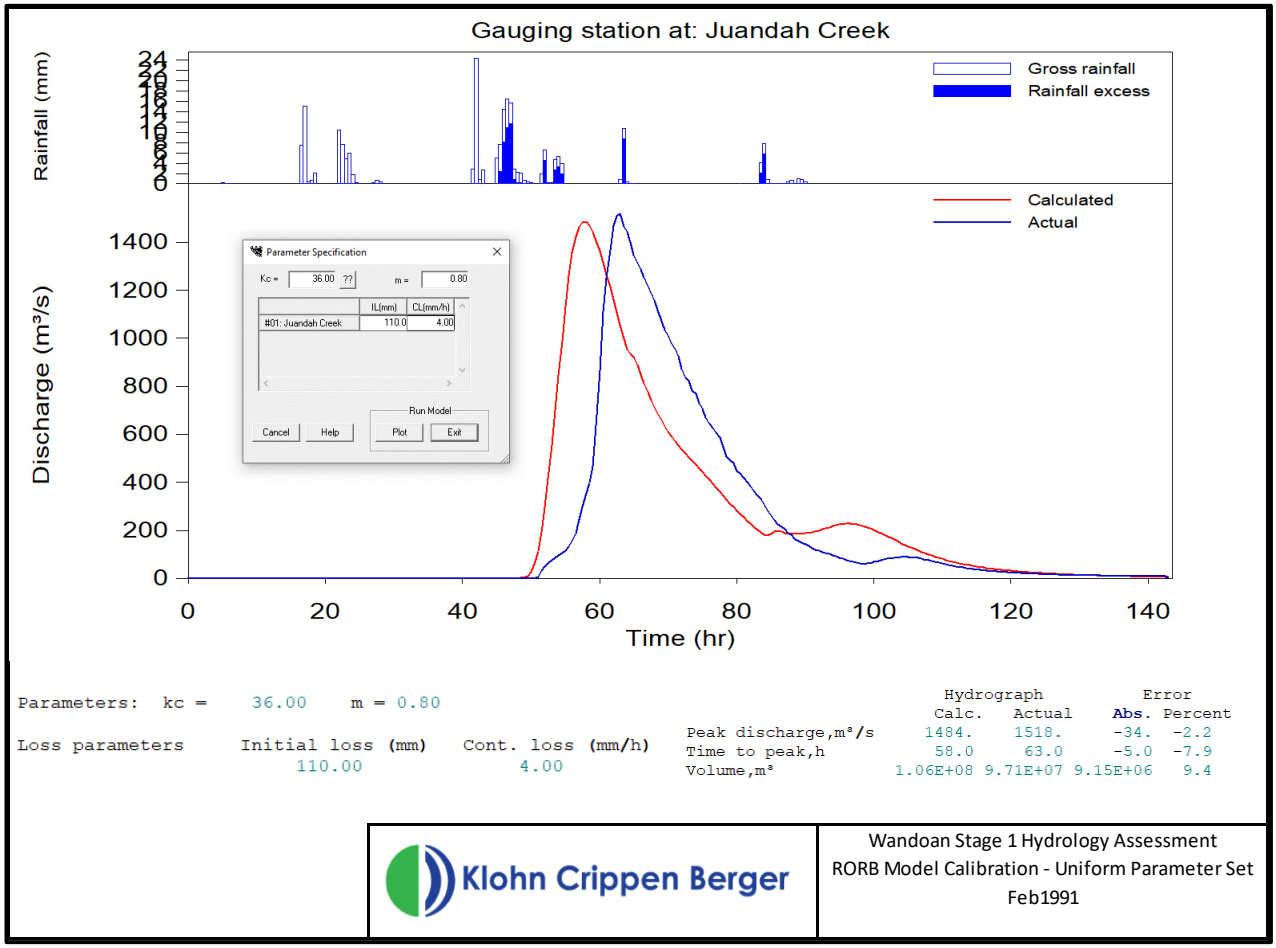


Figure IV.3 – February 1991 calibration

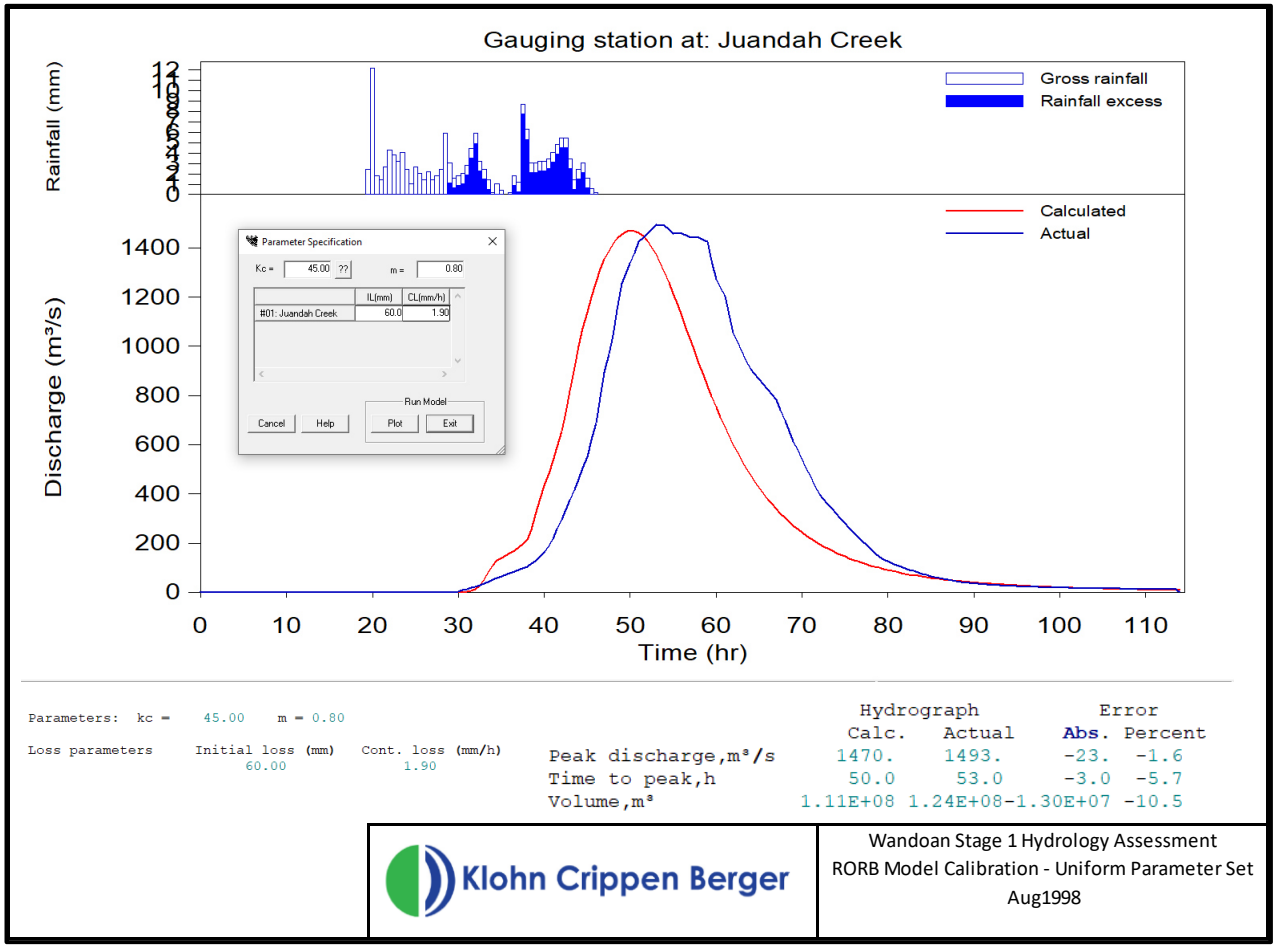


Figure IV.4 – August 1998 calibration

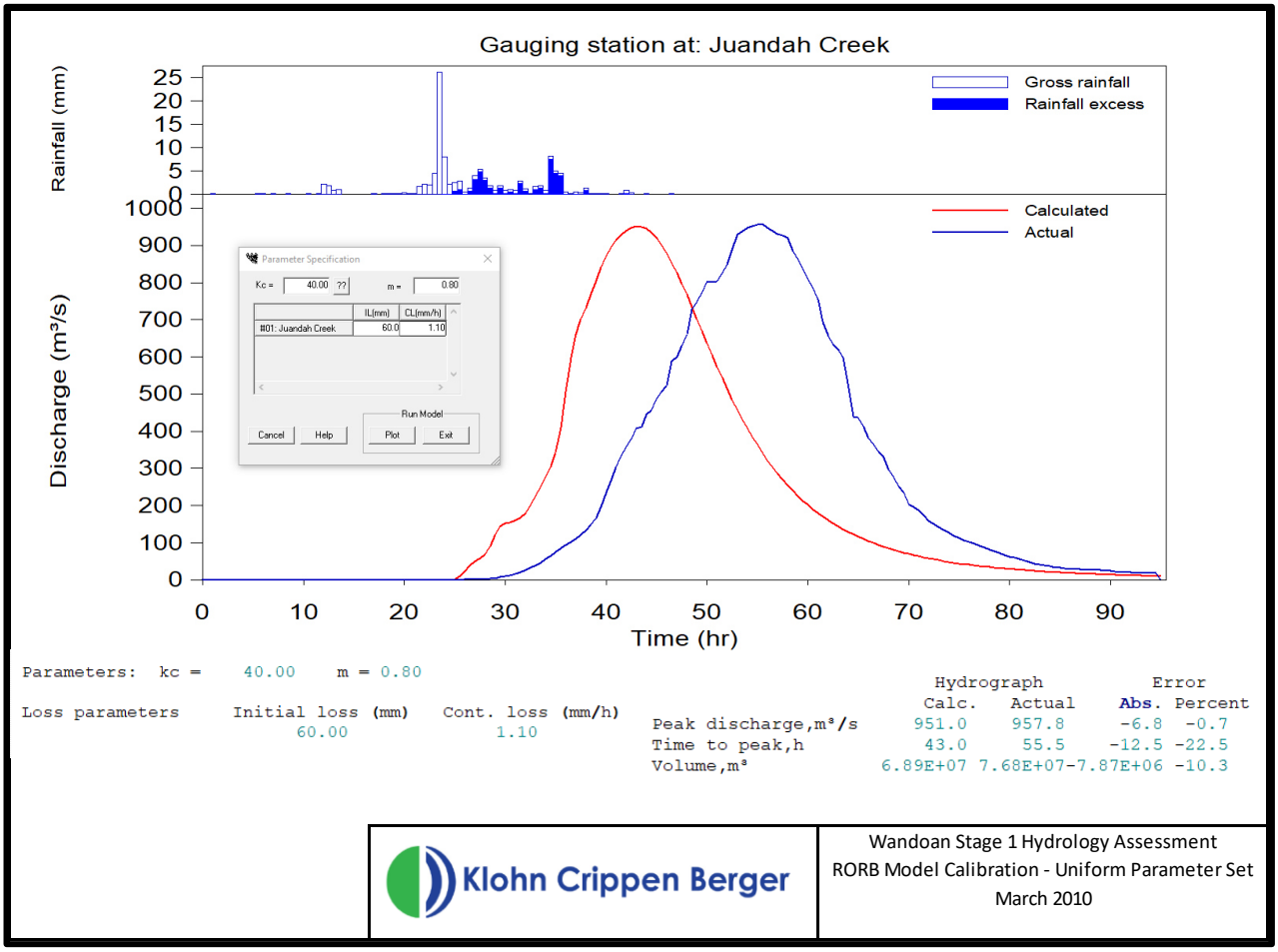


Figure IV.5– March 2010 calibration

APPENDIX V

IFD data

TableV.1 Juandah Creek IFD (mm)

Duration	AEP											
	1 in 200	1 in 500	1 in 1,000	1 in 2,000	1 in 5,000	1 in 10,000	1 in 20,000	1 in 50,000	1 in 100,000	1 in 200,000	1 in 500,000	PMP
12 hour	139	154	165	176	195	216	245	297	353	429	572	610
18 hour	162	181	195	209	233	259	293	355	420	506	668	710
24 hour	184	207	224	242	271	301	340	409	479	571	737	780
36 hour	215	243	265	287	324	361	409	491	574	681	872	920
48 hour	235	267	291	317	358	400	453	548	644	768	993	1050
72 hour	262	296	323	350	396	445	508	622	741	899	1193	1270
96 hour	277	312	340	368	417	469	538	668	807	994	1355	1450
120 hour	285	321	350	378	428	482	555	691	838	1038	1427	1530

Table V.2 Spring Creek IFD (mm)

Duration	AEP											
	1 in 200	1 in 500	1 in 1,000	1 in 2,000	1 in 5,000	1 in 10,000	1 in 20,000	1 in 50,000	1 in 100,000	1 in 200,000	1 in 500,000	PMP
15 min	36	40	43	46	50	54	58	65	71	77	88	140
30 min	56	62	66	71	77	83	90	100	108	119	134	210
45 min	68	75	81	86	95	102	110	123	134	147	168	270
1 hour	77	85	91	97	107	115	125	140	153	169	193	320
1.5 hour	89	98	105	112	122	132	143	161	178	198	231	420
2 hour	97	107	114	122	133	143	156	176	195	218	257	480
2.5 hour	103	113	121	128	139	150	163	186	207	232	275	540
3 hour	109	120	127	135	147	159	173	197	219	247	294	580
4 hour	119	130	139	147	160	173	189	215	240	271	324	660
5 hour	128	142	152	161	177	192	210	240	268	304	362	730
6 hour	137	152	163	174	192	208	228	261	292	329	391	770
9 hour	154	172	186	199	220	239	261	298	331	371	435	800
12 hour	165	185	199	214	236	256	279	317	351	392	458	820
18 hour	185	207	224	241	266	289	315	355	392	434	501	850
24 hour	202	227	246	265	294	319	348	391	430	473	541	870
36 hour	230	261	284	307	343	374	409	463	511	565	650	1070
48 hour	250	282	307	333	371	405	445	506	561	625	725	1250
72 hour	274	308	335	362	403	441	486	558	624	703	832	1570
96 hour	288	322	350	377	419	458	505	582	655	743	889	1770
120 hour	297	331	359	386	428	468	516	596	671	762	915	1850

Table V.3 Mud Creek IFD (mm)

Duration	AEP											
	1 in 200	1 in 500	1 in 1,000	1 in 2,000	1 in 5,000	1 in 10,000	1 in 20,000	1 in 50,000	1 in 100,000	1 in 200,000	1 in 500,000	PMP
15 min	29	32	34	37	40	43	47	52	58	65	76	120
30 min	48	53	56	60	65	70	75	85	93	103	119	180
45 min	60	66	70	75	81	87	94	106	117	129	150	230
1 hour	69	75	80	85	93	100	109	123	136	151	177	280
1.5 hour	80	88	93	99	107	115	126	143	159	180	214	360
2 hour	88	96	102	107	116	125	137	156	175	199	240	420
2.5 hour	94	102	108	114	123	132	145	166	187	213	259	470
3 hour	99	108	114	120	129	139	152	175	197	226	276	510
4 hour	110	120	127	133	144	155	170	196	221	253	309	570
5 hour	120	132	140	148	162	176	193	222	251	287	349	630
6 hour	129	143	153	163	179	194	213	245	276	315	381	670
9 hour	148	164	177	189	209	227	249	286	320	362	431	720
12 hour	159	177	191	204	225	244	268	306	343	387	460	760
18 hour	180	201	216	233	257	280	307	351	390	438	515	820
24 hour	198	222	240	259	288	313	343	390	432	482	561	860
36 hour	227	257	279	302	337	369	405	463	515	576	674	1040
48 hour	247	279	303	328	367	401	442	508	568	640	756	1210
72 hour	271	305	332	358	399	438	486	564	638	728	879	1520
96 hour	286	320	347	374	416	456	507	591	672	772	944	1700
120 hour	294	328	356	382	425	466	518	605	689	794	976	1790

APPENDIX VI

Flood modelling maps

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
MOUNT ORGAN CREEK
RANGE GULLY
BULL GULLY
WANDOAN CREEK
BLACKANT CREEK
WOLEEBEE CREEK
MUD CREEK
LOG HUT GULLY
JUANDAH CREEK
ROCHE CREEK
WERINGA CREEK
HALFWAY CREEK
FRANK CREEK

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Wolebee North
Frank Creek
Woleebee Creek
Woleebee
Wubagul
WANDOAN

0 1 2 km

Legend

- Town
- Watercourse
- Road
- Dam
- Reprofiled Void Depressions
- Wandoan Coal Project Mining Leases
- Final Landform

PRCP 1 in 1000 AEP Water Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3

PRCP 1 in 1000 AEP Water Depth (m)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

16/09/2024 OCiocca ianf.klohn.com\ProjData\DBE\DX7098\AXX - Wandoan Holding Pty Ltd\DX7098\A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
Turkey Hill
Summer Hill
MUD CREEK
JUANDAH CREEK
Mud Creek North
LOG HUT GULLY
Mud Creek East
Mud Creek
ROCHE CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
Austinvale North
WERINGA CREEK
Wolebee North Sat
Austinvale
Leichhardt
BLACKANT CREEK
Wolebee North
Frank Creek
Frank Creek North
WANDOAN
MOUNT ORGAN CREEK
Wolebee Creek
Wolebee
HALFWAY CREEK
Frank Creek South
RANGE GULLY
WOLEEBEE CREEK
FRANK CREEK
Wubagul
TWO MILE CREEK
BULL GULLY
WANDOAN CREEK
DOWNFALL

0 1 2 km

Legend

- Town
- Watercourse
- Road
- Dam
- Wandoan Coal Project Mining Leases
- Final Landform
- Reprofiled Void Depressions

PRCP 1 in 1000 AEP Velocity (m/s)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- > 3

PRCP 1 in 1000 AEP Velocity (m/s)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

12/09/2024 OCiocca I:\ent.klohn.com\Projects\DER\EIDX7098\AXX - Wandoan Holdings Pty Ltd\DX7098A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
MUD CREEK
JUANDAH CREEK
ROCHE CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
WERINGA CREEK
BLACKANT CREEK
MOUNT ORGAN CREEK
RANGE GULLY
BULL GULLY
WANDOAN CREEK
LOG HUT GULLY
WOLEEBEE CREEK
HALFWAY CREEK
FRANK CREEK
TWO MILE CREEK

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Leichhardt
Wolebee North Sat
Wolebee North
Frank Creek
Frank Creek North
Wolebee Creek
Woleebee
Frank Creek South
Wubagul
WANDOAN

0 1 2 km

Legend

- Town
- Watercourse
- Road
- Dam
- Wandoan Coal Project Mining Leases
- Reprofiled Void Depressions
- Final Landform
- Climate Change PRCP 1 in 1000 AEP Water Depth (m)
  - < 0.25
  - 0.25 - 0.5
  - 0.5 - 1
  - 1 - 2
  - 2 - 3
  - > 3

Climate Change PRCP 1 in 1000 AEP Water Depth (m)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

12/09/2024 OCiocca I:\ent.klohn.com\Projects\DER\EIDX7098\AXX - Wandoan Holdings Pty Ltd\DX7098\A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
MUD CREEK
JUANDAH CREEK
ROCHE CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
WERINGA CREEK
BLACKANT CREEK
MOUNT ORGAN CREEK
RANGE GULLY
BULL GULLY
WANDOAN CREEK
WOLEEBEE CREEK
HALFWAY CREEK
FRANK CREEK
TWO MILE CREEK
LOG HUT GULLY

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Leichhardt
Wolebee North Sat
Wolebee North
Frank Creek
Frank Creek North
Frank Creek South
Woleebee Creek
Woleebee
Wubagul
WANDOAN

0 1 2 km

12/09/2024 OCiocca ian.klohn.com\ProjData\DBE\DX7098\AXX - Wandoan Holdings Pty Ltd\DX7098A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

Legend

- Town
- Watercourse
- Road
- Dam
- Wandoan Coal Project Mining Leases
- Reprofiled Void Depressions
- Final Landform

Climate Change PRCP 1 in 1000 AEP Velocity (m/s)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- > 3

Climate Change PRCP 1 in 1000 AEP Velocity (m/s)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
MUD CREEK
JUANDAH CREEK
ROCHE CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
WERINGA CREEK
BLACKANT CREEK
MOUNT ORGAN CREEK
RANGE GULLY
BULL GULLY
WANDOAN CREEK
LOG HUT GULLY
WOLEEBEE CREEK
HALFWAY CREEK
FRANK CREEK
TWO MILE CREEK

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Leichhardt
Wolebee North Sat
Wolebee North
Frank Creek
Frank Creek North
Wolebee Creek
Wolebee
Frank Creek South
Wubagul

WANDOAN

0 1 2 km

Legend

- Town
- Watercourse
- Road
- Dam
- Wandoan Coal Project Mining Leases
- Reprofiled Void Depressions
- Final Landform

PRCP difference 1 in 1000 AEP Water Depth (m)

- < - 0.2
- -0.2 - 0
- 0.0 - 0.02
- 0.02 - 0.1
- > 0.1

PRCP difference to existing (pre-mining) 1 in 1,000 AEP Water Depth (m)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

12/09/2024 OCiocca I:\ent.klohn.com\Projects\DER\EIDX7098\AXX - Wandoan Holdings Pty Ltd\DX7098\A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

HORSE CREEK
DUCK CREEK
FOUR MILE GULLY
BACK CREEK
SPRING CREEK
MOUNT ORGAN CREEK
RANGE GULLY
BULL GULLY
WANDOAN CREEK
BLACKANT CREEK
MUD CREEK
JUANDAH CREEK
ROCHE CREEK
WERINGA CREEK
LOG HUT GULLY
WOLEEBEE CREEK
HALFWAY CREEK
FRANK CREEK
TWO MILE CREEK

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek
Mud Creek East
Austinvale North
Austinvale
Leichhardt
Wolebee North Sat
Wolebee North
Frank Creek
Frank Creek North
Woleebee Creek
Woleebee
Frank Creek South
Wubagul

WANDOAN

0 1 2 km

Legend

- Town
- Watercourse
- Road
- Dam
- Wandoan Coal Project Mining Leases
- Final Landform
- Reprofiled Void Depressions

PRCP difference 1 in 1000 AEP Velocity (m/s)

- < - 0.2
- -0.2 - 0
- 0.0 - 0.02
- 0.02 - 0.1
- > 0.1

PRCP difference to existing (pre-mining) 1 in 1,000 AEP Velocity (m/s)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

12/09/2024 OCiocca I:\ent.klohn.com\Proj\Data\DBE\DX7098\AXX - Wandoan Holdings Pty Ltd\DX7098A03 - Wandoan Mine Project Surface Water\A03 Drawings\ArcPro\ArcPro.aprx

APPENDIX VII

PMF flood modelling methodology and maps

PMP

The theoretical definition of PMP is the largest depth of precipitation for a given duration that is physically possible over a given size storm area, at a particular location at a certain time of year. The generalised methods for the estimation of PMP, provided by BOM, provide estimates of PMP and should not be regarded as a theoretical upper limit of rainfall at a given location (J. Ball et al. 2019). ARR provides a method for estimating the AEP of the PMP for a catchment that is based on catchment area. The approach of assigning an AEP to PMP estimates is consistent with the concept of PMP estimates, as it is conceivable that the PMP could be exceeded. Estimated PMP AEPs for the catchments considered in this study are presented in Table VII.1.

Table VII.1 Estimated PMP AEP.

Catchment	PMP AEP
Juandah Creek	1 in 603,500
Mud Creek	1 in 5,050,505
Spring Creek	1 in 10,000,000

The PMP has been estimated for each catchment using GSDM and GTSMR, published by BOM (BOM 2003) (BOM 2005). GSDM is applicable for durations between 15 minutes and 6 hours for catchments up to 1,000 km^2, and has been use for Mud and Spring Creek catchments but is not applicable to the Juandah Creek catchment. GTSMR is applicable for durations between 24 and 120 hours and has been used for the Mud, Spring and Juandah Creek catchment. Rainfall depths for intermediate durations (9, 12 and 18 hours) have been estimated using the envelope fitting procedure outlined in BOM (BOM 2005).

Areal PMP depths are plotted in Figure VII.1.

Review of Figure VII.1 indicates that there is somewhat of a discontinuity between the 6- and 24-hour durations for Mud and Spring. This is a result of different methods to derive PMP rainfall estimates and interpolation between each of the methods; the GSDM method is used for durations up to 6 hours and the GTSMR method is used for durations greater than 24 hours. This discontinuity is common in catchments which have or are affected by rough terrain. The GSDM guidelines state that terrain should be classified as rough when it is within 20 km of generally rough terrain. It has been assumed the terrain within these catchments is rough.

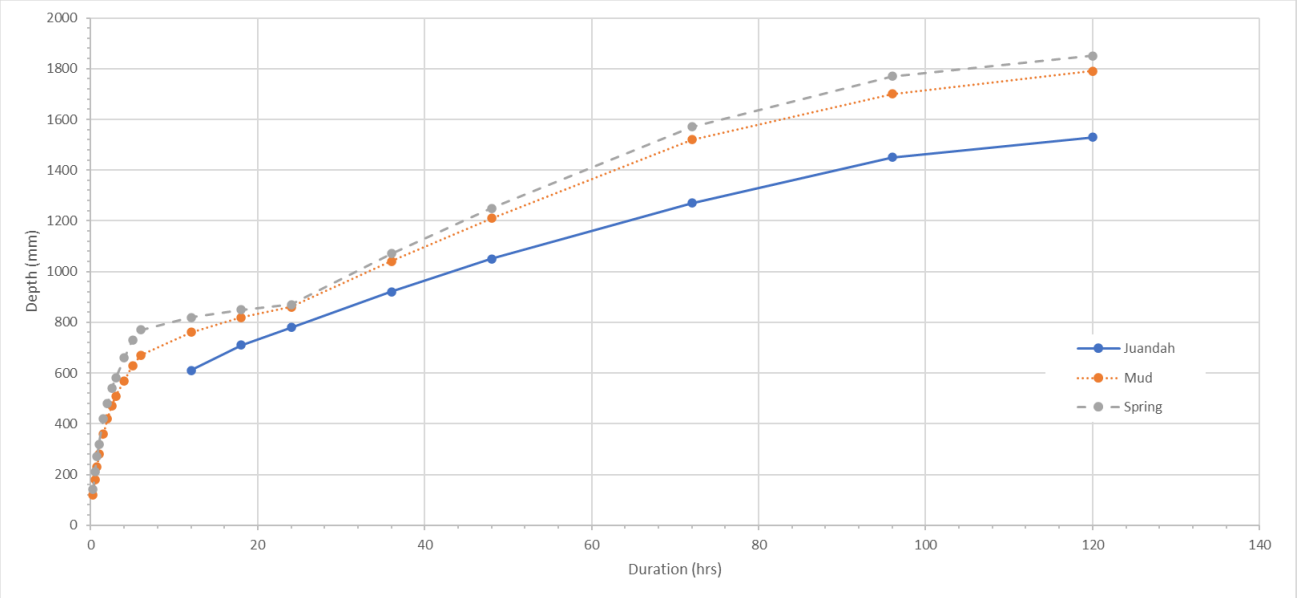


Figure VII.1 Areal PMP burst estimates

PMF

The PMF is the maximum flood which a catchment could be reasonably expected to generate. It represents a notional upper limit of flood magnitude and there is no AEP associated with such an event. The approach for estimating the PMF implemented in this study is summarised in Table V11.2.

Table VII.2 PMF

Design Parameter	Probable Maximum Flood
Design rainfall	PMP
Temporal pattern	Design flow taken as the maximum flow generated by the ensemble set of temporal patterns (GSDM and GTSMR as applicable) for the critical duration
Spatial pattern	GTSMR spatial pattern
Losses	Theoretical maximum losses: ▪ Initial burst loss: 0 mm ▪ Continuing loss: 1 mm/hr

Rainfall estimates of very rare and extreme floods are based on assumptions on the probabilistic behaviour of hydrologic processes rather than empirical evidence, theoretical knowledge, or an understanding of these processes. Estimates of the PMF lie beyond the credible limit of extrapolation of any available empirical data. The estimation of the PMF is based on an understanding of catchment processes for relatively frequent floods and it is assumed that these processes are unchanged when catchments are subjected to extreme rainfall. It should therefore, be recognised that the magnitude of uncertainty associated with the design flood estimates presented in this report for very rare and extreme floods (1 in 200 to PMF) is large and increases with increasing event magnitude (J. Ball et al. 2019).

Flood maps showing modelled flood depths, velocities, and flood extents for the PMF design event are presented below.

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Wolebee North
Frank Creek
WANDOAN
Woleebee Creek
Woleebee
Wubagul

0 1 2 km

PRCP PMF AEP Water Depth (m)

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

Legend

- Town
- Watercourse
- Road
- Reprofiled Void Depressions
- Dam
- Final Landform
- Wandoan Coal Project Mining Leases

PMF Water Depth (m)

- < 0.5
- 0.5 - 2.5
- 2.5 - 4.5
- 4.5 - 6.5
- 6.5 - 8.5
- > 8.5

12/09/2024 OCiocca iant.kohn.com\Projects\DBE\EDX7098\AXX - Wandoan Holdings Pty Ltd\DX7098\A09 - Wandoan Stage 1 Feasibility SWI\A00 Drawings\ArcPro\Hydraulic and Hydrology Results Operational.aprx

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000 805,000

7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

N

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Wolebee North
Frank Creek
WANDOAN
Woleebee Creek
Woleebee
Wubagul

0 1 2 km

PRCP PMF AEP Velocity (m/s)

Legend

Town
Watercourse
Road
Reprofiled Void Depressions
Dam
Final Landform
Wandoan Coal Project Mining Leases

PMF Velocity (m/s)
< 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.25
1.25 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
> 3

Scale: 1:120,000 | GDA2020 MGA Zone 55

Notes

12/09/2024 OCiocca ianf.klohn.com\Projects\DBE\EIDX7098\AXX - Wandoan Holdings Pty Ltd\DX7098\A09 - Wandoan Stage 1 Feasibility SWI\A00 Drawings\Arc Pro\Hydraulic ArcPro\Hydraulic and Hydrology Results Operational.aprx

APPENDIX VIII

RFI Response

Table VIII.1 RFI Comments

Item	PRCP Plan / Schedule	Issue	Required Information	KCB Response
34	Predicted flood levels and velocities	Considering potential high risk to the Woleebee voids (Woleebee Creek, Woleebee North, and Woleebee North Satellite) and dumps under 0.1% AEP and PMF (Woleebee Creek void) development of relevant milestones and criteria are required to manage the issue. The PRCP Schedule should contain milestone criteria that are linked to the site-specific risks informed by the risk assessment such as flood protection landforms or rock armouring where there is a high risk of erosion due to high flood velocities.	Provide an updated PRCP schedule that contains milestone criteria that are linked to the site-specific risks associated with predicted flood levels and velocities under 0.1%AEP and PMF and are informed by the risk assessment.	*Updated mapping for the 0.1% AEP velocities and discussion for the 0.1% AEP and PMF has been included around the Woleebee (Woleebee Creek, Woleebee North, and Woleebee North Satellite) dumps and voids. Refer to section 7.3.2.* *No voids are impacted by ingress of flood water in the 0.1% AEP event. For the toe of the dumps, scour will be mitigated through grassed vegetation of the final landforms.* *The PRCP guidelines state that voids in floodplains should be designed to withstand a 1 in 1,000 AEP event. The PMF is not used as a design criterion for the PRCP. PMF flood plain modelling is completed for information only and is not used to sized erosion protection.*

Wandoan Holdings Pty Ltd

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan

Hydrologic and Hydraulic Modelling Study

Klohn Crippen Berger

Wandoan Holdings Pty Ltd

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan

Reprofiled Void Depressions - Water Balance Study

Final – Rev 2

ISO 9001 14001 45001

14D70080A12

December 2025

Wandoan Holdings Pty Ltd

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan

Reprofiled Void Depressions - Water Balance Study

Final – Rev 2

VERSION MANAGEMENT

Rev	Date	KCB			Proponent / peer reviewer	Status	Revision description
		Author	Checked	Approved	Approved		
A	19/06/24	K. Bethune D. Byrne	O. Ciocca J. Heaslop	J. Heaslop	For approval	Draft	-
B	4/07/24	K. Bethune D. Byrne	O. Ciocca	J. Heaslop	For approval	Draft	First round of proponent / peer review feedback
0	31/07/24	K. Bethune D. Byrne	L. Evans J. Heaslop	J. Heaslop	For use	Draft	Second round of proponent / peer review feedback
1	16/09/24	K. Bethune D. Byrne	L. Evans J. Heaslop	J. Heaslop	For use	Final	Minor update to figures
2	2/12/25	K. Bethune	L. Evans J. Heaslop	J. Heaslop	For use	Final	Minor updates to address DETSI RFI

2 December 2025

Glencore Coal Assets Australia
On behalf of Wandoan Holdings Pty Ltd
Email: Melissa.Brunner@glencore.com.au

Melissa Brunner
PRCP and Approvals Coordinator (Wandoan)

Dear Melissa:

Wandoan Coal Project
Progressive Rehabilitation and Closure Plan
Reprofiled Void Depressions - Water Balance Study
Final – Rev 2

KCB Australia Pty Ltd is pleased to provide Glencore Coal Assets Australia (on behalf of Wandoan Holdings Pty Ltd) with this water balance report for the reprofiled void depressions planned to remain at closure of the Wandoan Coal Project.

We would like to thank you for the opportunity to work on this water balance study. Should you have any queries, please contact the undersigned.

Revision 2 of this report has been updated to address the request for further information from the Department of Environment, Tourism, Science and Innovation (DETSI), dated 30th May 2025. Specifically, items 5, 22 and 23 have been addressed in italics in Sections 6, 7, and 9, and Appendix V of this report.

Yours truly,

KCB AUSTRALIA PTY LTD.

Kirsty Bethune
Senior Water Resources Engineer

KB and DB: LE

KCB Australia Pty Ltd.
Level 3, 150 Mary St ▪ Brisbane QLD 4000 ▪ Australia
t +617.3004.0244 ▪ www.klohn.com

EXECUTIVE SUMMARY

This report is a summary of the water balance study on the reprofiled void depressions planned to remain as part of rehabilitation and closure of the Wandoan Coal Project (the Project). Reprofiled void depressions have been defined as shallow depressions in the landform created by reshaping the mining pit so that the base of the depression is above the elevation of the predicted post-closure groundwater level.

In developing the study, long-term catchment hydrology and water balance modelling was undertaken for the reprofiled void depression.

The hydrological characteristics of these proposed reprofiled void depressions were reviewed in the study, including modelled long-term water levels and water quality.

Key outcomes of long-term water balance modelling of the reprofiled void depressions include:

- Reprofiled void depressions will form ephemeral waterbodies which are expected to fill in wet periods when the inflows (runoff and rainfall) are greater than outflows (seepage and evaporation) and empty in dry periods when outflows are greater than inflows. For most of the reprofiled void depressions (in Summer Hill, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul mining areas), this cyclic filling and emptying is expected to occur annually. For Mud Creek mining area, the reprofiled void depression is expected to be able to sustain a waterbody for longer, with the cyclic filling and emptying expected to occur over larger periods (i.e., up to decades).
- No waterbodies within the reprofiled void depressions are expected to reach levels that would result in overflow into downstream watercourse via a surface-flow pathway.
- Salinity (modelled as total dissolved solids (TDS)) levels are expected to fluctuate dependent on the volume in the waterbodies of each reprofiled void depression (i.e., higher volumes – lower salinity). Although the salinity is expected to fluctuate, modelling has shown that the mass of salt in the reprofiled void depressions is not expected to accumulate over time as the loss of salt via infiltration and cattle consumption offsets TDS generation from runoff.
- Reprofiled void depressions can provide a supplementary water supply for beef cattle, when the TDS in the depression is less than 4,000 mg/L limit.
- Water levels remained well below the overflow level for sensitivity analysis which tested the influence of cattle consumption, catchment yield, climate, and seepage on the void water balance.
- Recommendations have been made to:
  - continue the monitoring of existing streams (flow and quality) to refine key modelling inputs (i.e., natural AWBM parameters and salinity generation); and
  - further investigate the ability of the waterbodies within the reprofiled void depressions to support opportunistic native flora and fauna species.

Sections 6, 7 and 9 of this report (Rev 2) have been updated (with changes in italics) to address the request for further information from the Department of Environment, Tourism, Science and Innovation (DETSI), dated 30th May 2025.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I
CLARIFICATIONS REGARDING THIS REPORT IX
1 INTRODUCTION 1
1.1 Project overview 1
1.2 Regulatory requirements 1
1.2.1 Relevant legislation and guidelines 1
1.2.2 PRCP guideline 3
1.2.3 Environmental authority 5
1.3 Report structure 6
2 PROJECT DESCRIPTION 7
2.1 Components 7
2.2 Closure plan 10
3 EXISTING ENVIRONMENT 14
3.1 Topography 14
3.2 Hydrology 14
3.2.1 Streams 14
3.2.2 Streamflow 16
3.3 Climate data 19
3.3.1 Rainfall and evaporation 19
3.3.2 Climate change 21
3.4 Groundwater systems 21
4 CONCEPTUAL MODEL 22
5 WATER BALANCE MODEL DEVELOPMENT 24
5.1 Model aims and objectives 24
5.2 GoldSim model 24
5.3 Physical characteristics 25
5.3.1 Reprofiled void depression data sheets 25
5.3.2 Topography 25
5.3.3 Level-surface area-volume relationship 26
5.3.4 Catchment areas 26
5.3.5 AWBM catchment land use categories 26
5.4 Hydrological inputs 28
5.4.1 Rainfall 28
5.4.2 Evaporation and adjustment factor 30
5.4.3 Climate change 30
5.4.4 Catchment yield 32
5.4.5 Initial conditions 33
5.5 Hydrogeological inputs and assumptions 34

TABLE OF CONTENTS
(continued)

5.6 Salinity generation 35
5.7 Cattle consumption 35
6 BASE CASE PREDICTIONS 39
7 CATTLE CONSUMPTION 51
8 SENSITIVITY AND RISK 53
8.1 Sensitivity assessment 53
8.2 Risk assessment 59
8.2.1 Storage capacity and release of surface water from reprofiled void depressions 59
8.2.2 Adverse water quality impacts from the reprofiled void depressions 59
9 CONCLUSIONS 60
10 CLOSING 62
VERSION MANAGEMENT 62
REFERENCES 63

List of Tables

Table 1.1 PRCP void closure plan requirements 3
Table 2.1 Summary of reprofiled void depression physical characteristics 13
Table 3.1 Stream gauge 16
Table 3.2 Mean rainfall and evaporation for -26.10 latitude and 149.90 longitude (SILO 2025) 20
Table 5.1 Catchment areas 26
Table 5.2 Catchment AWBM land use progression 27
Table 5.3 Annual rainfall statistics 29
Table 5.4 Annual evaporation and evapotranspiration summary 30
Table 5.5 Projected annual rainfall and pan evaporation change based on global climate models – HI RCP4.5 31
Table 5.6 Projected annual rainfall and pan evaporation change based on global climate models – HP RCP8.5 32
Table 5.7 AWBM catchment yield parameters – base case 32
Table 5.8 AWBM catchment yield parameters – sensitivity case 33
Table 5.9 Reprofiled void depression closure dates 33
Table 5.10 Salinity concentrations considered in the water balance model 35
Table 5.11 Private freehold land within Project MLs (GCAA 2024b) 36
Table 5.12 Tolerances of livestock to TDS (salinity) in drinking water (ANZECC and ARMCANZ 2000) 37
Table 5.13 Assessed stock areas and maximum water consumption associated with each reprofiled void depression 37

TABLE OF CONTENTS

(continued)

Table 6.1 Summary of base case results 48
Table 7.1 Predicted beef cattle consumption 51
Table 8.1 Sensitivity cases 53
Table I.1 Reprofiled void depression surface area – EA Table F5 (DES 2022) 65

List of Figures

Figure 1.1 Project location 2
Figure 2.1 EA approved pit and dump footprint 8
Figure 2.2 Pit and dump progression over the life of mine 9
Figure 2.3 Reprofiled void depression 10
Figure 2.4 Final landform (GCAA 2024) 12
Figure 3.1 Project area topography and drainage 15
Figure 3.2 Stream gauge location 17
Figure 3.3 Annual streamflow – Juandah Creek at Windemere (130344A) 18
Figure 3.4 Monthly streamflow – Juandah Creek at Windemere (130344A) 18
Figure 3.5 Daily streamflow – Juandah Creek at Windemere (130344A) 19
Figure 3.6 Monthly distribution of rainfall and evaporation for -26.10 latitude and 149.90 longitude (SILO 2025) 20
Figure 4.1 Conceptual reprofiled void depression water balance 22
Figure 5.1 Double mass curve comparison of monthly Project AWS and Data Drill rainfall 28
Figure 5.2 Data Drill annual rainfall totals – time series data and percentiles 29
Figure 5.3 Rainfall residual mass curve and seasonality analysis 29
Figure 5.4 Assessed stock areas associated with each reprofiled void depression 38
Figure 6.1 Summer Hill water levels – base case 40
Figure 6.2 Mud Creek water levels – base case 41
Figure 6.3 Woleebee North Satellite water levels – base case 42
Figure 6.4 Woleebee Creek water levels – base case 43
Figure 6.5 Woleebee water levels – base case 44
Figure 6.6 Austinvale water levels – base case 45
Figure 6.7 Frank Creek water levels – base case 46
Figure 6.8 Wubagul water levels – base case 47
Figure 8.1 Sensitivity water level ranges – Summer Hill 54
Figure 8.2 Sensitivity water level ranges – Mud Creek 54
Figure 8.3 Sensitivity water level ranges – Woleebee North Satellite 54
Figure 8.4 Sensitivity water level ranges – Woleebee Creek 54
Figure 8.5 Sensitivity water level ranges – Woleebee 55
Figure 8.6 Sensitivity water level ranges – Austinvale 55
Figure 8.7 Sensitivity water level ranges – Frank Creek 55
Figure 8.8 Sensitivity water level ranges – Wubagul 55
Figure 8.9 Sensitivity TDS level ranges – Summer Hill 56
Figure 8.10 Sensitivity TDS level ranges – Mud Creek 56

TABLE OF CONTENTS
(continued)

Figure 8.11 Sensitivity TDS level ranges – Woleebee North Satellite 56
Figure 8.12 Sensitivity TDS level ranges – Woleebee Creek 56
Figure 8.13 Sensitivity TDS level ranges – Woleebee 57
Figure 8.14 Sensitivity TDS level ranges – Austinvale 57
Figure 8.15 Sensitivity TDS level ranges – Frank Creek 57
Figure 8.16 Sensitivity TDS level ranges – Wubagul 57
Figure III.1 Predicted depth to water – 500 years post-closure (KCB 2025a) 68
Figure IV.2 Mud Creek cattle consumption 71
Figure IV.3 Woleebee North Satellite cattle consumption 72
Figure IV.4 Woleebee Creek cattle consumption 73
Figure IV.5 Woleebee cattle consumption 74
Figure IV.6 Austinvale cattle consumption 75
Figure IV.7 Frank Creek cattle consumption 76
Figure IV.8 Wubagul cattle consumption 77

List of Appendices

Appendix I Reprofiled void depression maximum surface area
Appendix II Reprofiled void depression data sheets
Appendix III Predicted post-closure depth to water
Appendix IV Cattle consumption
Appendix V DETSI RFI response

TABLE OF CONTENTS
(continued)

List of Acronyms

General terms

AEP	Annual exceedance probability
AHD	Australian height datum
Artificial feature	For land the subject of a PRCP schedule, means: a) a structure or feature that is temporary and, under the PRCP schedule or otherwise, is to be removed from the land; or b) a structure or feature that, under the PRCP schedule, will require a level of maintenance after the land is surrendered that is greater than the level of maintenance that would be required for the land is the relevant activities the subject of the PRCP schedule had not been carried out; or c) a feature forming part of the landform of the land, other than a natural landform, if the feature interferes with or affects – i. a relevant watercourse, or ii. the natural flow of water on the land (DETSI 2024)
AWBM	Australian Water Balance Model
AWS	Automated weather station
AVM	Average variability method
BOM	Bureau of Meteorology - Australian Government
CCS	Consistent climate scenarios
CHPP	Coal handling and preparation plant
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DETSI	Department of Environment, Tourism, Science and Innovation
DLGWV	Department of Local Government, Water and Volunteers
EA	Environmental authority under the *Environmental Projection Act 1994*
EC	Electrical conductivity
EIS	Environment impact statement
EMD	Environmental monitoring database
ERA	Environmentally relevant activity
EV	Environmental values
Flood plain modelling	For land the subject of a PRCP schedule, means modelling of the landform of the land: a) carried out under the ARR; and b) excluding any artificial features for the land. (Department of Environment and Science 2023)
FOS	Factor of safety
GIS	Geographic information system
Haul Roads	Roads specifically for hauling coal across the mining lease
HPP	Hydrogen preparation plant
KCB	KCB Australia Pty Ltd
LOM	Life of mine

TABLE OF CONTENTS
(continued)

MIA	Mine infrastructure area
Mine void	The area of excavation that remains after mining is complete.
ML	Mining lease under the *Mineral resources Act 1989*
M_{lake}	Morton lake evaporation
M_{wet}	Morton wet evaporation
NE	North-east
NSW	New South Wales
Overburden emplacements	Final landform constructed from overburden removed for mining coal
OOP	Out of pit
PMLU	Post-mining land use
PRCP	Progressive rehabilitation and closure plan
Project area	Spatial extent associated with the ground disturbance areas
QMRC	Queensland Mine Rehabilitation Commissioner
RCP	Representative concentration pathways
Reprofiled void depression	Reshaped mining pit depressed landforms
Reprofiled void depression waterbodies	Waterbodies contained within reshaped reprofiled void depressions
RFI	Request for information
RGS	RGS Environmental Consultants Pty Ltd
ROM	Run of mine
RRL	Rainfall runoff library
SEIS	Supplementary environmental impact statement
SLR	SLR Consulting Australia Pty Ltd
Strahler stream order	A method used to describe stream size based on the hierarchy of tributaries of the upstream network.
SW	South-west
TDS	Total dissolved solids
The Proponent	Wandoan Holding Pty Ltd
ToC	Table of contents
Watercourse	A watercourse as determined by the Department of Natural Resources and Energy under the *Water Act 2000*
Water year	1 September to 31 August, for the Dawson Valley Water Management Area. The Water Year starting in 2022 and ending in 2023 is the 2023 Water Year (BOM 2024)
WBM	Water balance model
WCP	Wandoan Coal Project

TABLE OF CONTENTS
(continued)

Legislation, policies and guidelines

EP Act	Environmental Protection Act 1994
EPP (WWB)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018
MLR Policy	Mined Land Rehabilitation Policy 2017
Water Act	Queensland Water Act 2000
WRP	Water resource plan

CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of KCB Australia Pty Ltd (KCB) and has been prepared for the exclusive use of Glencore Coal Assets Australia (Client) (on behalf of Wandoan Holdings Pty Ltd) for the specific application to the water balance study for the reprofiled void depressions associated with the Wandoan Coal Project. It may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
4. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
5. This report should not be relied upon as a final document for design, implementation and/or construction.
6. This report is electronically signed and sealed, and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

1 INTRODUCTION

KCB Australia Pty Ltd (KCB) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) to undertake surface water assessments to support the Wandoan Coal Project (the Project) progressive rehabilitation and closure plan (PRCP).

1.1 Project overview

The Project covers mining leases (ML) 50229, 50230 and 50231, to the west and northwest of Wandoan, as presented in Figure 1.1. The Project is an open cut coal mine authorised under environmental authority (EA) EPML00297613. However, since grant of the MLs in 2017, the Project has remained undeveloped.

The Project requires a PRCP to be developed. The reprofiled void depression water balance study is presented in this report. The report includes relevant legislation and guidelines, background information and water balance modelling undertaken to characterise the water holding nature (levels and quality measured as salinity) of the planned reprofiled void depressions.

1.2 Regulatory requirements

1.2.1 Relevant legislation and guidelines

Regulations, guidelines, and requirements relevant to the Project surface water assessments include:

- The Environmental Protection Act 1994 (EP Act) (State of Queensland 2025a) aims to protect Queensland's environment while allowing for ecologically sustainable development. To conduct an environmentally relevant activity (ERA), an EA is required.
- The Queensland Water Act 2000 (Water Act) (State of Queensland 2025b) aims to advance sustainable management and efficient use of resources by establishing a system for planning and allocation, and use of water. The act is enacted under the framework of catchment specific Water Resources Plans (WRPs) with the Project included in the Water Plan (Fitzroy Basin) 2011. The act includes criteria for determining watercourses and drainage features that require authorisation to interfere with the flow of water and overland flow, respectively.
- The Mined Land Rehabilitation Policy 2017 (MLR Policy) (State of Queensland 2017) ensures land disturbed by mining is rehabilitated to a stable, environmentally safe condition for approved post-mining land use (PMLU). The policy includes binding milestones for progressive rehabilitation.
- The PRCP guideline (ESR/2019/4964) (DETSI 2024) helps applicants develop a PRCP, aligning with the EP Act and the MLR Policy using best practices and industry standards.

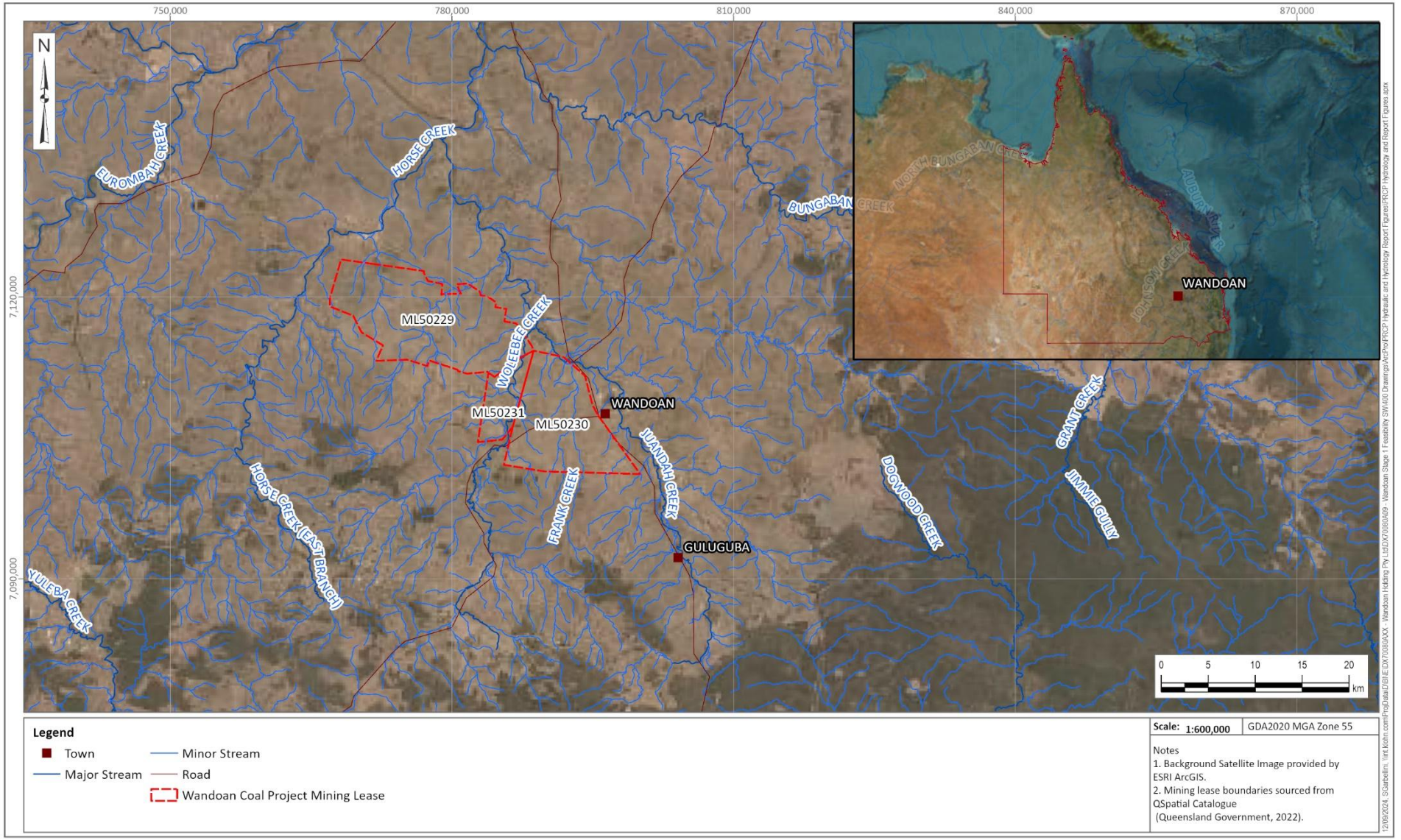


Figure 1.1 Project location

1.2.2 PRCP guideline

Closure requirements for reprofiled void depressions are detailed in the PRCP guideline (DETSI 2024):

- Section 3.2: PMLU;
- Section 3.4: Voids in flood plains; and
- Section 3.6.3: Voids.

The specific requirements and comment on how they relate to this study are presented in Table 1.1.

Table 1.1 PRCP void closure plan requirements

Requirement	Comment
Section 3.2: PMLU	▪ The final landform conditions and outcomes of this report, as summarised in Sections 2.2 and 9, respectively, directly inform the viability of the proposed PMLU associated with the Project.
Section 3.4: Voids in flood plains	▪ Not addressed as part of this study ▪ PRCP flood modelling has been undertaken by KCB as part of a concurrent PRCP technical study for the Project, refer to KCB's PRCP hydrologic and hydraulic modelling study report (KCB 2025b). ▪ PRCP flood modelling demonstrated that no ingress of flood waters from surrounding streams into the reprofiled void depressions is expected up to and including a 1 in 1,000 annual exceedance probability (AEP) event.
Section 3.6.3: Voids	
▪ Options available for minimising final void area and volume (where a final void is proposed).	▪ Not addressed as part of this study. ▪ The reprofiled void geometries provided to KCB by the Proponent have taken this into consideration.
▪ Proposed final dimensions of the void (i.e., depth, length and width).	▪ Summary provided in this report, refer to Section 5.3 and Appendix II.
▪ Pit wall geotechnical and geochemical stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events.	▪ Not addressed as part of this study. ▪ Stability assessment of the final landform and supporting erosion and weathering studies have been undertaken by SLR Consulting Australia Pty Ltd (SLR).
▪ Proposed final slope angles of high wall, low wall and end walls of each final void.	▪ Not addressed as part of this study. ▪ An assessment of the slope angles of the proposed final landform and reprofiled void depressions has been undertaken by SLR. ▪ Graphical presentation of slope angles is provided in reprofiled void depression data sheets, refer to Appendix II.
▪ Void hydrology, addressing the long-term water balance and water level in the voids, stratification connections to groundwater resources and potential for overflow.	▪ Void hydrology, long-term water balance and levels expected in the reprofiled void depressions are addressed in Sections 6 and 8. ▪ Stratification modelling has not been addressed as part of this study because of the shallow depth

Requirement	Comment
	and ephemeral nature of water expected in the reprofiled void depressions. ▪ Connections to groundwater resources have not been addressed as part of this study as the reprofiled void depressions have been designed to be at least 5 m above the predicted post-closure groundwater level. Summary provided in this report, refer to Section 5.5. ▪ Long-term water balance modelling demonstrated that no potential overflow is expected to occur from the reprofiled void depressions, refer to Sections 6 and 8.
▪ Groundwater modelling to determine whether the void is acting as a sink or a source for groundwater.	▪ Three-dimensional (3D) groundwater modelling has been undertaken by KCB as part of a concurrent PRCP technical study for the Project, refer to KCB's PRCP groundwater assessment report (KCB 2025a). ▪ Information from the groundwater model has been integrated into the water balance model as required (and vice versa), refer to Section 5.5. ▪ Based on the PRCP groundwater modelling, the final landform has been designed to be at least 5 m above the predicted post-closure groundwater level with reprofiled void depressions that hold water expected to act as a source for groundwater.
▪ A water balance study including an assessment of void surface and groundwater interactions such as: ♦ Groundwater lowering/reduction in hydraulic head (from new voids) (e.g. caves/karst system) ♦ Cones of depression and associated impacts	▪ Refer to KCB's PRCP groundwater assessment report (KCB 2025a).
♦ The drainage and flooding behaviours of surface water in the vicinity of the void.	▪ Catchments draining towards the reprofiled void depressions have been delineated and are discussed in Section 5.3.4 and Appendix II. ▪ Surface water flooding not assessed as part of this study. ▪ PRCP flood modelling demonstrated that no ingress of flood waters from surrounding watercourses into the reprofiled void depressions is expected up to and including a 1 in 1,000 AEP event, refer to KCB's PRCP hydrologic and hydraulic modelling study report (KCB 2025b).
♦ A conceptual model that incorporates all projected inflows, outflows, and recharge rates.	▪ The conceptual model for the water balance is provided in Section 4 and considers all major surface and groundwater fluxes into and out of the reprofiled void depressions.
♦ Water storage and long-term water balance and each of the major water fluxes into and out of the void	▪ Results from the water balance model are provided in Sections 6 and 8 and address water storage and long-term water balances expected within the reprofiled void depressions.

Requirement	Comment
◆ The sources of surface water within the mine catchment that are likely to influence the water quality in the void.	▪ Identification of specific catchment contamination sources is not addressed in this study. However, the water balance model accounts for salinity over time within the reprofiled void depressions.
▪ Predicted water quality in the long-term including potential stratification.	▪ The water balance model accounts for salinity over time within the reprofiled void depressions. ▪ Due to the shallow depth of water expected in the reprofiled voids (i.e., no stratification expected), stratification modelling has not been undertaken as part of this study

In completing this study, KCB considered three technical papers recently developed by the Office of the Queensland Mine Rehabilitation Commissioner (QMRC). These papers (Tomlin et al. 2025) (Tomlin et al. 2023b) (Tomlin et al. 2023a) provide advice on leading practices for mine void modelling used to support rehabilitation planning.

1.2.3 Environmental authority

The requirements for reprofiled void depressions are detailed in the Project EA EPML00297613 (DETSI 2022) as follows:

- Condition F1 (Table F1): Final land use and rehabilitation plan:
  - PMLU for reprofiled voids is nominated as low-density beef cattle grazing or native bushland. Requirements for water quality for beef cattle and sustainable stock grazing rates are detailed in Section 5.7.
- Condition F9: Reprofiled void outcome:
  - Reprofiled voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the reprofiled void itself, and subject to any other condition within the EA.
  - Reprofiled voids must comply with design specifications and locations in Table F4 and Figure F2 of the EA, respectively. EA requirements for maximum void surface area compared to planned reprofiled void depression surface areas are presented in Appendix I with locations presented in Figure 2.1. Maximum surface areas and locations of the planned reprofiled void depression comply with EA requirements.

1.3 Report structure

The report structure is:

- Section 2: Project description.
- Section 3: Existing environment summary (including topography, climate, hydrology, and groundwater systems).
- Section 4: Conceptual model outline (i.e., how surface and groundwater interact with the reprofiled void depressions).
- Section 5: Water balance model developed (i.e., physical characteristics, hydrological, hydrogeological, salinity assumptions, and modelling of cattle consumption (i.e., reuse options)).
- Section 6: Base case modelling results.
- Section 7: Cattle consumption.
- Section 8: Sensitivity modelling results (i.e., uncertainty testing undertaken on key model inputs and assumptions).
- Section 9: Water balance study conclusions.

2 PROJECT DESCRIPTION

2.1 Components

The Project includes:

- Open cut mining on ML50230 at the Leichhardt, Austinvale and Woleebee pits for the first 35 years of operation. Mine plans for these pits target the Upper Juandah Coal Measures (Kogan, Upper Macalister, Lower Macalister and Wambo coal seams).
- Open cut mining of remaining pits for the final 35 years of the life of mine.
- Overburden emplacements adjacent to the open pits.
- Raw and mine affected water storages.
- Mine infrastructure area (MIA).
- Coal handling and preparation plant (CHPP).

The Project will be operated in accordance with EA EPML00297613, with the latest Department of Environment, Tourism, Science and Innovation (DETSI) version taking effect on 2 December 2022 (DETSI 2022).

The approved pit disturbance areas for the Project are presented in Figure 2.1 along with the proposed mining scheduled in Figure 2.2.

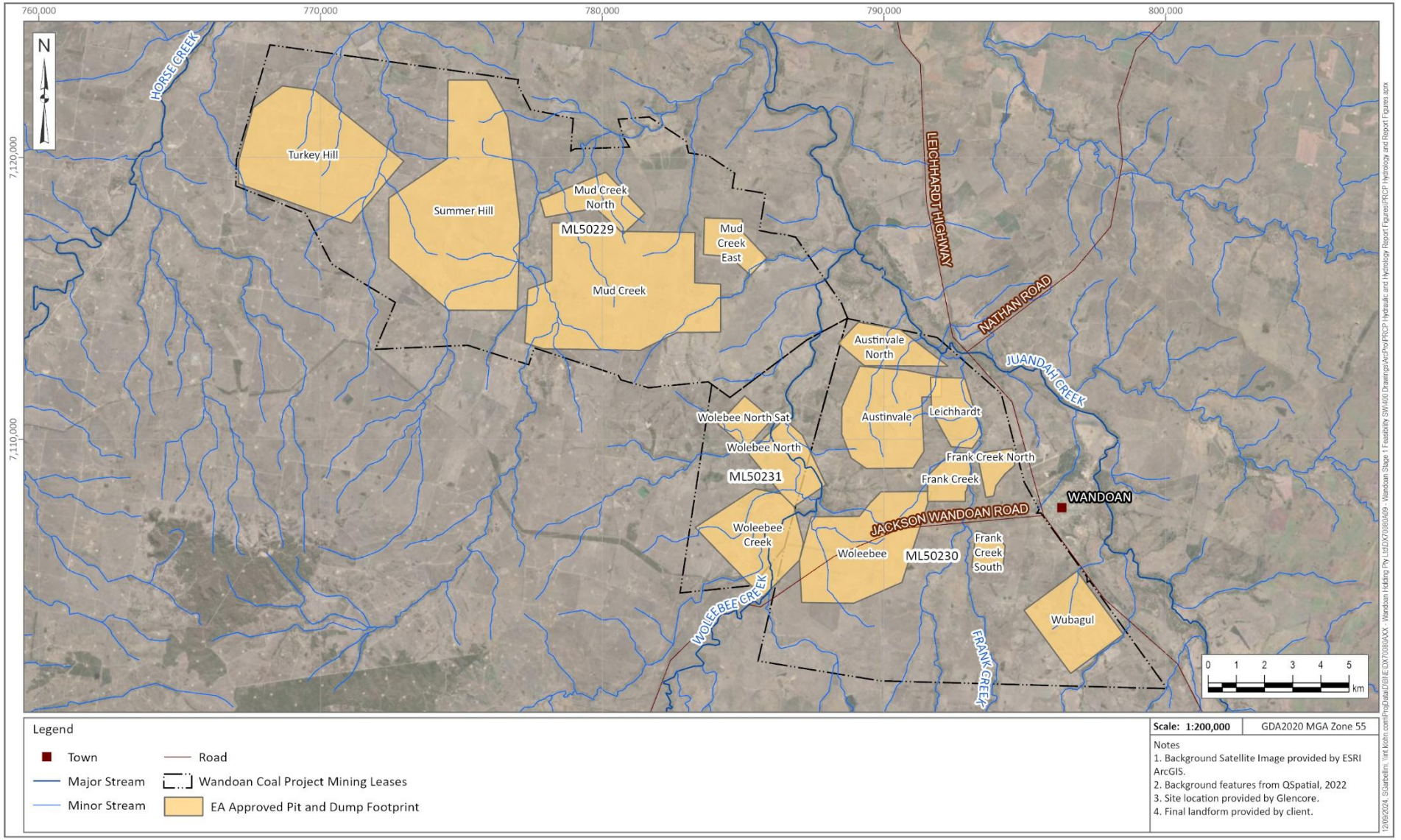


Figure 2.1 EA approved pit and dump footprint

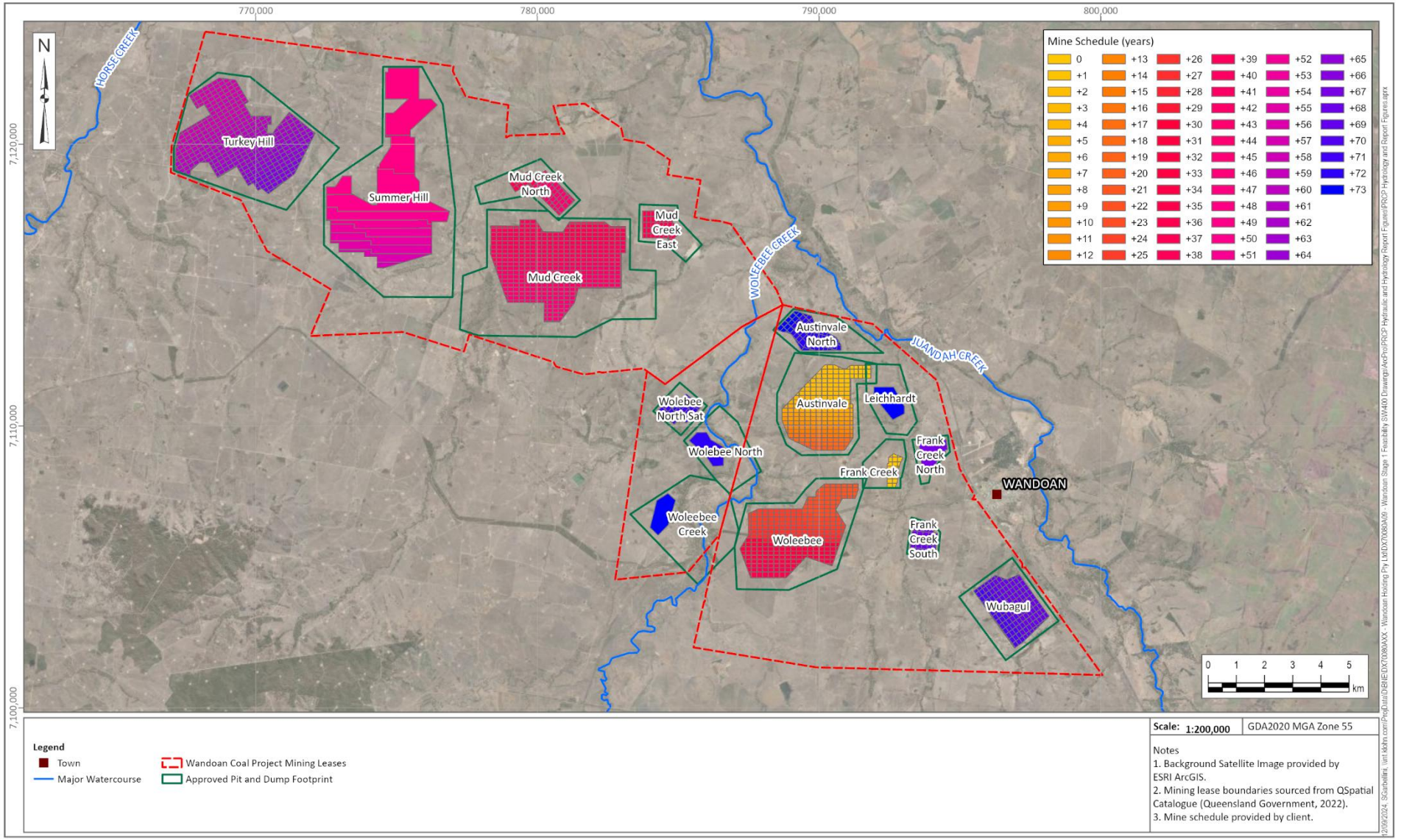


Figure 2.2 Pit and dump progression over the life of mine

2.2 Closure plan

The mined pits will be progressively backfilled with spoil material during mining operations. Each mining pit will be backfilled with spoil to at least 5 m above the predicted post-closure groundwater level, with only shallow surface depressions to remain. This will reduce the number of voids remaining at closure from 16 to eight. It is also expected to prevent the ingress of saline groundwater into the remaining depressions and the associated decline of water quality (due to groundwater ingress) within the waterbodies which may form in the depressions, providing a potential water source for stock.

As such, shallow reshaped mining pit depressed landforms (herein referred to a reprofiled void depressions) are planned to remain at closure. The reprofiled void depressions will have no groundwater as opposed to deep final voids with base levels below the groundwater (i.e., sinks) and pit lakes (as traditionally expected to remain at closure for open cut mining pits). The planned reprofiled void depressions and associated waterbodies are depicted graphically in Figure 2.3 with the traditional final void and pit lakes presented for comparison.

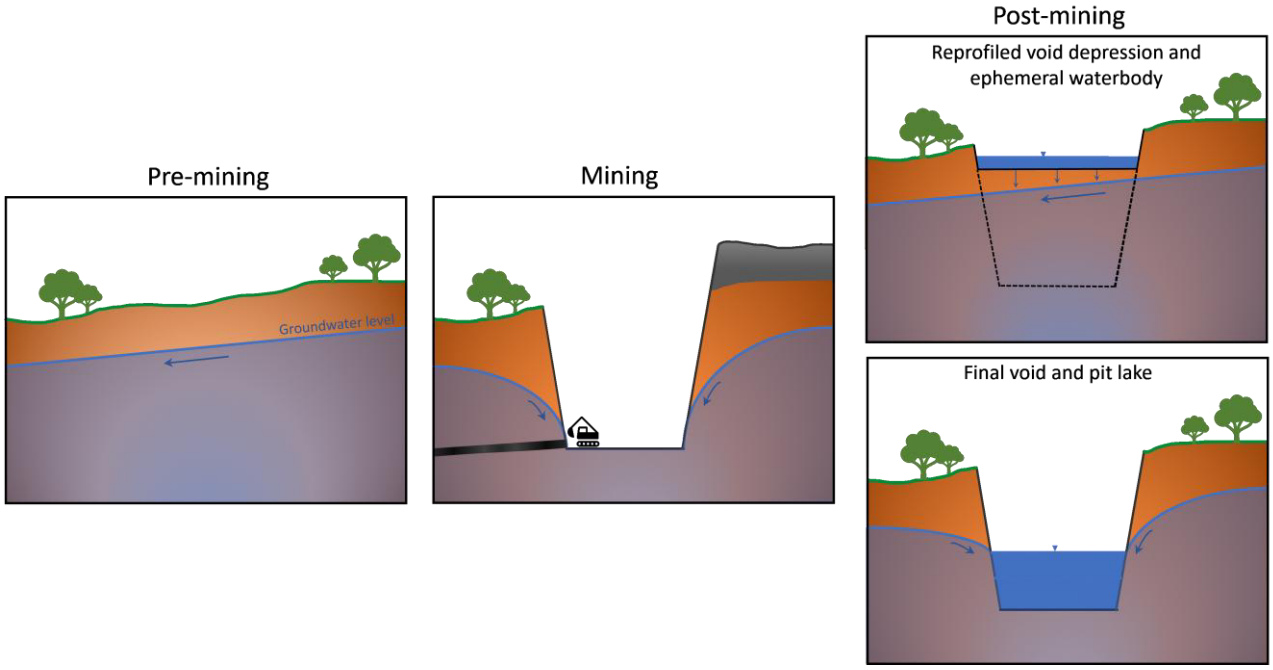


Figure 2.3 Reprofiled void depression

Key features of the reprofiled void depressions, as defined by the Proponent, include:

- Highwalls retained where the material is competent / unweathered, with slopes less than 214% (EA condition).
- Highwall weathered zones battered back to less than or equal to 22% (based on erosion studies) and revegetated to native bushland (EA PMLU) with grazing as a management tool where safety permits.
- Voids to be backfilled to be approximately 5 m above predicted post-closure groundwater levels.

- Low walls left will be reshaped to less than 22% and will be geotechnically stable with appropriate erosion rates.
- PMLU for the low walls and reprofiled void depressions is grazing with cattle to access the void water of stock drinking quality (less than 4,000 mg/L for total dissolved solids (TDS)).

The final landform surface, prepared by the Proponent (GCAA 2024a), is presented in Figure 2.4 and features the final landforms of the 16 mining areas. A summary of the physical characteristics of each mining area upon closure is provided in Table 2.1.

As shown in Figure 2.4 and Table 2.1, reprofiled void depressions are planned for eight of the 16 mining areas (i.e., Summer Hill, Mud Creek, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul). Further details of the physical characteristics of these reprofiled void depressions are provided in Section 5.3 and Appendix II. The remaining eight mining areas (Turkey Hill, Mud Creek North, Mud Creek East, Woleebee North, Austinvale North, Leichhardt, Frank Creek North and Frank Creek South) will be reshaped to form free draining landforms.

Long-term water balance modelling of the reprofiled void depressions has been assessed to determine the potential for waterbodies to form in the depressions.

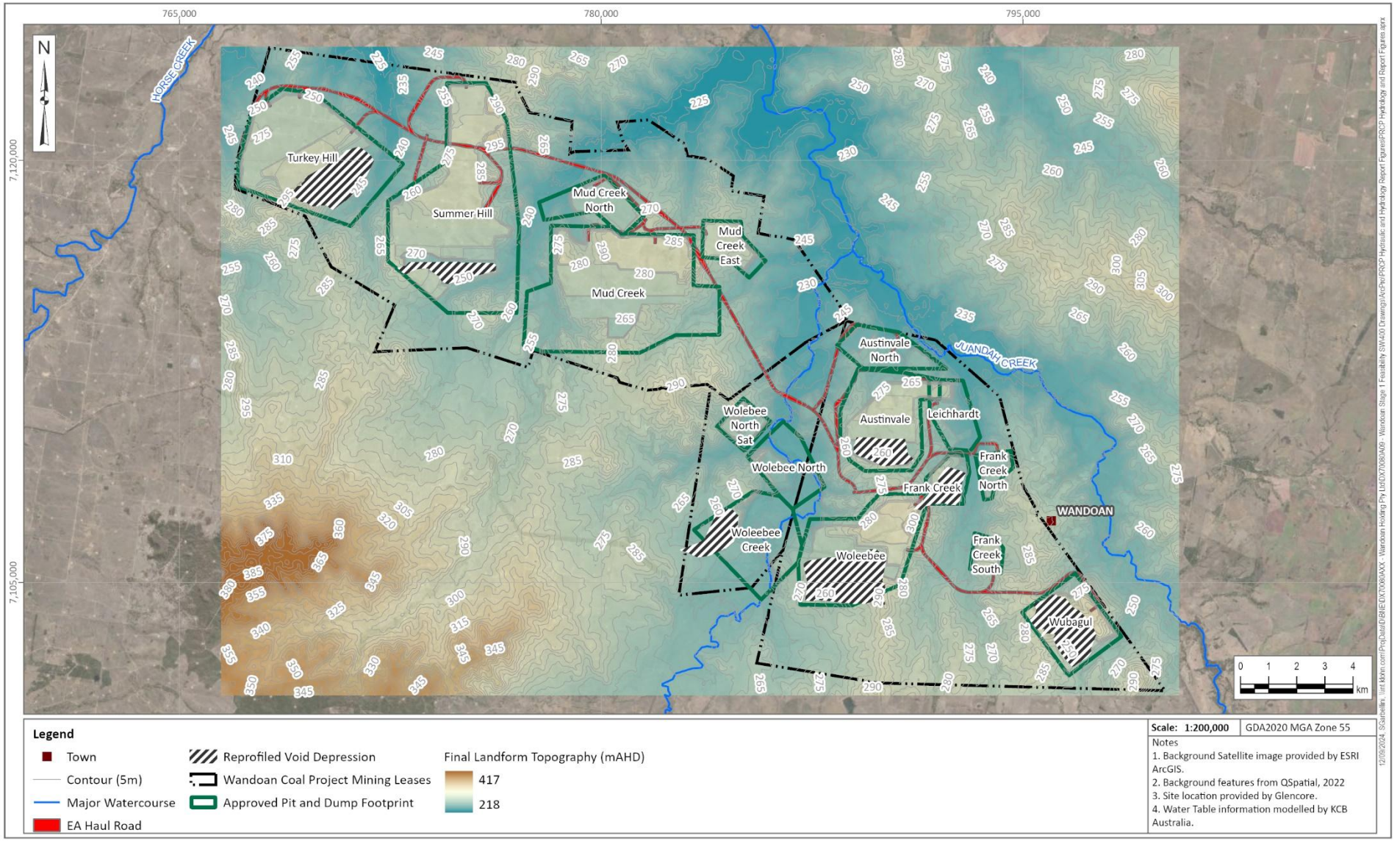


Figure 2.4 Final landform (GCAA 2024)

Table 2.1 Summary of reprofiled void depression physical characteristics

Mining area	Closure date (year from start of mining)	Maximum storage capacity (GL)	Base surface area (ha)	Base level of depression (mAHD)	Crest level of depression (mAHD)	Outlet type	Receiving waterway	Reprofiled void depression
Turkey Hill	68	0	No depression			Free draining	Spring Creek	No
Mud Creek North	46	0	No depression			Free draining	Mud Creek	No
Mud Creek East	40	0	No depression			Free draining	Juandah Creek tributary	No
Woleebee North	74	0	No depression			Free draining	Woleebee Creek	No
Austinvale North	75	0	No depression			Free draining	Juandah Creek	No
Leichhardt	75	0	No depression			Free draining	Frank Creek	No
Frank Creek North	69	0	No depression			Free draining	Frank Creek	No
Frank Creek South	69	0	No depression			Free draining	Frank Creek	No
Summer Hill	59	3.6	104.1	249.0	252.2	Crest overflow	Mud Creek	Yes
Mud Creek	48	3.1	46.3	260.2	267.7	Crest overflow	Mud Creek	Yes
Woleebee North Satellite	73	1.4	22.9	247.5	253.2	Crest overflow	Woleebee Creek	Yes
Woleebee Creek	75	4.0	43.0	242.9	249.9	Crest overflow	Wandoan Creek	Yes
Woleebee	38	29.0	24.3	243.6	264.9	Crest overflow	Woleebee Creek	Yes
Austinvale	21	4.7	47.3	253.7	261.9	Crest overflow	Woleebee Creek	Yes
Frank Creek	1	1.4	13.6	241.0	246.1	Crest overflow	Frank Creek	Yes
Wubagul	72	9.3	85.5	250.0	259.9	Crest overflow	Two Mile Creek	Yes

3 EXISTING ENVIRONMENT

3.1 Topography

The topography of the Project area is presented in Figure 3.1. Elevations across the Project MLs range between 180 to 300 m Australian height datum (AHD), with topographic highs to the south of the Project MLs. The natural flow path of drainage features through the Project MLs is from the south towards the north.

3.2 Hydrology

The Project is in the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. The Fitzroy River Basin is the second largest externally drained basin in Australia and the largest on the east coast. Covering an area of 150,000 km^2, the basin contains several significant tributaries, including the Nogoa, Comet, Mackenzie, and Dawson Rivers. The basin discharges into the Coral Sea east of Rockhampton.

The Maranoa-Balonne Rivers sub-basin, which is part of the Condamine River Basin, is to the south of the Project. The Maranoa-Balonne Rivers sub-basin contains several significant tributaries including the Balonne and Maranoa Rivers which drains southwest into New South Wales (NSW).

3.2.1 Streams

Key streams (as presented in Figure 1.1 and Figure 3.1) in the vicinity of the Project include:

- Juandah Creek: flows from the southeast of the Project MLs, towards the north to join the Dawson River, 3 km south of Taroom. Juandah Creek is joined by Woleebee Creek, Horse Creek from the south, and Bungaban Creek from the east before joining the Dawson River.
- Woleebee Creek: flows north from its headwaters through the Project MLs to join Juandah Creek to the northeast.
- Horse Creek: flows in a north-easterly direction on the western side of ML50229, to join Juandah Creek in the north, before joining the Dawson River.

Juandah and Woleebee Creeks are the main streams that flow through the Projects MLs and are stream order five based on the Strahler system used to describe stream hierarchy. These streams are named watercourses determined under the Water Act 2000.

There are several smaller named streams including Frank, Wandoan, Blackant and Mud Creeks (stream orders three to four) and Mount Organ and Spring Creeks (stream order two to three) that flow through the Project MLs. These named streams are mapped and defined as watercourses under the Water Act 2000. Halfway Creek (stream order three), Duck and Two Mile Creeks (stream orders two and three, respectively) and Tom's Gully (stream order one) are mapped drainage features under the Water Act 2000 along with several unnamed tributaries of Duck, Juandah, Spring and Woleebee Creeks.

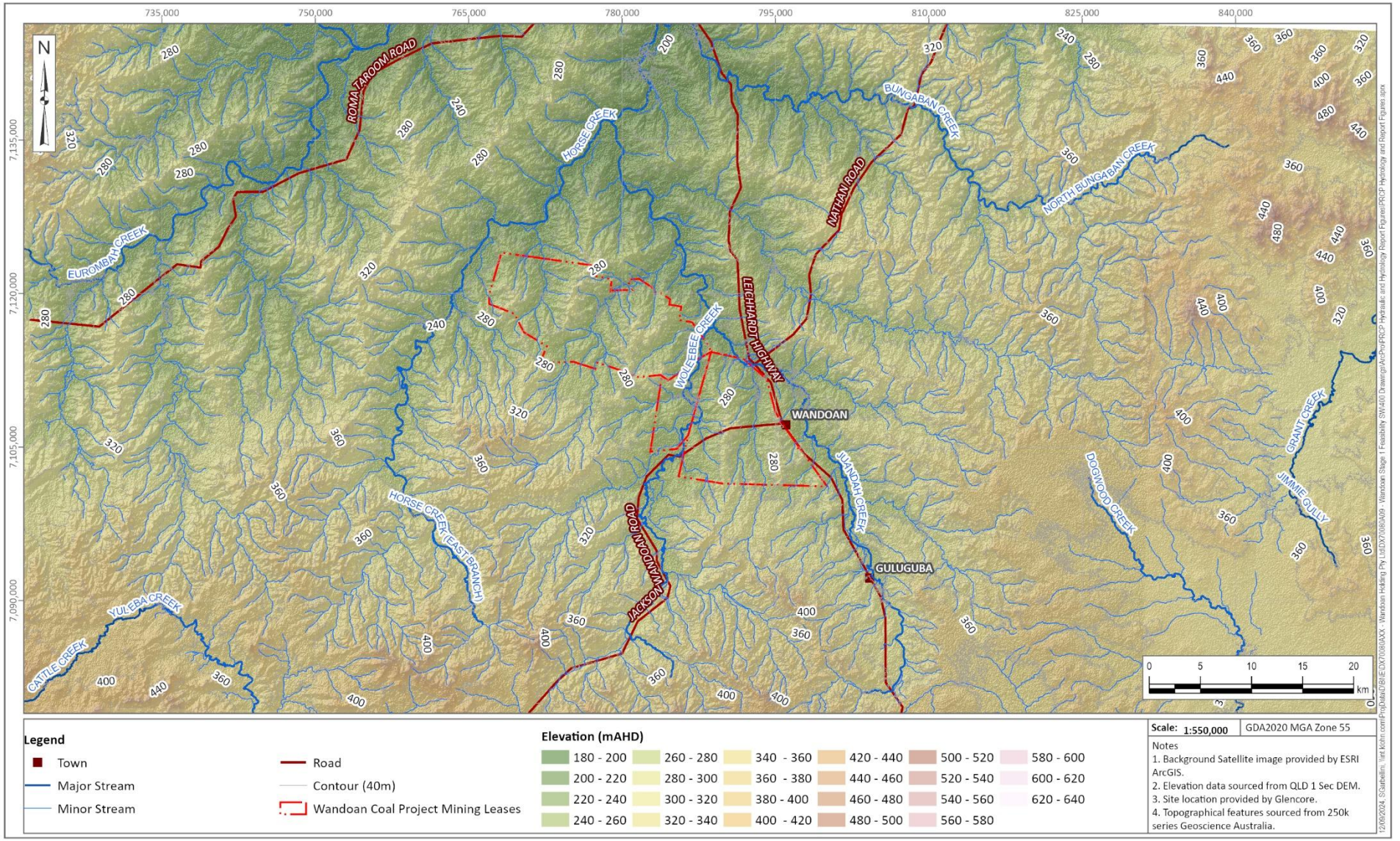


Figure 3.1 Project area topography and drainage

Streams across the Project MLs are ephemeral. This is a consequence of the streams being in a climate zone with seasonal rainfall and being in the upper reaches of the catchments, which means they have limited catchment. Ephemeral streams will typically only experience surface water flow during or immediately after heavy or sustained rainfall events (i.e., summer wet season). Following periods of flow, surface water will persist in the form of non-flowing, disconnected pools separated by dry / exposed stream bed.

3.2.2 Streamflow

A stream gauge is located within the vicinity of the Project, on Juandah Creek downstream of the confluence between Woleebee and Juandah Creeks (Figure 3.2). The steam gauge has a catchment area of approximately 1,657 km^2. This stream gauge is operated by the Department of Local Government, Water and Volunteers (DLGWV) with details presented in Table 3.1.

Table 3.1 Stream gauge

Name	Gauge ID	Owner	Latitude	Longitude	Date range	Years of data collected
Juandah Creek at Windamere	130344A	DLGWV	-26.03	149.88	27/06/1974 to 20/03/2024	49.7

Annual year, monthly and daily streamflow recorded for Juandah Creek at Windemere are presented in Figure 3.3 to Figure 3.5.

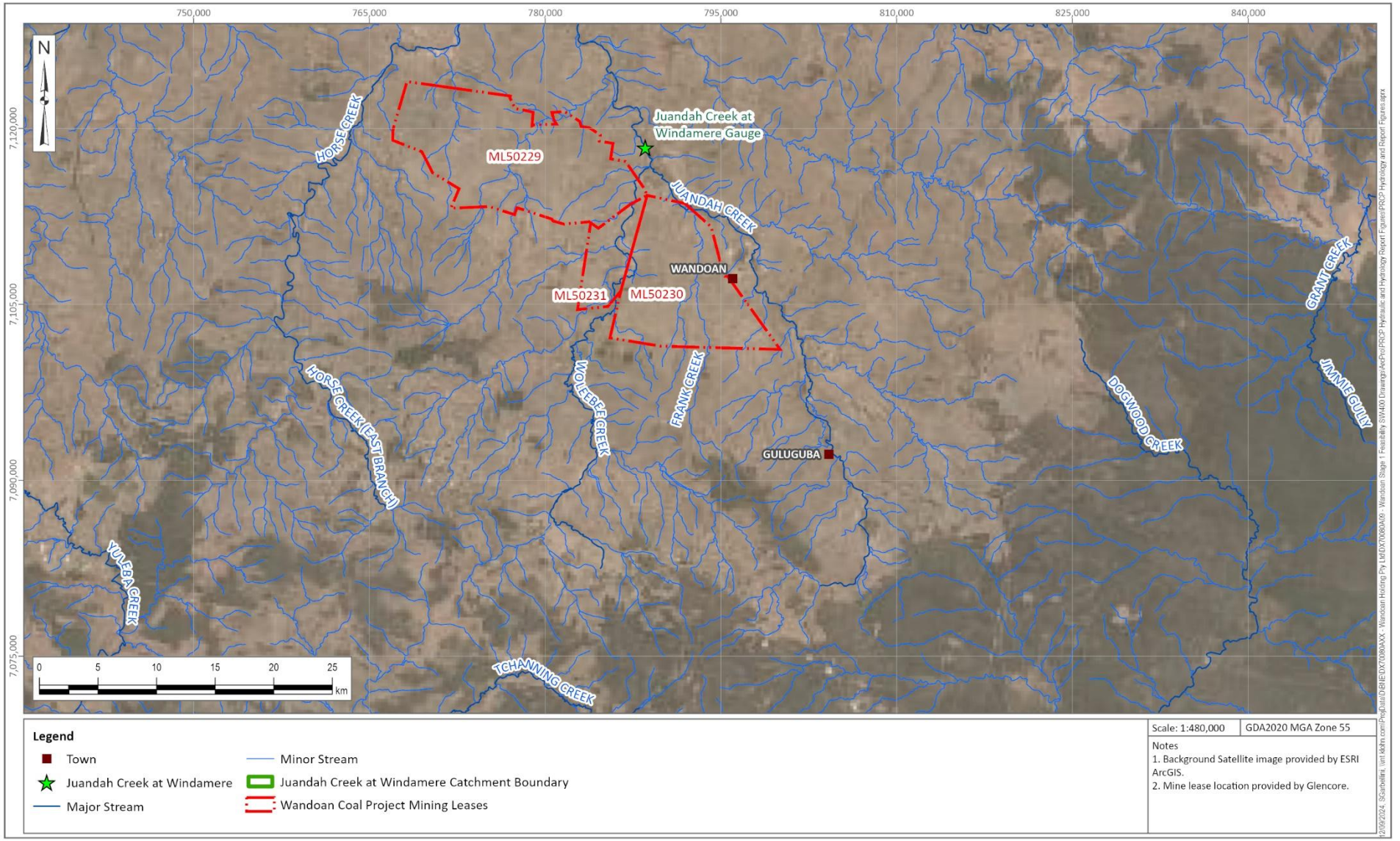


Figure 3.2 Stream gauge location

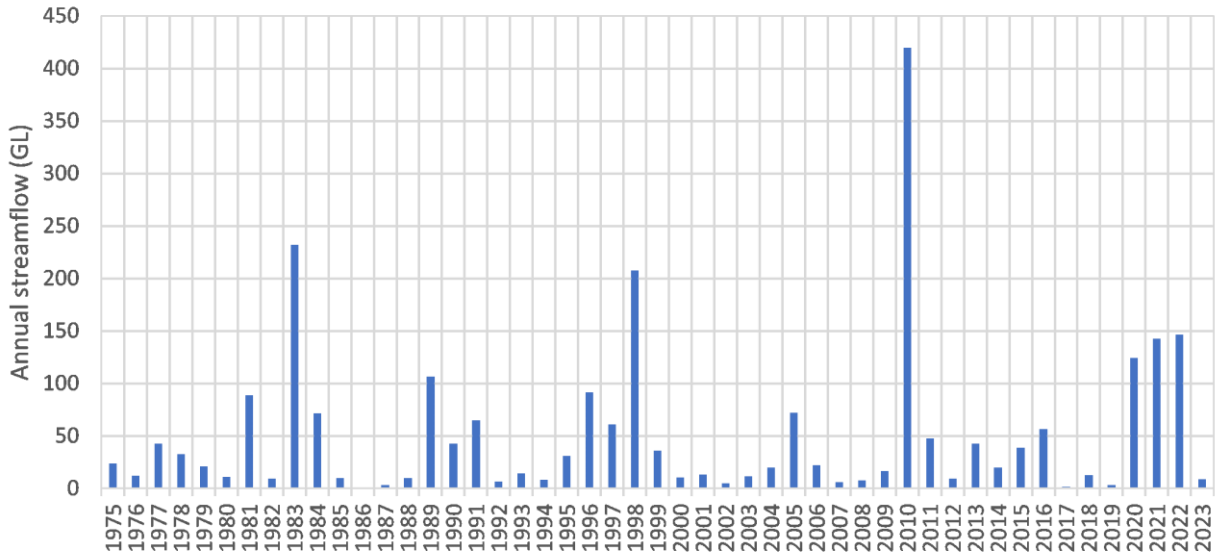


Figure 3.3 Annual streamflow – Juandah Creek at Windemere (130344A)

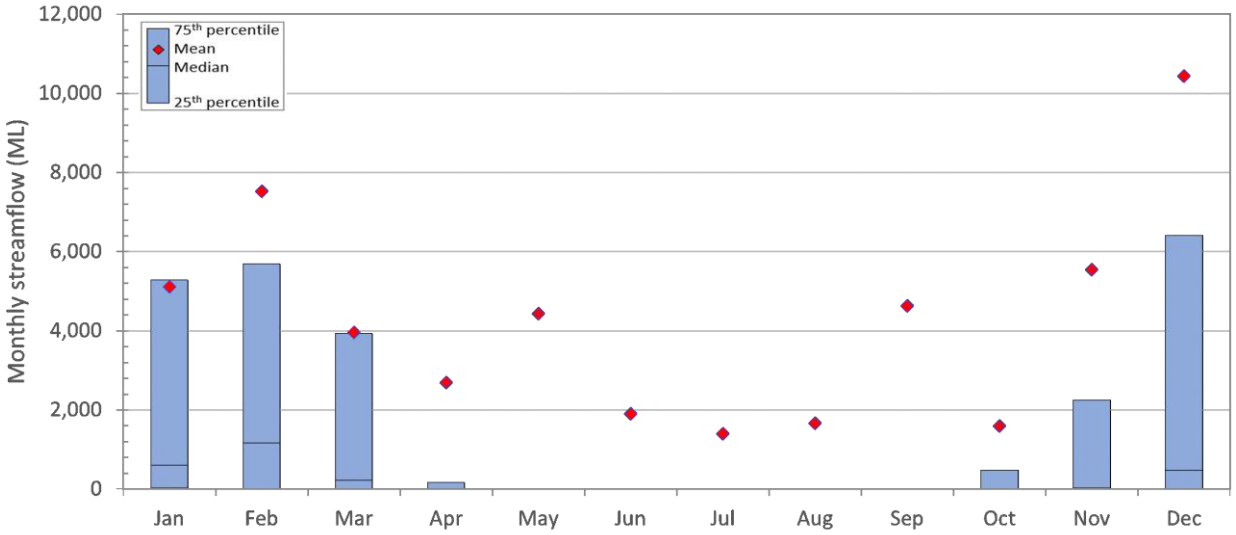


Figure 3.4 Monthly streamflow – Juandah Creek at Windemere (130344A)

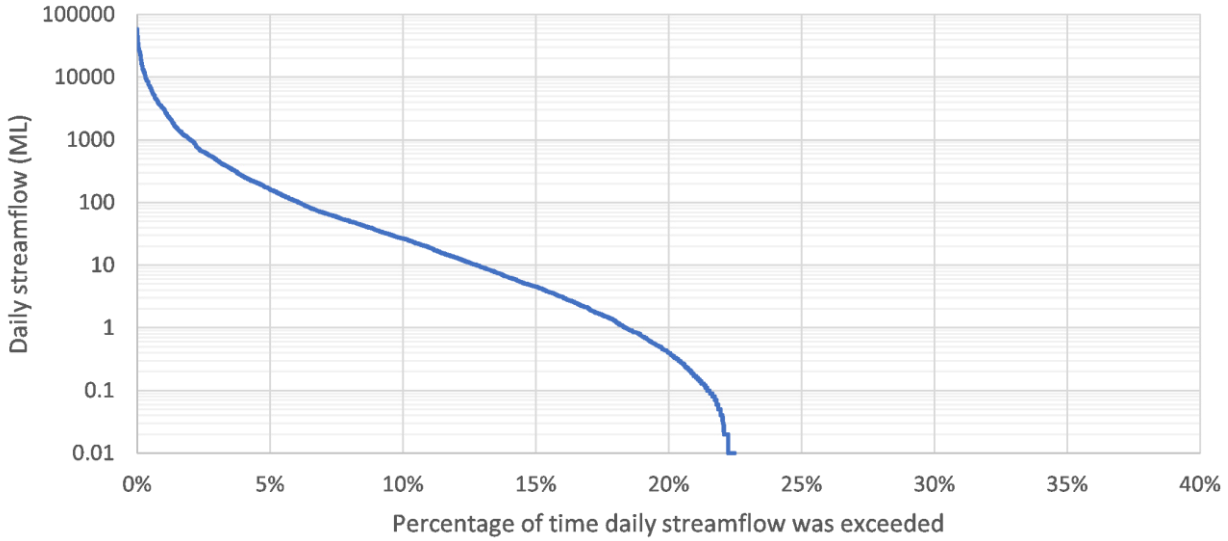


Figure 3.5 Daily streamflow – Juandah Creek at Windemere (130344A)

Review of streamflow volumes indicated that:

- most of the streamflow occurs during high rainfall months of December to March, with the highest mean monthly streamflow occurring in December;
- when streamflow was evident, mean flows were consistently higher than the median and 75th percentile of non-exceedance flows; and
- flow was ephemeral with no flow for several months in the dry season (at least 50% of the time).

Low to no-flow months shown in the monthly streamflow figure (Figure 3.4) were also captured in the daily streamflow (Figure 3.5) with approximately 80% of daily flow recorded with less than 0.1 ML/d and no flow for 78% of the time.

3.3 Climate data

3.3.1 Rainfall and evaporation

Climate data for the Project was obtained from the SILO Data Drill services (Data Drill) (SILO 2025) for a location central to the three Project MLs (-26.10 latitude, 149.90 longitude). Data Drill is an enhanced synthetic climate database that provides daily time series data for point locations and comprises actual station records interpolated on a grid basis, across Australia. Table 3.2 and Figure 3.6 show the mean monthly and annual rainfall and lake evaporation for the Project based on Data Drill data from 1 January 1889 to 31 December 2023.

Table 3.2 Mean rainfall and evaporation for -26.10 latitude and 149.90 longitude (SILO 2025)

Month	Mean rainfall (mm)	Mean lake evaporation* (mm)
January	90	208
February	78	171
March	60	163
April	33	120
May	36	85
June	36	64
July	32	73
August	26	100
September	32	135
October	54	174
November	71	193
December	87	211
Mean annual	638	1,699

Note: '* based on Mortin's lake evaporation (SILO 2025)

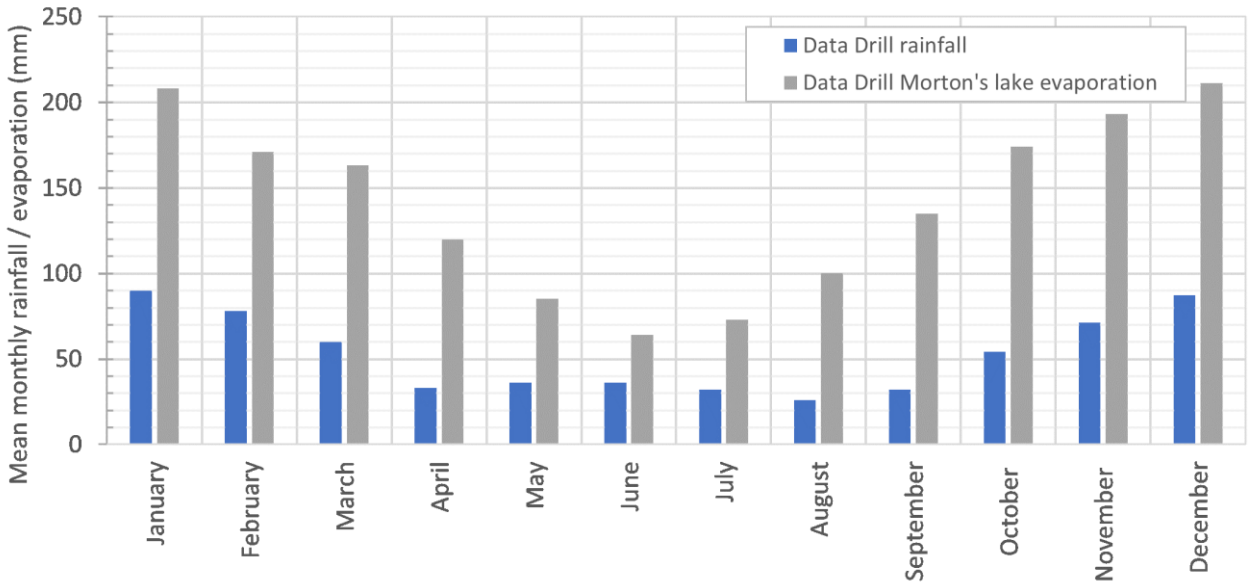


Figure 3.6 Monthly distribution of rainfall and evaporation for -26.10 latitude and 149.90 longitude (SILO 2025)

From the monthly distribution presented in Figure 3.6, most of the annual rainfall for the Project occurs over the summer months with winter rainfall generally less than 50% of that occurring in summer. The highest rainfall occurs during November to February, with the lowest rainfall occurring during April to September. Average lake evaporation exceeds average rainfall for all months of the year with an average annual rainfall deficit of around 1,060 mm/year.

The climatic processes affecting the hydrology of the reprofiled void depressions include direct rainfall on the waterbody within the depression, catchment runoff from areas external to the depression, evaporation from the waterbody surface and evapotranspiration from the reporting catchment. Application of rainfall and evaporation data in the water balance modelling undertaken as part of this study is discussed further in Section 5.4.

3.3.2 Climate change

Variations in the rainfall and evaporation resulting from global climate change are important factors to be considered during the assessment of the water balance modelling. To understand the potential changes to climate for the Fitzroy River region, high level projections by CSIRO and BoM (State of Queensland 2024) were reviewed for the east coast north and monsoonal north-east subcluster. CSIRO predictions relating to rainfall and evaporation for the region are:

- annual rainfall changes are possible but unclear, affected by factors such as topography;
- increased intensity of extreme rainfall events is projected;
- time spent in drought is expected to increase; and
- potential evapotranspiration is projected to increase in all seasons as warming occurs.

The potential climate change effects for the Project have been considered as model sensitivities and are discussed further in Section 8.

3.4 Groundwater systems

Groundwater systems and their expected interaction with the Project have been assessed as part of concurrent PRPC technical studies undertaken by KCB. For further information on the assumptions of the regional groundwater system as part of the groundwater model, reference should be made to the KCB's PRCP groundwater modelling report (KCB 2025a).

4 CONCEPTUAL MODEL

As detailed in Table 2.1, reprofiled void depressions are planned for the mining areas of:

- Summer Hill;
- Mud Creek;
- Woleebee North Satellite;
- Woleebee Creek;
- Woleebee;
- Austinvale;
- Frank Creek; and
- Wubagul.

The conceptual model for the water balance for the reprofiled void depressions is presented in Figure 4.1.

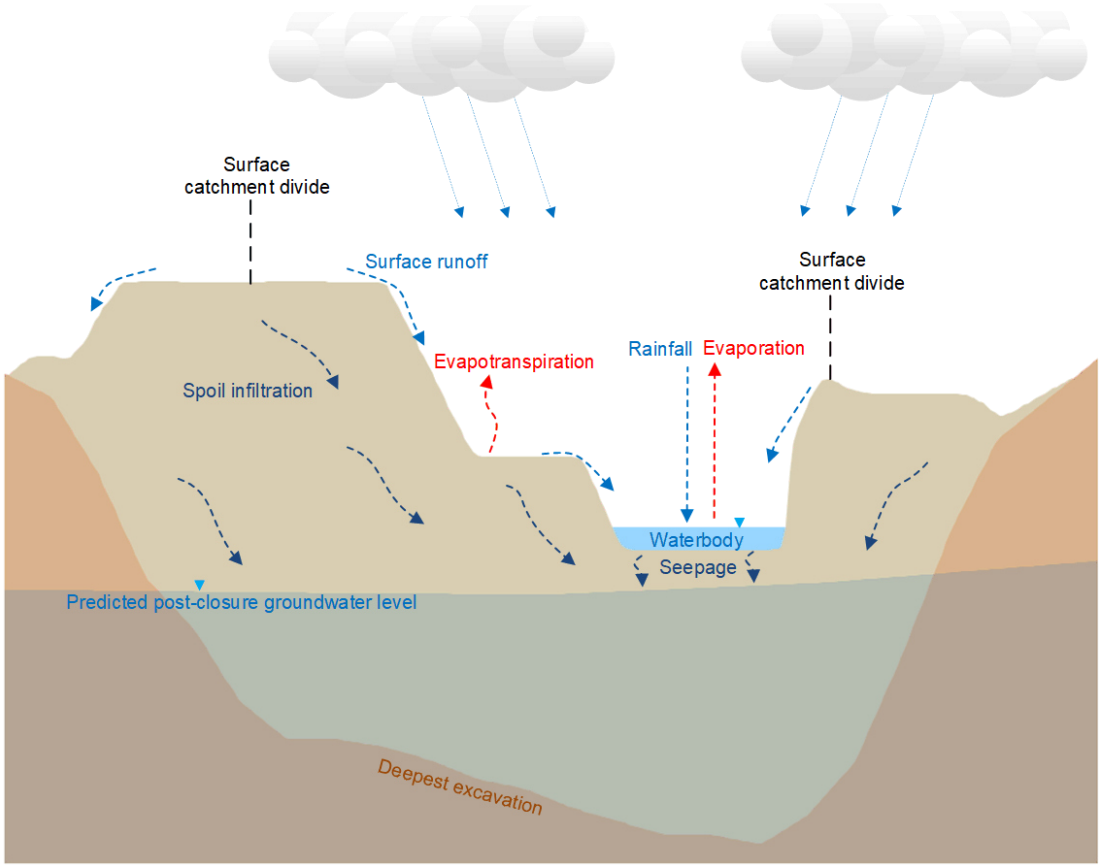


Figure 4.1 Conceptual reprofiled void depression water balance

Key water and TDS inputs and outputs include:

- Inputs:
  - direct rainfall on the water surface; and

  - runoff from final landform surface (i.e., highwall, low wall and overburden emplacements) and rehabilitated or natural upstream catchment areas.
- Outputs:
  - evaporation from the water surface (water only);
  - evapotranspiration from the contributing catchment (water only);
  - seepage outflow through the base of the reprofiled void depressions;
  - cattle consumption; and
  - surface outflow if the waterbody within the reprofiled void depression exceeds the containment of the depression (i.e., crest level).

As graphically presented in Figure 4.1, the planned final landform has been designed to use spoil to backfill the mining areas as much as practicable to be above the predicted post-closure groundwater level, with only shallow reprofiled void depressions expected to remain. The design (physical characteristics) of these reprofiled void depressions indicates:

- no ingress of groundwater into the reprofiled void depression is expected because the base of each depression has been specifically designed and optimised to be above the predicted post-closure groundwater level (KCB 2025a);
- the base of the reprofiled void depressions has been designed to be at least 5 m above the predicted post-closure groundwater level and this depth from surface to groundwater is expected to be sufficient that any groundwater that may seep up from the water table by capillary action will not reach the base of the depression (i.e., 5 m is greater than the capillary fringe); and
- no infiltration of water through the spoil and sub-surface drainage is expected to reach the reprofiled void depressions, with the infiltration reaching the groundwater table instead because of the large expanse of spoil.

Ephemeral waterbodies are expected to form in the reprofiled void depressions. Inflows (via catchment runoff and direct rainfall) are expected to exceed outflows (via evaporation, evapotranspiration, cattle consumption, seepage, and overflow) during the wet periods, resulting in the formation of a waterbody in the reprofiled void depression. However, during dry periods, this waterbody is expected to dry out with the outflows exceeding inflows.

With respect to understanding the water quality dynamics within the conceptual model, dissolved salts enter the reprofiled void depressions via catchment runoff. In the absence of seepage or surface outflows to the environment, there would generally be no removal of salts from the system with salts expected to accumulate over time. However, seepage has been assumed to occur from the base of each reprofiled void depression because of the nature and deposition method of the backfilled spoil material (i.e., dumped material likely to be porous) with water and salt lost to adjacent spoil material (i.e., removing salt). Dependent on the TDS level of the waterbodies formed in the reprofiled void depressions, cattle may drink the water, also removing salt.

5 WATER BALANCE MODEL DEVELOPMENT

5.1 Model aims and objectives

The aims and objectives of the water balance model are to:

- predict the long-term water level within each reprofiled void depression waterbody considering surface and groundwater inputs and outputs;
- determine whether any of the reprofiled void depression waterbodies are likely to overtop and release water to the receiving environment;
- determine the likely water quality of each reprofiled void depression waterbody using salinity as an indicator and understand whether the waterbodies could provide a water source for beef cattle; and
- undertake sensitivity testing on key model components to understand the potential variance in results.

5.2 GoldSim model

A water balance / water quality mass balance has been developed for each reprofiled void depression in the GoldSim (Version 14.0) . GoldSim is a general-purpose and highly graphical probabilistic simulation software program with specialised modules to support water and water quality modelling and reliability analysis. It is industry accepted and is used extensively in the Australian mining industry for water management applications (such as final void hydrology). The Proponent has developed a water balance model of the proposed operational water management system for the Project. This operational water balance model has been used as a basis to develop the water balance model.

This water balance model simulates the generation, movement and loss of water and TDS on a daily time step in each reprofiled void depression waterbody over a 1,000-year period. The model simulation is started at the onset of closure in the first mining area to be reshaped to the final landform (i.e., Frank Creek in year 1) and comprises two components:

- a component to simulate the water inflows and outflows as described in Section 4 (i.e., runoff, and direct rainfall inflows and evaporation, seepage, overflow, and cattle consumption outflows); and
- a component to allow prediction of the reprofiled void depression waterbody salinity (modelled as a TDS mass balance).

Both components are interlinked as the inflows and outflows and associated salinity loads contribute to the reprofiled void depression waterbody water quality. These components are used to estimate the volume of water and associated salinity of the water, that report to each reprofiled void depression, from other identified or known sources.

The key water balance model inputs and parameters, summarised in the following sub-sections of this report, include:

- Physical characteristics: based on the final landform (GCAA 2024a).

- Hydrological parameters: based on publicly sourced climate data and the Australian Water Balance Model (AWBM) catchment yield parameters adopted for the operational water balance model developed for the Project.
- Hydrogeological parameters: based on provided final landform and outcomes of concurrent PRCP groundwater and geochemistry technical studies (KCB 2025a) (RGS 2024).
- Salinity generation: based on outcomes of concurrent PRCP geochemistry technical studies (RGS 2024).
- Cattle consumption: based on publicly available government and Proponent recommendations for sustainable beef cattle stocking rates on rehabilitated land (GCAA 2024b).

5.3 Physical characteristics

5.3.1 Reprofiled void depression data sheets

For ease of interpretation, a physical characteristics data sheet has been developed for each of the eight reprofiled void depressions with the following information presented:

- locality and catchment plan featuring the final landform topography, catchment area, overflow paths, cross section alignment and neighbouring receiving streams;
- stage storage curve featuring the elevation–surface area–volume relationship of each reprofiled void depression;
- indicative cross section through each reprofiled void depression; and
- relevant notes.

Data sheets for the eight reprofiled void depressions are presented in Appendix II. Key physical components of the reprofiled void depressions are presented in the following sub-sections of this report.

5.3.2 Topography

Topographic data relevant to the reprofiled void depressions has been provided by the Proponent as follows:

- final landform 3D surface (GCAA 2024a);
- existing landform (as of August 2023 (GCAA 2023)); and
- deepest mined surface.

The reprofiled void depressions topography is presented in the data sheets (refer to Appendix II).

As detailed in Section 5.3.1, a representative cross section through each reprofiled void depression is also presented in the data sheets (refer to Appendix II). The section alignment has been generated using the final landform and deepest mined surfaces. The highwalls of the reprofiled void depressions, as presented in the cross-sections, are not located on the corresponding section alignments, but would be visible in the direction as detailed in the data sheet notes.

5.3.3 Level-surface area-volume relationship

Level–surface area–volume relationships for the storage within each reprofiled void depression is presented in the data sheets (refer to Appendix II). The level – surface area – volume relationships have been derived from computer analysis of the final landform 3D surface.

Key levels associated with each reprofiled void depression (base, dead storage and overflow levels) are also presented on the level – surface area – volume relationships in the data sheets.

5.3.4 Catchment areas

Surface runoff catchment areas reporting to each reprofiled void depression are summarised in Table 5.1 with delineations presented in the locality and catchment plan in each data sheet (refer to Appendix II).

As detailed in Figure 4.1, infiltration of water through the rehabilitated overburden emplacements and sub-surface drainage of this water is not expected to reach the reprofiled void depression waterbodies. Therefore, baseflow catchment areas, based on the deepest mined surface, were not required to be delineated with only surface water catchments required as input for the water balance model.

Table 5.1 Catchment areas

Reprofiled void depression	Catchment area (ha)
Summer Hill	809
Mud Creek	467
Woleebee North Satellite	78
Woleebee Creek	582
Woleebee	996
Austinvale	350
Frank Creek	101
Wubagul	325

5.3.5 AWBM catchment land use categories

As detailed in Section 5.2, the water balance model uses AWBM to model the runoff reporting to each reprofiled void depression, with different AWBM land use categories assigned to different AWBM parameters dependent on soil storage capacities.

Applicable AWBM land use categories for consideration in the water balance model include:

- Natural: still in a natural state (i.e., undisturbed by mining) or has been returned to the natural state through successful and stable rehabilitation (i.e., after five years);
- Mining pit: highwall areas;
- Reshaped spoil: out-of-pit (OOP) overburden emplacements including low walls reshaped to the final landform and rehabilitation commencing; and
- Rehabilitated: area successfully rehabilitated but not yet returned to a natural state.

With consideration to the progressive rehabilitation of the disturbed catchment areas, the AWBM land use classification adopted for the reprofiled void depression catchments over time is based on the following assumptions:

- OOP overburden emplacements and mining pit low walls are expected to be classified as reshaped spoil at the date of closure of each mining area. After five years, these spoil areas are expected to progress to a rehabilitated land use. After ten years, these rehabilitated areas are expected to revert to natural or pre-mining conditions because of topsoil consolidation and weathering. This transitional process is relevant as part of hydrological assumptions in the model.
- Rehabilitated low wall areas will be offset by the wetted surface area in each void (i.e., base area of each void will be covered by the waterbody during the wet season).
- Pit highwalls and end walls are expected to continue to produce higher runoff than the rehabilitated areas due to the relative difference in slope and cover and are assumed to remain as mining pit land use category.

A breakdown of catchment AWBM land use categories over time for the reprofiled void depressions is provided in Table 5.2.

Table 5.2 Catchment AWBM land use progression

Reprofiled void depression	Years (from start of mining)		Area (ha)				
			Natural	Mining pit	Reshaped spoil	Rehabilitated spoil	TOTAL
Summer Hill	59 – 64	Closure of mining area	21	69	719	-	809
	64 – 69	5-10 years post-closure	21	69	-	719	
	69 +	10+ years post-closure	740	69	-	-	
Mud Creek	48 – 53	Closure of mining area	3	21	443	-	467
	53 – 58	5-10 years post-closure	3	21	-	443	
	58+	10+ years post-closure	446	21	-	-	
Woleebee North Satellite	73 – 78	Closure of mining area	-	12	66	-	78
	78 – 83	5-10 years post-closure	-	12	-	66	
	83+	10+ years post-closure	66	12	-	-	
Woleebee Creek	75 – 80	Closure of mining area	436	12	134	-	582
	80 – 85	5-10 years post-closure	436	12	-	134	
	85+	10+ years post-closure	570	12	-	-	
Woleebee	38 -43	Closure of mining area	285	48	662	-	996
	43 – 48	5-10 years post-closure	285	48	-	662	
	48+	10+ years post-closure	947	48	-	-	
Austinvale	21 – 26	Closure of mining area	-	28	322	-	350
	26 – 31	5-10 years post-closure	-	28	-	322	
	31+	10+ years post-closure	322	28	-	-	
Frank Creek	1 – 6	Closure of mining area	-	15	86	-	101
	6 – 11	5-10 years post-closure	-	15	-	86	
	11+	10+ years post-closure	86	15	-	-	
Wubagul	72 – 77	Closure of mining area	-	56	269	-	325
	77 – 82	5-10 years post-closure	-	56	-	269	
	82+	10+ years post-closure	269	56	-	-	

5.4 Hydrological inputs

As detailed in the conceptual model (refer to Figure 4.1), the climatic influences on each reprofiled void depression include: direct rainfall on the waterbody surface, catchment runoff, evaporation from the waterbody surface and evapotranspiration from the contributing catchments. The water balance model uses long-term historical climate data, spanning over 135 years, to model rainfall, evaporation, and evapotranspiration within the catchments. These past climatic conditions are assumed to be indicative of persistent local trends which are likely to be observed in the future. The possible effects of climate change have been considered as sensitivities on the model outcomes and are discussed in Section 8.

As discussed in Section 3.3.1, long-term daily rainfall and evaporation datasets (from 1 January 1889 to 31 December 2023) were obtained through Data Drill (SILO 2025).

Short-term daily rainfall data (from April 2021 to April 2024) was obtained from the Proponent's Wandoan Environmental Monitoring Database (EMD) (GCAA 2024c) for the Project's automated weather station (AWS) (-26.12 latitude, 149.92 longitude).

A review of the monthly Data Drill and the Project's AWS, using a double mass curve (refer to Figure 5.1) indicated that the Data Drill set is generally consistent with the Project's AWS being recorded and hence deemed suitable to model the reprofiled void depression conditions.

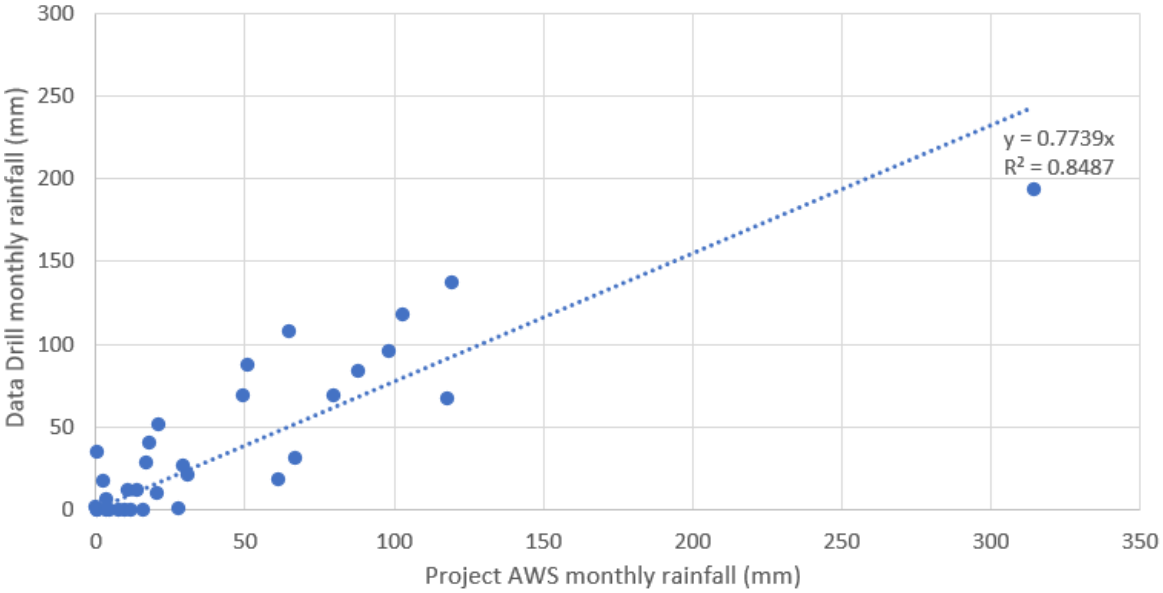


Figure 5.1 Double mass curve comparison of monthly Project AWS and Data Drill rainfall

Through sequential repetition of the 135-year Data Drill climate datasets, a long-term 1,000-year dataset was established for the reprofiled void depressions within the Project. The Data Drill rainfall and evaporation datasets used for the water balance model are summarised in the following sections of the report.

5.4.1 Rainfall

Historical annual rainfall totals over the recorded period and a percentile distribution for the Data Drill rainfall are presented in Figure 5.2.

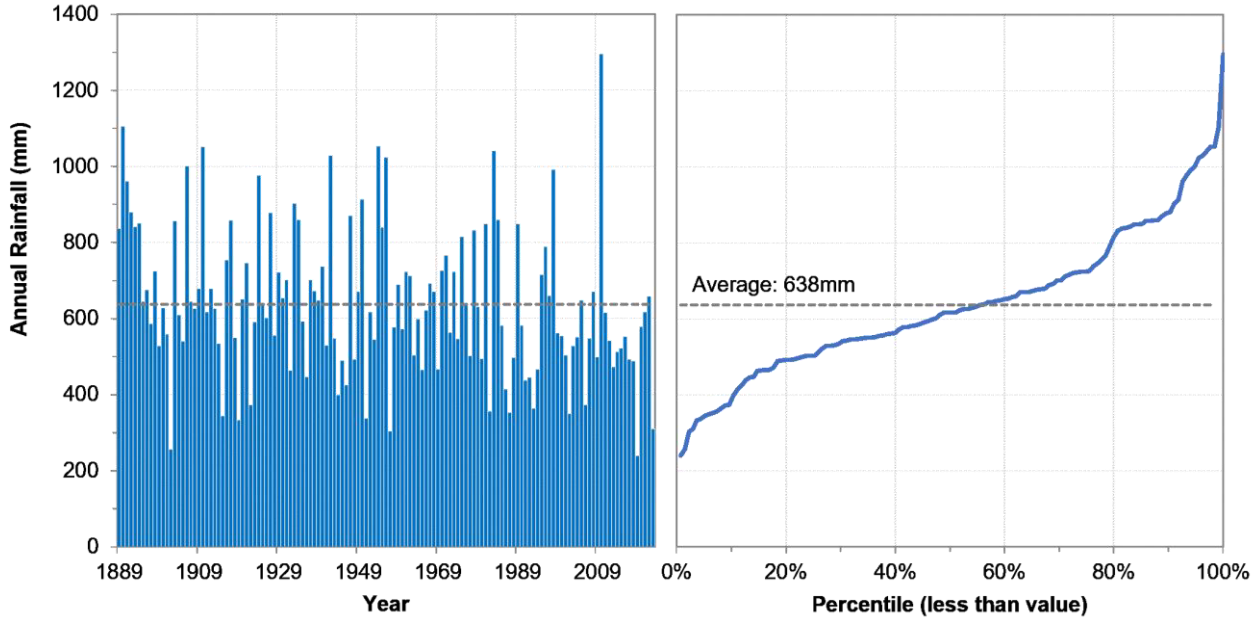


Figure 5.2 Data Drill annual rainfall totals – time series data and percentiles

Key annual rainfall statistics for the period 1889 to 2023 are summarised in Table 5.3.

Table 5.3 Annual rainfall statistics

Statistics	Annual rainfall (mm)
Minimum	240
Maximum	1,296
Average	638
80% Range	±240

A rainfall residual mass curve for the Data Drill rainfall, derived from the cumulative sum of the difference between each year's annual rainfall from the mean annual rainfall, is presented in Figure 5.3.

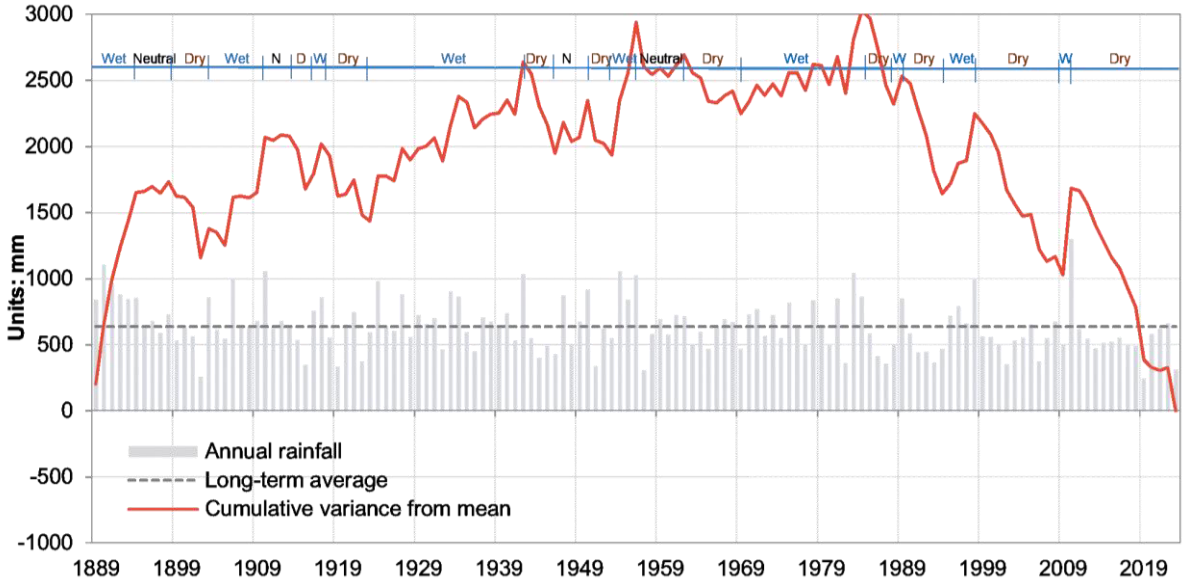


Figure 5.3 Rainfall residual mass curve and seasonality analysis

Figure 5.3 shows that the historical rainfall sequence, from 1889 to 2023, features several downward trends indicating periods of drought and persistent upward trends, typical of above average rainfall.

5.4.2 Evaporation and adjustment factor

Evaporative losses are calculated in the water balance model based on the following evaporation data sourced from the Data Drill (SILO 2025):

- Morton lake (M_{lake}) evaporation – used as the primary data input for the water balance model to estimate evaporation from the waterbody surface areas.
- Morton wet (M_{wet}) evaporation – used to estimate evapotranspiration losses from catchment areas.

A comparison of evaporation and evapotranspiration annual statistics for the period 1889 to 2023, from Data Drill are summarised in Table 5.4.

Table 5.4 Annual evaporation and evapotranspiration summary

Statistic	Annual M_{lake} (mm)	Annual M_{wet} (mm)
Minimum	1,510	1,486
Maximum	1,883	1,850
Average	1,699	1,669
80% range	±91	±87

For final voids with pit lakes, wind shielding and shading conditions may result in reduced evaporation from the pit lake surface. To account for this reduction in evaporative losses, an evaporation adjustment factor of 0.7 is commonly used. However, as the reprofiled void depressions and associated waterbodies are shallow, the evaporation factor is expected to increase due to the reduced shading and wind shielding. As such, an evaporation factor of 0.9 is incorporated in the water balance model.

Sensitivity has been undertaken to determine whether changing the evaporation adjustment factor impacts the overall containment of the reprofiled void depressions.

5.4.3 Climate change

To quantify the expected changes in rainfall and evaporation because of climate change, future climate projection data was downloaded from the biophysical modelling database for SILO data consistent climate scenarios (CCS) based on the Project (-26.10 latitude, 149.90 longitude).

The data developed by the biophysical modelling database applies climate change parameters to a baseline SILO dataset (1960 to 2024), dependent on the climate change scenario and future year projection selected.

The climate change data used within this assessment has been selected based on:

- Climate projection data for three pivotal periods:
  - 2030 to 2050;
  - 2050 to 2070; and

- 2070 to 2090.

- Climate projection after 2090 modelled by cycling the 2070 to 2090 projected dataset.
- Representative concentration pathways (RCPs) of 4.5 and 8.5 modelled representing moderate and highest baseline emissions scenarios, respectively.
- High climate warming sensitivity.
- SILO enables the selection of one of the four mean climate response patterns, defined as models HI, HP, WI, and WP. The data for each of these response patterns includes approximately 12 global climate models.
  - HI and HP composite data is based off a high global warming factor and a faster warming Western Pacific Ocean compared with the Eastern Indian Ocean:
    - HI predicts a drier southwest (SW) hemisphere and wetter northeast (NE) hemisphere; and
    - HP predicts a much drier content than HI.

A summary of the annual rainfall and pan evaporation changes for the pivotal periods are presented in Table 5.5 and Table 5.6 for the 10th, 50th and 90th percentile probabilities (i.e., P10, P50 and P90, respectively) for the adopted climate change scenarios of HI RCP4.5 and HP RCP8.5.

Table 5.5 Projected annual rainfall and pan evaporation change based on global climate models – HI RCP4.5

Value	Percentile	Present SILO data	HI RCP4.5		
			2030 - 2050	2050 - 2070	2070 - 2090
Rainfall					
Absolute value (mm)	P10	374.2	367.0	362.4	359.5
	P50	490	543.2	535.1	530.7
	P90	1295.9	968.8	953.8	944.7
Change compared with SILO (%)	P10		-1.9%	-3.2%	-3.9%
	P50		+10.9%	+9.2%	+8.3%
	P90		-25.2%	-26.4%	-27.1%
Pan evaporation					
Absolute value (mm)	P10	2135.5	2201.4	2248.2	2279.4
	P50	2036.7	2097.9	2144.4	2173.7
	P90	1555.6	1600.2	1635.1	1657.9
Change compared with SILO (%)	P10		3.1%	5.3%	6.7%
	P50		3.0%	5.3%	6.7%
	P90		2.9%	5.1%	6.6%

Table 5.6 Projected annual rainfall and pan evaporation change based on global climate models – HP RCP8.5

Value	Percentile	Present SILO data	HP RCP8.5 2030 - 2050	HP RCP8.5 2050 - 2070	HP RCP8.5 2070 - 2090
Rainfall					
Absolute value (mm)	P10	374.2	352.4	330.7	307.6
	P50	490	525.1	495.8	465.1
	P90	1295.9	938.7	887.7	832.1
Change compared with SILO (%)	P10		-5.8%	-11.6%	-17.8%
	P50		+7.2%	+1.2%	-5.1%
	P90		-27.6%	-31.5%	-35.8%
Pan evaporation					
Absolute value (mm)	P10	2135.5	2213.9	2297.1	2392.8
	P50	2036.7	2110.8	2189.5	2279.8
	P90	1555.6	1615.1	1675	1747.6
Change compared with SILO (%)	P10		+3.7%	+7.6%	+12.0%
	P50		+3.6%	+7.5%	+11.9%
	P90		+3.8%	+7.7%	+12.3%

Sensitivity has been undertaken to determine whether the impacts of climate change on changing rainfall and evaporation data sets (based on HI RCP4.5 and HP RCP8.5), impact the overall containment of the reprofiled void depressions.

5.4.4 Catchment yield

The water balance model uses AWBM to model catchment yield reporting to each reprofiled void depression. Use of this model in this water balance study is consistent with the operational water balance model developed for the Project and is widely accepted and commonly used for mine water balance models in Australia.

As outlined in Section 5.3.5, natural, mining pit, reshaped and rehabilitated spoil land use classifications are modelled as the most appropriate long-term representation of the reprofiled void depression catchment conditions. Adopted AWBM parameter sets for each land use type are presented in Table 5.7 which are consistent with the values used in the operational water balance model for the Project.

Table 5.7 AWBM catchment yield parameters – base case

Land use	Partial area			Soil moisture capacity (mm)			K_s	Baseflow*		S_{avg}
	A_1	A_2	A_3	C_1	C_2	C_3		K_b	BFI	
Natural	0.131	0.434	0.434	27	149	254	0.28	0.33	0.65	178
Mining pit	0.1	0.9	-	12	38	0	0	0	0	35
Reshaped spoil	0.1	0.4	0.5	20	100	200	0.80	0	0.80	142
Rehabilitated spoil	0.1	0.9	-	12	221	0	0.10	0.70	0.70	200

Note: * Baseflow component is not expected to reach the reprofiled void depression waterbody (refer to Section 5.5.5).
$S_{avg} = A_1*C_1 + A_2*C_2 + A_3*C_3$

Based on the average soil moisture capacity (S_{avg}) presented in Table 5.7, as rehabilitated areas transition to a natural state, catchment runoff should also increase. Mining pit areas (i.e., highwalls and end walls) are expected to generate the highest rates of runoff.

As detailed in Section 3.2.2, a DLGWV stream gauge with almost 50 years of daily flow data is located within Juandah Creek just downstream of the Project MLs (Juandah Creel at Windamere 130344A). As part of this water balance study, calibrated AWBM parameters for the natural land use were derived using eWater's Rainfall Runoff Library (RRL) and the metered daily streamflow volumes from the stream gauge. These calibrated natural AWBM parameters (Table 5.7) are based on a larger contributing catchment and may not be reflective of the smaller natural catchment areas reporting to the reprofiled void depressions. As such, sensitivity has been undertaken to determine whether changing AWBM parameters impacts the overall containment of the reprofiled void depressions. Sensitivity AWBM parameters for each land use type are based on the Proponent's similar mining operations and are presented in Table 5.8.

Table 5.8 AWBM catchment yield parameters – sensitivity case

Land use	Partial area			Soil moisture capacity (mm)			K_s	Baseflow*		S_{avg}
	A_1	A_2	A_3	C_1	C_2	C_3		K_b	BFI	
Natural	0.435	0.565	-	45	70	130	0.15	0.91	0.20	59
Mining pit	0.1	0.9	-	5	25	0	0.90	0.98	0.95	23
Reshaped spoil	0.05	0.95	-	12	70	0	0.90	0.995	0.95	67
Rehabilitated spoil	0.1	0.9	-	12	100	0	0.20	0.98	0.50	91

Note: * Baseflow component is not expected to reach the reprofiled void depression waterbody (refer to Section 5.5.5).
$S_{avg} = A_1*C_1 + A_2*C_2 + A_3*C_3$

In review of the base and sensitivity case AWBM parameters, the sensitivity parameters have reduced average surface storage capacities. Greater runoff was produced (i.e., greater catchment yield and more volume expected in the reprofiled void depressions) in comparison to the base case AWBM parameters.

5.4.5 Initial conditions

The water balance model is configured to simulate water accumulations from the expected water level within the reprofiled void depression waterbody at the onset of closure. At the onset of closure, mining areas are assumed to be reshaped to the final landform with revegetation started. The initial water level was set to the base level (empty) and corresponding salinity values have been set to zero at the onset of closure for each reprofiled void depression. The nominal closure dates (in years from the start of mining) are detailed in Table 2.1 and Table 5.9.

The soil moisture capacity, within the AWBM model, also considered an assumed initial condition of zero storage (i.e., dry catchment) at the onset of closure.

Table 5.9 Reprofiled void depression closure dates

Reprofiled void depression	Closure date (year from start of mining)
Summer Hill	59
Mud Creek	48
Woleebee North Satellite	73
Woleebee Creek	75
Woleebee	38
Austinvale	21
Frank Creek	1
Wubagul	72

5.5 Hydrogeological inputs and assumptions

Concurrent and relevant hydrogeological technical studies in support of the Project PRCP submission include:

- KCB's groundwater modelling (KCB 2025a): KCB's groundwater team have developed and calibrated a regional numerical groundwater model for the Project to predict changes in groundwater levels and flow during operations, closure and post-closure.
- RGS Environmental Consultants Pty Ltd.'s (RGS) geochemical and physical assessment (RGS 2024): RCS have undertaken geochemical and physical assessment of the mine materials for the Project which includes prediction of the hydraulic conductivity of the spoil material which is to be used to backfill the mining areas.

Key hydrogeological assumptions and inputs used in the water balance model include:

- Groundwater inflows:
  - Predicted closure groundwater levels within the Project MLs have been estimated through use of KCB's regional numerical groundwater model (KCB 2025a).
  - As detailed in Section 2.2, the Proponent has designed the reprofiled void depressions to be backfilled to approximately 5 m above the predicted closure groundwater level.
  - Predicted closure groundwater levels in the vicinity of each of the eight reprofiled void depressions are presented in the data sheets with depth from surface to groundwater ranging from around 5 m up to 10 m (refer to Appendix II (cross sections) and Appendix III (predicted depth to water 500 years post-closure (KCB 2025a))).
  - Reprofiled void depressions will act as sources, that is, water accumulating in the reprofiled void depressions is expected to seep to the surrounding strata.
  - A minimum depth from the base of the reprofiled void depressions to the predicted closure groundwater level of at least 5 m is expected to be sufficient that any groundwater that may seep up from the water table by capillary action will not reach the base of the depression (i.e., 5 m is greater than the capillary fringe).
  - No inflow from the groundwater table is expected and no groundwater inflows (water and salt) are included in the water balance model.
- Spoil inflows:
  - As detailed in Section 4 (and Figure 4.1), infiltration of water through the spoil and sub-surface drainage of this water is to be expected. However, this infiltration is not expected to reach the waterbodies in the reprofiled void depressions, due to the shallow depth and location of the depressions in addition to the large volume of backfilled spoil (i.e., infiltration expected to reach the groundwater table as opposed to the reprofiled void depressions).
  - No spoil inflows (water and salt) are included in the water balance model.
- Seepage outflows:

- As detailed in Section 4 (and Figure 4.1), the reprofiled void depressions have been designed with a large flat base area promoting seepage and the consequential removal of water and salt.
- Seepage from the base of the reprofiled void depressions is included in the water balance model using the Darcy equation driven by the heads of water in the reprofiled void depression, length of flow to the groundwater tables and hydraulic conductivity of the spoil material.
- Material properties for the spoil unit have been derived from review of RGS's study with a hydraulic conductivity value of 5.4 x 10^{-6} m/s (in-situ overburden material) adopted (RGS 2024). Sensitivity tests have been undertaken to determine whether changing hydraulic conductivity will impact the volume and salt mass within the reprofiled void depressions (refer to Section 8).

5.6 Salinity generation

The water balance model tracks the net accumulation of salt mass within each reprofiled void depression. Salt is modelled as a mass and reported in terms of TDS in units of milligrams per litre (mg/L) or electrical conductivity (EC) in units of micro-siemens per centimetre (µS/cm), calculated assuming a conversion factor of 0.67 (i.e., EC x 0.67 = TDS).

As indicated, as part of the model conceptualisation (refer to Section 4), salts enter the reprofiled void depression via catchment runoff. Salt inflows have been calculated by assuming a salinity concentration for each source. Adopted salinity concentrations are summarised in Table 5.10.

Table 5.10 Salinity concentrations considered in the water balance model

Land use	Salinity concentration	
	EC (µS/cm)	TDS (mg/L)
Mining pit/hardstand	600	402
Natural	215	144
Reshaped spoil	600	402
Rehabilitated spoil	300	201

Salinity generation rates detailed in Table 5.10 are based on:

- Natural: monitoring data for eight existing stream gauges located in the main streams that flow through the Project MLs.
- Reshaped spoil and mining pit: median EC values from geochemical testing of the Project's spoil, coal reject and coal material undertaken as part of the concurrent PRCP geochemical technical study (RGS 2024).
- Rehabilitated spoil: KCB's knowledge and experience with similar open cut coal mine in the Surat and Bowen Basins in Queensland.

5.7 Cattle consumption

Cattle consumption is expected to remove both water and salt from each reprofiled void depression waterbody and assist in reducing the long-term salt load. As detailed in the Project EA

(refer to Section 2.2), the main beneficial reuse of local surface water resources and PRCP PMLU requirement is stock (beef cattle) watering. Depending on the quality, water within the reprofiled void depression waterbodies may be used for stock watering.

Assumptions for the beef cattle consumption of water from the reprofiled void depression waterbodies in meeting livestock water demands considered in the water balance model are:

- Average beef cattle consumption of 50 L/head/day consistent with government recommendations for cattle water requirements (45 to 60 L/head/day water requirements for cattle (Future Beef 2022).
- Stock rating of 1 head/6 to 10 ha of area based on the Proponent's advice of current sustainable stock ratings. When compared to the Queensland Government advice of 1 head/5 ha (Future Beef 2021), this stock rating is deemed sustainable and conservative.
- Cattle able to safely travel a distance of 5 km per day to reach water (Meat and Livestock Australia, 2023).
- Existing terrain within the Project MLs is grazing land.
- Beef cattle within the private freehold areas can source water from the waterbodies within the reprofiled void depressions, that are accessible within the lot. Details of the private freehold lots, within which cattle can move around, are presented in Table 5.11 and Figure 5.4.
- Water used by stock is dependent on the drinking water quality requirements, with a TDS tolerance of 4,000 mg/L (equivalent EC of 5,970 µS/cm) adopted with beef cattle expected to be the main livestock to use the reprofiled void depressions as a water source (based on livestock TDS tolerances as presented in Table 5.12). Beef cattle are expected to be able to tolerate TDS up to 5,000 mg/L without loss of production, with levels greater than 5,000 mg/L resulting in loss of production.
- Cattle can safely access the water surface within the reprofiled void depression (refer to Section 2.2).
- Assessed stock area available for each reprofiled void depression based on the Project ML boundaries, areas of appropriate topography, 5 km maximum radius from the waterbody and private freehold lot boundaries are presented in Table 5.13 and Figure 5.4.

Table 5.11 Private freehold land within Project MLs (GCAA 2024b)

Lot plan	Area (ha)	Comment
34FT490	980	No access to any reprofiled void depression waterbody
35FT987		
35FT575	755	Access to waterbody in Summer Hill reprofiled void depression
36FT493	1,178	Access to waterbody in Mud Creek reprofiled void depression
37FT575		
52FT830	472	No access to any reprofiled void depression waterbody

Table 5.12 Tolerances of livestock to TDS (salinity) in drinking water (ANZECC and ARMCANZ 2000)

Impact	TDS (mg/L)			
	Beef cattle	Dairy cattle	Sheep	Horses
No adverse effects on animals expected	0 - 4,000	0 – 2,500	0 - 5,000	0 - 4,000
Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	4,000 – 5,000	2,500 – 4,000	5,000 – 10,000	4,000 – 6,000
Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually	5,000 – 10,000	4,000 - 7,000	10,000 – 13,000	6,000 – 7,000

Table 5.13 Assessed stock areas and maximum water consumption associated with each reprofiled void depression

Reprofiled void depression	Area (ha)	Stock rating of 1 head/6 ha		Stock rating of 1 head/10 ha	
		Cattle (head)	Water consumption (ML/year)	Cattle (head)	Water consumption (ML/year)
Summer Hill	5,802[1]	967	17.6	580	10.6
Mud Creek	1,188[1]	198	3.6	119	2.2
Woleebee North Satellite	1,877	313	5.7	188	3.4
Woleebee Creek	1,468	245	4.5	147	2.7
Woleebee	3,709	618	11.3	371	6.8
Austinvale	3,316	553	10.1	332	6.1
Frank Creek	1,662	277	5.1	166	3.0
Wubagul	2,860	477	8.7	286	5.2

Notes: [1] Private freehold land area included in stock access area estimate as the land boundaries provide direct access to the reprofiled void depression.

In review of Table 5.13, the maximum consumption of water through beef cattle is expected to range from:

- between 3.6 and 17.6 ML/year for the 1 head/6 ha stock rating; and
- between 2.2 and 10.6 ML/year for the decreased stock rating of 1 head/10 ha.

Consideration of cattle consumption of water from the waterbodies in the reprofiled void depressions is assessed in Sections 6 and 7.

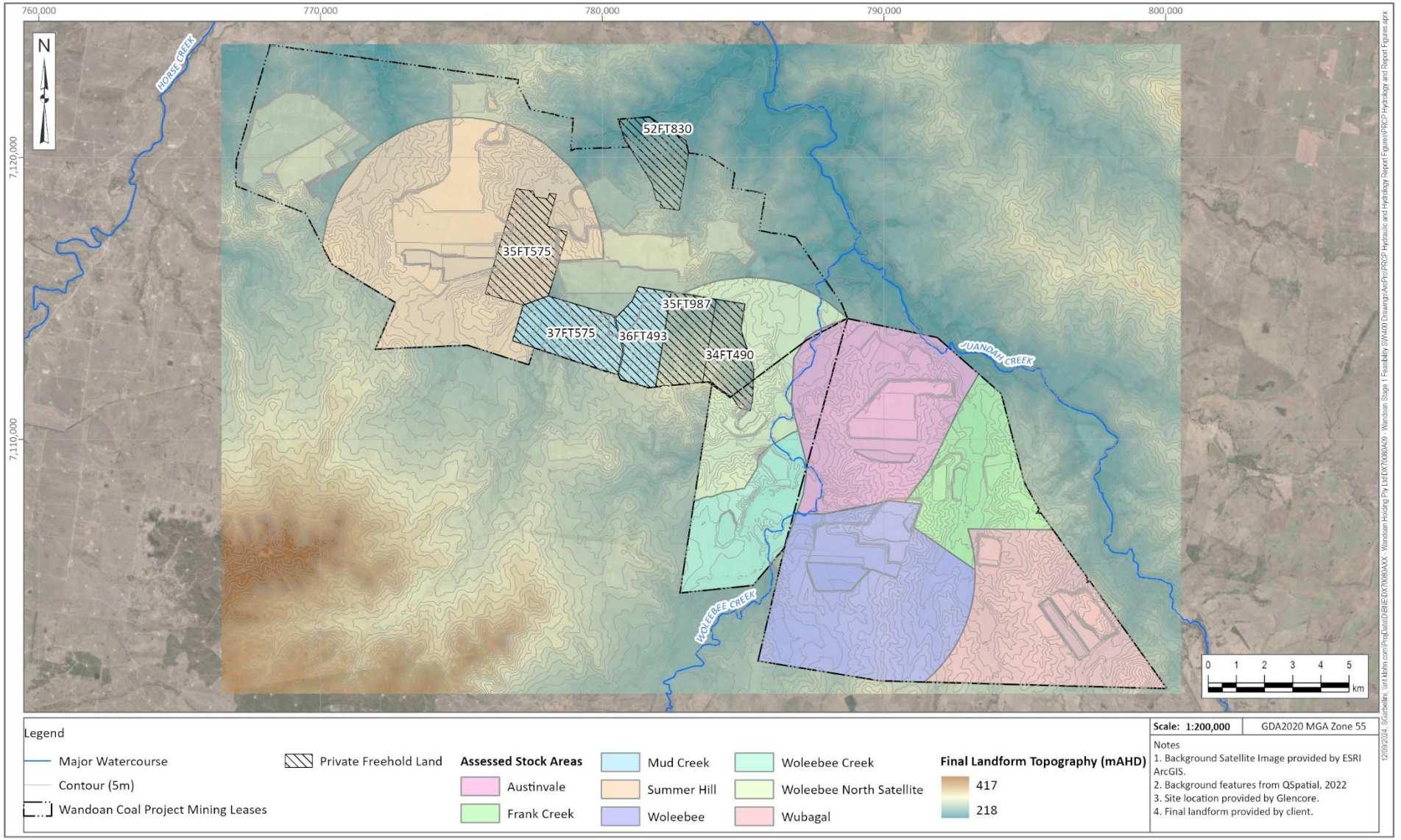


Figure 5.4 Assessed stock areas associated with each reprofiled void depression

6 BASE CASE PREDICTIONS

The water balance model base case is based on:

- physical parameters as presented in Section 5.3 (i.e., level–surface area–volume relationships, reporting catchment areas and associated land use characterisation);
- hydrology parameters as presented in Section 5.4 (i.e., rainfall, evaporation, and AWBM catchment yield parameters);
- hydrogeology inputs and assumptions presented in Section 5.5 (i.e., seepage);
- salinity generation rates as presented in Section 5.6; and
- potential water consumption as presented in Section 5.7 (i.e., cattle consumption at 1 head / 10 ha).

Modelled long-term water level and salinity (modelled as TDS) fluctuations within the reprofiled void depression waterbodies and percentage full are presented as follows:

- Summer Hill: Figure 6.1;
- Mud Creek: Figure 6.2;
- Woleebee North Satellite: Figure 6.3;
- Woleebee Creek: Figure 6.4;
- Woleebee: Figure 6.5;
- Austinvale: Figure 6.6;
- Frank Creek: Figure 6.7; and
- Wubagul: Figure 6.8.

A summary of the modelled results is presented in Table 6.1 which includes the 5th, 50th and 95th percentiles (i.e., P5, P50 and P95) for salinity levels when there is water in the waterbody.

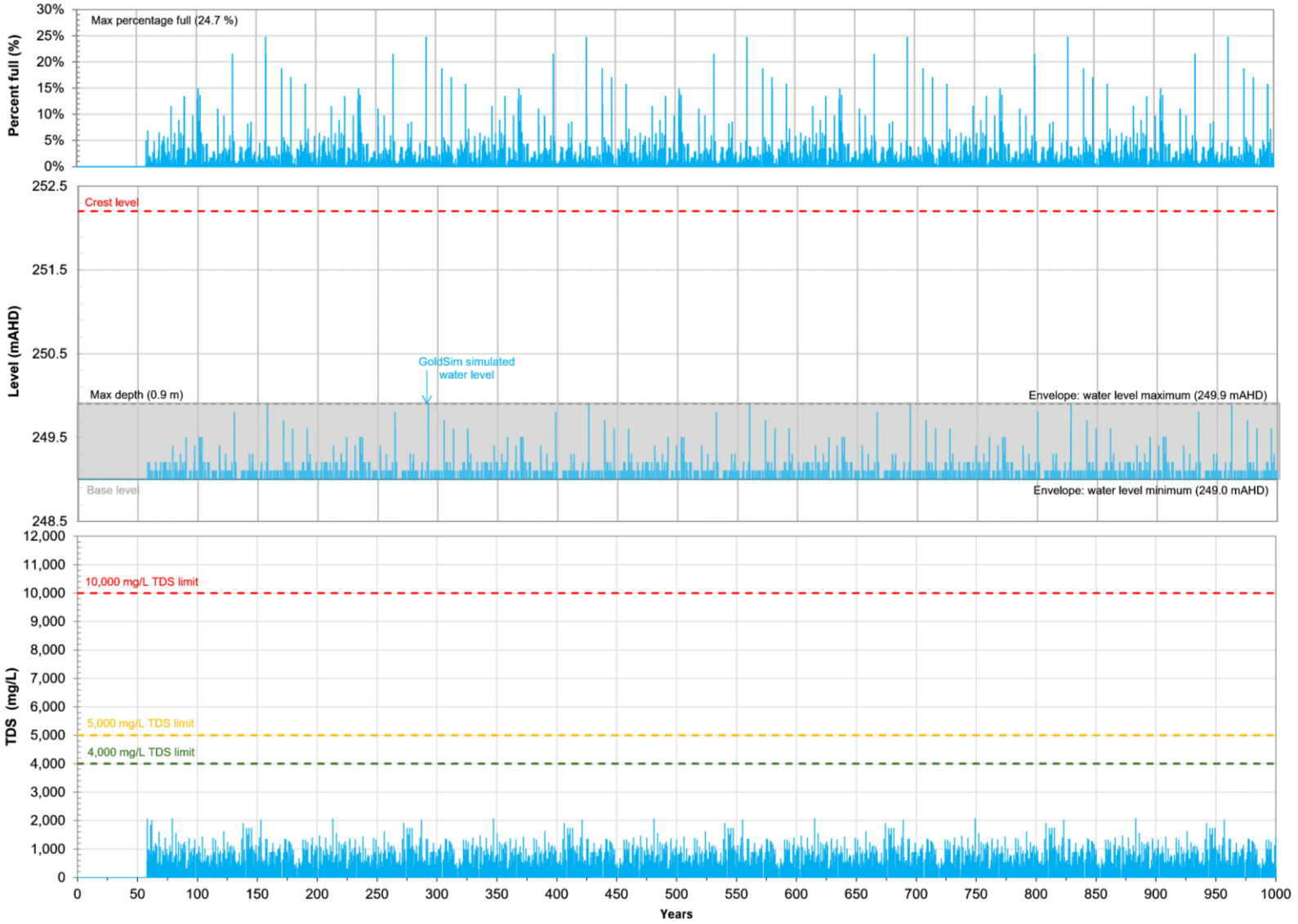


Figure 6.1 Summer Hill water levels – base case

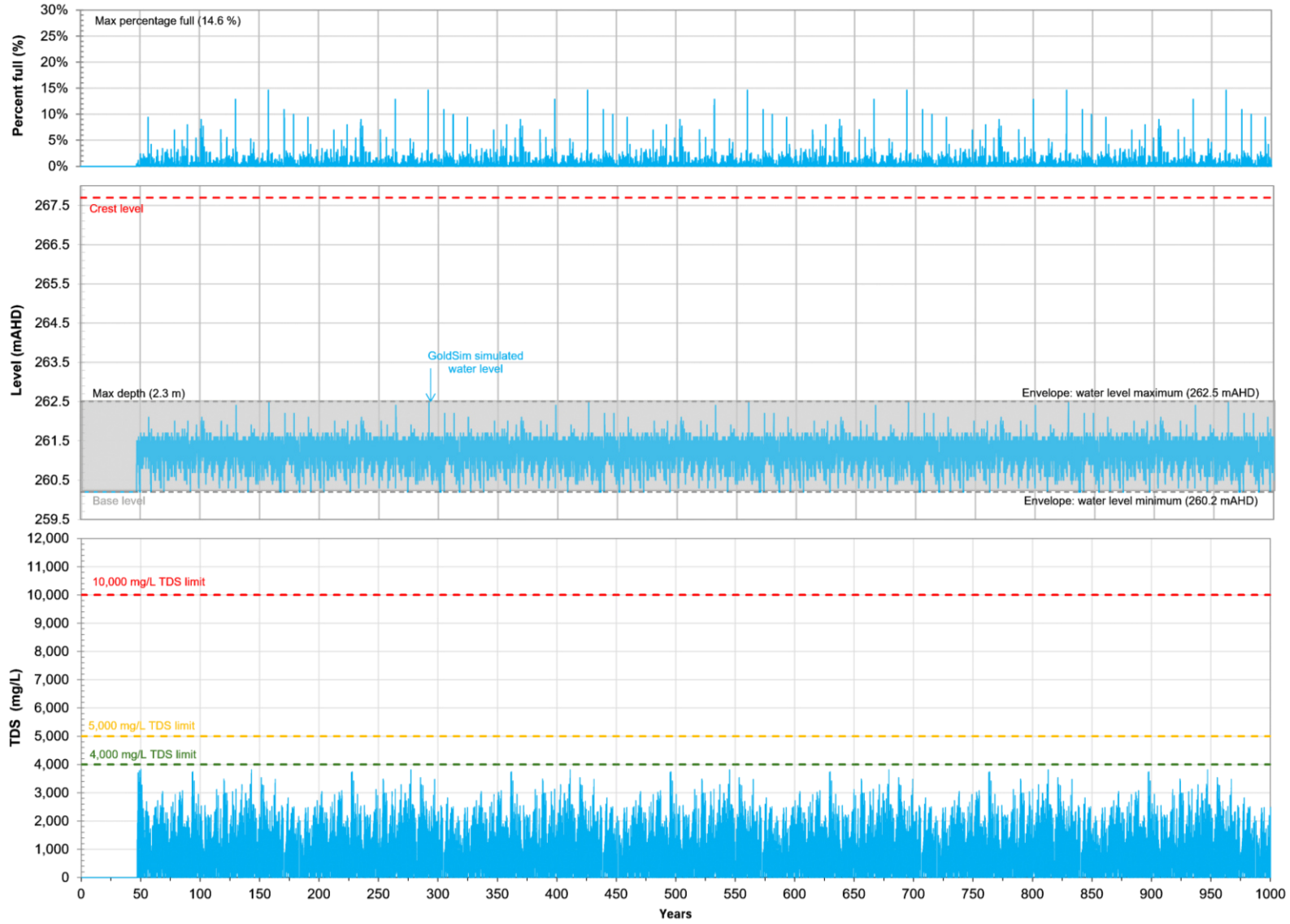


Figure 6.2 Mud Creek water levels – base case

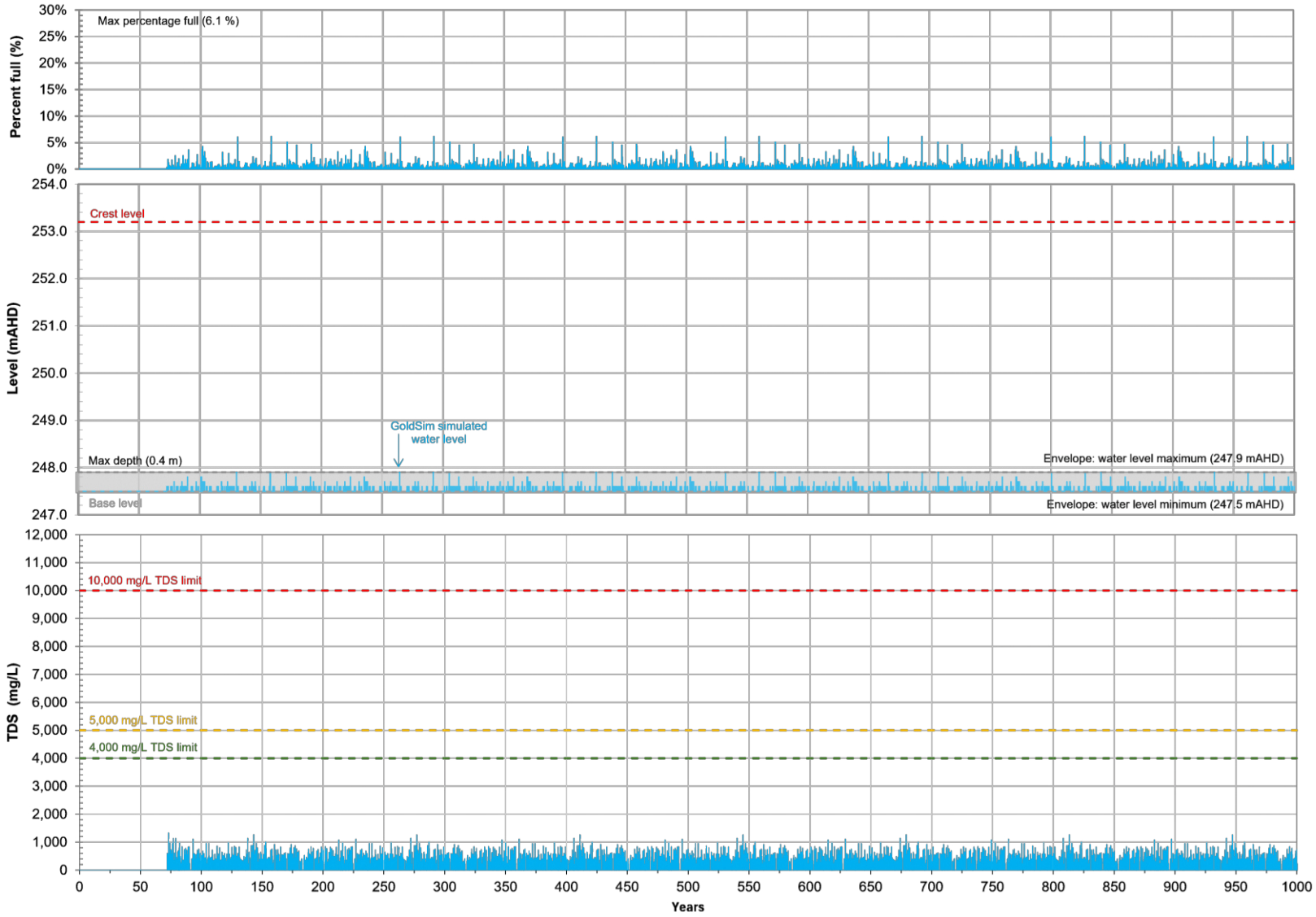


Figure 6.3 Woleebee North Satellite water levels – base case

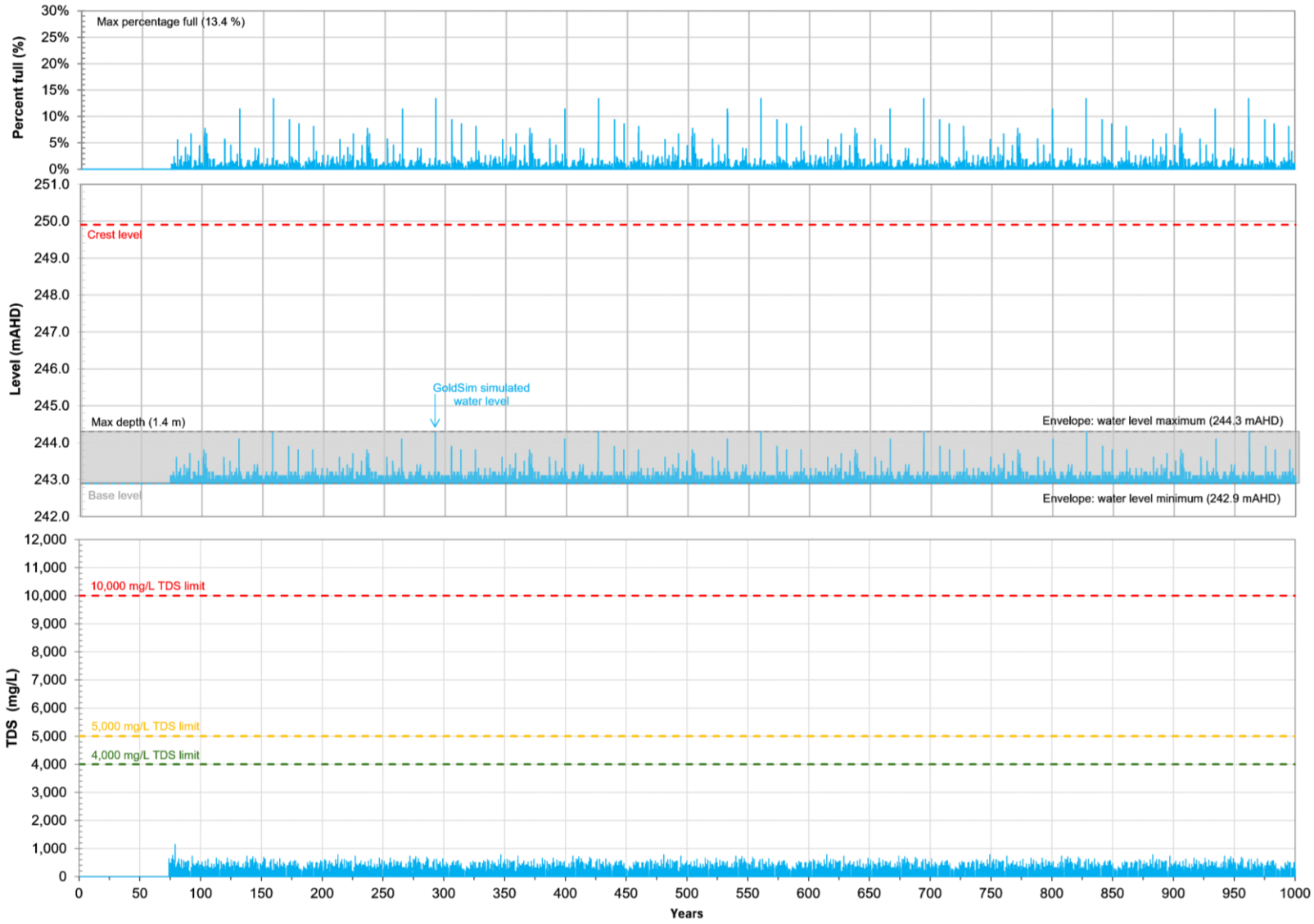


Figure 6.4 Woleebee Creek water levels – base case

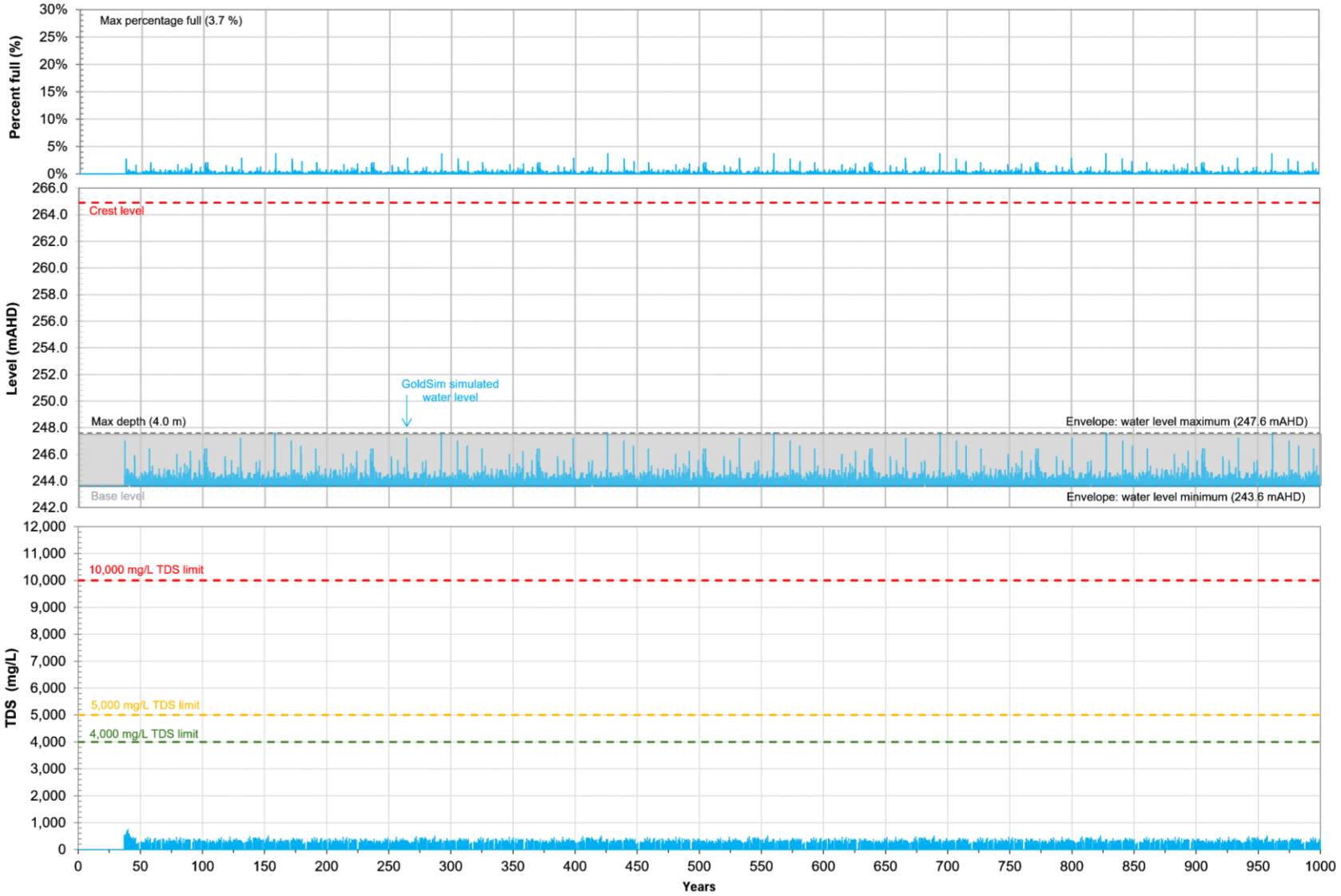


Figure 6.5 Woleebee water levels – base case

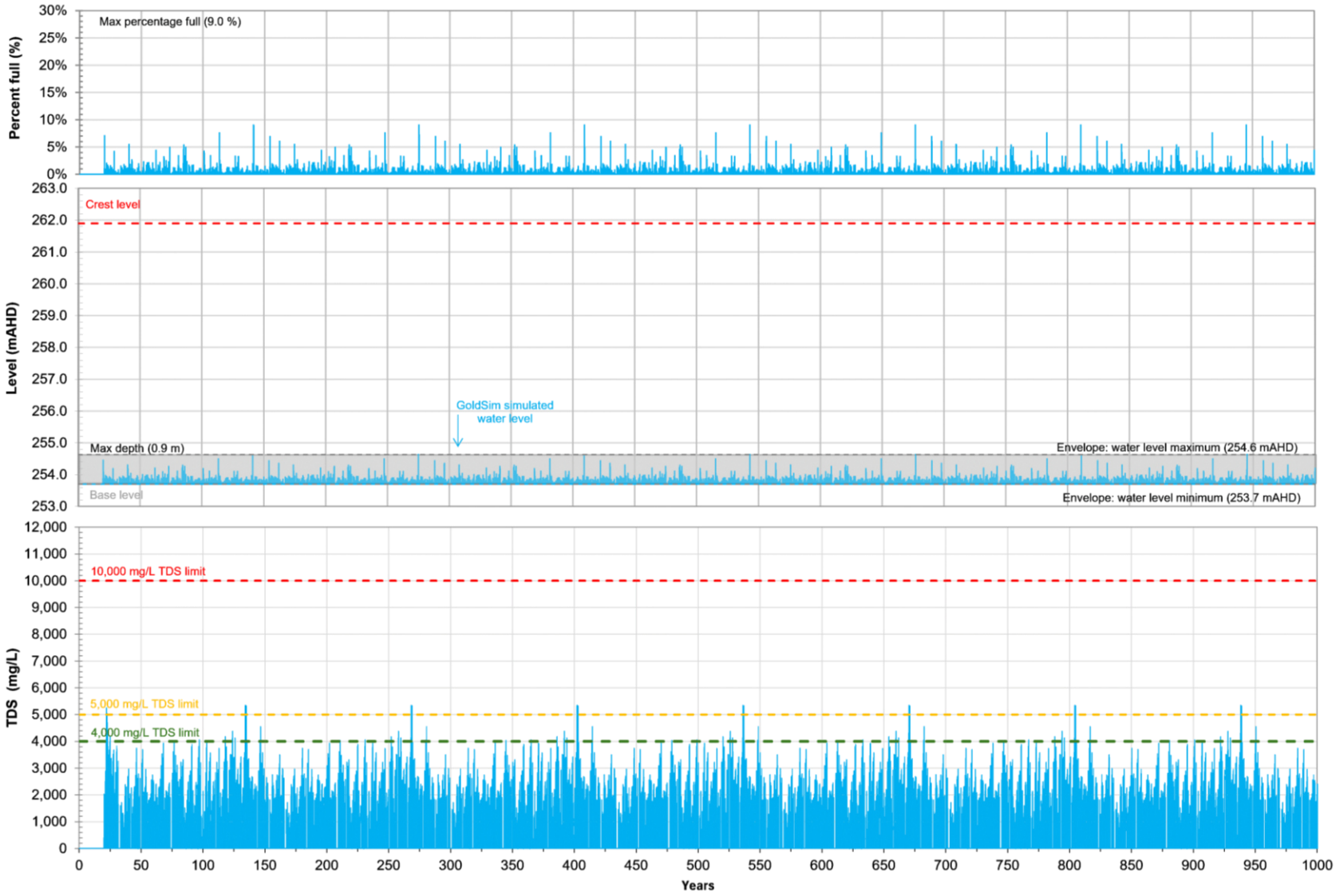


Figure 6.6 Austinvale water levels – base case

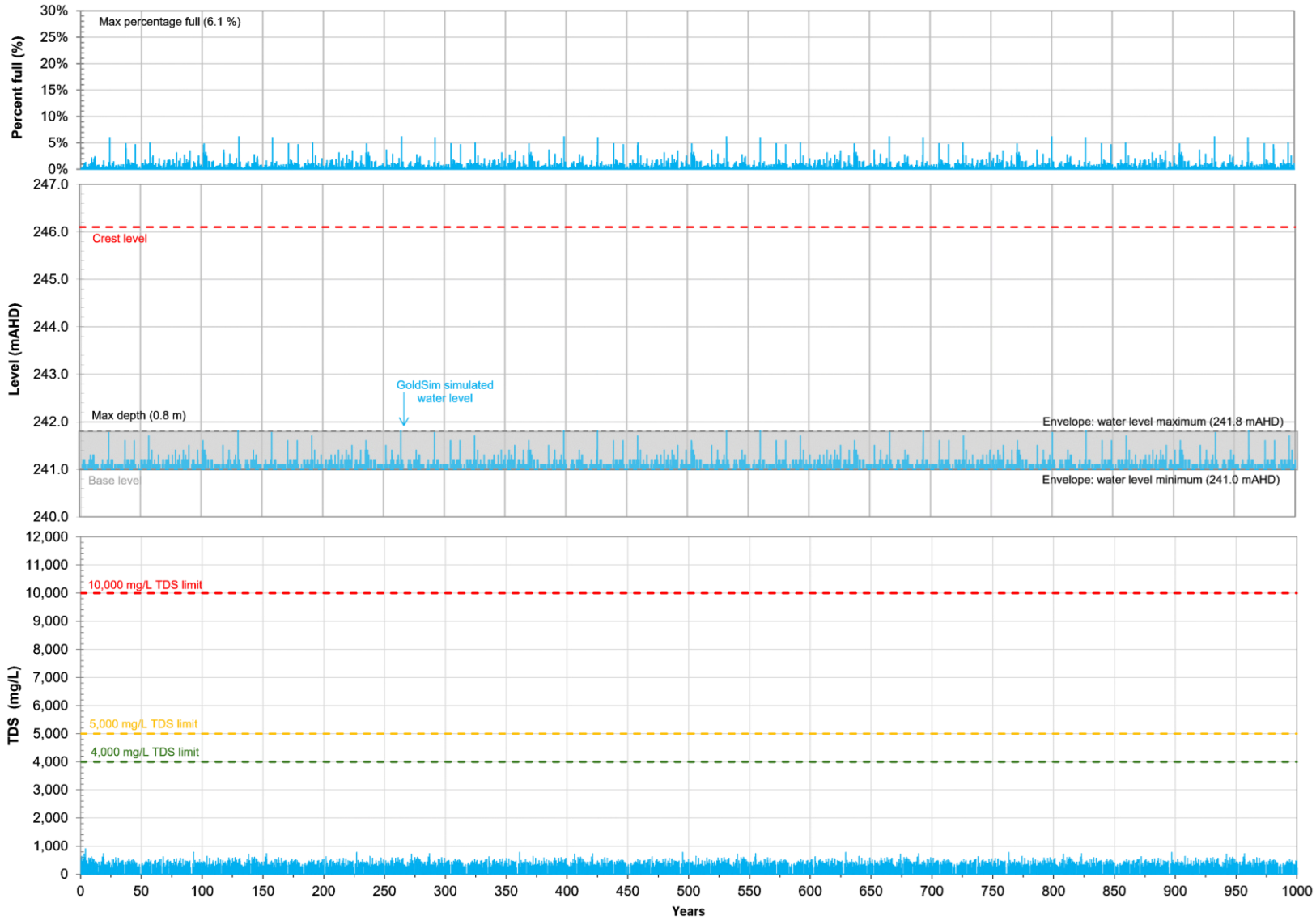


Figure 6.7 Frank Creek water levels – base case

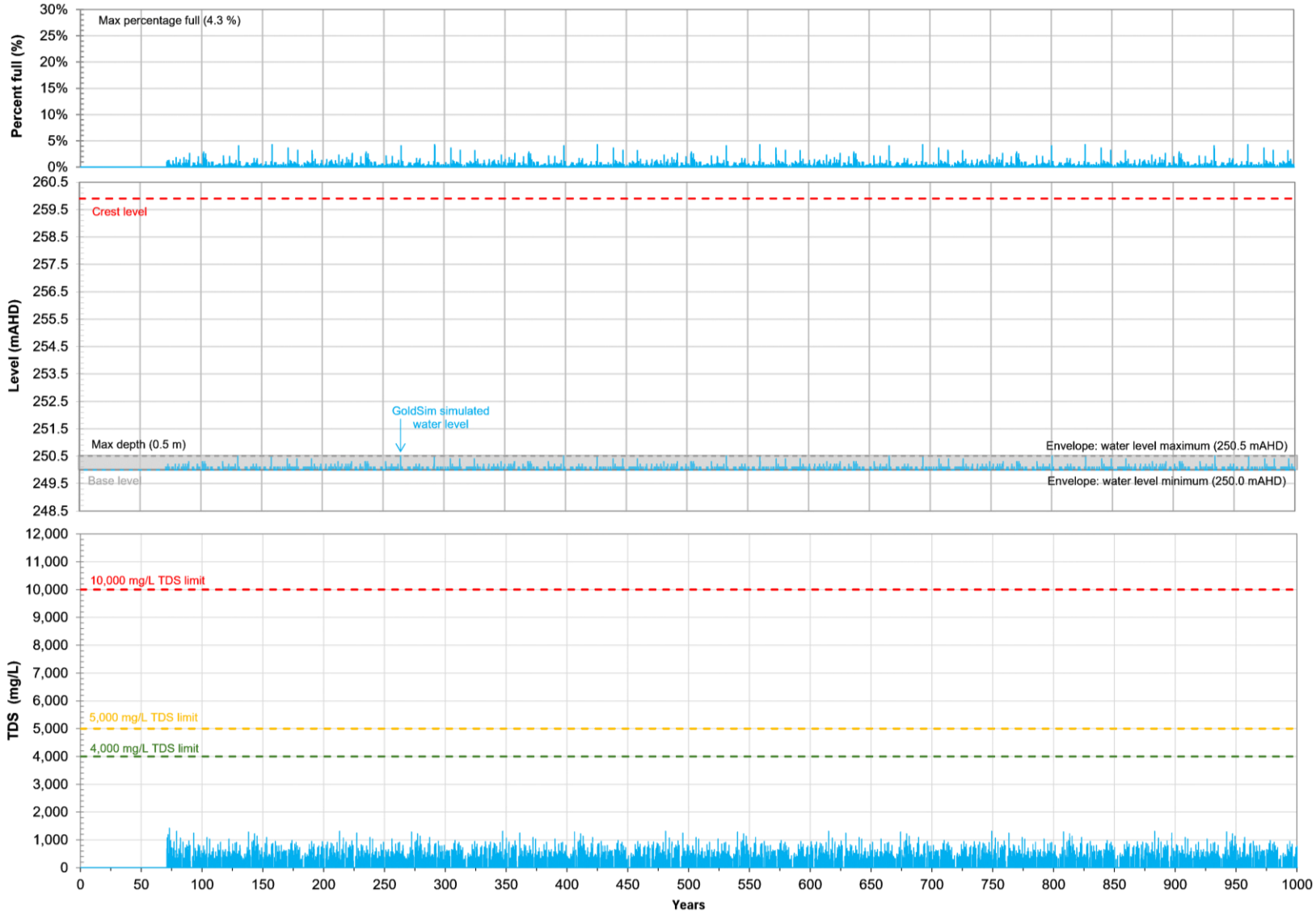


Figure 6.8 Wubagul water levels – base case

Table 6.1 Summary of base case results

Reprofiled void depression	Nature of waterbody		*Key void levels and depth*				*Key water levels and depth*			Overflow	TDS (mg/L)[C]		
	Ephemeral	Cycle	Base (mRL)	Dead storage (mRL)	Crest (mRL)	*Max void depth[A] (m)*	*Min (mRL)*	*Max (mRL)*	*Max water depth[B] (m)*		P5	P50	P95
Summer Hill	Yes	Annual	249.0	249.0	252.2	*3.2*	249.0	249.9	0.9	No	198	300	804
Mud Creek	Yes	Decade	260.2	261.1	267.7	*7.5*	260.2	262.5	2.3	No	228	1,100	2,260
Woleebee North Satellite	Yes	Annual	247.5	247.5	253.2	*5.7*	247.5	247.9	0.4	No	220	310	595
Woleebee Creek	Yes	Annual	242.9	243.0	249.9	*7.0*	242.9	244.3	1.4	No	145	194	384
Woleebee	Yes	Annual	243.6	244.1	264.9	*21.3*	243.6	247.6	4.0	No	176	218	328
Austinvale	Yes	Annual	253.7	253.7	261.9	*8.2*	253.7	254.6	0.9	No	206	888	3,260
Frank Creek	Yes	Annual	241.0	241.0	246.1	*5.1*	241.0	241.8	0.8	No	213	283	430
Wubagul	Yes	Annual	250.0	250.0	259.9	*9.9*	250.0	250.5	0.5	No	231	331	655

Notes:
[A] *Maximum void depth (m) = crest of void – base of void*
[B] *Maximum water depth (m) = maximum water level – base of void*
[C] TDS levels are expected to fluctuate dependent on the volume in the waterbodies of each reprofiled void depression but are not expected to accumulate over time due to loss of salt via infiltration and cattle consumption. Modelling has shown TDS spikes when the volume in the reprofiled void depression was low and nearly empty. These spikes in TDS are inherit in the mass balance modelling approach and may not occur to such an extent in practice. As such, the TDS levels for volumes lower than 0.05% of the reprofiled void depression volumes (dead storage volume) have been filtered out to depict a more realistic estimate for TDS levels

Base case results indicate that:

- *Waterbodies:*
  - *Expected to form during the first wet season following closure in each mining area. From then, the reprofiled void depressions are expected to have ephemeral waterbodies, filling during wet periods when the inflows (runoff and rainfall) are greater than outflows (seepage, evaporation and cattle consumption) and empty in dry periods when outflows are greater than inflows.*
  - *Most reprofiled void depressions (Summer Hill, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul) are expected to follow an annual cycle of filling and emptying.*
  - *Mud Creek reprofiled void depression is unique in its expected ability to sustain a waterbody over longer periods, potentially decades, because of the smaller, tiered base area of the void, with reduced seepage and evaporation (refer to physical characteristics in data sheets – Appendix II). This prolonged water retention, in an otherwise ephemeral environment, may influence vegetation growth:*
    - *Hydrophytic vegetation: extended saturation may support wetland or riparian species adapted to moist conditions, enhancing ecological stability and biodiversity.*
    - *Soil moisture and structure: sustained water may improve soil moisture and structure, aiding root development and plant establishment. However, waterlogging, particularly in fine-textured soils, may inhibit oxygen availability for root systems (though only a small area of the base of the reprofiled void depressions is expected to sustain area).*
    - *Vegetation planning: species selection should reflect the expected hydrological regime, prioritising plants tolerant of periodic inundation and low oxygen to support regrowth and long-term sustainability.*
  - *Expected to remain less than 25% full, with maximum modelled water levels well below overflow levels (i.e., no overflow into downstream watercourse via surface pathways expected).*
- *Salinity (modelled as TDS):*
  - *Expected to fluctuate dependent on the volume in the waterbodies of each reprofiled void depression (i.e., higher volumes – lower salinity).*
  - *Mass of salt in the reprofiled void depressions is not expected to accumulate over time as salt is lost via infiltration and cattle water supply appears to offset salt mass inflow from runoff inflows.*
  - *Salinity levels in existing ephemeral streams and pools in the vicinity of the Project fluctuate with the natural wetting-drying cycle. Initially, salinity tends to be high because of concentrated dissolved salts and organic acids in surface runoff, which dilute during subsequent flow/runoff events. As drying progresses, salinity increases again because of evapoconcentration (Australian Government 2020). This naturally occurring pattern is expected to be reflected in the reprofiled void depressions with*

increased modelled salinity when the volume in the reprofiled void depression was low and nearing empty. However, the magnitude of these salinity spikes is inherit in the mass balance modelling approach, which assumes the entire salt load remains dissolved (i.e., in solution), leading to artificially elevated salinity concentrations during low-volume periods. This simplification provides conservative estimates that may overstate the likelihood and severity of salinity peaks under actual field conditions. In reality, as the water body recedes, salts are likely to precipitate and form crusts on the base of the reprofiled void depression, reducing salinity levels.

- *Modelled TDS levels within Austinvale reprofiled void depression are expected to exceed the beef cattle thresholds of 4,000 mg/L, with an estimated 1 in 26 AEP. While 4,000 mg/L has been used as the threshold, beef cattle can tolerate TDS levels up 5,000 mg/L without loss of production (refer to Table 5.12), with exceedance events above this level expected with a 1 in 125 AEP.*
- *Although the ephemeral nature of the waterbodies within the reprofiled void depressions aligns with the surrounding ephemeral streams and pools, elevated salinity during low-volume periods may pose a risk to livestock health. While beef cattle can tolerate elevated salinity levels for short durations, access to these areas can be managed through appropriate control measures to mitigate potential impacts:*
  - *alternative water sources (i.e., off-stream tanks and troughs), which are already used during dry seasons; and*
  - *relocation of cattle to restrict access to affected reprofiled void depressions.*

7 CATTLE CONSUMPTION

As discussed in Section 5.7, water in the reprofiled void depression waterbodies is expected to be consumed opportunistically by cattle. This is expected to remove salt and reduce the salt load when there is sufficient water available in the waterbodies. As such, an assessment of cattle consumption over time has been undertaken considering cattle water assumptions (Section 5.7) for two stock ratings (i.e., 1 head/6 ha and 1 head/10 ha).

Based on the final landform design, cattle will be able to safely access the waterbodies (refer to Section 2.2).

Based on the stock water guideline quality (as detailed in Table 5.13) up to a TDS limit of 4,000 mg/L, modelled annual volumes of water able to be drunk from each reprofiled void depression and the longevity of this supply are presented in Table 7.1 for both stock ratings.

Modelled cattle consumption for both stock ratings and each reprofiled void depression are presented in Appendix IV over the 1,000 years modelled and a 20-year snapshot to show the trend in consumption (i.e., only able to supply water for cattle when there is sufficient water in the reprofiled void depressions).

Table 7.1 Predicted beef cattle consumption

Reprofiled void depression	Stock rating of 1 head/10 ha			Stock rating of 1 head/6 ha		
	Water (ML/year)		Longevity	Water (ML/year)		Longevity
	Max demand*	Max supply		Max demand*	Max supply	
Summer Hill	10.6	9.3	Full 1,000 years modelled (seasonally when water available)	17.6	15.0	Full 1,000 years modelled (seasonally when water available)
Mud Creek	2.2	2.2		3.6	3.6	
Woleebee North Satellite	3.4	2.6		5.7	4.0	
Woleebee Creek	2.7	1.8		4.5	2.9	
Woleebee	6.8	6.5		11.3	10.6	
Austinvale	6.1	4.7		10.1	7.9	
Frank Creek	3.0	1.8		5.1	2.9	
Wubagul	5.2	4.6		8.7	7.7	

Note: * Maximum demand from Table 5.13

Cattle consumption results indicate that:

- *For all reprofiled void depression except Mud Creek, the cattle supply is during the wet season only (when there is a waterbody within the reprofiled void depression) and would be used as a supplementary supply when available. Alternative water sources such as off-stream tanks and troughs, which are already in place, are expected to continue supporting cattle grazing during the dry season when ephemeral water sources are unavailable. For Mud Creek, the extended water retention is expected to improve cattle supply over both the wet and dry seasons (refer to Appendix IV – Figure IV.2).*
- For both the stock ratings, the maximum supply available is less than the maximum volume the cattle could drink because of the water supply limitations (i.e., ephemeral nature of waterbody) *in all reprofiled void depression except for Mud Creek. For Mud Creek, the*

extended water retention period is expected to assist with the maximum stock demand being able to be meet on an annual basis.

- Cattle are expected to be able to source water from the reprofiled void depressions seasonally over the full 1,000 years modelled with no overall deterioration of long-term water quality expected in the eight reprofiled void depressions.

8 SENSITIVITY AND RISK

8.1 Sensitivity assessment

Sensitivity analyses have been undertaken to better understand the uncertainty of several water balance model parameters and inputs and to quantify the impact on expected water level and TDS fluctuations, when compared to the base and cattle consumption cases (discussed in Sections 6 and 0).

Table 8.1 outlines the sensitivity cases considered.

Table 8.1 Sensitivity cases

Case	Parameter / input	Base case	Variability tested
1a and b	Cattle consumption	Stock rating of 1 head/10 ha	Varied consumption: Case 1a: no cattle consumption; and Case 2b: stock rating of 1 head/6 ha
2	AWBM parameter	KCB parameters (refer to Table 5.7)	Higher yield parameters (refer to Table 5.8)
3a and b	Climate change	Historical rainfall data from SILO	Detailed climate projection predictions for Queensland: Case 3a: moderate emission (HI RCP4.5); and Case 3b: worst-case emission (HP RCP8.5)
4a and b	Seepage – hydraulic conductivity	5.4×10^{-6} m/s	± order of magnitude Case 4a: 5.4×10^{-5} m/s; and Case 4b: 5.4×10^{-7} m/s
5a and b	Pit evaporation factor	0.9	Case 5a: Pit evaporation factor (1.0) Case 5b: Pit evaporation factor (0.8)

A comparison of base and sensitivity cases is provided in Figure 8.1 to Figure 8.8 for simulated water level fluctuations (maximum and minimum envelopes) and Figure 8.9 to Figure 8.16 for simulated TDS fluctuations (P5 and P95) for each reprofiled void depression. This provides a graphical presentation of the uncertainty range associated with each key parameter in relation to the base case and key levels (i.e., overflow level and TDS 4,000 mg/L cutoff for cattle consumption).

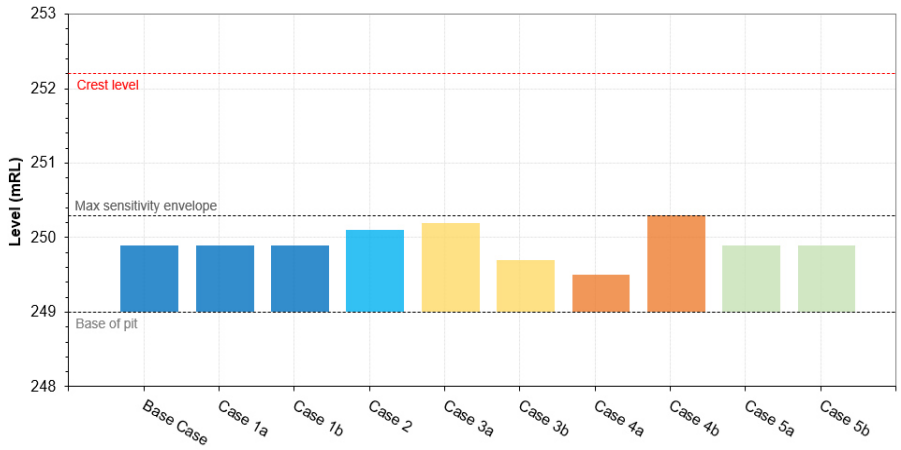


Figure 8.1 Sensitivity water level ranges – Summer Hill

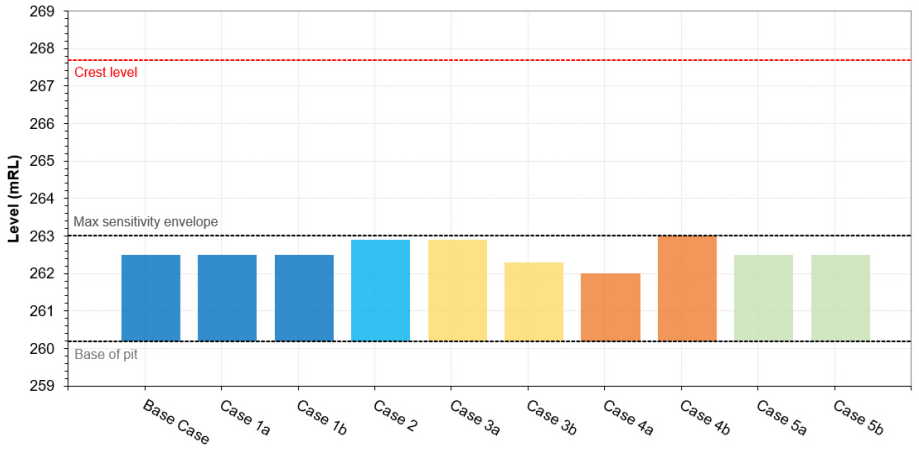


Figure 8.2 Sensitivity water level ranges – Mud Creek

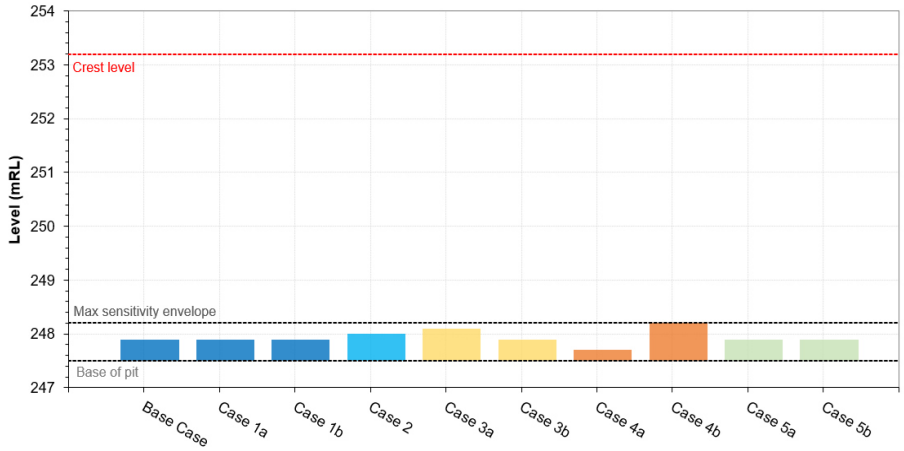


Figure 8.3 Sensitivity water level ranges – Woleebee North Satellite

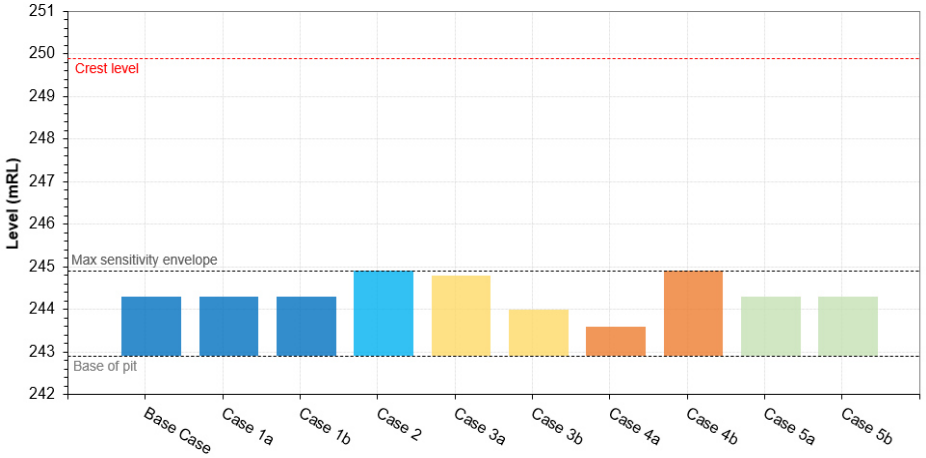


Figure 8.4 Sensitivity water level ranges – Woleebee Creek

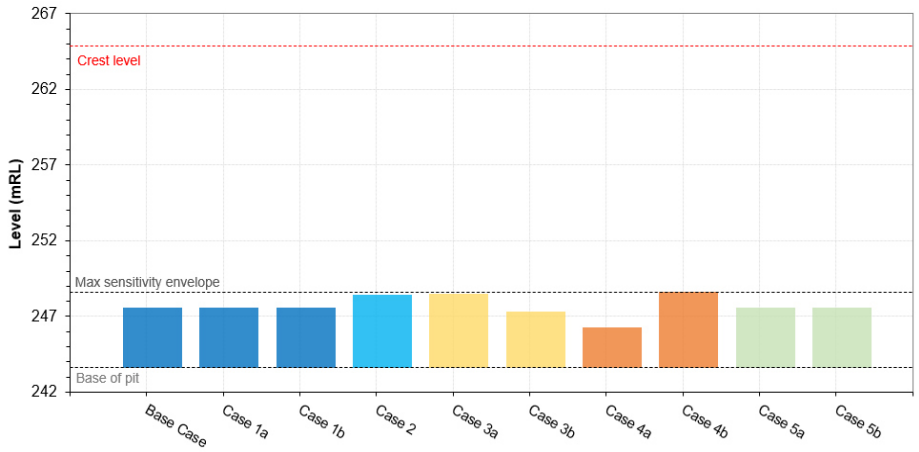


Figure 8.5 Sensitivity water level ranges – Woleebee

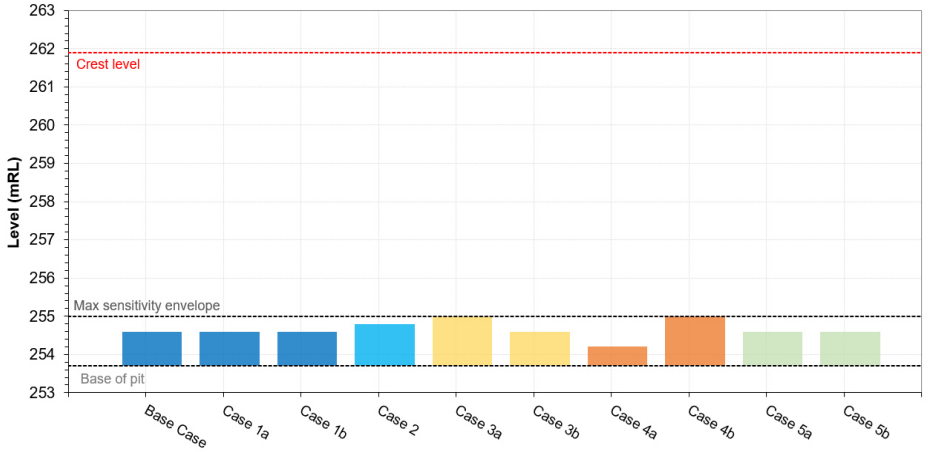


Figure 8.6 Sensitivity water level ranges – Austinvale

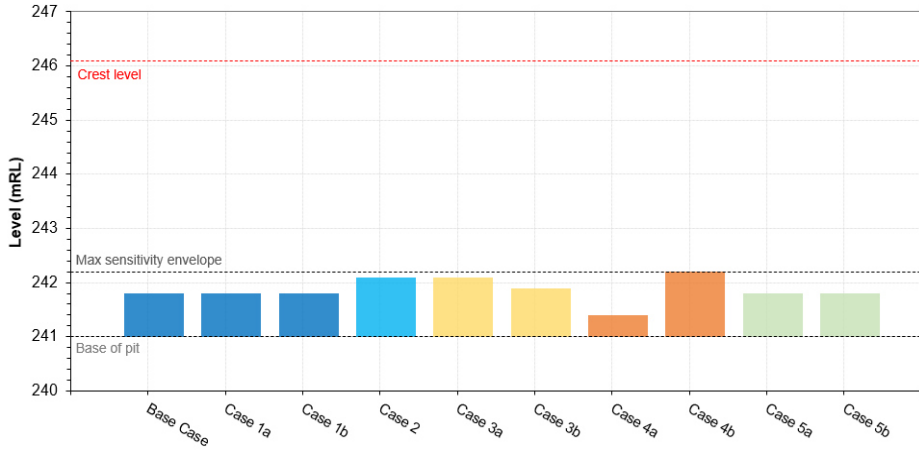


Figure 8.7 Sensitivity water level ranges – Frank Creek

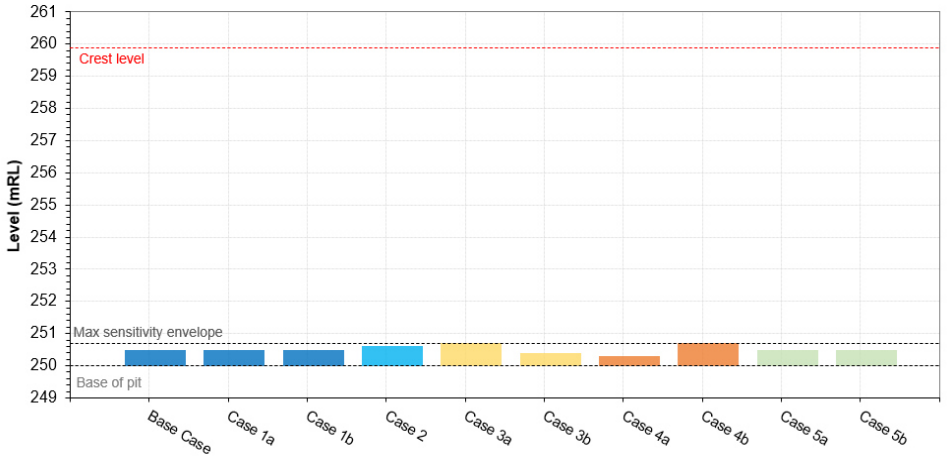


Figure 8.8 Sensitivity water level ranges – Wubagul

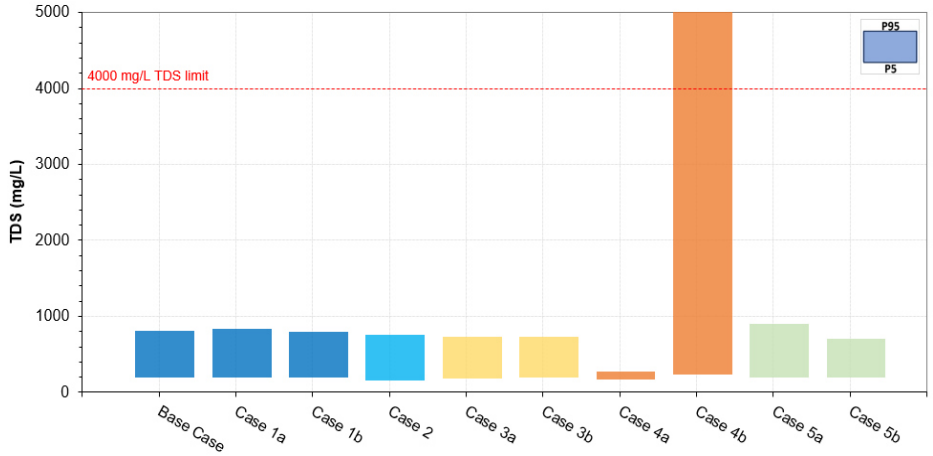


Figure 8.9 Sensitivity TDS level ranges – Summer Hill

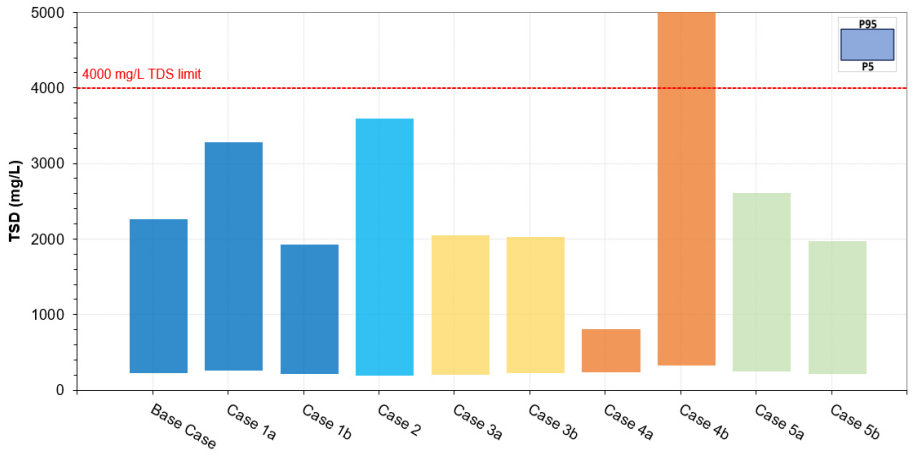


Figure 8.10 Sensitivity TDS level ranges – Mud Creek

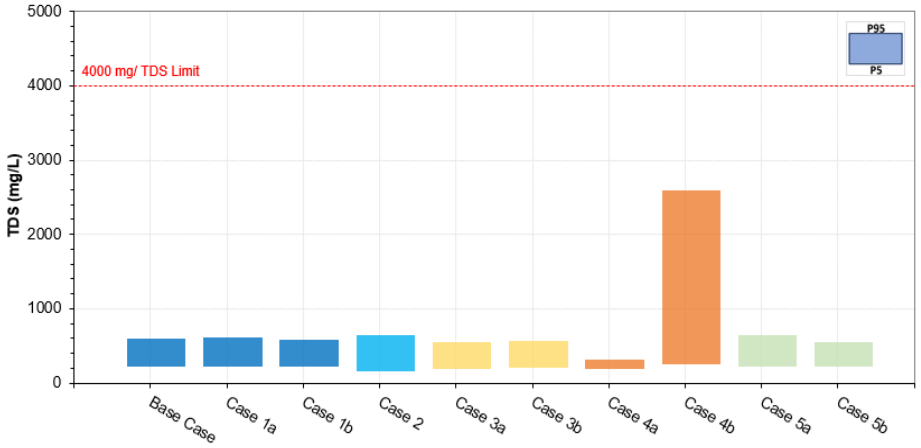


Figure 8.11 Sensitivity TDS level ranges – Woleebee North Satellite

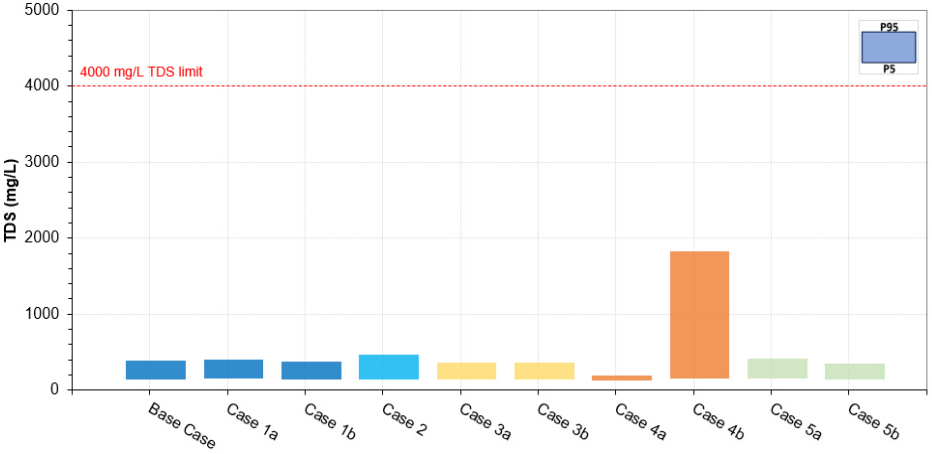


Figure 8.12 Sensitivity TDS level ranges – Woleebee Creek

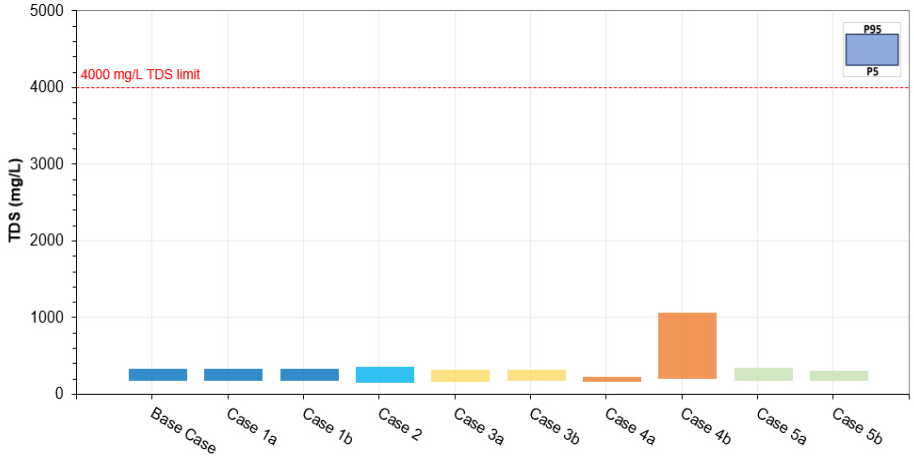


Figure 8.13 Sensitivity TDS level ranges – Woleebee

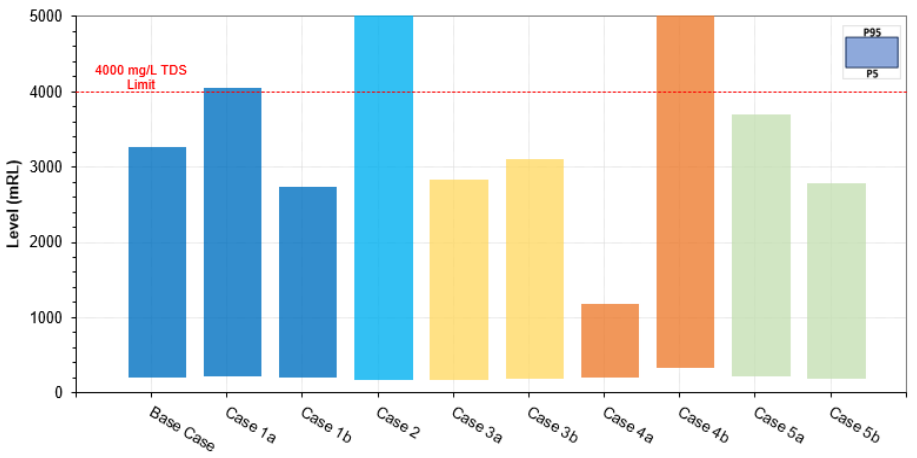


Figure 8.14 Sensitivity TDS level ranges – Austinvale

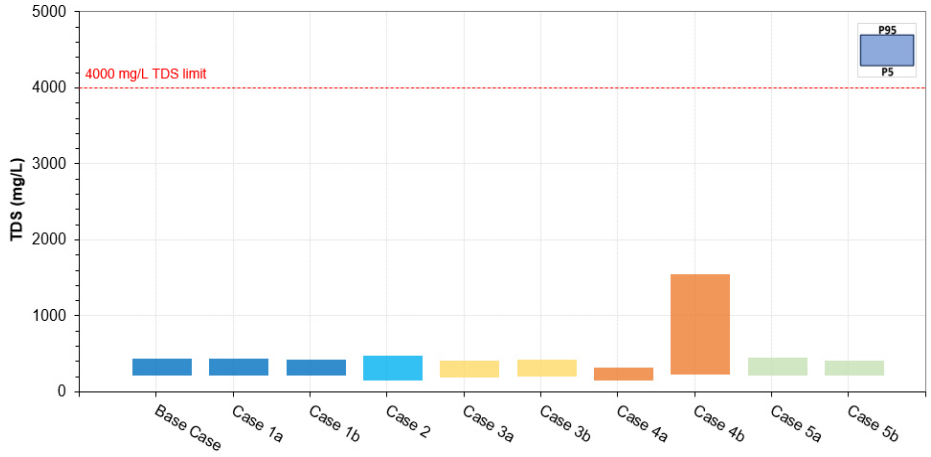


Figure 8.15 Sensitivity TDS level ranges – Frank Creek

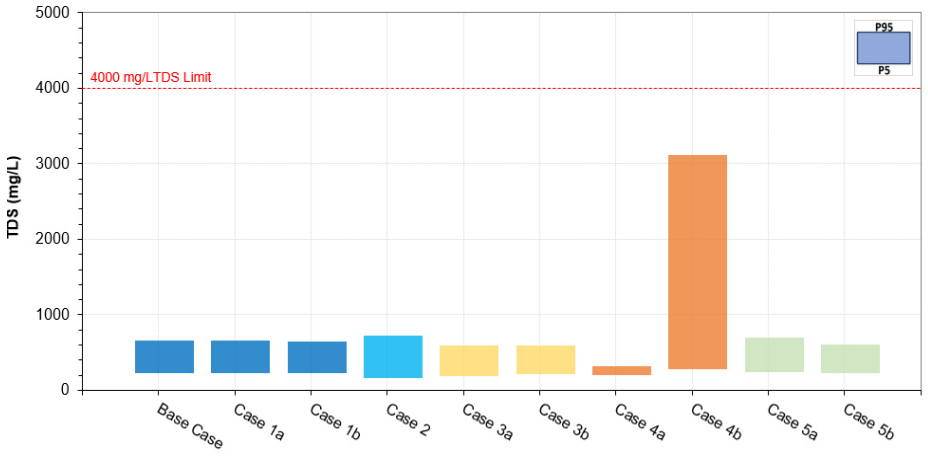


Figure 8.16 Sensitivity TDS level ranges – Wubagul

Sensitivity results indicate that:

- Case 1: Cattle consumption
  - Increased or null cattle consumption does not significantly impact the maximum water level envelope modelled within the reprofiled void depressions.
  - Increasing cattle consumption decreases the TDS levels, and null cattle consumption increases the TDS levels modelled for the reprofiled void depressions (most evident for Mud Creek and Austinvale).
- Case 2: Increased AWBM catchment yield
  - Adjusting the AWBM parameters to simulate increased catchment yield results in higher maximum water and TDS envelopes for the reprofiled void depressions, compared to the base case. The increase in water storage is most notable for storages like Summer Hill, Mud Creek, Woleebee Creek and Woleebee that have larger catchments. The increase in TDS levels is most notable for the Mud Creek and Austinvale storages.
  - The maximum water level for all reprofiled void depressions modelled remains well below overflow levels.
- Case 3: Climate change
  - The future climate projected datasets downloaded from the biophysical modelling base typically have extended dry periods with more intense rainfall bursts as the datasets progress further into the future.
  - The water level envelope results for the moderate emissions sensitivity case are above the base case water levels for all reprofiled void depressions, however, the maximum water level envelope remain well below the overflow level.
  - The water level envelope results for the high emissions sensitivity case show reduced maximum water level envelopes across all reprofiled void depressions. This can be attributed to the increase in evaporation applied across the emission dataset (summarised in Table 5.5 and Table 5.6).
  - The impact on TDS levels is expected to be minimal.
- Case 4: Hydraulic conductivity
  - Increasing the hydraulic conductivity by an order of magnitude decreases the maximum water and TDS level envelopes in response to the increased seepage volume leaving the system.
  - Reducing the hydraulic conductivity by an order of magnitude increases the maximum water and TDS level envelopes in response to decreased seepage volume from the system.
  - The hydraulic conductivity coefficient used for the base case assessment was provided by RGS for in-situ spoil material (detailed in Section 5.5). The reprofiled void depressions are to be backfilled using this spoil material. As such, the hydraulic conductivity is expected to remain equivalent, or increase dependent on how the material is placed (i.e., hydraulic conductivity not expected to decrease).

- Case 5: Evaporation adjustment factor
  - Changing the evaporation adjustment factor does not significantly impact the maximum water level envelope modelled within the reprofiled void depressions.
  - Changing the evaporation adjustment factor resulted in minor differences in modelled TDS levels within the reprofiled void depressions in comparison to the base case results.

8.2 Risk assessment

A risk assessment of potential environmental impacts caused by the reprofiled void depressions planned to remain at the Project upon closure has been undertaken based on the outcomes of the testing of sensitivities on input data and model assumptions.

8.2.1 Storage capacity and release of surface water from reprofiled void depressions

For the base and sensitivity cases modelled, maximum water level envelopes are predicted to remain well below the crest level for all eight reprofiled void depression, with overflow of water to the receiving environment unlikely.

The following outcomes were also determined from water balance modelling:

- Beef cattle consumption will reduce water level but has not been shown to have a significant impact on the maximum water level envelope based on the cattle being able to safely access and rink from the water surface.
- Increasing the catchment yield of the reporting catchment has been shown to result in a slight increase in maximum water level envelope. However, this has been modelled to remain well below overflow levels.
- Climate change datasets with moderate to low emissions produced higher maximum water level envelopes and the climate datasets with high emissions produced lower maximum water level envelopes. The maximum modelled water level envelopes remain well below the overflow levels for both climate scenarios.
- Decreasing the hydraulic conductivity by an order of magnitude produced higher water level envelopes that remain well below overflow levels. Increasing of hydraulic conductivity produce lower maximum water level envelopes.
- Changing the evaporation adjustment factor has been shown to make no significant impact on maximum water level envelope.

8.2.2 Adverse water quality impacts from the reprofiled void depressions

The water balance model included the consideration of how TDS levels change within the reprofiled void depression waterbodies over time. In all reprofiled void depressions, TDS levels are expected to fluctuate dependent on the volume of water in each waterbody. However, no net accumulation of salt over time is apparent for the cattle sensitivity consumption rates tested (case 1 including null consumption). For the 1 head/6 ha and 1 head/10 ha stock ratings modelled, cattle consumption was consistently available for periods with water stored in the reprofiled void depressions.

9 CONCLUSIONS

A water balance study has been undertaken for the reprofiled void depressions planned to remain at the Project after closure. This report documents aspects of the study relating to reprofiled void depressions hydrology and long-term water balance, including:

- Review of topographic data to define physical characteristics of the eight planned reprofiled void depressions including topography, drainage, catchment areas and level – surface area – volume characteristics associated with the eight mining areas where reprofiled void depressions are planned.
- Definition of hydrological characteristics for the reprofiled void depressions (i.e., rainfall, evaporation and catchment yield, etc.) based on review of available data.
- Definition of hydrogeological characteristics for the reprofiled void depressions (i.e., groundwater interactions) from work undertaken by KCB's groundwater team (KCB 2025a).
- A water balance model was developed for each reprofiled void depression.
- Predictive modelling to estimate hydrological characteristics of these reprofiled void depressions.

Key outcomes of the water balance study include:

- Eight reprofiled void depressions within the mining areas of Summer Hill, Mud Creek, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul are planned to remain as part of the final landform.
- The bases of all eight reprofiled void depressions were set to be above the predicted post-closure groundwater level to avoid ingress of saline groundwater into the depressions (from groundwater inflow and capillary action) and prevent a decline in water quality because of groundwater ingress.
- Waterbodies within the reprofiled void depressions are expected to form in the first wet season from the onset of closure in each mining area. From then, the reprofiled void depressions are expected to have ephemeral waterbodies which fill in wet periods when the inflows (runoff and rainfall) are greater than outflows (seepage, evaporation and cattle consumption) and empty in dry periods when outflows are greater than inflows. For most of the reprofiled void depressions (Summer Hill, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul), this cyclic filling and emptying is expected to occur annually. For Mud Creek, the reprofiled void depression is expected to be able to sustain a waterbody for longer, with the cyclic filling and emptying expected to occur over larger periods of time, because of the smaller, tiered base areas (refer to physical characteristics in data sheets – Appendix II).
- Waterbodies within the reprofiled void depressions are expected to remain less than 25% full, with maximum modelled water levels well below overflow levels (i.e., no overflow into downstream watercourse via surface pathways expected).
- Salinity (modelled as TDS) levels are expected to fluctuate dependent on the volume in the waterbodies of each reprofiled void depression (i.e., higher volumes – lower salinity). *This pattern reflects natural conditions observed in existing ephemeral streams and pools within*

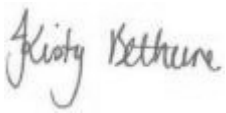
the vicinity of the Project, where salinity initially increases because of concentrated dissolved salts and organic acids in surface runoff, then dilutes with subsequent flow/runoff events. As drying progresses, salinity increases again because of evapoconcentration (Australian Government 2020). Although the salinity is expected to fluctuate, modelling has shown that the salt mass in the reprofiled void depressions is not expected to accumulate over time as the salt lost via infiltration and cattle water supply appears to offset salt mass inflow from runoff inflows. Modelling has also shown salinity spikes during low-volume conditions in the reprofiled void depression which are inherent to the mass balance modelling approach, which assumes all salt remains dissolved. In reality, as the water body recedes, salts are likely to precipitate and form crusts on the base of the reprofiled void depression, reducing actual salinity levels.

- Reprofiled void depressions can supplement beef cattle water needs (over the long-term) when there is water in the reprofiled void depressions with TDS levels expected to be suitable for cattle consumption based on a 4,000 mg/L limit (or EC of 5,970 µS/cm).
- Sensitivity analysis has been undertaken to determine how the reprofiled void depressions hydrological characteristics vary in response to changes in model parameters. Changes to parameters in isolation generally produced water level ranges that were well below the overflow levels.
- Water stratification was not assessed, because the ephemeral nature and shallow depth (with maximum depths ranging from 0.4m in Woleebee North Satellite up to 4.0 m in Woleebee) of the water bodies in the reprofiled void depressions does not present conditions where stratification is likely to occur.

10 CLOSING

We would like to thank you for the opportunity to work on this water balance study in support of the PRCP for the Project. Should you have any questions, please contact the undersigned.

KCB AUSTRALIA PTY LTD.



Kirsty Bethune
Senior Water Resources Engineer

VERSION MANAGEMENT

Rev	Date	KCB			Proponent / peer reviewer	Status	Revision description
		Author	Checked	Approved	Approved		
A	19/06/24	K. Bethune D. Byrne	O. Ciocca J. Heaslop	J. Heaslop	For approval	Draft	-
B	4/07/24	K. Bethune D. Byrne	O. Ciocca	J. Heaslop	For approval	Draft	First round of proponent / peer review feedback
0	31/07/24	K. Bethune D. Byrne	L. Evans J. Heaslop	J. Heaslop	For use	Draft	Second round of proponent / peer review feedback
1	16/09/24	K. Bethune D. Byrne	L. Evans J. Heaslop	J. Heaslop	For use	Final	Minor update to figures
2	02/12/25	K. Bethune	L. Evans J. Heaslop	J. Heaslop	For use	Final	Minor updates to address DETSI RFI

REFERENCES

ANZECC and ARMCANZ. 2000. “Australian and New Zealand Guidelines for Fresh and Marine Water Quality.” October.

Australian Government. 2020. “Assessing and Managing Water Quality in Temporary Waters - Technical Report.” October.

BOM. 2024. “Fitzroy: Geographic Information.” http://www.bom.gov.au/water/nwa/2021/fitzroy/regiondescription/geographicinformation.shtml#:~:text=In%20the%20Fitzroy%20region%2C%20the,from%201%20October%E2%80%9330%20September.

DETSI. 2022. “Environmental Authority Number: EPML00297613.” December.

DETSI. 2024. “Guideline - Progressive Rehabilitation and Closure Plans (PRC Plans) ESR/2019/4964 Version 3.01.” September 16.

Future Beef. 2021. “Dry Season Management - Queensland Government.” October.

Future Beef. 2022. “Water Requirements for Cattle - Meat and Livestock Association and Governments of Qld, NT and WA.” February.

GCAA. 2023. “Existing Landform.” August.

GCAA. 2024a. “PRCP Final Landform (Revision C).” May.

GCAA. 2024b. “Wandoan Coal Project - Beef Cattle Stock Ratings and Private Freehold Land (Email).” March.

GCAA. 2024c. “Wandoan Environmental Monitoring Database.” May.

KCB. 2025a. “Wandoan Coal Project - Progressive Rehabilitation and Closure Plan - Groundwater Assessment Report (Final).” December.

KCB. 2025b. “Wandoan Coal Project - Progressive Rehabilitation and Closure Plan - Hydrologic and Hydraulic Modelling Study (Final - Rev 5).” December 2.

Meat and Livestock Australia. 2023. “Grazing Distribution - Distance to Water.”

RGS. 2024. “Geochemical, Physical, and Spontaneous Combustion Assessment of Mine Material - Wandoan Coal Project - Draft Technical Report.” April.

SILO. 2025. “Scientific Information for Land Owners Patched Point Datasets for Queensland.” January. https://www.longpaddock.qld.gov.au/silo/point-data/.

State of Queensland. 2017. “Mined Land Rehabilitation Policy.”

State of Queensland. 2025a. “Environmental Protection Act 1994.” October. https://www.legislation.qld.gov.au/view/html/inforce/current/act-1994-062.

State of Queensland. 2025b. “Water Act 2000.” August. https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-2000-034.

Tomlin, J, K Phillipson, M Lenahan, et al. 2023a. “Applying Leading Practice Modelling of Residual Mine Voids for Mine Rehabilitation Planning: Technical Paper 3.”

Tomlin, J, K Phillipson, M Lenahan, et al. 2023b. “Approaches for Leading Practice Modelling of Residual Mine Voids for Rehabilitation Planning: Technical Paper 2.”

Tomlin, J, K Phillipson, M Lenahan, et al. 2025. “Review of Current Approaches to Model Residual Mine Voids for Rehabilitation Planning: Technical Paper 1.” July.

APPENDIX I

Reprofiled void depression maximum surface area

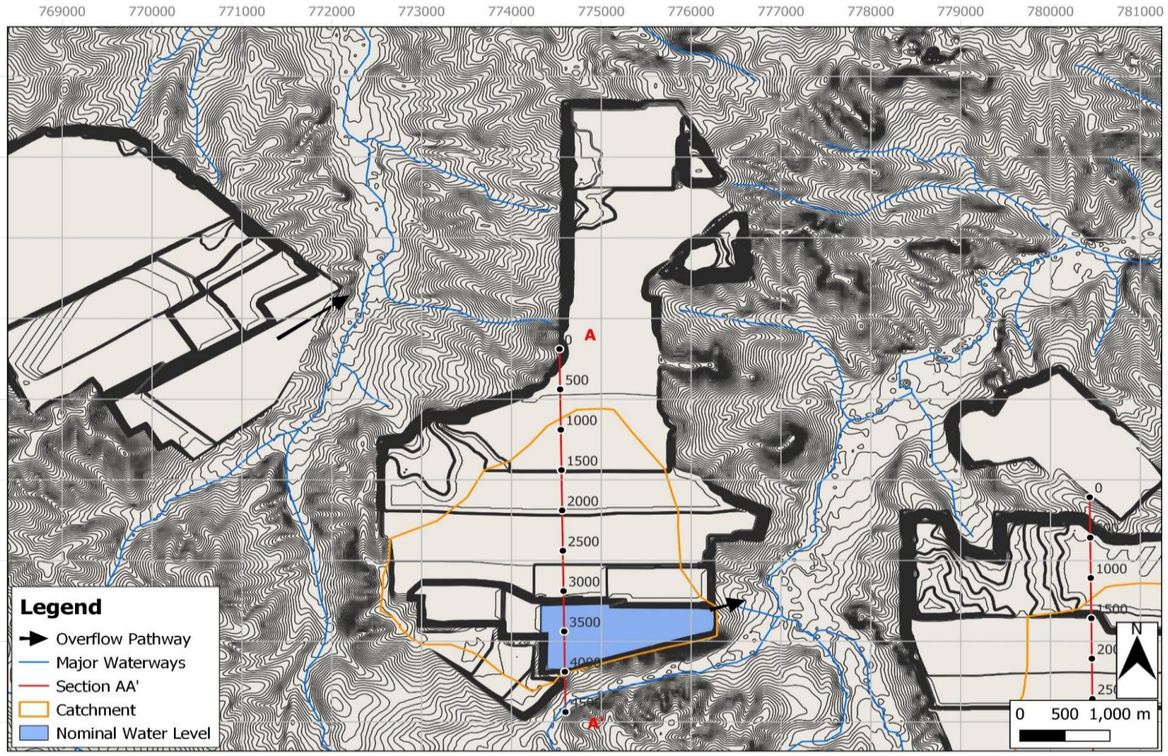
Table I.1 Reprofiled void depression surface area – EA Table F5 (DETSI 2022)

Reprofiled void depression identification	Void maximum surface area (ha)	
	EA requirements (Table F5)	Final landform
Turkey Hill	1,210	NA
Summer Hill	1,680	128
Mud Creek	2,080	56
Mud Creek North (satellite pit)	200	NA
Mud Creek East	160	NA
Woleebee Creek	640	73
Woleebee North	290	NA
Woleebee North (satellite pit)	140	28
Wubagul	570	104
Frank Creek North	80	NA
Frank Creek South	210	NA
Frank Creek West (Frank Creek)	210	39
Woleebee	1,012	199
Austinvale North	163	NA
Austinvale	736	67
Leichhardt	194	NA

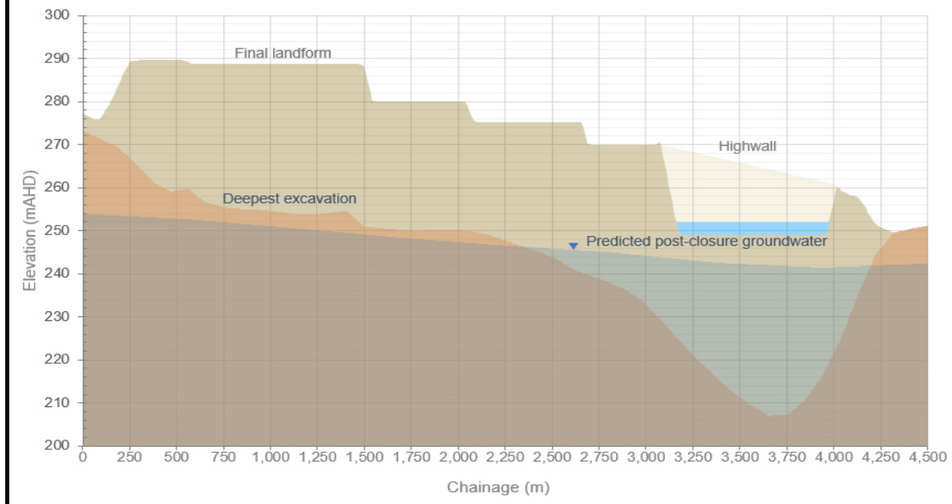
APPENDIX II

Reprofiled void depression data sheets

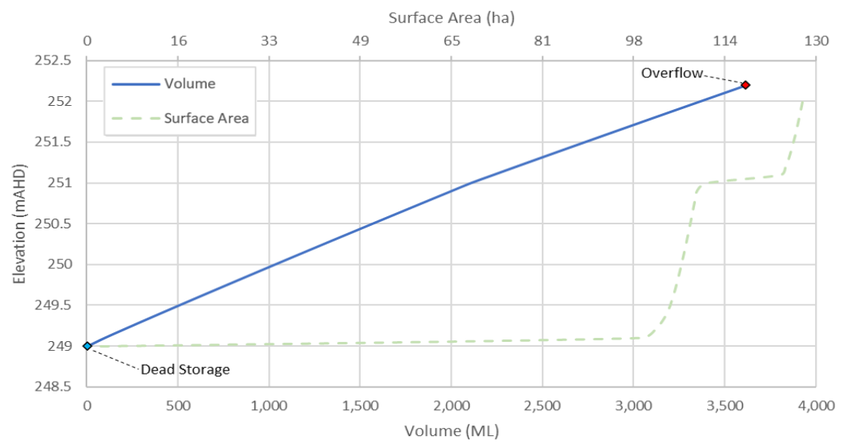
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 249mAHD.
Initial water level within Summer Hill was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Summer Hill is 252.2mAHD, with flows directed easterly towards Mud Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining from year 48 to 58 in ML50229
Adopted closure start date in year 59 of operation

Catchment area (ha)	809.3
Overflow level (mAHD)	252.2
Base of reprofiled void depression (mAHD)	249.0
Full supply volume (FSV)	3616.0
Depth to overflow (m)	3.2

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
COAL ASSETS AUSTRALIA
GLENCORE

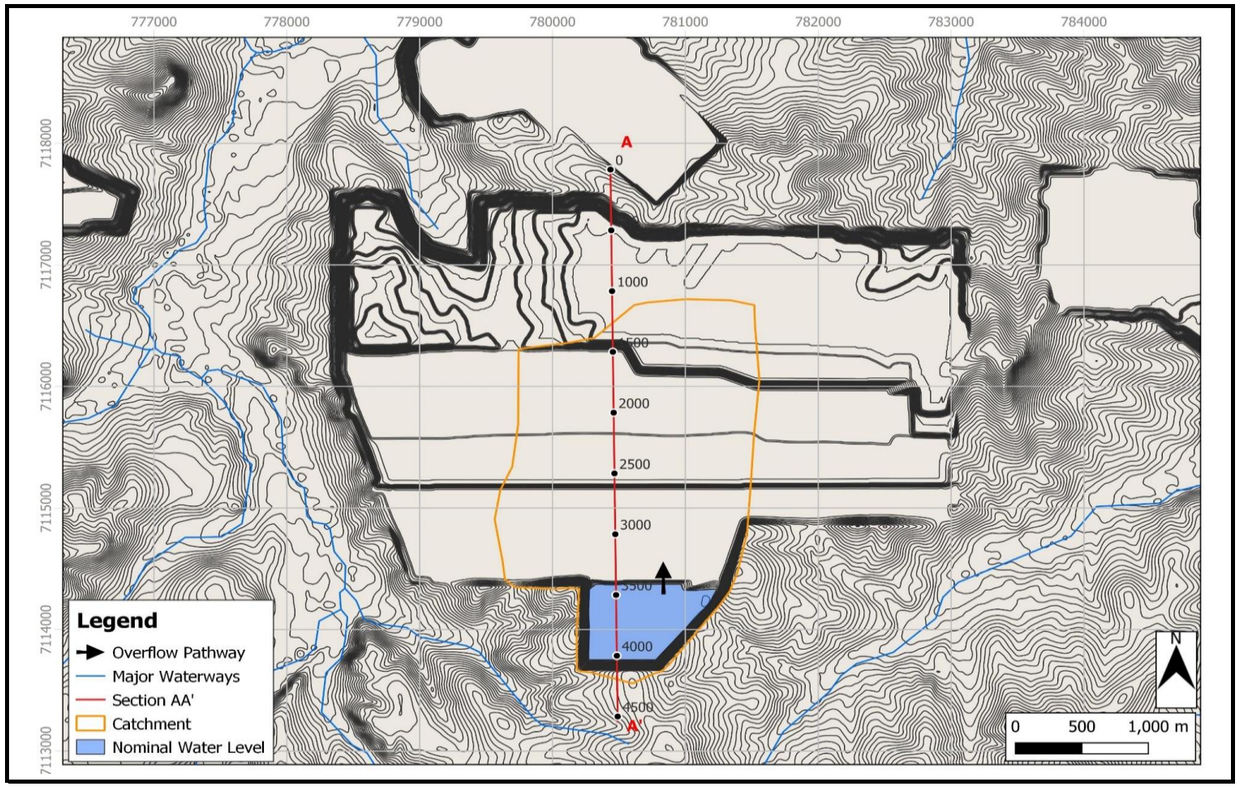
Klohn Crippen Berger

PROJECT
WANDOAN COAL PROJECT PRCP
WATER BALANCE STUDY

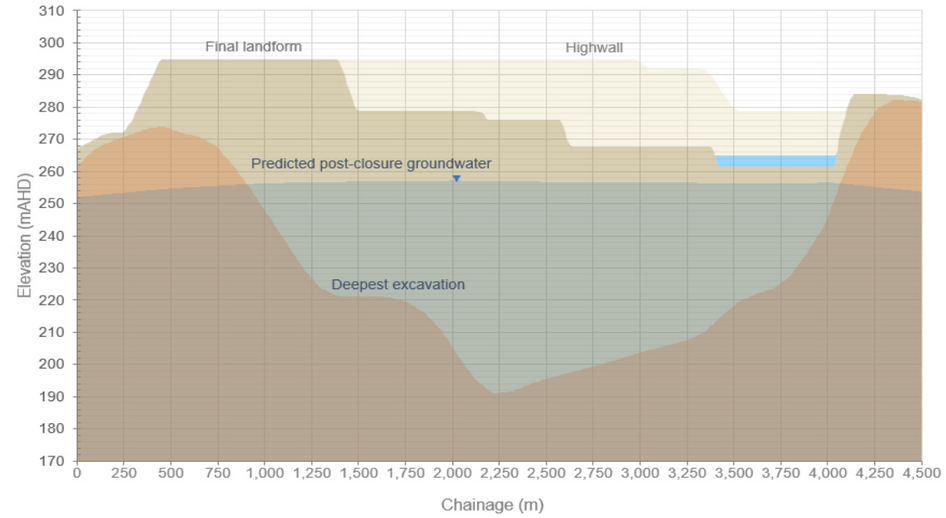
TITLE
REPROFILED VOID DEPRESSION
DATASHEET - SUMMER HILL

PROJECT No.
DX70080A09

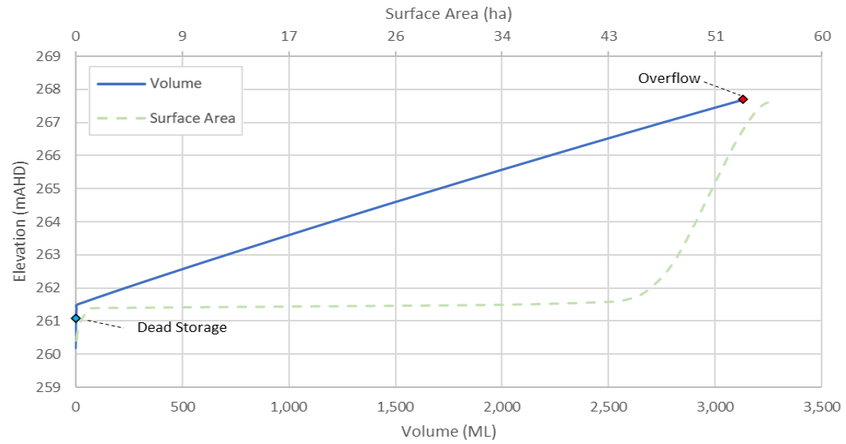
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 260.2mAHD.
Initial water level within Mud Creek Pit was assumed empty at the start of the simulation.
Lowest elevation for surface water overflow from Mud Creek is 267.7mAHD, overflow from the northern end of the pit drains westerly towards Mud Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining from year 39 to 47 in ML 50229.
Adopted closure start date in year 48 of operation

Catchment area (ha)	467.0
Overflow level (mAHD)	267.7
Base of reprofiled void depression (mAHD)	260.2
Full supply volume (FSV)	3132.0
Depth to overflow (m)	7.5

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: COAL ASSETS AUSTRALIA — GLENCORE

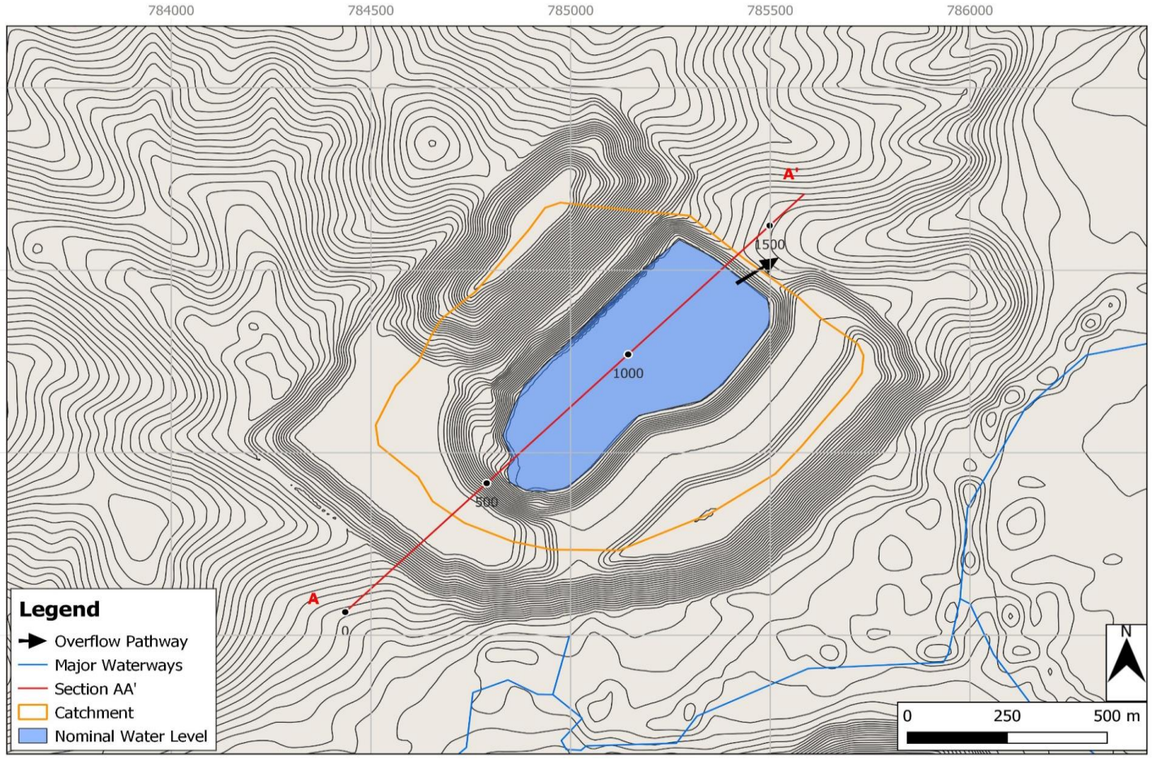
Klohn Crippen Berger

PROJECT: WANDOAN COAL PROJECT PRCP WATER BALANCE STUDY

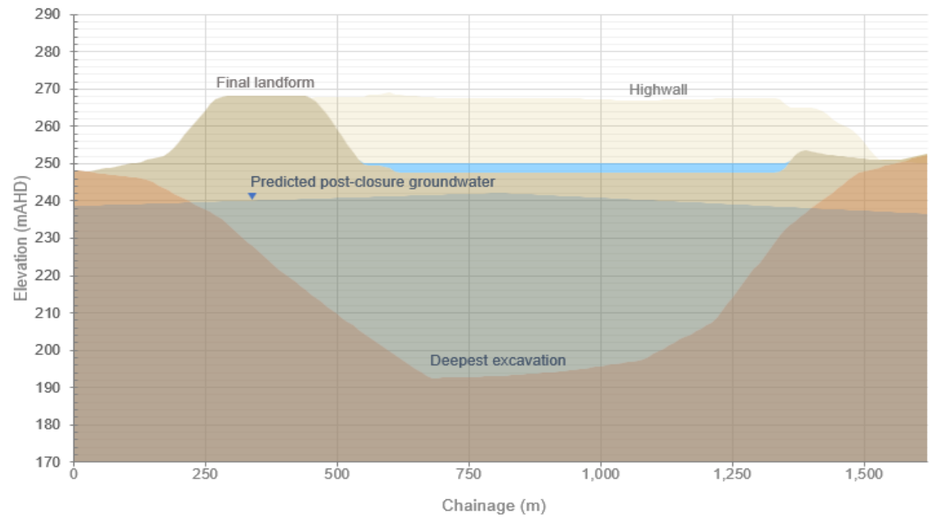
TITLE: REPROFILED VOID DEPRESSION DATASHEET - MUD CREEK

PROJECT No. DX70080A09

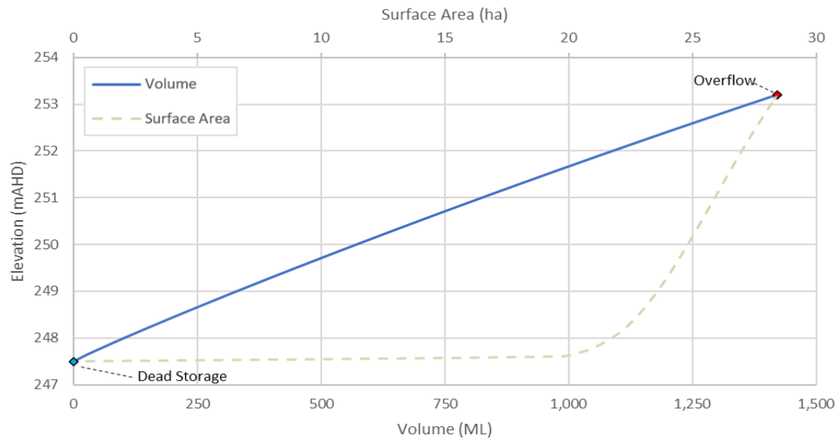
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 247.5mAHD.
Initial water level within Woleebee North Satelite was assumed empty at the start of the simulation.
Lowest elevation that water would overflow from Woleebee North Satelite is 253.2mAHD, with flows directed north-easterly towards Woleebee Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining in year 72 in ML 50231.
Adopted closure start date in year 73 of operation

Catchment area (ha)	77.7
Overflow level (mAHD)	253.2
Base of reprofiled void depression (mAHD)	247.5
Full supply volume (FSV)	1422.0
Depth to overflow (m)	5.7

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
COAL ASSETS AUSTRALIA
GLENCORE

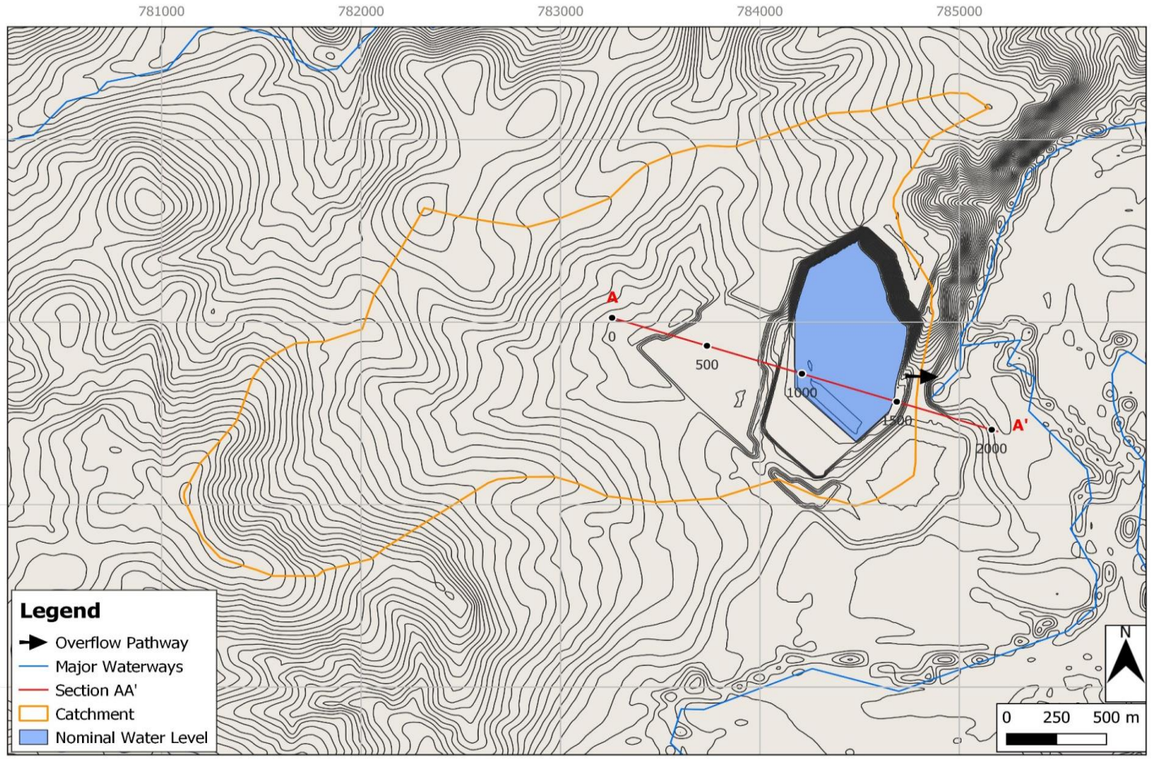
Klohn Crippen Berger

PROJECT
WANDOAN COAL PROJECT PRCP
WATER BALANCE STUDY

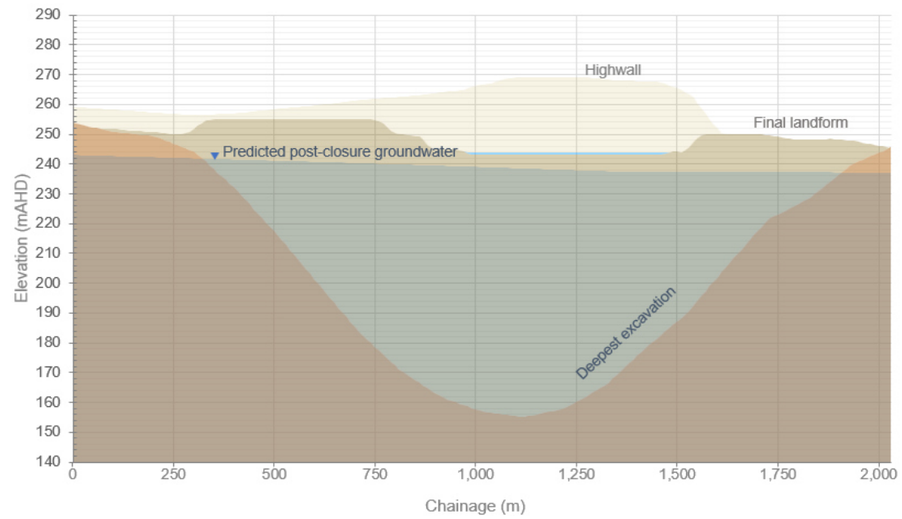
TITLE
REPROFILED VOID DEPRESSION DATASHEET
WOLEEBEE NORTH SATELITE

PROJECT No.
DX70080A09

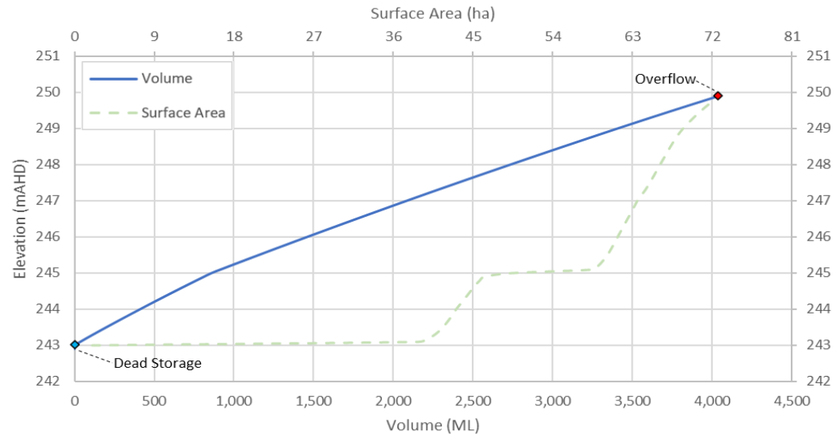
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 242.9mAHD.
Initial water level within Woleebee Creek was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Woleebee Creek is 249.9mRL, with flows directed easterly towards Wandoan Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining in year 74 in ML 50231.
Adopted closure start date in year 75 of operation

Catchment area (ha)	581.9
Overflow level (mAHD)	249.9
Base of reprofiled void depression (mAHD)	242.9
Full supply volume (FSV)	4037.0
Depth to overflow (m)	7.0

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
COAL ASSETS AUSTRALIA
GLENCORE

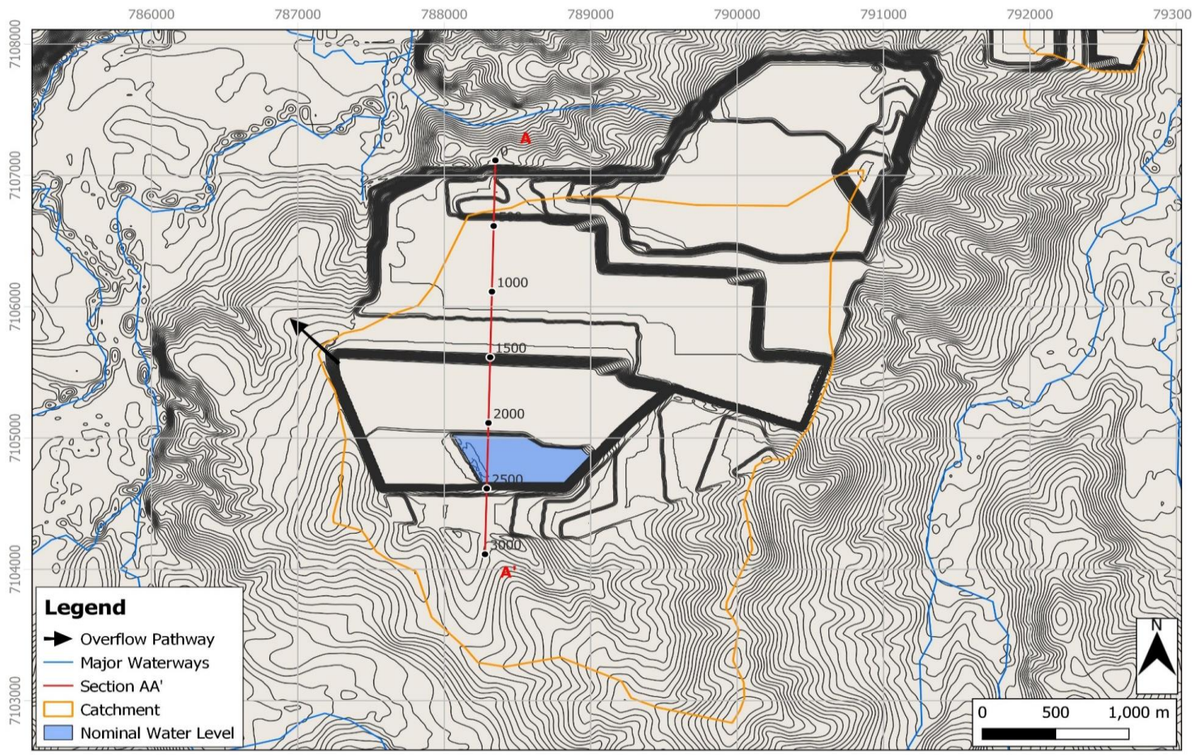
Klohn Crippen Berger

PROJECT
WANDOAN COAL PROJECT PRCP
WATER BALANCE STUDY

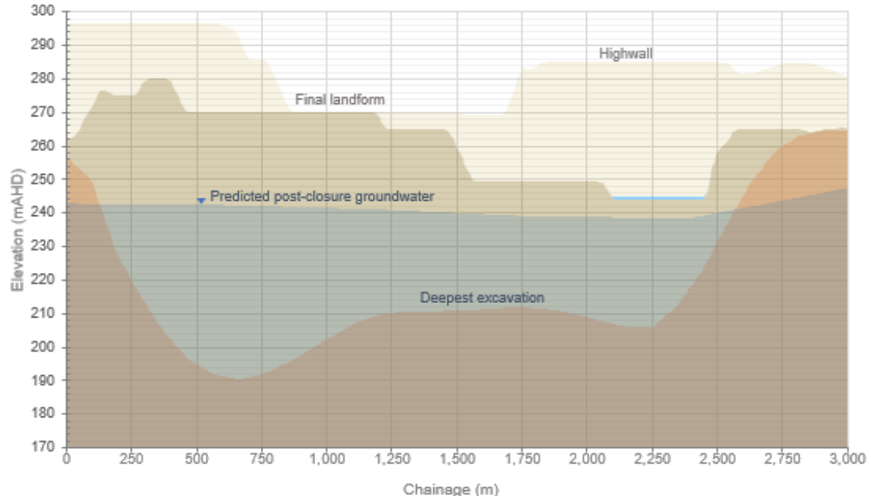
TITLE
REPROFILED VOID DEPRESSION
DATASHEET - WOLEEBEE CREEK

PROJECT No.
DX70080A09

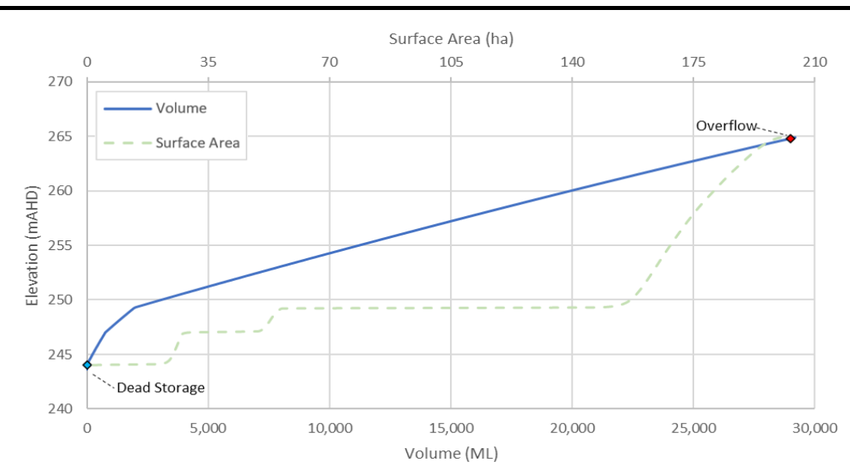
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 243.6mAHD.
Initial water level within Woleebee was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Woleebee is 264.9mRL, with flows directed north-westerly towards Woleebee Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining from year 22 to 37 in ML 50230.
Adopted closure start date in year 38 of operation

Catchment area (ha)	995.8
Overflow level (mAHD)	264.9
Base of reprofiled void depression (mAHD)	243.6
Full supply volume (FSV)	29,176.0
Depth to overflow (m)	21.3

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: COAL ASSETS AUSTRALIA — GLENCORE

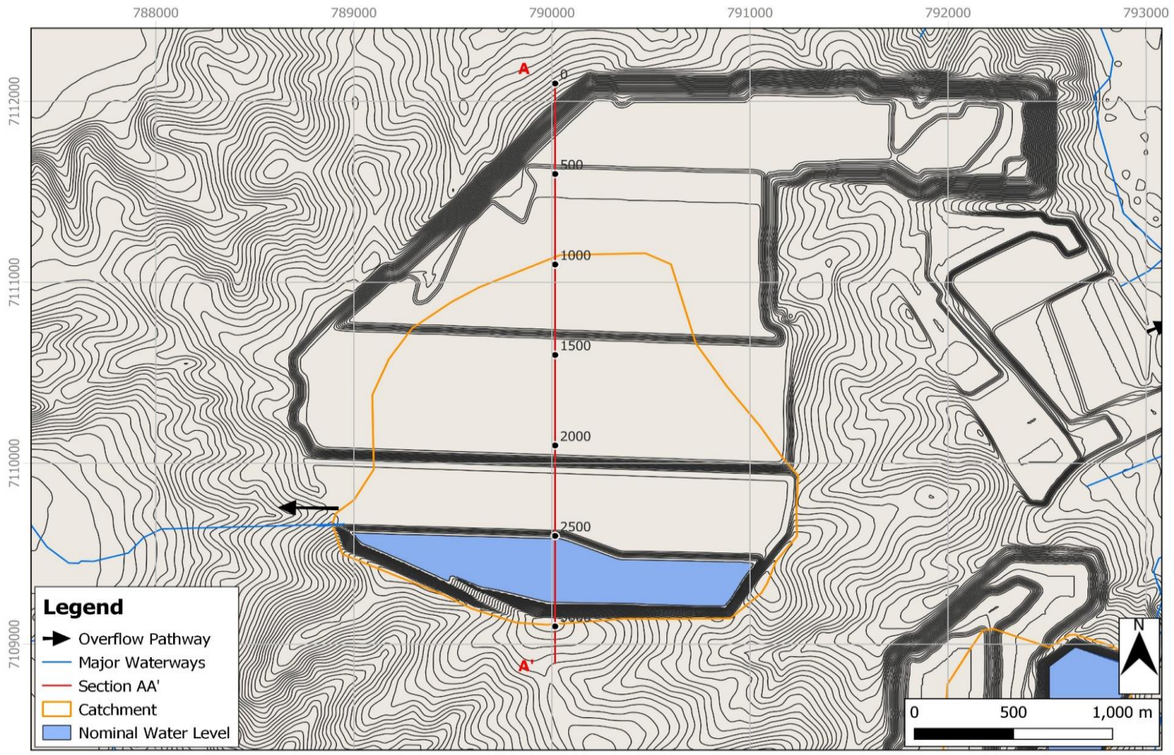
Klohn Crippen Berger

PROJECT: WANDOAN COAL PROJECT PRCP WATER BALANCE MODEL

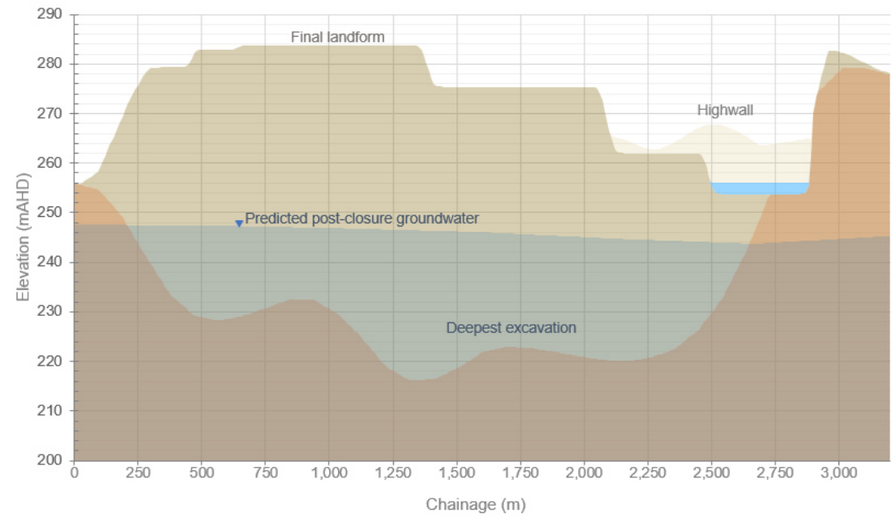
TITLE: REPROFILED VOID DEPRESSION DATASHEET - WOLEEBEE

PROJECT No.: DX70080A09

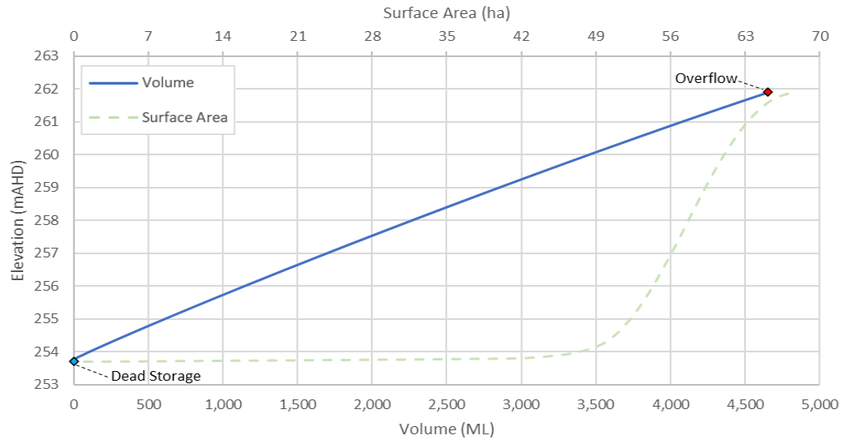
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 253.7mAHD.
Initial water level within Austinvale was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Austinvale is 261.9mRL, with flows directed westerly towards Woleebee Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining from year 0 to 20 in ML 50230.
Adopted closure start date in year 21 of operation

Catchment area (ha)	349.7
Overflow level (mAHD)	261.9
Base of reprofiled void depression (mAHD)	253.7
Full supply volume (FSV)	4,654.0
Depth to overflow (m)	8.2

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
COAL ASSETS AUSTRALIA
GLENCORE

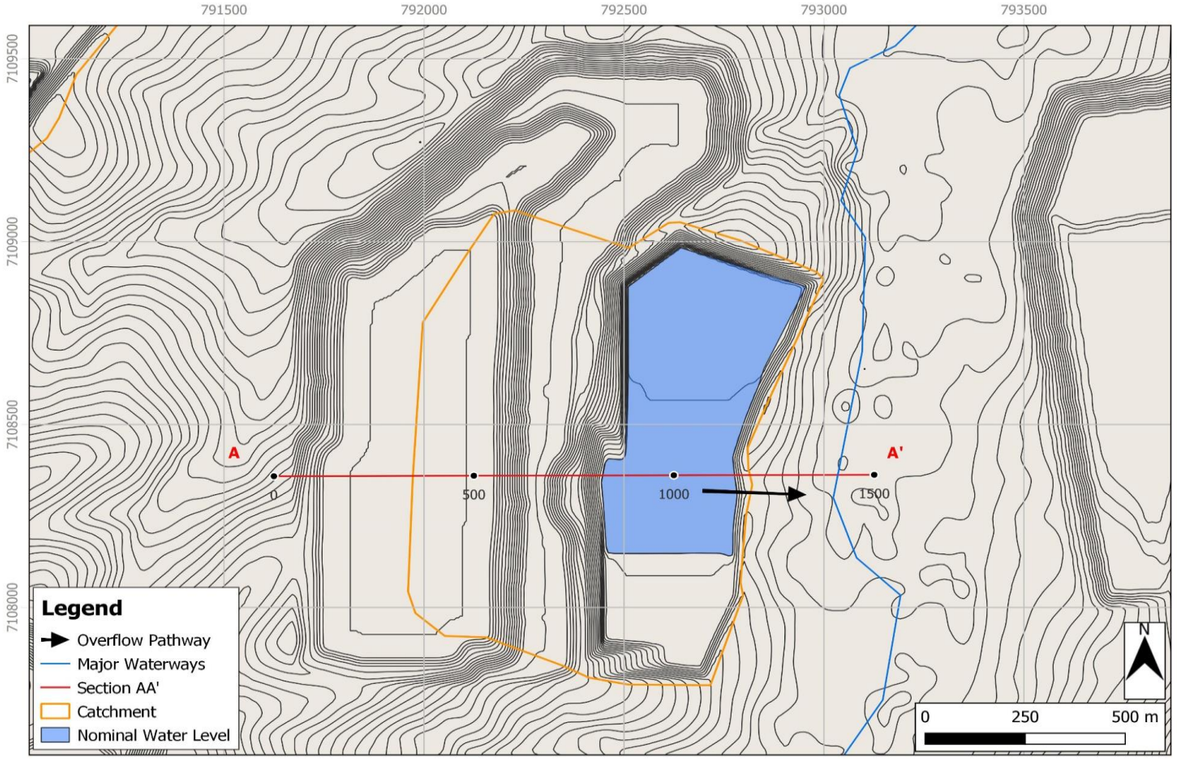
Klohn Crippen Berger

PROJECT
WANDOAN COAL PROJECT PRC
WATER BALANCE STUDY

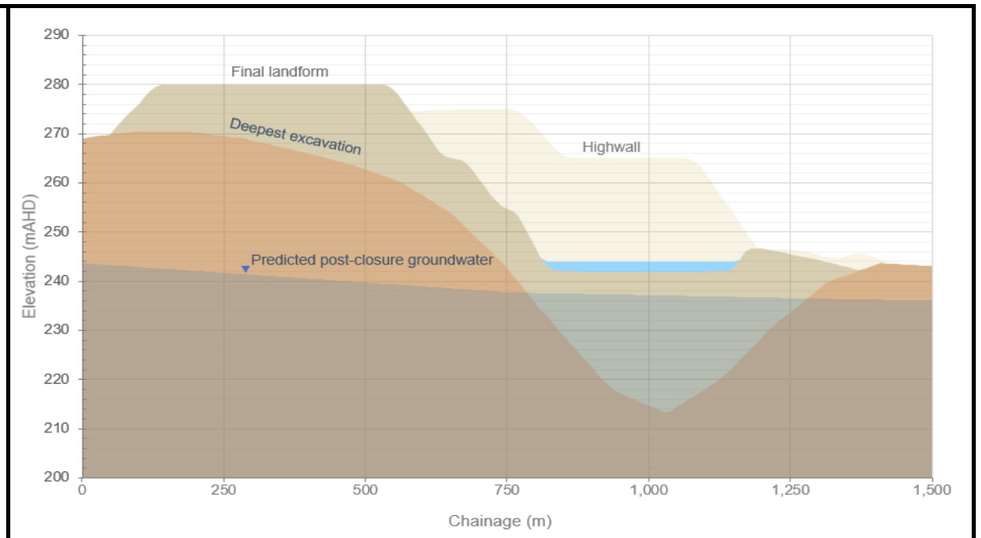
TITLE
REPROFILED VOID DEPRESSION
DATASHEET - AUSTINVALE

PROJECT No.
DX70080A09

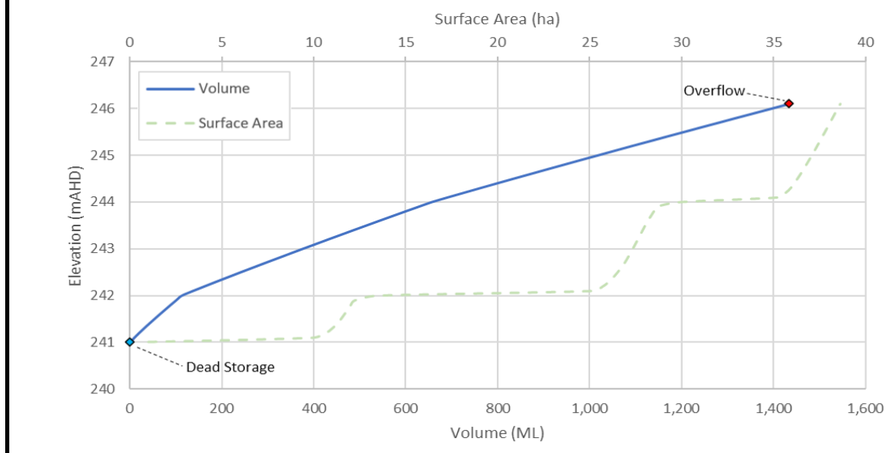
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 241.0mAHD.
Initial water level within Frank Creek was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Frank Creek is 246.1mRL, with flows directed easterly towards Frank Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining in year 0 in ML 50230.
Adopted closure start date in year 1 of operation

Catchment area (ha)	100.5
Overflow level (mAHD)	246.1
Base of reprofiled void depression (mAHD)	241.0
Full supply volume (FSV)	1434.0
Depth to overflow (m)	5.1

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
COAL ASSETS AUSTRALIA
GLENCORE

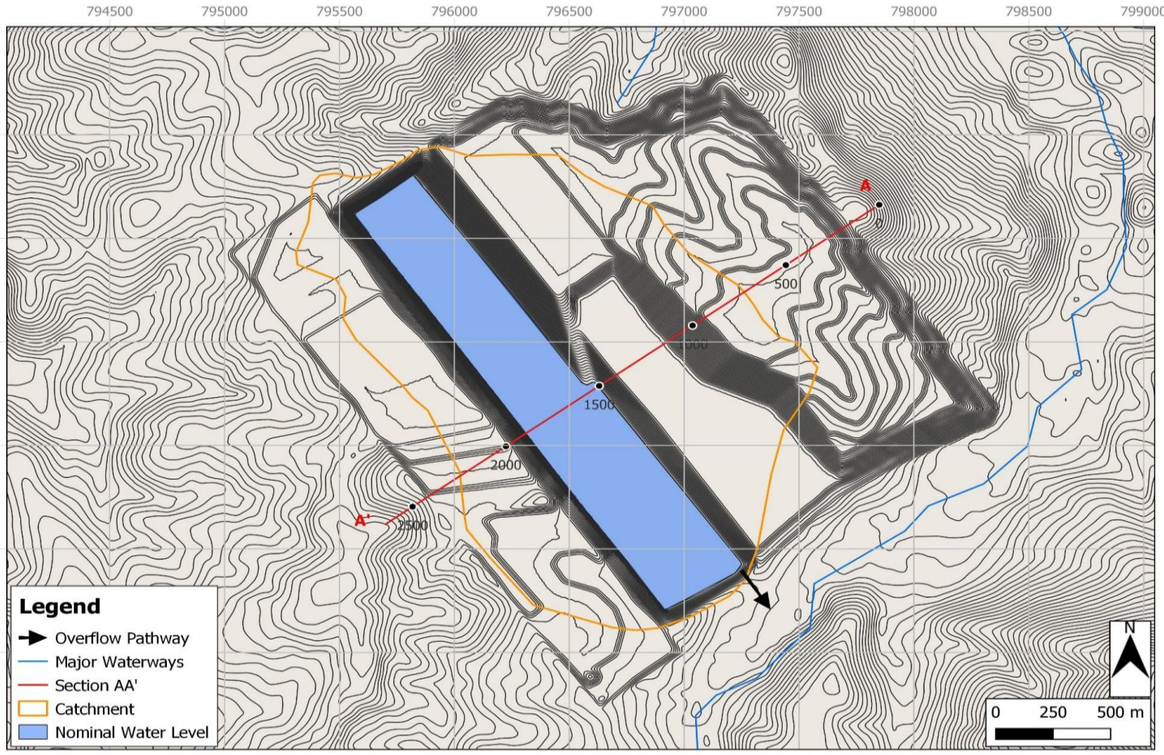
Klohn Crippen Berger

PROJECT
WANDOAN COAL PROJECT PRCP
WATER BALANCE MODEL

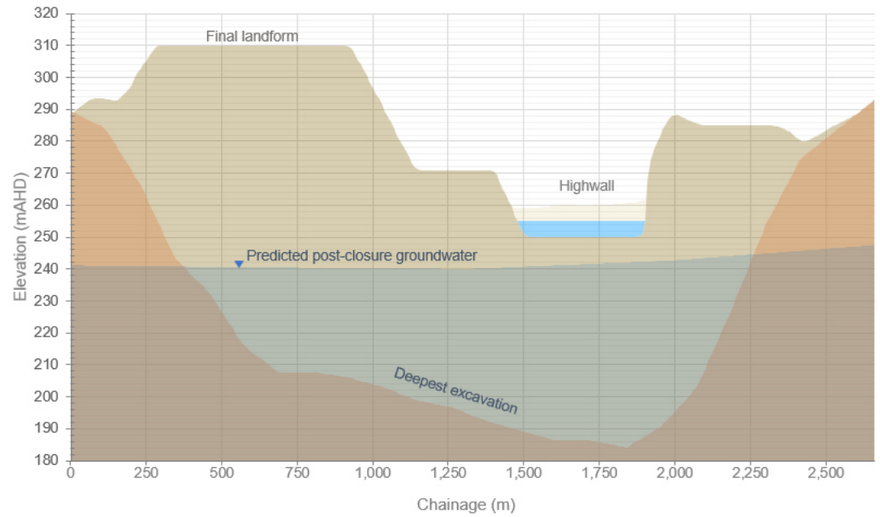
TITLE
REPROFILED VOID DEPRESSION
DATASHEET - FRANK CREEK

PROJECT No.
DX70080A09

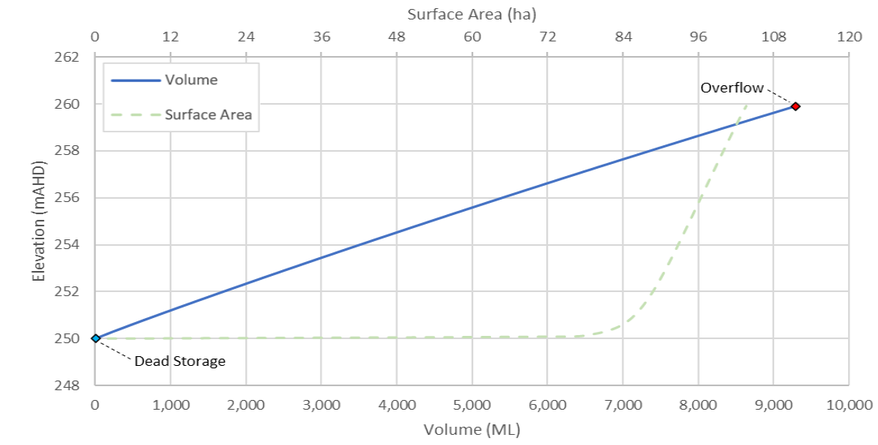
Locality and Catchment Plan



Cross Section AA'



Stage Storage Curve



Notes

Locality and Catchment Plan, Cross Section AA' and Stage Storage Curve

Lowest base level for the reprofiled void depression was measured at a nominal elevation of 250mAHD.
Initial water level within Wubugal was assumed empty at the start of the simulation.
Lowest elevation at which surface water would overflow from Wubugal at 259.9mRL, with flows directed south-easterly towards Two Mile Creek.
Highwall areas labeled in Cross Section AA' are not located on the plan sections, but would be visible looking perpendicular to the section line.
Mining from year 70 to 71 in ML 50230.
Adopted closure start date in year 72 of operation

Catchment area (ha)	324.9
Overflow level (mAHD)	259.9
Base of reprofiled void depression (mAHD)	250.0
Full supply volume (FSV)	9,295.0
Depth to overflow (m)	9.9

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICAITON OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: COAL ASSETS AUSTRALIA — GLENCORE

Klohn Crippen Berger

PROJECT: WANDOAN COAL PROJECT PRCP WATER BALANCE MODEL

TITLE: REPROFILED VOID DEPRESSION DATASHEET - WUBAGUL

PROJECT No.: DX70080A09

APPENDIX III

Predicted post-closure depth to water

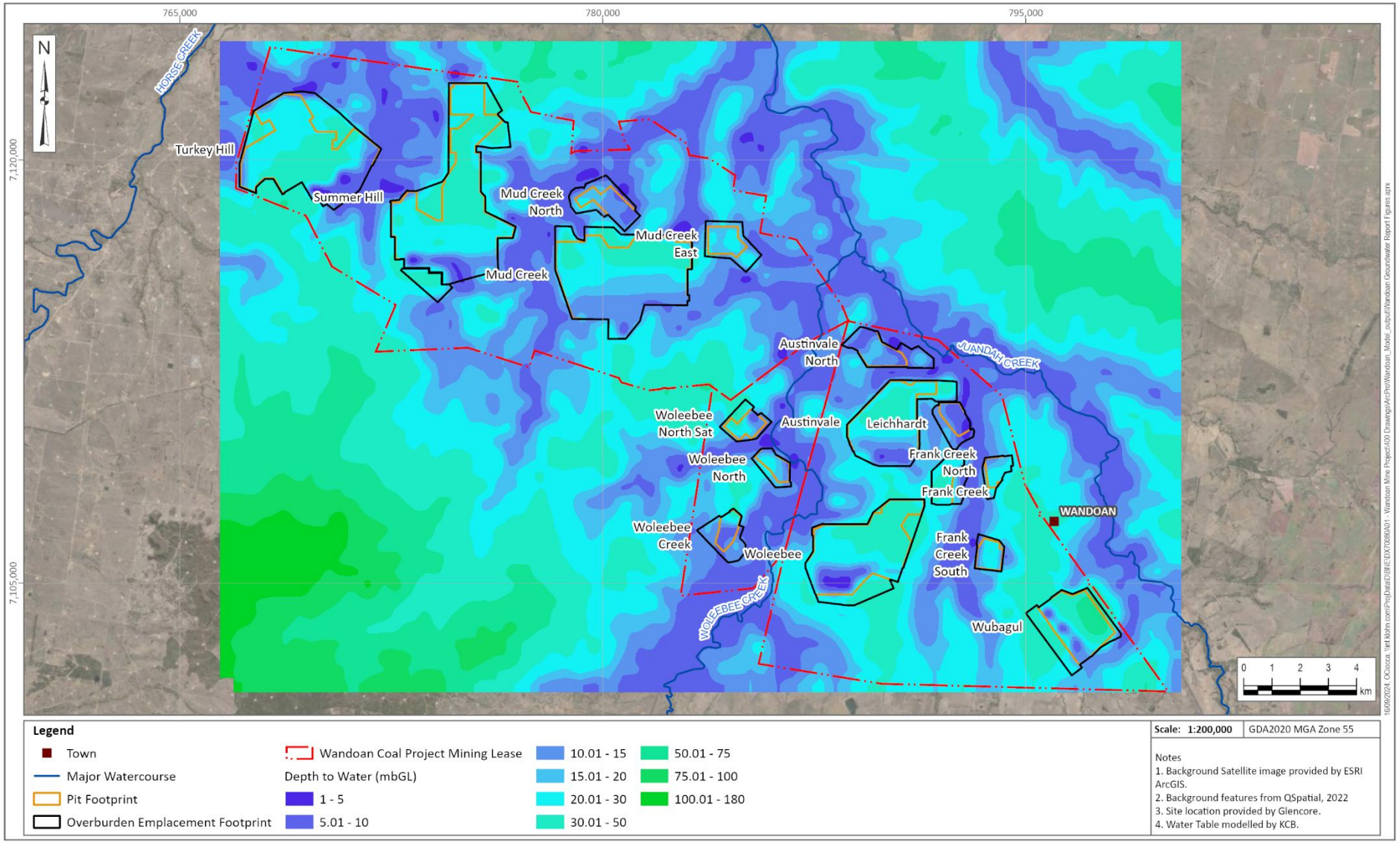


Figure III.1 Predicted depth to water – 500 years post-closure (KCB 2025a)

APPENDIX IV

Cattle consumption

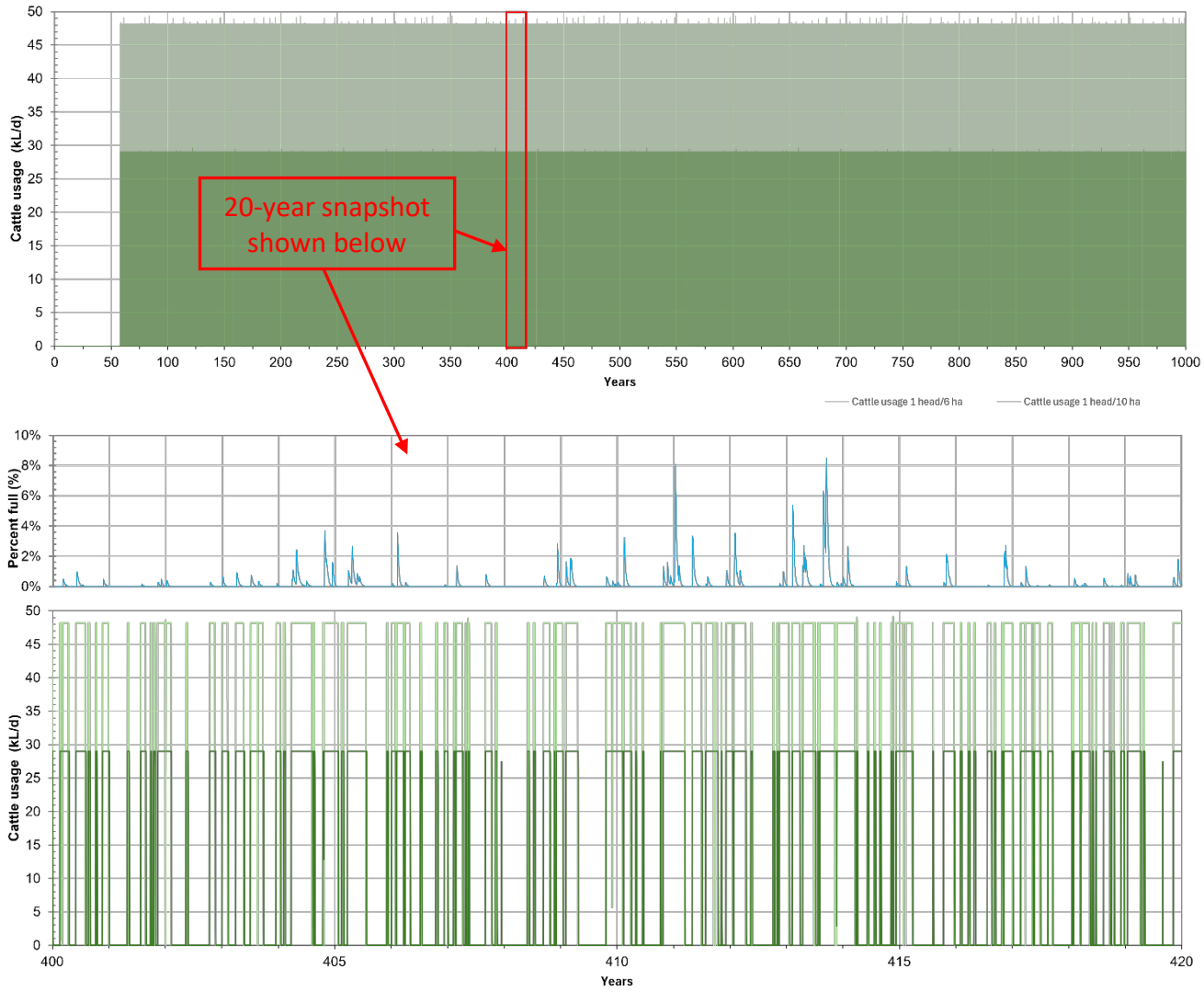


Figure IV.1 Summer Hill cattle consumption

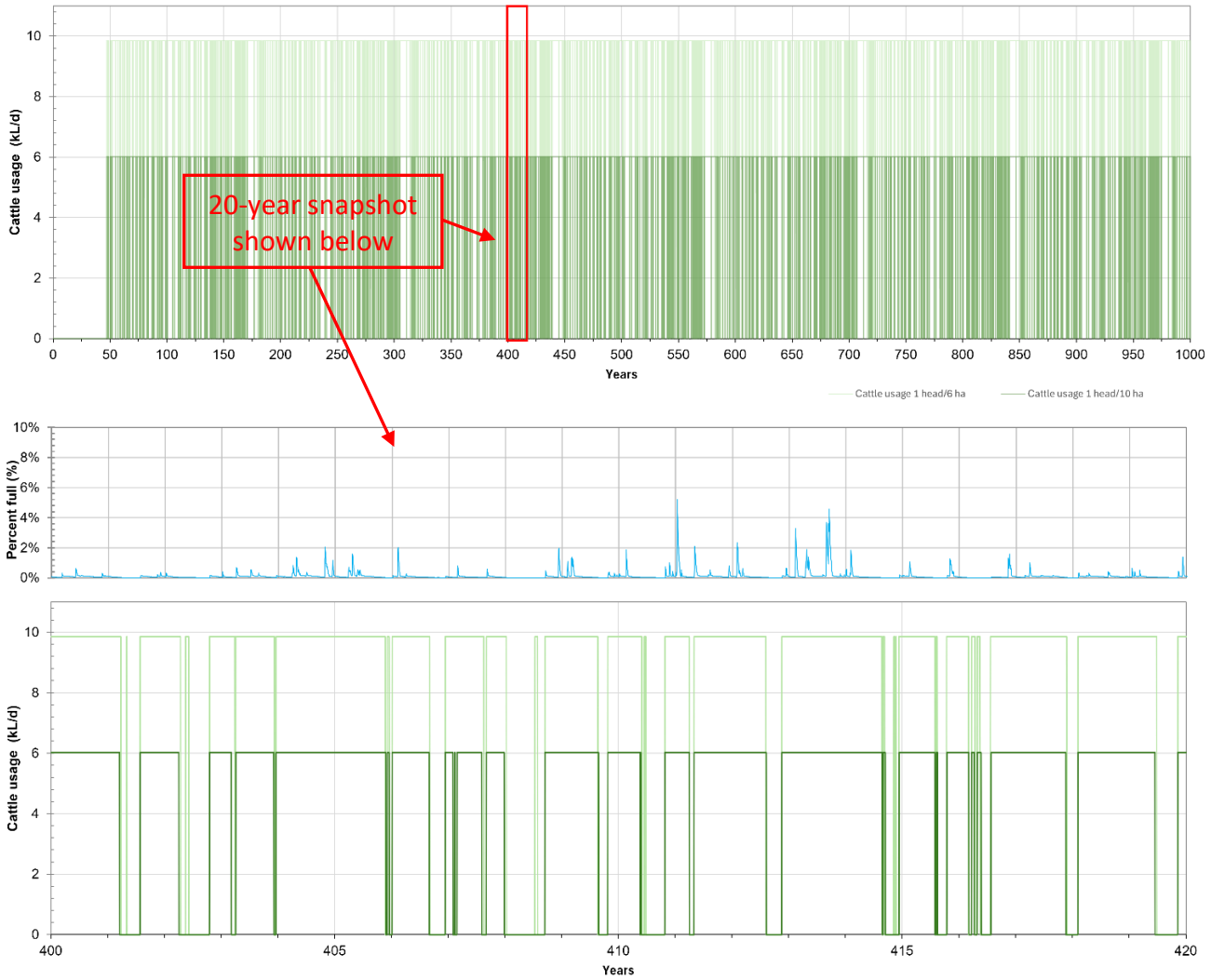


Figure IV.2 Mud Creek cattle consumption

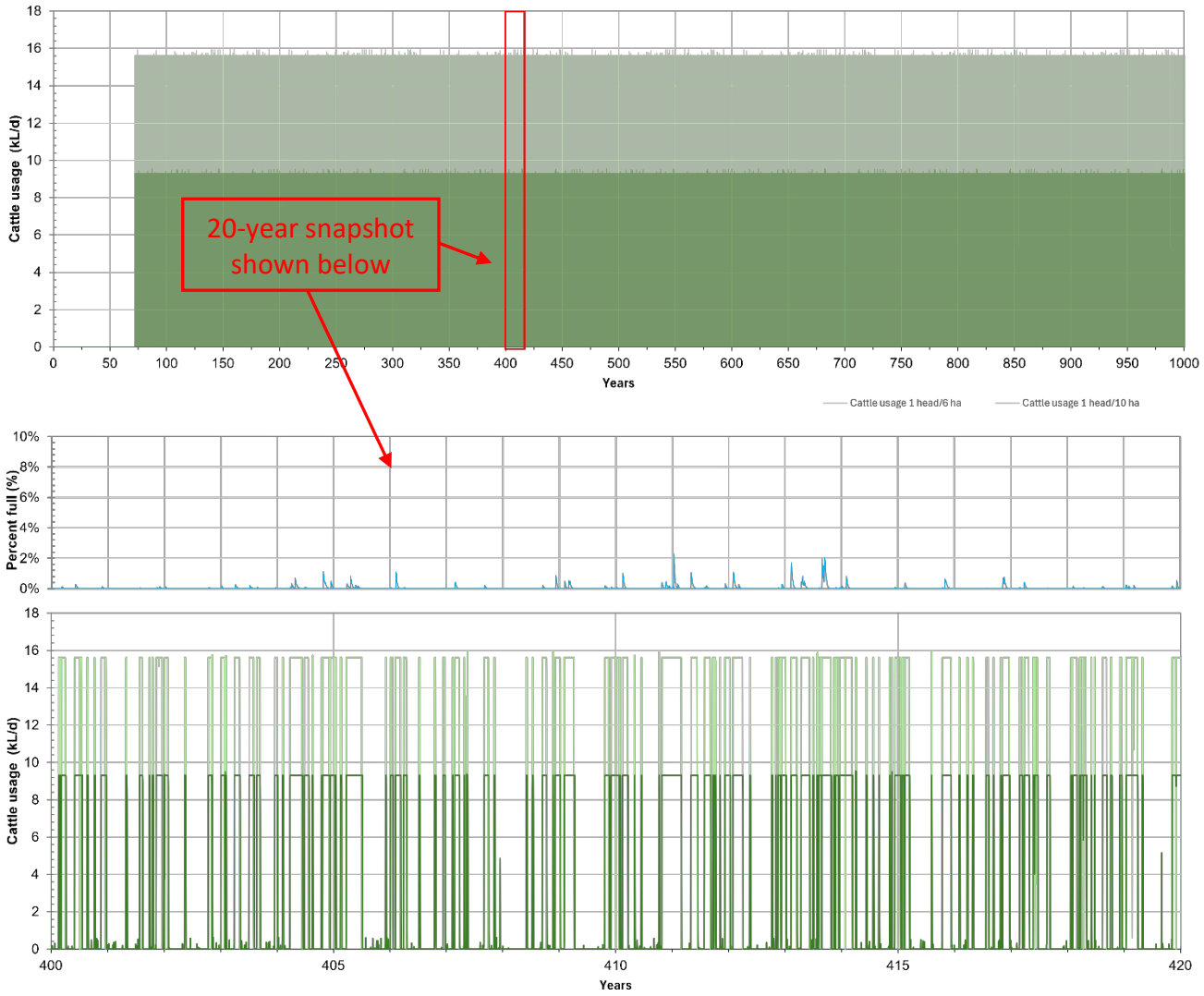


Figure IV.3 Woleebee North Satellite cattle consumption

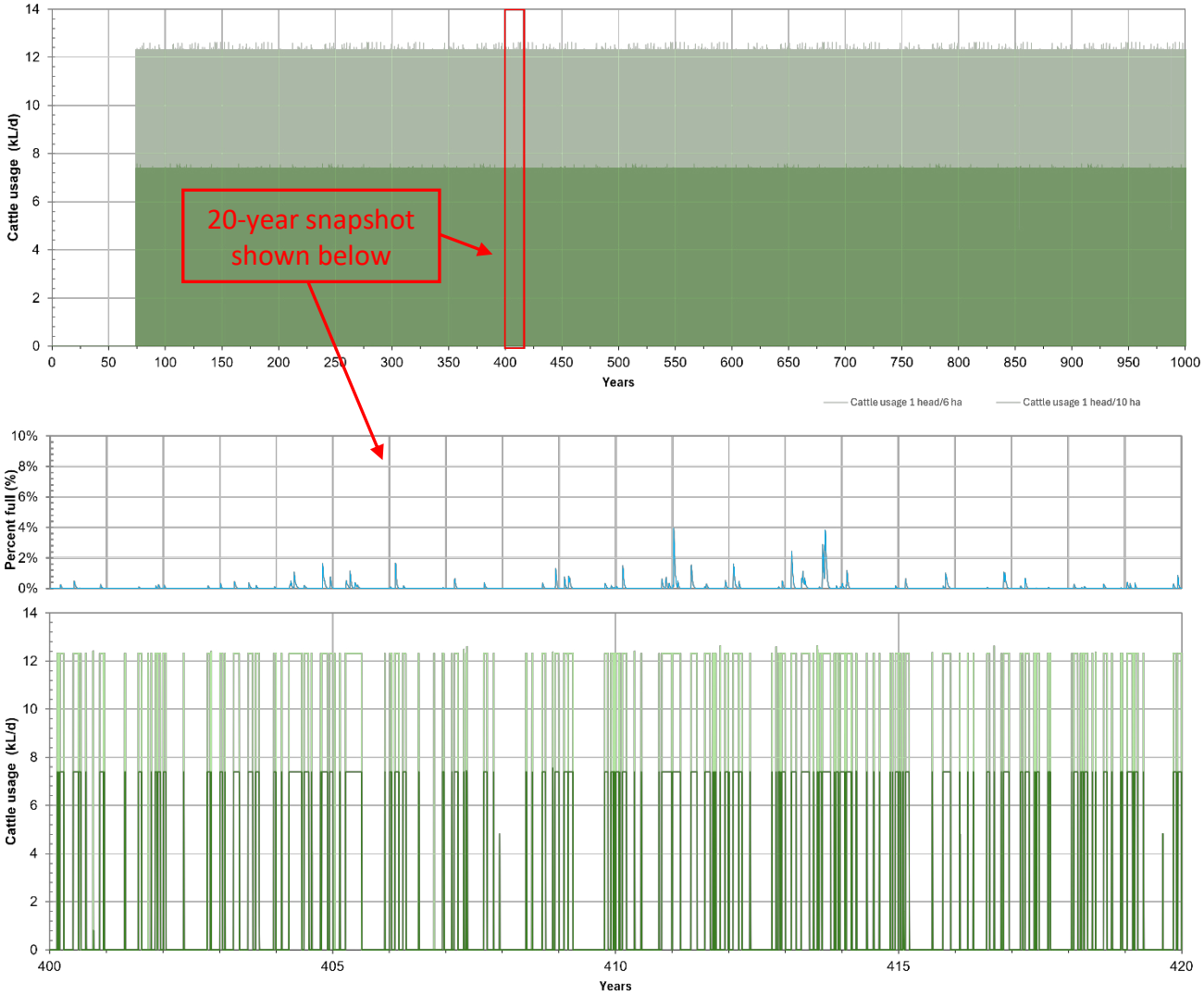


Figure IV.4 Woleebee Creek cattle consumption

Figure IV.5 Woleebee cattle consumption

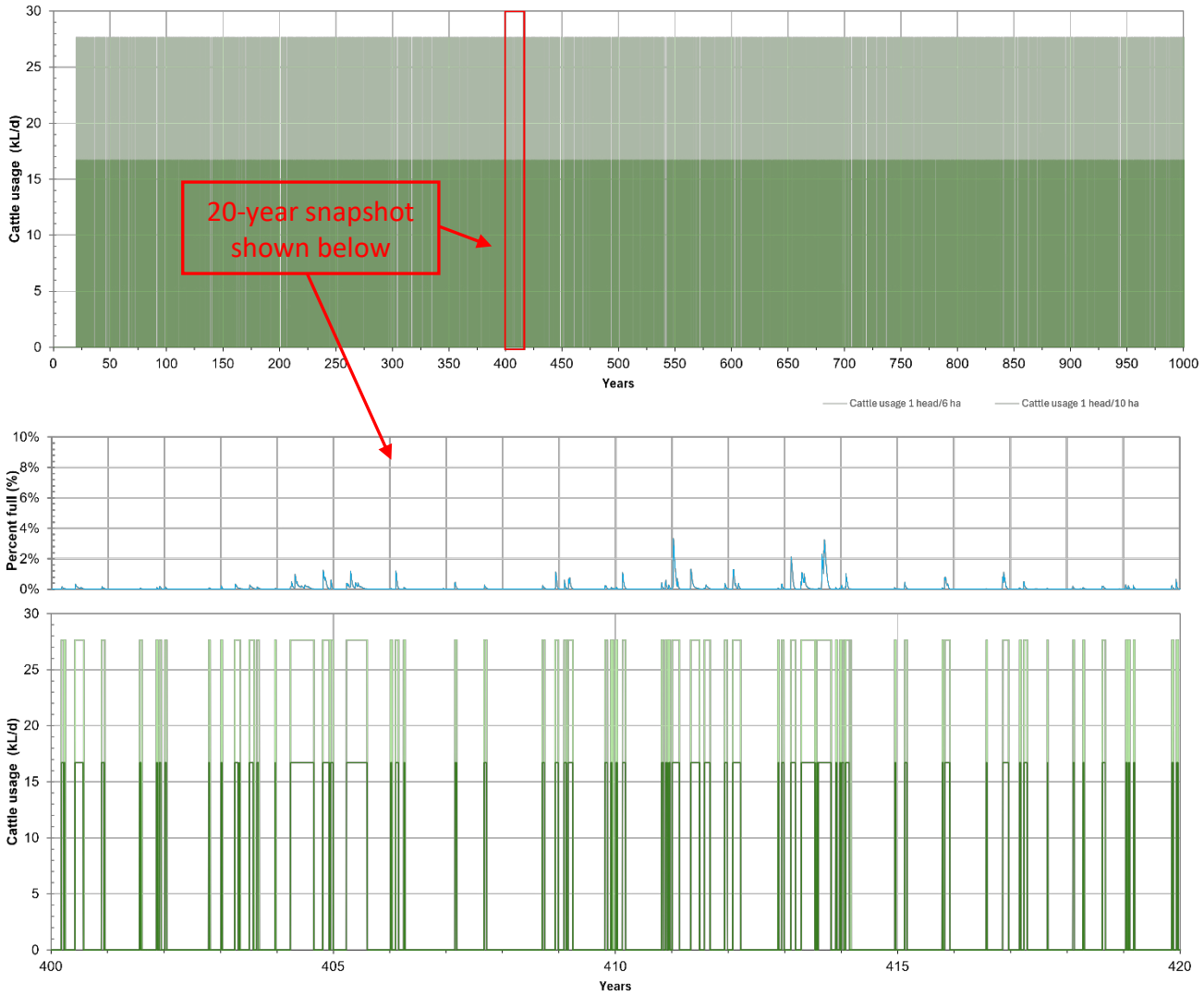


Figure IV.6 Austinvale cattle consumption

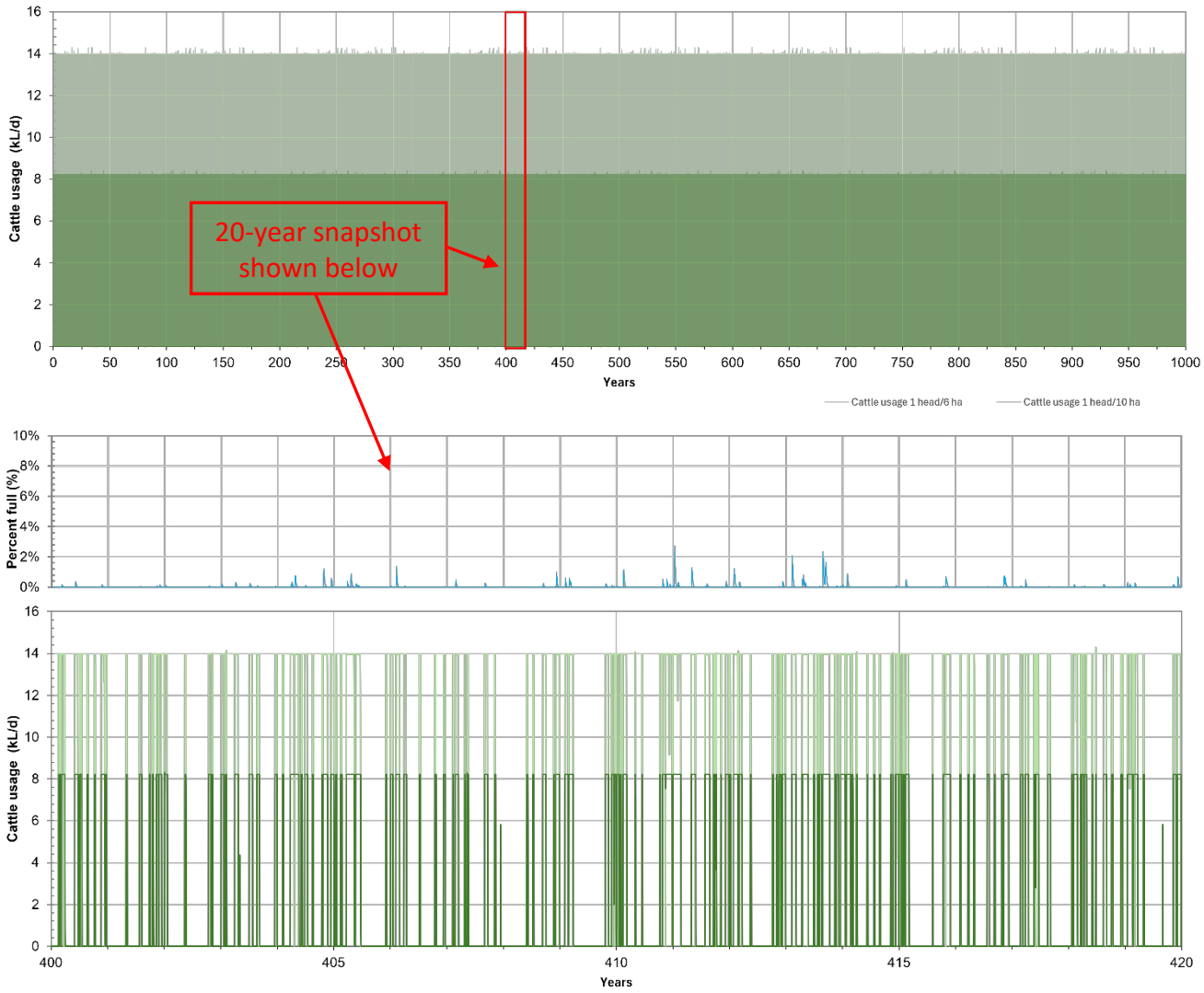


Figure IV.7 Frank Creek cattle consumption

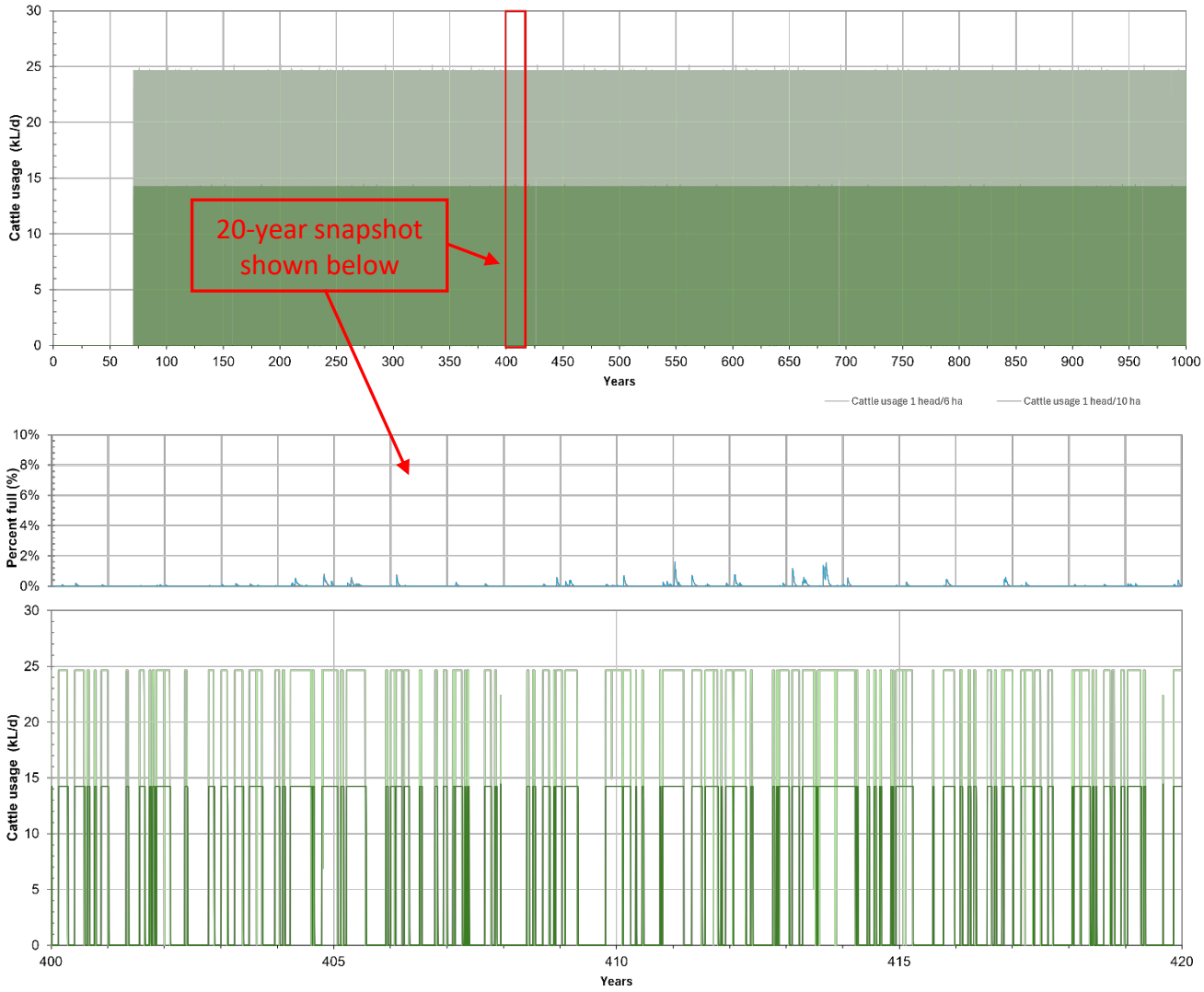


Figure IV.8 Wubagul cattle consumption

APPENDIX V

DETSI RFI response

Table V.1 DETSI RFI comments

Item	PRCP plan / schedule	Issue	Required information	KCB response
5	Reprofiled void depressions	Table 6.1 of Appendix I shows depth of reprofiled void depressions as difference between voids base and max water level. This should be maximum water depth and not maximum void depth.	For reprofiled void depressions, update Table 6.1 of Appendix I to: a) Rename the column titled as "Maximum depth (m)" to "Maximum Water depth (m)"; and b) Clarify maximum void depth.	*Table 6.1 has been updated to differentiate between maximum void and water depths with definitions added to the notes.*
22	Reprofiled voids depressions	Water in eight reprofiled voids are proposed to be used by cattle opportunistically and when total dissolved salinity (TDS) is less than 4,000mg/L. As per Appendix I, salinity of water in those voids can be higher than cattle consumption suitable limits (>4000 mg/L) due to catchment run-off and low water volume. Appendix I also states that salinity will not accumulate over time "as salt is lost via infiltration and cattle water supply appears to offset salt mass inflow from runoff inflows." The high salinity peaks have also been attributed to inherent nature of mass balance modelling approach and that it may not occur to such an extent in practice. Further details are required about: 1) Probability of scenarios when salinity levels will be high; 2) How cattle access will be limited in those times; and 3) Evidence that salinity peaks are due to nature of water balance model and that in practice it will not occur. This information is required to ensure that reprofiled void depressions will be able to sustain the targeted PMLU of stock watering.	For stock watering PMLU of reprofiled void depressions, provide an updated Rehabilitation Planning Part that will include details about: a) Probability of scenarios when water salinity levels will be high; b) How cattle will be restricted during high salinity levels; and c) Evidence that salinity peaks are due to nature of water balance model and that in practice it will not occur.	*Items a, b and c have been discussed in Sections 6 and 8, with a summary of outcomes as follows:* *a) There is a 1 in 26 and 1 in 125 AEP of salinity levels exceeding the 4,000 mg/L and 5,000 mg/L beef cattle thresholds (respectively) in Austinvale reprofiled void depression.* *b) Alternative water sources, access restrictions, or cattle relocation are viable cattle management options. In addition, the behavior of the waterbodies within the reprofiled void depressions reflects that of nearby existing ephemeral streams and pools, where isolated ponds with elevated salinity are expected to form during low volume periods. These wetting-drying cycles and associated salinity dynamics expected in the of the reprofiled void depressions are consistent with natural conditions.* *For all reprofiled void depressions except Mud Creek, the reprofiled void depressions are expected to be used as supplementary supply when available for beef cattle water needs. The water supply from the reprofiled voids is during the wet season only (when there is a waterbody within the reprofiled void depression). Alternative water sources such as off-stream tanks and troughs would be used for cattle grazing with alternative water*

Item	PRCP plan / schedule	Issue	Required information	KCB response
				sources already being used in the dry season (as streams are ephemeral). c) *Modelled salinity spikes occurred when water levels in the reprofiled void depression were low. These elevated concentrations are a result of the mass balance modelling approach, which assumes all salts remain dissolved, leading to conservative—potentially overstated—estimates during low-volume periods. In reality, salts are likely to precipitate and form crusts as water recedes, meaning actual salinity levels are expected to be lower than modelled.*
23	Mud Creek retention of vegetation	As per section 5.5 of PRC plan, 8 reprofiled void depressions will be ephemeral in nature. However, "*For Mud Creek, the reprofiled void depression is expected to be able to sustain a waterbody for longer, with the cyclic filling and emptying expected to occur over larger periods of time (i.e., up to decades), because of the smaller, tiered base areas.*" In addition to providing details required in IR item 23 above, further details are also required about implications of longer water retention on vegetation regrowth.	For Mud Creek Void, provide details about impacts of longer water retention on vegetation regrowth. Noting the longer retention period, the modelled water quality results will also help determine its suitability for stock watering.	*The potential impact of longer water retention on vegetation growth within the Mud Creek reprofiled void depression has been discussed in Section 6. Plant species selection should align with the hydrological environment, which are expected to support enhanced root development, improved plant establishment, and increased species diversity.* *The suitability of Mud Creek reprofiled void depression for stock watering has been discussed in Section 7. The extended water retention within this reprofiled void depression is expected to improve cattle supply, with Mud Creek being the only depression where the maximum modelled water availability is expected to meet the maximum cattle demand (1 head/6ha and 1 head/10ha) consistently over the full 1,000 years modelled.*

Erosion Risk Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia Pty Ltd

Level 23, 300 George Street, Brisbane QLD 4000

Prepared by:

SLR Consulting Australia

1/25 River Street, Mackay QLD 4740, Australia

SLR Project No.: 626.30100.00000

27 October 2025

Revision: 3.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
2.0	11 July 2024	Ashraf Khalifa	Brad Radloff Helena Howell	Peter Smith
3.0	27 October 2025 (IR)	Ashraf Khalifa	Greg Maddocks	Helena Howell

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Glencore Coal Assets Australia Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) on behalf of the joint venture partners to undertake a landform erosion assessment of the Wandoan Coal Project (WCP) to support the preparation of a Progressive Rehabilitation and Closure Plan (PRCP).

The landform erosion assessment has been undertaken in accordance with the Queensland Department of Environment, Tourism, Science and Innovation (DETSI) PRCP Guideline (ESR/2019/4964 v3.01). The landform erosion assessment utilises the advanced Watershed Erosion Prediction Project (WEPP) modelling to analyse the stability of the proposed landform and to predict the average annual soil loss over the hillslopes of the proposed landform.

Parameter inputs to the WEPP model included soil and subsoil physiochemical characteristics from field investigations at the WCP site, over 100 years of local daily climate data, vegetation cover scenarios, and multiple slope gradient scenarios as authorised under the WCP Environmental Authority (EA) EPML00297613.

Slope gradient scenarios proposed in the PRCP landform, and provided as inputs to the WEPP model (within the ranges authorised under the EA) include:

- Highwall weathered zones of 0 - 22 %;
- Low walls of 0 - 22 %; and
- External batters of recontoured spoil areas of 0 - 18 %.

The model was run to compute annual soil erosion rates across multiple slope gradients and lengths under various vegetation cover scenarios representing the post mining land uses (PMLU) of grazing and native bushland. The vegetation cover scenarios used to represent the pasture cover for grazing were bare, 30 % grass cover, 75 % grass cover and for a native bushland were 30 % canopy cover with 60 % grass cover. Slope grades and slope lengths were optimised for each material type and the landform design updated through multiple iterations to deliver a proposed stable PRCP landform.

Landform erosion modelling predicted an increase in erosion rates with increasing slope gradients however, a reduction in erosion rates was observed in areas with higher levels of vegetative cover. Although the post-mining land uses (PMLUs) of grazing and native bushland differ in their vegetative composition, both were found to be equally effective in reducing erosion rates by approximately 90 % across all modelled slope and soil type scenarios. Furthermore, a range of management strategies can be implemented during rehabilitation to mitigate erosion until sufficient vegetation cover is established including seeding for a cover crop which provides fast vegetation cover.

For a grazing PMLU, erosion modelling predicts an erosion rate of 6.4 tonnes per hectare per year (t/ha/yr) on 90 % of the landform (i.e. slopes up to 10 % with a 100 m slope length) once rehabilitation is established (after three years) and 75 % vegetation cover is achieved. Over the long term, it is expected that this erosion rate will be offset by natural soil genesis processes, primarily driven by the accumulation of organic matter and microbial activity.

Similarly, for a native bushland PMLU and slopes of up to 22 %, modelling indicates a maximum erosion rate of 19 t/ha/yr within 10 years when canopy cover and grass cover are at 30 % and 60 % respectively and is expected to continue to decrease as vegetation continues to mature. This rate is conservatively applied to 1.2 % of the landform. There are variations in soil loss rates due to the erosivity of the different soil types. Whilst modelling shows minor variations in erosion rates between the topsoil types available, modelling concluded that a minimum cover depth of 100 mm will be required to ensure that predicted erosion rates remain in equilibrium with soil genesis.

Based on the WEPP modelling outputs, the slope gradient scenarios proposed in the PRCP landform and authorised under the EA, deliver a landform that is stable to erosion when the relevant vegetation cover and 100 m slope lengths are achieved upon the proposed topsoil cover.

Table of Contents

Basis of Report ..... **ii**

Executive Summary ..... **iii**

Acronyms and Abbreviations ..... **vi**

1.0 Introduction **1**

1.1 Project Overview 1

1.2 Project Description 1

2.0 PRCP guideline requirements **5**

3.0 Site Characteristics **6**

3.1 Topography 6

3.2 Climate 6

3.3 Landform design specification 7

3.4 Landform Cover Materials 13

3.4.1 Topsoil 13

3.4.2 Subsoils 13

4.0 Numerical Modelling Methods **16**

4.1 Water Erosion Prediction Project (WEPP) Model 16

4.2 SIBERIA 17

5.0 Numerical Modelling Inputs **18**

5.1 Climate input file 18

5.2 Cover material input files 18

5.2.1 Soil input data source 18

5.2.2 Subsoil input data source 19

5.3 Landform Slope Design Input File 19

5.4 Surface Roughness and Vegetation Cover Input File 20

5.5 Erodibility Parameters 20

5.5.1 Published Parameters 20

5.5.2 Local and Regional Survey Data 20

5.6 Model Calibration and Validation 21

6.0 Numerical Modelling Results **23**

7.0 Numerical Modelling Discussion **32**

7.1 Landform Design 32

7.2 Erosion risk 33

7.3 Rill and Gully Erosion (soil loss) 34

9.0 Disclaimer **36**
10.0 References **37**

Tables in Text

Table 2-1: PRCP Guideline Soil Erosion Assessment Requirements 5
Table 3-1: Proposed landform slope analysis for WCP 7
Table 3-2: Proposed PRCP landform approximate highwall specifications 9
Table 5-1: Summary of the climate data for the selected station 18
Table 5-2: Soil samples and their properties and WEPP input files 22
Table 6-1: Soil loss rates due to erosion according to predictions using the WEPP model under various scenarios of slope and vegetation cover percentage. 24
Table 7-1 Maximum average erosion rates from modelling on proposed landform slopes after PMLU vegetation establishes. 33

Figures in Text

Figure 1-1: Project regional location 3
Figure 1-2 Proposed PRCP and EA Approved project site layout 4
Figure 3-1: Monthly average rainfall, maximum and minimum temperature at WCP 6
Figure 3-2 WCP conceptual highwall profile 8
Figure 3-3: Proposed landform elevations 10
Figure 3-4: The WCP proposed landform slope analysis 11
Figure 3-5 Proposed PMLUs 12
Figure 3-6 Soil associations across the WCP MLs 14
Figure 3-7 2008 soil sampling and test pit locations (PB 2008) 15
Figure 6-1: The average annual soil loss on different slopes and vegetation cover % for the soil types under investigation in the WCP area. 29
Figure 6-2: The average annual soil loss across various slopes with relevant PMLU vegetation coverage for the soil types under investigation in the WCP area. 31

Appendices

Appendix A RGS (2024): Multi-element results for mine materials from the Wandoan Coal Project

Acronyms and Abbreviations

AEP	Annual Exceedance Probability (rainstorms data)
AHD	Australian Height Datum used for altitude measurement in Australia.
AMD	Acid Mine Drainage
AS	Australian Standards
CEC	Cation Exchange Capacity provides a measure of the mass of exchangeable cations (Ca, Mg, Na and K) in a sample.
CHPP	Coal Handling and Processing Plant
DEM	Digital Elevation Model
DNRM	Department of Natural Resources and Mines
EA	Environmental Authority
EAg	Emmerson Aggregate
EC	Electrical Conductivity, expressed as µS/cm.
ESP	Exchangeable Sodium Percentage provides a measure of the sodicity of a material and propensity to erode.
GCAA	Glencore Coal Assets Australia Pty Ltd
K	Soil/spoil erodibility factor
K_i	Inter-rill erodibility factor
K_r	Rill erodibility factor
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
LRA	Land Resource Area
MIA	Mine Infrastructure Area
ML	Mining Lease
MLA	Mining Lease Application.
Mtpa	Million tonnes per annum
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NUMA	Non-Use Management Area
O.C%	Organic Carbon Percentage
O.M%	Organic Matter Percentage
PB	Parsons Brinckerhoff
pH	A measure of hydrogen ion (H^+) concentration.
PMLU	Post Mining Land Use
PRCP	Progressive Rehabilitation and Closure Plan
PSD	Particle Size Distribution.
R-factor	Rainfall/Runoff Erosivity factor
ROM	Run Of Mine
RUSLE	Revised Universal Soil Loss Equation
SILO	Scientific Information for Land Owners

AEP	Annual Exceedance Probability (rainstorms data)
SLR	SLR Consulting Australia Pty Ltd
τ	Shear stress (N/m^2)
$\tau\chi$	Soil critical hydraulic shear strength (N/m^2)
TSS	Total Suspended Solids is a measurement of the suspended solids concentration in a water sample.
WCP	Wandoan Coal Project
WEPP	Water Erosion Prediction Project

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) on behalf of the joint venture partners to undertake the erosion assessment to support the preparation of the Wandoan Coal Project (WCP) Progressive Rehabilitation and Closure Plan (PRCP).

The WCP was issued with environmental approvals by the State and Commonwealth Governments between 2011 and 2013 with mining leases granted in 2017. As such, the Department of Environment, Tourism, Science and Innovation (DETSI) issued a notice for a transitional PRCP to be prepared in accordance with the PRCP Guideline (ESR/2019/4964 v3.01). The transitional PRCP was submitted to DETSI on the 27 September 2024. In response to an information request (IR) received from DETSI on 30 May 2025 the PRCP was subsequently updated and resubmitted on 5 December 2025.

This erosion assessment has been prepared for the WCP PRCP to address the requirements of Sections 3.1, 3.3 and 3.6.1 of the PRCP Guideline (ESR/2019/4964 v3.01).

1.1 Project Overview

The WCP is authorised under Environmental Authority (EA) EPML00297613 on mining leases (MLs) 50229, 50230 and 50231 encompassing 30,068 hectares (ha). The WCP is located approximately 300 kilometres (km) southeast of Emerald and 250 km southwest of Gladstone in the Western Downs region of Queensland. The MLs extend approximately 34 km in an east-west direction and 22 km in a north-south direction (Figure 1-1).

The WCP remains a greenfield project that has not progressed to construction or operational execution. The project is currently in the conceptual design and planning phase, and as such, the level of technical detail and supporting assessments, including the erosion assessment presented in this report, are appropriate to this early stage of project development. At this stage, modelling is intended to inform and optimise the conceptual landform design and to demonstrate, in principle, that a stable post-mining landform can be achieved. Detailed calibration and validation will be undertaken during later project phases once site-specific empirical data becomes available, consistent with the adaptive and progressive nature of mine rehabilitation planning under the PRCP Guideline and section 111A of the EP Act.

1.2 Project Description

The current mine plan as described herein, meets the EA approval conditions for the site (Figure 1-2). Approximately 17,005 ha of the MLs will be used for mining operations. The mine plan supporting the PRCP contains 16 open cut mining pits designed to meet current approval conditions with:

- A mining rate of 4 to 12 million tonnes per annum (Mtpa) ROM coal until 2105;
- Disturbance areas within the approved pit, overburden emplacement, haul road, access roads and tracks and, dam and infrastructure footprints;
- A coal handling and preparation plant (CHPP) with associated coal handling, tailings dewatering facilities and ROM stockpiles;
- A mine infrastructure area (MIA) that includes workshops, washdown facilities, service bays, administration offices and bathhouses;
- Raw and mine affected water storages;

- All mining designed outside the 0.1 % Annual Exceedance Probability (AEP) flood levels;
- Post mining land use (PMLU) of predominantly grazing with areas of native bushland;
- No non-use management areas (NUMAs);
- Pit backfilling in 8 pits to be free draining with no depressions;
- Reprofiled void depressions in the remaining 8 pits to be ≥ 5 m above the long-term groundwater level with ephemeral non-permanent surface water bodies in the base; and
- Dry stacking methods and encapsulation with overburden emplacements for tailings, rejects and materials with spontaneous combustion risk.

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 1-1
REGIONAL LOCATION

LEGEND

- Town/City
- Highway
- Watercourse
- Wandoan Coal Project Mining Leases
- Protected Area

Service Layer Credits:
Department of Resources, DESI, Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 25 50 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,500,000 at A4
Project Number:	626.30100.00800
Date Drawn:	29-Aug-2024
Drawn by:	AS

SLR

Path: \\au.slr.local\Corporate\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F01-1 Regional Location

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 1-2
THE WCP SITE LAYOUT

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek
K Road
Kaburnga Road
Number Four Road
M One Road
Juandah Creek
M Two Road
Number Two Road
Walshs Road
Nathan Road
ML 50229
Turkey Hill
Ryals Road
Summer Hill
Mud Creek North
Booral Road
Mud Creek East
Mud Creek
Cecils Road
Q Road
Austinvale North
Leichhardt Highway
Woleebee Creek
Grosmont Road
Bundi Road
Woleebee Creek North 2
Austinvale
Leichhardt
Tip Road
Dillons Road
McAllisters Road
Bundi Two Road
L Road
Woleebee Creek North
Frank Creek North
ML 50231
Frank Creek
Roche Creek Road
WANDOAN
Woleebee Creek
Jackson Wandoan Road
Woleebee
Nelders Road
Frank Creek South
Peakes Road
Wubagul
Paradise Downs Road
ML 50230
Weldons Road
Burunga Lane

LEGEND

- Town/City
- Watercourse
- Road
- Rail Loop
- Conveyor
- Wandoan Coal Project Mining Leases
- EA Authorised Disturbance Footprint
- MIA
- CHPP
- ROM Pad
- Dam
- Haul Road
- Haul Road Extension
- Power Station
- Pit (PRCP)
- Dump (PRCP)
- Pit (EA Approved)
- Dump (EA Approved)

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	15-Oct-2025
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F02-2 The WCP Site Layout

2.0 PRCP guideline requirements

Section 3.1, 3.6.1 and 3.6.3 of the PRCP Guideline (ESR/2019/4964 v3.01) outlines the requirements to provide baseline information relating to land stability (pre-existing land degradation/ erosion and predisposition to ongoing stability issues) and an erosion assessment to inform the proposed landform design.

Table 2-1 summarises the erosion assessment requirements from the PRCP Guideline (ESR/2019/4964 v3.01).

Table 2-1: PRCP Guideline Soil Erosion Assessment Requirements

Requirement	Comments
Section 3.1 Project Planning	
Provide baseline information relating to land stability, including pre-existing land degradation/erosion and predisposition to ongoing stability issues.	• Baseline information related to the soils and subsoils of the WCP area is provided in **Sections 3.4 and 5.2** of this report.
Section 3.6.1 General Rehabilitation Practices	
Undertake an erosion assessment to determine landform heights, gradients, profiles and material placement.	• **Sections 5.0, 6.0 and 7.0** provide details on the erosion assessment for the WCP area including input files, results and discussion on the WCP PRCP slope profile design considering the interactions between soil erodibility, rainfall erosivity, landform height, gradient and vegetation cover to identify acceptable erosion rates over the long-term.
Consideration of the landform design report must include specific landform requirements committed to in stakeholder consultation, mine planning or other sources, which could include rock incorporation, designed flow paths, aesthetic considerations, non-linear batter slopes and targeted placement of materials.	• Ideal slope lengths for soil and subsoils cover materials are provided in **Section 5.3** of this report. • There are no additional specific landform requirements to be addressed.
Section 3.6.3 Voids	
Consider pit wall geotechnical and geochemical stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events.	• **Section 7.1** discusses long term highwall stability with erosion risks managed through the treatment of highwall weathered zones.

3.0 Site Characteristics

3.1 Topography

The land use surrounding the WCP has been influenced by the topography, geology and corresponding soil types. The topography at the WCP consists of two main terrain elements comprising the following:

- Alluvial floodplains of Woleebee Creek, Juandah Creek, Frank Creek, Mud Creek, Spring Creek, and their tributaries. These floodplains vary in width from less than 500 m to about 2 km and generally have a very gentle slope towards the creek channel and downstream, generally less than 2 %. This landscape unit occurs at a reduced level (RL) between approximately 230 m to 250 m Australian height datum (AHD). The floodplains have largely been cleared for agricultural uses, including beef cattle grazing and limited fodder cropping on the floodplain edges. Remnant riparian vegetation is present along the creek lines; and
- Low undulating hills, with an RL of between 250 mAHD and 295 mAHD make up the majority of the WCP ML area. The undulating hills are generally at a higher altitude to the south of the Project area than to the north. The undulating terrain has largely been cleared for agricultural uses, with fodder crops on the flatter gradients, and beef cattle grazing on steeper slopes.

3.2 Climate

The WCP area is categorised as a 'Cfa' climate: a humid subtropical environment with clear seasonal variations of wet summers and dry winters using the Köppen-Geiger climate classification system. The region receives an annual average precipitation of 666 mm/year (Figure 3-1), with heavy rainfall storm events predominating the wet season (SILO | LongPaddock | Queensland Government).

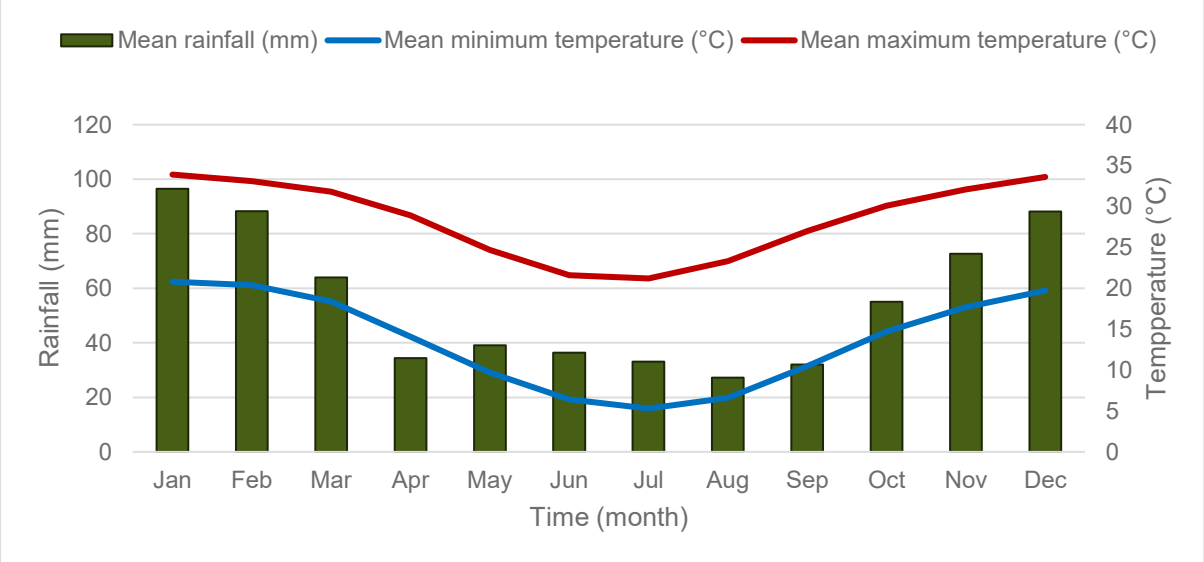


Figure 3-1: Monthly average rainfall, maximum and minimum temperature at WCP

SILO is a database of Australian climate data from 1889 to the present. It draws data from multiple weather stations surrounding the location of interest to deliver the necessary data set for the specified location and Watershed Erosion Prediction Project (WEPP) daily dataset input requirements over time. SILO datasets are constructed from observational records provided

by the Bureau of Meteorology (BOM). SILO interpolates the raw data, which may contain missing values, to derive datasets which are both spatially and temporally complete.

3.3 Landform design specification

In accordance with the current EA approval, the below Table 3-1 presents the approved landform design criteria for WCP including the disturbance type, the PMLU and the percentage of the total area for illustrative purposes.

Table 3-1: Proposed landform slope analysis for WCP

Disturbance Type	Approved PMLU	Proposed PMLU	EA Approved Slope Gradient (%)	Slope Gradient (%)	Total Area (hectare)	Percent of Total Area (%)
Roads and Tracks, Infrastructure and External Batter Recontoured Spoil Areas	Beef cattle grazing, native bushland, plantation forestry or infrastructure is retained for use	Grazing	0 - 10	0 - 5	13,655	80.30
				5 - 10	1,555	9.14
Infrastructure (including ROM areas), Waste Rock Dumps and External Batter Recontoured Spoil Areas	Beef cattle grazing, native bushland, plantation forestry or infrastructure is retained for use	Grazing	0 - 18	10 - 18	1,385	8.14
Residual Voids (low wall recontoured spoil areas)	Beef cattle grazing, native bushland, or plantation forestry	Grazing	0 - 100	18 - 22	198	1.16
Residual Voids (high wall) – weathered zone	Low density beef cattle grazing or native bushland	Native Bushland	0 - 214	0 - 22	174	1.02
Residual Voids (high wall) – unweathered zone	Low density beef cattle grazing or native bushland	Native Bushland	0 - 214	> 22	38	0.22
				Total area of disturbance	**17,005**	**100**

Table 3-1 illustrates the majority of the landform (97.58 %) has a slope that is less than 18 % and aligns with the EA approved slope gradient and PMLU. Low walls make up a total of 1.16 % and align with the EA approved slope gradient of less than 100 % and the EA approved

PMLU. Highwalls account for 1.24 % of the final landform and meet the EA slope requirements and EA approved PMLU.

The proposed WCP landform was provided to SLR as a concept design by the Proponent as .shp and, .dxf files with 1 m contour intervals and is shown in Figure 3-3. Slope gradient analysis was conducted on the area of disturbance within the proposed PRCP landform and shown in Figure 3-4. Figure 3-5 shows the PMLUs of the WCP landform.

Table 3-1 provides the slope analysis of the proposed landform for the planned areas of disturbance. All above slope ranges were used to inform the WEPP model and ensure the resulting landform designs will achieve a stable condition.

An analysis of Table 3-1 verifies that 80 % of the disturbance footprint has a gradient of 0 – 5 %, which encompasses the majority of the site including infrastructure areas, roads, the tops of overburden emplacement areas and the bases of the reprofiled void depressions. 18 % of the proposed landform area has a gradient of 5 - 18 % and includes recontoured external batters of the overburden emplacement areas which have been designed to a maximum slope of 18 %. Recontoured low walls designed to a maximum slope of 22 % comprise a further 1 % of the proposed landform area. These areas are all associated with a PMLU of grazing with all slopes designed within the EA authorisation.

The remaining 1 % of the proposed landform area has a PMLU of Native Bushland with much of the area being < 22 %. These areas are associated with the highwall weathered and some unweathered zones. Only unweathered component highwall slopes have gradients >22 %.

Figure 3-2 below shows the conceptual highwall profile for the proposed landform and consists of two components:

- Remnant unweathered rock highwall slope (red): composed of competent rock with authorised slopes up to 214 %, and heights up to 20 m; and
- Weathered highwall slope (yellow): upper portion of the highwall composed of weathered material which is battered to a maximum slope gradient of 22 %.

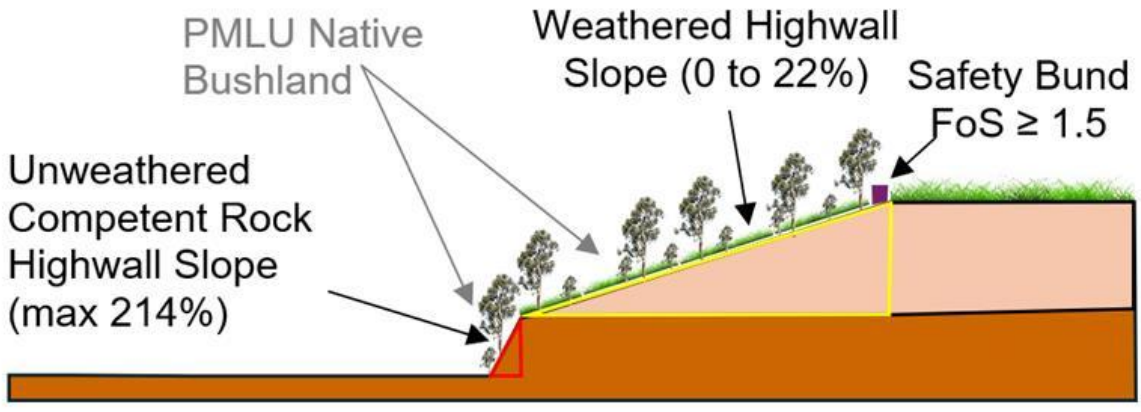


Figure 3-2 WCP conceptual highwall profile

Highwall slopes which are over 22 % only occur on remnant unweathered rock. As these areas are not composed of readily erodible material (i.e. no topsoil or weathered material), they have not been assessed in this erosion assessment report. Separate geotechnical assessments

have been undertaken and have found the unweathered rock highwalls are stable and have a high factor of safety (Appendix L of the WCP PRCP).

Whilst the EA authorises highwall slopes to a maximum gradient of 214 %, the slope gradients and heights proposed in the PRCP landform vary and remain in accordance with the EA approval. The approximate height and slope of unweathered highwalls in the proposed PRCP landform are shown in Table 3-2.

Table 3-2: Proposed PRCP landform approximate highwall specifications

Pit Area	Unweathered Competent Rock Highwall average Height (m)	Unweathered Competent Rock Highwall Authorised Max Slope (%)	Unweathered Competent Rock Highwall Indicative Max Slope (%)
Turkey Hill	8	214	46
Summer Hill	8	214	55
Mud Creek	10	214	45
Mud Creek North	8	214	21
Mud Creek East	No highwall	No highwall	No highwall
Woleebee	20	214	95
Woleebee Creek	2	214	18
Woleebee Creek North	No highwall	No highwall	No highwall
Woleebee Creek North 2	3	214	40
Austinvale	14	214	108
Austinvale North	7.5	214	20
Leichhardt	3	214	15
Frank Creek	5	214	36
Frank Creek North	2	214	12
Frank Creek South	No highwall	No highwall	No highwall
Wubagul	17	214	134

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 3-3
WCP FINAL LANDFORM

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek
Juandah Creek
Woleebee Creek

Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
Austinvale North
Austinvale
Leichhardt
Woleebee Creek North 2
Woleebee Creek North
Woleebee Creek
Frank Creek North
Frank Creek
Frank Creek South
Woleebee
Wubagul
WANDOAN

LEGEND

- Town/City
- Watercourse
- Final Landform Topographic Contour (10mAHD)
- Wandoan Coal Project Mining Leases
- Pit Extent

Final Landform Elevation (mAHD)

- 218 - 230
- 230 - 240
- 240 - 250
- 250 - 260
- 260 - 270
- 270 - 280
- 280 - 290
- 290 - 300
- 300 - 310
- 310 - 320
- 320 - 330
- 330 - 340
- 340 - 350
- 350 - 360
- 360 - 370
- 370 - 380
- 380 - 390
- 390 - 400
- 400 - 410
- 410 - 420

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	626.30100.00800
Date Drawn:	29-Aug-2024
Drawn by:	AS

SLR

Path: \\au.slr.local\Corporate\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F05-14 Final Landform Topography

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Wolfebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 5-4
SLOPE ANALYSIS ON THE WCP PROPOSED FINAL LANDFORM

LEGEND

- Town/City
- Watercourse
- Wandoan Coal Project Mining Leases
- Disturbance Area

Final Landform Slope Gradient (%)

- 0 - 5%
- 5 - 10%
- 10 - 18%
- 18 - 22%
- 22% - Max

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	20-Oct-2025
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F05-03 Slope Analysis

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Woleebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 3-5
POST MINING LAND USE

LEGEND

- Watercourse
- Wandoan Coal Project Mining Leases

Post Mining Land Use

- Grazing
- Native Bushland

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

N 0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	626.30100.00800
Date Drawn:	31-Jul-2025
Drawn by:	AS

SLR

Path: \\au.slr.local\Corporate\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F03-01 Post Mining Land Use

3.4 Landform Cover Materials

3.4.1 Topsoil

The soil characteristics of the Wandoan area as documented in The Atlas of Australian Soils (Northcote et al., 1960-68), identify the soils as predominantly Vertosol, with some minor areas of Sodosol. The Wandoan area soils were categorised under the Map Unit CB3, indicating their geographical distribution within the region and the WCP area (Figure 3-6).

A detailed investigation into the quality of the pre-mining soils was undertaken to support the WCP Environmental Impact Statement (EIS) (Parsons Brinckerhoff (PB), 2008). Forty-one test pits were developed, sampled and analysed for physiochemical attributes (Figure 3-7). Results show that all A1 topsoil horizons were identified as alkaline, except for Juandah which was neutral. The soils were also identified having low to moderate salinity and non-dispersive qualities except for Downfall and Wolleebee.

3.4.2 Subsoils

Subsoils from the Cheshire, Woleebee, Rolleston and Teviot soil units were identified as having moderate to extreme alkalinity and sodicity. All other subsoil within the Brigalow Uplands soil mapping unit were considered dispersive to a lesser extent (PB 2008).

Additional supporting information on the physiochemical properties of subsoil was provided by RGS Environmental (RGS, 2024) (Appendix A). Characterisation results for five selected individual samples of mine materials (composite subsoil and topsoil sample (0 m – 0.6 m), subsoil (0.6 m – 1.7 m), and shallow overburden) indicated that the samples have low salinity, moderate cation exchange capacity (CEC) and low macro-nutrients plant-available phosphorous (P) and potassium (K). These materials were deemed sufficient to support the growth of native bushland but would require supplementing if used as surface soils to support the growth of grazing pastures. The strong alkalinity and moderate to high exchangeable sodium percentage (ESP) values were an artefact of the topsoil/subsoil composite sampling and correlate more with subsoil sampled by PB (2008). Subsoil information was incorporated into the soil input files generated by the WEPP model for this report (Table 5-2) to assess subsoil erodibility.

These topsoil and subsoil characteristics, which represent the potential cover material for rehabilitation and sustainable PMLU establishment, were converted into WEPP inputs using the model's pedo-transfer functions (PTFs), which estimate erodibility and hydraulic parameters from readily available soil data.

Topsoil and subsoil characteristics for the WCP are further detailed in the PRCP Soil Assessment Report.

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Wolegebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 3-6 SOIL DISTRIBUTION ACROSS THE MINING LEASE

LEGEND

- Watercourse
- Wandoan Coal Project Mining Leases

Soil Associations

- Brigalow Upland Cracking Clays
- Brigalow Upland Non-cracking Clays
- Poplar Box Alluvia Texture Contrrast Soil
- Poplar Box Alluvia Uniform Soil

Service Layer Credits:
Earthstar Geographics
Soil Associations, Parsons Brinckerhoff, 2008

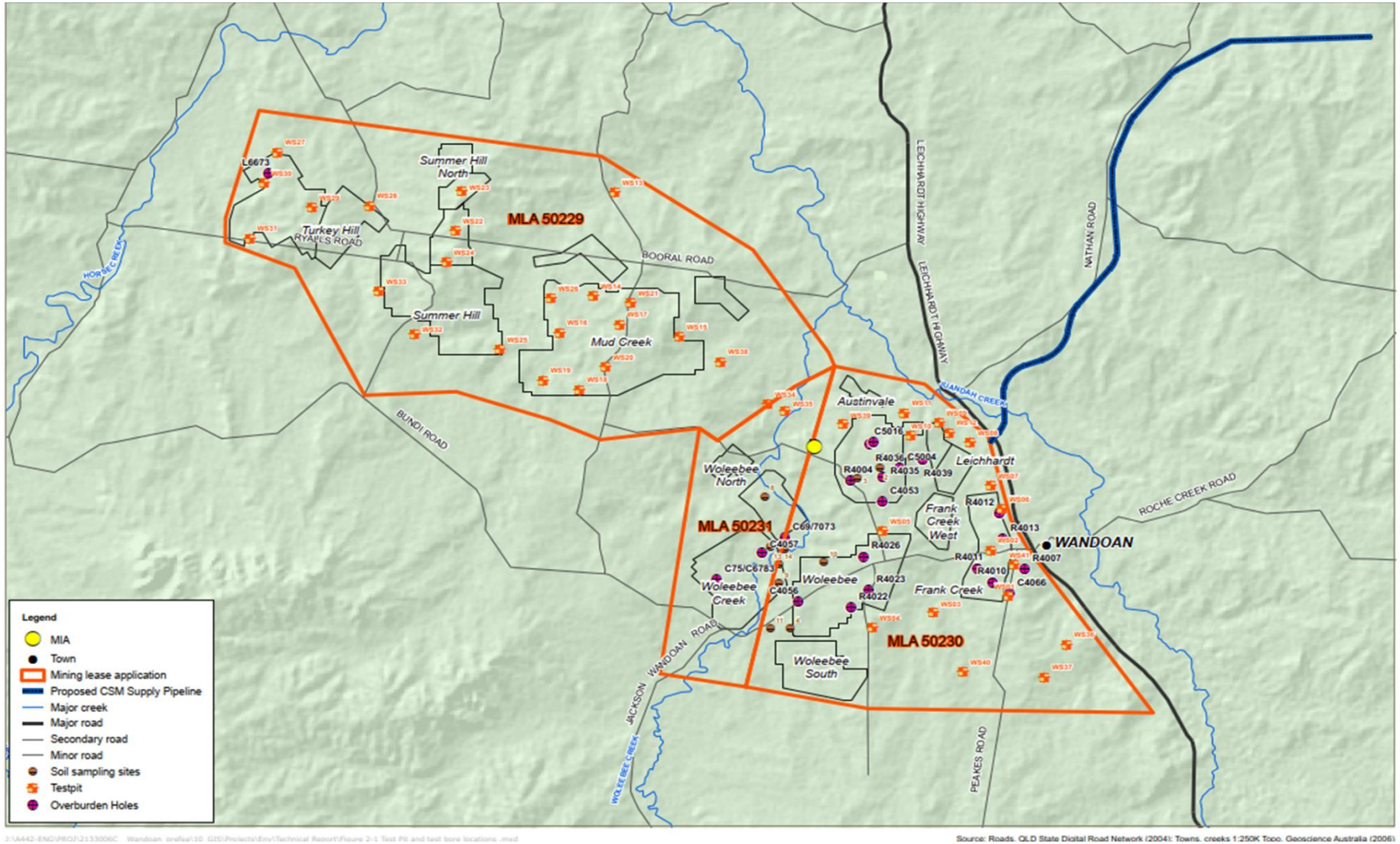
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:110,000 at A4
Project Number:	626.30100.00800
Date Drawn:	29-Aug-2024
Drawn by:	AS

SLR

Path: \\au.slr.local\Corporate\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F02-9 Soil distribution across the Mining Leases



Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006)

Figure 3-7 2008 soil sampling and test pit locations (PB 2008)

4.0 Numerical Modelling Methods

The WEPP model was utilised for the WCP erosion assessment to inform the design of the proposed PRCP landform and assess its ultimate erosional stability. WEPP was selected based on the models' capability to inform landform design by flexibly estimating erosion rates in different soil types, slope grades, slope lengths, vegetation cover percentages and with different remediation treatments (e.g. gypsum amelioration or mulching) at a landform level. The model estimates spatial and temporal distributions of soil loss including net soil loss for an entire hillslope or for defined points on a slope profile using a daily, monthly, or average annual timestep. The WEPP model can be extrapolated to a broad range of conditions (not practical or economical) to evaluate under field conditions. It is considered appropriate for a concept level long-life greenfield landform options analysis with low erosional risk such as at the WCP. The limitations of WEPP and an alternate model SIBERIA are outlined below.

4.1 Water Erosion Prediction Project (WEPP) Model

The United States Department of Agriculture (USDA) WEPP model was selected for the WCP as it provides a practical and reliable assessment of the typical configuration of the proposed landforms.

WEPP provides erosion assessment using the fundamentals of stochastic weather generation, infiltration theory, hydrology, soil physics, plant science, hydraulics, and erosion mechanics. The hillslope or landscape profile application of the model provides major advantages over existing erosion methods including USLE, RUSLE and SIBERIA. SIBERIA is limited to one material type across the entire surface of the landform whereas WEPP can include multiple materials on a single slope.

In watershed applications, the sediment yield from entire landforms can be estimated. Hillslope profile applications compute inter-rill and rill erosion and deposition along selected landscape profiles, while watershed applications also estimate channel erosion and deposition, and deposition in impoundments. The procedures do not consider gully erosion. The WEPP erosion model computes soil loss along a slope and sediment yield at the end of a hillslope. Inter-rill and rill erosion processes are considered. Inter-rill erosion is described as a process of soil detachment by raindrop impact, transport by shallow sheet flow, and sediment delivery to rill channels. Sediment delivery rate to rill flow areas is assumed to be proportional to the product of rainfall intensity and inter-rill runoff rate. Rill erosion is described as a function of the flow's ability to detach sediment, sediment transport capacity, and the existing sediment load in the flow.

Processes considered in hillslope profile model applications include rill and inter-rill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, climate, tillage effects on soil properties, effects of soil random roughness, and contour effects including potential overtopping of contour ridges. The model accommodates the spatial and temporal variability in topography, surface roughness, soil properties, crops, and land use conditions on hillslopes.

The WEPP model requires the following inputs: climate, infiltration, overland flow hydraulics, water balance, plant types and growth, residue decomposition (organic matter), soil chemical and physical parameters (random roughness, oriented roughness, bulk density, wetting-front suction, hydraulic conductivity, inter-rill erodibility, rill erodibility) from measured flume measurements if available), critical shear stress).

WEPP is the most supported erosion model in the USA. Under Australian conditions, Yu et al. (2000) documented that to run the WEPP model with maximum reliability, the model inputs

should incorporate daily climate input, 31 parameters for each crop, 12 for each tillage operation (soil disturbance), 10 for each soil and 22 entries to specify the initial conditions.

In post mining rehabilitation landscapes, the WEPP model is highly effective for use in soil erosion assessments (Howard & Roddy, 2012). The advantages of WEPP in this type of assessment include:

- Predicting erosion that may occur from specific storm events or under rapidly changing conditions.
- Simulating daily or seasonal variations in weather conditions, which can significantly impact erosion processes.
- Accounting for dynamic changes to vegetation cover and management practices over time.

In the instance of a greenfield conceptual landform options analysis such as required for landform generation and erosional assessment at the WCP, WEPP is considered a more appropriate model than SIBERIA. The WEPP model provides the flexibility of being able to model erosion over various slope grades, slope lengths, vegetation covers and material types.

4.2 SIBERIA

The limitations of SIBERIA in informing landform design include the time, cost and inflexibility inherently in the model. For each model run, the model does not allow ready comparison between material types, slope grades, lengths and vegetation cover being the key inputs into concept level landform design.

5.0 Numerical Modelling Inputs

The WEPP model is a process-based model that simulates the interaction of climate, hydrology, soil erodibility, slope length/gradient, and vegetation cover. Its ability to use physically meaningful parameters, stochastic climate input, and multiple slope/cover scenarios makes it particularly suitable for assessing long-term stability of post-mining landscapes.

5.1 Climate input file

The climate input files were generated by SLR using 100 years of climate data from Taroom Office QLD (Station No. 035070), The daily climate data was sourced from SILO | LongPaddock | Queensland Government.

The CLIGEN stochastic weather generator (Yu 2003) utilised in the WEPP model for weather generation produced the climate file, encompassing daily maximum and minimum temperatures, solar radiation, and rainfall details, including distribution parameters. CLIGEN has been widely used and validated in Australia.

Table 5-1: Summary of the climate data for the selected station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
P MEAN	96.5	88.3	64.0	34.4	39.1	36.4	33.1	27.2	32.0	55.0	72.7	88.2	mm
T MAX	33.9	33.1	31.8	28.9	24.7	21.6	21.2	23.3	27.0	30.1	32.1	33.6	°c
T MIN	20.8	20.4	18.4	14.1	9.7	6.4	5.3	6.6	10.5	14.7	17.7	19.7	°c

Average Annual Precipitation	665.8	mm
Average Monthly T Max	28.4	°C
Average Monthly T Min	13.7	°C

5.2 Cover material input files

Two input files (topsoil (A1 horizon) and subsoil) were used for the modelling assessment using data from PB (2008) and from RGS (2024) for topsoil and subsoil inputs, respectively.

5.2.1 Soil input data source

The chemical and physical attributes from 41 test pits developed, sampled and analysed in 2008 (PB, 2008) formed the basis of the soil input file for the model.

The soil characteristics of Wandoan area, documented in The Atlas of Australian Soils (Northcote et al., 1960-68). These soil units were categorised as Vertosols under the Map Unit CB3, indicating their geographical distribution within the region.

The soil mapping conducted as part of the WCP EIS encompassed the following categories within the WCP area:

1 **Brigalow upland cracking clay soils**, which are predominantly found on the mid to lower slopes of undulating hills with gradients ranging from 1 to 4 %. These soils exhibit a dark brown-grey heavy clay texture with blocky peds;

2 **Brigalow Shallow non-cracking uniform clay soils** are present on steeper gradient upper slopes characterised by weathered sandstone. These soils are categorised as Brigalow upland non-cracking clay soils; and

3 **Alluvial soils**: These can be categorised into "Poplar Box Alluvial Texture Contrast" at Retro and Woleebee, and "Poplar Box Alluvial Uniform Soil" at Juandah. The soil composition in the alluvial floodplains associated with Woleebee Creek, Frank Creek, Mud Creek, and Juandah Creek varies in width, ranging from less than 500 m to approximately 2 km.

5.2.2 Subsoil input data source

The RGS (2024) data was used to collate a subsoil input file using data obtained from the Wandoan Bulk Pit Sample (WBPS), collected from the proposed Austinvale pit area from depths of 0.6 m - 1.7 m. Laboratory analyses revealed that this subsoil layer has a high ESP value (c. 26 %), making it prone to dispersion and increasing the risk of soil erosion. This file was created to model erosion rates reflective of subsoil use as a cover material and to identify any limiting factors to its use, such as slope grade and length. It is also likely to be indicative of the material found in the weathered zone of the highwalls proposed to be battered back to an angle of up to 22 % and free dig weathered overburden in the mining areas.

Key criteria applied to the input files to estimate soil erodibility using the methods by Flanagan and Nearing (1995) include the following input parameters:

- Measured, pH, Electrical Conductivity (EC), organic matter, textural analysis of the < 2 mm soil fraction, CEC (Table 5-2);
- The soil albedo was calculated using the Baumer equation: soil albedo = 0.6/e(0.4*ORGMAT) where ORGMAT is the percentage of organic material content;
- The soil density for the existing soil clay/clay loam textured soil was 1,330 kg/m^3;
- There was no allowance for soil formation in the model file that occurs at or within the surface of the soil horizon through accumulation and decomposition of organic matter and crucially through the full extent of the root zone; and
- The soil input file does not include soil water characteristics, full particle size distribution e.g. < 75 mm samples, measured hydraulic conductivity or soil erodibility (k_{factor}).

5.3 Landform Slope Design Input File

The slope input files for modelling, encompassing physical land features such as slope length, slope steepness and aspect, were created using the WEPP software to model the following:

- All soil type inputs with a range of slopes with gradients of 10, 14, 16.6, 18, 20, 22, and 25 %, with a vertical slope length of 100 m; and
- Subsoil input with a range of slopes with gradients of 10, 14, 16.6, 18, 20, 22, and 25 %, with a vertical slope length of 50 m - 70 m.

The following aspects were utilised to develop the landform slope input criteria and the WEPP input file:

- Slope analysis of the proposed concept level constructed mine landform designs;
- The geotechnical properties of the overburden and interburden (Golder, 2008);
- Proposed landform designs that include reduced slope angles that will be optimised by backfilling mined open pits and using low out of pit landform elevations of 5 m - 25 m above pre-mine topography.

5.4 Surface Roughness and Vegetation Cover Input File

Surface roughness was set to 30 mm, which is typical of a smooth surface that would develop after iterative rainfall events. This assumption is based on the geotechnical analysis by Golder (2008) and stability analyses by RGS (2003). In practice, areas of respread topsoil will be ripped prior to seeding in the wet season increasing initial bare soil and early vegetation establishment surface roughness beyond the assumed parameters.

For the vegetation/management input files, four different scenarios were generated:

- Bare unconsolidated soil;
- 30 % vegetation cover (grasses) on the landform;
- 75 % vegetation cover (grasses) on the landform to represent the PMLU of grazing; and
- 30 % Tree/shrub canopy cover with 60 % grass cover on the landform to represent the PMLU of Native Bushland. The vegetation cover (bushland) scenario has been modelled to consider vegetation that is characteristic of local native bushland growing on representative slopes within the project area. It is assumed this vegetation scenario will be achieved 10 years after rehabilitation has been completed.

5.5 Erodibility Parameters

Erodibility parameters for WEPP (interrill erodibility *Ki*, rill erodibility *Kr*, critical shear stress τ_c, and effective hydraulic conductivity *Ke*) were derived using a combination of published parameters for Queensland soils and local and regional soil survey data.

5.5.1 Published Parameters

Published parameter databases for Queensland soils includes data on 46 soil samples and 47 spoil materials collected from 16 open-cut coal mines in Central Queensland. (Yu, 2000; Sheridan, 2001, Khalifa, 2010; Howard & Roddy, 2012; So et al., 2018), which provide regionally validated WEPP parameter sets for similar soil orders (Dermosols, Kurosols, and Rudosols). The primary dataset applied in this study was that of Khalifa (2010), who extended the earlier work of Sheridan et al. (2000a) by validating and substantially expanding the soil and spoil database from central Queensland coal mines. In addition to the 34 samples originally assessed by Sheridan, Khalifa incorporated 93 additional samples (46 soils and 47 spoils) from six further coal mines, creating a more comprehensive and regionally representative dataset. The expanded database embedded in the numerical model enhanced the characterisation of the physical and chemical properties of soils and spoils and incorporated both measured and estimated values of the key WEPP erodibility parameters (Ki, Kr, τc, and Ke), thereby strengthening its application in erosion modelling and post-mining landform stability assessment.

5.5.2 Local and Regional Survey Data

Soil survey data and mapping from the site and surrounding region (Table 5.2, Section 5.2.1 and 5.2.2), which identified typical soil types and spoil materials (e.g. sodic clays, texture-contrast soils). These properties were then converted into WEPP inputs using the model's pedotransfer functions (PTFs), which estimate erodibility and hydraulic parameters from readily available soil data.

This approach ensures that parameterisation is representative of local soils and consistent with values used in other Queensland rehabilitation studies.

5.6 Model Calibration and Validation

Direct field calibration (e.g. rainfall simulator or runoff plot data) was not available for this site as it is a greenfield operation and there are no field results available. Calibration of the WEPP model was achieved by:

- Cross-checking predicted soil loss rates with published ranges for equivalent land uses and soils in the region (e.g. 5 - 15 t/ha/yr under grazed pasture, 10 - 30 t/ha/yr under cropping, as reported in Queensland soil conservation studies);
- Comparison with modelled results from nearby mines where measured erosion data were available. These showed that predicted WEPP erosion rates for 10 – 22 % slopes with <70 % cover were consistent with observed erosion ranges (20 - 50 t/ha/yr) during early rehabilitation phases; and
- Sensitivity testing for the model, where key parameters (Ki, Kr, τc) were varied within expected ranges to confirm that model outputs were robust and not unduly sensitive to small parameter changes.

Regional datasets, cross-site calibration, and published erosion benchmarks provided were utilised to provide a robust validation framework.

Table 5-2: Soil samples and their properties and WEPP input files

Soil Association		Sample ID	Material type	Particle Size Distribution					Texture Class	pH	EC (dS/m)	O.M%	*C.E.C (cmol(+) /kg)	Soil Albedo
				(%) C.SAND	(%) F.SAND	(%) Sand	(%) SILT	(%) CLAY <2µm						
Brigalow upland cracking clay	**Teviot**	C258	Topsoil	18.4	31.6	50.0	10.2	39.8	Sandy Clay	7.8	0.13	2.1	24.1	0.26
		C258	Subsoil	12.0	29.0	41.0	18.0	41.0	Clay	7.9	0.82	1.1	22.7	0.39
	Rolleston	R330	Topsoil	5.1	22.2	27.3	11.1	61.6	Clay	8.3	0.12	2.6	36.0	0.21
		R330	Subsoil	4.1	21.4	25.5	11.2	63.3	Clay	9.1	0.28	1.3	34.3	0.35
	Downfall	C505	Topsoil	15.8	24.8	40.6	11.9	47.5	Clay	7.8	0.19	6.3	36.4	0.05
		C505	Subsoil	15.2	23.2	38.4	10.1	51.5	Clay	8.7	0.24	1.1	28.0	0.39
Brigalow upland non-cracking clay	**Cheshire**	R352	Topsoil	10.8	37.3	48.1	15.7	36.3	Sandy Clay	7.6	0.17	2.1	21.3	0.26
		R352	Subsoil	11.0	27.0	38.0	14.0	48.0	Clay	9.1	0.57	0.7	25.0	0.46
		R350	Topsoil	7.8	26.5	34.3	15.7	50.0	Clay	7.4	0.07	1.2	26.9	0.37
		R350	Subsoil	7.8	35.0	42.8	20.4	36.9	Clay Loam	8.5	0.09	0.5	19.2	0.49
Poplar box alluvia texture contrast	**Woleebee**	C506	Topsoil	12.9	47.5	60.4	21.8	17.8	Sandy Loam	7.6	0.19	2.4	13.6	0.23
		C506	Subsoil	14.9	33.7	48.6	15.8	35.6	Sandy Clay	8.8	0.63	0.4	18.7	0.50
Poplar box alluvia uniform soil	**Juandah**	R657	Topsoil	3.9	14.7	18.6	29.4	52.0	Clay	7.0	0.07	1.7	29.5	0.30
		R657	Subsoil	2.9	13.7	16.6	19.6	63.7	Clay	8.2	0.08	0.9	33.7	0.42
Wandoan Bulk Sample Pit (Austinvale) (0.6-1.7 m deep)			Subsoil			9	44.4	45	Silty Clay	8.9	0.692	1.1	14.8	0.3864

6.0 Numerical Modelling Results

The average annual erosion rates for the 14 soil and subsoil samples representing the available cover materials were obtained from 100 years of predicted rainfall data (SILO | LongPaddock | Queensland Government) under various surface conditions (Table 6-1 and Figure 6-1 and Figure 6-2). Results are presented as average annual erosion rates (t/ha/yr) across the modelling period to provide a long-term indicator of landform stability consistent with PRCP guideline requirements and appropriate for landform design decisions at a greenfield stage.

These results assumed that vegetation cover started at zero percent cover following (i) landform construction, final trim and topsoiling, (ii) soil amelioration (not considered in the soil input file) and seeding.

Within the WEPP model analysis, the slopes remained at this level of cover for the first 18 months.

The assumptions for vegetation cover were:

- 0 % grass cover month 0 to Month 18;
- 30 % vegetation cover composed of grasses from Month 18 to 30; and
- 75 % stable vegetation cover beyond Month 30.
- 30 % Tree/shrub canopy cover with 60 % grass cover for Native Bushland is achieved 10 years after rehabilitation.

Table 6-1: Soil loss rates due to erosion according to predictions using the WEPP model under various scenarios of slope and vegetation cover percentage.

Soil Association		Sample ID	Slope length (m)	10% Slope										14% Slope									
				Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years	Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years
				Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland			Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland		
Brigalow upland cracking clay	Teviot	C258_TS	100 m	91.4	33.6	3.0	5.0	6.9	2.5	0.22	0.4	18.9	52.4	141.5	54.4	5.3	8.6	10.6	4.1	0.4	0.6	30.1	88.3
		C258_SS		60.8	25.0	3.2	5.3	4.6	1.9	0.24	0.4	14.0	49.9	90.8	38.4	5.3	8.4	6.8	2.9	0.4	0.6	21.3	78.4
	Rolleston	R330_TS		86.5	40.7	6.4	6.1	6.5	3.1	0.48	0.5	20.1	61.4	132.9	63.5	11.0	9.9	10.0	4.8	0.8	0.7	31.4	98.4
		R330_SS		85.3	40.2	5.6	6.2	6.4	3.0	0.42	0.5	20.0	61.9	131.7	63.2	9.9	10.1	9.9	4.8	0.7	0.8	31.3	99.9
	Downfall	C505_TS		66.4	29.2	3.7	4.7	5.0	2.2	0.28	0.4	15.1	46.9	101.9	46.2	6.6	7.6	7.7	3.5	0.5	0.6	23.6	75.1
		C505_SS		78.8	35.1	4.7	6.4	5.9	2.6	0.35	0.5	18.4	61.9	120.4	55.0	8.5	10.4	9.0	4.1	0.6	0.8	28.6	99.3
Brigalow upland non-cracking clay	Cheshire	R352_TS		68.3	29.3	4.1	5.7	5.1	2.2	0.31	0.4	15.8	54.4	102.9	45.3	7.1	9.0	7.7	3.4	0.5	0.7	24.2	85.2
		R352_SS		75.2	31.6	3.9	6.2	5.7	2.4	0.29	0.5	17.2	59.0	113.9	49.5	6.9	10.0	8.6	3.7	0.5	0.7	26.6	94.1
		R350_TS		76.2	33.5	4.5	6.0	5.7	2.5	0.34	0.5	17.6	58.4	116.0	52 .4	7.9	9.7	8.7	3.9	0.6	0.7	27.3	93.3
		R350_SS		69.1	28.0	3.2	5.6	5.2	2.1	0.24	0.4	15.6	53.5	105.2	43.9	5.4	9.0	7.9	3.3	0.4	0.7	24.2	84.7
Poplar box alluvia textura contrast	Woleebee	C506_TS		68.0	26.3	3.0	4.8	5.1	2.0	0.22	0.4	14.8	47.5	103.0	41.4	5.1	7.9	7.7	3.1	0.4	0.6	23.0	76.4
		C506_SS		65.3	26.2	3.0	5.7	4.9	2.0	0.22	0.4	14.9	53.5	97.9	40.4	5.0	9.1	7.4	3.0	0.4	0.7	22.7	84.1
Poplar box alluvia uniform soil	Juandah	R657_TS		76.2	34.5	4.9	5.8	5.7	2.6	0.37	0.4	17.7	57.0	116.6	54.0	8.5	9.4	8.8	4.1	0.6	0.7	27.5	91.0
		R657_SS		83.6	38.8	4.8	6.0	6.3	2.9	0.36	0.5	19.4	60.0	129.6	61.6	8.7	9.8	9.7	4.6	0.7	0.7	30.6	97.2
Subsoil (0.6-1.7 m)			50 m	99.2	37.9	5.0	5.6	7.5	8.0	0.4	0.4	20.8	58.8	18.9	52.4	9.1	10.0	12.4	5.0	0.7	0.7	35.5	102.9
Subsoil (0.6-1.7 m)			70 m	147.9	57.5	7.5	8.2	11.1	12.1	0.6	0.6	31.2	86.8	238.5	97.0	14.0	14.6	17.9	7.3	1.1	1.1	51.7	150.4

Cont. Table 6-1: Soil loss rates due to erosion according to predictions using the WEPP model under various scenarios of slope and vegetation cover

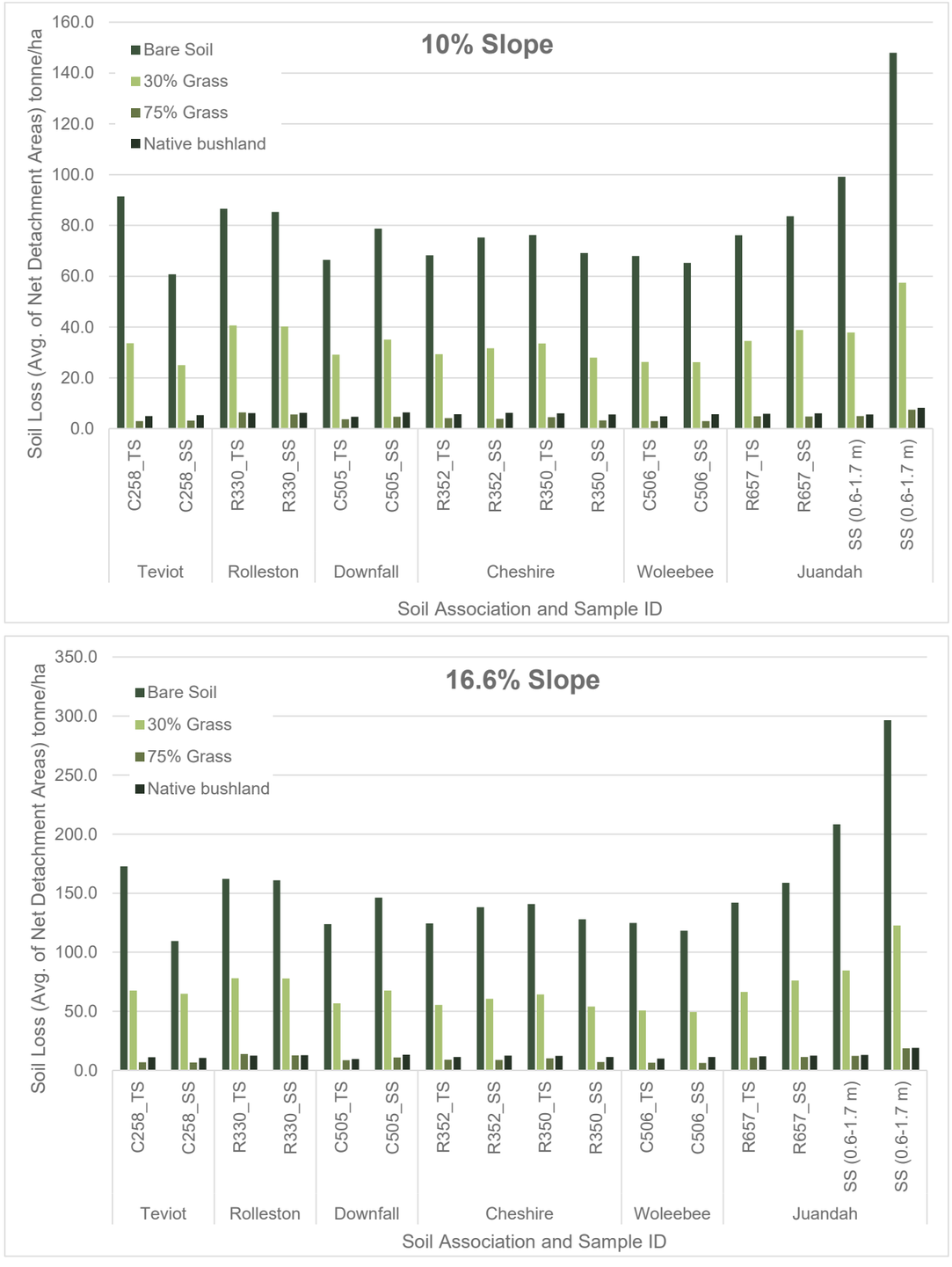
Soil Association		Sample ID	Slope length (m)	16.6% Slope										18% Slope									
				Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years	Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years
				Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland			Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland		
Brigalow upland cracking clay	Teviot	C258_TS	100 m	172.7	67.6	6.9	11.2	12.98	5.08	0.52	0.8	37.2	112.9	188.9	74.5	9.0	12.6	14.20	5.60	0.67	0.9	41.0	126.3
		C258_SS		109.5	64.8	6.8	10.6	8.23	4.88	0.51	0.8	29.3	100.7	119.1	51.3	8.6	11.7	8.95	3.85	0.64	0.9	28.3	107.5
	Rolleston	R330_TS		162.0	78.0	13.9	12.5	12.18	5.86	1.04	0.9	38.6	123.3	177.3	85.6	13.3	14.0	13.33	6.44	1.00	1.0	42.4	136.8
		R330_SS		161.0	77.9	12.7	12.9	12.11	5.86	0.95	1.0	38.6	125.9	176.4	85.7	12.8	14.4	13.26	6.44	0.96	1.1	42.5	139.9
	Downfall	C505_TS		123.9	56.8	8.5	9.5	9.32	4.27	0.64	0.7	28.9	93.4	135.4	62.3	8.9	10.6	10.18	4.69	0.67	0.8	31.8	103.2
		C505_SS		146.3	67.6	10.9	13.2	11.00	5.08	0.82	1.0	35.2	124.5	159.8	74.3	11.7	14.7	12.02	5.58	0.88	1.1	38.6	138.1
Brigalow upland non-cracking clay	Cheshire	R352_TS		124.4	55.4	9.0	11.3	9.35	4.17	0.67	0.8	29.5	105.7	135.6	60.7	9.7	12.5	10.20	4.56	0.73	0.9	32.3	116.7
		R352_SS		138.1	60.7	8.8	12.6	10.38	4.56	0.66	0.9	32.6	117.6	150.7	66.7	10.4	14.0	11.33	5.01	0.78	1.1	35.8	130.4
		R350_TS		140.9	64.4	10.1	12.3	10.60	4.84	0.76	0.9	33.5	116.6	154.0	70.6	10.8	13.7	11.58	5.31	0.81	1.0	36.8	129.3
		R350_SS		127.9	54.1	7.0	11.2	9.61	4.06	0.53	0.8	29.7	105.7	139.7	59.4	8.9	12.5	10.51	4.47	0.67	0.9	32.6	117.1
Poplar box alluvia texture contrast	Woleebee	C506_TS		124.8	50.8	6.5	10.0	9.38	3.82	0.49	0.7	28.1	95.5	136.1	55.8	7.9	11.1	10.23	4.20	0.59	0.8	30.8	105.9
		C506_SS		118.2	49.4	6.4	11.3	8.89	3.71	0.48	0.9	27.7	104.4	128.7	54.1	8.7	12.6	9.68	4.07	0.65	0.9	30.4	115.4
Poplar box alluvia uniform soil	Juandah	R657_TS		142.0	66.5	10.8	11.8	10.68	5.00	0.81	0.9	33.8	113.8	155.3	73.0	10.9	13.2	11.68	5.49	0.82	1.0	37.2	126.2
		R657_SS		158.8	76.1	11.3	12.5	11.94	5.72	0.85	0.9	37.9	122.7	174.2	83.8	11.9	14.0	13.09	6.30	0.90	1.1	41.7	136.5
Subsoil (0.6-1.7 m)			50 m	208.2	84.5	12.3	13.1	15.66	6.35	0.92	1.0	45.3	134.0	231.2	94.7	14.0	14.9	17.39	7.12	1.05	1.1	50.6	151.4
Subsoil (0.6-1.7 m)			70 m	296.5	122.7	18.6	19.1	22.29	9.23	1.40	1.4	65.1	194.6	327.2	136.6	21.2	21.7	24.60	10.27	1.59	1.6	72.3	219.1

Cont. Table 6-1: Soil loss rates due to erosion according to predictions using the WEPP model under various scenarios of slope and vegetation cover

Soil Association		Sample ID	Slope length (m)	20% Slope										22% Slope									
				Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years	Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m²/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years
				Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland			Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland		
Brigalow upland cracking clay	Teviot	C258_TS	100 m	211.6	84.3	9.2	14.6	15.9	6.3	0.7	1.1	46.3	145.4	233.6	93.8	11.8	16.7	17.56	7.05	0.89	1.3	51.5	164.6
		C258_SS		132.6	57.4	8.7	13.4	10	4.3	0.7	1.0	31.8	122.2	145.6	63.4	11.1	15.0	10.94	4.77	0.83	1.1	35.1	136.7
	Rolleston	R330_TS		198.7	96.4	17.8	16.0	14.9	7.2	1.3	1.2	47.7	156.0	219.4	106.8	17.4	18.0	16.5	8.03	1.31	1.4	53.0	175.0
		R330_SS		198	96.7	16.4	16.6	14.9	7.3	1.2	1.2	48.0	160.0	219	107.4	16.8	18.7	16.46	8.08	1.26	1.4	53.3	179.9
	Downfall	C505_TS		151.4	70.1	11	12.1	11.4	5.3	0.8	0.9	35.7	117.4	166.9	77.7	11.7	13.6	12.55	5.84	0.88	1.0	39.6	131.5
		C505_SS		178.8	83.6	14.1	16.9	13.4	6.3	1.1	1.3	43.5	157.6	197.2	92.6	15.4	19.0	14.82	6.96	1.16	1.4	48.2	176.9
Brigalow upland non-cracking clay	Cheshire	R352_TS		151.3	68.2	11.5	14.2	11.4	5.1	0.9	1.1	36.3	132.5	166.4	75.4	12.6	16.0	12.51	5.67	0.95	1.2	40.1	148.2
		R352_SS		168.4	75	11.5	16.0	12.7	5.6	0.9	1.2	40.3	148.6	185.5	83.1	13.6	18.0	13.94	6.25	1.02	1.4	44.7	166.6
		R350_TS		172.2	79.5	13.2	15.7	12.9	6	1	1.2	41.4	147.5	189.8	88.2	14.2	17.7	14.27	6.63	1.06	1.3	45.9	165.5
		R350_SS		156.3	67	9.1	14.3	11.8	5	0.7	1.1	36.7	133.5	172.4	74.3	11.7	16.1	12.96	5.59	0.88	1.2	40.7	149.7
Poplar box alluvia texture contrast	Woleebee	C506_TS		151.8	62.8	8.4	12.7	11.4	4.7	0.6	1.0	34.7	120.6	167	69.6	10.2	14.3	12.56	5.23	0.77	1.1	38.4	135.2
		C506_SS		143.5	60.8	8.3	14.4	10.8	4.6	0.6	1.1	34.1	131.2	157.6	67.2	11.2	16.1	11.85	5.05	0.85	1.2	37.7	146.8
Poplar box alluvia uniform soil	Juandah	R657_TS		174	82.2	14	15.1	13.1	6.2	1.1	1.1	41.9	144.0	192	91.2	14.3	17.0	14.44	6.85	1.07	1.3	46.5	161.7
		R657_SS		195.7	94.7	14.6	16.1	14.7	7.1	1.1	1.2	47.1	156.4	216.7	105.3	15.7	18.3	16.29	7.92	1.18	1.4	52.5	176.1
Subsoil (0.6-1.7 m)			50 m	263.7	109.2	16.6	17.5	19.8	8.2	1.3	1.3	58.2	176.6	295.6	123.5	19.2	20.2	22.2	9.3	1.4	1.5	65.7	202.1
Subsoil (0.6-1.7 m)			70 m	370.3	156	25	25.4	27.8	11.7	1.9	1.9	82.5	254.5	412.3	175.1	28.7	29.2	31	13.2	2.2	2.2	92.6	290.2

Cont. Table 6-1: Soil loss rates due to erosion according to predictions using the WEPP model under various scenarios of slope and vegetation cover

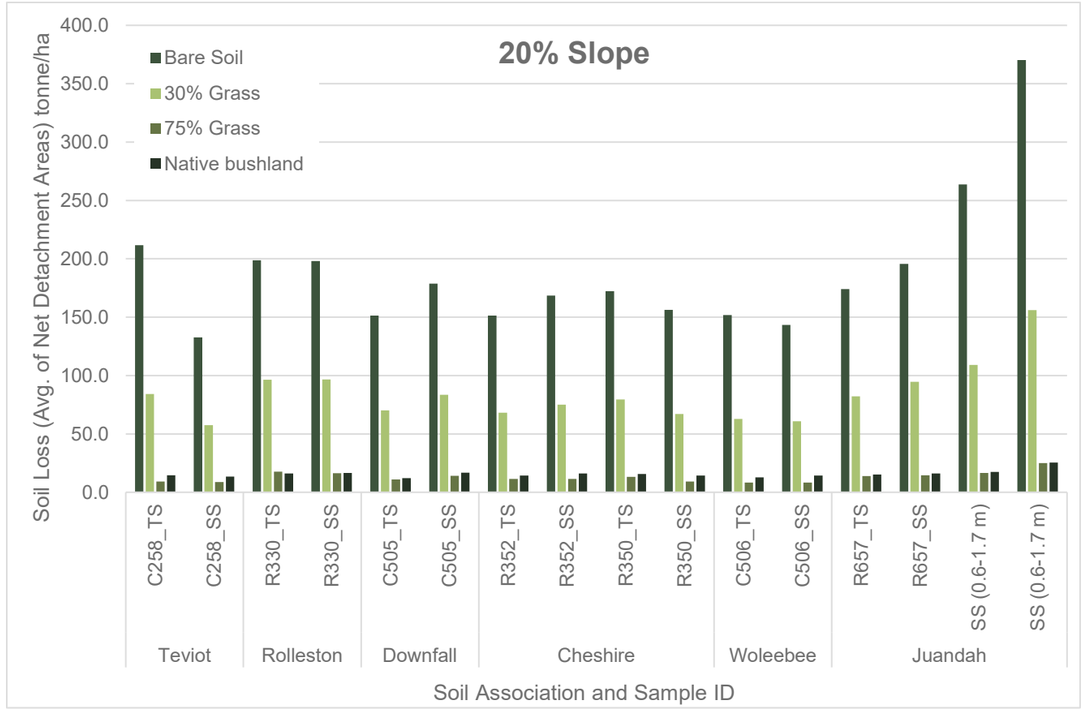
Soil Association		Sample ID	Slope length (m)	25% Slope									
				Soil Loss (Avg. of Net Detachment Areas) tonne/ha/yr				Av. Thickness of Soil Loss mm/m^2/yr				Soil Loss in mm for the first 10 years	Soil Loss in mm for 100 years
				Bare Soil	30% Grass	75% Grass	Native Bushland	Bare Soil	30% Grass	75% Grass	Native Bushland		
Brigalow upland cracking clay	Teviot	C258_TS	100 m	265.1	107.7	14.0	19.8	19.93	8.10	1.05	1.5	59.1	193.2
		C258_SS		164.2	72.1	13.0	17.4	12.35	5.42	0.97	1.3	39.9	157.9
	Rolleston	R330_TS		249.4	122.1	20.4	21.1	18.75	9.18	1.54	1.6	60.6	203.2
		R330_SS		249.3	123.0	19.8	21.9	18.75	9.25	1.49	1.6	61.1	209.4
	Downfall	C505_TS		189.1	88.6	13.8	15.8	14.22	6.66	1.04	1.2	45.1	152.2
		C505_SS		223.7	105.8	18.1	22.2	16.82	7.96	1.36	1.7	55.1	205.5
Brigalow upland non-cracking clay	Cheshire	R352_TS		188.0	85.8	14.7	18.6	14.14	6.45	1.11	1.4	45.7	171.3
		R352_SS		210.0	94.9	16.0	21.0	15.79	7.13	1.21	1.6	51.0	193.3
		R350_TS		215.2	100.6	16.7	20.6	16.18	7.56	1.25	1.6	52.5	192.1
		R350_SS		195.4	85.0	13.7	18.8	14.69	6.39	1.03	1.4	46.5	173.9
Poplar box alluvia texture contrast	Woleebee	C506_TS		188.8	79.4	12.0	16.7	14.20	5.97	0.90	1.3	43.8	156.8
		C506_SS		178.0	76.5	13.2	18.7	13.38	5.75	0.99	1.4	42.9	169.7
Poplar box alluvia uniform soil	Juandah	R657_TS		218.1	104.2	16.8	19.9	16.39	7.83	1.26	1.5	53.1	187.7
		R657_SS		247.0	120.8	18.5	21.4	18.57	9.08	1.39	1.6	60.2	205.3
Subsoil (0.6-1.7 m)			50 m	342.2	145.1	23.3	24.2	25.7	10.9	1.8	1.8	76.8	240.8
Subsoil (0.6-1.7 m)			70 m	473.5	204.1	34.5	34.9	35.6	15.3	2.6	2.6	107.5	343.9

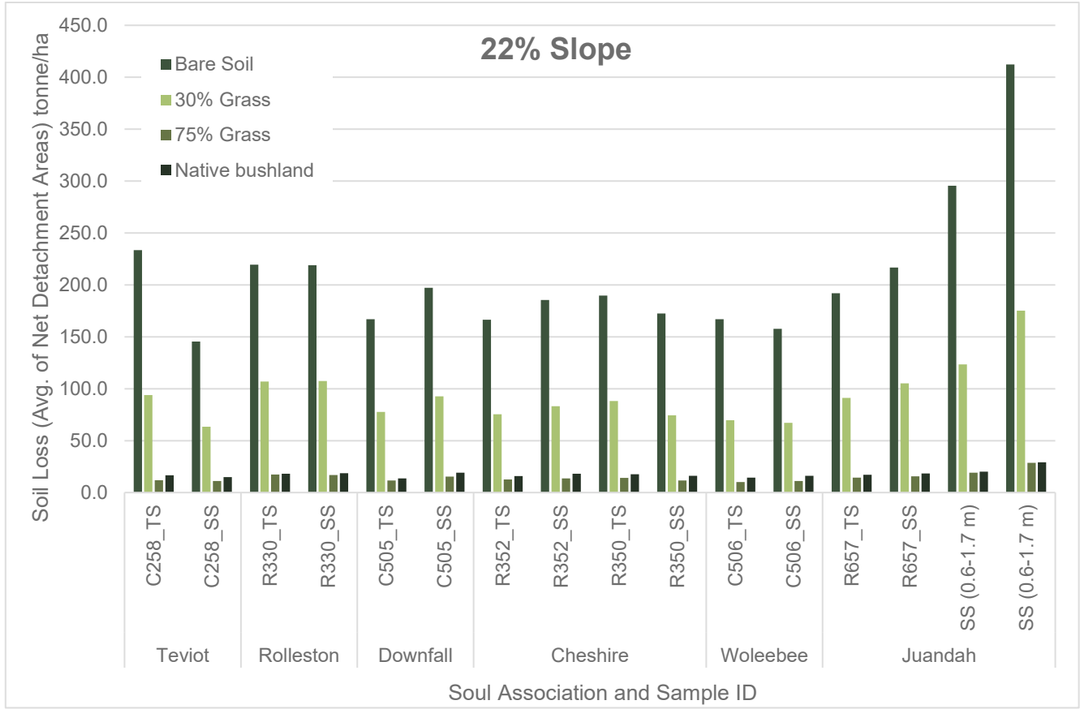

10% Slope
Bare Soil
30% Grass
75% Grass
Native bushland
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
C258_TS
C258_SS
R330_TS
R330_SS
C505_TS
C505_SS
R352_TS
R352_SS
R350_TS
R350_SS
C506_TS
C506_SS
R657_TS
R657_SS
SS (0.6-1.7 m)
SS (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID

14% Slope
Bare Soil
30% Grass
75% Grass
Native bushland
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
300.0
250.0
200.0
150.0
100.0
50.0
0.0
C258_TS
C258_SS
R330_TS
R330_SS
C505_TS
C505_SS
R352_TS
R352_SS
R350_TS
R350_SS
C506_TS
C506_SS
R657_TS
R657_SS
SS (0.6-1.7 m)
SS (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID

16.6% Slope
Bare Soil
30% Grass
75% Grass
Native bushland
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
C258_TS
C258_SS
R330_TS
R330_SS
C505_TS
C505_SS
R352_TS
R352_SS
R350_TS
R350_SS
C506_TS
C506_SS
R657_TS
R657_SS
SS (0.6-1.7 m)
SS (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID

18% Slope
Bare Soil
30% Grass
75% Grass
Native bushland
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
C258_TS
C258_SS
R330_TS
R330_SS
C505_TS
C505_SS
R352_TS
R352_SS
R350_TS
R350_SS
C506_TS
C506_SS
R657_TS
R657_SS
SS (0.6-1.7 m)
SS (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID





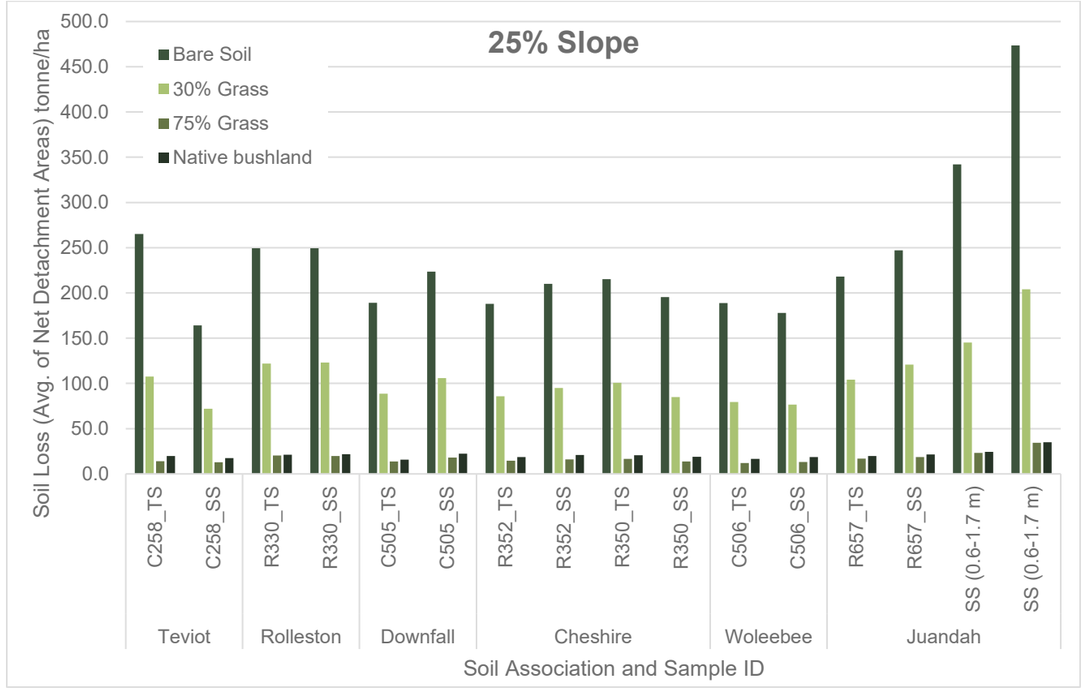
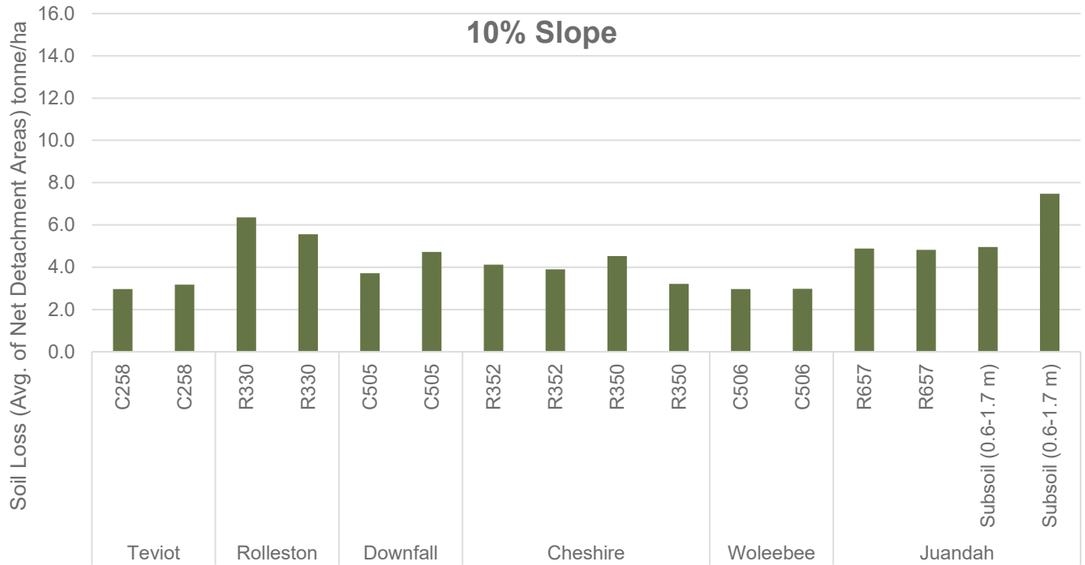
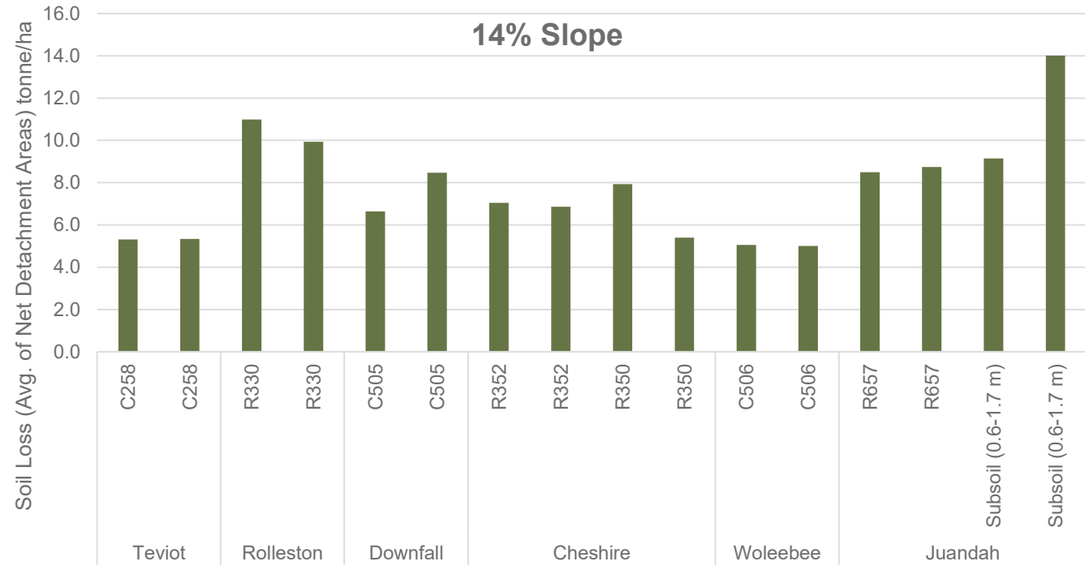
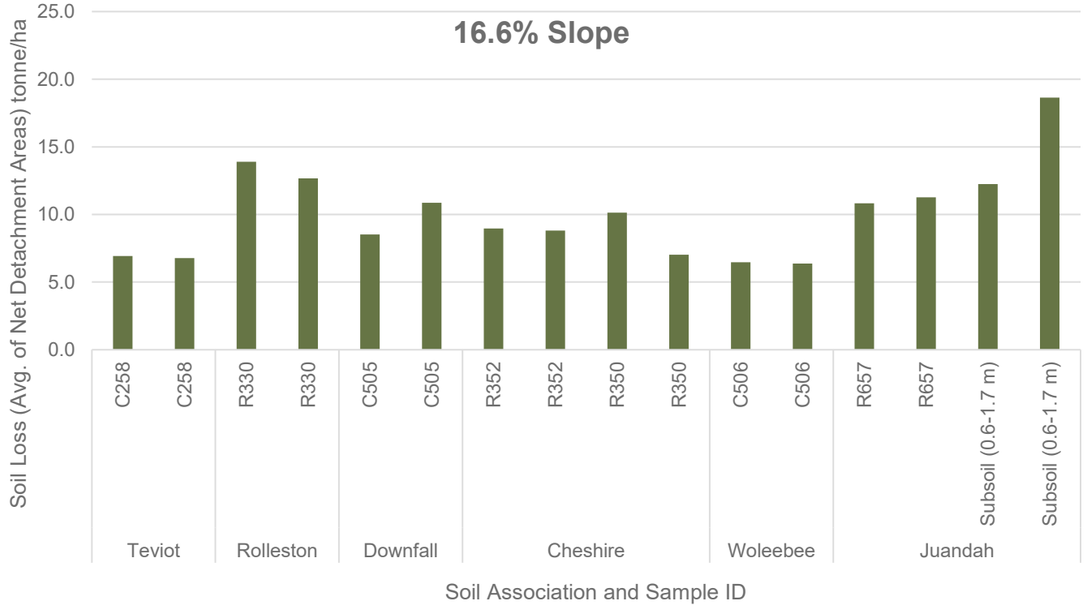
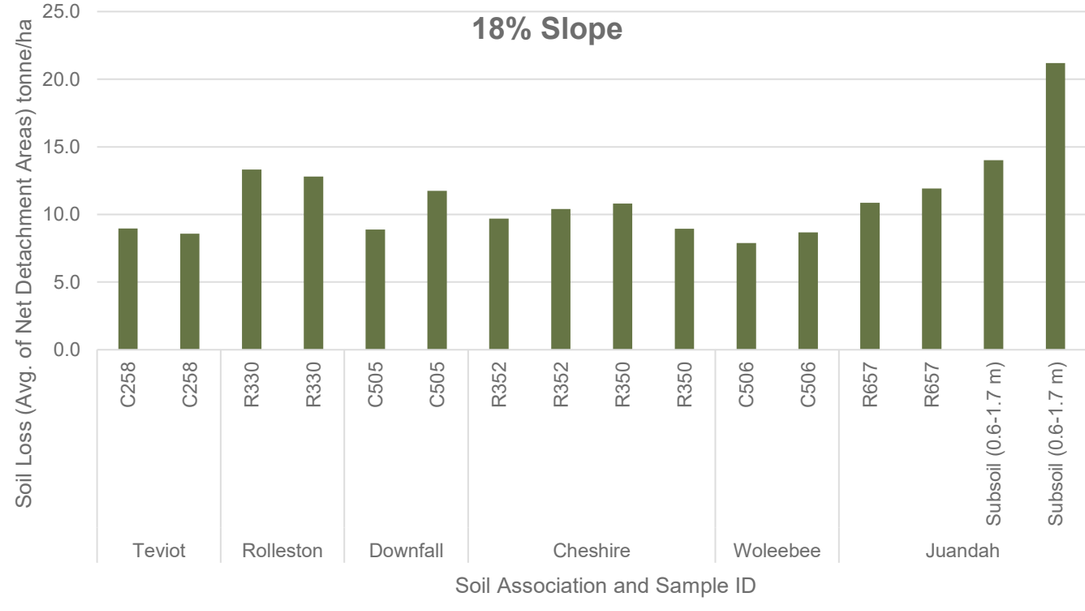


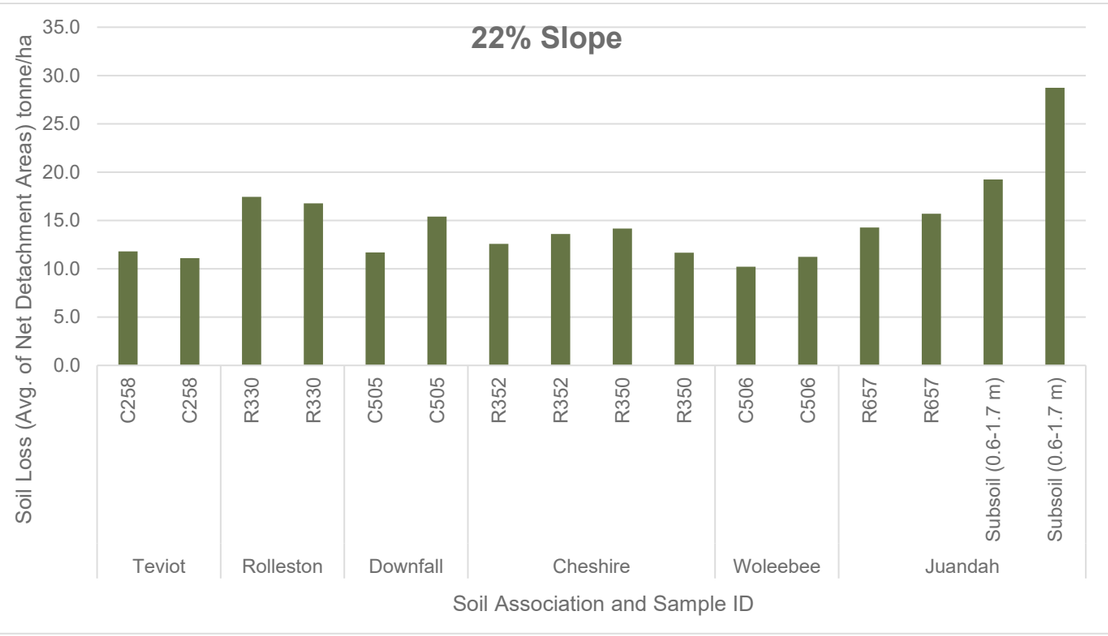
Figure 6-1: The average annual soil loss on different slopes and vegetation cover % for the soil types under investigation in the WCP area.


10% Slope
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
C258
C258
R330
R330
C505
C505
R352
R352
R350
R350
C506
C506
R657
R657
Subsoil (0.6-1.7 m)
Subsoil (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID


14% Slope
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
C258
C258
R330
R330
C505
C505
R352
R352
R350
R350
C506
C506
R657
R657
Subsoil (0.6-1.7 m)
Subsoil (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID


16.6% Slope
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
25.0
20.0
15.0
10.0
5.0
0.0
C258
C258
R330
R330
C505
C505
R352
R352
R350
R350
C506
C506
R657
R657
Subsoil (0.6-1.7 m)
Subsoil (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID


18% Slope
Soil Loss (Avg. of Net Detachment Areas) tonne/ha
25.0
20.0
15.0
10.0
5.0
0.0
C258
C258
R330
R330
C505
C505
R352
R352
R350
R350
C506
C506
R657
R657
Subsoil (0.6-1.7 m)
Subsoil (0.6-1.7 m)
Teviot
Rolleston
Downfall
Cheshire
Woleebee
Juandah
Soil Association and Sample ID



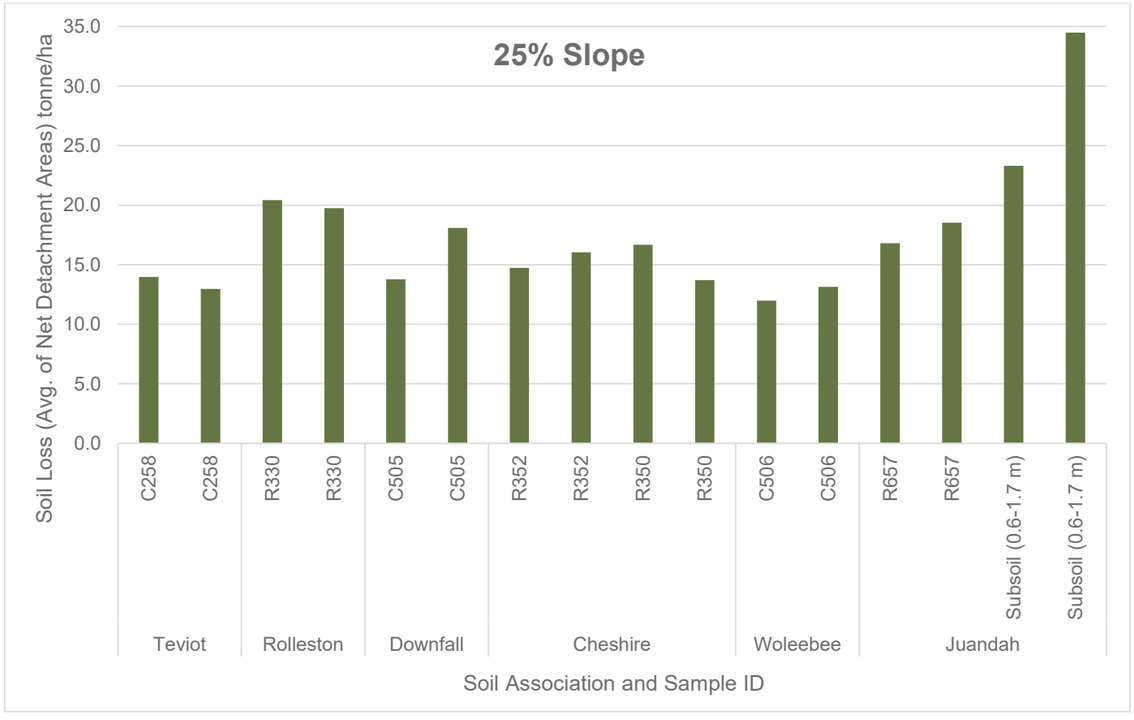


Figure 6-2: The average annual soil loss across various slopes with relevant PMLU vegetation coverage for the soil types under investigation in the WCP area.

7.0 Numerical Modelling Discussion

7.1 Landform Design

The proposed WCP landform was reinterrogated by the WEPP modelling outputs. The model was run to compute annual soil erosion rates across multiple slope gradients including those proposed on the WCP landform within the disturbance area and under various vegetation cover scenarios (bare, 30 % grass cover, 75 % grass cover and for native bushland 30 % canopy cover and 60 % grass cover). Vegetation cover scenarios are representative of the proposed PMLUs of grazing and native bushland. All topsoiled and vegetated overburden and weathered highwall slopes are stable to erosion in a closure context with maximum slope grades of 22 % and slope lengths of approximately 100 m. These slopes represent the maximum for the proposed landform and only occur on relatively small areas as shown in Figure 3-4. Slope grades and slope lengths were optimised for each material type and the landform design updated through multiple iterations to confirm a proposed WCP landform stable to erosion. Slopes of 18 – 22 % have been designed in the landform and include the low walls and the weathered zone of the highwalls. External batters of overburden emplacements have been designed with slopes of ≤ 18 %.

Whilst modelling predicted an increase in erosion rates with increasing slope gradients, the model also predicted the impact of vegetative cover on reducing erosion rates. The modelled vegetation cover scenarios are shown to be effective in reducing erosion rates by approximately 90 % across all modelled slopes and soil type scenarios. Various management strategies (including deep ripping prior to seeding) can be employed during rehabilitation activities to minimise erosion rates until vegetation cover is achieved.

For the PMLU of grazing, the maximum average erosion rate under the 75 % grass cover scenario on proposed PRCP landform slopes is 11.1 - 17.4 t/ha/yr which equates to 0.8 - 1.3 mm/m^2/yr of soil loss. The equivalent maximum predicted soil losses of 0.8 – 1.3 mm/m^2/yr occur on 22 % slope gradients with a 100 m slope length after 75 % vegetation cover has been established. It is expected these erosion rates would be reached approximately 3 years after rehabilitation is completed.

For the native bushland PMLU, comprising 30 % tree and shrub cover with 60 % grass cover, the modelling shows maximum erosion rates of 13.6 – 19 t/ha/yr. This occurs on slopes of up to 22 % which occupy approximately 1.5 % of the proposed PRCP landform and include some highwall unweathered zones.

These maximum erosion scenarios are predicted to occur on very small areas (1 %) of the proposed landform (see Figure 3-4 and Table 7-1).

The majority of the site (80 %) has slope gradients below 5 %. The modelling shows the maximum average annual rate of erosion on these slopes will be below 6.4 t/ha/yr once 75 % vegetation cover is reached.

Over the long term, it is anticipated that this erosion rate will be balanced by soil genesis driven by organic matter accumulation and microbial activity. Whilst modelling shows minor variations in erosion rates between the topsoil types available for rehabilitation activities, a minimum cover depth of 100 mm will be required to ensure predicted erosion rates are balanced with soil genesis.

Remanent unweathered (rock) highwall slopes between 0 - 214 % are authorised under the EA. Whilst these slopes have not been specifically considered in the WEPP model, they occur within competent rock and therefore not subject to significant erosional risk. The geotechnical stability of these remanent highwall slopes has been addressed by PSM (2024) (Appendix L

of the WCP PRCP) with all highwall slopes assessed as having factors of safety > 1.2 with a very low risk of instability.

Based on the WEPP modelling outputs, the slope gradient scenarios proposed in the WCP landform and authorised under the EA, deliver a landform that is stable to erosion when vegetation cover and 100 m slope lengths are achieved.

Table 7-1 Maximum average erosion rates from modelling on proposed landform slopes after PMLU vegetation establishes.

PMLU	Slope Gradient	Approx. Total Area (ha)	Area of Disturbance (%)	Maximum Average Erosion Rate (t/ha/yr)	Maximum Average Soil Loss (mm/m^2/yr)	Time to establish vegetation cover
Grazing 75% Grass Cover	0-5%	13,655	80.3	< 6.4	< 0.48	3 Years
	5-10%	1,555	9.1	6.4	0.48	
	10-18%	1,385	8.1	13.3	0.8	
	18 - 22%	198	1.1	17.4	1.31	
Native Bushland 30% Canopy with 60% Grass cover	0-22%	174	1.2	19	1.41	10 Years
	>22%	38	0.2	Only occurs on remnant unweathered (rock) highwall		
Total area of disturbance		**17,005**	**100**			

7.2 Erosion risk

The role of the cover system is to support vegetation and the associated soil biota, maximise the infiltration of water into the new soil profile and enhance moisture retention to support the vegetation by increasing soil organic matter and organic carbon.

The maximum average soil loss rates obtained from the WEPP numerical analysis of **bare topsoil** is modelled in the range of 10 - 20 mm/m^2/yr at 22 % slopes with a 100 m slope length. Slopes under this scenario occur on approximately 1 % of the disturbance area. The majority of the disturbance area (89 %) is modelled to experience maximum average soil loss rates of 4.6-6.9 mm/m^2/yr (0 - 10 % slopes).

It is anticipated that bare topsoil would only exist on site for less than 1.5 years while vegetation cover establishes. The erosion rates from bare topsoil, during the initial 1.5 years post-rehabilitation, can be mitigated by:

- Undertaking rehabilitation within the year of topsoil spreading largely in spring prior to the wet season;
- Using high seeding rates for grasses and high fertiliser rates to facilitate establishment;
- Applying gypsum to reduce exchangeable sodium percentage to a maximum of 6 %; and

- Deep ripping immediately prior to seeding to enhance infiltration, form a friable seed bed and minimise initial bare soil runoff and erosion above the modelled parameters.

In comparison, modelling predicts maximum average soil losses of 0.8 – 1.3 mm/m^2/yr at 22 % slopes with a 100 m slope length and with 75 % vegetation cover. It is anticipated that over the long term this erosion rate will be balanced by soil genesis activities driven by organic matter accumulation and microbial activity. As such, a minimum topsoil cover of 100 mm is recommended to ensure topsoil sustainability and provide a suitable seedbed for vegetation establishment.

With the encapsulation of all tailings, rejects and potential spontaneous combustion forming material within the final overburden emplacements and a low risk of acid production, the risk of exposure of any hostile materials at the landform surface is extremely low.

7.3 Rill and Gully Erosion (soil loss)

The WEPP analysis performed did not indicate any significant areas of rill erosion. Any area of the landform that receives concentrated surface flows may have the potential to develop rill and gully erosion. However, these will be identified by rehabilitation monitoring and management actions implemented to achieve relevant milestone criteria.

While WEPP is fundamentally a process-based model focused on interrill and rill erosion, its outputs offer significant value in assessing gully erosion risk, as gullies commonly develop where concentrated rill erosion surpasses soil resistance and drainage lines converge. In practice:

- WEPP simulates spatially distributed rill erosion patterns, runoff volumes, and peak discharges. These outputs can be used to identify locations of concentrated flow where gully initiation is most likely to occur.
- Numerous studies and rehabilitation assessments in Australia (Willgoose, G.R. & Loch, R.J. (1996), Moliere DR, Evans KG, Willgoose GR and Saynor MJ (2002) and Loch R, Dunlop J, and Nicolson L (2025)) have demonstrated that WEPP erosion rates >50–100 t/ha/yr, particularly on long unbroken slopes, are strongly correlated with incipient gully formation. Erosion rates of this magnitude are not modelled at WCP once vegetation is established. As such, adopting a monitor and maintain approach to the identification and repair of gully formation at WCP is appropriate.
- For the WCP PRCP assessment, WEPP was used not only to quantify average soil loss but also to highlight slope segments and drainage alignments at elevated risk of channelisation and gully development under high-intensity rainfall scenarios.

Therefore, although WEPP does not explicitly simulate channel headcut retreat or long-term gully morphology (as a Landform Evolution Model would), its hydrology - erosion coupling provides a reliable predictor of gully initiation risk. This aligns with QLD (OQMRC, 2025) Regulator guidance, which encourages the use of appropriate erosion models to identify “where high-risk erosion areas are likely to occur” (OQMRC, 2025) in final landform designs.

8.0 Conclusion

Slope gradient analysis and erosion modelling was conducted for the disturbance area within the proposed WCP PRCP. The proposed WCP PRCP landform has been designed to meet the requirements of the EA approval for slope gradients. The modelled outputs, including the maximum average erosion rates, provide supplementary information that directly correlates to the EA approved final landform slope criteria.

The landform erosion modelling predicts an increase in erosion rates with increasing slope gradients however, a reduction in erosion rates was observed based on an increasing level of vegetation cover. Vegetation cover, relevant to both proposed PMLUs, was shown to be effective in reducing erosion rates by approximately 90 % across all modelled slopes and soil type scenarios.

Slope gradient scenarios proposed in the PRCP landform that were provided as inputs to the WEPP model (within the ranges authorised under the EA) include:

- Highwall weathered zones of 0 - 22 %;
- Low walls of 0 - 22 %; and
- External batters of recontoured spoil areas of 0 - 18 %.

When considering the grazing PMLU, modelling predicts 90 % of the landform will have a maximum average erosion rate of 6.4 t/ha/yr within 3 years or once 75 % vegetation cover has been achieved. A further 8 % of the landform is predicted to have a maximum average erosion rate of 13.3 t/ha/yr within the same timeframe and assuming the most erosive soils are used in rehabilitation.

For a native bushland PMLU modelling indicates a maximum erosion rate of 19 t/ha/yr within 10 years when canopy cover and grass cover are at 30 % and 60 % respectively and is expected to continue to decrease as vegetation continues to mature. This rate is conservatively applied to 1.2 % of the landform however a proportion of this will comprise unweathered rock. Erosion rates from unweathered rock are expected to be negligible.

The proposed landform design ensures stability by limiting slope lengths to a maximum of 100 m at a 22 % gradient. This supports a sustainable stable and sustainable landform once PMLU vegetation targets are achieved, aligning with natural conditions and achieving manageable erosion rates.

A topsoil application of 100 mm is deemed sufficient based on modelled erosion rates and soil genesis.

9.0 Disclaimer

1 Erosion calculations and predictions conducted utilising the WEPP model. SLR disclaims any responsibility for errors arising from potential inadequacies in the coding or content of this model;

2 Calibration of the aforementioned model was partially based on an independent field assessment. The author cannot guarantee the absence of inaccuracies in the data, which may subsequently result in errors in the model's calculations and outputs; and

3 No guarantee is made that any prediction or result contained in the attached document will or might occur.

10.0 References

Bergsma, E. (1996). Terminology for soil erosion and conservation: concepts, definitions and multilinual list of terms for soil erosion and conservation.

Browning, G.M., Parish, C.L., Glass, J., 1947. A Method for Determining the Use and Limitations of Rotation and Conservation Practices in the Control of Soil Erosion in Iowa1. Agron J 39, 65–73. https://doi.org/https://doi.org/10.2134/agronj1947.00021962003900010008x

Flanagan, D.C., Nearing, M.A., 1995. USDA-Water Erosion Prediction Project: Hillslope profile and watershed model documentation. Nserl Rep 10, 1–123.

Golder Associates (2008) Geotechnical Evaluation for Open Pit Mining Wandoan Coal Project, Wandoan Queensland. Technical Report

Howard, E., Loch, R., 2019. Acceptable erosion rates for mine waste landform rehabilitation modelling in the Pilbara, Western Australia. https://doi.org/10.36487/ACG_rep/1915_121_Howard

Howard, E.J., Roddy, B.P., 2012. Evaluation of the water erosion prediction project model – validation data from sites in Western Australia. Mine Closure 2012: Seventh International Conference on Mine Closure.

https://www.dcceew.gov.au/science-research/supervising-scientist/publications/ssr/temporal-trends-erosion-and-hydrology-post-mining-landform-ranger-mine, accessed 3 June 2024.

Loch R, Dunlop J, and Nicolson L (2025) Leading practice guidance on erosion and landform evolution modelling to design post-mining landforms: Technical Paper, Office of the Queensland Mine Rehabilitation Commissioner, Queensland Government, Brisbane.

Loch, R.J., 2000. Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mine, Tarong, Queensland. Australian Journal of Soil Research 38, 299–312. https://doi.org/10.1071/SR99030

Lu Hua, Prosser Ian P., Moran Chris J., Gallant John C., Priestley Graeme Stevenson Janelle G. (2003) Predicting sheetwash and rill erosion over the Australian continent. Soil Research 41, 1037-1062.

Lu, H., Yu, B., 2002. Spatial and seasonal distribution of rainfall erosivity in Australia. Australian Journal of Soil Research 40, 887–901. https://doi.org/10.1071/SR01117

Moliere DR, Evans KG, Willgoose GR and Saynor MJ (2002) Temporal trends in erosion and hydrology for a post-mining landform at Ranger Mine - DCCEEW,

Nearing, M.A., Norton, L.D., Bulgakov, D.A., Larionov, G.A., West, L.T., Dontsova, K.M., 1997. Hydraulics and erosion in eroding rills. Water Resour Res 33, 865–876. https://doi.org/10.1029/97wr00013

OQMRC (2025) Applying erosion and Landscape Evolution Models to assess post-mining landform stability Technical Paper - Office of the Queensland Mine Rehabilitation Commissioner 2025

Parsons Brinckerhoff. 2008. Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment. Brisbane: Parsons Brinckerhoff.

PSM. (2024). (Letter) Stability Analyses Results for Progressive Rehabilitation and Closure Plan for the Wandoan Coal Project. North Ryde NSW. PSM Consultants.

RGS. (2023). Geophysical, Physical and Spontaneous Combustion – Sampling and Analysis Plan. Brisbane: RGS Environmental Consultants Pty Ltd.

RGS. (2024). Geophysical, Physical and Spontaneous Combustion Assessment of Mine Materials from the Bulk Sample Pit. Draft Interim Technical Report. Brisbane: RGS Environmental Consultants Pty Ltd.

Teng H, Viscarra Rossel R, Shi Z, Behrens T, Chappell A and Bui E 2016 Assimilating satellite imagery and visible-near infrared spectroscopy to model and map soil loss by water erosion in Australia.

Willgoose, G.R. & Loch, R.J. (1996). An assessment of the Nabarlek rehabilitation, Tim Camp Creek and other mine sites in the Alligator Rivers Region as test sites for examining long term erosion processes and the validation of the SIBERIA model. Supervising Scientist Report 165, Supervising Scientist, Canberra.

Yu, B., Ciesiolka, C.A.A., Langford, P., 2003. Calibration of an oscillating nozzle-type rainfall simulator. Earth Surf Process Landf 28, 1483–1490. https://doi.org/10.1002/esp.1001

Zhang, L., Huang, Y., Rong, L., Duan, X., Zhang, R., Li, Y., & Guan, J. (2021). Effect of soil erosion depth on crop yield based on topsoil removal method: a meta-analysis. Agronomy for Sustainable Development, 41(5), 63. https://doi.org/10.1007/s13593-021-00718-8

Appendix A RGS (2024): Multi-element results for mine materials from the Wandoan Coal Project

Erosion Risk Assessment

Progressive Rehabilitation Closure Plan

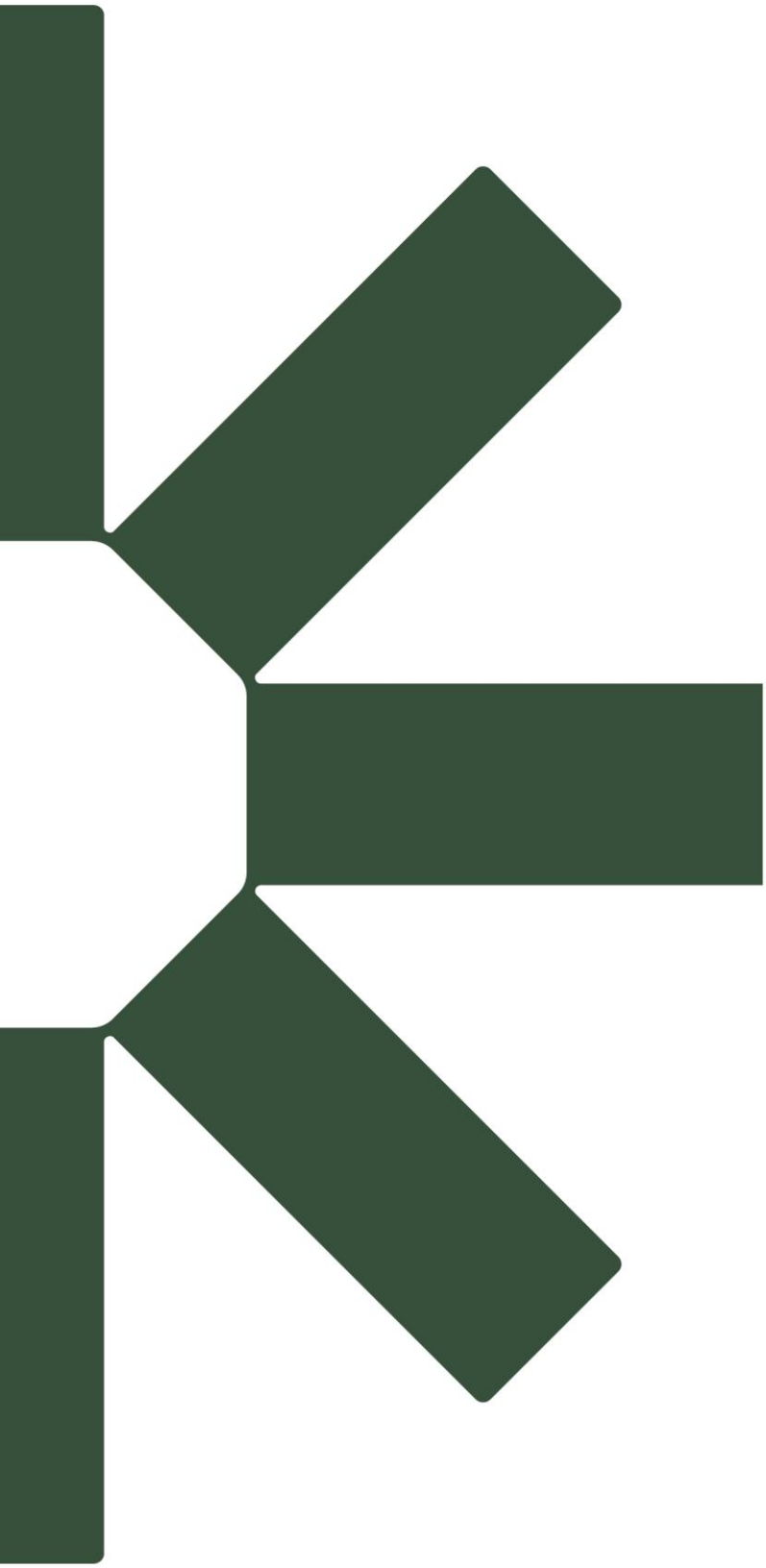
Glencore Coal Assets Australia Pty Ltd

SLR Project No.: 626.30100.00000

27 October 2025

	RGS Sample Number →		2022005_001	2022005_002	2022005_003	2022005_004	2022005_C03	2022005_C04	2022005_C05	2022005_C06	2022005_C07	2022005_C08
	Sampling Date →		27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022
	ALS Laboratory ID →		EB2215308001	EB2215308002	EB2215308003	EB2215308004	EB2215308005	EB2215308006	EB2215308007	EB2215308008	EB2215308009	EB2215308010
Parameters	**Limit of Reporting**	NEPC[1] Health-Based Investigation Level (HILs)-C	Topsoil (0-0.6 m)_1	Topsoil (0-0.6 m)_2	Subsoil (0.6-1.6 m)_1	Subsoil (0.6-1.6 m)_2	Overburden (1.6-2.2 m)	Poor Quality Coal (WS1A)_1	Poor Quality Coal (WS1A)_2	Poor Quality Coal (WS1A)_3	Coal (WS1B)_1	Coal (WS1B)_2
pH	0.1	-	8.80	8.80	8.90	9.00	9.10	6.20	6.20	5.60	7.60	7.60
Electrical Conductivity	1	-	374	349	743	674	605	703	775	747	538	479
Major Cations	All units mg/kg		All units mg/kg									
Calcium (Ca)	50	-	17,700	25,500	26,400	31,800	9,600	10,700	12,400	10,900	10,600	10,600
Magnesium (Mg)	50	-	4,320	4,800	5,200	5,780	3,620	2,000	1,860	2,120	1,420	1,390
Potassium (K)	50	-	890	860	790	910	940	440	590	480	190	200
Sodium (Na)	50	-	1,100	1,180	1,910	2,050	1,610	2,610	1,990	3,030	1,250	1,270
Aluminium (Al)	50	-	10,800	10,600	8,910	10,500	6,570	3,530	2,630	4,040	1,170	1,200
Iron (Fe)	50	-	24,300	24,000	26,400	28,500	16,200	3,030	2,190	3,010	2,460	2,180
Minor and Trace Elements	All units mg/kg		All units mg/kg									
Arsenic (As)	5	300	2.8	2.6	2.6	2.8	2.2	1.4	1.4	1.6	1.5	1.4
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium (Ba)	10	-	225	231	211	213	120	145	166	166	181	181
Beryllium (Be)	1	90	0.8	0.8	0.9	0.9	0.5	0.4	0.4	0.5	0.4	0.4
Cadmium (Cd)	1	90	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt (Co)	2	300	9	8	15	15	10	3	2	4	2	2
Chromium (Cr) **	2	300	10	10	9	10	8	2	2	2	1	2
Copper (Cu)	5	17,000	17	17	19	21	19	13	14	12	9	9
Mercury (Hg)	0.1	80	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese (Mn)	5	19,000	434	423	481	531	427	68	60	58	26	27
Molybdenum (Mo)	2	-	0.2	0.2	0.3	0.3	0.2	0.4	0.4	0.4	0.3	0.4
Nickel (Ni)	2	1,200	11	12	12	13	12	2	2	2	2	2
Lead (Pb)	5	600	12	12	13	15	12	9	9	9	8	8
Antimony (Sb)	5	-	0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	0.2	<0.1	<0.1
Selenium (Se)	5	700	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thorium (Th)	0.1	-	2.4	2.4	3.1	3.2	3.9	1.8	1.9	1.9	1.1	1.0
Uranium (U)	0.1	-	0.3	0.3	0.5	0.5	1.1	0.5	0.5	0.6	0.4	0.5
Vanadium (V)	5	-	41	40	35	39	23	22	31	26	19	19
Zinc (Zn)	5	30,000	39	40	47	50	58	11	7	12	5	4
Exchangeable Cations		-	All units meq/100g (except Exchangable Sodium Percentage (%))									
Exchangeable Calcium	0.2	-	9.8	9.6	4.5	7.0	2.5					
Exchangeable Magnesium	0.2	-	5.0	3.5	4.2	6.0	5.0					
Exchangeable Potassium	0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2					
Exchangeable Sodium	0.2	-	3.2	1.9	3.1	4.7	3.8					
Cation Exchange Capacity	0.2	-	18	14.9	11.8	17.7	11.2					
Exchangeable Sodium Percent	0.2%	-	17.7	12.7	26.1	26.6	33.8					
Calcium/Magnesium Ratio	0.2	-	1.9	2.8	1.1	1.2	0.5					
	All units mg/kg		All units mg/kg									
Bicarbonate Extractable K (Colwell)	100	-	130	117	128	122						
Bicarbonate Ext. P (Colwell)	5	-	<5	<5	<5	<5						
Chloride	10	-	150	20	680	570						
DTPA Extractable Metals	All units mg/kg		All units mg/kg									
Copper	1.00	-	<1.00	<1.00	<1.00	<1.00						
Iron	1.00	-	9.10	8.37	6.70	6.48						
Manganese	1.00	-	3.24	3.70	4.06	4.46						
Zinc	1.00	-	<1.00	<1.00	<1.00	<1.00						
Soil Nutrients	All units mg/kg		All units mg/kg									
Ammonia as N	20	-	<20	<20	<20	<20						
Nitrite as N (Sol.)	0.1	-	<0.1	0.2	<0.1	<0.1						
Nitrate as N (Sol.)	0.1	-	2.1	1.3	2.1	0.5						
Nitrite + Nitrate as N (Sol.)	0.1	-	2.1	1.5	2.1	0.5						
Total Kjeldahl Nitrogen as N	20	-	730	800	530	570						
Total Nitrogen as N	20	-	730	800	530	570						
Total Phosphorus as P	2	-	161	135	145	127						
Organic Matter	Units as shown		Units as shown									
Organic Matter	0.5%	-	1.6	1.6	1.0	1.2						
Total Organic Carbon	0.5%	-	1.0	0.9	0.5	0.7						
Emerson Class	-	-										
Emerson Class	-	-	2	2	2	2	1	2				

Notes:
< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg.
1. NEPC (2013). See main report for detailed reference.



Making Sustainability Happen

Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia

Prepared by:

SLR Consulting Australia

SLR Project No.: 626.30100.00000

1/25 River Street, Mackay QLD 4740, Australia

27 October 2025

Revision: 2

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.1	16 July 2024	Michelle Papenfus Nikita Bhatia	Rod Masters Helena Howell	
2 (Updates to areas based on PRCP IR Responses)	27 October 2025	Georgina Ball	Helena Howell	Helena Howell

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Glencore Coal Assets Australia (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

SLR Consulting Australia Pty Ltd (SLR) was commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) on behalf of the joint venture partners to undertake a soils assessment to support the development of the Wandoan Coal Project (WCP) Progressive Rehabilitation and Closure Plan (PRCP).

The soils assessment (this report) has been prepared to address the requirements of Section 3.6.1 of the PRCP Guideline (ESR/2019/4964 v3). As such, the soils assessment considers the availability, location, treatment and application of topsoil resources in rehabilitation activities at the WCP. The requirements for managing topsoil stockpiles are also outlined in the report.

Two Land Resource Areas (LRA) were identified in the WCP area. The 'Brigalow Uplands' with cracking and non-cracking clays is usually found in undulating plains, broad ridges and low hills, and the 'Poplar Box Alluvia' with uniform soils and texture contrast soils is found in floodplains and drainage channels. Within these LRAs, eight (8) soil types and their geomorphic/topographic positions were described and have informed the pre-mining land suitability assessment. The pre-mining land suitability assessment followed the Guidelines for Agricultural Land Evaluation in Queensland (DNRM 1990) with reference the Department of Mines and Energy (DME) Land Suitability Assessment Techniques (DME 1995). The assessment classified the WCP areas as Class 2 for beef cattle grazing and Class 3 and Class 4 for dryland cropping.

The WCP Environmental Authority EPML00297613 (EA) requires beef cattle grazing and native bushland as post mining land uses (PMLUs) and conditions the achievement of Class 2, Class 3 and Class 4 post mining land suitability class, per disturbance type, for beef cattle grazing PMLU. These PMLUs have been transitioned into the WCP PRCP. Soil investigations indicate the quality and quantity of topsoils across the WCP area are sufficient for use in rehabilitation activities. Topsoil will be selectively stripped from disturbed areas associated with the WCP and, if not directly placed in rehabilitation activities, stockpiled for later use in rehabilitation.

Topsoil depths to be applied over rehabilitation areas will be dependent on disturbance type and slope. Land used for exploration and infrastructure including roads; and generally located on lower gradient slopes will be rehabilitated with approximately 100 mm of topsoil whilst overburden emplacements, low walls and the weathered zone of highwalls will be treated with approximately 200 mm of topsoil. These depths are commensurate with local in-situ topsoil depths across the WCP area and are effective in establishing a seed bed for germination of vegetation species that will support both beef cattle grazing and native bushland PMLUs. A topsoil depth of 200 mm on higher slope gradients will also address some of the limitations identified in the post mining land suitability assessment such as plant water availability. Limitations such as erosion and nutrient content will be managed through the application of agricultural gypsum and fertilisers at the same time as ripping and seeding. Addressing these limitations will ultimately assist in the achievement of the prescribed land suitability class for grazing.

Table of Contents

Basis of Report i
Executive Summary ii
Acronyms and Abbreviations vi
1.0 Introduction 1
1.1 Project Overview 1
1.2 Project Description 1
1.3 PRCP Requirements 5
2.0 Soil Resources Available 6
2.1 Review of Documents 6
2.2 Native Soil Resources 6
2.2.1 Land Resource Areas 6
2.2.2 Soil Types 7
2.2.3 Soils Chemistry 17
2.3 Pre-mining Land Suitability 23
3.0 Post-Mining Rehabilitation Requirements 26
3.1 Proposed PMLUs 26
3.2 Landform Slope Analysis 30
3.3 Post-mining Suitability Assessment of Grazing PMLU 33
3.4 Topsoil Requirements 35
3.4.1 Topsoil Stripping Depth 35
3.4.2 Topsoil Application Depth 35
3.4.3 Topsoil Spreading 36
3.4.4 Fertilisers and Ameliorants 37
3.4.5 Seedbed Preparation 37
3.4.6 Topsoil Resources Availability 37
4.0 Rehabilitation Management 39
4.1 Stockpile Planning and Placement 39
4.1.1 Soil Inventory 39
4.1.2 Erosion Control and Drainage Management 40
4.2 Compaction Management 40
4.3 Weed Management 40
4.4 Monitoring and Maintenance 41
5.0 References 42

Tables in Text

Table 1-1 PRCP guideline soils and capping requirements 5
Table 2-1 Summary of available background information 6
Table 2-2 Properties of LRAs 7
Table 2-3 Soil classification within the WCP MLs 20
Table 2-4 Chemistry of topsoils within the WCP MLs 21
Table 2-5 Land suitability assessment summaries 23
Table 2-6 Land suitability classes (DNRM, 1990) 24
Table 2-7 Pre-mining land suitability area 24
Table 3-1 Characteristics of proposed PMLUs 28
Table 3-2 Final landform slope analysis for WCP LoM area of disturbance 30
Table 3-3 Summary of EA PMLU and final landform land suitability assessment 34
Table 3-4 Potential topsoil stripping depths and potential constraints for reuse (Parsons Brinckerhoff, 2008) 35
Table 3-5 Proposed topsoil stripping depths and available volumes for use per soil associations in LoM disturbance footprint 38
Table 3-6 Proposed topsoil placement depths 38

Figures in Text

Figure 1-1 Regional project location 3
Figure 1-2 Proposed PRCP and WCP site layout 4
Figure 2-1 Test pit locations (PB, 2008) 8
Figure 2-2 Soil management considerations 16
Figure 2-3 Soil association distribution with the mining lease 18
Figure 2-4 Soil associations within the LoM pit disturbance footprint 19
Figure 2-5 Pre-mining land suitability class for beef cattle grazing (PB, 2008) across WCP MLs and LoM pit extents 25
Figure 3-1 PMLU within the proposed final landform 27
Figure 3-2 Slope analysis for the WCP MLs and LoM disturbance 32

Photos in Text

Photo 1 Typical profile of the Cheshire soil (reproduced from PB (2008)) 9
Photo 2 Typical profile of the Kinnoul soil (reproduced from PB (2008)) 10
Photo 3 Typical profile of the Teviot soil (reproduced from PB (2008)) 11
Photo 4 Typical profile of the Rolleston soil (reproduced from PB (2008)) 12

Photo 5 Typical profile of the Juandah soil (reproduced from PB (2008)) 13
Photo 6 Typical profile of the Woleebee soil (reproduced from PB (2008)) 14

Appendices

Appendix A Soil Chemical Property Ratings

Appendix B DME, 1995 Land Suitability for Grazing Criteria

Appendix C Laboratory data – PB, 2008 and Slater, 1986

Appendix D Key Soil Types in the Wandoan Project Area

Appendix E Regional land suitability framework for beef cattle grazing PMLU rehabililitation in the Bowen Basin

Acronyms and Abbreviations

AMD	Acid mine drainage
AEP	Annual exceedance probability
CHPP	Coal handling and processing plant
DETSI	Department of Environment, Tourism, Science and Innovation
DME	Department of Mines and Energy
DNRM	Department of Natural Resources and Mines
EA	Environmental Authority
EIS	Environmental Impact Statement
GCAA	Glencore Coal Assets Australia Pty Ltd
LoM	Life of Mine
LRA	Land resource area
MIA	Mine infrastructure area
ML	Mining lease
Mtpa	Million tonnes per annum
NUMA	Non-use management area
PB	Parsons Brinckerhoff
PMLU	Post mining land use
PRCP	Progressive rehabilitation and closure plan
ROM	Run of mine
SLR	SLR Consulting Australia Pty Ltd
WCP	Wandoan Coal Project

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Wandoan Holdings Pty Ltd (herein referred to as the Proponent) on behalf of the joint venture partners to undertake a soils assessment to support the development of the Wandoan Coal Project (WCP) Progressive Rehabilitation and Closure Plan (PRCP).

The soils assessment has been prepared to address the requirements of Section 3.6.1 of the PRCP Guideline. As such, the soils assessment considers the availability, location, treatment and application of topsoil resources in rehabilitation activities at the WCP.

Waste characterisation and capping requirements for the WCP PRCP are addressed in the report, *Geochemical, physical, and spontaneous combustion assessment of mine materials* (RGS, 2024) which also supports this PRCP application.

1.1 Project Overview

The WCP is authorised under the Environmental Authority EPML00297613 (EA) on mining leases (MLs) 50229, 50230 and 50231, encompassing 30,100 ha. The WCP is located approximately 300 kilometres (km) southeast of Emerald and 250 km southwest of Gladstone in the Western Downs region of Queensland. The MLs extend approximately 34 km in an east-west direction and 22 km in a north-south direction as presented in **Figure 1-1**.

The WCP was issued with environmental approvals by State and Commonwealth Governments between 2011 and 2013 with MLs granted in 2017.

The Queensland Department of Environment, Tourism, Science and Innovation (DETSI) issued a notice for a transitional PRCP in accordance with the PRCP Guideline to be delivered for the WCP by the 27 September 2024.

1.2 Project Description

The WCP remains undeveloped and mining operations have not commenced. The current mine plan, as described herein, meets the approval conditions for the WCP. The WCP site layout is shown in **Figure 1-2**.

17,005 ha of the total ML area will be used for mining operations. The mine plan supporting the PRCP contains 16 open cut mining pits designed to meet current approval conditions with:

- A mining rate of 4 to 12 million tonnes per annum (mtpa) run of mine coal (ROM) until 2105;
- Disturbance areas within the approved pit, overburden emplacement, haul road, access roads and tracks, and dam and infrastructure footprints;
- A coal handling and preparation plant (CHPP) with associated coal handling, tailings dewatering facilities and ROM stockpiles;
- A mine infrastructure area (MIA) that includes workshops, washdown facilities, service bays, administration offices and bathhouses;
- Dry stacking methods and encapsulation within overburden emplacements for tailings, rejects and materials with spontaneous combustion risk.
- Raw and mine affected water storages; and
- All mining is designed outside the 0.1% Annual Exceedance Probability (AEP) flood levels.

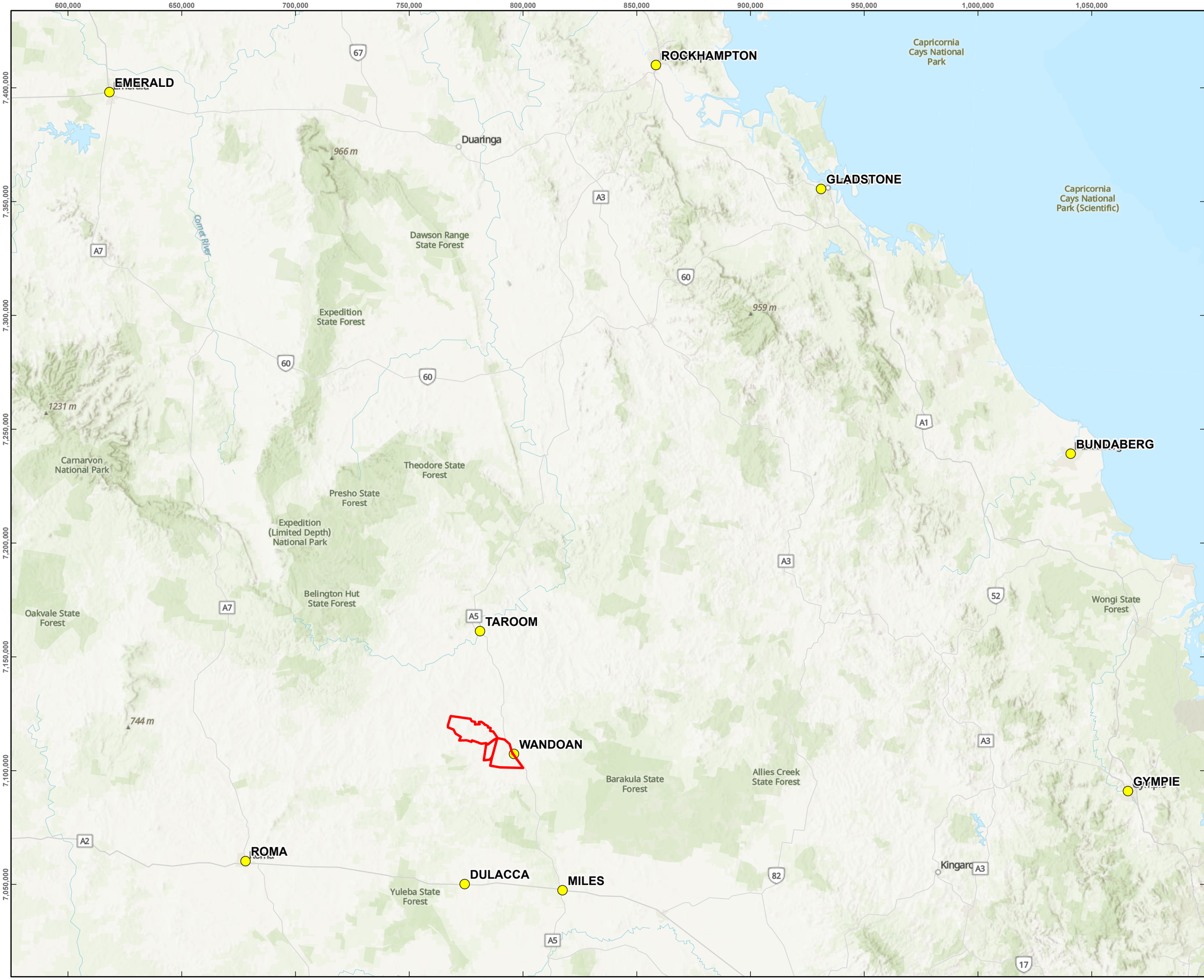
The WCP final landform at closure has been designed to comply with the EA and contains the following as relevant to this soils assessment:

- PMLUs of predominantly grazing with small areas of native bushland;
- No non-use management areas (NUMAs);
- 16 mining pits as per the EA;
- Pit backfilling in 8 pits to create a free draining landform with no depressions;
- Reprofiled void depressions in the remaining 8 pits to ≥ 5 m above the final groundwater level with ephemeral waterbodies periodically containing water compatible with the grazing PMLU;
- Overburden emplacements with external maximum slope grades of 18 % and low wall grades of 22 %; and
- Maximised progressive rehabilitation rates within the PRCP Schedule.

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 1-1
PROJECT LOCATION



LEGEND

- Town/City
- Highway
- Watercourse
- Wandoan Coal Project Mining Leases
- Protected Area

Service Layer Credits:
Department of Resources, Dept.of Environment and Science, Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, CGIAR

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 25 50 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,500,000 at A4
Project Number:	626.30100.00800
Date Drawn:	05-Mar-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F1-1 Project Location

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 1-2
THE WCP SITE LAYOUT

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek
K Road
Kaburnga Road
Number Four Road
M One Road
Juandah Creek
M Two Road
Number Two Road
Walshs Road
Nathan Road
ML 50229
Turkey Hill
Ryals Road
Summer Hill
Mud Creek North
Booral Road
Mud Creek East
Mud Creek
Cecils Road
Q Road
Austinvale North
Leichhardt Highway
Woleebee Creek
Grosmont Road
Bundi Road
Woleebee Creek North 2
Austinvale
Leichhardt
Tip Road
Dillons Road
McAllisters Road
Bundi Two Road
L Road
Woleebee Creek North
Frank Creek North
ML 50231
Frank Creek
Roche Creek Road
WANDOAN
Woleebee Creek
Jackson Wandoan Road
Woleebee
Nelders Road
Frank Creek South
Peakes Road
Wubagul
Paradise Downs Road
ML 50230
Weldons Road
Burunga Lane

LEGEND

- Town/City
- Watercourse
- Road
- Rail Loop
- Conveyor
- Wandoan Coal Project Mining Leases
- EA Authorised Disturbance Footprint
- MIA
- CHPP
- ROM Pad
- Dam
- Haul Road
- Haul Road Extension
- Power Station
- Pit (PRCP)
- Dump (PRCP)
- Pit (EA Approved)
- Dump (EA Approved)

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	15-Oct-2025
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F02-2 The WCP Site Layout

1.3 PRCP Requirements

Section 3.6.1 of the PRCP Guideline outlines the requirements for a soil and capping material assessment. The available soil resources and capping material should be assessed prior to the commencement of operations. A soil assessment must be carried out that, at a minimum, identifies and characterises the following items listed in **Table 1-1**.

Table 1-1 PRCP guideline soils and capping requirements

Requirement	Comments
Section 3.6.1: Soil and Capping Material Assessment	
The quality and quantity of available resources (topsoil) to complete the target rehabilitation methodology.	• Topsoil has been addressed in **Section 3.4.1** of this report. • Waste characterisation and tailings and rejects encapsulation are addressed in the attached appendices RGS 2024 and PSM 2024. • RGS 2024 and PSM 2024 indicate capping material such as clay and competent rock is not required to complete the rehabilitation methodology for the WCP PRCP.
The location of topsoil located on the tenure.	• All required topsoil is located on the tenure and will be stripped and stockpiled or directly placed and reused during operations. **Section 2.0** • All materials are available on tenure and no other approvals will be required for topsoil or other material requirements.
An assessment to determine the need for ameliorants and fertilisers.	• Soil quality characteristics are addressed in **Section 2.2.3** of this report.
The relationship between soils and vegetation ecosystems for the PMLU and rehabilitation strategy.	• Native soils as related to native bushland are discussed in **Section 2.2** of this report.
Section 3.6.1: Revegetation	
Identify the growth media that would be suitable to sustain the PMLU and whether this is available on site.	• Rehabilitation methodologies for the PMLUs of grazing and native ecosystems are presented in **Section 2.0** of this report.
Identify topsoil depth requirements for revegetation success and sustainable PMLU.	• Topsoil depths for the sustainability of grazing and native bushland PMLUs are discussed in **Section 3.3** of this report.
The application and incorporation of ameliorants (if required for chemical balance) and bulk ameliorants such as gypsum, lime, fertiliser and other organic materials.	• Surface treatments, ameliorants and fertiliser requirements are addressed in **Section 3.4.4** of this report.
Spreading of growth medium layer (topsoil, topsoil/rock mix, or suitable waste if appropriate) to a depth suitable for the target vegetation.	• See **Section 3.4.3.** • A topsoil/rock mix or the use of suitable waste as a growth medium is not required for the WCP PRCP.

2.0 Soil Resources Available

2.1 Review of Documents

The documents reviewed in developing this report are listed in **Table 2-1**.

Table 2-1 Summary of available background information

Date	Author	Title
2008	Seedsman	Status Report - Wandoan
2008	Golder Associates	Geotechnical Evaluation for Open Pit Mining - Wandoan Coal Project
2008	PB	Geology, Mineral resources, Overburden & Soils Impact Assessment - Wandoan Coal Project
2008	Xstrata Coal	Wandoan Sample Pit Report - Wandoan JV Project
2009	PB	Geology, mineral resources, overburden and soils impact assessment. Addendum to the Wandoan Coal Project.
2010	URN	Wandoan Project Hydrogeological Study - Alluvium and Spoil Dump Assessment
2019	QLD EPA	Environmental authority EPML00297613
2023	RGS	Geochemical, Physical and Spontaneous Combustion - Sampling and Analysis Plan Wandoan Phase 2 (GPSC-SAP)
2023	RGS	DRAFT Geochemical, physical and spontaneous combustion assessment of mine materials from the Bulk Sample Pit
2024	RGS	Geochemical, physical, and spontaneous combustion assessment of mine materials
2024a	SLR	Terrestrial Ecology Technical Report
2024b	SLR	Wandoan Erosion Assessment
2024	PSM	Geotechnical Assessment – Stability Analyses
Unknown	Xstrata Coal	Geology, Mineral Resources, Overburden & Soils - Wandoan Coal Project

2.2 Native Soil Resources

2.2.1 Land Resource Areas

Land Resource Areas (LRAs) are reoccurring landscape units characterised by similar geology, landforms, soils and vegetation associations used to aid field identification of land resource unit mapping and subsequent land management.

The Wandoan District Land Management Field Manual (Gray, H.J., Macnish, S.E. 1958) identified two LRAs in the WCP area described as ‘Brigalow Uplands’ with cracking and non-cracking clays and ‘Poplar Box Alluvia’ with uniform soils and texture contrast soils shown in **Table 2-2**. Brigalow Uplands is usually found in undulating plains, broad ridges and low hills and Poplar Box Alluvia is found in floodplains and drainage channels.

Table 2-2 Properties of LRAs

Property	Brigalow Uplands Cracking clays and non-cracking clays	Poplar Box Alluvia Uniform soil and texture contrast soil
Landform	Undulating plains with broad ridges and low hills, on sandstones and shales.	Floodplains of generally narrower width than Coolibah LRA; often associated with active secondary stream channels; mixed and sandy alluvia.
Soil Type	Grey and brown non-cracking and gilgaied cracking clays; shallow sandy and loamy soils on ridges and some texture contrast soils.	Predominantly deep, cracking, grey clays and loams, texture contrast soils.
Common Soils	Rolleston (including, Rolleston Family), Teviot Downfall, Cheshire, Kinnoul.	Juandah, Retro, Woleebee.
Vegetation	Brigalow open forest and softwood scrub. Brigalow open forest with either poplar box or belah or Dawson gum or bauhinia. Scattered wilga and softwood scrub species frequently occur.	Predominantly poplar box grassy woodland. Scattered false sandalwood and softwood scrub species frequently occur.
Land Use	Predominantly winter grain cropping with occasional summer cropping. Grazing of native and improved pastures.	Predominantly winter grain cropping and grazing of native and improved pastures. Summer cropping is difficult. Moderate flooding hazard.

2.2.2 Soil Types

A geology, mineral resources, overburden and soils assessment was undertaken to support the WCP Environmental Impact Statement (EIS) (Parson Brinckerhoff (PB), 2008), to assess and define the existing land-related site characteristics that may impact on or be impacted by the WCP and, to assess the soil and overburden management requirements and reuse potential. The assessment comprised a review of available published data, field investigation, laboratory testing, classification and mapping of soils, and a land suitability assessment. A laboratory testing program was carried out to determine chemical and physical characteristics of soils and overburden relevant for land suitability assessment, construction design and rehabilitation.

The field work for PB (2008) comprised:

- Excavation and sampling of 41 test pits within the MLs shown in **Figure 2-1** (numbered WS01 to WS41); and
- Walk-over survey.

All test pits were excavated to between 0.4 m and 2.3 m in depth. Selected disturbed samples of surface and subsurface soils were obtained at regular intervals or at a change of strata for material identification and laboratory testing purposes.

Eight (8) soil types were identified across the WCP area including cracking and non-cracking clays on the undulating hills and uniform and texture contrast soils on the floodplain.

Predominant soil types found within each LRA over much of the WCP area include: Cheshire, Kinnoul, Downfall, Teviot, Rolleston for Brigalow Upland Soils LRA and Juandah, Woleebee and Retro for Poplar Box Alluvia Soils LRA.

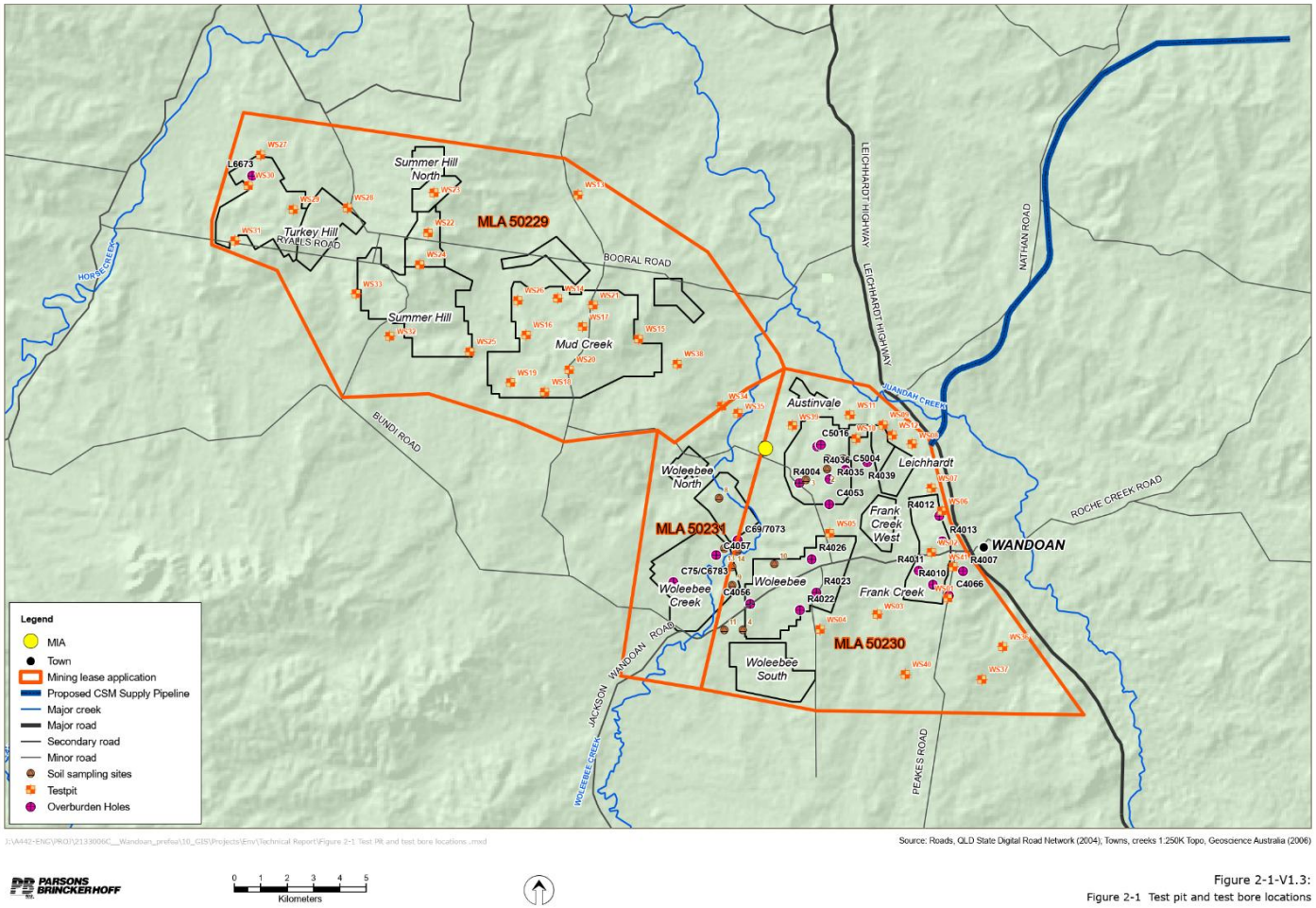


Figure 2-1 Test pit locations (PB, 2008)

2.2.2.1 Brigalow Upland Soils

Cheshire

Cheshire soils in the WCP area occur on upper slopes (up to 3%). They have largely been cleared and are used for cattle grazing. These soils comprise shallow, non-cracking uniform clays, classified as a Brown Dermosol under the Australian Soil Classification (Isbell 2021).

The topsoil (A1) shown in **Photo 1** was approximately 400 mm – 600 mm deep and consisted of dark, sandy clay to light clay, with a fine structure and a mildly alkaline pH. The topsoil has low to moderate salinity and a non-dispersive A1 horizon.

The B horizon consists of a brown to grey-brown medium clay, with calcareous concretions. This horizon turns yellow brown at less than approximately 1.0 m depth and the subsoil were characterised as strongly alkaline, highly saline and dispersive throughout the B and C horizons. Weathered sandstone or siltstone is typically encountered within 1.0 m to 1.5 m depth.

Photo 1 Typical profile of the Cheshire soil (reproduced from PB (2008))

Kinnoul

Kinnoul soils occur on ridgetops and upper slopes in the WCP area and are commonly covered by regrowth brigalow. Being a shallower version of Cheshire, it often grades into Cheshire on upper slopes. Under the Australian soil classification (Isbell 2021) this soil is a Brown Dermosol.

The topsoil (A1) is approximately 300 mm to 400 mm deep and consists of a dark, sandy clay or light clay, with a well-developed blocky structure. It has a neutral to mildly alkaline pH, low to moderate salinity and is considered non-dispersive.

The B horizons consist of brown and blocky light clay, with mildly alkalinity, low to moderate salinity and low dispersivity, increasing to strongly dispersive with depth. Calcareous concretions are generally absent but may be present on slopes where the soil grades into other soil types, or in areas of poorer drainage. Weathered sedimentary rock is generally encountered within 0.75 m depth. The yellow-brown lower subsoil encountered in Cheshire is generally poorly developed in this soil. **Photo 2** shows the typical profile of the Kinnoul soil.

Photo 2 Typical profile of the Kinnoul soil (reproduced from PB (2008))

Downfall

Downfall soil occurs on mid to lower slopes of approximately 2% grade in areas of sediment accumulation within the Brigalow Uplands. The soil description is a Brown Vertosol uniform cracking clay. Slater (1986) recorded moderate gilgai formation with a vertical interval of 400 mm and horizontal interval of 4 m.

The topsoil (A1) is shallow, about 50 mm – 150 mm deep, consisting of a neutral brown-grey clay of medium plasticity, with a fine granular structure, neutral to mildly alkaline pH, low

salinity and dispersive. The topsoil has low nitrogen and phosphorus availability and approximately 2% organic carbon. The A2 horizon is generally absent.

The upper B horizons consist of a medium to heavy clay with fine blocky peds, slightly alkaline pH, dispersive and traces of calcareous concretions. The lower subsoils are dispersive grey and/or yellow-brown heavy clays with strongly alkaline pH. Weathered sandstone or colluvium is typically encountered at greater than 1.5 m depth (Photo not available).

Teviot

Teviot soil occurs on gently inclined midslopes with a gradient of 1% to 3% and under the Australian Soil Classification (Isbell 2021) this soil is a Brown Vertosol.

The topsoil (A1) shown in **Photo 3** is approximately 200 mm deep and consists of brown-grey to dark brown-grey clay with neutral to slightly alkaline pH, low salinity and non-dispersive. The topsoil has medium nitrogen and phosphorus availability and approximately 2% to 3% organic carbon.

The B horizon comprises high plasticity clay with strong blocky peds and is dispersive. The lower subsoil consists of strongly dispersive grey-yellow-brown clay and appears highly susceptible to tunnel erosion if exposed. Weathered sandstone is typically encountered within 1.0 m to 1.5 m depth. Subsoils are moderately alkaline as is the B and C horizons. Salinity is moderate in the B horizon and increases with depth.

Photo 3 Typical profile of the Teviot soil (reproduced from PB (2008))

Rolleston

The Rolleston soil shown in **Photo 4** occurs on mid and lower slopes, on slopes of approximately 1% to 4%. It is typically used for dryland grain cropping and is a uniform

cracking clay classified as a Brown Dermosol. The topsoil is approximately 200 mm deep and comprises non-dispersive to dispersive dark brown-grey heavy clay with blocky peds, is slightly alkaline and has low salinity. The topsoil (A1) has low to medium nitrogen and phosphorus content and low organic carbon content. The A2 horizon may be absent.

The B horizon consists of dispersive, high plasticity clay with strong blocky peds and calcareous concretions. The lower subsoil is strongly acidic or strongly alkaline pale-yellow brown to yellow-orange and strongly dispersive, with weathered sandstone or siltstone encountered at depths greater than 1.5 m.

Photo 4 Typical profile of the Rolleston soil (reproduced from PB (2008))

2.2.2.2 Poplar Box Alluvia Soils

Juandah

Juandah soils occur on flat floodplains in the WCP area with less than 1% gradient within Poplar Box Alluvia. They are deep uniform clays developed on alluvium, typically used for cattle grazing and classified as a Brown Vertosol under the Australian Soil Classification (Isbell 2021).

The topsoil (A1) is shown in **Photo 5** approximately 500 mm deep and comprises high plasticity dark brown-grey clay with a granular to blocky structure and hard setting surface where previously disturbed by agriculture. They have neutral pH and low salinity, with low to medium nitrogen and phosphorus availability. The A1 horizon is non-dispersive, with a dispersive A2 horizon.

The B horizon consists of dispersive, high plasticity, dark brown-grey clay, with coarse blocky to massive structure, slight to moderately alkaline pH and low to medium salinity. Subsoils

grade to yellow-brown massive, alkaline, clays. The soil profile is generally greater than 1.5 m deep and underlain by alluvium.

Photo 5 Typical profile of the Juandah soil (reproduced from PB (2008))

Woleebee

Woleebee soil occurs on the floodplains of Woleebee and Juandah Creeks in the WCP area. The soils are texture contrast soils developed on alluvium and are typically used for cattle grazing. The topsoil (A1) shown in **Photo 6** is approximately 150 mm deep and comprises grey silt loam. It is dispersive, has a neutral pH, low to medium salinity, and low organic carbon content.

The B horizon comprises strongly dispersive dark medium clay, with layered alluvium encountered at less than 1.0 m depth. The pH and salinity increase with depth to strongly alkaline and medium to high salinity from approximately 500 mm.

Under the Australian Soil Classification (Isbell 2021) this texture contrast soil is classed as a Brown Sodosol.

Photo 6 Typical profile of the Woleebee soil (reproduced from PB (2008))

Retro

The Retro soils occur on gently undulating floodplains in the WCP area with slopes of less than 0.5% within Poplar Box Alluvia and are typically uncleared, with grassy open woodland of poplar box and sandalwood. The soils are deep texture contrast soils, developed over weathered sedimentary rock or colluvium, but within the floodplain of the streams. They are classified under the Australian Soil Classification (Isbell 2021) as a Brown Chromosol.

The topsoil (A1) horizon is approximately 150 mm deep and consists of a non-dispersive dark brown-grey clay-loam with neutral pH and low salinity. The topsoil has low to medium nutrient availability, with medium to high organic carbon content and is commonly underlain by a bleached, pale orange A2 horizon.

The B horizon consists of non-dispersive, high plasticity, dark brown heavy clay with medium sized blocky peds. Calcareous concretions may be present, and the soil has an alkaline pH. The lower subsoil is dispersive, brown, heavy clay, grading to weathered sediments or colluvium at approximately 1.0 m depth (Photo not available).

2.2.2.3 Subsoils and Further Management Considerations

Much of the subsoils in the WCP areas were found to be alkaline, sodic and dispersive. The subsoils of the Cheshire, Woleebee, Rolleston and Teviot were identified as having moderate to extreme alkalinity and sodicity whilst, all other subsoils within the Brigalow Uplands LRA were considered dispersive to a lesser extent. These subsoils will require specific management techniques to be considered for use in rehabilitation activities however, currently subsoils are not anticipated to be required. Soils identified as most susceptible to erosion include Cheshire, Woleebee and Teviot (PB, 2008).

The distribution of Alluvia soils across the MLs is shown in **Figure 2-2.** These soils may also require management techniques as they are shown as poorly workable when wet, however with the mine plan being designed outside of the 0.1% AEP, this will not significantly affect topsoil management as these soils will not be subject to long periods of water logging as those located further down on the flood plain.

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 2-2
SOIL MANAGEMENT CONSIDERATIONS

LEGEND

- Road
- Major Watercourse
- Minor Watercourse
- Wandoan Mining Lease
- Dispersive, Erosion Prone Subsoils
- Poor Workability, When Wet

MLA 50229
MLA 50230
MLA 50231

CULGOWIE
WANDOAN

RYALLS ROAD
BOORAL ROAD
GROSEMONT ROAD
GROSMONT ROAD
CECILS ROAD
BUNDI ROAD
K ROAD
KABUNGA ROAD
LEICHHARDT HIGHWAY
JACKSON WANDOAN ROAD
GULUGUBA DOWNFALL CREEK ROAD
PARADISE DOWNS ROAD
PEAKES ROAD

SPRING CREEK
MOUNT ORGAN CREEK
LOG HUT GULLY
BACK CREEK
BLACK ANT CREEK
WOLEEBEE CREEK
FRANK CREEK
JUANDAH CREEK
TWO MILE CREEK
WANDOAN CREEK
MUD CREEK
NAIL CAN CREEK
HALFWAY CREEK

770,000 775,000 780,000 785,000 790,000 795,000 800,000
7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Service Layer Credits:

Soil Management Considerations, Parsons Brinckerhoff, 2008

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	16-Jul-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP SOILS F02-2 Soil Management Considerations

2.2.3 Soils Chemistry

A detailed investigation into the soil quality of the pre-mining soils was undertaken by PB (2008) and Slater (1986) and is included in **Appendix C**.

All A1 topsoil horizons were identified as alkaline, except for Juandah which was neutral, of low to moderate salinity and non-dispersive except for Downfall and Wolleebee. The subsoils of the Cheshire, Woleebee, Rolleston and Teviot were identified as having moderate to extreme alkalinity and sodicity. All other subsoil within the Brigalow Uplands LRA were considered dispersive to a lesser extent.

Subsequent investigations undertaken by RGS (2024) focussed on the characterisation of bulk samples obtained from the Wandoan Bulk Sample Pit (WBSP) located within the proposed footprint of the Austinvale Pit. Soil quality testing was completed on four samples from the WBSP collected by site personnel. Sample depths for all samples were listed as 0 m to 0.6 m. Soil characterisation results for the topsoil and subsoil composite samples indicated that the soils have low salinity, moderate cation exchange capacity (CEC) and low macro-nutrients plant-available phosphorous (P) and potassium (K). However, these were deemed sufficient to support native vegetation but would require supplementing for establishing grazing pastures.

However, based on soil depths estimated by PB (2008), the topsoil depth of 0 m to 0.6 m is unlikely and as such all four samples were considered a mixture of topsoil and subsoil. The results for the four samples indicated subsoils that are strongly alkaline with low salinity. Samples were found to be strongly sodic with an Emerson Class of 2, indicating potential for partial dispersion (RGS, 2024). These results correspond to subsoil quality as described by PB (2008).

A summary of the soil types is presented in **Table 2-3** and chemistry of each soil type is presented in **Table 2-4**. It is noted that historic agricultural activities in the WCP area may have altered the soil profiles. As a result, soils described in these tables may not represent soils in their ‘native or natural’ condition. The practice of blade plough ripping has occurred in 10-to-20-year intervals across the Wandoan region to control vegetation growth (i.e. suppress Brigalow regeneration), as well as to control water erosion. Although blade plough ripping is not intended to turn the soil, the practice may have altered the top ~200 mm of topsoil and produced a more diffuse boundary between subsoils and topsoils.

The occurrence of buffel grass (*Cenchrus ciliaris*) was also observed to have impacted the soil profile, with an apparent correlation between the depth of the A1 horizon and the buffel grass rooting depth. At sites where this grass was encountered, the A1 soil horizon was generally not more than approximately 50 mm.

A distribution of soil types across the MLs has been presented in **Figure 2-3**. Soils with similar physical or chemical properties have been grouped together as soil associations, however whilst discrete boundaries between soil types are presented, the soils actually grade into each other over a distance of approximately 300 m. Abrupt boundaries between soil types generally do not occur in the WCP area, except along drainage lines.

Soil associations (updated from PB (2008)) within current life of mine (LoM) pit extents are presented in **Figure 2-4**.

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Ndeebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 2-3
SOIL DISTRIBUTION ACROSS THE MINING LEASE

LEGEND

- Watercourse
- Wandoan Mining Lease

Soil Associations

- Brigalow Upland Cracking Clays
- Brigalow Upland Non-cracking Clays
- Poplar Box Alluvia Texture Contrrast Soil
- Poplar Box Alluvia Uniform Soil

Service Layer Credits:
Earthstar Geographics
Soil Associations, Parsons Brinckerhoff, 2008

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	24-Jun-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP SOILS F02 Soil Distribution Across the Mining Lease

765,000 770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Turkey Hill

Summer Hill

ML 50229

Mud Creek North

Mud Creek

Mud Creek East

Austinvale North

Austinvale

Leichhardt

Woleebee Creek North 2

Woleebee Creek North

ML 50231

Woleebee Creek

Frank Creek North

Frank Creek

Woleebee

ML 50230

Frank Creek South

Wubagul

Woleebee Creek

Soil Association	Total Area (ha)
Brigalow Upland Cracking Clays	3382.83
Brigalow Upland Non-cracking Clays	3153.61
Poplar Box Alluvia Texture Contrrast Soil	18.11
Poplar Box Alluvia Uniform Soil	42.34
Total	6596.89

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 2-4 SOIL ASSOCIATION WITHIN APPROVED PITS

LEGEND

- Watercourse
- Wandoan Mining Lease
- Pit Extent

Soil Associations

- Brigalow Upland Cracking Clays
- Brigalow Upland Non-cracking Clays
- Poplar Box Alluvia Texture Contrrast Soil
- Poplar Box Alluvia Uniform Soil

Service Layer Credits:
Earthstar Geographics
Soil Associations, Parsons Brinckerhoff, 2008

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:110,000 at A3
Project Number:	626.30100.00800
Date Drawn:	11-Jul-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP SOILS F06 Soil Association within Approved Pits

Table 2-3 Soil classification within the WCP MLs

Soil Association	Soil type	Australian Soil Classification	Slope	A1 horizon depth (mm)	Depth to weathered horizon	Dispersivity
LRA: Brigalow Upland Soils - Undulating plains, broad ridges and low hills						**Topsoil**
Cracking clays	Rolleston	Brown Dermosol	Mid or lower slopes 1 to 4%	200	Weathered sandstone or siltstone >1.5 m	Non-dispersive
	Teviot	Brown Vertosol	Gently inclined mid slope 1 to 3%	200	Weathered sandstone 1.0 -1.5 m	Non-dispersive to dispersive
	Downfall	Brown Vertosol	Mid to lower slopes 2%	50 – 150	Weathered sandstone or colluvium >1.5 m	Dispersive
Non-cracking clays	Kinnoul (Shallow Cheshire)	Brown Dermosol	Upper slopes	300 - 400	Weathered sedimentary rock 0.75 m	Non-dispersive
	Cheshire	Brown Dermosol	Steeper gradient upper slopes. Up to 3%	400 - 600	Weathered sandstone or siltstone 1.0 – 1.5 m	Non-dispersive
LRA: Poplar Box Alluvia Land Resource Area – Floodplains and drainage channels						**Topsoil**
Texture contrast soils	Retro	Brown Chromosol	Gently undulating floodplains < 0.5%	150	Weathered sediments or colluvium 1.0 m	Non-dispersive
	Woleebee	Brown Sodosol	On floodplains	150	Weathered alluvium 1.0 m	Dispersive
Uniform texture soil	Juandah	Brown Vertosol	Flat floodplains with less than 1% gradient	500	Weathered alluvium > 1.5 m	A1 non-dispersive A2 dispersive

Table 2-4 Chemistry of topsoils within the WCP MLs

Soil Association	Soil type	Profiles analysed	Texture	pH	Salinity	Cation exchange capacity	Calcium to magnesium ratio	Trace metals	Nitrate as N	Bicarbonate phosphorus	Organic matter
LRA: Brigalow Upland Soils - Undulating plains, broad ridges and low hills											
Cracking clays	Rolleston	4	Heavy clay	Neutral to strongly alkaline	Low	Very low to high	Low Ca to balanced	Medium Cu, medium to high Mn and medium Zn	Low to high	Moderate	Low to moderate
	Teviot	8	Clay	Mildly to moderately alkaline	Low	Very low to high	Low Ca to balanced	Medium Cu, medium to high Mn, low to medium Zn	Low to moderate	Very low to low	Moderate to high
	Downfall	5	Clay	Neutral to moderately alkaline	Low	Very low to high	Low Ca	Medium Cu, Mn and Zn	Low to high	High	Moderate
Non-cracking clays	Kinnoul (Shallow Cheshire)	6	Sandy clay or light clay	Neutral to mildly alkaline	Low to moderate	Low	Balanced	Zn and Cu below detection limit, Mn medium	Low to high	Very low	Moderate to high
	Cheshire	4	Sandy clay to light clay	Neutral to mildly alkaline	Low to moderate	Low to high	Low Ca	Medium Cu and Zn, medium to high Mn	Moderate to high	Very low to low	Moderate to high
LRA: Poplar Box Alluvia Land Resource Area – Floodplains and drainage channels											
Texture contrast soils	Retro	3	clay loam	Neutral to mildly alkaline	Low	Very low to low	Balanced	Zn below detection limit, medium Mn, very high Zn	Low to moderate	Low	Moderate
	Woleebee	1	Silt loam	Mildly alkaline		Moderate	Balanced		High	High	Moderate

Soil Association	Soil type	Profiles analysed	Texture	pH	Salinity	Cation exchange capacity	Calcium to magnesium ratio	Trace metals	Nitrate as N	Bicarbonate phosphorus	Organic matter
					Low to moderate			Low Cu, medium Mn and Zn			
Uniform texture soil	Juandah	4	Clay	Neutral	Low	Very low to high	Low Ca to balanced	Medium Cu, medium to high Mn and low to medium Zn	Low to high	Moderate	Moderate to high
Cu: Copper, Mn: Manganese, Zn: Zinc Ratings are provided (Appendix A)											

2.3 Pre-mining Land Suitability

Several land suitability assessments of parts of the Wandoan region have been completed previously and are listed in **Table 2-5**. Land suitability assessments have been undertaken to identify agricultural suitability for various uses including dry-land cropping and cattle grazing on improved pasture.

Table 2-5 Land suitability assessment summaries

Study Number	Summary
1 (Forster, B.A. 1985)[1]	This study was conducted at a LRA scale and classed the Brigalow Upland soils (with a slope of < 6%) as arable and the Poplar Box Alluvia soils as marginally arable.
2 (Slater, B. 1986) [1]	This study assessed each soil type identified for the study area and classed land as Land Suitability Classes 2, 3 and 4.
3 (Environsciences Pty Ltd 1992) [1]	This study assessed each soil type identified for the study area and classed land as Land Suitability Classes 3 and 4 for dryland cropping.
4 (Parsons Brinckerhoff 2005)	This study assessed the soil suitability at the Site for both beef cattle grazing and dryland cropping. Soil suitability of the study area for beef cattle grazing was classified as Class 2 for the entire site with the Site mainly classified as Class 3 and Class 4 dryland cropping land. Cheshire and Kinnoul soils were classified as Class 4 due to high erosion potential by surface runoff and the presence of alkaline subsoils, which results in low nutrient availability. Alluvial soils were rated Class 3, due to the potential for flooding. It was found that this assessment largely correlated with those aforementioned historical assessments.
5 (Parsons Brinkerhoff, 2009)	An addendum to the report prepared in 2008 took into consideration modified land suitability criteria for use in Central Queensland for cropping. The cropping land suitability was amended based on the new criteria. The site was still classified as Class 3 and Class 4 dryland cropping land with a larger portion of the site now classified as Class 3. Soil suitability for beef cattle grazing remained unchanged.

Studies:

1. Forster, B.A. (1985). Evaluation of Agricultural Land in Taroom Shire. (Forster, B.A. 1985)
2. Slater, B. (1986). Edaphic Properties of Soil and Overburden from a Potential Coal Mine near Wandoan, Queensland. (Slater, B. 1986)
3. Environsciences Pty Ltd. (1992). Land Capability and Use. Austinvale and Frank Creek Coal Deposit Areas, Wandoan. (Environsciences Pty Ltd 1992)
4. Parsons Brinkerhoff (PB) Australia Pty Ltd. (2008). Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment. (Parsons Brinckerhoff, 2008)
5. Parsons Brinkerhoff (PB) Australia Pty Ltd. (2008). Addendum to the Wandoan Coal Project. Geology, mineral resources, overburden and soils impact assessment. (PB 2009)

Note:

[1] these assessments were prepared prior to the release of the Department of Mines and Energy (DME) Land Suitability Assessment Techniques (DME 1995).

The pre-mining land suitability assessment was completed by PB in 2008 and revised in 2009. The land suitability assessment was completed using the *Guidelines for Agricultural Land Evaluation in Queensland* (DNRM 1990) with reference to DME (1995). Land suitability is categorised into five classes, ranging from Class 1 to Class 5, with Class 1 being the most suitable and Class 5 the least suitable. Classes are shown in **Table 2-6**. Earlier studies (Foster 1985 and Slater 1986 etc) largely correlated with the investigations undertaken by PB (PB, 2008 and revised 2009).

The pre-mining land suitability classes were derived from a combination of the identified soil types, and geomorphic/topographic position. Tables showing the criteria and classes assigned for each criteria are provided in **Appendix B**. PB (2008) and PB (2009) assessments as

presented in the WCP EIS formed the basis for conditioning in the EA as it relates to appropriate land suitability classes being nominated with correlating land uses.

Table 2-6 Land suitability classes (DNRM, 1990)

Classification*		Description
1	*Suitable land with negligible limitations*	Land which is well suited to a proposed use.
2	*Suitable land with minor limitations*	Land which is suited to a proposed use, but which may require minor changes in management to sustain the use.
3	*Suitable land with moderate limitations*	Land which is moderately suited to a proposed use, but which requires significant inputs to ensure sustainable use.
4	*Marginally suitable land*	Land which is marginally suited for a proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for the particular purpose and is hence considered presently unsuited.
5	*Unsuitable land with extreme limitations*	Land which is unsuited and cannot be sustainably used for a proposed use.

The beef cattle grazing pre-mining land suitability assessment is relevant to the areas of the proposed WCP landform that have a PMLU of beef cattle grazing. Whilst a pre-mining land suitability was conducted for dryland cropping no further consideration is given to this assessment as dryland cropping is neither proposed as a PMLU for the WCP nor authorised under the EA. The pre-mining soil suitability for the WCP MLs for beef cattle grazing was assessed as Class 2 for all soil types across the WCP MLs as presented in **Figure 2-5** with the areas associated with the WCP LoM disturbance shown in **Table 2-7**.

Table 2-7 Pre-mining land suitability area

Land Use	Area (ha)
Land Suitability (DME, 1995)	**Beef Cattle Grazing Class 2**
Total ML Area	30,100
Total LoM Disturbance Footprint within all MLs	17,005
Undisturbed Area within all MLs	13,096

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek
Juandah Creek
Turkey Hill
Summer Hill
Mud Creek North
Mud Creek East
Mud Creek
ML 50229
Austinvale North
Austinvale
Leichhardt
Woleebee Creek North 2
Woleebee Creek North
ML 50231
Woleebee Creek
Woleebee Creek
Frank Creek North
Frank Creek
Woleebee
Frank Creek South
WANDOAN
ML 50230
Wubagul

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 2-5
PRE-MINING LAND SUITABILITY CLASS FOR BEEF CATTLE GRAZING

LEGEND

- Town/City
- Watercourse
- Wandoan Mining Lease
- Pit Extent

Land Suitability Class

- 2

Service Layer Credits:
Earthstar Geographics
Land Suitability Class, Parsons Brinckerhoff, 2008

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	11-Jul-2024
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP SOILS F4 Pre-Mining Land Suitability Classes for Cattle Grazing

3.0 Post-Mining Rehabilitation Requirements

3.1 Proposed PMLUs

The WCP EA requires beef cattle grazing and native bushland as PMLUs and conditions the achievement of a post mining land suitability class for the beef cattle grazing PMLU per disturbance type. The post mining land suitability classes required to be achieved for the beef cattle grazing PMLU are:

- Land used for exploration, infrastructure including roads and Mine Infrastructure Areas (MIA) will have limitations related to water availability (through compaction and breakdown of the subsoil structure). This land will be returned to Class 3 grazing. Class 2 grazing will be considered where practicable; and,
- Overburden emplacements will have limitations related to plant water availability, salinity, slope, erosion and nutrient content. Flatter slope gradient sections will be returned to Class 2 grazing land where practicable. Steeper overburden slopes will be returned to Class 4 grazing land.

Areas of third-party infrastructure are located within the MLs including public roads. Some access tracks, roads and water storages will be retained under a landholder agreement to support the PMLU of beef cattle grazing. All PMLUs for the WCP are presented in **Figure 3-1** with the characteristics of the beef grazing PMLU defined in **Table 3-1**.

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Wolleebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 3-1
POST MINING LAND USE

LEGEND

- Watercourse
- Wandoan Coal Project Mining Leases

Post Mining Land Use

- Grazing
- Native Bushland

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	626.30100.00800
Date Drawn:	31-Jul-2025
Drawn by:	AS

SLR

Path: \\au.slr.local\Corporate\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F03-01 Post Mining Land Use

Table 3-1 Characteristics of proposed PMLUs

PMLU	Definition / Characteristics
Grazing	Grazing on land that has been rehabilitated to have varying slope gradients can be safely and sustainably grazed if effective land management controls are implemented to mitigate the potential for land degradation, erosion or injury to cattle. Grazing must be carried out in a considered manner and the intensity can be light, moderate and/or intensive. The intensity should be managed dependent on the landform's capability to sustain that intensity over a long period. Livestock are able to feed on pasture vegetation in areas where the land has undergone a restoration process, and the following effective land management controls must be implemented to maintain the land in a stable and productive state: • Pasture rotation ensures the land is not overgrazed and that vegetation cover remains, and biomass is >1,000 kg/ha. • Permanent water infrastructure to supply stock water of appropriate quality would support grazing in areas with moderately steep slopes. Water placement is a determinant of the areas where cattle prefer to graze, and consideration is required to be given where a clean water source is installed. • Revegetation utilising native species that support a productive pasture including 3P species (palatable, productive and perennial) and is drought resistant. Grazing on land that has been rehabilitated and is on low sloped areas involves the practice of allowing livestock to feed on pasture vegetation in areas where the land has undergone a restoration process to return it to a stable and productive state. This rehabilitation process often involves soil stabilization, re-vegetation, and the re-establishment of ecosystems to create a suitable environment for grazing. This type of grazing is typically part of sustainable land management practices aimed at maintaining the health and productivity of the rehabilitated land while supporting commercial agricultural activities. Permanent water infrastructure to supply stock water of appropriate quality would encourage grazing in these areas. As part of sustainable land management techniques, light grazing on rehabilitated land with moderately steep slopes involves the primary use of the land for periodic grazing of pasture areas. This type of grazing is designed to sustain short-term grazing for a reduced number of livestock per hectare compared to more intensive grazing practices. Ephemeral water bodies utilised for temporary water supply of stock water of appropriate quality would support the periodic nature of grazing in these areas. The priority for moderately steep slopes is to maintain the land in a stable condition, in accordance with the Environmental Protection Act (EP Act s111A). To support moderate/ high intensity grazing on these slopes, additional erosion controls may be required. Class 4 land is considered marginal for grazing improved pastures but is generally considered suitable for grazing native pastures of varying quality all year round, depending on soil characteristics (QDME 1995, Shields and Williams 1991). In inland Central Queensland such country is typically termed 'breeding country'. It encompasses a range in productivity from the lower end of Class 3 growing country through to the poorer end of Class 4 breeding country. Land suitability for sustainable grazing

PMLU	Definition / Characteristics
	should be considered to be Class 4 breeding country for beef cattle, marginally suitable for grazing of improved pastures but suitable for grazing native pastures year-round, if seasons permit. Characteristics: • Slope is <22 %; • Vegetation cover of ~ 70% can be maintained over the long-term (5-10 years); • Pasture biomass is > 1,000kg/ha; • Land suitability class < 5; and • Landform is stable.
Native bushland	Land that has a primary use of native bushland refers to areas primarily maintained as natural ecosystems, where the protection of native flora and land stability are the main objectives. Land that has a primary use of native bushland can also support light grazing as a management tool, when required. Light grazing can be used as a strategic management tool to help maintain the health and stability of the native bushland. This involves allowing livestock to graze in a controlled manner to achieve specific land management goals, such as reducing excessive pasture biomass, controlling invasive species, and mitigating bushfire risk. The grazing is typically short-term and involves a limited number of livestock to ensure minimal impact on the native vegetation and soil stability. This approach supports biodiversity conservation while also utilising grazing to maintain the ecological balance of the bushland, even on steep slopes. Characteristics: • Groundcover (inclusive of rock, vegetation and organic matter) of ~ 60% can be maintained over the long-term (10-15 years); • Native vegetation is established; and • Landform is stable.

3.2 Landform Slope Analysis

The slope gradient analysis was conducted by (SLR 2024b) on the area of disturbance within the PRCP final landform. The slope analysis results are shown in **Table 3-2** and presented for the WCP in **Figure 3-2**.

This analysis verifies that 80 % of the proposed landform with a PMLU of beef cattle grazing has a gradient of 0 % – 5 %, which encompasses the majority of the WCP disturbance area including infrastructure areas, roads, the tops of overburden emplacement areas, the bases of the reprofiled void depressions and ephemeral water bodies. 94 % of the proposed landform across the disturbance footprint has slopes less than 15 % and approximately 4.8 % of the proposed final landform area with a PMLU of beef cattle grazing has a gradient of 15 % - 22 %. This area comprises:

- Recontoured external batters of the overburden emplacement areas which have been designed to a maximum slope of 18 %; and,
- Low walls with a maximum slope of 22 %.

Table 3-2 illustrates the majority of the landform (97.58 %) has a slope that is less than 18 % and aligns with the EA approved slope gradient and PMLU. Low walls make up a total of 1.16 % and align with the EA approved slope gradient of less than 100 % and the EA approved PMLU. Highwalls account for 1.24 % of the final landform and meet the EA slope requirements and EA approved PMLU.

Slopes associated with PMLUs other than beef cattle grazing i.e. native bushland are not considered in the land suitability assessment.

Table 3-2 Final landform slope analysis for WCP LoM area of disturbance

Disturbance Type	Approved PMLU	Proposed PMLU	EA Approved Slope Gradient (%)	Slope Gradient (%)	Total Area (hectare)	Percent of Total Area (%)
Roads and Tracks, Infrastructure and External Batter Recontoured Spoil Areas	Beef cattle grazing, native bushland, plantation forestry or infrastructure is retained for use	Grazing	0 - 10	0 - 5	13,655	80.30
				5 - 10	1,555	9.14
Infrastructure (including ROM areas), Waste Rock Dumps and External Batter Recontoured Spoil Areas	Beef cattle grazing, native bushland, plantation forestry or infrastructure is retained for use	Grazing	0 - 18	10 - 18	1,385	8.14
Residual Voids (low wall	Beef cattle grazing, native bushland, or plantation forestry	Grazing	0 - 100	18 - 22	198	1.16

Disturbance Type	Approved PMLU	Proposed PMLU	EA Approved Slope Gradient (%)	Slope Gradient (%)	Total Area (hectare)	Percent of Total Area (%)
recontoured spoil areas)						
Residual Voids (high wall) – weathered zone	Low density beef cattle grazing or native bushland	Native Bushland	0 - 214	0 - 22	174	1.02
Residual Voids (high wall) – unweathered zone	Low density beef cattle grazing or native bushland	Native Bushland	0 - 214	> 22	38	0.22
				Total area of disturbance	**17,005**	**100**

770,000 775,000 780,000 785,000 790,000 795,000 800,000

7,125,000 7,120,000 7,115,000 7,110,000 7,105,000 7,100,000

Horse Creek

Juandah Creek

Wolseebee Creek

ML 50229

ML 50231

ML 50230

WANDOAN

WANDOAN COAL PROJECT

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

FIGURE 3-2
SLOPE ANALYSIS ON THE WCP PROPOSED FINAL LANDFORM

LEGEND

- Town/City
- Watercourse
- Wandoan Coal Project Mining Leases
- Disturbance Area

Final Landform Slope Gradient (%)

- 0 - 5%
- 5 - 10%
- 10 - 18%
- 18 - 22%
- 22% - Max

Service Layer Credits:
Earthstar Geographics

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

N 0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A3
Project Number:	626.30100.00800
Date Drawn:	20-Oct-2025
Drawn by:	AS

SLR

Path: H:\Projects-SLR\626-MKY\626.30100.00000 Wandoan Mine Site EA Amend and PRCP\06 SLR Data\01 CADGIS\GIS\Wandoan PRCP\Wandoan PRCP.aprx\62630100 Wandoan PRCP F05-03 Slope Analysis

3.3 Post-mining Suitability Assessment of Grazing PMLU

The final landform land suitability classes were assessed using DME 1995 which align with the land suitability classes as specified in the EA requirements, specifically Table F1.

Where slopes gradients are <12 %, the rehabilitated land can be returned to Class 2 grazing land if the reinstated profile also comply with the other requirements outlined in DME 1995 for Class 2 grazing land as presented in **Appendix B**.

Topsoil depths to be applied over rehabilitation areas will be dependent on disturbance type and slope. Land used for exploration and infrastructure including roads; and generally located on lower gradient slopes will be rehabilitated with approximately 100 mm of topsoil whilst overburden emplacements, low walls and the weathered zone of highwalls will be treated with approximately 200 mm of topsoil. To stabilise any dispersive sodic spoil, agricultural gypsum should be applied. Nutrient deficiency can be adjusted by the application of fertilisers at the same time as ripping and seeding. For stockpiled topsoil, the rate of application of ameliorants will be assessed before placement to ensure the ameliorants are specifically tailored to the quality of the soil at the time of placement.

In **Table 3-3**, disturbance types were compared to the corresponding PMLU as described in Table F1 of the EA and compared against the PMLU proposed in the PRCP and their subsequent land suitability classification. The post mining landform has been designed to ensure both a beef cattle grazing PMLU and the associated land suitability classes, as outlined in the EA, can be achieved.

Table 3-3 Summary of EA PMLU and final landform land suitability assessment

Area/ EA Disturbance Type (EA Table F1)	Total Area (hectares)	Pre-approved PMLU (EA Table F1)	Proposed PMLU	Proposed Final Landform Slope (%) (EA Table F2)	Land Suitability Criteria for Water Erosion (DME, 1995)	PRCP Final Landform Class for Grazing PMLU (DME, 1995)
a) Exploration, Infrastructure including roads, MIA, etc.; and b) Low gradient overburden disposal stockpiles including tailings disposal	15,978 (94.0 %)	Beef cattle grazing, native bushland or plantation forestry	Grazing	Roads and Tracks < 10 % Infrastructure and Spoil areas < 18 %	3 – 20%	Class 3*
a) Steeper gradient overburden disposal stockpiles; and b) Final voids (ephemeral water bodies and low walls)	815 (4.8%)	Low density beef cattle grazing or native bushland	Grazing (light)	Spoil Areas and Waste Rock Dumps < 18 % Lowwalls < 22 %	20 – 45%	Class 4
Final voids (highwalls including weathered and unweathered zones)	212 (1.2%)	native bushland (high wall) and low density beef cattle grazing (low wall as included above))	Native bushland (with light grazing as a land management tool)	0 % - < 214 %%	20 – 45%	N/A as this is native bushland and not a grazing land use.

Table Notes:

* Where practicable this land will be returned to Class 2 grazing land, otherwise it will be returned Class 3 grazing land.

3.4 Topsoil Requirements

3.4.1 Topsoil Stripping Depth

Suggested topsoil stripping depths and identified constraints for the encountered soil associations, as identified by PB (2008) are summarised in **Table 3-4**.

Table 3-4 Potential topsoil stripping depths and potential constraints for reuse (Parsons Brinckerhoff, 2008)

Soil Association	Soil Type	Surface Soil Composition	Potential Topsoil Stripping Depth (mm)	Potential Constraints
LRA: Brigalow Upland Soils - Undulating plains, broad ridges and low hills				
Cracking clays	Rolleston	Clay	200	alkaline topsoil potentially dispersive dispersive subsoil
	Teviot	Clay	200	dispersive subsoil moderately alkaline and saline
	Downfall	Clay	150	shallow topsoil depth dispersive subsoil
Non-cracking clays	Kinnoul (Shallow Cheshire)	Clay	300	low nutrient availability in topsoil dispersive subsoil
	Cheshire	Light clay	400	highly alkaline and saline subsoil dispersive subsoil
LRA: Poplar Box Alluvia Land Resource Area – Floodplains and drainage channels				
Texture contrast soils	Retro	Clay loam	150	shallow topsoil depth poor workability when wet
	Woleebee	Silty loam	150	shallow topsoil depth dispersive topsoil and subsoil highly alkaline and saline subsoils low nutrients and organic matter poor workability when wet
Uniform texture soil	Juandah	Clay	500	dispersive A2 horizon poor workability when wet

The baseline indicative topsoil depth (A1 horizon) in the WCP area ranges from 150 mm to 400 mm for the Brigalow Upland soils and 150 mm to 500 mm for the Poplar Box Alluvia soils as identified by PB (2008). The majority of topsoils proposed to be stripped are from the cracking and non-cracking clays of the brigalow upland soils as shown in **Figure 2-4**, with actual stripping depths proposed to be lower than that available to ensure subsoils are not exposed during topsoil stripping operations.

3.4.2 Topsoil Application Depth

Topsoil depths to be applied over rehabilitation areas will be dependent on disturbance type and slope.

It is recommended for rehabilitation of the grazing PMLU area, land disturbed by exploration, infrastructure including roads; and land generally located on lower gradient slopes will be rehabilitated with approximately 100 mm depth of topsoil (A1) horizon whilst overburden emplacements and low walls will be treated with approximately 200 mm depth of topsoil (A1) horizon. Topsoil depths are sufficient to establish an effective seed bed for germination, with 200 mm of topsoil respread on higher slopes providing for the rapid establishment of vegetation and addressing the limitations identified in the post mining land suitability assessment such as plant water availability.

For the weathered zone of highwalls with a native bushland PMLU, a minimum of 200 mm depth of topsoil (A1) horizon will be utilised to establish an effective seed bed for germination and to address the limitations identified in the post mining land suitability assessment such as plant water availability. These depths are comparable to the native soil depths in the WCP area, refer **Table 2-3**.

3.4.3 Topsoil Spreading

Prior to placement, the topsoil stockpiles will be characterised to ensure they meet the threshold values for Land Suitability Classes 2, 3 or 4 as provided in **Appendix B** and are of low (< 30% total gravimetric water content) to preserve soil structure.

Topsoil placement will involve:

- Ensuring the surface is suitable for topsoil application;
- Nominating the topsoil stockpile(s) or direct stripping areas to be utilised for the area or source location if to be directly placed from stripped areas in accordance with the topsoil requirements for the PMLU;
- Calculating the estimated quantity of suitable topsoil required for the area;
- Ensuring the equipment operators have been briefed on the topsoiling plan/ requirements for the area;
- Scheduling topsoil placement to avoid forecasted heavy rain;
- Applying the topsoil evenly at the nominated thickness either ≥ 100 mm on roads and infrastructure areas or ≥ 200 mm on spoil emplacements, low walls and the weathered zone of high walls; and
- Re-surveying topsoil stockpiles after topsoil extraction and deducting this quantity from the topsoil register.

It is recommended that topsoil spreading be undertaken with dozers from dumped windrows of topsoil sourced from stockpiles or as directed return from stripped areas. Direct return topsoil should be prioritised where possible to utilise the native nutrients, organic matter and soil microbes within the in-situ soils.

Scraper placement of topsoils is viable for areas where placement is possible without excessive topsoil wheel compaction. Where scraper placement is utilised, care to minimise soil compaction and the dozer contour ripping of areas where compaction has occurred should be utilised to maintain the topsoil water infiltration characteristics (thus minimising erosion), oxygenation and plant water holding capacity available for soil pore water space. Dozer ripping of any scraper compacted wheel tracks should occur shortly after topsoil placement (within days or weeks but not months).

3.4.4 Fertilisers and Ameliorants

Topsoil characterisation indicated the soils of the WCP area present negligible to moderate limitations to supporting cattle grazing and native bushland PMLUs, except for dispersive topsoils in the Rolleston, Woleebee, Juandah LRAs (refer **Table 2-3**).

Before spreading, analysis of the topsoil stockpiles or direct stripping areas will be undertaken to determine the requirements for fertiliser and other ameliorants. Following the results of the topsoil analysis, the amelioration requirements will be applied at rates recommended by an appropriately qualified person.

The Brigalow Upland Soils cracking and on-cracking clays are nutrient deficient, and the addition of an initial fertiliser application at the time of seeding will facilitate plant establishment and growth. A controlled release fertiliser is to be applied at the time of seeding as required.:

Application rates should follow the manufacturer's guidelines, however, are expected to be 100kg/ha - 200 kg/ha, depending on nutrient concentrations

Although stripped topsoils are not expected to be dispersive, the subsoils/overburden may be sodic and susceptible to dispersion and erosion (RGS 2024) and if used in rehabilitation activities should be treated with application of agricultural gypsum at a rate of at least 5 t/ha to stabilise dispersive material and improve the soil structure, increase water and plant root penetration into the soil.

Further detail on specific application rates of fertilisers and if required for amelioration, should be assessed before use of topsoil stockpiles or direct stripping areas. Native bushland fertiliser rates will be reduced in comparison to those for gazing to reduce Buffel grass competition from the topsoil seedbed and to not over fertilise native tree and grass species as they are adapted to low nutrient soils.

3.4.5 Seedbed Preparation

Following topsoil placement, it is recommended that any required ameliorant addition, seeding and contour ripping be undertaken as soon as practicable to minimise erosion and improve germination and establishment rates.

Seedbed preparation should consist of:

- The addition of ameliorants at the required rates as determined by an appropriately qualified person;
- Contour Ripping to a depth of ≥ 300 mm with tyres at 1.5 m maximum centres; and
- Seeding with the seed mix for the appropriate PMLU.

Seeding during or immediately after ripping is crucial to rehabilitation success. The crusting of ripped topsoil and the prepared seed bed will severely limit rehabilitation success.

Seeding should ideally occur during optimal weather patterns, i.e., in anticipation of upcoming periods of favourable temperatures and rain that promotes germination and growth of preferred species.

Timing of preparation to avoid the risk of erosion from heavy rainfall events and to minimise weed colonisation. Ripping and seeding will be undertaken in spring prior to the wet season.

3.4.6 Topsoil Resources Availability

Potential topsoil (A1 horizon) stripping depths determined in PB (2008) and as detailed in **Section 3.4.1** were used to determine the volume of topsoil available for rehabilitation sourced from the pit disturbance footprints and as shown in **Table 3-5**. Proposed topsoil stripping

depths are conservative to ensure in situ subsoils are not exposed. The texture contrast soils of Retro and Woleebee have been excluded from material balance calculations based on the constraints of their soil characteristics. Topsoil is anticipated to be stripped from the majority of disturbed areas and when direct placement on rehabilitation areas is not possible, will be stockpiled for future use.

Table 3-5 Proposed topsoil stripping depths and available volumes for use per soil associations in LoM disturbance footprint

Soil Association	Total Area (ha)	Topsoil Stripping Depth (mm)	Topsoil Volume (m^3)
Brigalow upland cracking clay	5,899	200	11,798,000
Brigalow upland non-cracking clay	4,165	300	12,495,000
Poplar box alluvia uniform soil	73	150	109,500
Total available (excluding Poplar box alluvia texture contrast soil)	**10,137**	**-**	**24,402,500**
Total available (including handling loss of 10%)	**-**	**-**	**21,962,250**

Based on initial calculations of topsoil availability and topsoil required for rehabilitation activities as presented in **Table 3-6**, sufficient topsoil will be available to rehabilitate the total disturbance footprint. With the surplus being available as a contingency to provide topsoil for approximately 50 % of the area associated with exploration and ancillary activities.

Table 3-6 Proposed topsoil placement depths

Disturbance Type	Area (ha)	Topsoil Respread Depth (mm)	Topsoil Volume Required (m^3)
Spoil emplacements, low walls and highwalls etc	8,595	200	17,190,000
Infrastructure (including contingency for retained water storages if required and excluding retained haul roads and exploration and ancillary area*)	1,236	100	1,236,000
Total required for rehabilitation activities			**18,426,000**
Total available (including handling loss of 10%)	**-**	**-**	**21,962,250**

With the available soil volumes produced from stripping the pit areas, a soil profile of either 100 mm on roads and infrastructure areas or 200 mm on spoil emplacements, low walls and the weathered zone of high walls can be re-instated. This takes into consideration a 10 % handling loss of stockpiled topsoil. The re-instatement depth is designed to allow for variation in spreading and settling.

Topsoil stripping depths have been estimated based on previous investigations undertaken across the WCP area. There may be natural variations in the topsoil depths available. Topsoil availability will be revised based on actual topsoil stripping depths post stripping activities.

4.0 Rehabilitation Management

Topsoil is an important and potentially scarce resource and should be managed appropriately. An inventory of topsoil stockpile volumes and locations, utilising geospatial systems (i.e. ArcGIS) should be maintained.

Opportunities should be taken to strip topsoil and directly return it to an area that has been reshaped ready for rehabilitation. However, if that is not achievable, topsoil will need to be stockpiled.

4.1 Stockpile Planning and Placement

The following sections outline the requirements for managing long term soil stockpiles, which are stockpiles expected to exist for longer than six months.

Where feasible, stockpiles should be located as close as possible to final re-spread location to minimise haulage length post recovery. Direct return topsoil should be utilised where mine scheduling and haul distances apply.

Topsoil stripping will be undertaken with the following considerations:

- All topsoil stockpiled will be stripped based on the stripping depth guideline provided and stored separately dependent upon classification;
- Placement of topsoil should consider the landscape position the topsoil was stripped from, with soils of the undulating topography (Brigalow uplands cracking clays and non-cracking clays) used on slopes and hilltops, and the alluvial soils (Poplar box alluvial uniform and texture contrast) used in lower slopes and flat areas; and
- All topsoil units to be removed will remain separated from each other based on the limitations identified with each material and the stockpile or final respread area will be recorded to ensure individual soil units are tracked from in situ to final rehabilitation.

Care should be taken to ensure topsoil stripping is done as efficiently as possible to allow for optimal material recovery for use in future rehabilitation and to not to contaminate the topsoil with subsoil which will increase sodicity.

4.1.1 Soil Inventory

Stockpile locations will be planned prior to stockpiling and will be communicated to the relevant parties to ensure materials are placed at appropriate locations, ideally close to rehabilitation areas (if practical) to support rehabilitation.

Signs nominating whether stockpiles contain topsoil will be placed appropriately to support rehabilitation. Signs will include the following information:

- Identification of soil type (topsoil referenced by colour) presented in **Appendix E**; and
- Stockpile number.

A database will be maintained detailing the following:

- Soil type;
- Date stripped;
- Volume; and
- Stockpile number.

4.1.2 Erosion Control and Drainage Management

To maintain the integrity of topsoil stockpiles and minimise topsoil losses, an erosion and sediment control plan (ESCP) for the WCP should be prepared and implemented prior to the commencement of construction and mining activities. Erosion control measures specifically relating to topsoil stockpiles should generally consider:

- Seeding or establishment of vegetation cover on long-term topsoil stockpiles to minimise wind and water erosion;
- When topsoil susceptible to wind erosion (e.g. Woleebee and Retro) are stripped and stockpiled, even if for only a few months, the stockpiles should be covered by grass, other vegetation, geofabric or less erosive topsoil to minimise wind erosion;
- Diverting clean water from areas upslope of all topsoil stockpiles around stockpile areas using contour banks or diversion channels, thereby reducing water flowing into the stockpile area;
- Bunding topsoil stockpiles with earthen bunds or similar, with sediment traps or similar features installed downslope of stockpiles to prevent eroded sediment entering waterways; and
- Only disturbing stockpiles for weed and erosion control or for seeding and fertilising purposes until required for rehabilitation.

4.2 Compaction Management

The compaction of soil increases the potential for rainwater induced erosion and reduces seed germination and root establishment of vegetation. The following measures should be applied in relation to compaction:

- Compaction of topsoil can be reduced by selection of appropriate earthmoving machinery when working with these soils (i.e., light weight vehicles with large wheel/ track size);
- Soils that will be trafficked or compacted during the operation of the mine should have water control and sediment containment measures installed to minimise potential erosion and sediment entering into waterways;
- Previously compacted areas that are to be rehabilitated should be remediated by ripping the top layer of soil/ overburden material, and then applying topsoil as required to establish a suitable plant growth environment. The depth of ripping/reworking required is dependent on the impact and should be assessed at the time or rehabilitation; and
- Ripping the top layer of soil breaks down the soil structure, and as a result protection of these areas from re-compaction (i.e. vehicles or grazing animals) after ripping is required to allow the soil structure to reform.

4.3 Weed Management

Prior to stripping and placement of soils, inspections will be carried out to identify and undertake weed control measures, with a focus on identification and control of weeds. Selective herbicides will be used wherever possible.

Machinery and vehicles attending the WCP will be required to be cleaned to remove weed seeds and a weed clearance certificate obtained prior to entry.

Weed management will be used to control weeds in rehabilitation areas with weed identification is included in rehabilitation monitoring. Selected herbicides will be used wherever possible.

4.4 Monitoring and Maintenance

Regular inspections of the stockpile areas will be made particularly after significant rainfall events and include:

- Integrity of sediment control;
- Effectiveness of drainage;
- Integrity of erosion control measures;
- Pasture/ grass growth; and
- Weed infestation.

5.0 References

DME. 1995. *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.* Department of Minerals and Energy.

DNR. 1997. *Salinity Managment Handbook.* Brisbane: Department of Natural Resources, Queensland. Scientific Publishing. Resource Sciences Centre #222.

DNRM. 1990. *Guidelines for Agricultural Land Evaluation in Queensland.* Coorparoo: Department of Natural Resources and Mines.

DSITI and DNRM. 2015. “Guidelines for Agricultural Land Evaluation in Queensland, 2nd edition.” *Queensland Government.* Accessed August 20, 2023. https://www.publications.qld.gov.au/dataset/qld-agricultural-land-evaluation-guidelines/resource/d6591386-08e2-453f-a6fa-dff2a756215f.

DSITIA and DNRM. 2013. “Regional Land Suitability Frameworks for Queensland.” *Queensland Government.* Accessed August 20, 2023. https://www.publications.qld.gov.au/dataset/bf5588bc-a0ee-4e1b-ab09-dc69e4e5680a/resource/865d2e71-39e3-4db8-92bd-5fc9bc2956be/download/regionallandsuitabilityframeworks.pdf.

Envirosciences Pty Ltd. 1992. *Land Capability and Use. Austinvale and Frank Creek Coal Deposit Areas, Wandoan.* Brisbane: MIM Holdings Ltd.

EPA, QLD. 2019. “Environmental Authority EPML00297613.”

Forster, B.A. 1985. *Evaluation of Agricultural Land in Taroom Shire.* Brisbane: Forster. B.A.

Gray, H.J., Macnish, S.E. 1958. *Land Management Field Manual Wandoan District.* Gray, H.J., Macnish, S.E.

Harris, P S, A JW Biggs, and A J Coutts. 1999. *Central Darling Downs Land management Manual - Field Manual.* DNRQ990102, Department of Natural Resources, Queensland.

Hazelton, Pam, and Brian Murphy. 2016. *Interpreting Soil Test Results. What do the Numbers Mean? 3rd Edition.* Clayton South, Victoria: CSIRO Publishing.

Parsons Brinckerhoff. 2005. *Lake Lindsay Project - overburden, soils and land assessment report.* Brisbane: Barsons Brinckerhoff Pty Ltd.

Parsons Brinckerhoff, . 2008. *Wandoan Coal Project: Geology, mineral resources, overburden and soils impact assessment.* Brisbane: Parsons Brinckerhoff.

PB. 2009. *Addendum to the Wandoan Coal Project. Geology, mineral resources, overburden and soils impact assessment.* Brisbane: Parsons Brinckerhoff.

RGS. 2023. *Geophysical, Physical and Spontaneous Combustion – Sampling and Analysis Plan.* Brisbane: RGS Environmental Consultants Pty Ltd.

RGS. 2024. *Geophysical, Physical and Spontaneous Combustion Assessment of Mine Materials from the Bulk Sample Pit. Draft Interim Technical Report.* Brisbane: RGS Environmental Consultants Pty Ltd.

Short, T. 2023. *Rehabilitated mined land suitability for beef cattle grazing in the Bowen Basin: Technical paper 1.* Brisbane: Queensland Mine Rehabilitation Commissioner, Queensland Government.

Slater, B. . 1986. *Edaphic Properties of Soil and Overburden from a Potential Coal Mine near .* Brisbane: University of Queensland & the Government of Queensland Department of Agriculture.

SLR. 2024a. *Terrestrial Ecology Technical Report - Wandoan Coal Project.* Cairns: SLR Consulting Australia Pty Ltd.

SLR. 2024b. *Wandoan Erosion Assessment - DRAFT.* Brisbane: SLR Consulting Australia Pty Ltd.

Verterra. 2020. *Application of Amendmen of Capcoal Environmental Authority EMPL00739113 (Lake Lindsay) and EMPL00732613 (German Creek).* Brisbane: Verterra Ecological Engineering.

Appendix A Soil Chemical Property Ratings

Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia

SLR Project No.: 626.30100.00000

27 October 2025

Soil pH rating (after Hazelton and Murphy, 2016)

Rating	pH	Some indications for soil chemistry	Occurrence
Very strongly acid	<3 3.0-4.0	Very high levels of acidifying soil organic matter (peats); presence of acid sulfate soils	Extreme pH for peat soils; disturbed acid sulfate soils
Strongly acid *	4.0-5.0 5.0-5.5	Acidified soils, Al^{3+} ions in solution	Range in pH for mineral soils in humid regions
Moderately acid	5.5-6.0	Range most suitable for plant growth	
Slightly acid	6.0-7.0		
Slightly alkaline	7.0-8.0		Range in pH common for minerals soils in arid regions
Moderately alkaline **	8.0-8.5 8.5-9.0		
Strongly alkaline	9.0-10.0	Some nutrients becoming unavailable, indication of sodicity, sodium bicarbonate possible present	Range in pH common for minerals soils in arid regions
Very strongly alkaline	10.0-11.0	Extreme pH, high sodicity and carbonates	

* with increasing acidity, exchangeable aluminium increases to toxic levels, cadmium and heavy metals become available and molybdenum becomes increasingly unavailable.
** With increasing alkalinity, test for calcium carbonate (CaCO3). Fe and Zn may be deficient.

Soil salinity rating (after Hazelton and Murphy, 2016)

Soil salinity rating	Electrical conductivity rating (1:5 dS/m) for a range of soil clay contents			
	10-20% clay	20-40% clay	40-60% clay	60-80% clay
Very low	<0.07	<0.09	<0.12	<0.15
Low	0.07-0.15	0.09-0.19	0.12-0.24	0.15-0.30
Medium	0.15-0.34	0.19-0.45	0.24-0.56	0.30-0.70
High	0.34-0.63	0.45-0.76	0.56-0.96	0.70-1.18
Very high	0.63-0.93	0.76-1.21	0.96-1.53	1.18-1.87
Extreme	>0.93	>1.21	>1.53	>1.87

Cation exchange capacity rating (after Metson, 1961; Hazelton and Murphy, 2016)

Rating	Cation exchange capacity (CEC) cmol(+)/kg
Very low	<6
Low	6-12
Moderate	12-25
High	25-40
Very high	>40

Soil organic matter rating (after Hazelton and Murphy, 2016)

Rating	Organic matter %
Extremely low	<0.70
Very low	0.70-1.00
Low	1.00-1.70
Moderate	1.70-3.00
High	3.00-5.15
Very high	>5.15

Exchangeable sodium percentage (after Hazelton and Murphy, 2007)

Rating	Exchangeable sodium percentage %
Non-sodic	<6
Marginally sodic to sodic	6 – 15
Strongly sodic	>15

Trace metal ratings (after Biggs, Coutts and Harris, 1999)

Rating	Copper mg/kg	Manganese mg/kg	Zinc pH>7 mg/kg
Very low	<0.1	<1	<0.3
Low	0.1-0.3	1-2	0.3-0.8
Medium	0.3-5	2-50	0.8-5
High	5-15	50-500	5-15
Very high	>15	>500	>15

Available-P rating (after Cambell *et al.*, 2012)

Rating	Bicarbonate extractable-P mg/kg
Very low	<4
Low	4 - 8
Medium	8 - 14
High	14 – 20
Very high	>20

Appendix B DME, 1995 Land Suitability for Grazing Criteria

Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia

SLR Project No.: 626.30100.00000

27 October 2025

ATTACHMENT 2

LAND SUITABILITY CLASSIFICATION FOR CROPPING AND GRAZING IN THE SEMI-ARID SUB-TROPICS OF QUEENSLAND

The following ratings tables present criteria for determining land suitability for rainfed broadacre cropping and for beef cattle grazing in the semi-arid sub-tropics (see Note 1). These tables are based upon Queensland Department of Primary Industries guidelines for agricultural land evaluation (Land Resources Branch 1990). The criteria used in these tables are necessarily general to be applicable over a wide area. The Department of Primary Industries is developing land suitability classifications for several specific locations within the semi-arid sub-tropics (Shields and Williams 1991) as part of detailed land resource surveys and the Department's detailed land suitability criteria may be more appropriate for each of these locations.

TABLE 2.1
SUITABILITY FOR RAINFED BROADACRE CROPPING

Limitation	Land suitability class				
	1	2	3	4	5
Water availability (See Table 1.3)	PAWC >150 mm	PAWC 125-150 mm	PAWC 100-125 mm	PAWC 75-100 mm	PAWC <75 mm
Nutrient deficiency	Bicarbonate P >10 ppm	Bicarbonate P 5-10 ppm and Exchangeable K >0.3 meq. %	Bicarbonate P 5-10 ppm and Exchangeable K ≤0.3 meq. % or pH <5 60-90 cm below surface or pH >9 60-90 cm below surface	Bicarbonate P <10 ppm and Exchangeable K ≤0.3 meq. %, and Exchangeable Ca <3 meq.%, or pH <5 30-60 cm below surface, or pH >9 30-60 cm below surface	pH <5 within 30 cm of surface or pH >9 within 30 cm of surface
Soil physical factors	Cracking clays with very fine self-mulch (peds <2 mm), or Rigid soils with a loose, soft or firm surface when dry	Cracking clays with fine self-mulch (peds 2-10 mm)	Cracking clays with coarse self-mulch (peds 10-20 mm) or Rigid soils with a hard setting surface when dry	Cracking clays with coarse peds at the surface (≥20 mm)	
Soil workability	Friable cracking clays (indicated by very fine self-mulch), or Rigid soils with a loose, soft or firm surface when dry	Firm cracking clays (indicated by fine self-mulch) or Rigid soils with a hard setting surface when dry	Stiff cracking clays (indicated by coarse self-mulch with peds>10 mm, crusting or hard setting surface)		
Salinity	Rootzone EC <0.15mS/cm or Rootzone Cl <300 ppm	Rootzone EC 0.15 -0.3 mS/cm or Rootzone Cl 300-600 ppm	Rootzone EC 0.3-0.9 mS/cm or Rootzone Cl 600-900 ppm	Rootzone EC 0.9-1.2 mS/cm, or Rootzone Cl 900-1500 ppm	Rootzone EC >1.2 mS/cm or Rootzone Cl ≥1500 ppm
Rockiness	<10% coarse surface gravel (>6 cm diam.) and rock outcrop	10-20% coarse surface gravel and rock outcrop	20-50% surface cobble (6-20 cm diam.)and rock outcrop	50-90% surface cobble and rock outcrop, or 20-50% stone and boulders (>20 cm diam.)	>90% surface cobble and rock outcrop, or >50% stone and boulders and rock outcrop
Microrelief	No melonholes (semi-circular depressions <30 cm deep and usually surrounded by mounds)	Melonholes 30-60 cm deep cover <20% surface area or Melonholes >60 cm deep cover <10% surface area	Melonholes 30-60 cm deep cover 20-50% of surface area or Melonholes >60 cm deep cover 10-20% surface area	Melonholes 60-100 cm deep cover 50 % surface area	Melonholes at least 100 cm deep cover 50% surface area
Wetness	Undulating terrain or elevated plains	Low-lying level plains with melonholes covering <25% surface area, or Rigid soils with sodic subsoil (ESP 6-14) within 60 cm of the surface, or Non-sodic rigid soils with coarse pale grey and yellow mottles within 75 cm of the surface	Low-lying level plains with melonholes covering 25-50% surface area, or Rigid soils with strongly sodic subsoil (ESP≥15) within 60 cm of the surface, or Non-sodic rigid soils with coarse pale grey and yellow mottles within 50 cm of the surface	Seasonal swamps and low-lying run-on areas	Permanent swamps and lakes
Topography	No gully dissection	Occasional deep gullies impede cultivation slightly	Many deep gullies reduce arable area by < 33% or require major changes to cultivation practices	Many deep gullies make the arable areas too small to cultivate	Abundant deep gullies prevent any practical cultivation
Water erosion	Slopes <0.5% on cracking clays without melonholes, or Slopes <1% on melonhole clays, or Slopes <1% on non-sodic rigid soils, or Slopes <0.5% on sodic rigid soils	Slopes 0.5-1% on cracking clays without melonholes or Slopes 1-3% on melonhole clays, or Slopes 1-2% on non-sodic rigid soils, or Slopes 0.5-1% on sodic rigid soils	Slopes 1-3% on cracking clays without melonholes or Slopes 2-4% on non-sodic rigid soils or Slopes 1-2% on sodic rigid soils	Slopes 3-5% on all cracking clays or Slopes 4-6% on non-sodic rigid soils or Slopes 2-3% on sodic rigid soils	Slopes >5% on all cracking clays or Slopes >6% on non-sodic rigid soils or Slopes >3% on sodic rigid soils
Flooding	No flooding	Rare flooding (only during abnormal 1 in 50 to 100 year events)	Infrequent flooding (inundation occurs <half the times that stream flow increases)	Occasional flooding (inundation occurs ≥half the times that stream flow increases)	Regular flooding (inundation occurs whenever stream flow increases)

TABLE 2.2
SUITABILITY FOR BEEF CATTLE GRAZING

Limitation	Land suitability class (see Table 2.4)				
	1	2	3	4	5
Water availability (See Table 1.3)	PAWC >125 mm	PAWC 100-125 mm	PAWC 75-100mm	PAWC 50-75 mm	PAWC ≤50 mm
Nutrient deficiency	Brigalow, gidgee, blackwood or softwood scrub soils and former scrub soils with Bicarbonate P >10 ppm	Eucalypt vegetation and downs with Bicarbonate P >10 ppm	Other soils with Bicarbonate P 5-10 ppm except Sands and loams at least 75 cm deep or overlying rock at shallow depth	Sands and loams at least 75 cm deep or overlying rock at shallow depth, with Bicarbonate P 5-10 ppm,or Bicarbonate P ≤4 ppm	
Soil physical factors	Cracking clays with very fine self-mulch (peds <2 mm), or Rigid soils with a loose, soft or firm surface when dry	Cracking clays with fine self-mulch (peds 2-10 mm), or Rigid soils with a hard setting surface when dry	Cracking clays with coarse peds (peds ≥10 mm) or crust on the surface		
Salinity	Rootzone EC < 0.15 mS/cm or Rootzone Cl <300 ppm	Rootzone EC 0.15-0.3 mS/cm or Rootzone Cl 300-600 ppm	Rootzone EC 0.3-0.9 mS/cm or Rootzone Cl 600-900 ppm	Rootzone EC 0.9-1.2 mS/cm or Rootzone Cl 900-1500 ppm	Rootzone EC >1.2 mS/cm or Rootzone Cl ≥1500 ppm
Rockiness	<20% coarse surface gravel (>6 cm diam.) and rock outcrop	20-50% coarse surface gravel and rock outcrop	50-90% surface cobble and rock outcrop	>90% surface cobble and rock outcrop	Rock outcrop and surface coarse fragments cover total area
Microrelief	Melonholes cover <20% surface area (semi-circular depressions at least 30 cm deep and usually surrounded by mounds)	Shallow melonholes (30-60 cm deep) cover 20-50% surface area	Deep melonholes (>60 cm deep) cover 20-50% of surface area		
pH (1:5)	5.6-6.6	6.6-8.0 5.0-5.6	8.0-9.0 4.5-5.0	9.0-10.0 4.0-4.5	>10.0 < 4.0
ESP (10cm)% Exchangable Sodium Percentage	<5.0	5-10	10-15	15-30	>30
Wetness	Undulating terrain or elevated plains	Low-lying level plains , or Rigid soils with strongly sodic subsoil (ESP≥15) within 60 cm of the surface, or Non-sodic rigid soils with coarse pale grey and yellow mottles within 50 cm of the surface	Shallow seasonal and permanent swamps		Permanent lakes and deep swamps
Topography				Many deep gullies make cultivation for sowing pastures impractical, or Slopes >15% make cultivation along contours impractical	Strongly dissected terrain over ≥75% of the area preventing adequate herd management
Water erosion	Slopes <1% on sodic rigid soils or Slopes <3% on all other soils	Slopes 1-3% on sodic rigid soils or Slopes 3-6% on cracking clays, or Slopes 3-12% on non-sodic rigid soils	Slopes 3-6% on sodic rigid soils or Slopes 6-9% on cracking clays, or Slopes 12-20% on non-sodic rigid soils	Slopes 6-12% on sodic rigid soils or Slopes 9-15% on cracking clays or Slopes 20-45% on non-sodic rigid soils	Slopes >45%
Flooding	No flooding	Periodic flooding (from once in 50 years to whenever stream flow increases)			
Vegetation regrowth (management limitation)	Softwood, brigalow, gidgee or blackwood scrub without melonholes , or Queensland bluegrass grasslands, or Mountain coolabah, bloodwood and ironbark open woodlands	Brigalow, gidgee or blackwood scrub with melonholes, or Box and ironbark woodlands without wattle understorey, or Coolabah woodlands on flooded country		Eucalypt woodlands with wattle understorey or Broad-leaved teatree woodlands	

TABLE 2.3
SURROGATE FIELD PROPERTIES FOR ESTIMATING PLANT AVAILABLE WATER CAPACITY (PAWC)

PAWC ≥150 mm	PAWC 125-150 mm	PAWC 100-125 mm	PAWC 75-100 mm	PAWC 50-75 mm	PAWC ≤50 mm
Cracking clays: ≥90 cm depth to weathered or hard rock and very fine self-mulch (ped size <2 mm) and infrequent cracking at surface when dry (≤1 crack per square metre) and alkaline to neutral pH throughout and Cl<600 ppm within 90 cm of the surface and ESP<15 within 90 cm of the surface	Cracking clays: ≥90 cm depth to weathered or hard rock and fine self-mulch (ped size 2-10 mm) and dense cracking at surface when dry (>1 crack per square metre) and alkaline to neutral pH throughout and Cl<600 ppm within 90 cm of the surface and ESP<15 within 90 cm of the surface	Cracking clays: alkaline to neutral pH throughout and 60-90 cm depth to 1)weathered or hard rock, 2) Cl≥600 ppm or 3) ESP≥15 or acid to neutral pH at depth and 60-90 cm to salt bulge with EC≥0.9 mS/cm or Cl≥900 ppm	Cracking clays: alkaline pH throughout and 40-60 cm depth to weathered or hard rock or acid to neutral pH at depth and 40-60 cm to salt bulge with EC≥0.9 mS/cm or Cl≥900 ppm	Cracking clays: alkaline pH throughout and 20-40 cm depth to weathered or hard rock or acid to neutral pH at depth and 20-40 cm to salt bulge with EC≥0.9 mS/cm or Cl≥900 ppm	Cracking clays: alkaline pH throughout and ≤20 cm depth to weathered or hard rock or acid to neutral pH at depth and ≤20 cm to salt bulge with EC≥0.8 mS/cm or Cl≥800 ppm
	Rigid soils (non-sodic) Loams, clay loams, non-cracking clays, duplex soils and gradational earths and >125 cm depth to weathered or hard rock or >125 cm to salt bulge with EC≥0.9 mS/cm or Cl ≥900 ppm	Rigid soils (non-sodic) Loams, clay loams, non-cracking clays, duplex soils and gradational earths and 75-125 cm depth to weathered or hard rock or 75-125 cm to salt bulge with EC≥0.9 mS/cm or Cl ≥900 ppm	Rigid soils (non-sodic) Loams, clay loams, non-cracking clays, duplex soils and gradational earths and 50-75 cm depth to weathered or hard rock or 50-75 cm to salt bulge with EC≥0.9 mS/cm or Cl≥900 ppm Sands and sandy loams >90 cm deep Rigid soils (sodic) Duplex soils with subsoil becoming sodic (ESP 6-14) within 60 cm of the surface but not strongly sodic (ESP≥ 15) within 90 cm	Rigid soils (non-sodic) Loams, clay loams, non-cracking clays, duplex soils and gradational earths and 30-50 cm depth to weathered or hard rock or 30-50 cm to salt bulge with EC≥0.9 mS/cm or Cl≥900 ppm Sands and sandy loams 45-90 cm deep Rigid soils (sodic) Duplex soils with a sodic subsoil (ESP 6-14) becoming strongly sodic (ESP≥15) within 60 cm of surface	Rigid soils (non-sodic) Loams, clay loams, non-cracking clays, duplex soils and gradational earths and ≤30 cm depth to weathered or hard rock Shallow sands and sandy loams ≤45 cm deep Rigid soils (sodic) Duplex soils with a strongly sodic subsoil (ESP≥25) within 45 cm of surface

TABLE 2.4
MAJOR TYPES OF GRAZING COUNTRY IN EACH LAND SUITABILITY CLASS

Land suitability class	Brief description	Productivity of native pastures	Potential for pasture improvement	Significant limitations
1	Softwood, brigalow, gidgee and blackwood scrub on fertile cracking clays with a very fine self-mulch and few melonholes; not subject to flooding	Low under standing scrub, moderate after clearing	A wide range of sown pastures following clearing	Slight woody weed regrowth
2	Softwood, brigalow, gidgee and blackwood scrub on fertile soils and/or many shallow melonholes; not subject to flooding	Low under standing scrub, moderate after clearing	A wide range of sown pastures following clearing	Minor pasture establishment problems; minor woody weed regrowth; sown pastures don't persist in melonholes
	Uplands with downs and mountain coolabah, bloodwood or ironbark woodlands on cracking clays with a fine self-mulch	High in the virgin state	A limited range of sown pastures on cracking clays; a wide of sown pastures on rigid soils	Minor pasture establishment problems on cracking clays; minor woody weed regrowth in ironbark woodlands
	Uplands with ironbark woodlands on friable red and brown rigid soils	Moderate to high in the virgin state	A limited range of sown pastures	Minor woody weed regrowth
	Flooded country with variable vegetation on cracking clays, loams, clay loams, non-cracking clays, duplex soils and gradational earths	High in the virgin state	A limited range of sown pastures on the areas infrequently flooded; no suitable introduced species for frequently flooded areas	Periodic inundation; woody weed regrowth after clearing some vegetation
3	Brigalow, gidgee and blackwood scrub with 1) infertile soils, 2) poor surface condition, and/or 3) many deep melonholes; not subject to flooding	Low under standing scrub and after clearing	A wide range of sown pastures following clearing	Moderate pasture establishment problems; moderate woody weed regrowth; sown pastures don't persist in melonholes
	Uplands with eucalypt woodlands and no wattle understorey on infertile rigid soils	Low to moderate in the virgin state	Clearing and oversowing with legumes	Phosphorus fertilisers/supplements required; production of improved species severely limited by low fertility in some soils; minor woody weed regrowth
	Uplands with downs and mountain coolibah, bloodwood or ironbark woodlands on cracking clays with a coarse self-mulch	Moderate to high in the virgin state	A limited range of sown pastures	Establishment of sown pastures severely restricted; minor woody weed regrowth in ironbark woodlands
	Shallow swamps	Nil to low in the virgin state	Para grass and a few other grasses	Shallow water required most of the year
4	Hills and mountains with eucalypt woodlands and lancewood/bendee scrub on shallow rigid soils	Low in the virgin state	Nil	Production of improved species severely limited by low fertility
	Uplands with eucalypt woodlands and a wattle understorey on infertile rigid soils	Low in the virgin state	Oversowing with legumes but fertilisers also necessary	Production of improved species severely limited by low fertility; severe woody weed regrowth if mechanically cleared
5	Very steep, strongly dissected hills and mountains	Low in the virgin state	Nil	Extremely low pasture production ; topography prevents effective herd management; high erosion potential precludes clearing
	Rocklands	Nil	Nil	Negligible pasture production
	Lakes and permanent deep swamps	Nil	Nil	No pasture production

Notes:

1. The semi-arid sub-tropics refer to the region bounded by Duaringa, Rolleston, Hughenden and Greenvale. The Mitchell grass downs and vast outwash plains of the Gulf of Carpentaria form the western boundary and the coastal strip to the east is also excluded. The average annual rainfall is approximately 500 to 800 mm of which at least 75% falls during summer but there is also a significant winter component averaging between 50 and 175 mm.
2. Rainfed broadacre crops include sorghum, sunflower, wheat, safflower, cotton, chick peas and annual fodder crops (sorghum, millet and oats). These crops are often grown in sequence, with the actual crops planted being dependant upon rainfall (Shields & Williams 1991).
3. The plant available water capacity (PAWC) of a soil is extremely difficult to measure in the field and there are no models available that can be applied to all soils within the semi-arid sub-tropics to accurately determine these values. The figures used in Table 2.1 have been estimated for a range of soils with a maximum rooting depth of 100cm and compared with long-term crop yields. Surrogate soil properties that can be readily identified in the field and used to allocate soils into a class are presented in Table 2.2.
4. The soil fertility criteria are based on standard QDPI analytical test using a bulk 0-10 cm surface sample. The QDPI soil analytical methods and guidelines for interpreting analytical results are described by Baker and Eldershaw (1993).
5. The effects of soil salinity upon plant growth depend upon the soil type, the plants being grown and the climate. The criteria used in Table 2.1 represent a generalisation of this complex issue and are meant to provide an estimate of salinity effects upon plant growth within the root zone.

   The depth to any salt bulge indicates the maximum depth to which water moves through the soil and is thus used as a surrogate for the rooting depth. Therefore, the depth of a salt bulge is used in estimating PAWC but this represents a physical limit on plant roots (lack of water) and does not account for any chemical effect that soluble salts above this bulge have on plant growth.

   The rootzone salinity accounts for chemical effects on plant growth and is averaged over the rooting depth which is the depth to hard or weathered rock, or the depth to any significant salt bulge (EC≥0.8 mS/cm or Cl≥800 ppm).

   In the absence of any rock or salt bulge the maximum rooting depth is taken as 100 cm for crops and 60 cm for pastures.
6. These tables may be useful when assessing the suitability of soils for topsoiling and as growth media but more detailed guidance is available in the Guideline on Growth Media Management.

References:

Baker, D.E. Eldershaw, V.J. (1993), Interpreting soil analyses - for agricultural land use in Queensland, Queensland Department of Primary Industries Project Report QO93014

Land Resources Branch (1991), Guidelines for agricultural land evaluation in Queensland, Queensland Department of Primary Industries Information Series QI90005

Shields, P.G. Williams, B.M. (1991), Land resource survey and evaluation of the Kilcummin area, Queensland, Queensland Department of Primary Industries Land Resources Bulletin QV91001

Appendix C Laboratory data – PB, 2008 and Slater, 1986

Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia

SLR Project No.: 626.30100.00000

27 October 2025

CERTIFICATE OF ANALYSIS

Work Order	: **EB0710108**	Page	: 1 of 16
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Brisbane
Contact	: MS OLIVIA WHITE	Contact	: Tim Kilmister
Address	: GPO BOX 2907 BRISBANE QLD AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: owhite@pb.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32185438	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 38314223	Facsimile	: +61-7-3243 7218
Project	: 2133006A-3011-1	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: 58628		
C-O-C number	: 202224	Date Samples Received	: 05-SEP-2007
Sampler	: OLIVIA WHITE	Issue Date	: 21-SEP-2007
Site	: Wandoan		
		No. of samples received	: 81
Quote number	: BN/103/06	No. of samples analysed	: 68

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

This document is issued in accordance with NATA accreditation requirements.

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*
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	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 preformed, 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 insuffient 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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = Result(s) reported is calculated using analyte detections at or above the LOR. (eg. <5 + 5 + 7 = 12).

- **LCS recovery for various inorganic analyses fall outside Dynamic Control Limits. They are however within ALS Static Control Limits and hence deemed acceptable.**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS01/0.0-0.1	WS01/0.3-0.4	WS01/0.9-1.0	WS02/0.0-0.1	WS02/0.2-0.3
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-001	EB0710108-002	EB0710108-003	EB0710108-004	EB0710108-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.4	8.9	8.4	7.9	8.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	164	1080	1720	67	294
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	18.9	15.4	15.0	15.8	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	6.8	7.6	----	4.4	7.7
^ Exchangeable Magnesium	----	0.1	meq/100g	0.8	1.5	----	1.3	2.5
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	----	0.2	0.2
^ Exchangeable Sodium	----	0.1	meq/100g	0.2	2.2	----	0.2	0.9
^ Cation Exchange Capacity	----	0.1	meq/100g	8.1	11.4	----	6.1	11.2
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	1.6
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	<10	560	3180	----	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	60	750	1110	----	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.83	1.68	----	----	----
Iron	7439-89-6	1.00	mg/kg	12.0	6.10	----	----	----
Manganese	7439-96-5	1.00	mg/kg	67.1	42.3	----	----	----
Zinc	7440-66-6	1.00	mg/kg	1.50	<1.00	----	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	9.3	1.4	----	1.1	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	3090	940	----	1850	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	3100	950	----	1850	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	394	198	----	418	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	5.1	2.3	----	2.8	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID : WS02/0.4-0.5	WS03/0.0-0.1	WS03/0.4-0.5	WS03/0.6-0.7	WS04/0.0-0.1
				Client sampling date / time : [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-006	EB0710108-007	EB0710108-008	EB0710108-009	EB0710108-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	9.0	8.6	9.2	9.3	7.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	559	130	964	1160	32
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	19.6	----	----	15.0
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	7.2	7.2	5.9	5.1	4.2
^ Exchangeable Magnesium	----	0.1	meq/100g	2.5	1.3	1.6	1.7	0.7
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.2	<0.1	0.1	0.2
^ Exchangeable Sodium	----	0.1	meq/100g	1.4	0.5	2.0	2.6	0.2
^ Cation Exchange Capacity	----	0.1	meq/100g	11.2	9.3	9.6	9.6	5.5
^ Exchangeable Sodium Percent	----	0.1	%	2.3	----	3.9	4.6	----
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	----	----	----	20
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	----	----	----	50
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	1.4	----	----	16.1
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	690	----	----	1760
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	690	----	----	1770
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	121	----	----	310
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	1.4	----	----	3.0

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS04/0.2-0.3	WS04/0.4-0.5	WS05/0.0-0.1	WS05/0.2-0.3	WS05/0.6-0.7
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-011	EB0710108-012	EB0710108-013	EB0710108-014	EB0710108-015
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	9.0	9.1	7.5	8.0	5.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	462	850	19	430	736
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	10.9	14.0	18.4	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	7.4	----	----	3.2	1.8
^ Exchangeable Magnesium	----	0.1	meq/100g	1.4	----	----	1.8	1.6
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	----	----	0.1	0.1
^ Exchangeable Sodium	----	0.1	meq/100g	1.3	----	----	1.0	1.4
^ Cation Exchange Capacity	----	0.1	meq/100g	10.2	----	----	6.1	4.9
^ Exchangeable Sodium Percent	----	0.1	%	2.3	----	----	----	6.0
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	510	20	50	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	870	30	580	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	----	1.32	<1.00	----
Iron	7439-89-6	1.00	mg/kg	----	----	36.9	19.8	----
Manganese	7439-96-5	1.00	mg/kg	----	----	27.0	20.0	----
Zinc	7440-66-6	1.00	mg/kg	----	----	<1.00	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	1.5	2.1	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	1380	740	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	1380	740	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	----	202	138	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	2.7	1.2	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS06/0.0-0.1	WS06/0.2-0.3	WS06/0.8-0.9	WS09/0.0-0.1	WS09/0.2-0.3
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-016	EB0710108-017	EB0710108-018	EB0710108-019	EB0710108-020
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.6**	**8.6**	**8.1**	**6.9**	**9.3**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**40**	**431**	**845**	**36**	**516**
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	**14.0**	----	**13.2**	**7.5**	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**3.6**	**7.6**	**2.4**	**0.8**	**6.5**
^ Exchangeable Magnesium	----	0.1	meq/100g	**1.7**	**2.5**	**2.4**	**0.4**	**2.1**
^ Exchangeable Potassium	----	0.1	meq/100g	**0.2**	**0.2**	**0.2**	<0.1	<0.1
^ Exchangeable Sodium	----	0.1	meq/100g	**0.4**	**1.3**	**1.8**	**0.1**	**1.5**
^ Cation Exchange Capacity	----	0.1	meq/100g	**5.9**	**11.6**	**6.8**	**1.3**	**10.2**
^ Exchangeable Sodium Percent	----	0.1	%	----	**2.4**	**4.4**	----	**3.3**
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	----	**40**	<10	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	----	**1270**	<10	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	**2.06**	**1.66**	----	----	----
Iron	7439-89-6	1.00	mg/kg	**25.4**	**21.6**	----	----	----
Manganese	7439-96-5	1.00	mg/kg	**88.9**	**46.7**	----	----	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	----	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**4.0**	----	----	**4.8**	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1470**	----	----	**1180**	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**1480**	----	----	**1190**	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	**396**	----	----	**512**	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	**2.3**	----	----	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS09/0.4-0.5	WS10/0.0-0.1	WS10/0.3-0.4	WS11/0.05-0.1	WS11/0.3-0.4
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-021	EB0710108-022	EB0710108-023	EB0710108-024	EB0710108-025
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**9.3**	**8.8**	**8.8**	**8.3**	**8.4**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**942**	**100**	**91**	**93**	**149**
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	**15.6**	----	----	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**5.1**	----	**7.3**	**6.4**	**5.9**
^ Exchangeable Magnesium	----	0.1	meq/100g	**2.3**	----	**1.9**	**0.8**	**1.0**
^ Exchangeable Potassium	----	0.1	meq/100g	**0.1**	----	**0.1**	**0.1**	**0.1**
^ Exchangeable Sodium	----	0.1	meq/100g	**1.9**	----	**1.0**	<0.1	**0.1**
^ Cation Exchange Capacity	----	0.1	meq/100g	**9.4**	----	**10.3**	**7.5**	**7.1**
^ Exchangeable Sodium Percent	----	0.1	%	**3.5**	----	**1.8**	----	**0.4**
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	<1.00	----	----	**1.25**	----
Iron	7439-89-6	1.00	mg/kg	**6.54**	----	----	**11.0**	----
Manganese	7439-96-5	1.00	mg/kg	**3.18**	----	----	**51.1**	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	**3.1**	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**880**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	**890**	----	----	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	**158**	----	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	**2.3**	----	**1.9**	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS13/0.0-0.1	WS13/0.1-0.2	WS14/0.0-0.1	WS14/0.3-0.4	WS15/0.0-0.1
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-026	EB0710108-027	EB0710108-028	EB0710108-029	EB0710108-030
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.3	7.1	8.2	9.0	8.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	37	23	136	404	108
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	7.2	----	12.8	13.8	11.5
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	1.9	3.1	5.3	6.9	----
^ Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.8	0.5	1.7	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	<0.1	<0.1	----
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	0.1	1.1	----
^ Cation Exchange Capacity	----	0.1	meq/100g	2.6	4.3	6.1	9.9	----
^ Exchangeable Sodium Percent	----	0.1	%	----	0.6	----	2.6	----
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	<10	----	<10	240	<10
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	<10	----	30	180	20
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	----	2.90	2.00	----
Iron	7439-89-6	1.00	mg/kg	----	----	15.2	12.2	----
Manganese	7439-96-5	1.00	mg/kg	----	----	58.3	19.5	----
Zinc	7440-66-6	1.00	mg/kg	----	----	1.09	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	5.1	----	----	----	2.9
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1120	----	----	----	1550
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1130	----	----	----	1560
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	276	----	----	----	230
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.7	----	2.6	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID : WS15/0.2-0.3	WS15/0.4-0.5	WS16/0.0-0.1	WS16/0.2-0.3	WS17/0.0-0.05
				Client sampling date / time : [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-031	EB0710108-032	EB0710108-033	EB0710108-034	EB0710108-035
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	9.2	9.0	7.8	9.0	7.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	271	922	49	101	42
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	----	9.4	----	11.6
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	6.8	6.3	----	6.5	----
^ Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.4	----	1.6	----
^ Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	----	<0.1	----
^ Exchangeable Sodium	----	0.1	meq/100g	1.3	2.2	----	1.2	----
^ Cation Exchange Capacity	----	0.1	meq/100g	9.5	10.0	----	9.4	----
^ Exchangeable Sodium Percent	----	0.1	%	2.8	4.9	----	2.6	----
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	----	----	----	<10
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	----	----	----	30
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	----	----	<1.00	----
Iron	7439-89-6	1.00	mg/kg	----	----	----	5.93	----
Manganese	7439-96-5	1.00	mg/kg	----	----	----	10.7	----
Zinc	7440-66-6	1.00	mg/kg	----	----	----	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	4.9	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	1120	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	1120	----	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	----	150	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS17/0.2-0.3	WS18/0.0-0.05	WS18/0.3-0.4	WS20/0.0-0.05	WS20/0.2-0.3
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-036	EB0710108-037	EB0710108-038	EB0710108-039	EB0710108-040
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.9**	**6.7**	**7.9**	**7.2**	**6.9**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**216**	**45**	**100**	**58**	**534**
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	**8.9**	----	**11.4**	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	**2.9**	**2.9**	**3.0**
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	**1.2**	**1.1**	**1.6**
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	**0.1**	**0.2**	**0.1**
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	**0.5**	**0.3**	**1.4**
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	**4.7**	**4.5**	**6.2**
^ Exchangeable Sodium Percent	----	0.1	%	----	----	**2.2**	----	**4.9**
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	**10**	----	<10	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	<10	----	**40**	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	<1.00	----	----	----
Iron	7439-89-6	1.00	mg/kg	----	**55.4**	----	----	----
Manganese	7439-96-5	1.00	mg/kg	----	**151**	----	----	----
Zinc	7440-66-6	1.00	mg/kg	----	**1.07**	----	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	**9.8**	----	**4.7**	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**1380**	----	**1260**	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	**1390**	----	**1270**	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	**220**	----	**252**	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	----	**2.0**	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS22/0.0-0.05	WS22/0.2-0.3	WS23/0.0-0.05	WS23/0.2-0.3	WS24/0.0-0.1
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-041	EB0710108-042	EB0710108-043	EB0710108-044	EB0710108-045
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.2	8.3	7.2	8.7	7.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	126	119	120	552	51
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	14.4	----	10.7	----	6.5
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	----	7.7	4.1	7.8	2.2
^ Exchangeable Magnesium	----	0.1	meq/100g	----	0.5	1.2	2.2	0.4
^ Exchangeable Potassium	----	0.1	meq/100g	----	<0.1	0.6	0.2	0.2
^ Exchangeable Sodium	----	0.1	meq/100g	----	<0.1	<0.1	1.0	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	----	8.3	5.9	11.2	2.8
^ Exchangeable Sodium Percent	----	0.1	%	----	0.2	----	2.1	----
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	----	10	----	<10
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	----	20	----	<10
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	----	1.12	<1.00	<1.00
Iron	7439-89-6	1.00	mg/kg	----	----	12.8	8.07	15.8
Manganese	7439-96-5	1.00	mg/kg	----	----	40.3	11.3	112
Zinc	7440-66-6	1.00	mg/kg	----	----	1.23	<1.00	<1.00
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	7.2	----	12.0	----	5.5
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1750	----	2910	----	1210
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1760	----	2920	----	1220
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	443	----	556	----	183
EP004: Organic Matter								
Organic Matter	----	0.5	%	3.5	0.9	3.7	----	2.5

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS24/0.2-0.3	WS26/0.0-0.05	WS26/0.2-0.3	WS26/0.5-0.6	WS31/0.0-0.1
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-046	EB0710108-047	EB0710108-048	EB0710108-049	EB0710108-050
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.0	6.8	7.4	6.2	7.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	36	79	123	333	40
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	9.3	15.5	----	9.6
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	4.1	2.3	2.8	2.1	3.9
^ Exchangeable Magnesium	----	0.1	meq/100g	0.6	0.9	1.0	1.1	0.6
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	<0.1	<0.1	0.1
^ Exchangeable Sodium	----	0.1	meq/100g	0.2	0.3	0.6	1.0	0.2
^ Cation Exchange Capacity	----	0.1	meq/100g	5.0	3.6	4.4	4.4	4.9
^ Exchangeable Sodium Percent	----	0.1	%	0.6	----	2.6	4.5	----
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	<10	<10	----	<10
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	40	150	----	<10
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	<1.00	<1.00	----	----
Iron	7439-89-6	1.00	mg/kg	----	35.2	19.1	----	----
Manganese	7439-96-5	1.00	mg/kg	----	33.1	22.2	----	----
Zinc	7440-66-6	1.00	mg/kg	----	<1.00	<1.00	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	6.4	2.6	----	4.1
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	990	830	----	1420
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	1000	830	----	1430
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	224	108	----	286
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	2.4	1.6	----	2.8

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS31/0.2-0.3	WS32/0.0-0.1	WS32/0.4-0.5	WS33/0.0-0.1	WS33/0.4-0.5
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-051	EB0710108-052	EB0710108-053	EB0710108-054	EB0710108-055
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.5	8.2	8.7	7.7	9.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	390	175	532	113	687
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	17.7	18.7	11.9	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	5.6	5.6	6.4	3.1	6.6
^ Exchangeable Magnesium	----	0.1	meq/100g	1.3	0.7	1.0	1.3	1.9
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	<0.1	0.4	<0.1
^ Exchangeable Sodium	----	0.1	meq/100g	0.8	0.6	1.2	0.2	1.3
^ Cation Exchange Capacity	----	0.1	meq/100g	7.8	7.1	8.7	5.0	10.0
^ Exchangeable Sodium Percent	----	0.1	%	2.0	----	2.7	----	2.6
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	40	80	30	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	90	380	30	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	<1.00	----	<1.00	----
Iron	7439-89-6	1.00	mg/kg	----	6.28	----	36.9	----
Manganese	7439-96-5	1.00	mg/kg	----	17.0	----	61.7	----
Zinc	7440-66-6	1.00	mg/kg	----	<1.00	----	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	48.3	----	15.9	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	700	----	2220	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	750	----	2230	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	130	----	296	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	1.8	----	3.1	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS34/0.0-0.1	WS34/0.2-0.3	WS34/0.5-0.6	WS35/0.0-0.1	WS35/0.2-0.3
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-056	EB0710108-057	EB0710108-058	EB0710108-059	EB0710108-060
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.8	8.3	8.7	7.2	6.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	87	124	445	34	41
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	13.7	----	----	8.2	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	5.6	6.4	----	2.9	1.9
^ Exchangeable Magnesium	----	0.1	meq/100g	1.0	0.8	----	0.7	0.5
^ Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	----	0.2	0.2
^ Exchangeable Sodium	----	0.1	meq/100g	0.1	0.2	----	0.2	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	7.1	7.6	----	4.1	2.6
^ Exchangeable Sodium Percent	----	0.1	%	----	0.6	----	----	0.5
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	<10	----	----	<10	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	<10	----	----	<10	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.92	----	----	<1.00	----
Iron	7439-89-6	1.00	mg/kg	16.0	----	----	52.6	----
Manganese	7439-96-5	1.00	mg/kg	47.8	----	----	83.5	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	----	----	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	7.3	----	----	6.5	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	2120	----	----	850	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	2130	----	----	860	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	406	----	----	264	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	----	1.8	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS36/0.0-0.01	WS36/0.3-0.4	WS37/0.0-0.1	WS38/0.0-0.1	WS38/0.4-0.5
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]
				EB0710108-061	EB0710108-062	EB0710108-063	EB0710108-064	EB0710108-065
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.0	9.2	6.6	7.2	6.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	56	292	257	147	467
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	15.7	----	7.0	20.2	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	3.2	6.4	2.5	3.4	2.8
^ Exchangeable Magnesium	----	0.1	meq/100g	1.0	1.2	0.6	2.9	3.2
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.1	0.1	0.2	0.1
^ Exchangeable Sodium	----	0.1	meq/100g	0.4	0.8	0.5	0.5	1.2
^ Cation Exchange Capacity	----	0.1	meq/100g	4.8	8.6	3.8	7.1	7.3
^ Exchangeable Sodium Percent	----	0.1	%	----	1.9	----	----	3.3
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	<10	----	60	40	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	80	----	80	150	----
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	1.08	----	1.11	2.79	----
Iron	7439-89-6	1.00	mg/kg	20.8	----	96.7	21.0	----
Manganese	7439-96-5	1.00	mg/kg	95.2	----	172	20.6	----
Zinc	7440-66-6	1.00	mg/kg	<1.00	----	1.54	<1.00	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	6.1	----	24.8	6.5	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1050	----	3770	900	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1060	----	3800	910	----
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	138	----	261	209	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.1	----	5.3	1.8	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: WS38/0.6-0.7	WS40/0.0-0.1	WS40/0.2-0.3		
				Client sampling date / time: [05-SEP-2007]	[05-SEP-2007]	[05-SEP-2007]		
				EB0710108-066	EB0710108-067	EB0710108-068		
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	**7.0**	**8.8**		
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**553**	**88**	**361**		
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	----	**13.6**	----		
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	----	**8.1**	**7.1**		
^ Exchangeable Magnesium	----	0.1	meq/100g	----	**1.0**	**1.1**		
^ Exchangeable Potassium	----	0.1	meq/100g	----	**0.2**	<0.1		
^ Exchangeable Sodium	----	0.1	meq/100g	----	**0.4**	**0.8**		
^ Cation Exchange Capacity	----	0.1	meq/100g	----	**9.6**	**9.1**		
^ Exchangeable Sodium Percent	----	0.1	%	----	----	**1.7**		
ED040S: Soluble Major Anions								
Sulphate as SO4 2-	14808-79-8	10	mg/kg	----	**30**	----		
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	**10**	----		
ED092: DTPA Extractable Metals								
Copper	7440-50-8	1.00	mg/kg	----	<1.00	----		
Iron	7439-89-6	1.00	mg/kg	----	**13.2**	----		
Manganese	7439-96-5	1.00	mg/kg	----	**26.9**	----		
Zinc	7440-66-6	1.00	mg/kg	----	<1.00	----		
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	**4.5**	----		
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**1580**	----		
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	**1580**	----		
EK067: Total Phosphorus as P								
Total Phosphorus as P	----	20	mg/kg	----	**199**	----		
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	**2.3**	----		

Attachment D

Test pit logs from Slater (1986)

Appendix 1. Morphological and Analytical Data for Selected Soil Profiles.

Soil Profile Class:	Teviot (Profile 1)
Great Soil Group:	Grey clay
Principal Profile Form:	Ug 5.14
Parent Material:	Highly weathered feldspathic sandstone of Juandah Coal Measures (Jurassic).
Topography:	Upper slope of undulating landscape, westerly aspect, 2.5% slope.
Location:	SG55-12. Roma. GM9011. Austinvale area. Near Theiss Core hole C258 on track leading from "A" road to trial excavation; 870 m west of trial excavation. Site 1.
Vegetation:	Cleared. Previously open forest of brigalow (*Acacia harpophylla*) and bauhinia (*Lysiphyllum carronii*) with occasional bottle tree (*Brachychiton rupestre*) and shrub understorey of wilga (*Geijera parviflora*) and false sandalwood (*Eremophila mitchellii*). Sucker regrowth of brigalow has occurred.
Land Use:	Currently low intensity agistment grazing, but to be prepared for summer cropping.
Profile Morphology:	Surface: moderately self mulching with thin (5 mm) fragile surface crust.
m	
A11 0 - 0.06	Brownish black (10YR3/1); light-medium clay, (fine sandy); strong 2-5 mm granular; dry, moderately weak; few small subangular siliceous pebbles. Clear to -
A12 0.06 - 0.20	Brownish black (10YR3/1); light medium clay; moderate 10-20 mm angular blocky; dry, moderately strong; very few fine calcareous nodules. Clear to -

Appendix 1 (cont.)

B21K 0.20 - 0.40	Yellowish grey (2.5Y4/1); medium clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common medium calcareous nodules; few fine soft calcareous segregations. Gradual to -
B22 0.40 - 0.75	Yellowish grey (2.54 4/1); medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to -
B23 0.75 - 1.0	Dark greyish yellow (2.54 4/2); medium clay; moderate 20 - 50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to -
B24 1.0 - 1.3	Dull yellow orange (1oYR6/3); medium clay; moderate 20-50 mm lenticular breaking to moderate 20-50 mm angular blocky; dry, very firm; very few fine marganiferous veins. Gradual to -
C 1.3+	Dull yellow orange (10YR6/4); sandy clay loam; massive; dry, moderately weak. Highly weathered feldspathic sandstone.

Laboratory Data

Depth(m)	0-0.1	0.1-0.2	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
pH	7.8	8.5	8.3	7.9	8.0	7.6
Electrical conductivity (mS cm^{-1})	0.13	0.22	0.44	0.82	0.89	0.79
Chloride (%)	0.0015	0.002	0.038	0.165	0.183	0.100
Particle size distribution (%)						
Coarse sand (2.0-0.2mm)	18		12	12	10	10
Fine sand (0.2-0.02mm)	31		28	29	28	26
Silt (0.02-0.002mm)	10		21	18	16	16
Clay (< 0.002mm)	39		40	41	51	50
Cation exchange capacity (meq $100g^{-1}$)	29		31	34	37	36
Gravimetric moisture %						
Air dry	5.4		5.8	7.0	7.6	6.8
0.1 bar	32		35	38	41	40
15 bar	17		18	20	23	22
Organic carbon (%)	1.22		0.80	0.66	0.67	0.30
Nitrate nitrogen (µg g^{-1})	7.0		8.8	8.4	4.6	3.0
Extractable phosphorus (µg g^{-1})						
BSES	22		13	9	14	10
Bicarbonate	12		4	3	4	3
Sulphate sulphur (µg g^{-1})	8.0		8.5	5.5	5.0	4.0
DTPA-Extractable micronutrients:						
Iron (µg g^{-1})	9		8	10	7	16
Manganese (µg g^{-1})	6		2	2	3	4
Copper (µg g^{-1})	0.8		0.5	0.5	0.5	0.3
Zinc (µg g^{-1})	0.4		0.3	0.3	0.5	0.3
Cations:						
Calcium (meq. $100g^{-1}$)	31		45	33	33	23

Laboratory Data (cont.)

Depth(m)	0-0.1	0.1-0.2	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
Cations (cont.):						
Magnesium (meq. $100g^{-1}$)	6.3		7.5	7.9	7.8	7.4
Sodium (meq. $100g^{-1}$)	2.1		5.4	7.9	8.9	9.9
Potassium (meq. $100g^{-1}$)	0.83		0.44	0.28	0.24	0.15
Mineralogy*:						
Major minerals	KQ		KQ	KQ		K
Minor minerals				MI		QM
Trace minerals						

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class:	Teviot (Profile 2)
Great Soil Group:	Grey clay
Principal Profile Form:	Ug 5.14
Parent Material:	Weathered feldspathic sandstone (Juandah Coal Measures)
Topography:	Mid-slope, undulating landscape, slope 2%, WSW aspect.
Location:	SG55-12. Roma. GM8912. Near Austinvale area. Theiss chip hole site R348. 500 m north of gate on track leading to trial excavation. Site 2.
Vegetation:	Cleared, with brigalow sucker regrowth. Previously brigalow open forest with shrub understorey of Wilga.
Land Use:	Previously cropped (canary, grain sorghum)
Profile Morphology:	Surface: Moderately self mulching, cracking, with thin fragile, laminar surface crust. A few subrounded silicified wood cobbles are present on surface.
A11 0-0.03	Brownish black (10YR3/1); light medium clay; moderate 2-5 mm granular; dry, moderately weak. Clear to -
A12 0.03 - 0.12	Black (10YR 2/1); light medium clay; moderate 10-20 mm angular blocky; dry, moderately firm; few fine calcareous nodules. Clear to -
B21K 0.12 - 0.45	Brownish grey (10YR4/1); light medium clay; moderate 20 - 50 mm lenticular breaking to moderate 10 - 20 mm angular blocky; dry moderately strong; common medium calcareous nodules. Gradual to -

B22K 0.45 - 0.75	Greyish yellow brown (10YR4/2); light medium clay; moderate 20-50 mm lenticular; dry very firm; common medium calcareous nodules. Gradual to -
B23 0.75 - 1.0	Dull yellow orange (10YR6/4); light medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few fine calcareous nodules. Clear to -
C 1.0 +	Highly weathered friable feldspathic sandstone.

Laboratory Data

Depth (m)	0 - 0.1	0.2-0.3	0.5-0.6	0.8-0.9
pH	7.9	8.9	8.9	8.6
Electrical conductivity ($mS\ cm^{-1}$)	0.20	0.50	0.80	0.83
Chloride (%)	0.0145	0.053	0.094	0.114
Particle size distribution(%):				
Coarse sand (2.0-0.2 mm)	18	10	11	16
Fine sand (0.2-0.02 mm)	32	33	31	35
Silt (0.02-0.002 mm)	11	16	14	11
Clay (< 0.002 mm)	40	40	42	38
Cation exchange capacity ($meq\ 100g^{-1}$)	35	36	36	29
Gravimetric moisture %:				
Air dry	6.7	6.8	6.9	5.8
0.1 bar	32.4	35.5	38.5	34.9
15 bar	17.8	19.5	22.5	19.8
Organic carbon (%)	1.08	0.53	0.41	0.24
Nitrate nitrogen ($\mu g\ g^{-1}$)	9.6	2.0	1.4	0.8
Extractable phosphorus ($\mu g\ g^{-1}$):				
BSES	12	8	8	5
Bicarbonate	6	2	2	2
Sulphate sulphur ($\mu g\ g^{-1}$)	6.5	27.0	59.5	50.5
DTPA-Extractable micronutrients:				
Iron ($\mu g\ g^{-1}$)	15	8	6	4
Manganese ($\mu g\ g^{-1}$)	5	7	8	1
Copper ($\mu g\ g^{-1}$)	0.9	1.1	0.9	0.5
Zinc ($\mu g\ g^{-1}$)	1.6	0.9	1.3	0.7

Laboratory Data (cont.)

Depth (m)	0 - 0.1	0.2-0.3	0.5-0.6	0.8-0.9
Cations:				
Calcium (meq. $100g^{-1}$)	19.5	84	69	21
Magnesium (meq. $100g^{-1}$)	6.1	11.3	11.0	9.8
Sodium (meq. $100g^{-1}$)	2.69	7.60	10.43	11.83
Potassium (meq. $100g^{-1}$)	0.54	0.38	0.34	0.31
Mineralogy*:				
Major	KQ	KQ	KQM	K
Minor				Q
Trace	I			M

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Rolleston

Great Soil Group: Black earth - brown clay

Principal Profile Form: Ug 5.15

Parent Material: Weathered siltstone (Juandah Coal Measures)

Topography: Lower midslope; 1% slope, ENE aspect.

Location: SG 55-12 Roma. GM 8910 Austinvale area. Theiss chip hole R 330. 530 m west of Coolanna homestead. Site 3.

Vegetation: Cleared for cultivation. Previously open forest of brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*).

Land Use: Annual cropping (currently grain sorghum).

Profile Morphology:

Surface: Moderately self mulching, cracking.

	m	
Ap1	0 - 0.05	Brownish black (7.5YR3/2); medium heavy clay; strong 2-5 mm granular; dry, moderately weak. Clear to -
Ap2	0.05 - 0.20	Brownish black (7.5YR3/1); heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
B21	0.20 - 0.40	Brownish black (10YR3/1); heavy clay; moderate 20-50 mm lenticular; dry, moderately strong; very few fine calcareous nodules. Gradual to -
B22K	0.40 - 0.75	Brown (7.5YR4/4); heavy clay; moderate 20-50 mm lenticular; dry, very strong; common medium calcareous nodules. Gradual to -
B23n	0.75 - 1.0	Bright brown (7.5YR5/5); heavy clay; moderate 20-50 mm breaking to moderate 10-20 mm lenticular; dry, very strong; few medium calcareous nodules; common district mangans; few fine manganiferous veins. Gradual to -

B24 1.0 - 1.5+ Orange (7.5YR6/6); heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, very strong; few fine manganiferous veins.

Weathered siltstone is encountered at 2.6 m.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
pH	8.3	8.6	9.1	8.9	8.6	5.8
Electrical conductivity ($mS\ cm^{-1}$)	0.12	0.19	0.28	0.89	0.83	0.58
Chloride (%)	0.003	0.004	0.011	0.055	0.063	0.061
Particle size distribution(%):						
Coarse sand (2.0-0.2 mm)	5	3	4	3		2
Fine sand (0.2-0.02 mm)	22	24	21	19		15
Silt (0.02-0.002 mm)	11	10	11	14		21
Clay (< 0.002 mm)	61	61	62	62		60
Cation exchange capacity ($meq\ 100g^{-1}$)	40	38	39	39		38
Gravimetric moisture %:						
Air dry	7.0	6.9	8.1	7.8		6.4
0.1 bar	36	38	40	42		38
15 bar	19	20	20	21		20
Organic carbon (%)	1.50	0.91	0.78	0.47		0.39
Nitrate nitrogen ($\mu g\ g^{-1}$)	13.6	4.8	3.2	2.6		4.9
Extractable phosphorus ($\mu g\ g^{-1}$):						
BSES	38	28	18	14		10
Bicarbonate	24	8	3	3		2
Sulphate sulphur ($\mu g\ g^{-1}$)	16	18	81	86		80
DTPA-Extractable micronutrients:						
Iron ($\mu g\ g^{-1}$)	11	10	10	8		10
Manganese ($\mu g\ g^{-1}$)	6	6	6	7		9
Copper ($\mu g\ g^{-1}$)	2.4	2.0	2.2	2.0		2.2
Zinc ($\mu g\ g^{-1}$)	1.1	1.3	0.6	0.6		1.6
Cations:						
Calcium ($meq.\ 100g^{-1}$)	40	38	39	39		38

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
Cations (cont.)						
Magnesium (meq. $100g^{-1}$)	5.3	5.8	11.0	11.4		10.1
Sodium (meq. $100g^{-1}$)	1.1	2.1	7.6	8.9		10.3
Potassium (meq. $100g^{-1}$)	1.06	0.47	0.61	0.43		0.36
Mineralogy*:						
Major	K	K	K	K		K
Minor	Q	Q	Q	Q		Q
Trace	I		M			MI

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Downfall

Great Soil Group: Grey clay

Principal Profile Form: Ug 5.24

Parent Material: Weathered mudstone (Juandah Coal Measures)

Topography: Upper midslope; patch of normal gilgai along contour; 1% slope W aspect.

Location: SG. 55-12. Roma. GM 8705. Woleebee area. Adjacent to Jackson Road, 2.2 km east of Woleebee Creek bridge. Across road from Theiss core hole C 505. Site 4.

Vegetation: Open forest of belah (*Casuarina cristata*) with shrub understorey of wilga (*Geijera parviflora*). Limited clearing has occurred.

Land Use: Beef cattle grazing; cultivation nearby.

Profile Morphology: Surface: Gilgai - moderate; normal; 50% small depressions; vertical interval 0.4 m horizontal interval 4 m. Moderately self mulching.

Depression profile:

	m	
A11	0 - 0.03	Greyish yellow brown (10YR4/2); medium clay; moderate 2-5 mm granular; dry, moderately weak; few medium calcareous nodules. Clear to -
A12	0.03 - 0.15	Greyish yellow brown (10YR4/2); medium heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
B21	0.15 - 0.40	Greyish yellow brown (10YR4/2); medium heavy clay; moderate 20-50 mm lenticular; dry, moderately strong, few medium carbonate nodules. Gradual to -
B22K	0.40 - 1.0	Dull yellowish brown (10YR5/3); medium heavy clay; moderate 20-50 mm lenticular; dry,

B22K (cont.)		moderately strong; common medium calcareous nodules; common medium soft calcareous segregations. Gradual to -
B23	1.0 - 1.5+	Dull yellow orange (10YR6/4); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry moderately strong; few fine manganiferous veins.
		Mudstone is encountered at 1.9 m.

Mound Profile:

	m	
A11	0 - 0.05	Greyish brown (7.5YR4/2); medium heavy clay; strong 2.5 mm granular; dry moderately weak; common medium calcareous nodules. Clear to -
A12	0.05 - 0.15	Greyish yellowish brown (10YR4/2); medium heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
B21K	0.15 - 0.50	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 20-50 mm lenticular; dry, moderately strong; common medium calcareous nodules. Gradual to -
B22	0.50 - 1.0	Dull yellowish brown (10YR5/3); medium heavy clay, moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to -
B23	1.0 - 1.5	Dull yellow orange (10YR6/3); medium heavy clay; moderate 20-50 mm prismatic; dry, moderately strong.

Laboratory Data (Depression profile)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
pH	7.8	8.2	8.7	8.6	8.4
Electrical conductivity (mS cm^{-1})	0.19	0.20	0.24	0.48	0.98
Chloride (%)	0.0035	0.005	0.008	0.045	0.093
Particle size distribution(%):					
Coarse sand (2.0-0.2 mm)	16	17	15	16	16
Fine sand (0.2-0.02 mm)	25	25	23	24	22
Silt (0.02-0.002 mm)	12	11	10	11	11
Clay (< 0.002 mm)	48	49	51	50	50
Cation exchange capacity (meq. $100g^{-1}$)	32	34	35	36	33
Gravimetric moisture %:					
Air dry	5.4	4.8	6.6	7.0	6.8
0.1 bar	36	38	39	37	37
15 bar	18	19	19	18	18
Organic carbon (%)	3.68	1.44	0.64	0.38	0.38
Nitrate nitrogen (µg g^{-1})	12.0	10.4	6.4	2.6	3.8
Extractable phosphorus (µg g^{-1}):					
BSES	120	42	10	14	14
Bicarbonate	58	17	3	2	2
Sulphate sulphur (µg g^{-1})	17.5	11.0	20.0	90.0	115
DTPA-Extractable micronutrients:					
Iron (µg g^{-1})	15	13	10	10	11
Manganese (µg g^{-1})	8	5	4	3	3
Copper (µg g^{-1})	0.7	0.7	0.6	0.4	0.5
Zinc (µg g^{-1})	1.4	0.7	0.4	0.2	0.3
Cations:					
Calcium (meq. $100g^{-1}$)	26.9	43.4	46.7	28.3	25.2

Laboratory Data (Depression profile)(cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
Cations (cont.)					
Magnesium (meq. 100 g^{-1})	4.03	3.43	3.95	4.22	4.22
Sodium (meq. 100g^{-1})	0.73	1.60	3.10	6.27	8.38
Potassium (meq. 100g^{-1})	1.90	1.08	0.63	0.33	0.28
Mineralogy*:					
Major	KQ		KQ		K
Minor					Q
Trace	I				MI

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Laboratory Data (Mound profile)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6
pH	7.3	8.3	8.6
Electrical conductivity (mS cm^{-1})	0.15	0.17	0.39
Chloride (%)	0.003	0.002	0.022
Organic carbon (%)	2.57	1.20	0.35
Nitrate nitrogen (µg g^{-1})	12.0	9.6	3.6
Extractable phosphorus (µg g^{-1}):			
BSES	29	15	15
Bicarbonate	16	4	3
Sulphate sulphur (µg g^{-1})	6.5	8.5	50
DTPA-Extractable micronutrients:			
Iron (µg g^{-1})	9	8	7
Manganese (µg g^{-1})	4	2	2
Copper (µg g^{-1})	0.4	0.3	0.3
Zinc (µg g^{-1})	0.7	0.4	0.2
Cations:			
Calcium (meq. $100g^{-1}$)	34.2	46.1	35.2
Magnesium (meq. $100g^{-1}$)	3.56	4.58	4.85
Sodium (meq. $100g^{-1}$)	0.60	2.09	5.03
Potassium (meq. $100g^{-1}$)	1.16	0.58	0.34

Soil Profile Class: Coolanna

Great Soil Group: Brown clay

Principal Profile Form: Ug 5.15

Parent Material: Weathered siltstone (Juandah Coal Measures)

Topography: Midslope; 1% slope; NNE aspect.

Location: SG 55-12 Roma. GM 9112. Austinvale area. 50 m south of Theiss chip hole R 344. 700 m NNE of trial excavation. Site 5.

Vegetation: Cleared. Previously woodland of brigalow.

Land Use: Cropping. Currently fallow.

Profile Morphology: Surface: moderately self-mulching, cracking, with thin fragile crust.

	m	
A11	0 - 0.05	Brownish black (7.5YR3/2); medium clay; strong 2-5 mm granular; dry, moderately weak; few medium ferruginous nodules; few small sub-rounded siliceous pebbles. Clear to -
A12	0.05 - 0.12	Brownish black (10YR3/2); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
A13	0.12 - 0.20	Greyish brown (7.5YR4/2); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
B21K	0.20 - 0.40	Brown (7.5YR4/3); medium heavy clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common medium calcareous nodules. Gradual to -
B22	0.40 - 0.75	Dull reddish brown (5YR5/4); medium heavy clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; few medium calcareous nodules. Gradual to -

B23	0.75 - 1.35	Bright reddish brown (5YR5/6); medium heavy clay; moderate 20-50 mm lenticular; dry moderately strong; few medium gypseous crystals. Gradual to -
B24	1.35 - 1.50	Bright reddish brown (5YR5/8); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; few medium gypseous crystals.

Weathered siltstone is encountered at 2.1 m.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
pH	8.3	8.9	9.0	8.2	5.0	5.7
Electrical conductivity (mS cm^{-1})	0.15	0.23	0.39	0.75	0.82	0.81
Chloride (%)	0.0095	0.012	0.025	0.121	0.100	0.071
Particle size distribution (%):						
Coarse sand (2.0-0.2mm)	8	7	8	8		9
Fine sand (0.2-0.02mm)	29	23	27	24		25
Silt (0.02-0.002mm)	16	16	10	16		15
Clay (< 0.002mm)	48	52	54	51		51
Cation exchange capacity (meq. $100g^{-1}$)	34	33	32	35		34
Gravimetric moisture %:						
Air dry	7.2	7.1	6.9	7.4		7.6
0.1 bar	37	38	39	39		38
15 bar	18	19	20	20		20
Organic carbon (%)	1.44	0.70	0.45	0.31		0.24
Nitrate nitrogen (µg g^{-1})	13.2	3.2	1.9	2.0		4.0
Extractable phosphorus (µg g^{-1}):						
BSES	39	13	14	15		15
Bicarbonate	6	3	3	3		3
Sulphate sulphur (µg g^{-1})	13.0	28.0	83.0	145.0		290.0
DTPA-Extractable micronutrients:						
Iron (µg g^{-1})	16	10	9	12		17
Manganese (µg g^{-1})	5	4	4	3		2
Copper (µg g^{-1})	0.8	0.7	0.6	0.6		0.6
Zinc (µg g^{-1})	2.0	1.0	0.9	0.9		0.9

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
Cations:						
Calcium (meq. $100g^{-1}$)	30	63	29.8	14.8		11.2
Magnesium (meq. $100g^{-1}$)	7.62	13.0	13.0	11.5		11.0
Sodium (meq. $100g^{-1}$)	1.93	3.9	6.0	7.4		8.8
Potassium (meq. $100g^{-1}$)	0.51	0.31	0.28	0.28		0.31
Mineralogy*:						
Major	K	K	K	K		KQ
Minor	Q	Q	Q	Q		M
Trace						I

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Cheshire

Great Soil Group: No suitable group.

Principal Profile Form: Uf 6.31

Parent Material: Feldspathic sandstone or fine sandy siltstone (Juandah Coal Measures)

Topography: Near crest in undulating landscape; 2% slope; N aspect.

Location: SG 55-12 Roma. GM 9011 Austinvale area. 50 m west of Theiss chip hole R 352. 700 m NNE of trial excavation. Site 6.

Vegetation: Cleared apart from isolated shade trees. Previously open forest of brigalow (*Acacia harpophylla*), bumbil (*Capparis mitchellii*), bauhinia (*Lysiphyllum carronii*), bottle tree (*Brachychiton rupestre*) with associated softwood species and wilga (*Geijera parviflora*).

Land Use: Previously cultivated; currently cattle grazing.

Profile morphology: Surface: moderately self mulching, common surface strew of silicified wood 1 mm to 0.25 m.

	m	
A11	0 - 0.05	Brownish black (10YR3/2); light clay; moderate 2-5 mm granular; dry, moderately weak, few medium ferruginous nodules; common medium subangular siliceous pebbles. Clear to -
A12	0.05 - 0.20	Brownish black (10YR3/2); light medium clay; moderate 5-10 mm angular blocky; dry, moderately firm. Clear to -
B21	0.20-0.40	Dull yellowish brown (10YR4/3); medium clay; moderate 10-20 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common fine to medium calcareous nodules. Gradual to -

B22	0.40 - 0.75	Dull yellowish brown (10YR5/4); medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few fine carbonate nodules. Gradual to -
B23	0.75 - 1.30	Yellowish brown (10YR5/6); medium clay; moderate 20-50 mm lenticular; dry, moderately strong. Gradual to -
C	130+	Bright yellowish brown (10YR6/6); weathered fine sandy siltstone.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
pH	7.6	8.9	9.1	8.9	8.9
Electrical conductivity ($mS\ cm^{-1}$)	0.17	0.27	0.57	0.58	0.55
Chloride (%)	0.005	0.011	0.061	0.067	0.066
Particle size distribution(%):					
Coarse sand (2.0-0.2 mm)	11	10	11		15
Fine sand (0.02-0.002 mm)	38	30	27		31
Silt (0.02-0.002 mm)	16	16	14		11
Clay (< 0.002 mm)	37	35	48		45
Cation exchange capacity ($meq.\ 100g^{-1}$)	30	34	33		32
Gravimetric moisture %:					
Air dry	7.4	7.6	7.8		7.5
0.1 bar	32	35	36		33
15 bar	17	20	20		19
Organic carbon (%)	1.22	0.67	0.40		0.16
Nitrate nitrogen ($\mu g\ g^{-1}$)	25.6	19.4	8.0		1.0
Extractable phosphorus ($\mu g\ g^{-1}$):					
BSES	25	11	7		9
Bicarbonate	10	2	2		1
Sulphate sulphur ($\mu g\ g^{-1}$)	10	9	13		5.5
DTPA-Extractable micronutrients:					
Iron ($\mu g\ g^{-1}$)	10	9	5		6
Manganese ($\mu g\ g^{-1}$)	6	3	2		1
Copper ($\mu g\ g^{-1}$)	0.6	0.5	0.3		0.2
Zinc ($\mu g\ g^{-1}$)	1.4	0.8	0.6		0.6

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
Cations:					
Calcium (meq. $100g^{-1}$)	27.6	85	90		26.5
Magnesium (meq. $100g^{-1}$)	7.7	13.3	15		13
Sodium (meq. $100g^{-1}$)	2.17	5.13	10.17		12.17
Potassium (meq. $100g^{-1}$)	0.44	0.27	0.27		0.23
Mineralogy*:					
Major	K		KQM		KQ
Minor					
Trace	MI		I		M

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Austinvale

Great Soil Group: No suitable group

Principal Profile Form: Uf 6.31

Parent Material: Fine sandy siltstone (Juandah Coal Measures)

Topography: Midslope; 2% slope; N aspect.

Location: SG 55-12. Roma GM 9011. Austinvale area. 50 m south west of Theiss chip hole R 350. Site 7.

Vegetation: Cleared. Previously brigalow open forest. Regrowth of bitterbark (*Alstonia constricta*).

Land Use: Previously cultivated, currently cattle grazing.

Profile morphology: Surface: moderately hardsetting, some sheet erosion.

	(m)	
A11	0 - 0.05	Brown (7.5YR4/4); medium clay; weak 5-10 mm angular blocky; dry, moderately firm. Clear to -
A12	0.05 - 0.10	Dull reddish brown (5YR4/4); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to -
B21	0.10 - 0.20	Reddish brown (5YR4/6); medium clay; moderate 20-50 mm angular blocky; dry, very firm. Gradual to -
B22	0.20 - 0.40	Bright brown (7.5YR5/6); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, moderately strong; few fine calcareous nodules. Gradual to -
B23	0.40 - 0.54	Yellowish brown (10YR5/7); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry moderately strong; few medium soft calcareous segregations. Clear to -

C 0.54+ Slightly weathered yellowish brown (10YR5/8) fine sandy siltstone.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6
pH	7.4	8.1	8.5
Electrical conductivity (mS cm^{-1})	0.07	0.07	0.09
Chloride (%)	0.003	0.001	0.001
Particle size distribution (%):			
Coarse sand (2.0-0.2 mm)	8	6	8
Fine sand (0.2-0.02 mm)	27	23	36
Silt (0.02-0.002 mm)	16	16	21
Clay (< 0.002 mm)	51	55	38
Cation exchange capacity (meq. $100g^{-1}$)	34	34	28
Gravimetric moisture percentage:			
Air dry	7.6	6.8	4.1
0.1 bar	35	38	31
15 bar	19	20	16
Organic carbon (%)	0.72	0.53	0.30
Nitrate nitrogen (µg g^{-1})	6.4	0.2	0.4
Extractable phosphorus (µg g^{-1}):			
BSES	9	46	95
Bicarbonate	4	2	2
Sulphate sulphur (µg g^{-1})			
DTPA-Extractable micronutrients:			
Iron (µg g^{-1})	10	5	5
Manganese (µg g^{-1})	4	3	2
Copper (µg g^{-1})	1.0	0.8	1.0
Zinc (µg g^{-1})	4	3	0.5

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6
Cations:			
Calcium (meq. $100g^{-1}$)	19.5	23	45
Magnesium (meq. $100g^{-1}$)	7.75	7.67	6.91
Sodium (meq. $100g^{-1}$)	0.74	0.60	0.54
Potassium (meq. $100g^{-1}$)	0.36	0.29	0.26
Mineralogy*:			
Major	K	K	K
Minor	Q	Q	Q
Trace	M	M	I

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Beechley

Great Soil Group: Grey clay

Principal Profile Form: Ug 5.14

Parent Material: Feldspathic sandstone (Juandah Coal Measures)

Topography: Near crest, undulating landscape; slope 2.5%; NNE aspect.

Location: S 44-12 Roma. GM 8509. Woleebee area. 200 m north of Theiss chip hole R 473. Site 8.

Vegetation: Cleared. Nearby vegetation is brigalow open forest with associated softwood species.

Land Use: Grazing. Cultivated for grain sorghum nearby.

Profile Morphology: Surface: Stone cover - abundant subrounded siliceous large pebbles, cobbles and stones.

	m	
A11	0 - 0.04	Black (10YR2/1); light medium clay; moderate 2-5 mm granular; dry, very weak; abundant subrounded siliceous pebbles and cobbles. Clear to -
A12	0.04 - 0.15	Brownish black (10YR3/1); light medium clay; moderate 5-10 mm angular blocky; dry, moderately firm; common medium and large subrounded siliceous pebbles. Clear to -
B21	0.15 - 0.45	Brownish grey (10YR4/1); light medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules; few medium subrounded siliceous pebbles. Gradual to -
B22	0.45 - 0.75	Greyish yellow brown (10YR4/2); medium clay; moderate 20-50 mm lenticular; dry moderately strong. Gradual to -

B23	0.75 - 0.90	Dull yellowish brown (10YR5/3); medium clay; moderate 20-50 mm lenticular; dry, moderately strong. Clear to -
C	0.90+	Weathered feldspathic sandstone.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8 0.9
pH	7.2	8.3	8.5	7.1
Electrical conductivity ($mS\ cm^{-1}$)	0.05	0.11	0.67	0.75
Chloride (%)	0.001	0.003	0.035	0.092
Particle size distribution (%):				
Coarse sand (2.0-0.2 mm)	13			
Fine sand (0.2-0.02 mm)	28			
Silt (0.02-0.002 mm)	18			
Clay (< 0.002 mm)	42			
Cation exchange capacity ($meq.\ 100g^{-1}$)	33			
Gravimetric moisture percentage:				
Air dry	6.9			
0.1 bar	32			
15 bar	18			
Organic carbon (%)	1.97			
Nitrate nitrogen ($\mu g\ g^{-1}$)	3.8			
Extractable phosphorus ($\mu g\ g^{-1}$):				
BSES	29			
Bicarbonate	12			
Sulphate sulphur ($\mu g\ g^{-1}$)	2.5			
DTPA-Extractable micronutrients:				
Iron ($\mu g\ g^{-1}$)	9			
Manganese ($\mu g\ g^{-1}$)	6			
Copper ($\mu g\ g^{-1}$)	0.8			
Zinc ($\mu g\ g^{-1}$)	1.1			

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9
Cations:				
Calcium (meq. $100g^{-1}$)	14.83			
Magnesium (meq. $100g^{-1}$)	1.89			
Sodium (meq. $100g^{-1}$)	0.05			
Potassium (meq. $100g^{-1}$)	0.83			
Mineralogy*:				
Major	KQ			

* K = kaolinite, Q = quartz.

Soil Profile Class: Salisbury Park

Great Soil Group: Lithosol

Principal Profile Form: Uc 1.21

Parent Material: Outcrop of Springbok sandstone

Topography: Crest of low hill, slope 2% W aspect.

Location: SG 55-12 Roma. GM 8807. Woleebee area.
50 m south of Theiss core hole C 670. Site 10.

Vegetation: Woodland of silver-leaved ironbark (*Eucalyptus melanophloia*) with some brigalow (*Acacia harpophylla*).

Land Use: Rough grazing.

Profile Morphology: Surface: hardsetting.

	m	
A11	0 - 0.04	Dull yellowish brown (10YR5/3); coarse loamy sand; massive; dry, moderately weak; abundant subangular medium to large siliceous pebbles. Clear to -
A12	0.04 - 0.10	Dull yellow orange (10YR6/4); coarse sand; massive; dry moderately weak; abundant subangular medium siliceous pebbles and sandstone fragments. Clear to -
C	0.10+	Quartzose sandstone and gravel.

Laboratory Data

Depth (m)	0-0.1
pH	6.7
Electrical conductivity (mS cm^{-1})	0.02
Chloride (%)	0.001
Particle size distribution (%):	
Coarse sand (2.0-0.2 mm)	68
Fine sand (0.2-0.02 mm)	18
Silt (0.02-0.002 mm)	5
Clay (< 0.002 mm)	7
Cation exchange capacity (meq. $100g^{-1}$)	6.4
Gravimetric moisture percentage:	
Air dry	2.1
0.1 bar	16
15 bar	7
Organic carbon (%)	0.45
Nitrate nitrogen (µg g^{-1})	1.0
Extractable phosphorus (µg g^{-1}):	
BSES	14
Bicarbonate	7
Sulphate sulphur (µg g^{-1})	2.0
DTPA-extractable micronutrients:	
Iron (µg g^{-1})	19
Manganese (µg g^{-1})	5
Copper (µg g^{-1})	0.3
Zinc (µg g^{-1})	0.5

Laboratory Data (cont.)

Depth (m)	0-0.1
Cations:	
Calcium (meq. $100g^{-1}$)	3.18
Magnesium (meq. $100g^{-1}$)	1.02
Sodium (meg. $100g^{-1}$)	0.23
Potassium (meq. $100g^{-1}$)	0.27
Mineralogy*:	
Major	Q
Trace	K

* K = kaolinite, Q = quartz.

Soil Profile Class: Retro

Great Soil Group: Solodized solonetz

Principal Profile Form: Dy 2.43

Parent Material: Feldspathic sandstone (Springbok sandstone) with colluvial influence.

Topography: Lower slope, marginal to drainage floor of Woleebee Creek. 2% slope, west aspect.

Location: SG 55-12 Roma GM 8705. Near Theiss chip hole R 652. Woleebee area. Site 9.

Vegetation: Open forest of brigalow *(Acacia harpophylla)*, poplar box *(Eucalyptus populnea)*, belah *(Casuarina cristata)* with shrub understorey of false sandalwood *(Eremophila mitchellii)* and bull-oak *(Casuarina leuhmarinii)*.

Land Use: Road reserve. Partially cleared for grazing nearby.

Profile Morphology: Surface: hardsetting.

	m	
A1	0 - 0.11	Brownish grey (10YR4/1); sandy clay loam; massive; dry, moderately firm. Clear to -
A2cb	0.11 - 0.13	Conspicuously bleached; dull yellow orange (10YR7/2D); fine sandy clay loam; dry, moderately firm; few rounded medium siliceous pebbles. Clear to -
B21t	0.13 - 0.25	Dark greyish yellow (2.5Y4/2); medium clay; moderate 50-100 mm collumnar breaking to moderate 50-100 mm angular blocky; dry, very strong. Gradual to -
B22tk		Dark greyish yellow (2.5Y4/2); medium clay; moderate 50-100 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, very strong; common fine calcareous nodules; few

B23t	0.45 - 0.85	Greyish yellow (2.5Y6/2); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry moderately strong; few fine carbonate nodules. Gradual to -
C	0.85+	Friable weathered sandstone.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6
pH	7.1	8.3	8.9
Electrical conductivity (mS cm^{-1})	0.03	0.18	0.42
Chloride (%)	0.001	0.005	0.040
Particle size distribution (%):			
Coarse sand (2.0-0.2 mm)	14	3	2
Fine sand (0.2-0.02 mm)	42	36	36
Silt (0.02-0.002 mm	16	14	16
Clay (< 0.002 mm)	28	49	47
Cation exchange capacity (meq. $100g^{-1}$)	17	33	31
Gravimetric moisture percentage:			
Air dry	2.7	6.5	6.7
0.1 bar	22	39	39
15 bar	11	26	25
Organic carbon (%)	0.73	0.60	0.52
Nitrate nitrogen (µg g^{-1})	1.0	3.4	2.2
Extractable phosphorus (µg g^{-1}):			
BSES	21	6	5
Bicarbonate	12	3	3
Sulphate sulphur (µg g^{-1})	3.0	5.5	48
DTPA-Extractable micronutrients:			
Iron (µg g^{-1})	10	10	10
Manganese (µg g^{-1})	11	7	4
Copper (µg g^{-1})	0.6	0.7	0.4
Zinc (µg g^{-1})	0.6	0.4	0.2

Laboratory Data (cont.)

Depth (m)	0-0.1	0.2-0.3	0.5-0.6
Cations:			
Calcium (meq. $100g^{-1}$)	6.6	12.31	87.31
Magnesium (meq. $100g^{-1}$)	11	7	4
Sodium (meq. $100g^{-1}$)	0.08	2.25	5.71
Potassium (meq. $100g^{-1}$)	0.33	0.08	0.09
Mineralogy*:			
Major	KQ		KQ
Minor			
Trace			IM

* I = illite, K = kaolinite, M = montmorillorite, Q = quartz.

Soil Profile Class: Woleebee

Great Soil Group: Solodized solonetz

Principal Profile Form: Dd 1.43

Parent Material: Quaternary alluvium

Topography: Flat alluvial plant associated with Woleebee Creek.

Location: SG 55-12 Roma. GM 8505. Woleebee area. Adjacent to road leading to Cambrai homestead. Theiss core hole C 506. Site 11.

Vegetation: Woodland of poplar box (*Eucalyptus populnea*) with understorey of false sandalwood (*Eremophila mitchellii*) and mimosa (*Acacia farnesiana*). Ground cover includes kangaroo grass (*Themeda australis*), barbed-wire grass (*Cymbopogon refractus*), spear grass (*Heteropogon contortus*), buffel grass (*Cenchrus ciliaris*).

Land Use: Cattle grazing on native pasture.

Profile Morphology: Surface: hardsetting.

	m	
A1	0 - 0.09	Greyish yellow brown (10YR4/2); silt loam; massive or weak 5-10 mm subangular blocky; dry, moderately weak. Clear to -
A2cb	0.09 - 0.10	Conspicuously bleached; light grey (10YR7/1D); silt loam; massive; dry, moderately weak. Abrupt to -
B21t	0.10 - 0.35	Brownish black (10YR3/1); medium clay; moderate 50-100 mm collumnar, breaking to moderate 20-50 mm angular blocky; dry, moderately strong; few fine calcareous nodules. Gradual to -
B22tk	0.35 - 0.60	Brownish black (10YR3/2); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry, moderately strong; common fine calcareous

B22tk 0.35 - 0.60 (cont.) nodules; common medium soft calcareous segregations. Gradual to -

D 0.60+ Greyish yellow brown (10YR4/2); fine sandy clay loam; weak 5-10 mm angular blocky; dry, moderately firm.

Laboratory Data

Depth (m)	0-0.1	0.1-0.2	0.2-0.3	0.4-0.5
pH	7.6	7.5	8.3	8.8
Electrical conductivity (mS cm^{-1})	0.19	0.39	0.46	0.63
Chloride (%)	0.018	0.045	0.055	0.093
Particle size distribution (%):				
Coarse sand (2.0-0.2 mm)	13	12	14	15
Fine sand (0.2-0.02 mm)	48	28	28	34
Silt (0.02-0.002 mm)	22	18	16	16
Clay (< 0.002 mm)	18	42	38	36
Cation exchange capacity (meq. $100g^{-1}$)	14	31	28	26
Moisture percentage:				
Air dry	2.1	5.6	5.3	4.9
0.1 bar	25.2	37.1	36.6	32.9
15 bar	14.8	24.3	22.0	22.2
Organic carbon (%)	1.38	0.97	0.59	0.26
Nitrate nitrogen (µg g^{-1})	10.6	3.6	3.0	1.2
Extractable phosphorus (µg g^{-1}):				
BSES	83	16	30	37
Bicarbonate	49	5	5	6
Sulphate sulphur (µg g^{-1})	17.5	16.5	15.0	21.5
DTPA-Extractable micronutrients:				
Iron (µg g^{-1})	17	23	8	7
Manganese (µg g^{-1})	21	3	2	1
Copper (µg g^{-1})	0.3	0.4	0.3	0.3
Zinc (µg g^{-1})	0.7	0.3	0.2	0.3

Laboratory Data (cont.)

Depth (m)	0-0.1	0.1-0.2	0.2-0.3	0.4-0.5
Cations:	21%	23%	27%	
Calcium (meq. $100g^{-1}$)	9.72	16.31	14.31	14.12
Magnesium (meq. $100g^{-1}$)	2.06	5.39	4.53	3.32
Sodium (meq. $100g^{-1}$)	2.74	6.68	7.27	6.94
Potassium (meq. $100g^{-1}$)	0.89	0.55	0.48	0.34
Mineralogy:				
Major	KQ	KQ	KQ	KQ
Minor				
Trace	I		IM	IM

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Juandah

Great Soil Group: Black earth

Principal Profile Form: Ug 5.16

Parent Material: Quaternary argillaceous alluvium.

Topography: Depression (relict channel) in drainage floor of Woleebee Creek. 0% slope.

Location: SG 55-12 GM8707. Woleebee area. 320 m west of Theiss chip hole R 657. Site 12.

Vegetation: Grassland with scattered coolibah (*Eucalyptus microtheca*) and poplar box (*Eucalyptus populnea*).

Land Use: Cattle grazing on native pasture.

Profile Morphology:

	m	
A11	0 - 0.05	Surface: moderately self mulching. Brownish black (10YR3/1); with few fine distinct orange root mottles; heavy clay; strong 5-10 mm angular blocky; dry, moderately strong. Clear to -
A12	0.05 - 0.10	Black (2.5Y2/1); heavy clay; strong 10-20 mm angular blocky; dry, moderately strong. Clear to -
B21	0.10 - 0.50	Brownish black (2.5Y3/1); heavy clay; moderate 20-50 mm lenticular; dry, moderately strong. Gradual to -
B22	0.50 - 1.30	Greyish yellow brown (10YR4/2); heavy clay; medium 20-50 mm lenticular; dry, very strong. Gradual to -
B23	1.30 - 1.50	Greyish yellow brown (10YR5/2); heavy clay; moderate 20-50 mm prismatic; dry, very strong.

Laboratory Data

Depth (m)	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
pH	7.0	7.6	8.2	8.2	8.3	8.2
Electrical conductivity (mS cm^{-1})	0.07	0.06	0.08	0.16	0.29	0.31
Chloride (%)	0.004	0.006	0.018	0.039	0.069	0.095
Particle size distribution(%):						
Coarse sand (2.0-0.2mm)	4		3			
Fine sand (0.2-0.02mm)	15		14			
Silt (0.02-0.002mm)	30		20			
Clay (< 0.002 mm)	53		65			
Cation exchange capacity (meq. $100g^{-1}$)	39		44			
Gravimetric moisture percentage:						
Air dry	7.2		8.4			
0.1 bar	41		48			
15 bar	24		26			
Organic carbon (%)	1.01		0.53			
Nitrate nitrogen (µg g^{-1})	4.2		2.4			
Extractable phosphorus (µg g^{-1}):						
BSES	34		10			
Bicarbonate	35		8			
Sulphate sulphur (µg g^{-1})	16.0		22			
DTPA-Extractable micronutrients:						
Iron (µg g^{-1})	85		29			
Manganese (µg g^{-1})	11		6			
Copper (µg g^{-1})	1.4		0.8			
Zinc (µg g^{-1})	0.7		0.6			

Laboratory Data (cont.)

Depth (m)	0 -0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.4-1.5
Cations:						
Calcium (meq. $100g^{-1}$)	17.83		25.91			
Magnesium (meq. $100g^{-1}$)	6.11		3.84			
Sodium (meq. $100g^{-1}$)	2.43		2.61			
Potassium (meq $100g^{-1}$)	1.39		0.78			
Mineralogy*:						
Major	K		K			
Minor			M			
Trace	Q		Q			

* K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Cambrai

Great Soil Group: Alluvial

Principal Profile Form: Gn 3.92

Parent Material: Quaternary alluvium deposited by Woleebee and Wandoan Creeks.

Topography: Creek levee 0.5% slope westwards towards Wandoan Creek.

Location: SG 55-12 Roma GM 8607. Woleebee area. 50 m west of Theiss core hole C 539. Site 13.

Vegetation: Cleared. Nearby vegetation is open forest of poplar box *(Eucalyptus populnea)*, rusty gum *(Angophora costata)* & Queensland blue gum *(Eucalyptus tereticorins)*.

Land Use: Cropping, currently forage sorghum.

Profile Morphology: Surface: firm.

	m	
A11	0 - 0.20	Brownish grey (10YR4/1); loam, weak 10-20 mm angular blocky; dry, moderately weak. Gradual to -
A12	0.20 - 0.38	Dark grayish yellow (2.5Y4/2); sandy clay loam; moderate 10-20 mm angular blocky; dry moderately weak. Gradual to -
B1	0.38 - 0.60	Greyish yellow brown (10YR4/2); clay loam; fine sandy; moderate 10-20 mm angular blocky; dry moderately firm. Gradual to -
B2	0.60 - 1.0	Brown (10YR4/3); loamy sand; massive; dry, moderately firm; few small rounded siliceous pebbles. Gradual to -
B3	1.0 - 1.5	Dull yellowish brown (10YR5/4); clayey sand; massive; dry, moderately firm.

Laboratory Data

Depth (m)	0-0.1	0.5-0.6
pH	6.4	7.3
Electrical conductivity (mS cm^{-1})	0.04	0.06
Chloride (%)	0.0005	0.001
Particle size distribution (%):		
Coarse sand (2.0-0.2 mm)	13	10
Fine sand (0.2-0.02 mm)	38	34
Silt (0.02-0.002 mm)	25	24
Clay (<0.002 mm)	23	32
Cation exchange capacity (meq. $100g^{-1}$)	16	23
Gravimetric moisture percentage:		
Air dry	2.6	3.9
0.1 bar	22.3	29.7
15 bar	11.7	18.2
Organic carbon (%)	0.78	0.43
Nitrate nitrogen (µg g^{-1})	4.6	2.8
Extractable phosphorus (µg g^{-1}):		
BSES	54	17
Bicarbonate	35	10
Sulphate sulphur (µg g^{-1})	3.5	4.0
DTPA-extractable micronutrients:		
Iron (µg g^{-1})	22	9
Manganese (µg g^{-1})	11	2
Copper (µg g^{-1})	0.3	0.5
Zinc (µg g^{-1})	0.6	0.3

Laboratory Data (cont.)

Depth (m)	0-0.1	0.5-0.6
Cations:		
Calcium (meq. $100g^{-1}$)	7.03	15.51
Magnesium (meq. $100g^{-1}$)	2.23	3.92
Sodium (meq. $100g^{-1}$)	0.04	0.29
Potassium (meq. $100g^{-1}$)	0.90	0.75
Mineralogy*:		
Major	QK	QK
Trace		M

* K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Elsbar

Great Soil Group: Earthy sand

Principal Profile Form: Uc 5.22

Parent Material: Alluvium

Topography: Slight rise within alluvial plain between creeks.

Location: SG 55-12 Roma. GM 8606. Woleebee area. Thiess chip hole R 994. Site 14. 500 m east of Cambrai homestead.

Vegetation: Partially cleared. Clumps of rough-barked apple (*Angophora floribunda*) occur.

Profile Morphology: Surface: loose.

	m	
A1	0 - 0.30	Brownish black (2.5Y3/2); sand; single grain; dry, loose. Gradual to -
A2	0.30 - 0.65	Dull yellowish brown (10YR4/3); sand; massive; dry, very weak. Diffuse to -
B2	0.65 - 1.50	Brown (10YR4/4); sand; dry, moderately weak; few small rounded quartz pebbles.

Laboratory Data

Depth (m)	0-0.1
pH	6.6
Electrical conductivity (mS cm^{-1})	0.02
Chloride (%)	0.0005
Particle size distribution (%):	
Coarse sand (2.0-0.2 mm)	78
Fine sand (0.2-0.02 mm)	14
Silt (0.02-0.002 mm)	4
Clay (< 0.002 mm)	5
Cation exchange capacity (meq. $100g^{-1}$)	5
Moisture percentage:	
Air dry	0.5
0.1 bar	8
15 bar	3
Organic carbon (%)	0.38
Nitrate nitrogen (µg g^{-1})	6.4
Extractable phosphorus (µg g^{-1}):	
BSES	35
Bicarbonate	24
Sulphate sulphur (µg g^{-1})	2.5
DTPA-Extractable micronutrients:	
Iron (µg g^{-1})	15
Manganese (µg g^{-1})	12
Copper (µg g^{-1})	0.3
Zinc (µg g^{-1})	0.9
Cations:	
Calcium (meq. $100g^{-1}$)	2.87

Laboratory Data (cont.)

Depth (m)	0-0.1
Cations (cont.)	
Magnesium (meq. $100g^{-1}$)	0.66
Sodium (meq. $100g^{-1}$)	0.06
Potassium (meq. $100g^{-1}$)	0.62
Mineralogy*:	
Major	Q
Trace	K

* K = kaolinite, Q = quartz.

Appendix D Key Soil Types in the Wandoan Project Area

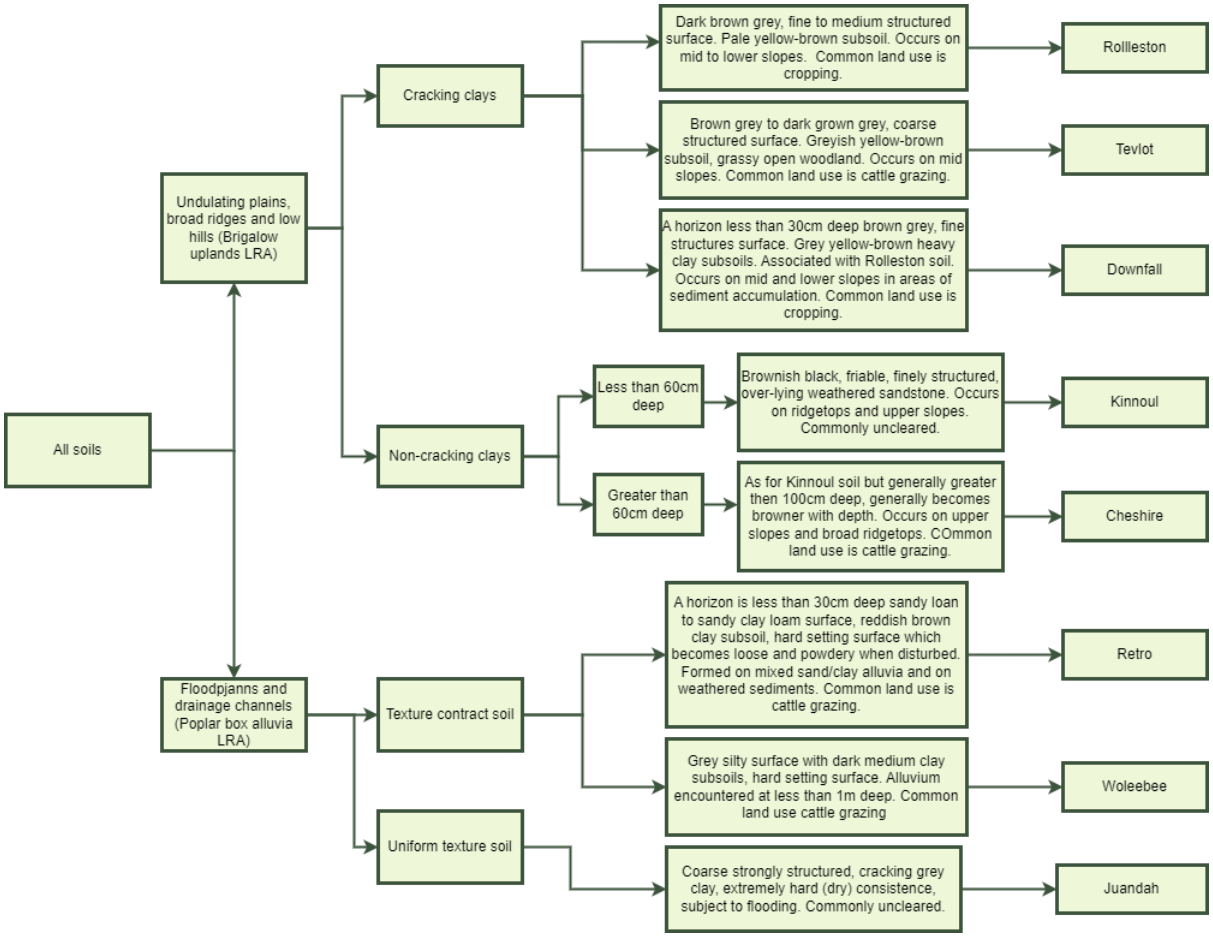
Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

Glencore Coal Assets Australia

SLR Project No.: 626.30100.00000

27 October 2025


All soils
Undulating plains, broad ridges and low hills (Brigalow uplands LRA)
Floodpjanns and drainage channels (Poplar box alluvia LRA)
Cracking clays
Non-cracking clays
Texture contract soil
Uniform texture soil
Dark brown grey, fine to medium structured surface. Pale yellow-brown subsoil. Occurs on mid to lower slopes. Common land use is cropping.
Brown grey to dark grown grey, coarse structured surface. Greyish yellow-brown subsoil, grassy open woodland. Occurs on mid slopes. Common land use is cattle grazing.
A horizon less than 30cm deep brown grey, fine structures surface. Grey yellow-brown heavy clay subsoils. Associated with Rolleston soil. Occurs on mid and lower slopes in areas of sediment accumulation. Common land use is cropping.
Less than 60cm deep
Greater than 60cm deep
Brownish black, friable, finely structured, over-lying weathered sandstone. Occurs on ridgetops and upper slopes. Commonly uncleared.
As for Kinnoul soil but generally greater then 100cm deep, generally becomes browner with depth. Occurs on upper slopes and broad ridgetops. COmmon land use is cattle grazing.
A horizon is less than 30cm deep sandy loan to sandy clay loam surface, reddish brown clay subsoil, hard setting surface which becomes loose and powdery when disturbed. Formed on mixed sand/clay alluvia and on weathered sediments. Common land use is cattle grazing.
Grey silty surface with dark medium clay subsoils, hard setting surface. Alluvium encountered at less than 1m deep. Common land use cattle grazing
Coarse strongly structured, cracking grey clay, extremely hard (dry) consistence, subject to flooding. Commonly uncleared.
Rollleston
Tevlot
Downfall
Kinnoul
Cheshire
Retro
Woleebee
Juandah

Appendix E Regional land suitability framework for beef cattle grazing PMLU rehabililitation in the Bowen Basin

Soil and Capping Material Assessment

Progressive Rehabilitation Closure Plan

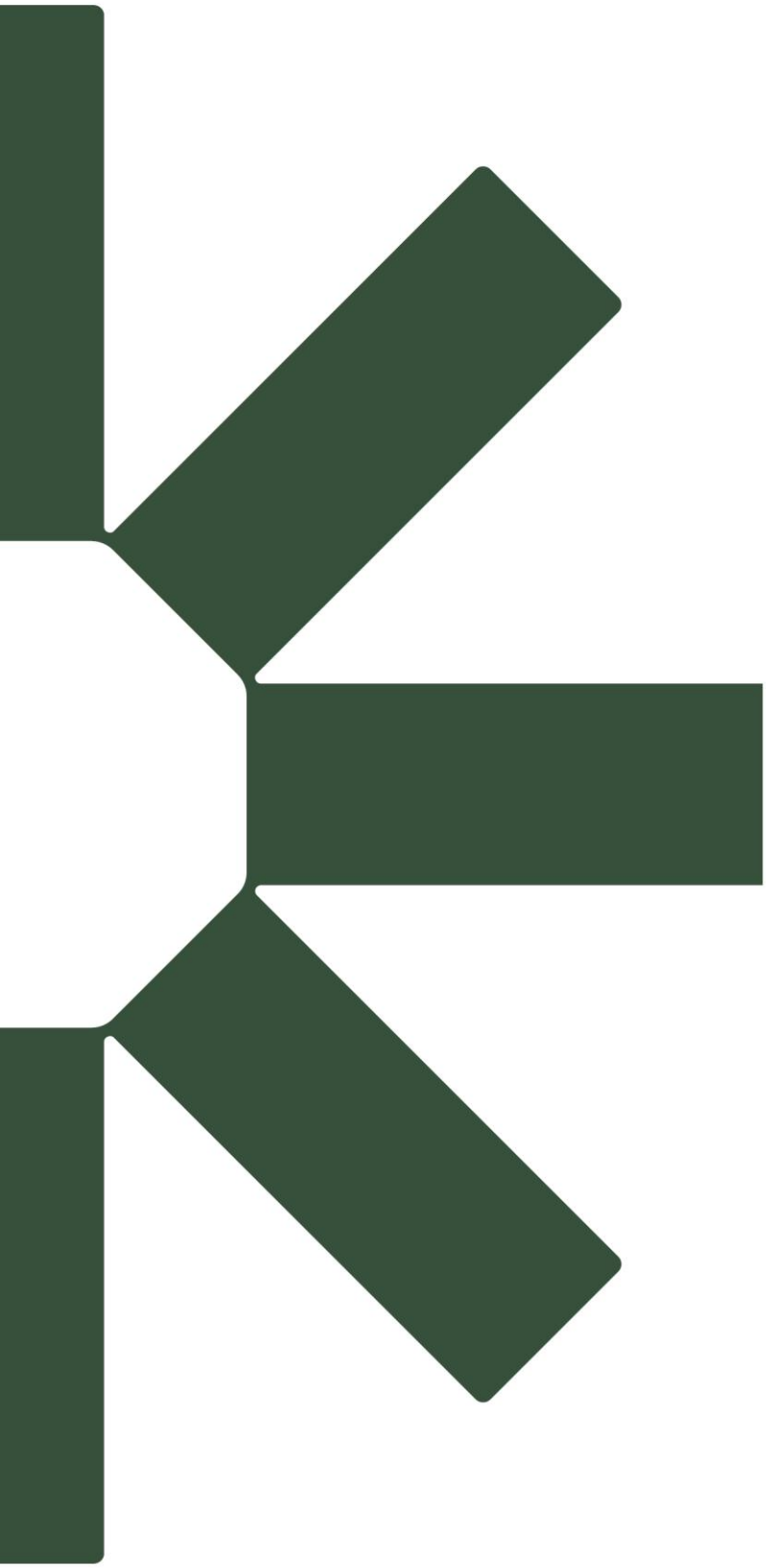
Glencore Coal Assets Australia

SLR Project No.: 626.30100.00000

27 October 2025

Regional land suitability framework for beef cattle grazing PMLU rehabilitation in the Bowen Basin

Limitation	Indicator	Suitable			Unsuitable	
		Class 1	Class 2	Class 3	Class 4	Class 5
Water availability (M)	Soil water storage (mm)	>75	75-60	<60-40	<40-30	<30
Nutrient deficiency (Nd)	Available-P (mg/kg) in 0-0.1 m depth increment	>20	20-14	<14-8	<8-4	<4
Nutrient availability and toxicity (Nr)	pH in 0-0.1 m depth increment	7.3-6.6	<6.6-6.0 >7.3-7.9	<6.0-5.6 >7.9-8.4	<5.6-5.0 >8.4-9.0	<5.0 >9.0
Surface condition (P)	Surface condition	Fine (peds <10mm)	Coarse (peds >10mm)	Surface crust	Very hard setting	Massive
Salinity (S)	ECe (dS/m) in ERD (0-0.6 m depth increment)	<2	2-4	>4-10	>10-16	>16
Rockiness (R)	Gravel, 20 – 60 mm (%) Cobble, 60 – 200 mm (%) Stone, 200 – 600 mm (%) Boulders, >600 mm (%)	<20 <10 <2 0	20-50 10-20 2-10 <2	>50-70 >20-50 >10-20 2-10	>70-85 >50-75 >20-50 >10-20	>85 >75 >50 >20
Slope (Ts)	Slope grade (%)	<5	5-10	<10-15	>15-20	>20
Microrelief (Tm)	Vertical interval (m)	0	<0.2	0.2-0.4	>0.4-0.6	>0.6
Water erosion (Ea)	Slope (%), ESP <6 (%) in 0-0.1 m soil depth increment Slope (%), ESP >6-14 (%) in 0-0.1 m soil depth increment Slope (%), ESP >14 (%) in 0-0.1 m soil depth increment	<5 <3 <1	5-8 3-6 1-2	>8-12 >6-10 >2-4	>12-18 >10-12 >4-6	>18 >12 >6
Subsoil erosion (Eb)	ESP (%) at 0.5 m depth	<6	6-14	>14-23	>23-34	>34
PAF materials (D)	Strongly acid conditions (pH <4.5) within (x) m depth	>3	3-2	<2-0.9	<0.9-0.6	<0.6



Making Sustainability Happen

G3 56 Delhi Road
North Ryde NSW 2113
P +61-2 9812 5000
E mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM1430-112L

3 June 2024

Project Manager
Coal Assets Australia, GLENCORE
Address
bronwen.morrison@glencore.com.au

Attention: Bronwen Morrison

Dear Bronwen

RE: WANDOAN - PRELIMINARY PRCP

1. Introduction

This letter provides results of stability analyses addressed by PSM as a geotechnical assessment for the Progressive Rehabilitation Closure Plan (PRCP) for the Wandoan Coal Project (WCP).

The study is based on a final landform and with assessment required of:

- Final landform and wherein there are minor voids left in some pit areas and with use of regraded slopes of up to 22% (12.4°)
- Review of stability of the Leichardt South pit, intended as a potential water storage facility for the life of mine (75 years) and with storage capacity estimated some 0.5m below base of weathering.

The assessment is in keeping with PSM proposal, PSM1430-111P dated 24 April 2024 and addresses landform, tailings and reject disposal geotechnical requirements of the PRCP Guideline (ESR/2019/4964, 04/04/2023).

2. Approach

Stability analyses using Limit Equilibrium Stability Analysis (LESA) were undertaken to address any potential issues in the final landform and in key areas as noted above.

Eleven cross-sections across the deposit were provided to PSM and highlighting the following aspects:

- Final dumped profile
- Final regarded profile
- Extent of in-situ and backfilled/overburden material
- Base of weathering in the in-situ material
- Final groundwater level.

Stability analyses were undertaken to address the following aspects:

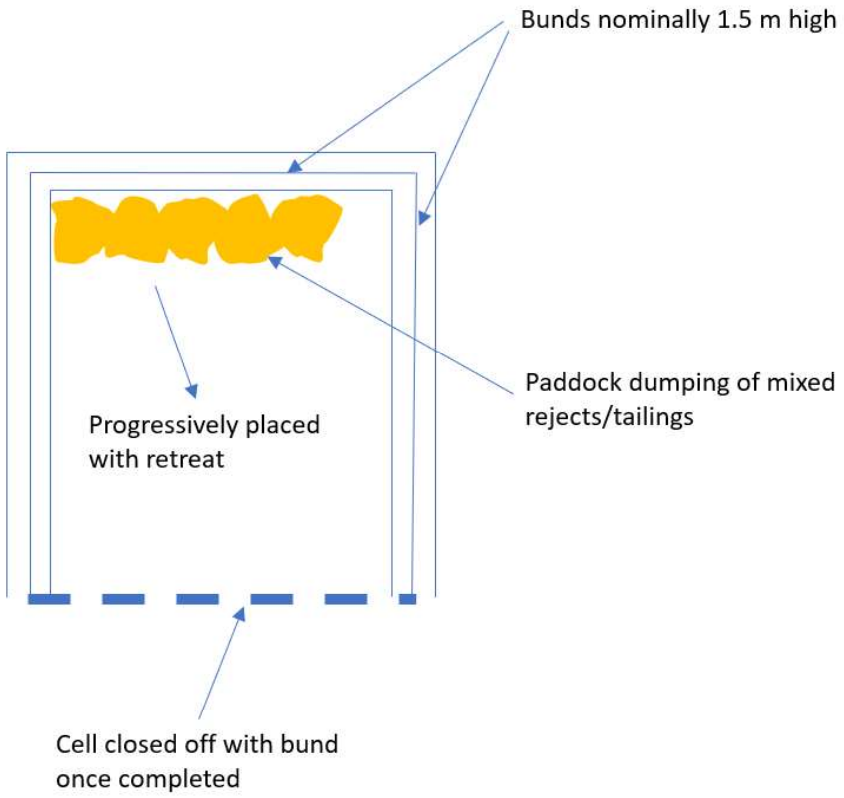
- Stability of final spoil/overburden, three cross-sections were selected where the highest exposed height of spoil/overburden would remain and this included cross-sections in Summer Hill, Turkey Hill and Wubagul.

- Final spoil/overburden and focusing on where proximity of tailings and reject disposal near final exposed landform may impact on stability.
- Stability of final open voids: the voids were reviewed to assess maximum height of exposed overall and three cross-sections were selected; one in Austinvale pit (maximum height of 26 m), one in Wabagul pit (maximum height of 30 m) and one in Woleebee pit (maximum height of 32 m).
- Stability of the Leichardt South pit highwall.

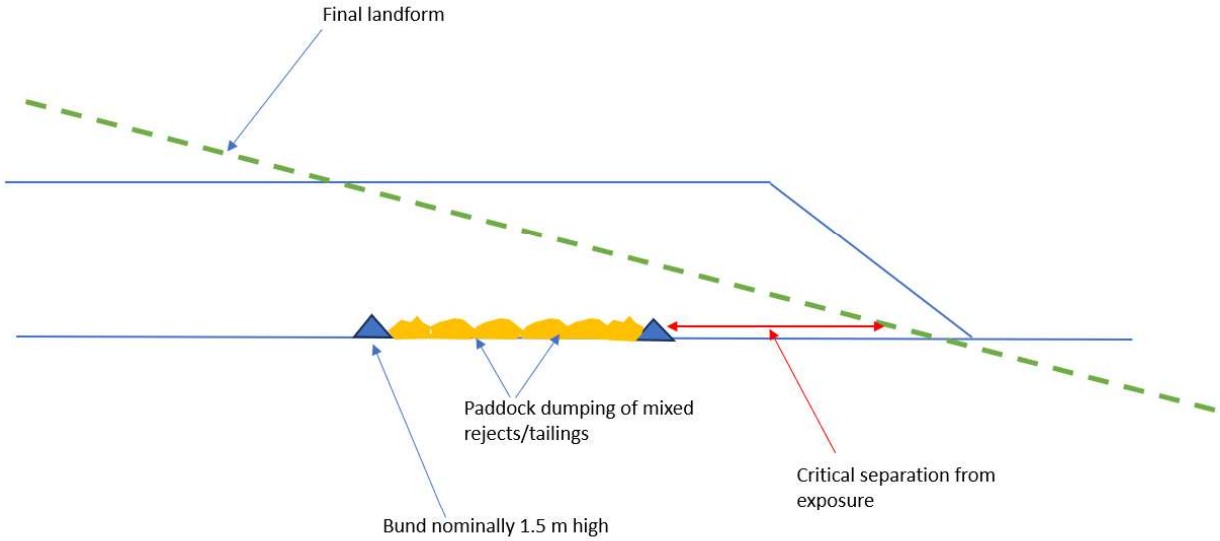
3. Tailings/Rejects Placement

The proposed tailings and rejects disposal method is the placement of tailings and rejects within cells that would be encapsulated with each dump lift. The process would involve the following steps:

- Setting out bunds to define a 50 m by 50 m cell, with one wall left open for entry, Inset 1
- Bund wall height of nominally 1.5 m
- Progressively fill cell with paddock dumped rejects/tailings and retreating to open end of cell, Inset 1
- Close each cell with a bund wall once the cell is largely completed, Inset 1
- Allow rejects/tailings in cell to dry out prior to encapsulating cell (dumping over) with a subsequent dump lift, Inset 2.

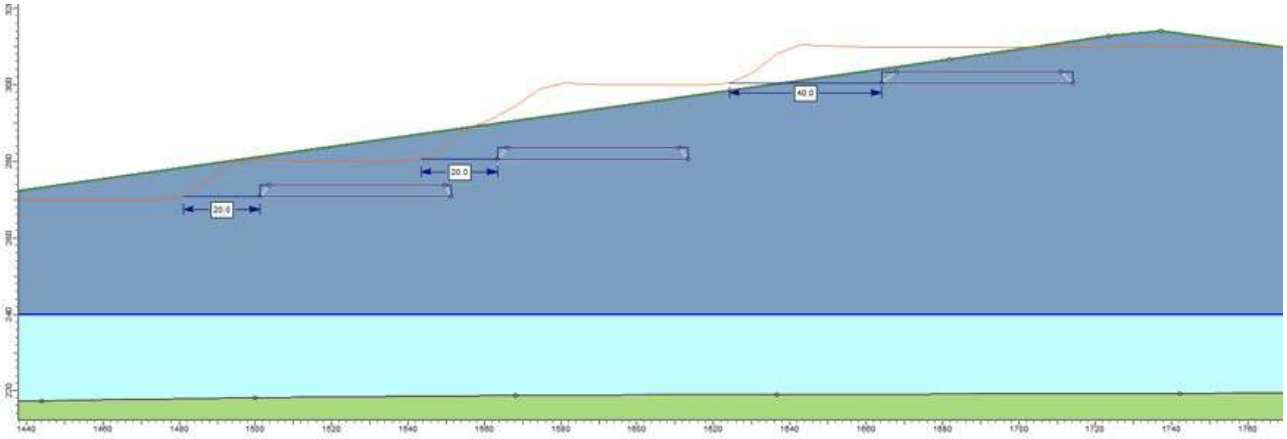


Inset 1: Plan view of cells for encapsulation of rejects/tailings



Inset 2: Sectional view of cells for encapsulation of rejects/tailings

Of key importance in the above, is the critical separation of the rejects/tailings from the nearest final exposed face. The distance utilised will be dependent on the final landform configuration, Inset 3. As such, whilst a 20 m offset is appropriate in the lower dump lifts, Inset 3, a much larger offset will be required in the upper lifts of the dump and this will require appropriate planning of placement with consideration for final landform.



Inset 3: Sectional view of cells in overall dump profile and note larger offset required in upper lifts to ensure final encapsulation of rejects/tailings

4. Material Parameters

Table 1 provides an overview of the strength parameters utilised in the stability analyses within the assessment.

Of note are the shear strengths applied to the spoil/overburden and these parameters are in keeping with the BMA shear strength framework for spoil waste of Simmons & McManus (2004) which had been utilised in prior PSM studies for Wandoan (PSM1430-107R of 7 November 2011). The unsaturated spoil/overburden equating to a Category 2 spoil and the saturated spoil/overburden relating to a Category 1 spoil and in recognition of the low intact strengths and potential slaking of materials at Wandoan.

Table 1 – Material Parameters for Stability Analyses

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction angle (degrees)	GSI	mi	D	UCS (MPa)	Vertical Stress Ratio
Weathered	22	90	37	NA				
Fresh rock	24	NA		55	5	0	13	NA
Spoil Unsaturated	20	30	28	NA				
Spoil Saturated	20	0	18	NA				
Tailings/Rejects Undrained	20							0.3/0.4
Tailings/Rejects Drained	20	0[1] 25[2]	42[1] 35[2]	NA				

1 for normal stress < 200 kPa

2 for normal stress > 200 kPa

Of note are the material strengths assigned to the tailings and rejects. Where behaviour is anticipated to be potentially undrained, which may occur once the materials are loaded by the progressive placement of spoil/overburden, two strengths have been assigned. Where largely tailings, a shear strength ratio of 0.4 to vertical stress is considered applicable, whilst a shear strength ratio of 0.3 is considered applicable where a mixture of coarse and mixed rejects is present. Under the case that there is drained behaviour (i.e. materials have largely dried out), a bilinear strength has been assigned and dependent on the vertical stress range. These strengths are in keeping with recent findings within a PSM assessment looking at laboratory testing results from both materials using WCP samples (PSM4869-002R of 14 July 2023).

5. Critical Failure Mechanisms

Three different failure mechanisms were considered within the stability analyses.

For stability analyses considering the tailings/rejects, a bi-linear mechanism was considered with shearing along the base of the deposited rejects/tailings and failure through the spoil/overburden.

For stability analyses considering the global final landform, reshaped to a 22% (12.4°) overall angle in spoil/overburden, a circular mechanism was considered.

For stability analyses considering final remaining voids or the Leichardt South pit, a circular mechanism was considered.

In former two cases, the stability analyses have underestimated stability and slightly higher Factors of Safety (FOS) would be expected if more detailed and rigorous stability analyses had been undertaken.

6. Results of Stability Analyses

6.1 Spoil/Overburden Stability

Results for the stability analyses of the spoil/overburden are presented in Appendices A and B and with a summary of the FOSs presented in Tables 2 and 3.

The stability analyses considered two failure mechanism, circular failure in assessing overall stability, Appendix A, and a bi-linear failure when assessing deposited rejects/tailings near the final landform, Appendix B. These latter analyses considered potential for either undrained or drained behaviour in the tailings.

Table 2 – FOS Results of Stability Analyses – Overall Spoil Stability

Pit Area	Location	FOS
Wubagul	Lower slope	2.66
	Upper Slope	3.18
Summer Hill	Lower slope	2.35
	Upper Slope	4.72
Turkey Hill	Lower slope	4.68
	Overall Slope	2.29

Very high FOS's are indicated for overall stability of the reshaped spoil/overburden and indicative of a very low risk of instability in the final landforms. The high FOSs are in keeping with the combination of shallow overall angle (22%) and limited overall height.

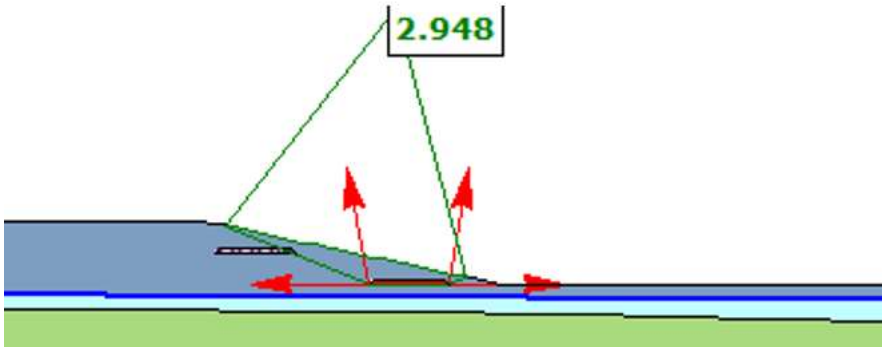
Table 3 – FOS Results of Stability Analyses – Spoil Stability near Tailings Cells

Pit Area	Tailing cell Location	Tailing Strength	FOS
Wubagul	Top	Undrained	3.79
	Top	Drained	5.59
	Middle	Undrained	3.62
	Middle	Drained	4.68
	Bottom	Undrained	3.32
	Bottom	Drained	4.89
Summer Hill	Top	Undrained	66.18
	Top	Drained	73.56
	Bottom	Undrained	3.28
	Bottom	Drained	4.75
Turkey Hill	Top	Undrained	3.17
	Top	Drained	4.49
	Bottom	Undrained	2.95
	Bottom	Drained	3.83

Of note is the potential location of the tailings/rejects cells. To avoid exposing the tailings during final reshaping of the landform, there will be a requirement as to where the cells are placed from the as-constructed final face. Whilst high FOSs are indicated where cells are no closer than 20 m from the final face of the landform, Inset 4, PSM recommend that for closure considerations a minimum offset of 20 m of any cell from the final landform is recommended. Whilst a smaller distance could be considered, this could pose an issue operationally during final reshaping.

Ignoring the very high FOSs for analyses of the top cell in Summer Hill, the stability analyses indicate the following FOSs:

- bi-linear mechanism impacted by undrained tailings/rejects FOS of 2.95 to 3.79
- bi-linear mechanism impacted by drained tailings/rejects FOS of 3.83 to 5.59.



Inset 4: Stability analysis result, Turkey hill, undrained tailings/rejects in bottom lift

6.2 Highwall

Results for the stability analyses of the highwall with open voids are presented in Appendix C and with a summary of the FOSs presented in Table 4.

Table 4 – FOS Results of Stability Analyses – Highwall with Open Void

Pit Area	Location	FOS
Wubagul	Upper slope	3.90
Woleebee	Upper slope	3.67
	Overall Slope	5.36
Austinvale	Overall Slope	4.96

Very high FOS's are indicated for components of the highwall that will be left in final exposed voids and indicative of a very low risk of instability for these components of the final landforms.

6.3 Leichardt South Pit

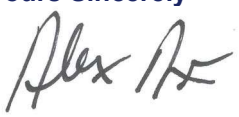
It is understood that prior to final reshaping, the highwall at Leichardt South pit is intended as a potential water storage facility for the life of mine (~75 years). Stability analyses are presented in Appendix D. PSM addressed stability considering two wall configurations: as provided by GCAA with a single 40° overall batter in fresh rock or a PSM alternative with 15 m high batters at 60° and with 15m wide berms. The stability analyses considered no water in the void, as this is the most critical case.

Both designs provided very similar FOSs, 2.30 for the GCAA provided design and 2.50 for the PSM alternative. These are high FOS's and indicative of a very low risk of instability for either of the design options.

7. Closure

We trust this letter meets your immediate requirements and please contact the undesigned if you have any queries.

Yours Sincerely



ALEX DURAN
PRINCIPAL

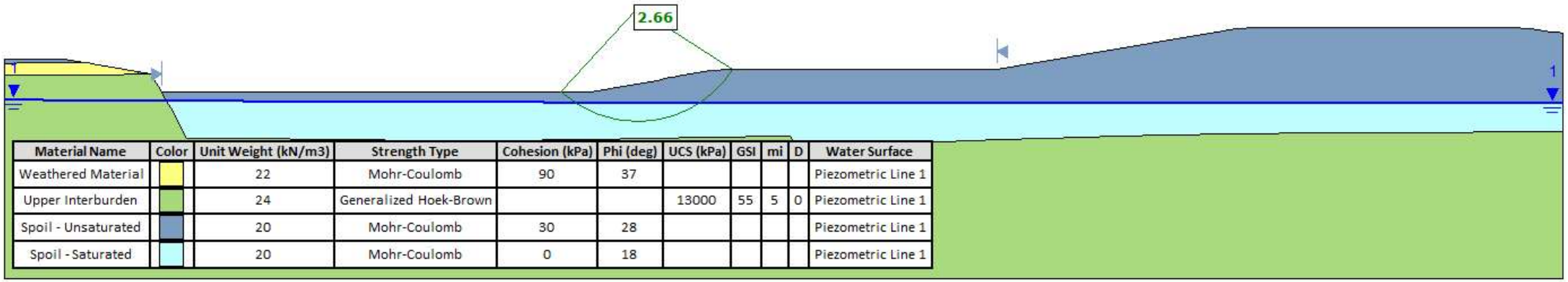
Encl:

	Appendix A	Stability Analyses – Global Spoil/Overburden
	Appendix B	Stability Analyses – Tailings Cells in Spoil/Overburden
	Appendix C	Stability Analyses – Highwall in Open Voids
	Appendix D	Stability Analyses – Highwall in Leichardt South Pit

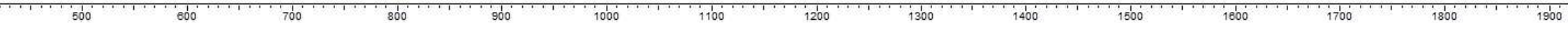
Appendix A
Stability Analyses – Global Spoil/Overburden

Waste Dump

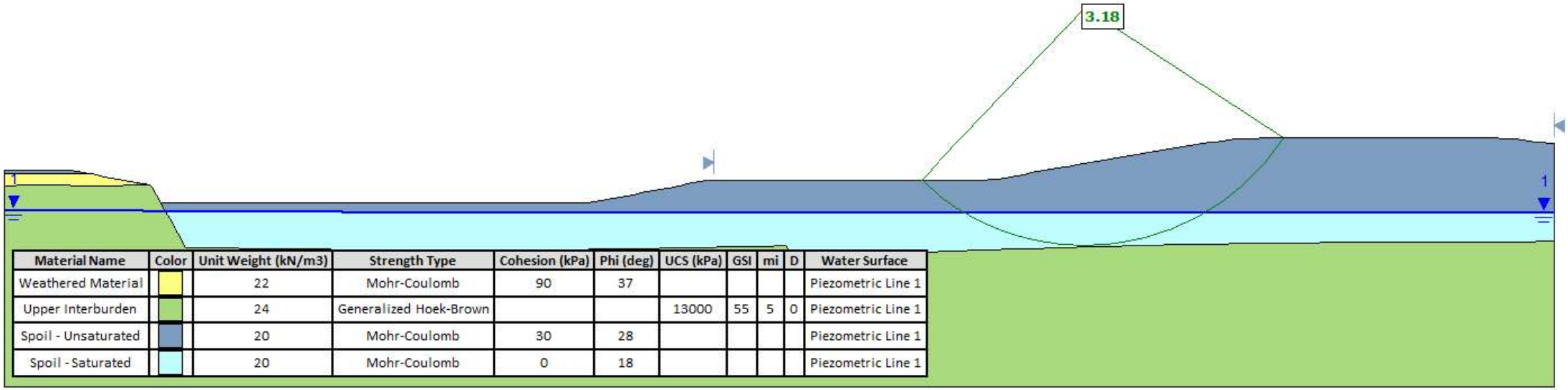
Waste dump – Wubagul



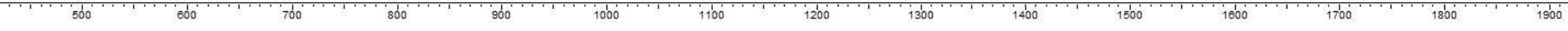
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



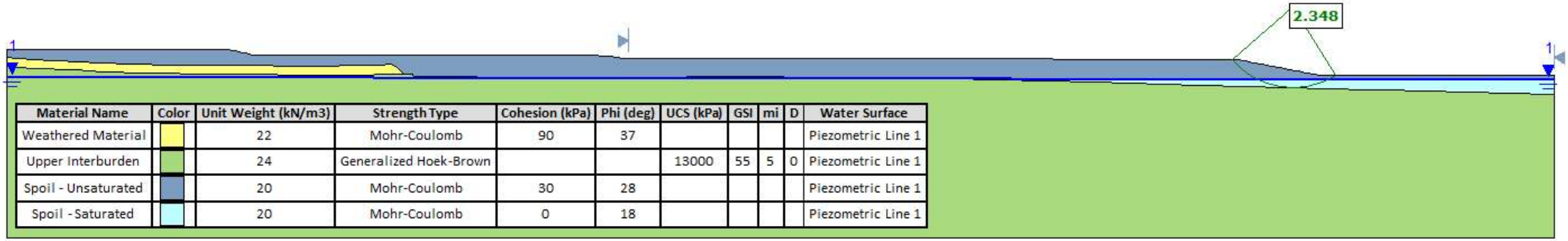
Waste dump – Wubagul



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



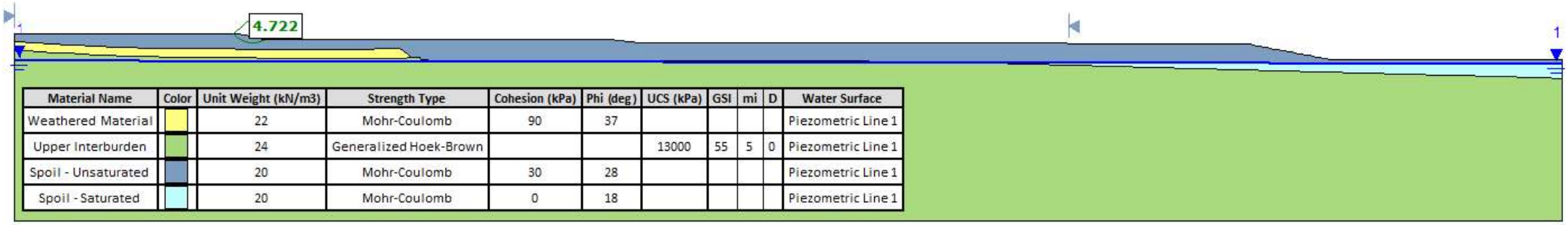
Waste dump – Summer Hill



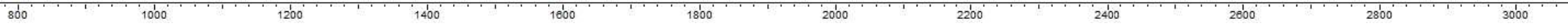
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1

800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000

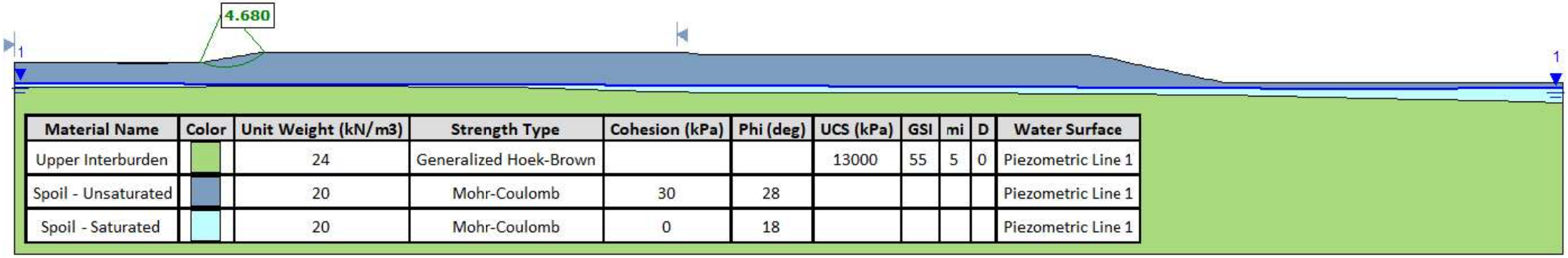
Waste dump – Summer Hill



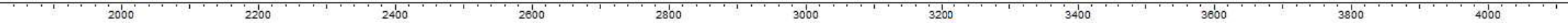
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



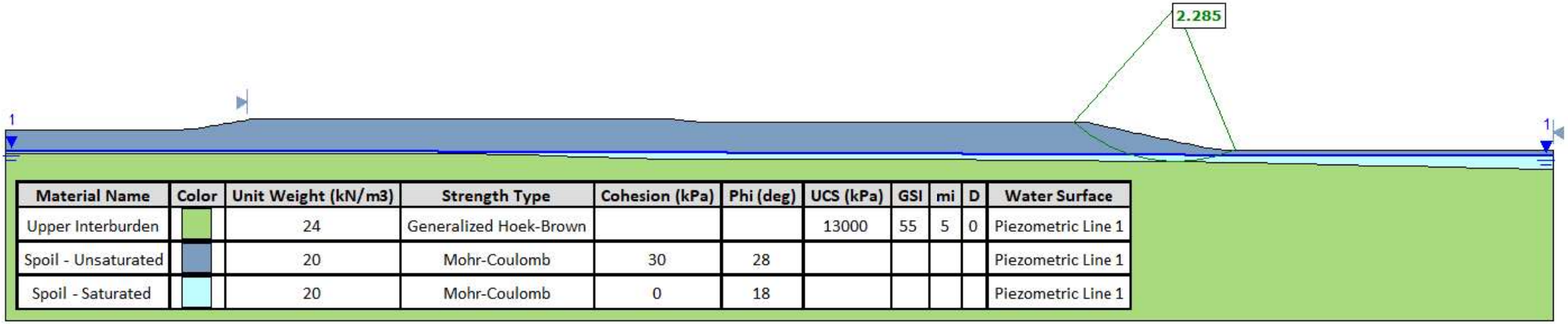
Waste dump – Turkey Hill



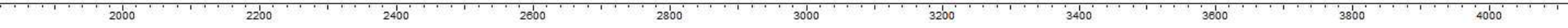
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



Waste dump – Turkey Hill



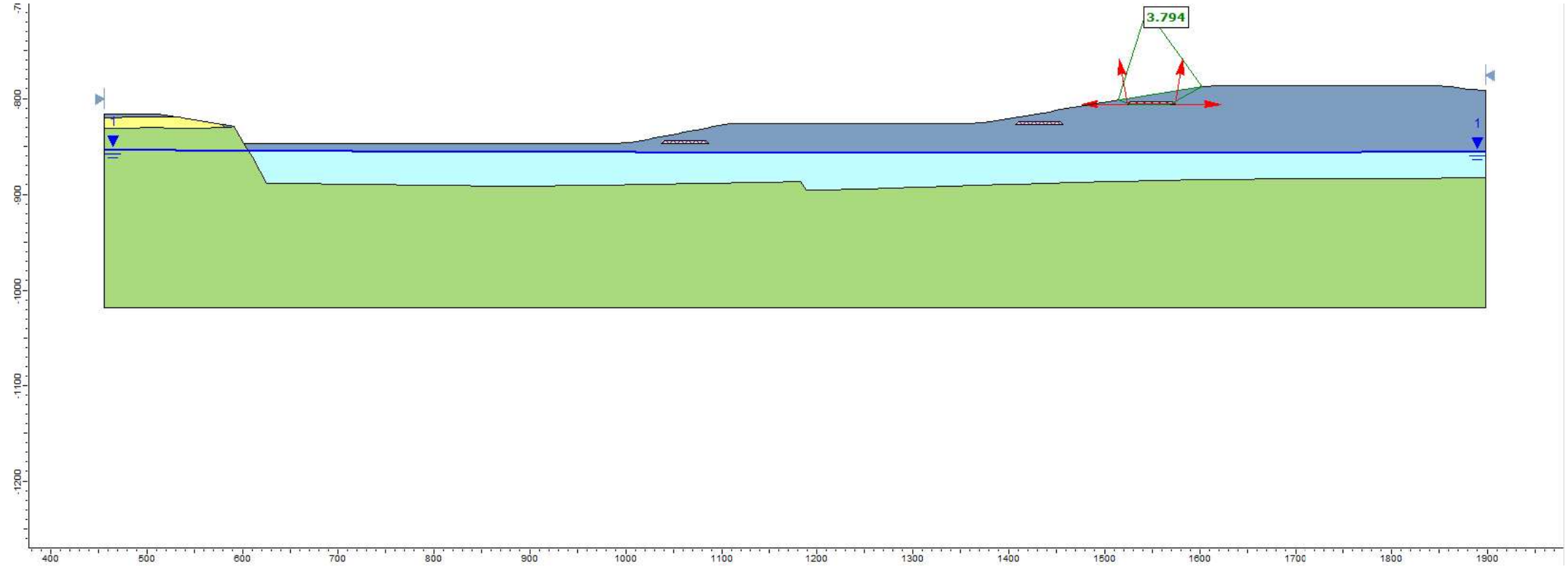
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



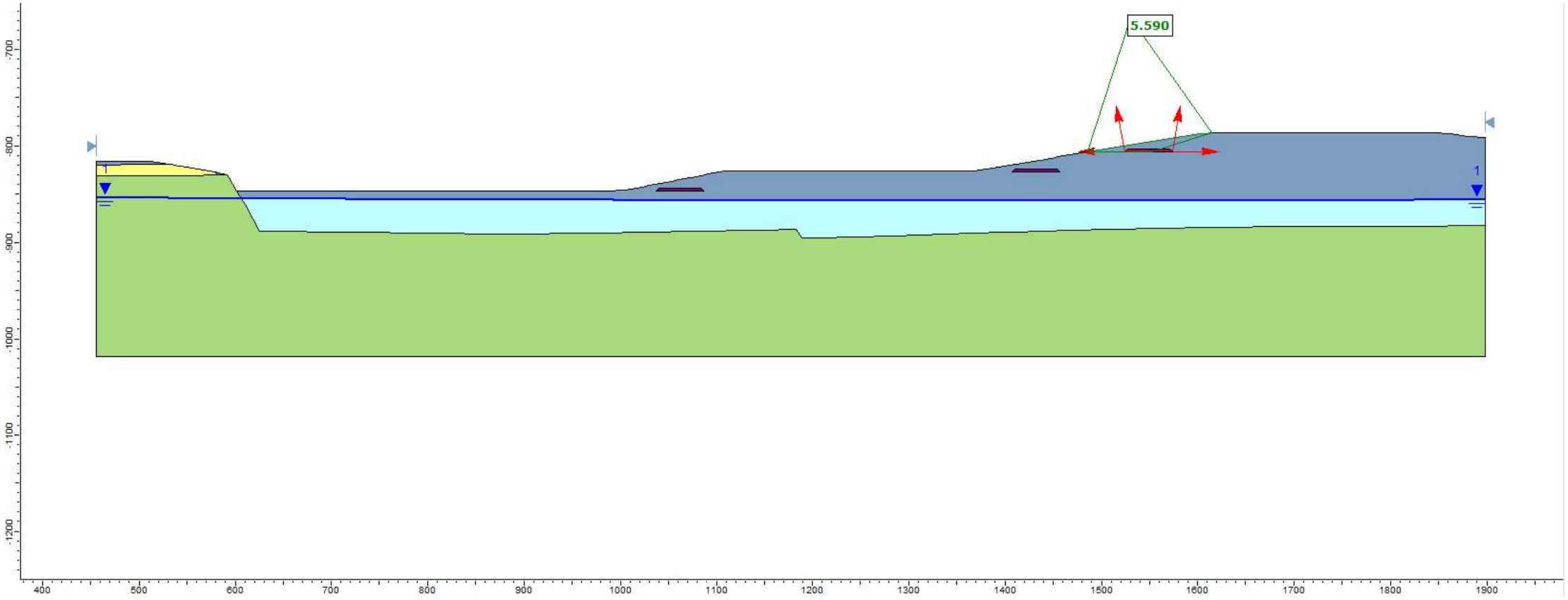
Appendix B
Stability Analyses – Tailings Cells in Spoil/Overburden

Tailings

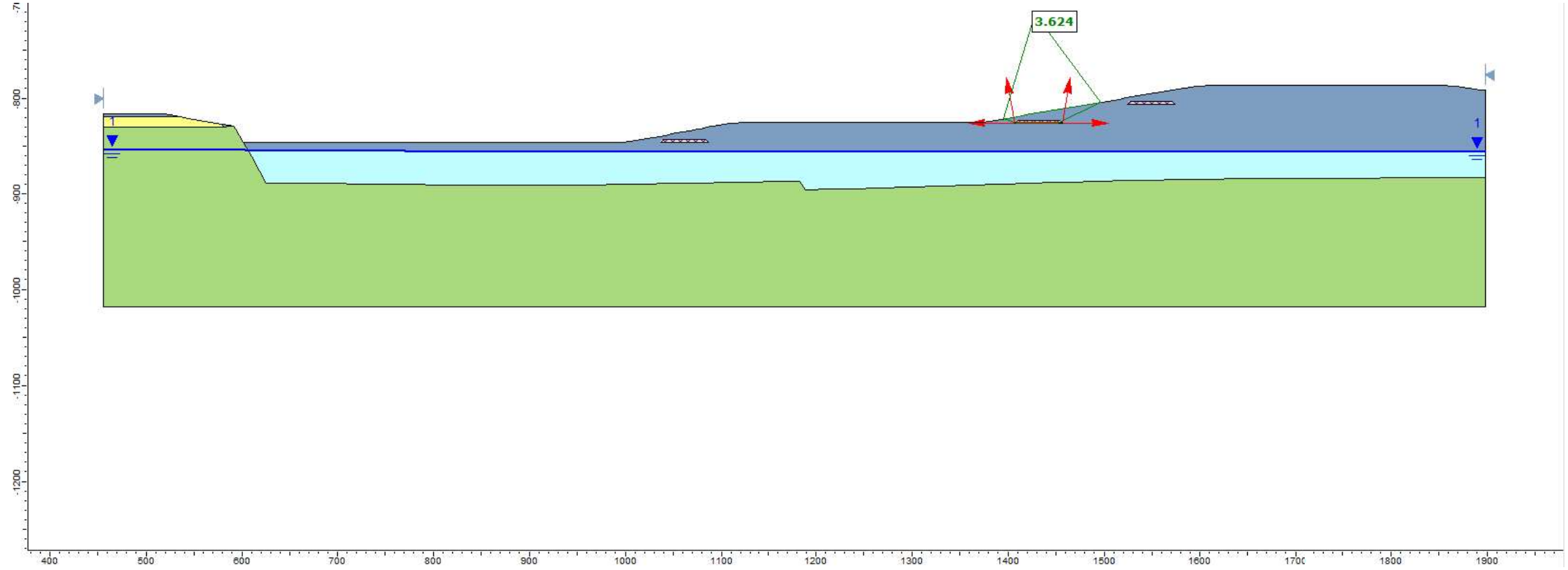
Tailings (Undrained) – Wubagul
Top tailing



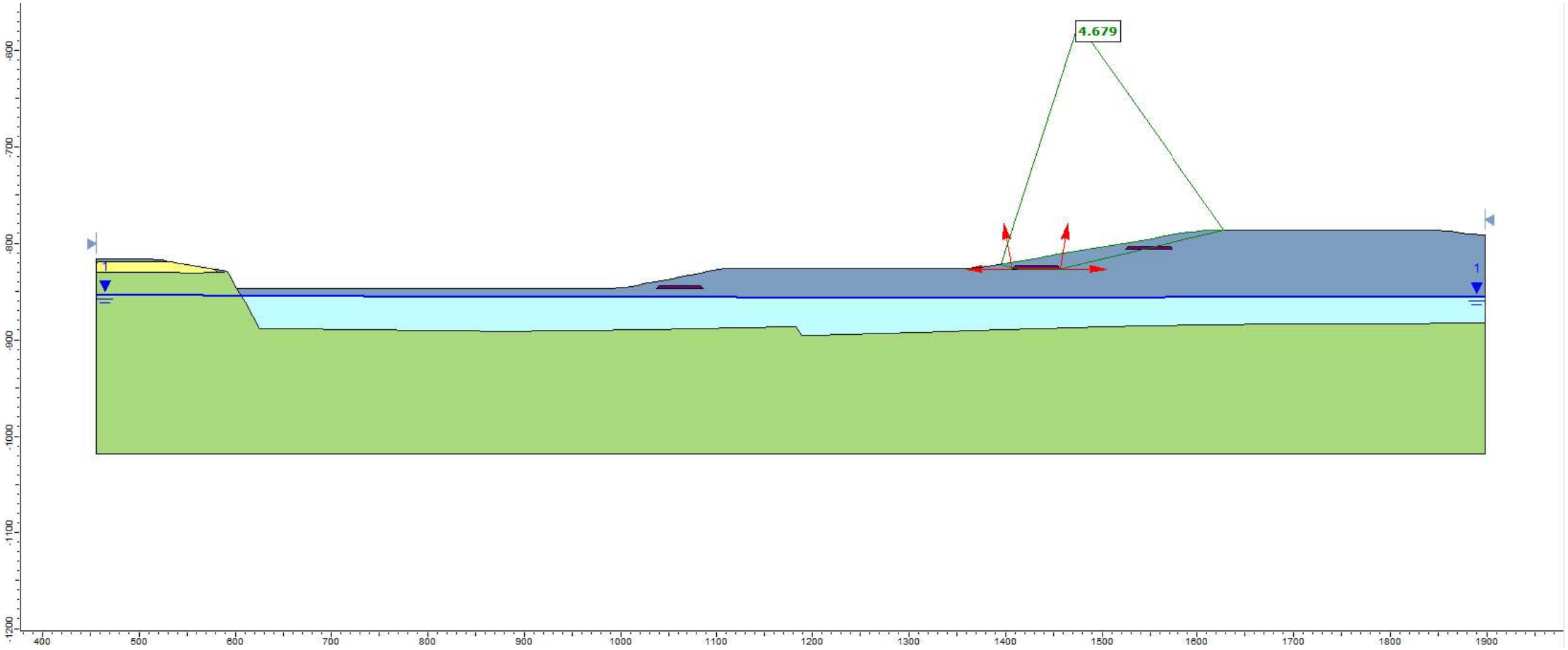
Tailings (Drained) – Wubagul
Top tailing



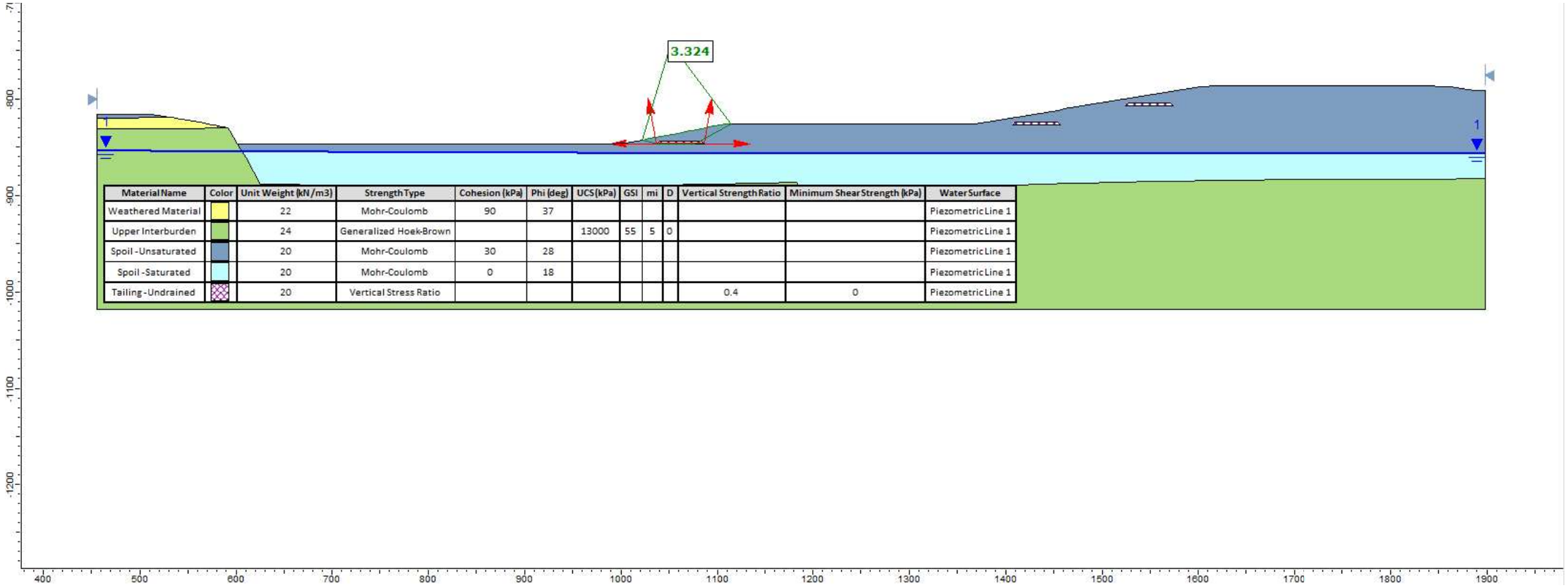
Tailings (Undrained) – Wubagul Middle tailing



Tailings (Drained) – Wubagul
Middle tailing

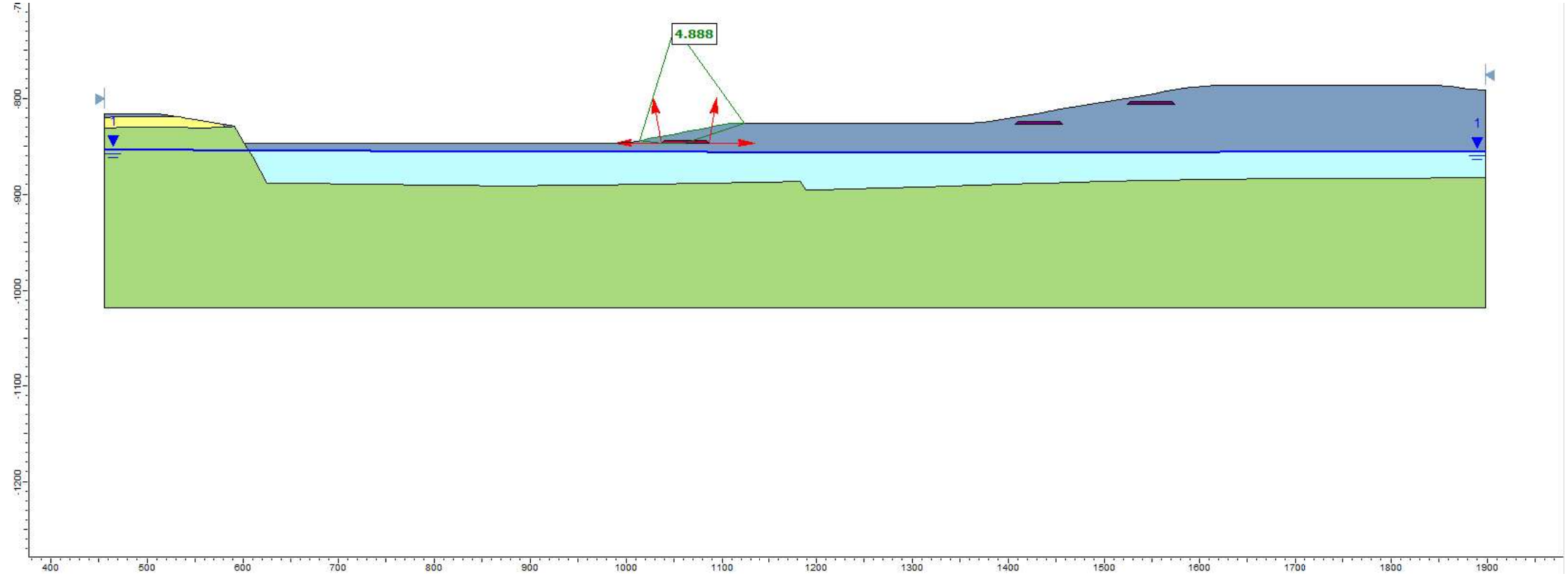


Tailings (Undrained) – Wubagul Bottom tailing

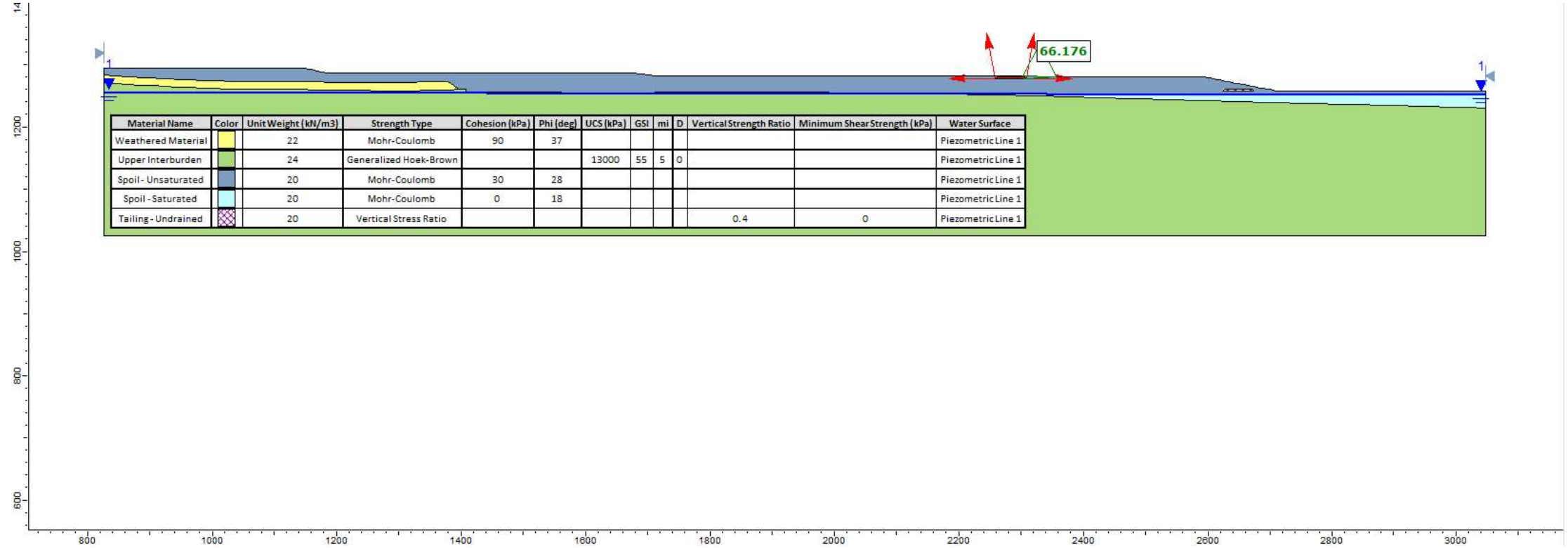


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37							Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0			Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28							Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18							Piezometric Line 1
Tailing - Undrained		20	Vertical Stress Ratio							0.4	0	Piezometric Line 1

Tailings (Drained) – Wubagul
Bottom tailing

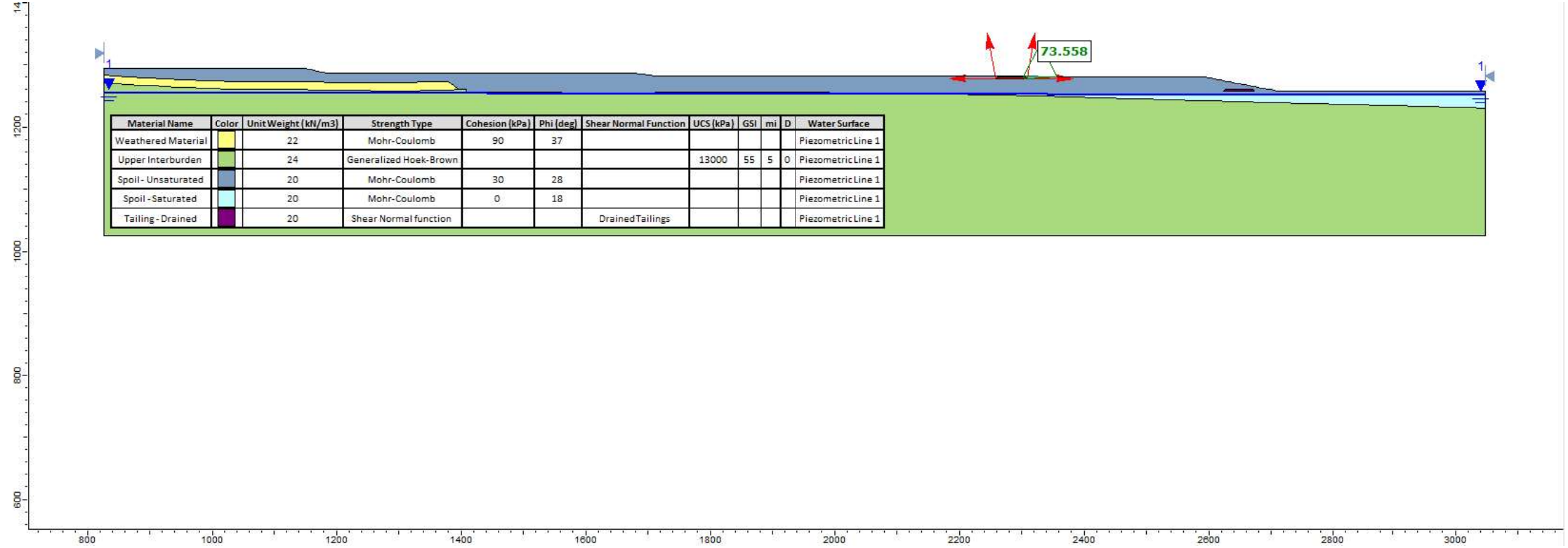


Tailings (Undrained) – Summer Hill
Top tailing



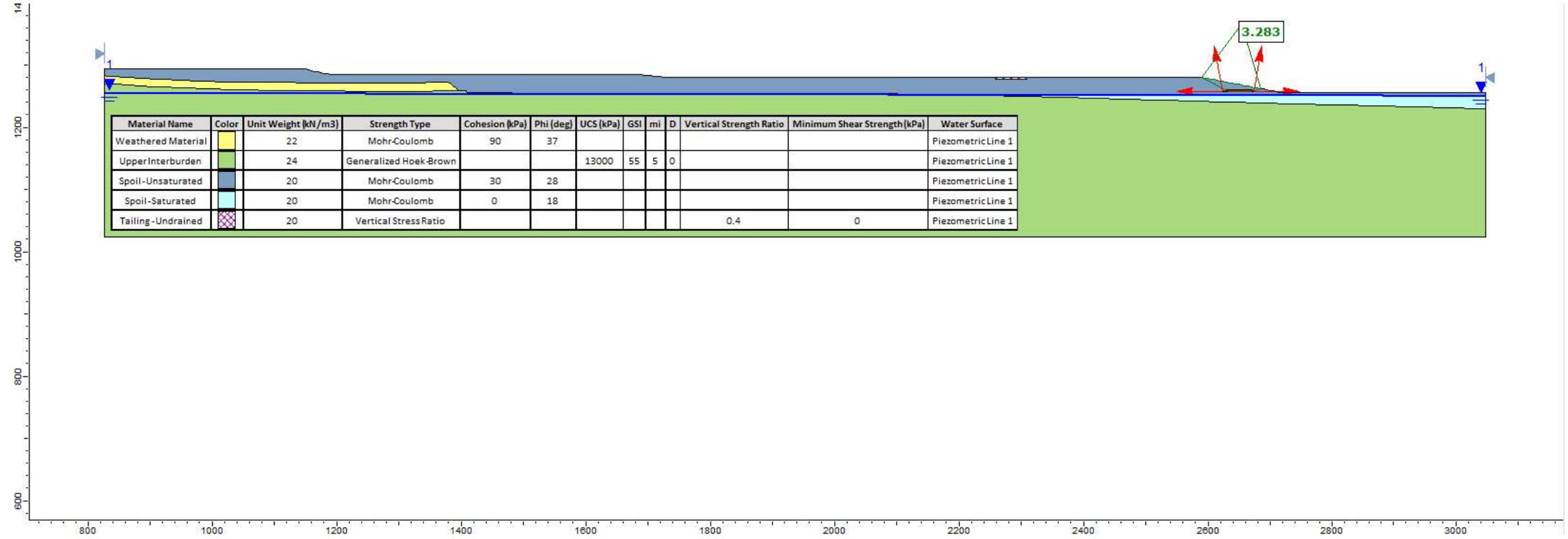
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37							Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0			Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28							Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18							Piezometric Line 1
Tailing - Undrained		20	Vertical Stress Ratio							0.4	0	Piezometric Line 1

Tailings (Drained) – Summer Hill
Top tailing



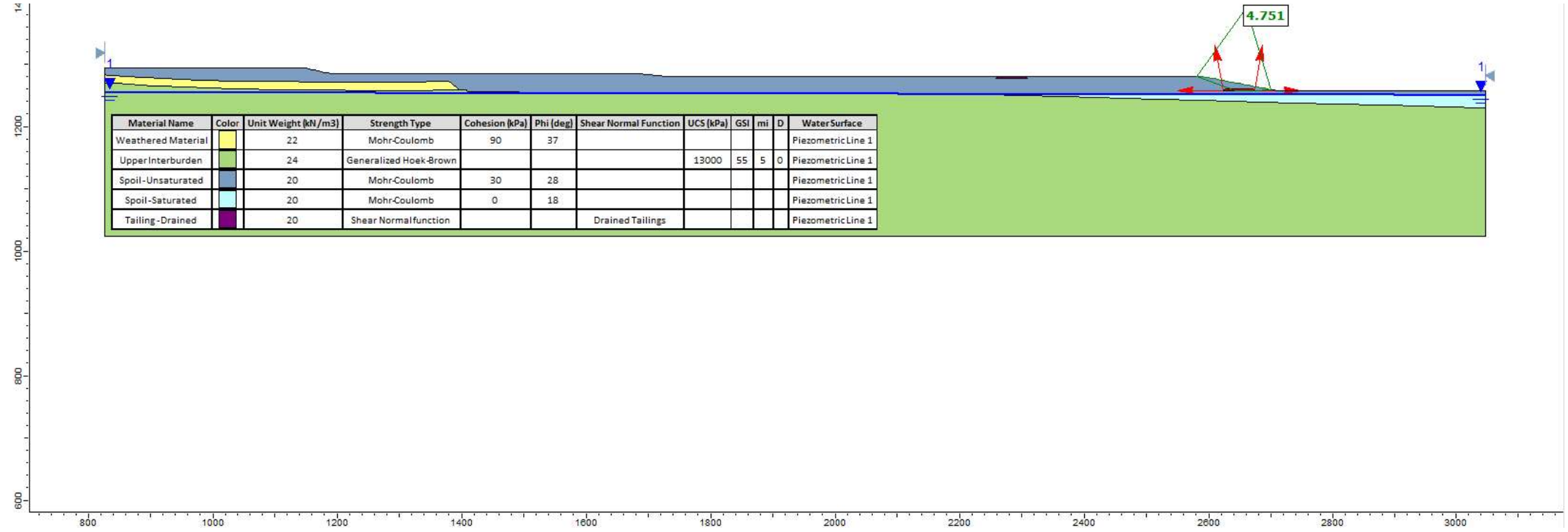
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Shear Normal Function	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37						Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown				13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28						Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18						Piezometric Line 1
Tailing - Drained		20	Shear Normal function			DrainedTailings					Piezometric Line 1

Tailings (Undrained) – Summer Hill Bottom tailing



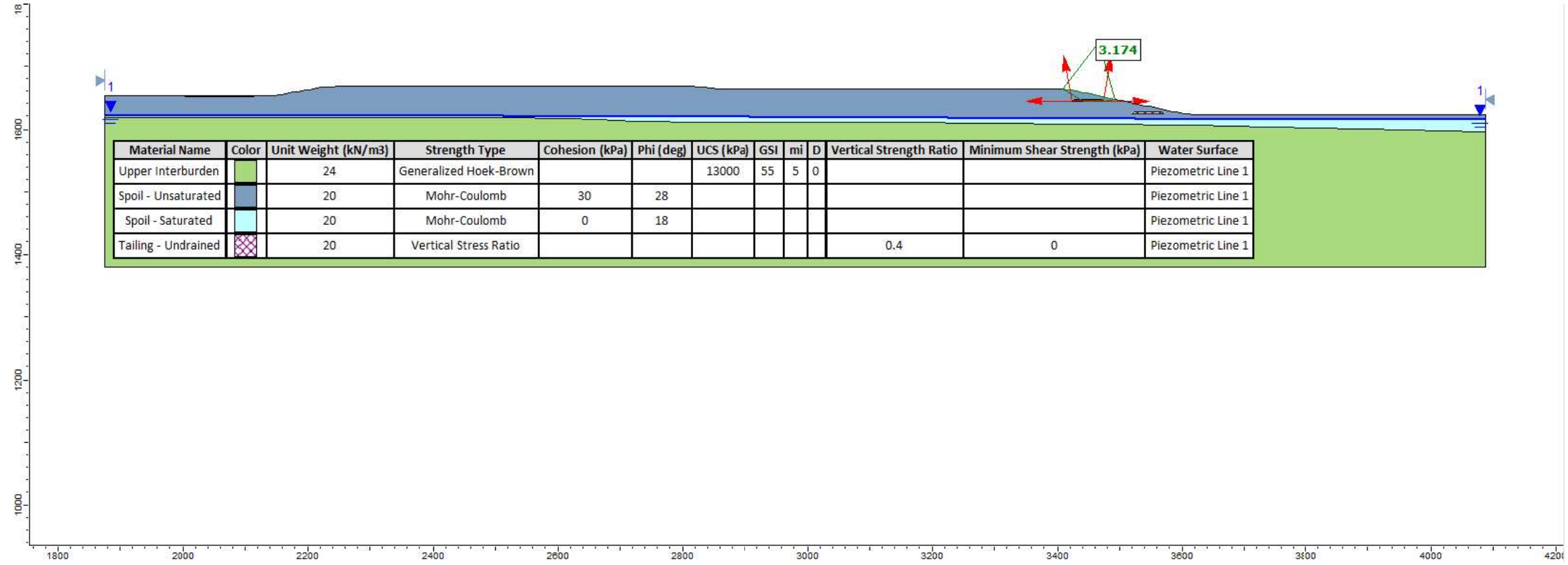
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37							Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0			Piezometric Line 1
Spoil-Unsaturated		20	Mohr-Coulomb	30	28							Piezometric Line 1
Spoil-Saturated		20	Mohr-Coulomb	0	18							Piezometric Line 1
Tailing-Undrained		20	Vertical Stress Ratio							0.4	0	Piezometric Line 1

Tailings (Drained) – Summer Hill Bottom tailing



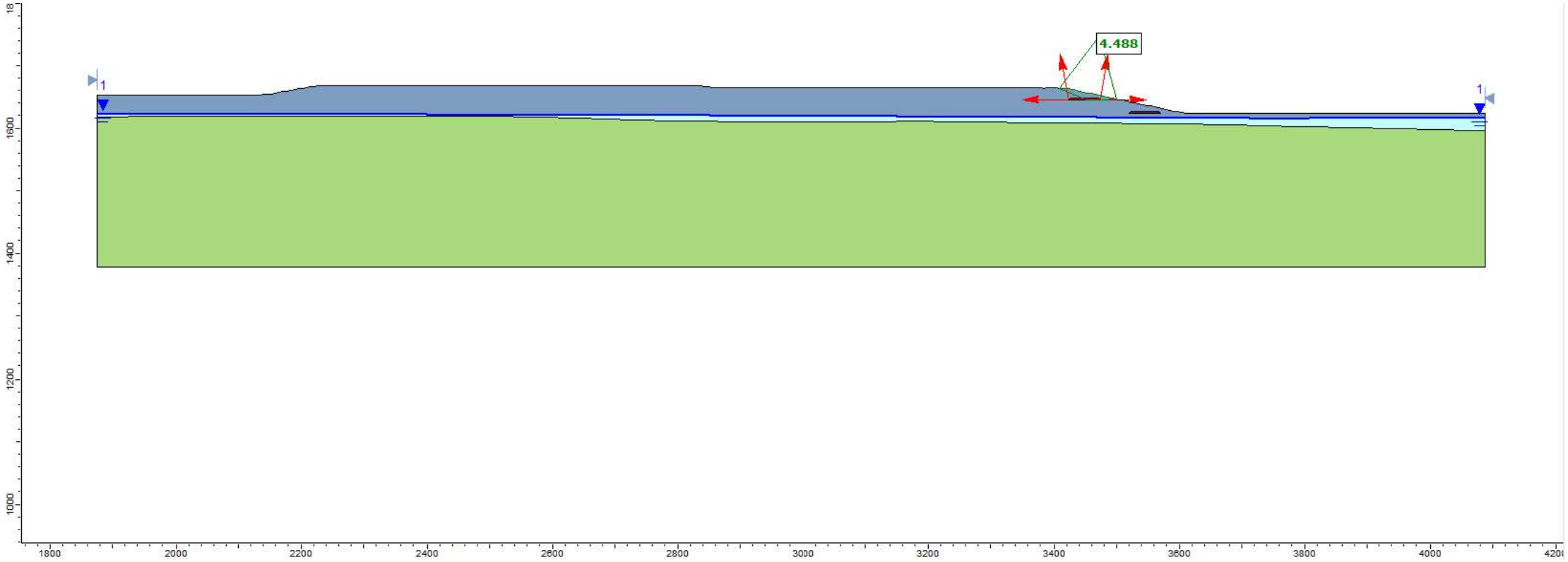
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Shear Normal Function	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37						Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown				13000	55	5	0	Piezometric Line 1
Spoil-Unsaturated		20	Mohr-Coulomb	30	28						Piezometric Line 1
Spoil-Saturated		20	Mohr-Coulomb	0	18						Piezometric Line 1
Tailing-Drained		20	Shear Normalfunction			Drained Tailings					Piezometric Line 1

Tailings (Undrained) – Turkey Hill
Top tailing

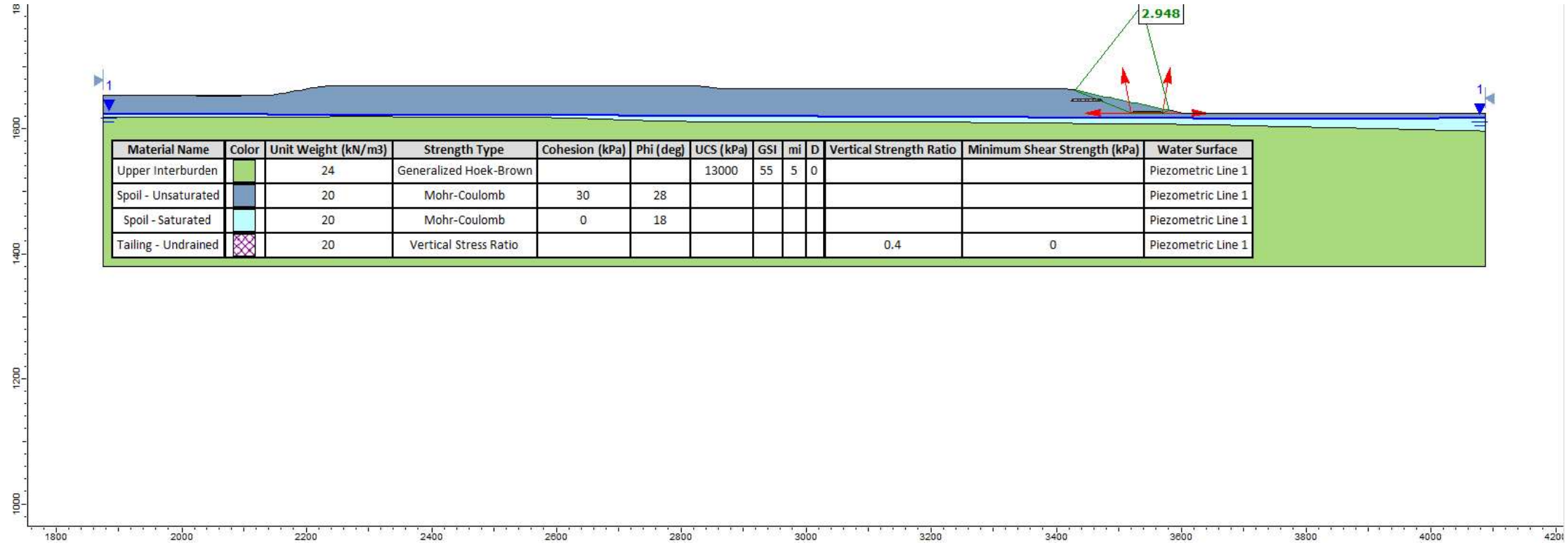


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0			Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28							Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18							Piezometric Line 1
Tailing - Undrained		20	Vertical Stress Ratio							0.4	0	Piezometric Line 1

Tailings (Drained) – Turkey Hill
Top tailing

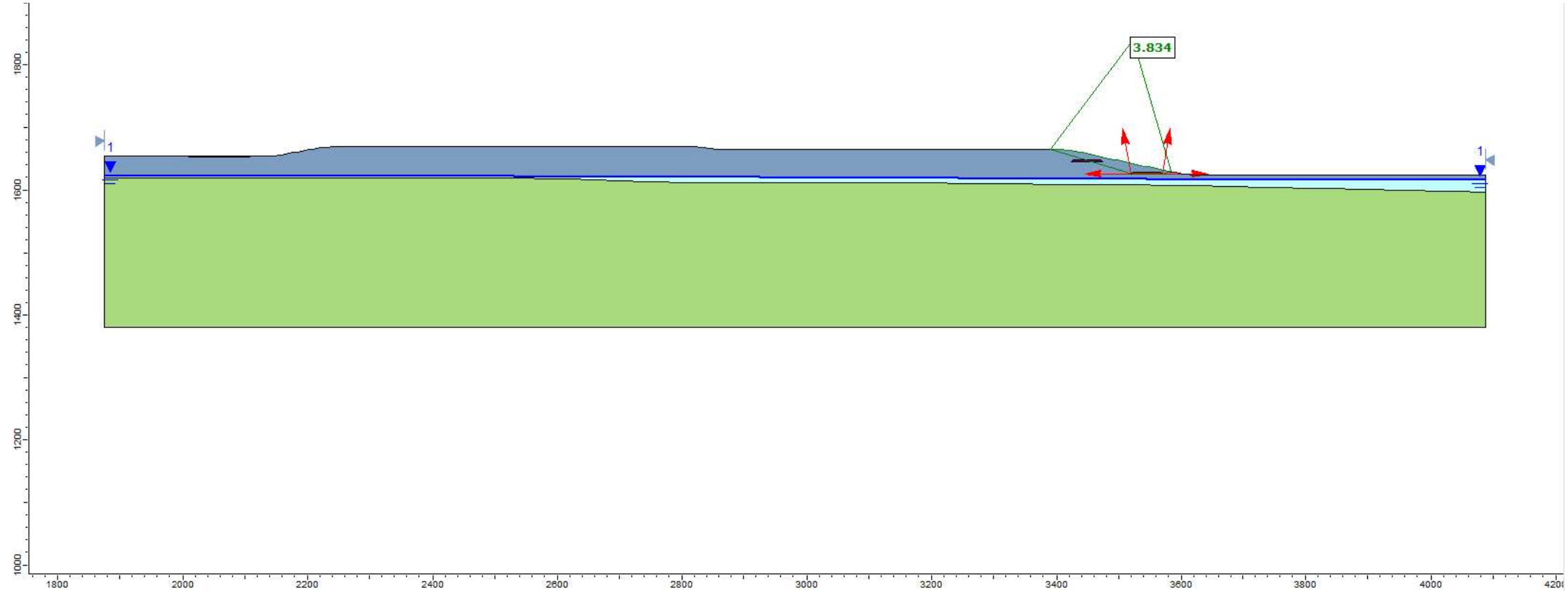


Tailings (Undrained) – Turkey Hill Bottom tailing



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0			Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28							Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18							Piezometric Line 1
Tailing - Undrained		20	Vertical Stress Ratio							0.4	0	Piezometric Line 1

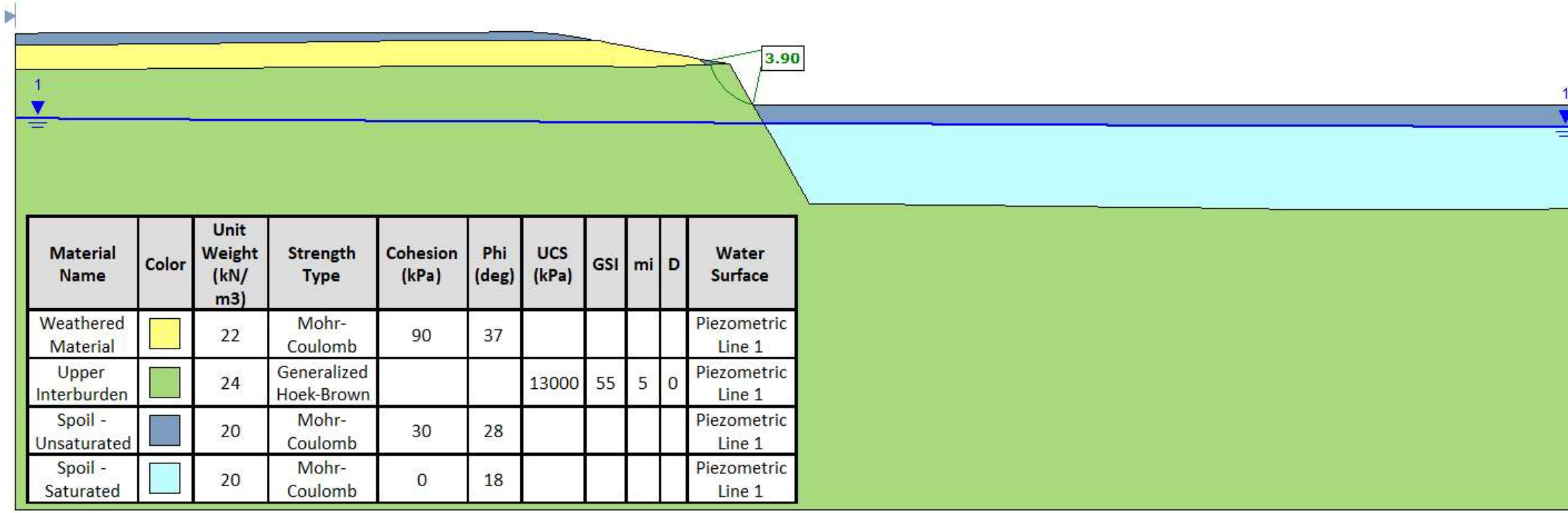
Tailings (Drained) – Turkey Hill Bottom tailing



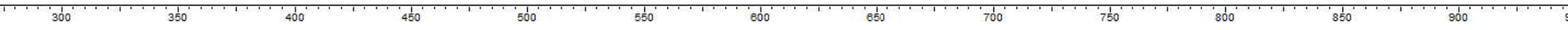
Appendix C
Stability Analyses – Highwall in Open Voids

Reshaped Highwall

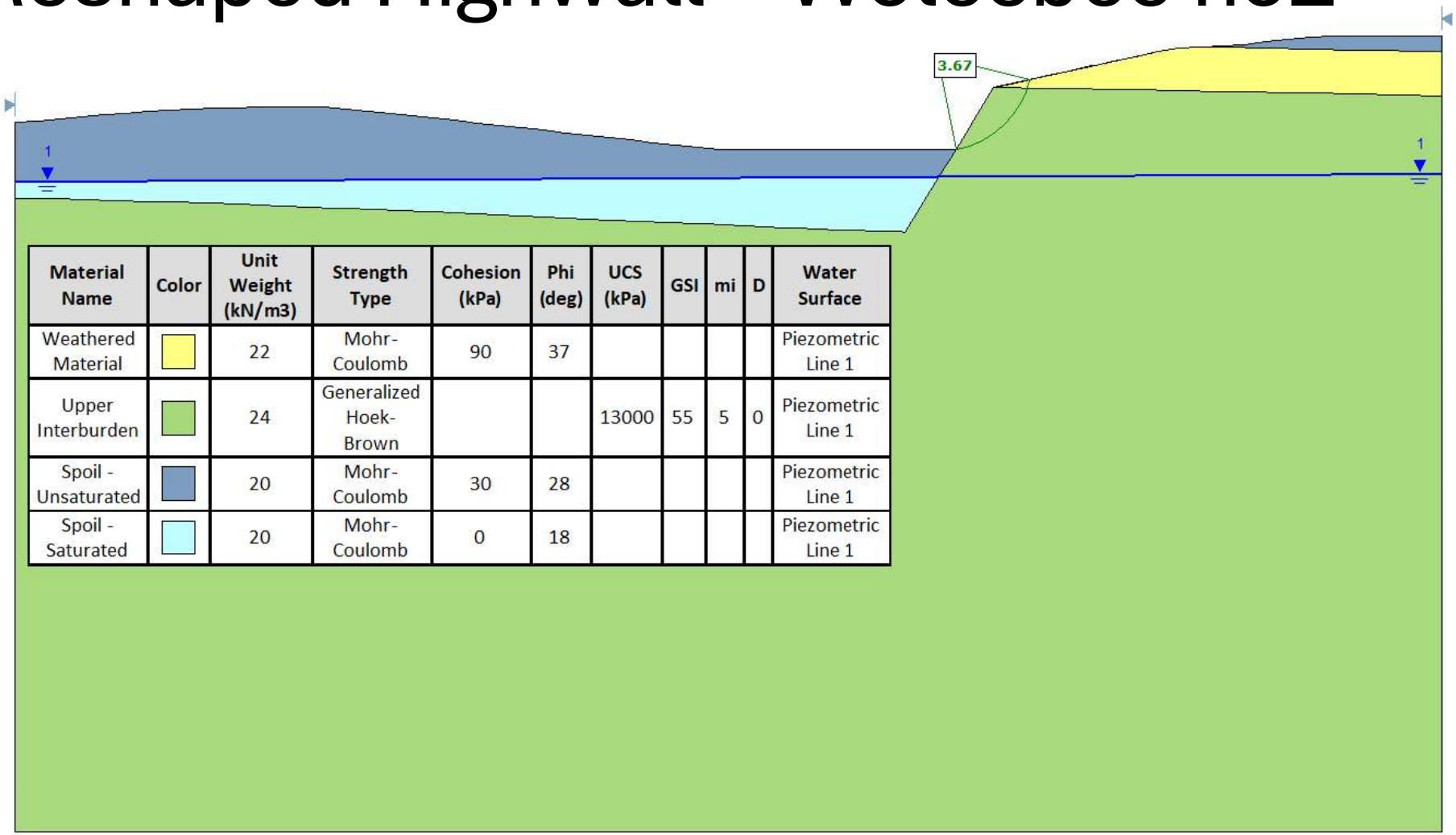
Reshaped Highwall – Wubagul



Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1

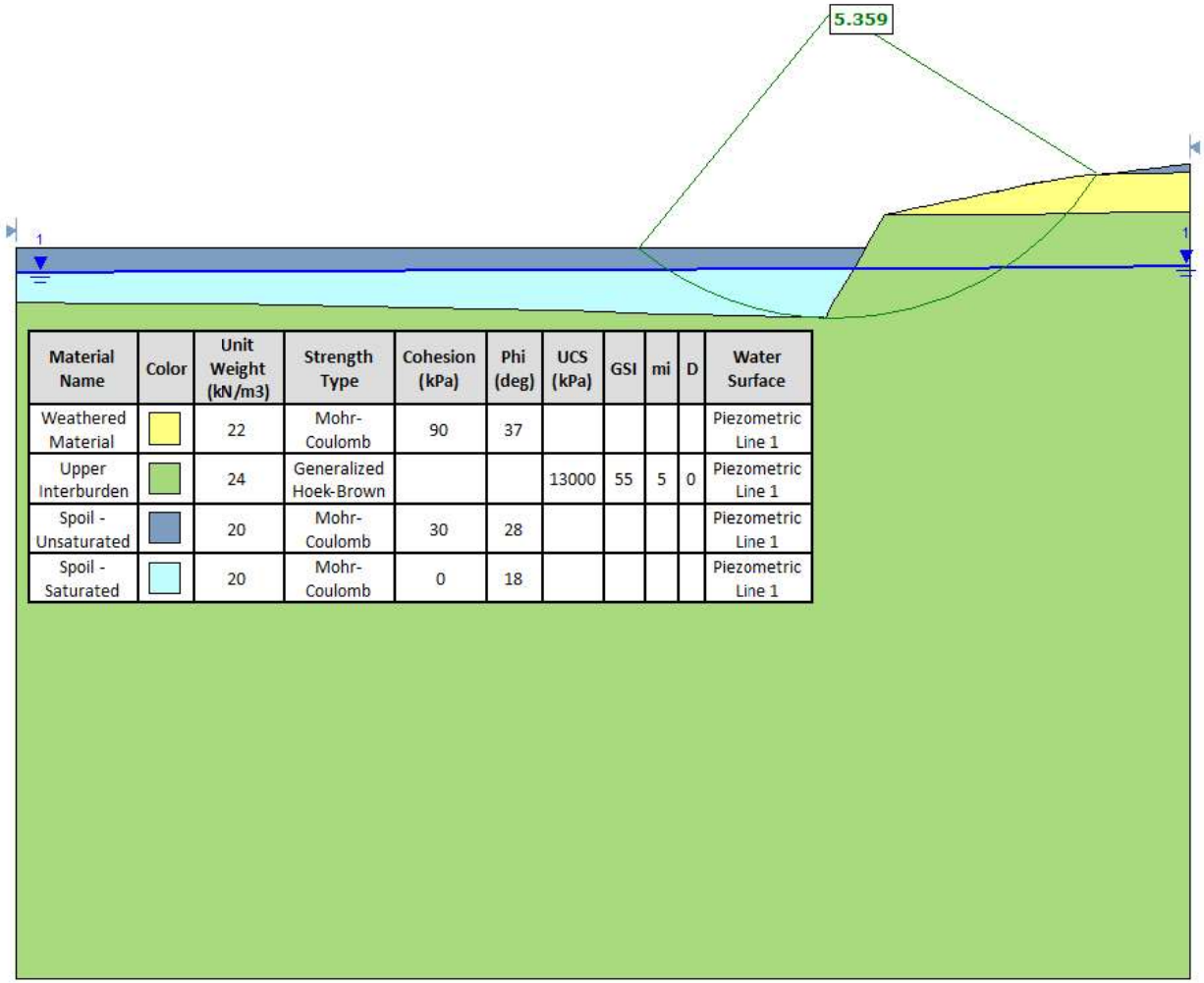


Reshaped Highwall – Woleebee no2

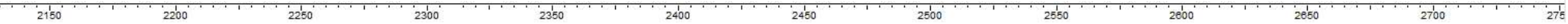


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1

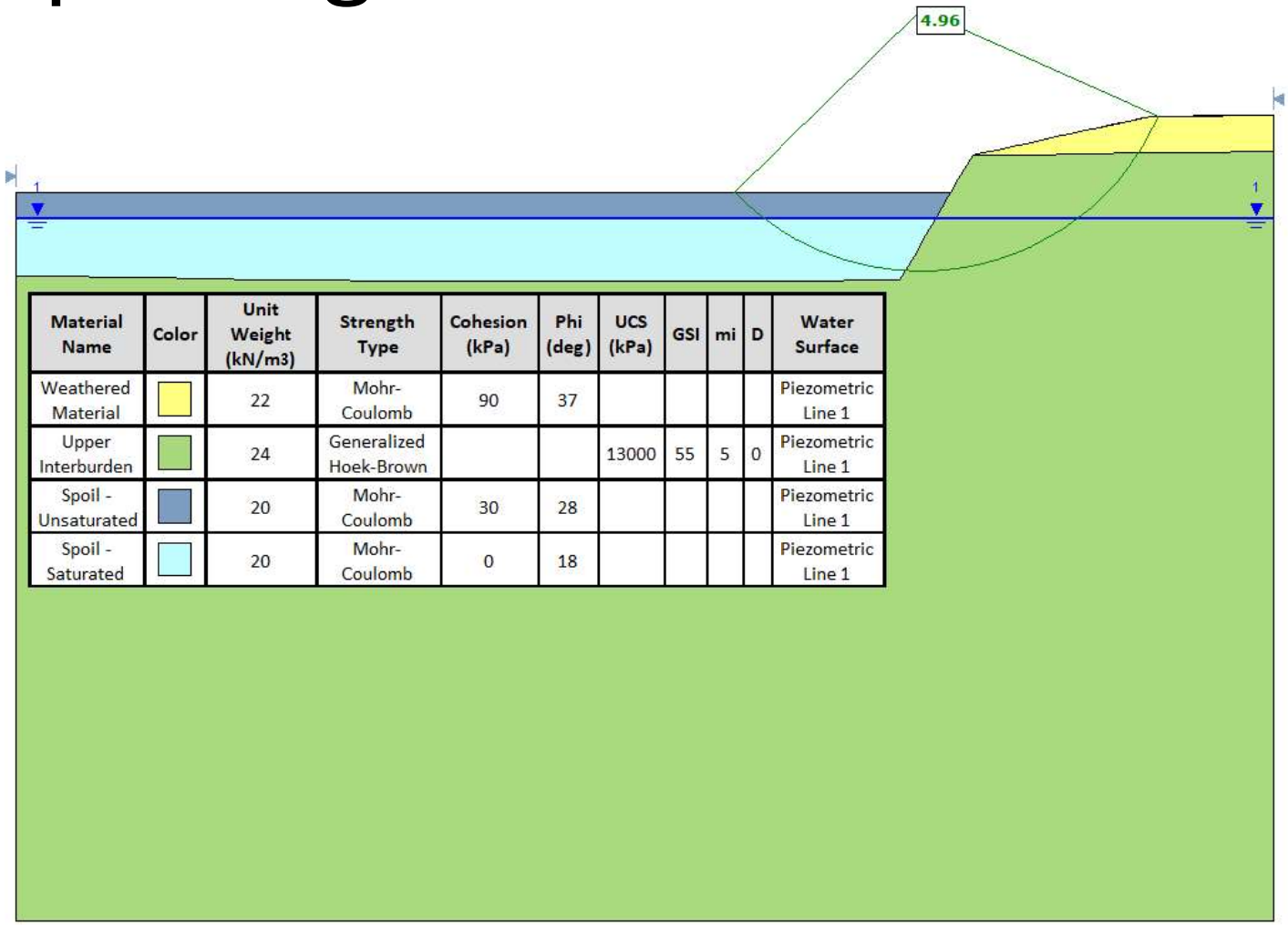
Reshaped Highwall – Woleebee no1



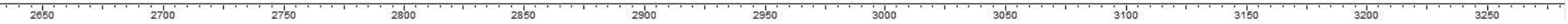
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



Reshaped Highwall – Austinvale



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1
Spoil - Unsaturated		20	Mohr-Coulomb	30	28					Piezometric Line 1
Spoil - Saturated		20	Mohr-Coulomb	0	18					Piezometric Line 1



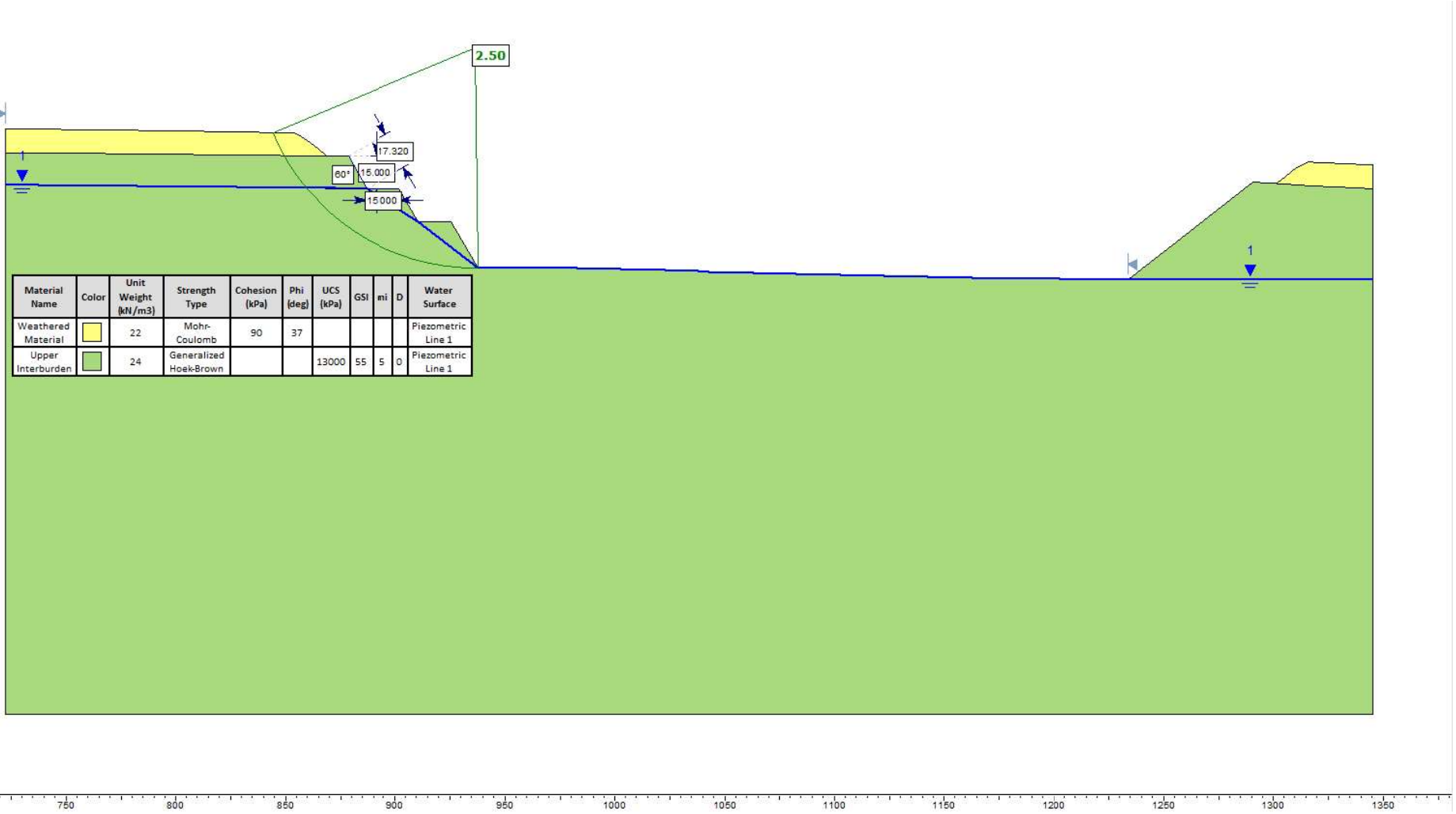
Appendix D
Stability Analyses – Highwall in Leichardt South Pit

Original Highwall

Original Highwall – Leichhardt South no3

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1

Original Highwall – Leichhardt South no3 PSM Modified Design



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface
Weathered Material		22	Mohr-Coulomb	90	37					Piezometric Line 1
Upper Interburden		24	Generalized Hoek-Brown			13000	55	5	0	Piezometric Line 1

		Risk Assessment						Risk Treatment Plan							
Risk no.	**Category**	**Risks at Closure**	**Causes**	**Description of Consequences / Impacts**	**Consequence rating**	**Likelihood of event**	**Uncontrolled Risk Rating**	**Proposed controls/treatment/actions**	**Reasons for treatment selection**	**Performance measures and constraints**	**Monitoring and Reporting Requirements**	**Resource Requirements**	**Timing**	**Responsibility**	**Controlled Risk Rating**
Mine Layout, LOM and Sequencing															
1	Mine Layout, LOM and Sequencing	Variance in mining commencement or mining rates cause delay and non-compliance with PRCP Schedule.	Delays in secondary approvals. Market or stakeholder influences. Productivity, weather impacts.	Non-compliance with PRCP Schedule.	2 - Minor	5 - Almost Certain	19 - Significant	PRCP Schedule timeframes based on year of commencement not calendar years. PRCP Schedule delivery communicated to Technical Services Department. Undertake PRCP Schedule amendment if required.	Compliance with PRCP Schedule. Achieving relinquishment.	Delivery of PRCP Schedule.	PRCP Schedule progress monitoring. Internal audits. Annual Returns. 3 Yearly PRCP Audit.	Technical Services Department.	During operations.	Site Senior Executive.	5 - Low
2	Mine Layout, LOM and Sequencing	Increasing/changing regulator expectations.	Increased community expectations. Poor industry rehabilitation performance.	Need for rework. Regulatory non-compliance. Delay in relinquishment.	3 - Moderate	3 - Possible	13 - Significant	Effective rehabilitation methodologies at WCP and GCAA sites. PRCP Schedule delivery. Progressive rehabilitation certification at WCP and GCAA sites.	Effective rehabilitation performance at WCP and GCAA operations to demonstrate rehabilitation success.	Delivery of PRCP Schedule. GCAA progressive rehabilitation certification performance.	PRCP Schedule progress monitoring. Internal audits. Annual Returns. 3 Yearly PRCP Audit. Progressive Rehabilitation Targets Achieved.	Technical Services Department. Environment and Community Department.	During operations.	Site Senior Executive.	5 - Low
Residual Voids															
3	Residual Voids	Highwalls in landform present safety risk.	Poor design. Poor construction. Highwall failure. Falling from height.	Injury or death of person, fauna or stock.	4 - Significant	3 - Possible	18 - Significant	Competent design engineers and QA/QC. Design Engineers undertake geotechnical assessment. Maximum slope for unweathered highwalls as per EA Maximum slope for all weathered material above the highwall as per EA Highwalls achieve a FoS >1.2. Safety berm at FoS 1.5. Construction surveys and geological mapping. Land Management Plan.	Safe, stable and sustainable PMLU.	Highwalls constructed to design. Highwall stability criteria. No unauthorised access to highwalls. No safety incidents	Final Landform Survey and LIDAR. Final Landform QA/QC. Highwall stability assessment.	Operations Team. Geotechnical Engineer.	During pit reshaping.	Site Senior Executive	10 - Medium
4	Residual Voids	Highwalls in landform present land use risk.	Poor design. Poor construction. Highwall failure. Erosion of final surfaces. Failure of vegetation to establish.	Void footprint increased beyond approved area. Need for rework. Non-compliance with PRCP Schedule. Failure to achieve PMLU.	3 - Moderate	3 - Possible	13 - Significant	Geotechnical and erosion assessments. Maximum 214% slope for unweathered highwalls Maximum 22% for all weathered material above the highwall. Residual void and highwalls within approved disturbance footprint. Selective placement of growth medium. Selective use of erosion controls such as rock armouring. Selective species selection. Relinquishment/Land Management Plan.	Achievement of EA approved PMLU. Achieving relinquishment.	Highwalls constructed to design. Highwall stability criteria. PRCP Schedule completion criteria.	Final Landform Survey and LIDAR. Final Landform QA/QC. Highwall erosion monitoring and maintenance. Revegetation monitoring and maintenance.	Operations Team. Technical Services Department. Environment and Community Department.	During pit reshaping.	Site Senior Executive	9 - Medium
5	Residual Voids	Contamination of groundwater from residual void water.	Void is a source of saline or acidic drainage water.	Offsite groundwater contamination. Contamination of third party bores. Contamination of alluvial aquifers.	4 - Significant	3 - Possible	18 - Significant	Voids partially backfilled so final void depressions are above groundwater levels. Voids are ephemeral non-permeant void waterbodies. Catchment yield and groundwater modelling and design input. Geochemistry assessment and design input.	Groundwater, surface water contamination not acceptable.	Groundwater and surface water quality criteria.	Ongoing groundwater and surface water quality monitoring. Annual groundwater report.	Operations Team. Environment and Community Department.	During pit reshaping. Ongoing monitoring	Site Senior Executive	3 - Low
6	Residual Voids	Residual void depression water bodies becoming NUMAs.	Salt accumulation in depression water bodies. Depression water bodies acting as a groundwater sink.	Saline void water. Unapproved NUMAs. Need for EA amendment with public consultation.	4 - Significant	3 - Possible	18 - Significant	Final landform designed and reshaped so void depressions are above groundwater levels. Ephemeral non-permanent void waterbodies. Catchment yield (depression water balance) and groundwater modelling and assessment.	Achievement of EA approved PMLU.	Residual void depression water quality criteria.	Void water quality monitoring. WaTers reporting.	Environment and Community Department.	Ongoing	Environment and Community Department	3 - Low
Overburden															
7	Overburden	Final landform not constructed to design.	Design inadequate. Design not followed. Inadequate QA/QC.	Non-compliance with EA and PRCP Schedule. PMLU not achieved. Need for rework. Delayed relinquishment.	4 - Significant	2 - Unlikely	14 - Significant	3D landform model produced and constructed to. Final landform designs issued by technical services. Swell assumptions verified. QA/QC process for landform construction. Dig and dump to design.	Control and certification of landform design. Achieving relinquishment.	Compliance with final landform 3D envelope.	Final Landform Survey and LIDAR. Final Landform QA/QC. Internal compliance audits. 3 Yearly PRCP Audits.	Operations Team.	During landform reshaping.	Site Senior Executive.	3 - Low
8	Overburden	Incorrect placement of material results in landform instability.	Poor material characterisation. Design inadequate. Poor material placement in landform construction. Spontaneous combustion. Inadequate QA/QC.	Geotechnical failure and/or erosion of final surfaces. Non-compliance with EA and PRCP Schedule. PMLU not achieved. Need for rework. Delayed relinquishment.	4 - Significant	3 - Possible	18 - Significant	Materials characterisation program for overburden, tailings and rejects. Spontaneous combustion controls to minimise exposure of waste coal to oxygen. Geotechnical and erosion studies for final landform design. Landform construction and rehabilitation methodology communicated with Technical Services. Final landform designs verified and issued by technical services. QA/QC process for landform construction.	Achievement of EA approved PMLU. Achieving relinquishment.	Landform constructed to design in consideration of geochemical characterisation of material	Material Characterisation. Material placement QA/QC and as built 3D model. PRCP Schedule progress monitoring. Rehabilitation monitoring. Internal compliance audits. 3 Yearly PRCP Audits..	Operations Team.	During landform reshaping.	Site Senior Executive.	3 - Low
9	Overburden	Potential for acid or saline drainage	Poor material characterisation. Design and/or construction of voids and tailings/reject disposal inadequate. Poor material placement in landform construction. Inadequate QA/QC.	Acid or saline seeps. Acid or saline residual void depression water. Non-compliance with EA and PRCP Schedule. PMLU not achieved. Need for rework. Delayed relinquishment.	3 - Moderate	3 - Possible	13 - Significant	Materials characterisation program for overburdens, tailings and rejects. PRCP includes acid and saline drainage studies for final landform design. Low acid production potential of overburden. Tailings and rejects encapsulated in overburden emplacements. Landform designed to limit saline seepage. QA/QC process for landform construction.	Achievement of EA approved PMLU. Achieving Relinquishment.	Landform constructed to design in consideration of geochemical characterisation of material	Material Characterisation. Material placement QA/QC and as built 3D model. PRCP Schedule progress monitoring. Rehabilitation Monitoring. Internal compliance audits. 3 Yearly PRCP Audits.	Operations Team.	During landform reshaping.	Site Senior Executive.	3 - Low
9															
10	Infrastructure	Infrastructure decommissioning and removal does not meet standard.	Infrastructure not correctly decommissioned. Contaminated material not removed to sufficient depth. Waste not appropriately disposed of.	Non-compliance with EA and PRCP Schedule. PMLU not achieved. Need for rework. Delayed relinquishment.	2 - Minor	2 - Unlikely	5 - Low	Hydrocarbon Management Protocol Guideline for Managing Geochemical Risk Waste Management Protocol Phase 2 Contamination Study during decommissioning feasibility study. Licenced demolition contractor for demolition works. Contaminated waste to be disposed of by registered waste contractor with waste tracking. QA/QC process for demolition. Landholder agreement to be obtained if required to maintain any infrastructure. Decommissioning and demolition plan and costings in closure execution plan.	Achievement of EA approved PMLU. Achieving relinquishment.	Decontamination certification. Detailed Mine Closure Plan. Delivery of PRCP Schedule	Infrastructure disposal and location records/survey. Waste tracking forms. Contaminated materials testing and sign off.	Contaminated Land Consultant. Licenced Decommissioning Contractor.	During infrastructure demolition.	Closure Study Manager.	2 - Low

11	Infrastructure	Insufficient capacity for disposal of inert materials onsite.	Insufficient disposal area. Inadequate forward planning.	Increased costs for disposal of inert demolition waste to a licensed facility. Non-compliance with EA and PRCP Schedule Delayed relinquishment	2 - Minor	2 - Unlikely	5 - Low	Waste Management Protocol Licenced demolition contractor for demolition works Decommissioning and demolition plan and costings in closure execution plan.	Achievement of EA approved PMLU. Achieving relinquishment.	Decommissioning Schedule. Detailed Mine Closure Plan. Infrastructure and waste disposal bill of quantities. Delivery of PRCP Schedule	As built infrastructure plans. Ongoing monitoring of disposal area/capacity.	Technical Services Department	5 years pre-closure.	Closure Study Manager.	2 - Low
12	Infrastructure	Contaminated material volumes greater than planned.	Hydrocarbon/chemical spills not adequately reported/recorded. New contaminants classification. Previously unknown contamination identified.	Need for rework. Increased closure costs. Non-compliance with EA and PRCP Schedule Delayed relinquishment.	3 - Moderate	2 - Unlikely	9 - Medium	Hydrocarbon Management Protocol Waste Management Protocol Hazardous substances Standard operating Procedures (SOPs), Bunding and operational inspections. Contamination register. Radiation/radioactive sources register (Management protocol). Phase 2 Contamination Study during decommissioning feasibility study. Decommissioning and demolition plan and costings in closure execution plan.	Achievement of EA approved PMLU.. Achieving relinquishment.	Achievement of PRCP Schedule completion criteria.	Inventory Tracking. Incident Reporting. Operational Inspections. GCAA Hydrocarbon Audits.	Operations Team.	During operations.	Maintenance Manager.	5 - Low
13	Infrastructure	Failure to reach agreement with the post mining landowner to retain infrastructure.	Landowners not wishing to retain infrastructure, e.g. haul roads and dams.	Requirement for additional rehabilitation. Increased closure costs. Non-compliance with EA and PRCP Schedule Delayed relinquishment.	3 - Moderate	2 - Unlikely	9 - Medium	WJV will retain the majority of haul roads and dams on properties for which it is the landowner. Infrastructure on private property is assumed to be removed for the PRCP.	Achievement of EA approved PMLU. Achieving relinquishment.	Agreements and transfer of infrastructure.	Signed Landowner Agreement/s. DESI rehabilitation report.	Legal support	5 years pre-closure.	Environment and Community Department	3 - Low
14	Infrastructure	Inability to access private property.	Local council roads removed for mining and no haul roads retained for access.	Landholders and/or WJV unable to access private property.	2 - Minor	2 - Minor	3 - Low	Haul roads to be retained in PRCP Schedule to access WJV land. Local council roads generally retained on ML50229 (location of private properties) and diverted as required prior to mining.	Achievement of EA approved PMLU. Achieving relinquishment.	Access roads retained	Signed Landowner Agreement/s. Agreement with Council. DESI rehabilitation report.	Legal support	During rehabilitation.	Environment and Community Department	1 - Low
Water Management															
15	Water Management Infrastructure and Dams	Mine affected water (MAW) dams not successfully dewatered and desilted to meet stock water quality requirements at closure.	Inadequate dewatering of MAW. Inadequate storage and/or treatment capacity of MAW from dams. Insufficient desilting of MAW dams.	Water does not meet stock water quality PMLU requirements. MAW dam contains excessive sediment which may be contaminated. MAW dam cannot be transferred to landholder. Need for rework. Non-compliance with EA and PRCP Schedule Delayed relinquishment.	2 - Minor	3 - Possible	8 - Medium	Water Management Protocol Desilt water storages in operations. Desilt water storages at closure. Removal of MAW at closure. Sediment testing at closure. Surface Water Monitoring.	Dams retained for water storage to support final grazing land use.	Grazing water quality criteria.	Dam water quality monitoring.	Environment and Community Department.	Ongoing	Environment and Community Department	3 - Low
16	Water Management Infrastructure and Dams	Sediment dams do not meet stock water quality requirements	Erosion and runoff from final landform. Sediment load.	Non-compliance with EA and PRCP Schedule PMLU not achieved. Need for rework. Delayed relinquishment.	1 - Insignificant	2 - Unlikely	2 - Low	Desilt water storages at closure Ongoing water quality monitoring Landform design to reduce erosion and sediment	Dams retained for water storage to support final grazing land use.	Grazing water quality criteria.	Dam water quality monitoring.	Environment and Community Department.	Ongoing	Environment and Community Department	1 - Low
16															
17	Revegetation	Topsoil volume deficit for revegetation establishment	Incorrect stripping of topsoil. Incorrect stockpiling of topsoil. Incorrect topsoil characterisation and/or mapping. Topsoil not applied to appropriate depth. Insufficient or incorrect amelioration applied.	PRCP Schedule not complied with. PMLU not achieved. Need for rework. Delayed relinquishment.	4 - Significant	3 - Possible	18 - Significant	Topsoil characterisation completed. Topsoil in disturbance areas is of good quality and adequate thickness. Topsoil material balance and inventory tracking in place. Topsoil Management Plan to control topsoil stripping and stockpiling during operations. Amelioration to be applied if required in accordance with site-specific recommendations. Rehabilitation QA/QC. Ground disturbance permit system.	Achievement of EA Approved PMLU.	Achievement of PRCP Schedule completion criteria.	Maintain topsoil sampling records. Maintain topsoil inventory. Survey topsoil application depths. Maintain records of ameliorants applied. Auditing.	Environment and Community Department. Specialist consultant.	Prior to stripping, stockpiling and application of topsoil.	Environment and Community Department	2 - Low
18	Revegetation	Seed mix does not meet specifications for required PMLU	Incorrect seed mix used. Inappropriate application. Appropriate seed mix unavailable. Poor quality of seed mix.	Vegetation not establishing. PRCP Schedule not complied with. PMLU not achieved. Need for rework. Delayed relinquishment.	3 - Moderate	2 - Unlikely	9 - Medium	Seed mix contains minimum species requirements. Pre-order seed mix in advance to ensure availability. Undertake seed quality testing for suitability. Rehabilitation Monitoring and maintenance Rehabilitation Monitoring and Maintenance Plan	Achievement of EA approved PMLU.	Achievement of PRCP Schedule completion criteria	Maintain records of seed mix supplied and used	Environment and Community Department. Specialist consultant.	Prior to seeding	Environment and Community Department	4 - Low
19	Revegetation	Declared weeds in excess of completion criteria allowance and impacting revegetation success	Introduction of weeds through cattle grazing, machinery, vehicles etc. Introduction of weeds through contaminated seed.	Vegetation not establishing. Success of revegetation impacted. PRCP schedule not complied with. PMLU not achieved. Need for rework. Delayed relinquishment.	2 - Minor	4 - Likely	12 - Medium	Undertake weed control measures. Machinery washdowns prior to site entry. Weed and seed declarations. Rehabilitation Monitoring and Maintenance Plan. Weed surveys and control on topsoil stockpiles. Weed management plan as required.	Achievement of EA approved PMLU	Achievement of PRCP Schedule completion criteria	Rehabilitation monitoring	Environment and Community Department	Annually and prior to topsoil stripping	Environment and Community Department	4 - Low
20	Revegetation	Overgrazing resulting in rehabilitation failure.	Overgrazing of rehabilitation by post mining land holder. No stipulated grazing carrying capacity limits. No/ineffective Relinquishment and Land Management Plan.	Revegetation success impacted. PRCP schedule not complied with. PMLU not achieved. Need for rework. Delayed relinquishment.	2 - Minor	2 - Unlikely	5 - Low	Carrying capacity limits within agistment and landowner agreements. Implement good grazing practices. Fencing of rehabilitation areas until well established Rehabilitation Monitoring and maintenance Rehabilitation Monitoring and Maintenance Plan Progressive Rehabilitation Certification	Achievement of EA Approved PMLU. Achieving relinquishment	Achievement of PRCP Schedule completion criteria	Rehabilitation monitoring	Environment and Community Department	Annually or as required	Environment and Community Department	2 - Low
General															
21	General	Pests and stock damaging rehabilitation areas	Feral animals accessing rehabilitation areas. Stock prematurely introduced to rehabilitation prior to its establishment.	Increase in closure costs and rework. Impact to vegetation establishment. Delay in relinquishment. Rehabilitation doesn't meet completion criteria. Failure to achieve PMLU.	2 - Minor	4 - Likely	12 - Medium	Undertake pest eradication measures. Fencing of rehabilitation areas until well established. Engage with neighbours for joint management. Early maintenance activities. Rehabilitation Monitoring and Maintenance Plan.	Achievement of EA approved PMLU.	Achievement of PRCP Schedule completion criteria	Pest control (weed and feral animal) monitoring.	Environment and Community Department	Annually or as required	Environment and Community Department	2 - Low
22	General	Lack of maintenance to sustain post mining land use (5 years for grass)	Failure to monitor and maintain rehabilitation	Increase in closure costs and rework. Delay in relinquishment Rehabilitation doesn't meet completion criteria Failure to achieve PMLU.	3 - Moderate	3 - Possible	13 - Significant	Early identification of issues with rehabilitation. Early maintenance activities Rehabilitation Monitoring and Maintenance Plan	Achievement of EA Approved PMLU.	Achievement of PRCP Schedule completion criteria	Rehabilitation monitoring and report card. Record keeping.	Environment and Community Department	Annually or as required	Environment and Community Department	5 - Low
Climate															
23	Climate	Flood event impacting rehabilitation success	Significant flood event (>1% AEP event) Timing of seeding	Impacts to revegetation establishment. Additional costs to re-establish vegetation. Weed introduction. Delay in relinquishment. Non-compliance with PRCP Schedule. Inability to achieve progressive rehabilitation certification.	2 - Minor	2 - Unlikely	5 - Low	PRCP final landform designed to accommodate 1% AEP flood event. No permanent void water. Progressive rehabilitation to minimise exposed areas. Allow contingency for weather events in PRCP schedule. Rehabilitation maintenance. Rehabilitation Monitoring and Maintenance Plan. Retention of infrastructure required for rehabilitation works and maintenance activities.	Achievement of EA Approved PMLU. Achieving relinquishment.	Achievement of PRCP Schedule completion criteria	Rehabilitation Monitoring 3 Yearly PRCP Audits	Environment and Community Department	Annually or as required	Environment and Community Department	2 - Low

24	Climate	Drought impacting rehabilitation success	Climate variability (no rain)	Impacts to revegetation establishment. Additional costs to re-establish vegetation Delay in relinquishment Non-compliance with PRCP schedule. Inability to achieve progressive rehabilitation certification.	3 - Moderate	3 - Possible	13 - Significant	Allow contingency for weather events in PRCP schedule. Accelerate rehabilitation rates in wetter years where land is available. Species selection to consider drought tolerance. Rehabilitation maintenance. Rehabilitation Monitoring and Maintenance Plan. Retention of infrastructure required for rehabilitation works and maintenance activities.	Achievement of EA Approved PMLU. Achieving relinquishment.	Achievement of PRCP Schedule completion criteria	Rehabilitation Monitoring 3 Yearly PRCP Audits	Environment and Community Department	Annually or as required	Environment and Community Department	5 - Low
25	Climate	Bushfire impacting rehabilitation success	Climate variability Poor management of fuel loads and/or fire breaks	Impacts to revegetation establishment. Additional costs to re-establish vegetation. Delay in relinquishment. Non-compliance with PRCP schedule. Inability to achieve progressive rehabilitation certification.	2 - Minor	3 - Possible	9 - Medium	Allow contingency for weather events and environmental risks in PRCP schedule. Accelerate rehabilitation rates in wetter years where land is available. Species selection to consider response to fire. Rehabilitation Maintenance. Rehabilitation Monitoring and Maintenance Plan. Retention of infrastructure required for rehabilitation works and maintenance activities.	Achievement of EA Approved. Achieving relinquishment	Achievement of PRCP Schedule completion criteria	Rehabilitation monitoring 3 Yearly PRCP Audits	Environment and Community Department	Annually or as required	Environment and Community Department	5 - Low
26	Climate	Climate variability impacting rehabilitation success	Variable and less predictable climate cycles Seasonal variation	Rehabilitation works not performing through climate cycles. Impacts to revegetation establishment. Additional costs to re-establish vegetation. Delay in rehabilitation schedule Delay in relinquishment. Inability to achieve progressive rehabilitation certification.	2 - Minor	2 - Unlikely	5 - Low	Allow contingency for weather events and environmental risks in PRCP schedule Accelerate rehabilitation rates in wetter years where land is available Species selection to include resilient species Rehabilitation Maintenance Rehabilitation Monitoring and Maintenance Plan Retention of infrastructure required for rehabilitation works and maintenance activities.	Achievement of EA Approved PMLU. Achieving relinquishment.	Achievement of PRCP Schedule completion criteria	Rehabilitation monitoring 3 Yearly PRCP Audits	Environment and Community Department	Annually or as required	Environment and Community Department	2 - Low

Progressive Rehabilitation and Closure Plan Schedule template

Instructions

General Instructions:

- **This form can be used for completing a PRCP schedule for the submission of a progressive rehabilitation and closure plan (PRC plan).**
- **See the PRCP schedule section of the PRC plan guideline (ESR/2019/4964) for further information requirements.**

- A default value of one (1) Rehabilitation Area (RA) is represented by one RA sheets below (RA1).
- A default value of one (1) Improvement Area (IA) is represented by one IA sheet below (IA1).

- To record additional RAs for your project make a copy of the RA sheet below and update it to the relevant RA number (i.e. RA2).
- To record additional IAs for your project make a copy of the IA sheet below and update it to the relevant IA number (i.e. IA2).
- To remove the IA sheet if there is no IA for your project, delete the IA sheet below.

- Each RA and IA sheet contains **two separate excel tables** (yellow and blue) for recording the time-based rehabilitation milestones.
- Add a new column or row to each table as required for your information requirements.

- Two (2) separate sheets below exist for recording the "Rehabilitation Area Milestones" and "Improvement Area Milestones".
- Delete the Improvement Area Milestone sheet if it does not apply to your project.
- Delete additional rows in either sheet if they do not apply to your project.
- See the PRC plan guideline for a list of reference milestones and further information for developing additional site-specific milestones where appropriate.

Further Instructions when inputting PMLUs

Headings under Rehabilitation Area (RA) sheets

Rehabilitation area - The rehabilitation area must align with the spatial information included in the rehabilitation planning part of the PRC plan. This area must have the same PMLU and same milestones applied to the whole area.

Relevant activities - The relevant activities must align with the activities identified in the rehabilitation planning part of the PRC plan. The relevant activities are those undertaken within the rehabilitation area prior to land becoming available for rehabilitation.

Total size of rehabilitation area (ha) - Total size of rehabilitation area in hectares.

Commencement of first milestone - The applicant must nominate a date for when the first milestone for the rehabilitation area will commence. The milestone reference for the first milestone must be included in the heading.

PMLU - The PMLU must align with those identified in the rehabilitation planning part of the PRC plan and in the proposed final site design.

Date area is available - The PRCP schedule must identify when land within the rehabilitation area becomes available for rehabilitation. If the whole rehabilitation area becomes available at once there should be only one date. If the rehabilitation areas becomes available progressively there should be multiple dates. These dates should reflect the information provided in the rehabilitation planning part of the PRC plan.

Cumulative area available (ha) - The PRCP schedule must identify the area of land within the rehabilitation area that will become available at a given time.

Milestone completed by - The PRCP schedule must identify completion dates for milestones to be completed.

Cumulative area achieved (ha) - The PRCP schedule must show how progressive rehabilitation is being achieved over the life of the mine. This section must reflect the proposed rehabilitation work required for the rehabilitation area to achieve stable condition. The milestone reference to be included refers back to the Rehabilitation Area Milestones sheet with the detailed milestone criteria. The milestones must be achieved consecutively.

Headings under Rehabilitation Area Milestones sheet

Rehabilitation milestone & Milestone criteria - The “rehabilitation milestone” is a short description of the rehabilitation activities. The "milestone criteria" must be able to demonstrate achievement of the milestone.

Further Instructions when inputting NUMAs

Headings under Improvement Area (IA) sheets

Improvement area - The improvement area must align with the spatial information included in the rehabilitation planning part of the PRC plan. This area must have the same NUMA and same milestones applied to the whole area.

Relevant activities - The relevant activities must align with the activities identified in the rehabilitation planning part of the PRC plan. The relevant activities are those undertaken within the improvement area prior to land becoming available for improvement.

Total size (ha) - Total size of improvement area in hectares.

Commencement of first milestone - The applicant must nominate a date for when the first milestone for the improvement area will commence. The milestone reference for the first milestone must be included in the heading.

NUMA - The NUMA must align with those identified in the rehabilitation planning part of the PRC plan and in the proposed final site design.

Date area is available - The PRCP schedule must identify when land within the improvement area becomes available for improvement. If the whole improvement area becomes available at once there should be only one date. If the improvement areas becomes available progressively there should be multiple dates. These dates should reflect the information provided in the rehabilitation planning part of the PRC plan.

Cumulative area available (ha) - The PRCP schedule must identify the area of land within the improvement area that will become available at a given time.

Milestone completed by - The PRCP schedule must identify completion dates for milestones to be completed.

Cumulative area achieved (ha) - The PRCP schedule must show how progressive improvement is being achieved over the life of the mine. This section must reflect the proposed management work required for the improvement area to achieve sufficient improvement. The milestone reference refers back to the Improvement Area Milestones sheet with the detailed milestone criteria. The milestones must be achieved consecutively.

Headings under Improvement Area Milestones sheet

Post-mining land uses (PMLU)																				
Rehabilitation area	RA1																			
Relevant activities	Pits including Lowwalls and Overburden Emplacements																			
Total rehabilitation area size (ha)	8383																			
Commencement of first milestone: RM1	20XX + 5																			
PMLU	Grazing																			
Date area is available	10 December 20XX + 5	10 December 20XX + 10	10 December 20XX + 15	10 December 20XX + 20	10 December 20XX + 25	10 December 20XX + 30	10 December 20XX + 35	10 December 20XX + 40	10 December 20XX + 45	10 December 20XX + 50	10 December 20XX + 55	10 December 20XX + 60	10 December 20XX + 65	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 76				
Cumulative area available (ha)	176	291	361	527	710	930	1035	1772	2387	3711	4370	5342	5939	6799	8031	8383				
Milestone completed by	10 December 20XX + 5	10 December 20XX + 10	10 December 20XX + 15	10 December 20XX + 20	10 December 20XX + 25	10 December 20XX + 30	10 December 20XX + 35	10 December 20XX + 40	10 December 20XX + 45	10 December 20XX + 50	10 December 20XX + 55	10 December 20XX + 60	10 December 20XX + 65	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 80	10 December 20XX + 85	10 December 20XX + 95	10 December 20XX + 100	10 December 20XX + 105
Milestone Reference	**Cumulative area achieved (ha)**																			
RM1	170	220	361	489	693	872	1015	1396	2387	3541	4370	4984	5683	6536	7497	8383				
RM3		170	220	361	489	693	872	1015	1396	2387	3541	4370	4984	5683	6536	7497	8383			
RM5		85	184	361	361	649	802	1015	1251	2300	3319	4185	4786	5525	6204	6948	8383			
RM6		85	184	361	361	649	802	1015	1251	2300	3319	4185	4786	5525	6204	6948	8383			
RM8				85	184	361	361	649	802	1015	1251	2300	3319	4185	4786	5525	6204	8383		
RM9					85	184	361	361	649	802	1015	1251	2300	3319	4185	4786	5525	6948	8383	
RM10																				8383

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)	
Rehabilitation area	RA2
Relevant activities	Infrastructure
Total rehabilitation area size (ha)	1009
Commencement of first milestone: RM1	20XX + 5
PMLU	Grazing

Date area is available	10 December 20XX + 5	10 December 20XX + 10	10 December 20XX + 25	10 December 20XX + 30	10 December 20XX + 40	10 December 20XX + 45	10 December 20XX + 50	10 December 20XX + 55	10 December 20XX + 60	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 77						
Cumulative area available (ha)	15	20	36	109	187	246	344	378	473	602	752	1009						
Milestone completed by	10 December 20XX + 10	10 December 20XX + 20	10 December 20XX + 25	10 December 20XX + 30	10 December 20XX + 35	10 December 20XX + 40	10 December 20XX + 45	10 December 20XX + 50	10 December 20XX + 55	10 December 20XX + 60	10 December 20XX + 65	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 80	10 December 20XX + 85	10 December 20XX + 95	10 December 20XX + 100	10 December 20XX + 105
Milestone Reference	**Cumulative area achieved (ha)**																	
RM1	20	20	20	109	109	128	246	274	378	378	473	496	664	1009				
RM2	20	20	20	93	109	109	246	262	378	378	473	496	623	1009				
RM5	15	20	20	93	109	109	225	262	344	378	473	473	623	898	1009			
RM6	15	20	20	93	109	109	225	262	344	378	473	473	623	898	1009			
RM8		15	20	20	20	93	109	109	225	262	344	378	473	473	623	1009		
RM9			15	20	20	20	93	109	109	225	262	344	378	473	473	898	1009	
RM10																		1009

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA3									
Relevant activities	Decommissioned haul roads and ROM pads									
Total rehabilitation area size (ha)	101									
Commencement of first milestone: RM2	20XX + 70									
PMLU	Grazing									
Date area is available	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 80							
Cumulative area available (ha)	7	39	101							
Milestone completed by	10 December 20XX + 75	10 December 20XX + 80	10 December 20XX + 85	10 December 20XX + 90	10 December 20XX + 95	10 December 20XX + 100				
Milestone Reference	**Cumulative area achieved (ha)**									
RM2	7	101								
RM4	7	101								
RM5	7	71	101							
RM6	7	71	101							
RM8			7	101						
RM9				7	101					
RM10						101				

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA4									
Relevant activities	Retained Haul Roads									
Total rehabilitation area size (ha)	548									
Commencement of first milestone: RM2	20XX + 76									
PMLU	Grazing									
Date area is available	10 December 20XX + 76									
Cumulative area available (ha)	548									
Milestone completed by	10 December 20XX + 78	10 December 20XX + 79	10 December 20XX + 89	10 December 20XX + 94	10 December 20XX + 99					
Milestone Reference	**Cumulative area achieved (ha)**									
RM2	548									
RM4		548								
RM8			548							
RM9				548						
RM10					548					

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA5									
Relevant activities	Water Infrastructure									
Total rehabilitation area size (ha)	126									
Commencement of first milestone: RM7	20XX + 76									
PMLU	Grazing									
Date area is available	10 December 20XX + 76									
Cumulative area available (ha)	126									
Milestone completed by	10 December 20XX + 78	10 December 20XX + 88	10 December 20XX + 93	10 December 20XX + 98						
Milestone Reference	**Cumulative area achieved (ha)**									
RM7	126									
RM8		126								
RM9			126							
RM10				126						

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)												
Rehabilitation area	RA6											
Relevant activities	Highwalls and End walls including weathered zone											
Total rehabilitation area size (ha)	212											
Commencement of first milestone: RM3	20XX + 26											
PMLU	Native Bushland											
Date area is available	10 December 20XX + 30	10 December 20XX + 45	10 December 20XX + 50	10 December 20XX + 60	10 December 20XX + 70	10 December 20XX + 75	10 December 20XX + 80					
Cumulative area available (ha)	20	58	99	134	153	189	212					
Milestone completed by	10 December 20XX + 35	10 December 20XX + 50	10 December 20XX + 55	10 December 20XX + 60	10 December 20XX + 65	10 December 20XX + 75	10 December 20XX + 80	10 December 20XX + 85	10 December 20XX + 90	10 December 20XX + 100	10 December 20XX + 105	10 December 20XX + 110
Milestone Reference	**Cumulative area achieved (ha)**											
RM3	20	58	99	99	134	153	189	212				
RM5	20	58	74	99	99	134	168	212				
RM6	20	58	74	99	99	134	168	212				
RM8		20	20	20	58	99	99	134	134	212		
RM9			20	20	20	74	99	99	134	168	212	
RM10												212

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA7									
Relevant activities	Exploration and Ancillary Activities									
Total rehabilitation area size (ha)	6627									
Commencement of first milestone: RM1	20XX + 102									
PMLU	Grazing									
Date area is available	10 December 20XX + 102									
Cumulative area available (ha)	6627									
Milestone completed by	10 December 20XX + 103	10 December 20XX + 108	10 December 20XX + 109	10 December 20XX + 119	10 December 20XX + 124	10 December 20XX + 129				
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	6627									
RM3		6627								
RM5			6627							
RM6			6627							
RM8				6627						
RM9					6627					
RM10						6627				

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioned and removed	1.1With the exception of any infrastructure to remain as part of the post-mining land use (PMLU) or to be retained under landholder agreement, the following are complete: (a)All services disconnected and removed; (b)All buildings and associated infrastructure dismantled and removed offsite. (c)All hardstand, concrete areas and roads (bitumen, blue metal, aggregate etc.) removed. (d)All fencing and associated foundations removed. (e)All pipelines drained and removed. (f)All waste not authorised to be disposed of on-site under EA EPML00297613 removed. (g)All drillholes, bores, sediment ponds and sumps decommissioned. (h)All machinery and equipment, not required for rehabilitation works removed from site. (i)Watercourse crossings and culverts removed. 1.2Below-ground infrastructure and services deeper than 0.5m in relation to the final landform surface may be retained provided: (a)All pipelines have been drained and capped or filled with inert material; and (b)All below-ground infrastructure to be retained is mapped; and (c)The intended PMLU is not compromised; and (d)There is no ongoing risk of environmental harm.
RM2	Contaminated land remediated	2.1Contaminated Land Investigation Document completed in accordance with the EP Act, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan. 2.2Contaminated water and sediment removed from dams. 2.3Contaminated and hazardous material either remediated in-situ or removed/transported to facility lawfully able to accept the material. 2.4Suitably Qualified Person (SQP) provides a suitability statement that confirms the land is not unsuitable for the PMLU.
RM3	Landform reshaped / reprofiled	3.1External batters of overburden emplacements have a maximum slope of 18 %. 3.2Final void lowwall slopes are ≤ 22 %. 3.3Highwall weathered zones have been battered back to ≤ 22 % and achieved a FoS of ≥ 1.2. 3.4Highwall unweathered material is retained with slopes ≤ 214 % and achieved a FoS of ≥ 1.2. 3.5Constructed landform achieves geotechnical stability. 3.6Where highwalls remain, competent safety bund or equivalent landform installed at minimum FoS ≥ 1.5 to prevent access to the voids constructed to the following specifications: (a)A minimum 2m in height; (b)A minimum of 5m base width; and (c)Constructed from non-weathered, non-dispersive dumped rockfill. 3.7Where the waste placement strategy of tailings/reject encapsulation within overburden emplacements exists, a separation offset of 20 m between the encapsulation cell and the nearest exposed final batter is required. 3.8Slope lengths of approximately 100 m. 3.9The following pits are constructed to RM3.1 and RM3.4 and are reprofiled to form free draining landforms: Turkey Hill, Mud Creek North, Mud Creek East, Woleebee North, Austinvale North, Leichhardt, Frank Creek North and Frank Creek South. 3.10The following pits are constructed to RM3.1 and RM3.4 and are reprofiled to create void depressions and may contain ephemeral waterbodies: Summer Hill, Mud Creek, Woleebee North Satellite, Woleebee Creek, Woleebee, Austinvale, Frank Creek and Wubagul . 3.11For the interaction of landform and 0.1 % AEP, selective use of scour protection such as vegetation and/or rock mulch as determined by AQP.
RM4	Carbonaceous material removed	4.1Carbonaceous material removed from all haul roads by scalping to a depth of ≥ 300 mm. 4.2Carbonaceous material removed from ROM by scalping to a depth of ≥ 500 mm.
RM5	Surface prepared	5.1Topsoil placed to a depth of: (a)≥ 100 mm for infrastructure areas and roads. (b)≥ 200 mm for overburden emplacements and lowwalls areas. (c)≥ 200 mm for weathered zones of highwalls. 5.2Topsoil or growth medium is tested prior to placement on the landform for the below parameters: (a)pH 5.4 – 9.5; (b)Electrical Conductivity < 1800 µS/cm; (c)Nitrate > 5 mg/kg; (d)Total Kjeldahl Nitrogen > 500 mg/kg; (e)Total Phosphorus ≥ 50 mg/kg; (f)Exchangeable Sodium Percentage ≤ 6 %. 5.3Where the topsoil or growth medium tested does not meet the criteria under RM5.2, the topsoil or growth medium is ameliorated and fertilised to the recommendations of an AQP. 5.4Contour ripping completed at a depth ≥ 200 mm.
RM6	Surface revegetated	6.1The seed mix will be derived from a selection of species listed in the species list provided in PRCP Schedule Attachment 1 or in the event of species not being available other suitable alternatives, for the relevant PMLU. 6.2Seed mix applied at the rate listed in PRCP Schedule Attachment 1 for the relevant PMLU. 6.3Livestock are excluded from newly seeded areas via physical or virtual fencing.
RM7	Rehabilitation of water infrastructure	7.1All water infrastructure, either retained as evidenced by a written and signed landholder agreement or ephemeral water bodies which are to remain as part of the PMLU to comply with the following: (a)All contaminated sediment has been removed; (b)Safely accessible; and (c)Total dissolved solids ≤ 5,000 mg/L 7.2All water infrastructure which are not to remain or be retained under criterion RM7.1, comply with the following: (a)Where present, liners are removed; (b) All contaminated sediment has been removed; and (c)Earthworks are completed to decommission dam walls.

RM8	Achievement of surface requirements	8.1Grazing PMLU vegetation groundcover is ≥ 65 %. 8.2Native Bushland vegetation groundcover and / or rock cover is ≥ 50 %. 8.3Proportion of weeds is < 10 % of total vegetative groundcover. 8.4The landform is free draining with the exception of water management infrastructure retained under RM7 where residual voids hold ephemeral waterbodies. 8.5An AQP certifies that there is no erosion classified as 'moderate' or 'severe' as defined by Attachment 2 – Erosion Classification Framework. 8.6Despite RM8.5 erosion is acceptable in the achievement of surface requirements provided an AQP certifies that all active erosion has been identified and remediation activities have been completed. 8.7 There is no evidence of saline, metalliferous or acid mine drainage from landforms to the receiving environment.
RM9	Achievement of post-mining land use to a stable condition	9.1For a Grazing PMLU, vegetation groundcover is ≥ 75 %. 9.2For a Grazing PMLU, vegetation species diversity includes ≥ 3 productive grass species. 9.3For a Grazing PMLU, average pasture yield is > 1,000 kg/ha. 9.4For a Native Bushland PMLU, vegetation groundcover and / or rock cover is ≥ 60 %. 9.5For a Native Bushland PMLU, ≥ 3 native tree / shrub species. 9.6Weed presence is less than 10% of total vegetation cover. 9.7An AQP certifies that there is no erosion classified as 'moderate' or 'severe' as defined by Attachment 2 – Erosion Classification Framework. 9.8Despite RM9.7 gullies are acceptable in the achievement of a stable landform provided they meet the following criteria as certified by an AQP: (a)does not exceed 1 m in depth at any point; and (b)has not exposed environmentally problematic materials; and (c)the cause of the gully is known and has been resolved; and i)has established and persistent vegetation cover, and/ or rock armouring at the head of the gully; and ii)is in a stabilised state, demonstrated by monitoring data over a 5-year period; and (d)does not provide a safety hazard within the context of the PMLU; and (e)are isolated. 9.9Engineered Structures to remain in the final landform s (e.g., rock drains), must be certified by an AQP as stable and can be expected to remain stable and functional. 9.10A rehabilitation performance assessment is completed using the methodology outlined in PRCP Schedule Attachment 3 – Method of Assessment. 9.11Risk Assessment completed demonstrates risks in the rehabilitation area are similar to risks in neighbouring unmined landscapes subject to a similar PMLU.
RM10	Achievement of post-mining land use water quality	10.1Groundwater quality results will be monitored quarterly at the monitoring locations specified in PRCP Schedule Attachment 4 – Groundwater Monitoring Locations. For Five (5) consecutive years prior to surrender, the quality characteristics listed in PRCP Schedule Attachment 5 – Groundwater Quality Limits, must not exceed the limits in PRCP Schedule Attachment 5, for three (3) consecutive results. 10.2Surface water quality results will be monitored during flow at downstream locations specified in PRCP Schedule Attachment 6 – Surface Water Monitoring Locations. For Five (5) consecutive years prior to surrender, the quality characteristics listed in PRCP Schedule Attachment 7 – Surface Water Quality Limits must not exceed the limits in PRCP Schedule Attachment 7 – Surface Water Quality Limits. 10.3If (A) the surface water quality results exceed the criteria in RM10.2; and (B) if there is flow at both the upstream and downstream monitoring location for each creek; then, each year by 1 November, an AQP must complete and provide to the administering authority an assessment of the cause of the exceedance, and the risk of rehabilitation not achieving a stable condition. Where the assessment concludes: (a)that there is low risk to achieving a stable condition, then no further action is to be taken; (b)that there is a risk greater than low to achieving a stable condition, then an assessment of potential environmental harm and any changes or rectification actions to rehabilitation activities must be determined and implemented. 10.4If RM10.3(b) is triggered, then the 5-year timeframe under RM10.2 is reset.

Attachment 1 Seed Mix Species / Rates

Scientific Name	Common Name	Application Rate (kg/ha)
Native bushland trees (T) / shrubs (S) (Native Bushland PMLU)		
Acacia harpophylla (T)	Brigalow	Between 6-10 species from the list with bulk seed at 3 kg/ha (assuming some chaff and impurities in seed lots). Use 1.5 kg/ha if using pure seed for trees. And Between 8-12 species from the list with bulk seed at 8 kg/ha, subject to availability of seed stock for shrubs.
Acacia oswaldii (T)	Umbrella Wattle	
Acacia pendula (T)	Weeping Myall	
Acacia salicina (S)	Sally Wattle	
Acacia stenophylla (T)	Shoestring Acacia	
Alectryon diversifolius (T)	Scrub Boonaree	
Alectryon oleifolius (T)	Boonaree	
Allocasuarina luehmannii (T)	Bull Oak	
Alphitonia excelsa (T)	Soap Tree	
Atalaya hemiglauca (S)	Whitewood	
Bauhinia carronii (T)	Bean Tree	
Brachychiton populneus (T)	Kurrajong	
Brachychiton rupestris (T)	Queensland Bottle Tree	
Capparis lasiantha (S)	Nipan	
Carissa ovata (S)	Currant bush	
Casuarina cristata (T)	Belah	
Citrus glauca (S)	Desert Lime	
Corymbia tessellaris (T)	Moreton Bay Ash	
Dodonaea viscosa (S)	Hopbush	
Ehretia membranifolia (T)	Weeping Koda	
Eremophila bignoniiflora (S)	Bignonia Emu-bush	
Eremophila deserti (S)	Turkey Bush	
Eremophila maculata (S)	Spotted Emu-bush	
Eremophila mitchellii (S)	Budda	
Eucalyptus crebra (T)	Narrow-leaved red ironbark	
Eucalyptus melanophloia (T)	Narrow-leaved ironbark	
Eucalyptus orgadophila (T)	Silver-leaved ironbark	
Eucalyptus populnea (T)	Poplar Box	
Flindersia australis (T)	Australian Teak	
Geijera parviflora (S)	Wilga	
Grevillea striata (S)	Beefwood	
Lysiphyllum carronii (T)	Queensland Ebony	
Notelaea macrocarpa (S)	Native Olive	
Psydrax oleifolia (S)	Wild Lemon	
Native bushland grass / legumes (Native Bushland PMLU)		
Ancistrachne uncinulata	Hooky Grass	3-6 species from the list with a bulked seed weight of 3 kg/ha.
Atriplex muelleri	Lagoon Saltbush	
Aristida caput-medusae	Many-headed Wiregrass	
Aristida latifolia	Feathertop Wiregrass	
Aristida personata	Purple Wiregrass	
Boerhavia dominii	Tarvine	
Bothriochloa bladhii	Forest Bluegrass	
Bothriochloa ewartiana	Creeping Bluegrass	
Bothriochloa insculpta	Desert Bluegrass	
Breynia oblongifolia	Coffee bush	
Chloris divaricata	Slender Chloris	
Cyperus fulvus	Sticky Sedge	
Cyperus gracilis	Slender Flat Sedge	
Dichanthium sericeum	Queensland Bluegrass	
Echinochloa esculenta	Jap Millet	
Einadia nutans	Climbing Saltbush	
Enchylaena tomentosa	Ruby Saltbush	
Enneapogon lindleyanu	Lindley Nineawn	
Enteropogon acicularis	Curly Windmill Grass	
Enteropogon unispiceus	Windmill Grass	
Eragrostis megalosperma	Lovegrasses	
Eragrostis spartinoides	Lovegrasses	
Goodenia glabra	Shiny pansy	
Heteropogon contortus	Black Speargrass	
Paspalidium caespitosum	Brigalow Grass	
Grazing pasture / legumes (Grazing PMLU)		
Bothriochloa bladhii	Creeping Bluegrass / Forest Bluegrass	3-6 species from the list with a bulked seed weight of 3 kg/ha.
Astrebla lappacea	Curly Mitchell Grass	
Astrebla squarrosa	Bull Mitchell Grass	
Bothriochloa ewartiana	Desert Bluegrass	
Clitorea ternatea	Butterfly Pea	
Desmanthus virgatus	Desmanthus	
Dichanthium sericeum	Silky Bluegrass / Queensland Bluegrass	
Digitaria brownii	Cotton Panic	
Digitaria ciliaris	Summer Grass	
Echinochloa esculenta	Jap Millet	
Enchylaena tomentosa	Ruby Saltbush	
Enteropogon acicularis	Curly Windmill Grass	
Heteropogon contortus	Black Speargrass	
Megathyrsus maximus	Green Panic	
Panicum effusum	Hairy Panic	
Panicum maximum	Gatton Panic	
Paspalidium caespitosum	Brigalow Grass	
Paspalidium globoideum	Shot Grass	
Stylosanthes scabra	Shrubby Stylo	
Stylosanthes seabrana	Caribbean Stylo	
Themeda triandra	Kangaroo Grass	

Attachment 2 Erosion Classification Framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope	Loss of surface horizon; subsoil exposure; root exposure; substantial soil deposits downslope
Rill erosion <0.3m deep	Occasional rills	Common rills	Numerous rills forming corrugated ground surface
Gully erosion >0.3m deep	Absent	Occasional gullies	Common/numerous gullies
Tunnel erosion	Absent	Absent	Present
Mass movement	Absent	Absent	Present

Source: NCST (2024) Australian Soil and Land Survey Field Handbook, 4th edition. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.

**Transect linear 100 m across the contour (Source: Tongway, D. J. and Hindley, N. L. 2005. Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes. CSIRO Publishing, Canberra, Australia)*

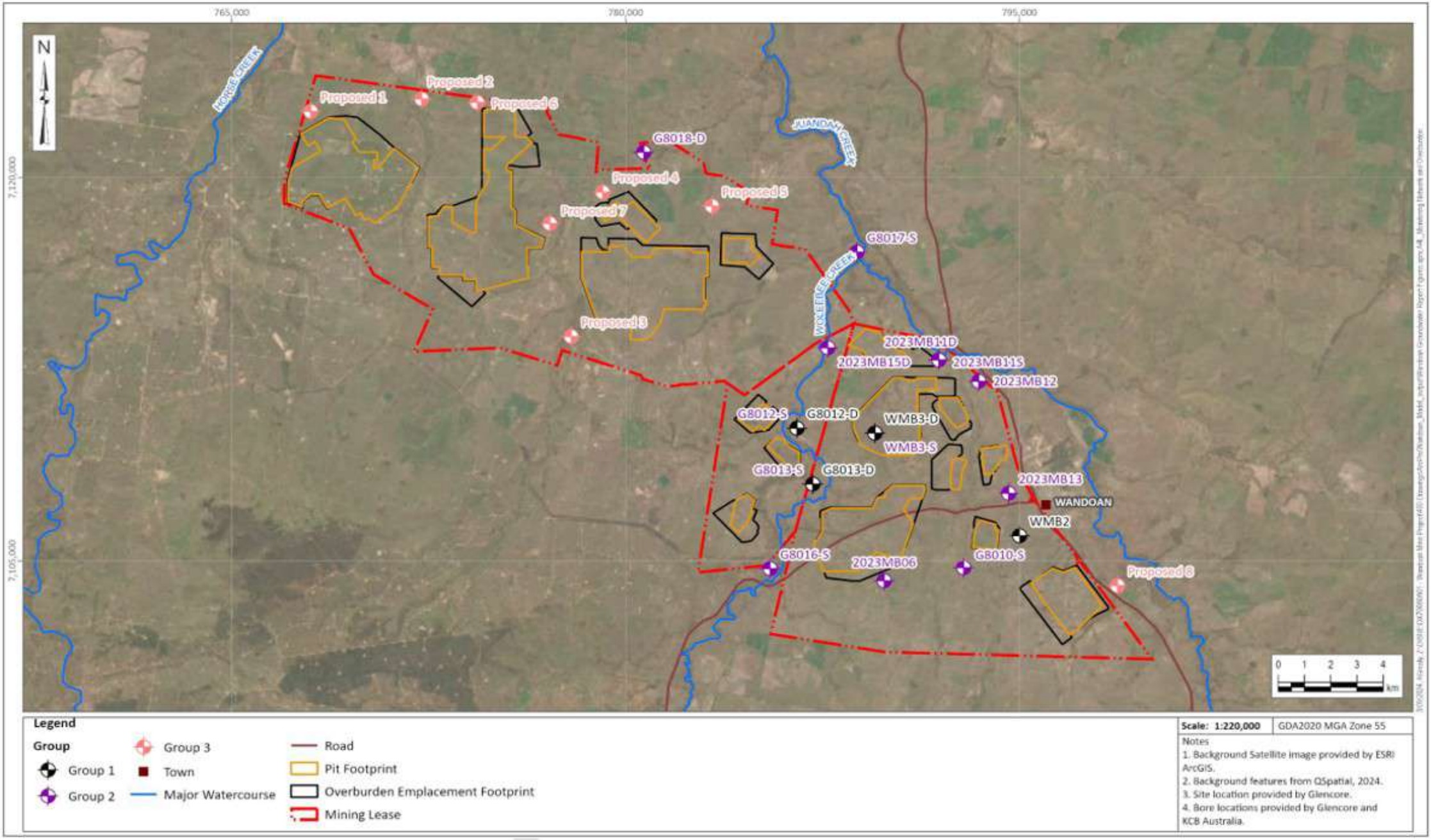
Attachment 3 Rehabilitation Performance Method of Assessment

Parameter	Method
Tree canopy height	Five 5x10m subplots in 10x50m plot. All woody species over 2m measured
Recruitment of dominant canopy spp.	Five 5x10m subplots in 10x50m plot Assess number of individuals per framework species, recruitment
Native tree spp. richness	Five 5x10m subplots in 10x50m plot Assess number of individuals per framework species, recruitment
Tree canopy cover	100m transect using line intercept method (Grieg-Smith 1964)
Shrub cover	100m transect using line intercept method (Grieg-Smith 1964)
Coarse woody debris	Five 5x10m subplots in 10x50m plot
Native plant spp. richness	Five 5x10m subplots in 10x50m plot
Non-native cover	Non-natives species richness recorded (see below)
Native perennial grass cover	Recorded as part of overall live ground cover in five 1x1m quadrats every 10m along transect
Organic litter, rock, bare, cryptograms	Five 1x1m quadrats every 10m along transect
Slope	At each transect
Soils	Bulk sample from five sub-samples at 10m Intervals along transect. Assessed for suite of variables
Erosion	Record distance along transect where present, severity rating 1 (no erosion) to 5 (gully >1m deep)
Non-native spp. richness	Five 5x10m subplots in 10x50m plot
Biomass	Five 1x1m quadrats every 10m along transect
Tree hollows	Visually estimated at three points at 0, 25, 50m along transect
Free water	Visually estimated at three points at 0, 25, 50m along transect

Attachment 4 Groundwater Monitoring Locations

(KCB, Groundwater monitoring program, September 2024)

Group	Name	Current EA	Easting (m)	Northing (m)	Screen Interval (mbGL)	Screened Hydrostratigraphic Unit	Location	Comments
Group 1	WMB2	Yes	795003	7105981	70.0 to 73.0	WCM (Macalister Lower)	East of Frank Creek South Pit	
Group 1	WMB3-D	Yes	789498	7110001	49.0 to 58.0	WCM (Wambo)	Footprint of Austinvale Pit	To be decommissioned during operations
Group 1	G8012-D	Yes	786527	7110194	16.1 to 19.1 28.1 to 38.1	WCM	East of Woleebee North Sat Pit	
Group 1	G8013-D	Yes	787130	7108005	33.2 to 39.5	WCM	Between Woleebee North and Woleebee Pits	
Group 2	WMB3-S	Yes	789498	7110001	38.0 to 44.0	WCM (Macalister Upper)	Footprint of Austinvale Pit	To be decommissioned during operations
Group 2	G8010-S	Yes	792878	7104734	4.9 to 7.8	Alluvium	Southwest of Frank Creek South Pit	Additional data required to develop baseline/trigger values
Group 2	G8012-S	Yes	786527	7110194	6.0 to 9.0	Alluvium	East of Woleebee North Sat Pit	Additional data required to develop baseline/trigger values
Group 2	G8013-S	Yes	787130	7108005	9.0 to 12.0	Alluvium	Between Woleebee North and Woleebee Pits	Additional data required to develop baseline/trigger values
Group 2	G8016-S	Yes	785498	7104694	5.1 to 8.3	Alluvium	East of Woleebee Pit	Additional data required to develop baseline/trigger values
Group 2	G8017-S	Yes	788811	7117095	3.4 to 6.4	Alluvium	East of Mud Creek East Pit	Additional data required to develop baseline/trigger values
Group 2	G8018-D	Yes	780693	7120994	19.4 to 22.2 28.6 to 31.5	WCM	North of Mud Creek North Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB06	No	789846.8	7104224	51.0 to 57.0	Sandstone	South of Woleebee Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB11D	No	791924.4	7112863	19.0 to 25.0	WCM (Wambo)	East of Austinvale North Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB11S	No	791928.8	7112863	1.0 to 3.0	Alluvium	East of Austinvale North Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB12	No	793453.6	7112027	19.0 to 22.0	WCM (Wambo)	East of Austinvale Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB13	No	794590	7107644	30.0 to 36.0	WCM (Macalister Upper)	South of Frank Creek North Pit	Additional data required to develop baseline/trigger values
Group 2	2023MB15D	No	787706	7113343	24.0 to 30.0	WCM (Wambo)	West of Austinvale North PiT	Additional data required to develop baseline/trigger values
Group 3	Proposed 1	No	768008.1	7122594	TBD	TBD	North of Turkey Hill Pit	To be drilled 2 years prior to mining (approx. year 59)
Group 3	Proposed 2	No	772235.4	7123082	TBD	TBD	Northeast Summer Hill Pit	To be drilled 2 years prior to mining (approx. year 49)
Group 3	Proposed 3	No	777926.1	7113781	TBD	TBD	South of Mud Creek Pit	To be drilled 2 years prior to mining (approx. year 50)
Group 3	Proposed 4	No	779129.2	7119440	TBD	TBD	North of Mud Creek North Pit	To be drilled 2 years prior to mining (approx. year 39)
Group 3	Proposed 5	No	783291.5	7118887	TBD	TBD	Northeast Mud Creek East Pit	To be drilled 2 years prior to mining (approx. year 39)
Group 3	Proposed 6	No	774349.1	7122952	TBD	TBD	Northwest of Summer Hill Pit	To be drilled 2 years prior to mining (approx. year 49)
Group 3	Proposed 7	No	777113.1	7118204	TBD	TBD	East of Summer Hill Pit	To be drilled 2 years prior to mining (approx. year 49)
Group 3	Proposed 8	No	798737.5	7104026	TBD	TBD	East of Wubagul Pit	To be drilled 2 years prior to mining (approx. year 70)



Legend

Group

- Group 1
- Group 2
- Group 3
- Town
- Major Watercourse
- Road
- Pit Footprint
- Overburden Emplacement Footprint
- Mining Lease

Scale: 1:220,000 | GDA2020 MGA Zone 55

Notes

1. Background Satellite Image provided by ESRI ArcGIS.
2. Background features from QSpatial, 2024.
3. Site location provided by Glencore.
4. Bore locations provided by Glencore and KCB Australia.

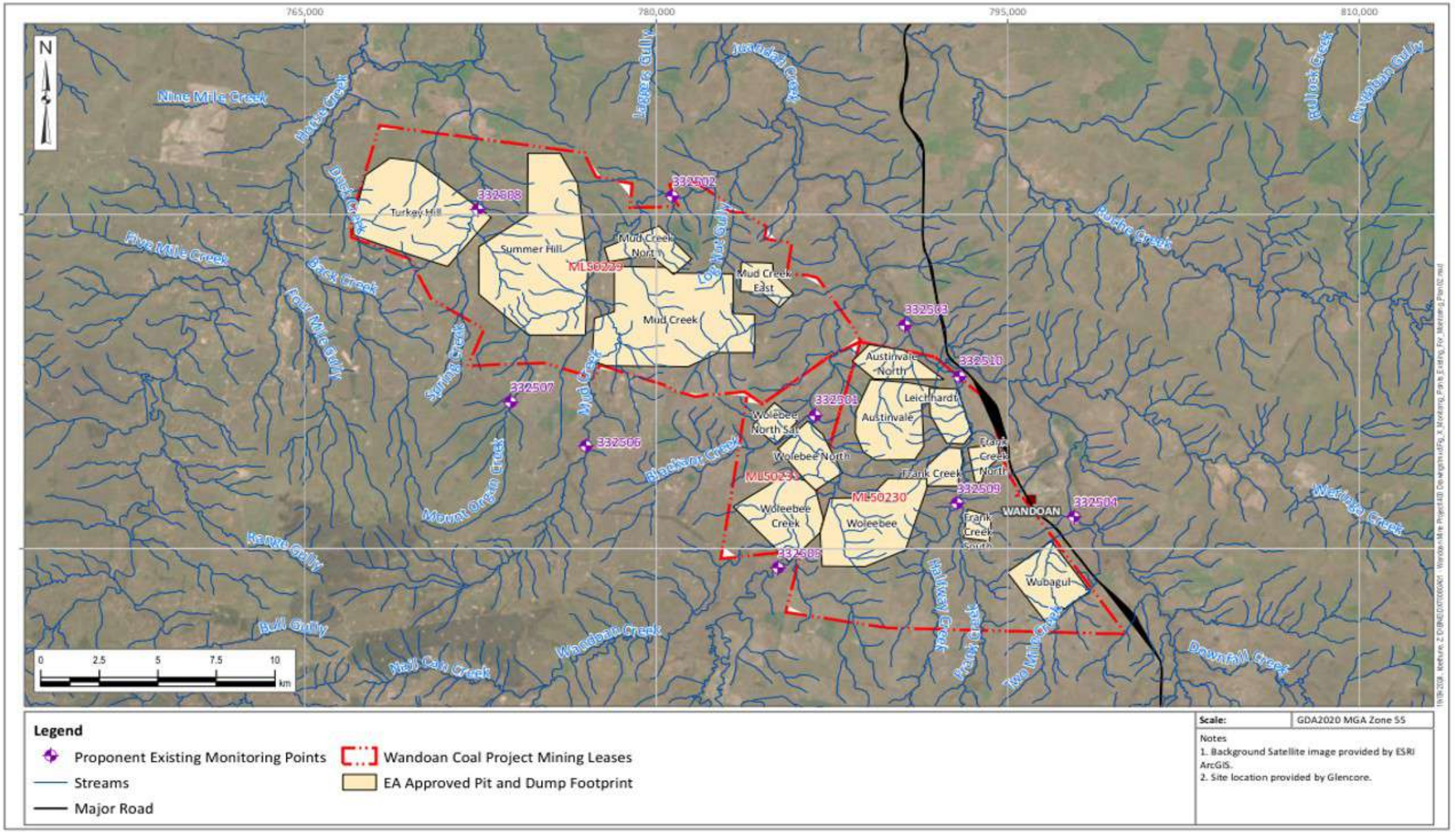
Attachment 5 Groundwater Quality Limits

Parameter	Unit	Bore Specific Triggers				Interim Triggers		Source
		Aquifer						
		Walloon Coal Measures				Alluvium	Walloon Coal Measures	
		Bore ID				N/A		
		G8012-D	G8013-D	WMB2	WMB3-D			
pH	--	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	Site Specific
EC	uS/cm	5,795	16,965	20,435	18,455	20,115	26,375	Site Specific
Sulfate	mg/L	500	500	500	500	500	500	ANZG (2023). Livestock drinking water guidelines
Aluminium (dissolved)	ug/L	55	55	55	55	55	55	ANZECC aquatic ecosystem trigger value (95% species protection level)
Iron (dissolved)	ug/L	300	475	880	1780	300	300	No guideline value for Australia. Canadian value recommended for use as 300 µg/L
Arsenic (dissolved)	ug/L	24	24	24	24	24	24	ANZECC aquatic ecosystem trigger value (95% species protection level)
Selenium (dissolved)	ug/L	11	11	11	11	11	11	ANZECC aquatic ecosystem trigger value (95% species protection level)

Attachment 6 Surface Water Monitoring Locations

(KCB, Surface water monitoring plan – draft rev A, September 2024)

Site	Name	Easting (WGS84)	Northing (WGS84)	Status	Location
332504	Juandah Creek Upstream	797837	7106415	Operational	Outside ML 50230 to the east upstream of the confluence with Two Mile Creek. Upstream of Wubagul mining area footprint.
332503	Juandah Creek Downstream	790608	7115035	Operational	Outside ML 50230 to the north downstream of the confluence with Frank Creek and the unnamed tributary flowing through the north boundary of ML 50230. Downstream of the Austinvale and Austinvale North mining area footprints.
332509	Frank Creek Upstream	792840	7107024	Operational	Within ML 50230 to the east upstream of the confluence with Halfway Creek. Downstream of the Frank Creek South mining area footprint. Upstream of the Frank Creek, Frank Creek North and Leichardt mining area footprints.
332510	Frank Creek Downstream	792942	7112749	Operational	Just outside ML 50230 to the north and immediate upstream of the confluence with Juandah Creek. Downstream of the Franck Creek South, Frank Creek, Frank Creek North and Leichardt mining area footprints.
332505	Woleebee Creek Upstream	785189	7104126	Operational	Outside ML 50231 to the south. Upstream of the Woleebee Creek mining area footprint.
332501	Woleebee Creek Downstream	786786	7110999	Operational	Within ML 50231 to the west. Downstream of Woleebee Creek, Woleebee North and Woleebee North Satellite mining area footprints and proposed MAWD1 RP.
332506	Mud Creek Upstream	776996	7109607	Operational	Outside ML 50229 to the south. Upstream of Mud Creek mining area footprint.
332502	Mud Creek Downstream	780687	7120829	Operational	Just outside ML 50229 to the north. Downstream of Mud Creek, Mud Creek North and Summer Hill mining area footprints.
332507	Mount Organ Creek Upstream	773794	7111578	Operational	Outside ML 50229 to the south. Upstream of Summer Hill mining area footprint.
332508	Spring Creek Upstream	772396	7120207	Operational	Inside ML 50229 to the west. Just downstream of Turkey Hill mining area footprint.



Legend

- Proponent Existing Monitoring Points
- Streams
- Major Road
- Wandoan Coal Project Mining Leases
- EA Approved Pit and Dump Footprint

Scale:	GDA2020 MGA Zone 55

Notes
1. Background Satellite image provided by ESRI ArcGIS.
2. Site location provided by Glencore.

Attachment 7 Surface Water Quality Limits

Parameter	Unit	Proposed Site Limit	EA Limits	Guidelines Values	Source
pH	--	6.0-9.0	6.5-9	6.5-8.5	Site Specific
EC	uS/cm	750	1000	370	Site Specific
Sulfate	mg/L	10	1000	5	Site Specific
Turbidity	NTU	1750	1000	50	Site Specific
Arsenic (dissolved)	ug/L	13	13	13	ANZECC aquatic ecosystem trigger value (95% species protection level)
Boron (dissolved)	ug/L	370	370	370	ANZECC aquatic ecosystem trigger value (95% species protection level)
Copper (dissolved)	ug/L	4	2	1.4	Site Specific
Molybdenum (dissolved)	ug/L	34	34	34	ANZECC aquatic ecosystem trigger value (95% species protection level)
Nickel (dissolved)	ug/L	11	11	11	ANZECC aquatic ecosystem trigger value (95% species protection level)
Selenium (dissolved)	ug/L	5	10	5	ANZECC aquatic ecosystem trigger value (95% species protection level)
Uranium (dissolved)	ug/L	0.5	1	0.5	ANZECC aquatic ecosystem trigger value (95% species protection level)
Zinc (dissolved)	ug/L	8	8	8	ANZECC aquatic ecosystem trigger value (95% species protection level)
Major ions: Calcium, Chloride, Magnesium, Sodium, Potasium, Carbonate and Bicarbonate	ug/L	For Interpretation Only			