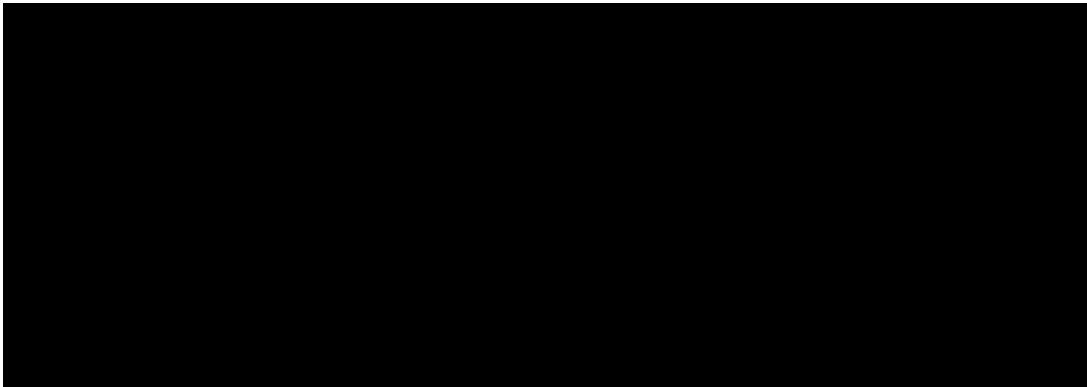




APPLICATION FOR A WORKS APPROVAL UNDER THE *ENVIRONMENTAL PROTECTION ACT 1986* – REQUEST FOR FURTHER INFORMATION

I refer to your application for a works approval under Part V Division 3 of the *Environmental Protection Act 1986* (EP Act), at Roe Gold Mine for category 6 mine dewatering and Category 89 putrescible landfill.

The department is validating your application and has taken into account information provided in your application.

In order to finalise the validation of your application, please provide the information set out in Schedule 1, **by 15 May 2026**. You may request an extension from the department, should you require additional time.

Until further information has been received, the department has suspended the assessment timeframe for your application validation (stop the clock). This timeframe will recommence upon receipt of your information.

Please note that if the required information is not provided, or an extension requested, by the date set out above, the CEO may decline to deal with your application.

You are also advised that the fee calculation you provided with the application form was in error as it relied on the amendment fee calculator rather than the calculation needed for a works approval. The fee required for a works approval is set by Regulation 5BA of the Environmental Protection Regulations 1987, as determined from the cost of works as detailed in Schedule 3 of those regulations. Refer [Industry-regulation-fees.pdf](#).

The recalculated fees, using the cost breakdown you provided with your application, is provided in Schedule 2 of this letter. This is not an invoice; an invoice will be issued when the delegated officer is satisfied that the further information provided as per Schedule 1 of this is received and found to be sufficient to validate the application.

If you have any queries regarding the above information, please contact the Environmental Officer listed above.

Yours sincerely



*Officer delegated under section 20
of the Environmental Protection Act 1986*

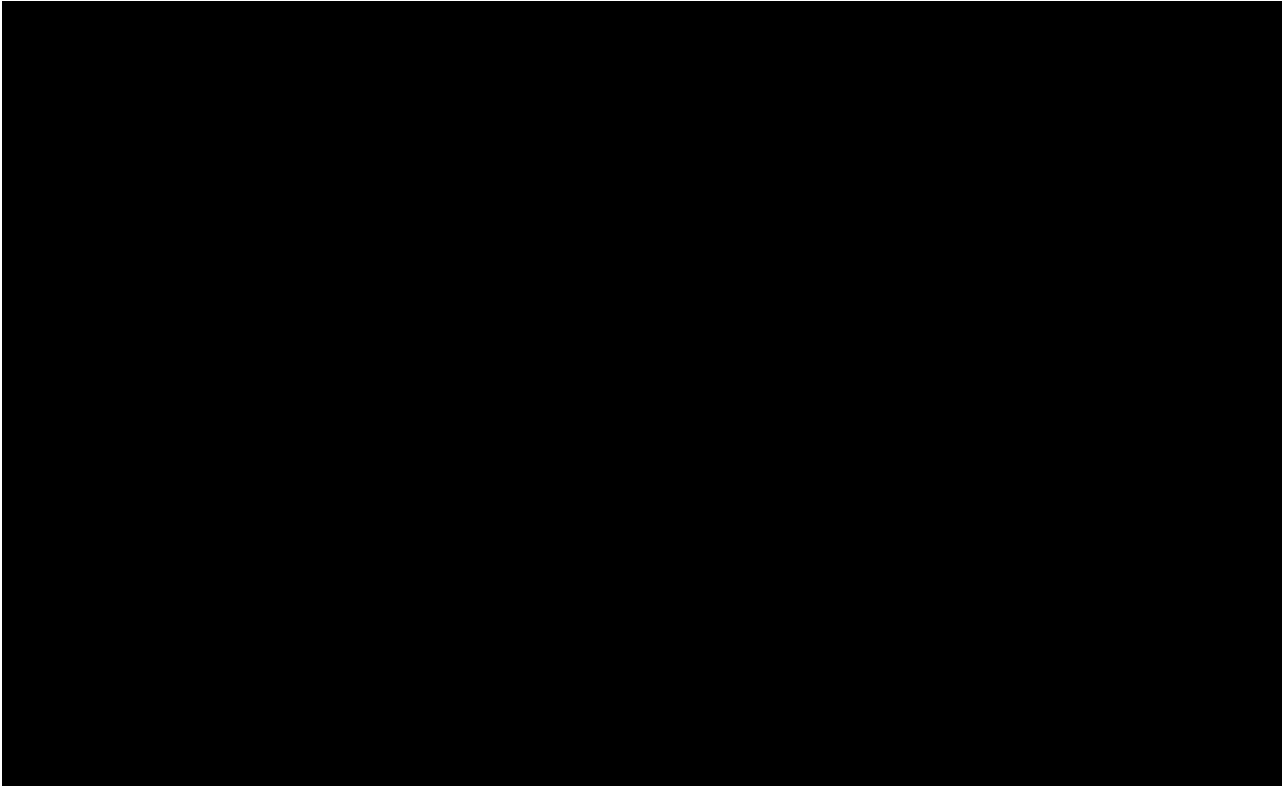
23 April 2026

Schedule 1

Relevant Application form part / section	Information requirements	Rationale
Part 3.4: Attachment 2 – Premises map(s)	Provide clear and current maps showing all key infrastructure, including evaporation ponds, settling ponds, pipelines, bunds and sumps. All features are to be clearly labelled with unique identifiers. Identify unlined ponds. Show mine pits, WRLs, landfill trench location, ancillary infrastructure, sensitive receptors and distances to those receptors. Maps must include a north arrow, scale, premises boundary, emission and discharge points, monitoring locations (with GPS coordinates where available), land uses and areas proposed for clearing.	The maps submitted identify the premises boundary and general activity areas but do not provide sufficient detail to support a full environmental risk assessment. Detailed mapping is required in accordance with IR-F09 to enable assessment of emissions, discharges, receptor proximity and environmental controls.
Part 4.2: Detailed description of proposed activities	Provide detailed designs and supporting diagrams for the evaporation and sedimentation ponds, including embankments, lining systems, seepage and overflow controls. Describe and diagram the transfer of mine dewater between settlement ponds, evaporation ponds and pond cells. Specify expected permeability for each pond or cell. Identify all proposed water quality and quantity monitoring points, including the number and location of monitoring bores and vegetation monitoring sites. Clearly distinguish conceptual design elements from final design parameters.	The application includes a water balance and construction sequence; however, the design of the ponds and cells is not sufficiently detailed to assess environmental risk. Additional detail is required to clarify pond configuration, lining installation and sediment pond design.
	Confirm whether the initial landfill trench will be constructed at ground surface level or whether waste disposal will commence only after construction of the waste rock landform has started.	The management and control measures rely on trenches being located within an active waste rock landform. Confirmation is required to ensure the proposed controls are appropriate for the actual staging.
	Provide the document(s) used to derive the evaporation pond water balance and capacity calculations, including any modelling reports referenced in the supporting document.	The application references external modelling for evaporation pond capacity; however, the supporting document has not been provided and is necessary to verify assumptions and results.
	Provide details of ancillary activities such as power generation, fuel storage and wastewater treatment facilities.	Ancillary activities may require a works approval if they trigger the throughput of the relevant prescribed premises categories. Your current application indicates the following activities may occur, but no details have been provided: electricity generation (category 52), fuel storage (category 73) and sewage treatment (category 54 or 85).

	Provide hydrogeological and hydrological assessments for the premises, including the referenced AQ2 (2025) hydrogeology report and source report for surface water flow mapping. Include supporting data and discussion specific to the proposed infrastructure, including surface water diversion features and discharge locations.	Insufficient information has been provided on background aquifers and site hydrology to assess environmental risks. The existing discussion does not adequately describe surface water management measures relevant to this application, and supporting reports are required.

Schedule 2





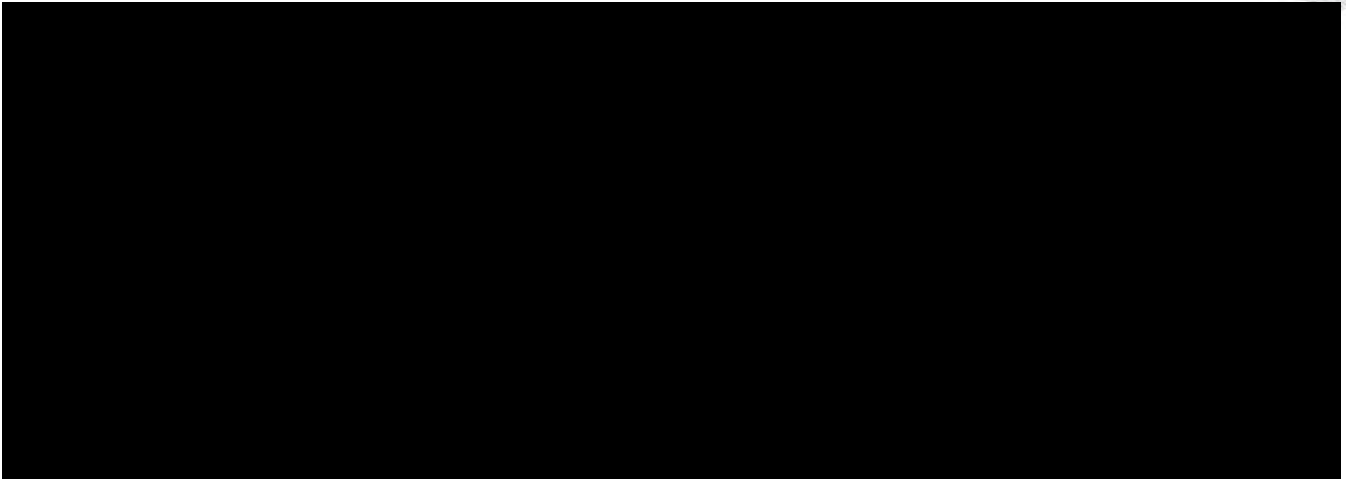
Roe Gold Project Bombora Hydrogeological Dewatering Assessment

Prepared for:

Ramelius Resources

September 2025

AQ2 Pty Ltd
Ground Floor, 1 Howard Street
Perth WA 6000 Australia
Tel +61 8 9322 9733
www.aq2.com.au



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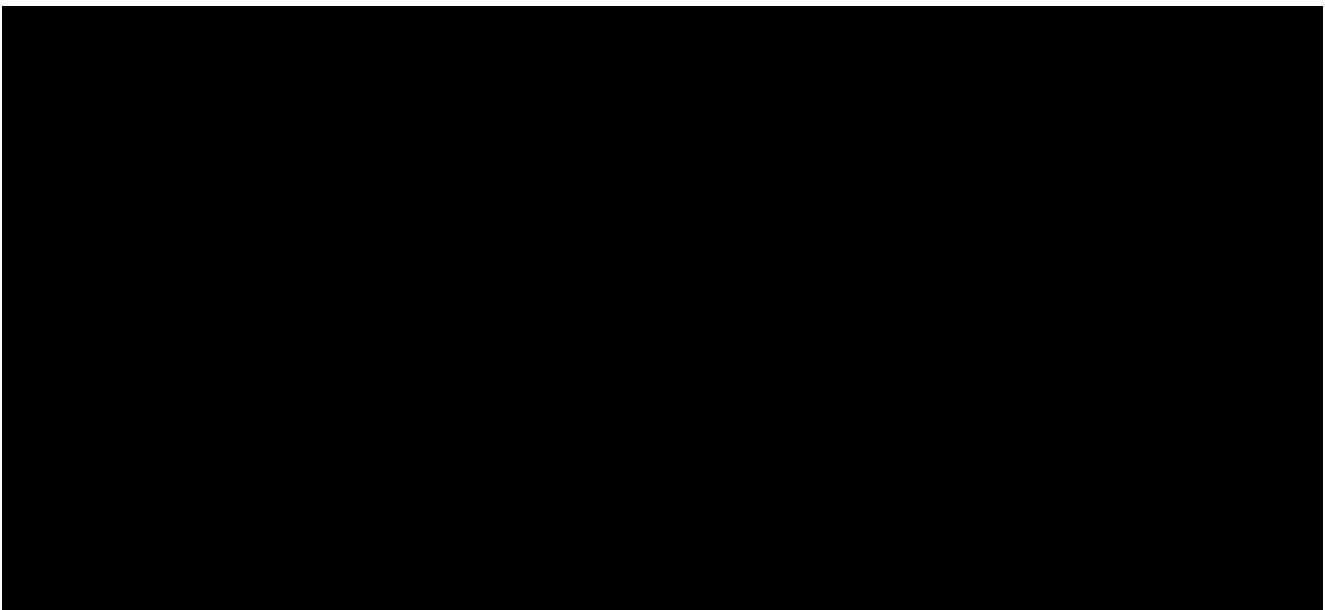


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1. INTRODUCTION

1.1 Project Overview

Ramelius Resources (Ramelius) are currently undertaking a Definitive Feasibility Study (DFS) for the Roe Gold Project (the Project) associated with the Bombora gold deposit (Bombora), located approximately 100 km east of Kalgoorlie and about 45 km southwest of Ramelius' Rebecca Gold Project (Rebecca), in the Eastern Goldfields Region of Western Australia (Figure 1.1).

Ramelius plans to develop Bombora with a mine approximately 2.5 km in length, which will consist of three open-cut pits (numbered 1800, 1100 and 700 pits) together with an underground mine over a total period of 9 years. The Project lies within mining tenement M28/388, which is held by fully owned subsidiaries of Ramelius. Mining of all open pits will be completed prior to the commencement of the underground mining operation. The proposed underground mine will be accessed from three portals located in the 1800 pit and the underground workings will extend some 750 m north of the 1800 pit and also beneath the 1100 and 700 pits. Parts of all 3 pits lie within one of the larger salt lakes of the Lake Roe system, with the southern half of the underground mine beneath it. An overview of the proposed Project layout is presented in Figure 1.2.

To enable optimal resource recovery, the mining at Bombora will occur below the groundwater level and hence, dewatering of the open-cut pits and underground workings is required to provide dry mining conditions. A Prefeasibility Study (PFS) level dewatering investigation was previously conducted on Bombora in 2019 by Groundwater Resource Management (GRM) for its former owner, Breaker Resources (GRM, 2019). This involved the drilling and testing of 17 narrow diameter bores in and around the Bombora deposit. Small scale permeability testing was carried out to determine aquifer properties and a basic groundwater model was constructed to assess likely dewatering requirements. The modelling predicted that the required dewatering pumping rates may be in the 50 to 60 L/s (1.6 to 1.9 GL/a) range, owing to a north to south orientation zone of fracturing, which runs through and close to all 3 proposed pits.

It should be noted that mineral processing is planned to take place at Rebecca, with ore being transported from it to Roe. A 65 km long haul road is planned to be constructed to link the Rebecca and Roe Project sites together. Any dewatering volumes abstracted from the Bombora mine is planned to be used on-site for dust suppression and construction purposes, with any excess water being discharged into planned evaporation ponds located at Bombora. There will be no discharge of surplus dewatering water into the environment (i.e. Lake Roe). The water demand for the Processing Plant at Rebecca (~3 GL/year, or 95 L/s) is planned to be mainly supplied from the regional Rebecca Palaeochannel system and its palaeo-tributary channels (the Rebecca Palaeochannel Borefield), supplemented with any surplus dewatering from the Rebecca Project pits.

AQ2 has been engaged by Ramelius to undertake a DFS level hydrogeological dewatering study at Bombora to further investigate a zone of enhanced permeability, to confirm local aquifer parameters and to more accurately determine dewatering pumping rates likely to be required during mining of the Bombora pits and underground.

Ramelius is currently preparing regulatory approval applications for the development of the Bombora deposit and this report has been prepared in line with required submissions to the Department of Mines, Petroleum and Exploration (DMPE) and the Department of Water and Environmental Regulation (DWER). In order to assess potential impacts that the proposed abstraction of groundwater from the weathered/fractured aquifer at the Bombora Mine (due to dewatering) may have on other existing groundwater users and the environment, an H2 hydrogeological assessment report is required to be prepared, and the results are presented herein. This H2 hydrogeological report will support Ramelius' 5C groundwater licence (GWL) application to DEWR.

This report presents the results of site groundwater investigations completed to date at the Bombora mine and an H2 level of hydrogeological assessment. This report has been prepared in line with *Operational Policy No 5.12 – Hydrogeological reporting associated with a groundwater well licence* (DWER, 2009).



Figure 1.1 Roe Project Location

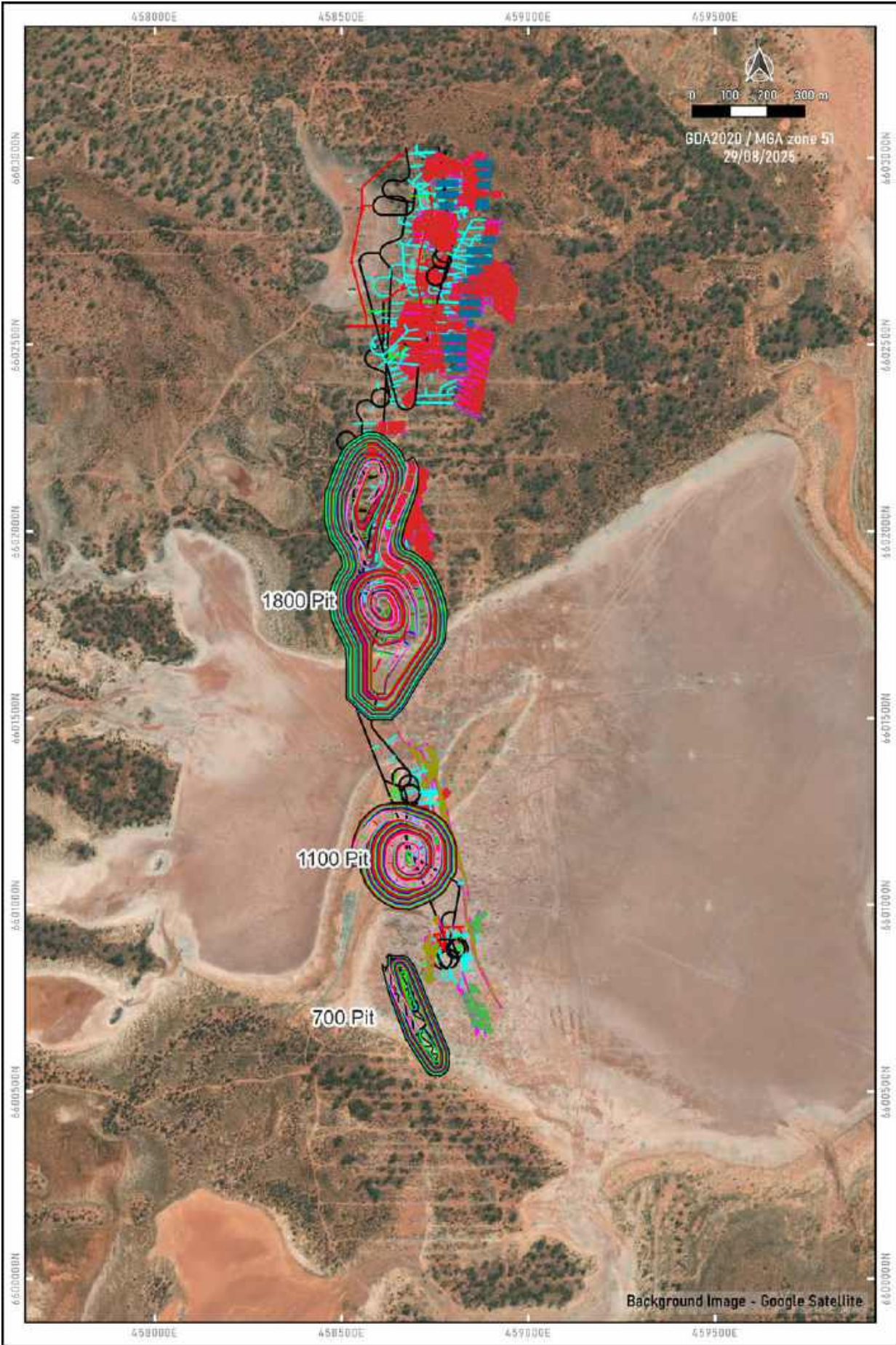


Figure 1.2 Roe Project Deposits Location

2. PHYSICAL SETTING

2.1 Climate and Rainfall

The Project area is located within the northeastern Goldfields region of Western Australia and has a semi-arid climate with dry, hot summers and cool to mild winters. January is the hottest month with mean daily minimum and maximum temperatures of 16.8°C and 33.7°C respectively. In winter, July is the coldest month with an average minimum temperature of 5.1°C and an average maximum temperature of 18.3°C.

There are a number of regional weather stations which collect rainfall data. The location and data availability from each of these weather stations is summarised in Table 2.1.

Table 2.1 Regional Weather Stations

Weather Station	Lake Roe Distance (km)	Direction from Lake Roe	Data Collection Period
Karonie	30	South	1915-1986
Cowarna Downs	40	South-southwest	1968-2020
Kalgoorlie Airport	100	West	1939-2025
Gindalbie	95	Northwest	1918-2025

The nearest Bureau of Meteorology (BoM) rainfall station to the Project is at Cowarna Downs (BoM Station Number 12220), located approximately 40 km away. A summary of the Cowarna Downs station SILO dataset is as follows:

- Long-term average annual rainfall of 260.7 mm.
- Annual average Class A pan evaporation rate of 2,420 mm and an annual average Morton's shallow lake evaporation rate of 1,560 mm (from SILO interpolation at Cowarna Downs).
- Long-term average maximum temperature of 26 °C.

Monthly average rainfall, Class A pan evaporation, Morton's shallow lake evaporation, maximum and minimum temperature (1970–2024) are shown in Figure 2.1.

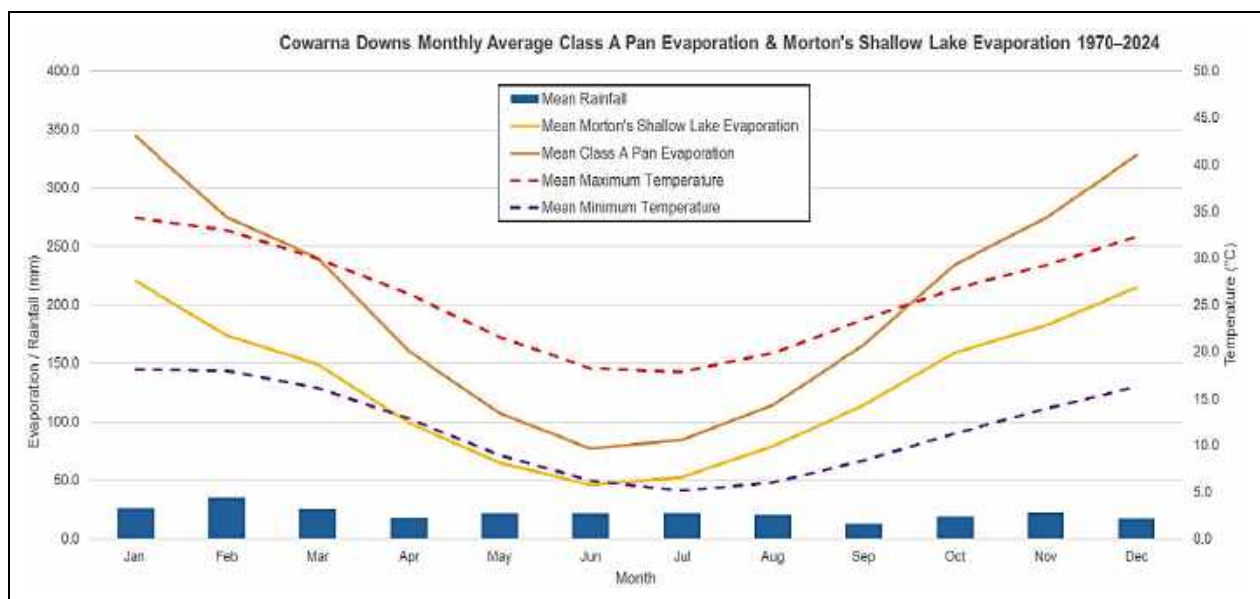


Figure 2.1 Cowarna Downs Monthly Average Climate Characteristics (1970–2024)

The rainfall has also been monitored at an on-site weather station at Bombora since 2018 (Figure 2.2). The average rainfall for the more recent period 2018 to 2023 was 233 mm, but varied between 146 and 482 mm per annum. Rainfall is relatively evenly spread throughout the year, with evaporation greatly exceeding rainfall during every month of the year and being the highest in January (Figure 2.1). The long-term average annual evaporation rate is about 9 to 10 times higher than the long and short-term annual rainfall averages.

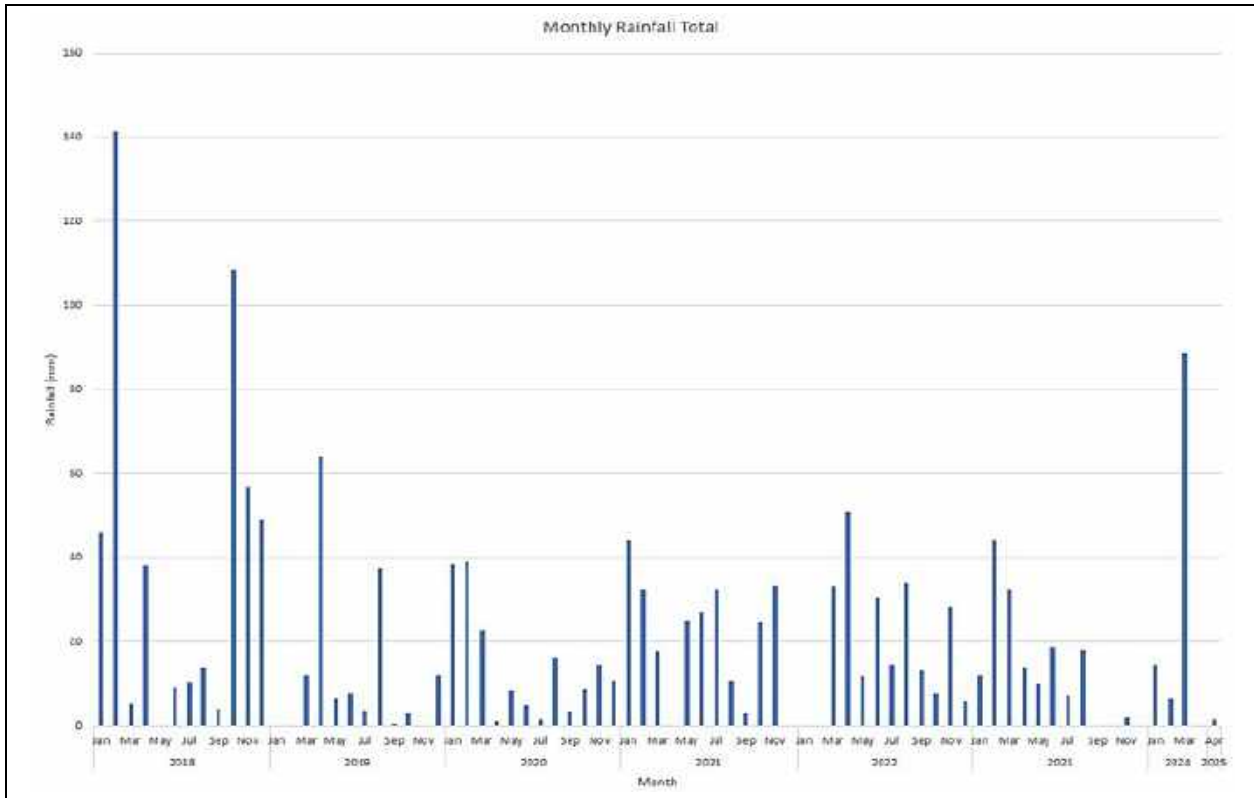


Figure 2.2 Bombora On-Site Rainfall Station Data

2.2 Landforms and Drainage

The Project site is located within the catchment area of Lake Roe. The area colloquially referred to as Lake Roe is a complex of interconnected smaller lake sub-areas which span approximately 90 km in length (west to east), situated within a broader paleo-drainage system that historically flowed from northwest to southeast. As the elevation gradient of the paleo-drainage system has reduced with time and the climate dried, the system has become a number of salt lakes which become terminal drainage points under most runoff events.

The region lies within an arid zone characterised by large dryland creek systems and highly variable hydrological conditions, which range from prolonged droughts to episodic flood events. These extremes influence the region's physical, chemical, and biological characteristics. There are no natural permanent watercourses or wetlands within the project area. All drainage lines in the project area are small and intermittent, flowing only after major rainfall events. Drainage is internal, terminating in salt lakes and clay pans and surface drainage is only significant immediately following rainfall events. Local flooding may occur, especially following cyclonic thunderstorms.

Most of the Project area is gently undulating and of subdued relief, with elevations between 310 to 350 mAHD (metres above Australian Height Datum).

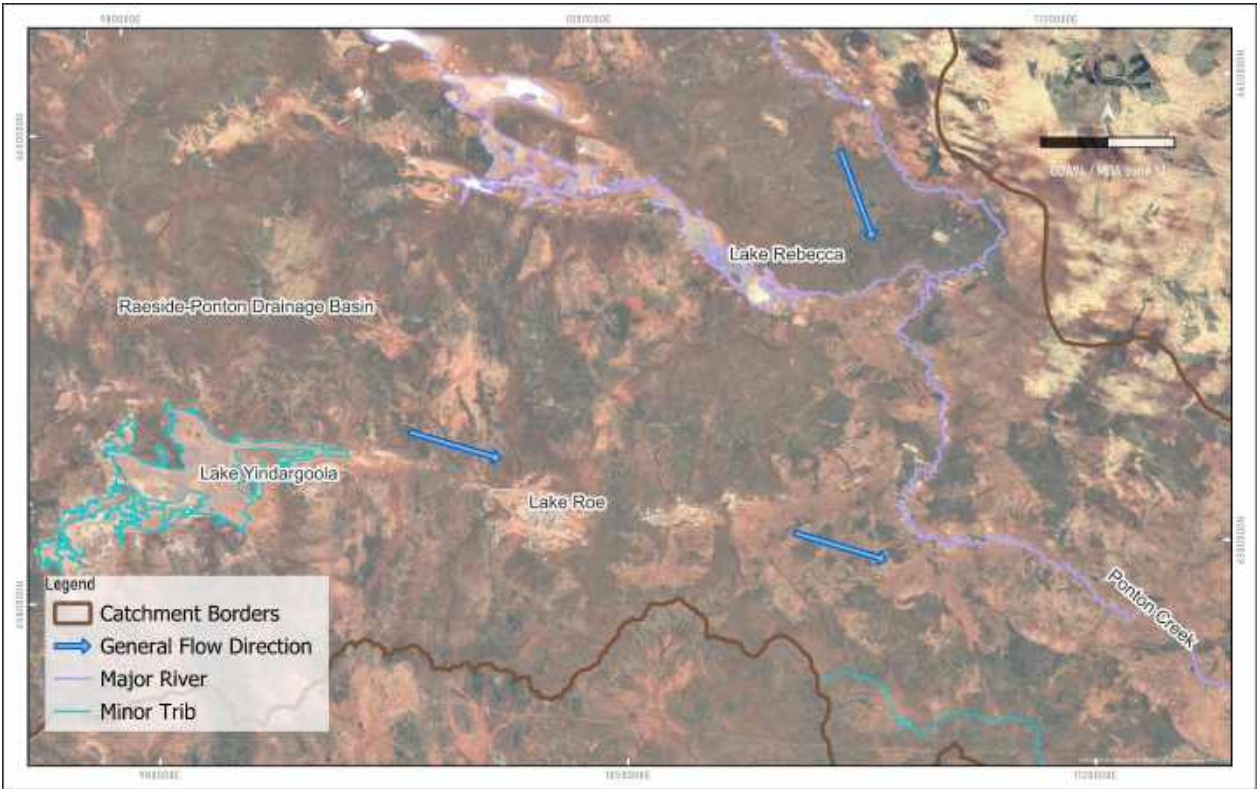


Figure 2.3 Regional Hydrology

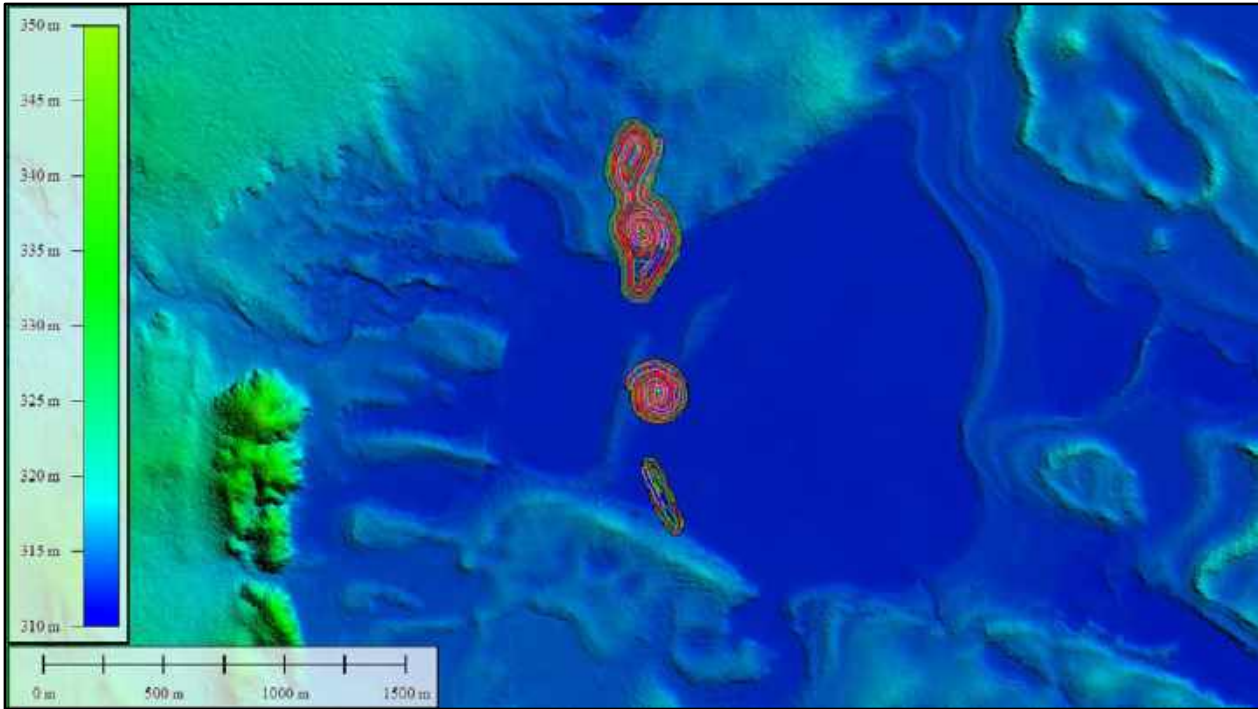


Figure 2.4 Regional Topography

3. HYDROGEOLOGY

3.1 Geology

3.1.1 Regional Geology

The Roe project area is underlain by greenstone and granitoid rocks belonging to the Kurnalpi Terrane of the Archean Yilgarn Craton (GSWA terminology of Smithies, 1994). Two craton-scale structural corridors transect the project area; the Roe Shear Zone and the Claypan Shear Zone (Figure 3.1).

The greenstone geology of the Roe project area can be divided into the Yindi (Western) domain and the Edjudina (Eastern) domain. The Yindi Domain is centred around the ~60-70° E-dipping Roe Shear Zone corridor. Lithology is dominated by mafic amphibolite, fine-to coarse-grained felsic-intermediate schists, and turbiditic siltstone-shale. The Edjudina domain is distinguished from the Yindi domain by major lithological, metamorphic and structural changes that occur across the interpreted western branch of the Claypan Shear Zone. A major lithological distinction is the presence of large volumes of high-Fe tholeiitic mafic rocks, mostly in the form of fractionated dolerite sills. The Bombora Sill is the largest of these bodies and hosts most of the gold mineralisation at Bombora. The main body of the Bombora Sill is 150-300 m in true thickness at the centre of the project area, but magmatic and/or structural duplication creates a sill complex up to ~500 m true thickness towards the southern end of the Project area.

The Bombora deposit is located on the eastern limb of the Bombora Antiform, a moderately southeasterly plunging, partly preserved isoclinal fold, which occupies a low-strain domain between the Claypan Shear Zone west and east branches. The plan geometry of the fold is illustrated by the folded trace of a BIF marker horizon, and the rotation of the Bombora Sill into the southern hinge, where it is truncated by the Claypan Shear Zone west branch. The westward younging of the eastern limb (that is, towards the hinge) makes the fold an antiformal syncline.

A cover of Cenozoic sediments is widespread in the Eastern Goldfields region. The thickest sections of cover occur in the form of a network of narrow palaeovalleys (palaeochannels) that were incised into the weathered bedrock surface of the Yilgarn Craton during the Early Eocene, and then filled with continental to shallow marine sediments as a result of changes in climate and sea level rise during the Middle Eocene to Miocene (de Broekert, 2002).

Overlying the palaeochannels and basement rock are a variety of Cainozoic superficial deposits (alluvials/colluvials, laterites, eolian and lake deposits). The colluvial and alluvial deposits occur in outwash fans and stream channels respectively and can reach thicknesses of up to 10 m.

3.1.2 Local Geology

The dominant host lithology at Bombora is the Bombora Sill, a fractionated quartz dolerite. In the deposit area, the sill is consistently ~ 300 m in thickness, dips ~ 45 to 60° east (flatter dips towards the southern fold hinge) and is overturned (younging westward/down). The sill was emplaced into a 5 to 15 m wide fine-grained interflow sedimentary unit (sulphidic shale, siltstone) deposited between a volcanic sequence (hanging wall; stratigraphically below the sill) and a low-iron basalt-dolerite sequence (footwall; stratigraphically above the sill). Three major faults, the Argus Thrust, the Inlet Fault, and the Peninsula Fault, significantly modify the architecture of the Bombora Sill at the deposit scale.

Gold mineralisation at Bombora is largely strata bound, occurring preferentially in an iron-rich granophyric quartz dolerite zone of the Bombora Sill (western zone) over a 3 km strike length. Mineralisation is hosted in three main lode orientations: north northwest striking, subvertical steep lodes; gently north to northeast dipping flat lodes and moderately west dipping west lodes. Lamprophyre dykes run the full length of Bombora, mainly in a 30 to 40 m wide moderately west dipping swarm, subparallel

to mineralised west lodes. Individual dykes are typically 1 to 10 m in thickness. The lamprophyres are interpreted to post-date most or all gold mineralisation.

The Bombora deposit is completely concealed under a thin (5 to 15 m) layer of transported cover developed within and peripheral to the Lake Roe Salt Lake system. The transported cover is dominated by lacustrine clays, overlain by aeolian sands and transported ferricrete adjacent to the lake footprint. The in-situ regolith profile is strongly stripped, with the upper saprolite rarely preserved in the deposit area. The bedrock is generally fresh from depths of about 20–60 m (average of 30 mbgl), with the bedrock varying from being deeply weathered (saprolite) to partially weathered (saprock). Depth of weathering across the deposit does not appear to be affected by rock type. The outcrop and bedrock geology in the Bombora deposit area are shown in Figures 3.2 and 3.3.

3.2 Hydrogeological Setting

3.2.1 Regional Hydrogeology

The regional hydrogeology has been well documented in numerous previous reports (Kern, 1995; Johnson, et. al., 1999 and RPS, 2013). The occurrence of groundwater across the Goldfields region (the Project area) is mainly associated with the following main aquifer systems:

- Weathered/ fractured bedrock – low yielding, saline to hypersaline aquifer associated with partially weathered bedrock (i.e. saprock zone) at the base of weathering profiles (especially over coarse-grained felsic rocks), vuggy secondary minerals such as a calcrete and silcrete developed within weathered bedrock, and fresh fractured bedrock related to local and regional structures (i.e. fractures, faults, shear zones). This aquifer varies in extent and hydraulic properties, depending upon structural integrity, degree of weathering, bedrock depth and lithology. The weathered bedrock is generally in hydraulic connection with the underlying fractured bedrock.
- Tertiary-age sediments – high yielding, hypersaline aquifer associated with alluvial sands and gravels deposited within the base of the paleovalleys (palaeochannel aquifers). This aquifer can provide stable, long-term sustainable yields, due to 'high' permeability, large groundwater storage and significant leakage from the overlying clays and surrounding basement rocks.
- Quaternary-age sediments deposited along modern drainage lines – low yielding, shallow and intermittent brackish to saline aquifer associated with the alluvial and lacustrine deposits, which are sporadically saturated after heavy rainfall events, with the water table close to the surface in playa lake environments.

The regional water table ranges from less than 1 mbgl in playa-lake environments to more than 40 mbgl in elevated areas. The regional water table may be absent in high areas where the weathered and fractured zone is unsaturated or where fractures are poorly developed. Regional groundwater flow is generally to the east towards the major palaeodrainage systems, the ephemeral lakes and salt pans. Directions of groundwater flow and variation in salinity are closely related to topography. Recharge to the aquifers is via rainfall infiltration and is thought to be minimal due to high evaporation rates and low vertical infiltration rates. Groundwater discharge occurs mainly by evaporation from salt lakes, with a small amount by throughflow within the palaeochannel aquifers.

Most groundwater in the region is of saline or hypersaline quality. Lower salinity concentrations typically occur in low elevated areas of enhanced recharge and are typically located within unweathered fractured bedrocks (Kern, 1995) or in the uppermost reaches of palaeochannel systems. The higher salinity concentrations are typically found in the groundwater of palaeochannels and in bedrock aquifers which are adjacent and below alluvial flats and playa lakes, where salinity values of up to 300,000 mg/L total dissolved solids (TDS) have been recorded.

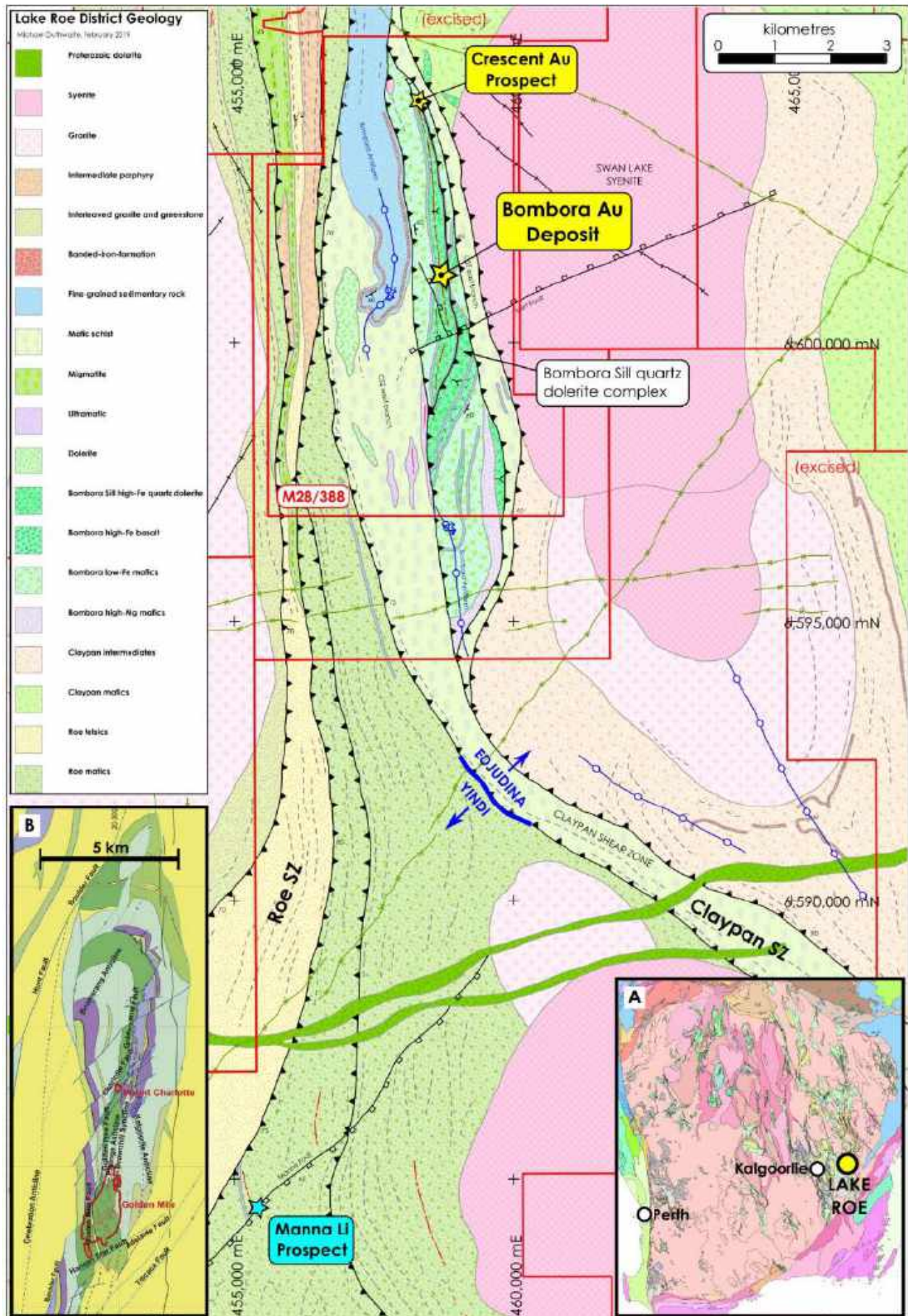


Figure 3.1 Roe Project, Regional Simplified Bedrock Geology



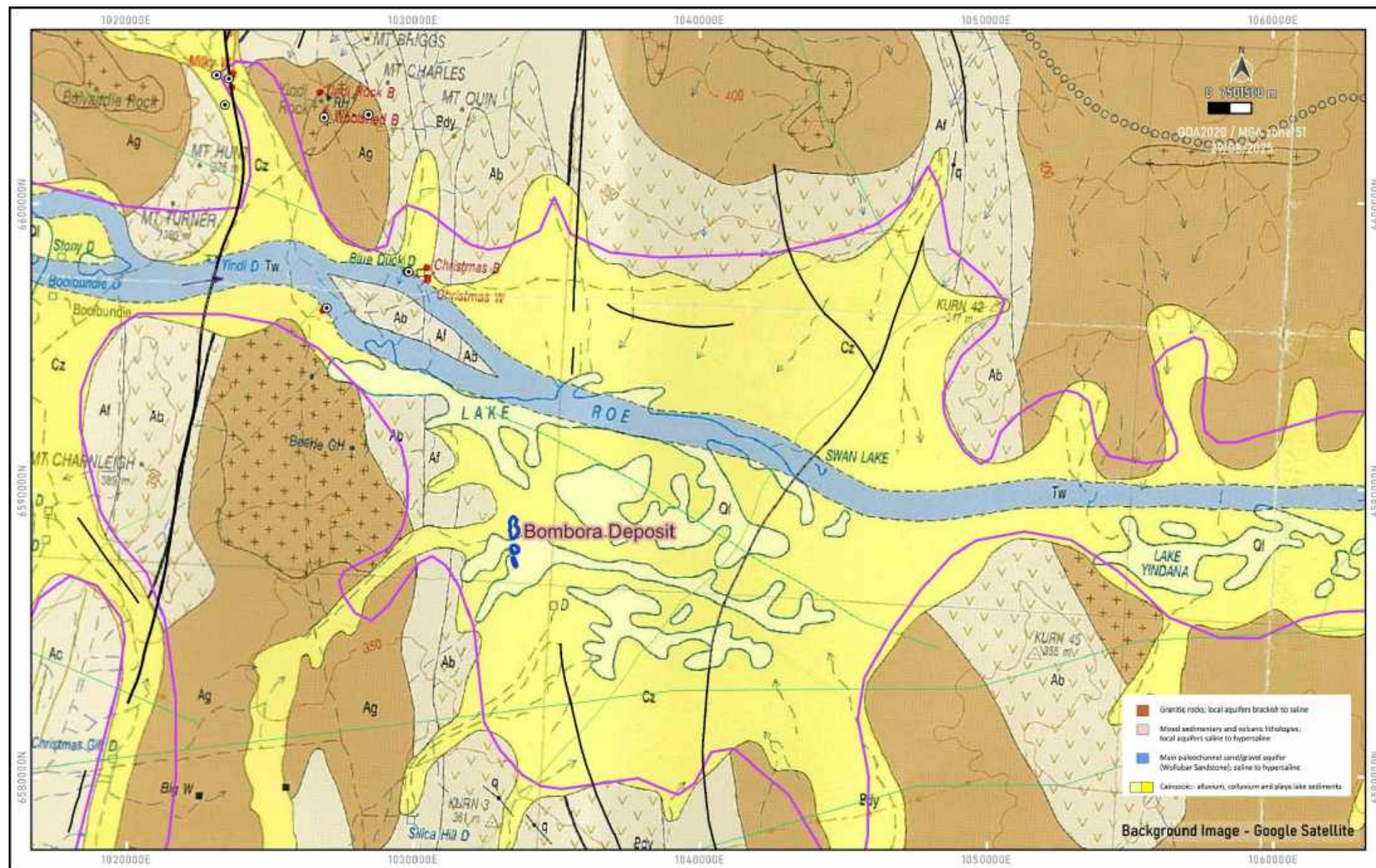


Figure 3.3 Roe Project, Local Outcrop Geology

3.2.2 Local Hydrogeology

The hydrogeology of the Bombora deposit area has previously been documented by GRM (2019a). The current understanding of the site's hydrogeological conditions has been based on the review of all available literature in the region, mineral exploration drilling data for the site, together with the assessment of hydrogeological data collected during the recent fieldwork undertaken by AQ2 (where exploration and production bores were drilled and tested).

The local and regional bedrocks have little to no primary aquifer properties and aquifer potential is associated with fracture and weathering induced secondary permeability and porosity.

It should be noted that there is no evidence of the Roe basal palaeochannel aquifer (i.e. high yielding, hypersaline aquifer associated with alluvial sands and gravels deposited within the base of the palaeovalleys) within the footprint of the mining area.

A more comprehensive description of the local hydrogeology and the conceptual hydrogeological model for the Project area are presented in Sections 5 and 6.

4. EXISTING GROUNDWATER USE

4.1 Groundwater Dependent Ecosystems

4.1.1 Wetlands and Vegetation

Groundwater Dependent Ecosystems (GDE) includes biological assemblages of species such as wetlands or vegetation that use groundwater either opportunistically or as their primary water source.

The Bureau of Meteorology (BOM) has developed the Groundwater Dependent Ecosystems Atlas (GDE Atlas) as a national dataset of Australian GDEs to inform groundwater planning and management (BoM, 2023). The GDE Atlas contains information about three key types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater; this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs.
- Terrestrial ecosystems that rely on the subsurface presence of groundwater; this includes all vegetation ecosystems.
- Subterranean ecosystems; this includes cave and aquifer ecosystems.

The Bureau of Meteorology (BOM) GDE Atlas shows no aquatic GDEs (i.e. no wetlands of environmental significance) present in the vicinity (10 km radius) of the Project area. The area is mapped with terrestrial GDEs of low, medium and high potential, which are as follows:

- Low potential terrestrial GDE described as extensive sandplain, with scattered granite outcrop supporting mainly spinifex hummock grasslands and mulga and mallee shrublands.
- Medium potential terrestrial GDE described as fresh or brackish ephemeral lakes and swamps with cane grass, lignum and paperbark shrublands.
- High potential terrestrial GDE described as salt lakes with extensively fringing saline plains, dunes and sandy banks, supporting low halophytic shrublands and scattered tall acacia shrublands.

Notwithstanding, the high, moderate and low potential GDE areas are also mapped as being respectively highly likely, moderately likely and likely to be inflow dependent ecosystems (IDE), reliant on water sources in addition to rainfall, such as water stored in the unsaturated zone, surface water or groundwater (BOM, 2024).

Database searches and a literature review done by Stantec (2018) indicated that the Project area does not lie within any areas of environmental significance. However, there are several reserves within 30 km of the Project area including the Wallaby Rocks Timber Reserve, Cardunia Rocks Nature Reserve and Coonana Timber Reserve. These timber and nature reserves have been set aside by the Department of Biodiversity, Conservation and Attractions (DBCA) for the management of biodiversity values, and specifically for the conservation of flora and fauna in relation to the Cardunia Rocks Nature Reserve (Cowan 2001).

A reconnaissance and targeted flora and basic fauna survey of the Project area was undertaken by Botanica Consulting Pty Ltd (Botanica) in 2025. The results of this assessment concluded the following:

- There are no wetlands of international importance (Ramsar Wetlands) or national importance (Australian Nature Conservation Agency Wetlands) within the survey area.
- No Environmentally Sensitive Areas were identified within the survey area.
- No critical habitat listed under the WA (Biodiversity Conservation Act 2016) BC Act was recorded within the survey area.
- No threatened ecological community (TEC) was located in the survey area.

- Four priority ecological communities (PECs, as listed by DBCA) were identified within the survey area, that are protected by the WA BC Act and are the Ponton Land System PEC, the Emu Land System PEC, Cundlegum Land System and Mount Belches of *Acacia quadrimarginea*/*Ptilotus obovatus* banded ironstone community; (Figure 4.1). All PECs are Priority 3 listed communities with several occurrences known in the Goldfields region.

The vegetation present in the vicinity (10 km radius) of the Project area is likely to source water from soil moisture in the unsaturated zone above the water table and is likely to rely on sporadic rainfall and overland water flow events, with no association with groundwater (i.e. phreatophytic vegetation). It should be noted that the rooting zone of the vegetation found overlying the palaeochannels in the Kalgoorlie region is relatively shallow, only extending down to 1.5 m depth. In addition, the groundwater is hypersaline (more than 140,000 mg/L Total TDS and does not support any groundwater dependent ecosystems).

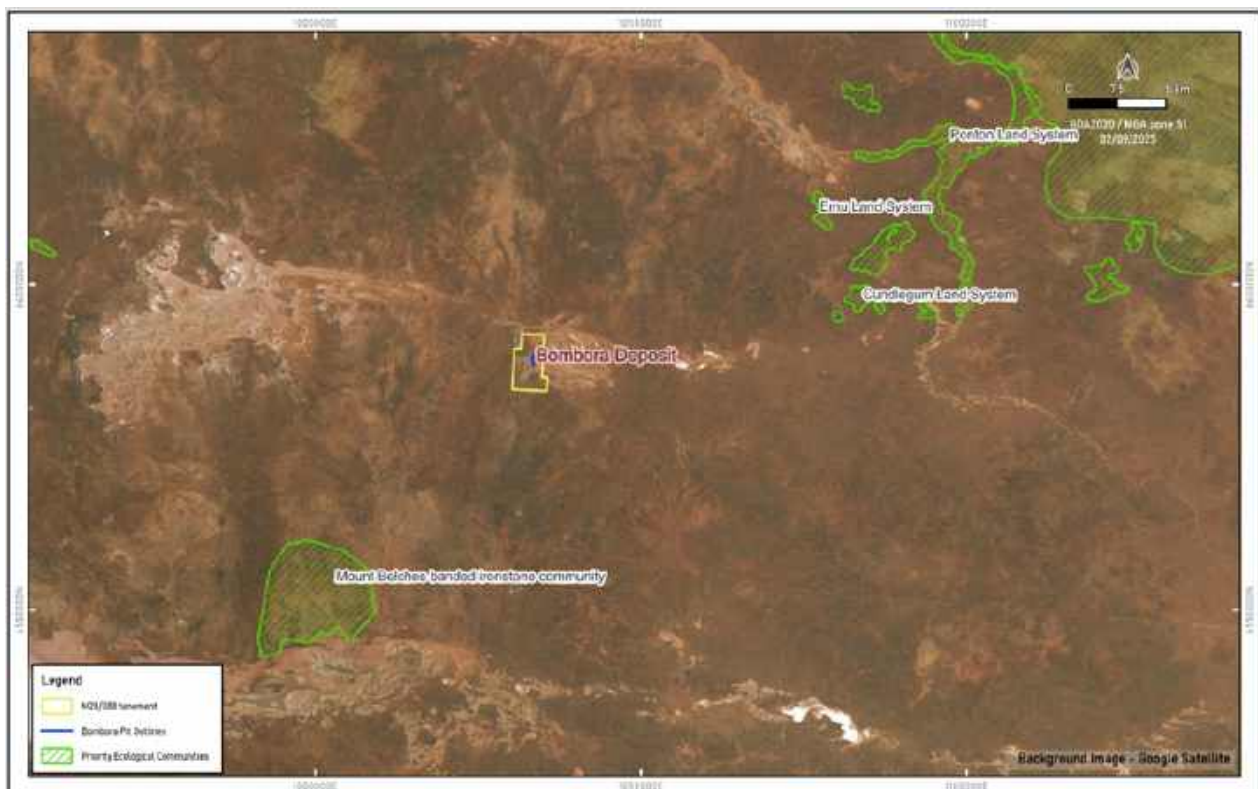


Figure 4.1 Nearest priority ecological communities (PECs, as listed by DBCA)

4.1.2 Stygofauna

The issue of stygofauna and troglifauna has become increasingly prevalent for mining operations throughout WA. Stygofauna are known to exist in the Eastern Goldfields, are mostly prolific in “fresh” calcrete aquifers, but have been found in other types of aquifers with salinity levels in excess of 60,000 mg/L TDS. It is also known (EPA, 2013) that stygofauna are unlikely to occur in deep sands and clays (especially over solid rock) and do not exist in groundwater environments where salinity exceeds marine concentrations (sea water).

The Level 1 subterranean fauna assessment undertaken by Stantec (2019), incorporating a desktop review and pilot survey, has demonstrated that the Project area does not provide prospective habitat for subterranean fauna and does not support stygofauna or troglifauna values. The survey findings confirmed that the clay dominated regolith does not provide the extensive interconnected vugs, voids and open fractures required for subterranean fauna colonisation.

The acidic and hypersaline groundwater conditions within and surrounding the study area, in conjunction with the clay-dominated strata that restricts the influx of resources (e.g., nutrients and oxygen), present unfavourable habitat for stygofauna. For troglifauna, the limited unsaturated strata, due to the shallow water table, lacks the interconnected vugs and voids required for troglifauna habitation.

The findings indicate that stygofauna and troglifauna do not represent an environmental factor for future regulatory approvals of the Project in accordance with EPA (2016), and there is no risk of impacts to subterranean fauna values (i.e. does not pose a threat to maintaining subterranean fauna representation, diversity, viability and ecological function at the species, population or assemblage level). Therefore, no further stygofauna or troglifauna assessment is considered necessary to provide further information on the subterranean fauna values of the study area.

4.2 Surface Water

The Lake Roe ponding behaviour in the vicinity of the Project was assessed by AQ2 (2024) and it was interpreted that groundwater does not contribute to inflow into the Lake Roe, and surface water recession/periodic standing water within the claypan(s) is solely accounted for by evaporative losses and seepage. In other words, ponding in the lake is attributed to infrequent surface water runoff or flooding events rather than surface expression of groundwater. It is noted that it might be possible for groundwater levels to rise close to the surface in low lying areas during and following extreme rainfall events (e.g. cyclones), due to higher than normal recharge. However, at such times, flow within the local lakes and creeks would be dominated by surface water runoff, with a minimal contribution from the groundwater (due to the low flow gradients and the low permeability of the lake beds). Following significant inundation events, the lake may hold water for months. Seepage rate analyses indicated that in the order of 3 mm/day of seepage may occur from the lake bed when it is inundated.

4.3 Other Groundwater Users

Existing groundwater use has been assessed via the DWER Water Register Database of licensed registered users. According to this database there are currently no other groundwater users within a 10 km radius of the Project area. However, there are licensed groundwater users that abstract water from the fractured rock aquifer system further out from the Project area. Licensed drawpoints of the existing groundwater users and their annual allocations are shown in Figure 4.2. The nearest fractured rock aquifer user is located approximately 14 km to the south (Global Lithium Resources Ltd; GWL209352, allocation of 90,000 kL/year).

In addition to the DWER Water Register Database, the DWER Water Information Reporting (WIR) database provides information regarding water bores drilled (including licensed and unlicensed bores). This shows that the closest registered bores to Bombora are the Christmas and F8 bores located around 10 km to the northwest of Bombora (Figure 4.2). Christmas bore is privately owned and may be in use as a stock watering bore by the local pastoralist. However, it will need to be confirmed if this bore is still operational. The F8 bore has no known owner and is likely a historic bore abandoned due to its high salinity (72,000 mg/L TDS).

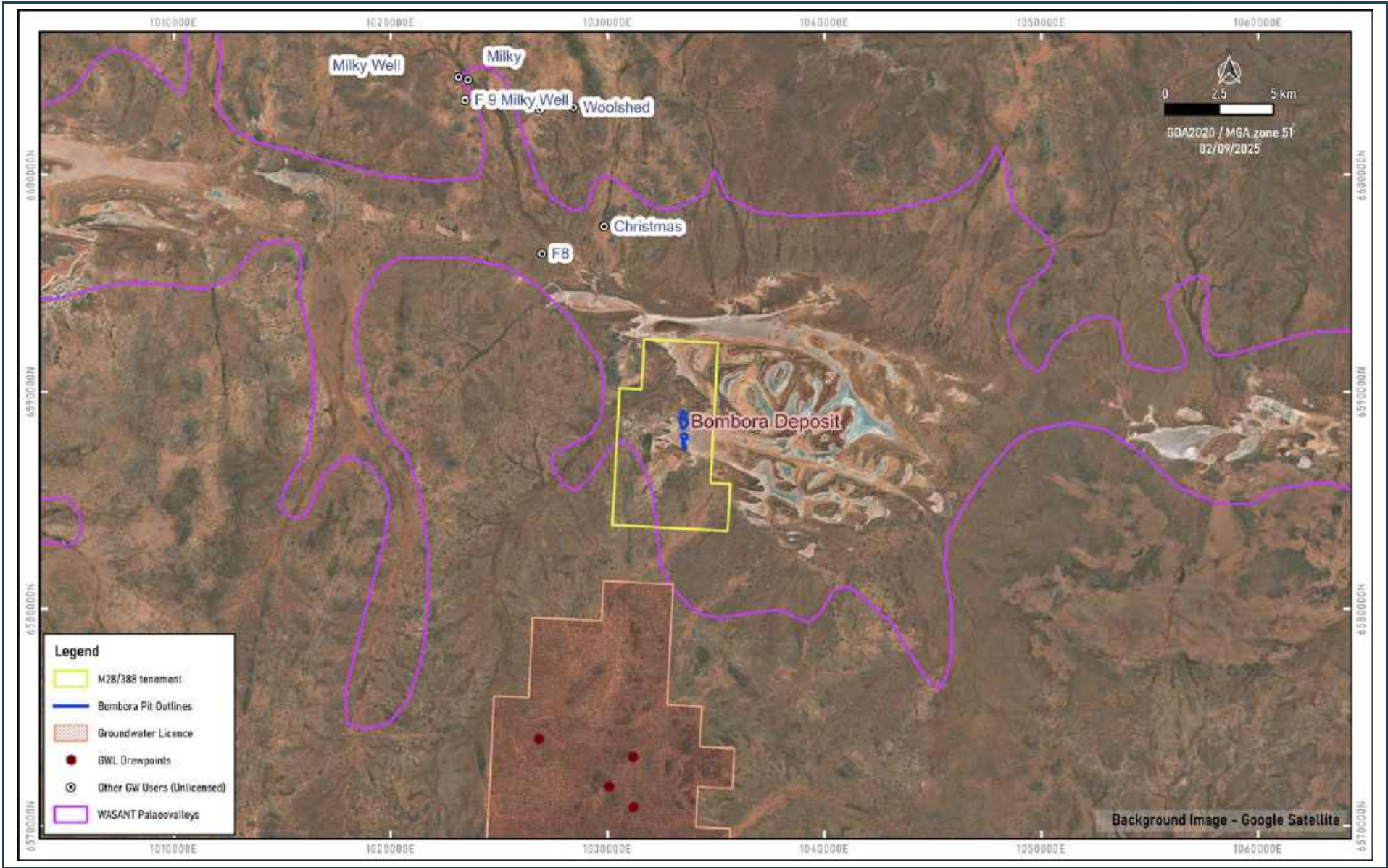


Figure 4.2 Nearest Other Groundwater Users

5. GROUNDWATER INVESTIGATION PROGRAMMES

5.1 Previous Hydrogeological Field Investigation

A prefeasibility study (PFS) level dewatering investigation was previously conducted on Bombora in 2019 by GRM for its former owner, Breaker Resources (GRM, 2019). The field programme comprised the drilling and testing of 17 investigation bores in and around the Bombora deposit, collection of hydrogeological information and assessment of aquifer properties with small scale permeability testing.

Breaker engaged Kalgoorlie based reverse circulation (RC) drilling contractors Raglan Drilling (Raglan), to undertake the hydrogeological investigation drilling. Raglan initially drilled 7 land based targets with an RC rig between 23 January and 2 February 2019. The remaining 10 investigation bores were drilled on the Lake Roe surface between 18 February to 4 March 2019. The lake bores were drilled using the same RC rig, after it had been reconfigured with a tracked drive to allow operation on the soft lake bed. The bores (BWE01 -BWE18) were drilled at 144 mm (5½") diameter with RC air-hammer techniques. Where possible, the completed bores were cased with slotted and blank 50 mm diameter Class 12 PVC casing to allow for small scale permeability testing and construction as long-term groundwater monitoring bores. None of the bores were finished with formal headworks at the time. This was later done during the 2025 drilling programme detailed in this report.

Eleven of the seventeen groundwater exploration bores (BWE01 -BWE11) were drilled to depths of between 130 and 200 m, targeting various structures and higher permeability fracture zones, and the remaining seven bores (BWE12-14, and BWE16-18) were drilled to depths of between 50 and 60 m to confirm if elevated permeabilities were associated with a north striking weathered lamprophyre dyke system on the eastern side of Bombora. Bore BWE15 was not drilled, as it was located adjacent to the deeper BWE03 bore, which had a low yield in the upper part of the hole, removing the need for BWE15 to be drilled. Bore BWE06 collapsed during drilling and PVC casing was not installed in it, other than shallow surface casing. Bore BWE17 partially collapsed and 50 mm PVC casing could only be installed in it to 24 mbgl.

The locations of the GRM monitoring bores at Bombora are shown in Figure 5.1 and the bore details are given in Table 5.1. Bore logs are presented in Appendix A.

Airlift yields and field water quality data were collected during drilling and were measured at the end of each 6 m drill rod by either timed filling of a 10-litre bucket or measuring the water level height over a v notch weir. The airlifting method involved activating the rig's blowdown air valve, which forced all air down the rod string and back up the annulus of the hole. The water flow returns were measured from the discharge pipe leading from the rig's 'T piece'. Maximum airlift yields of between 0.4 to 10 L/s were recorded during RC drilling, with high yields recorded in bores which intersected the transition zone between weathered and highly fractured fresh bedrock (approximately 30-55 m depth). Lower airlift yields were recorded in bores that were targeting a lamprophyre dyke or cross faults.

Small scale permeability testing was undertaken on the completed bores, either by airlift-recovery testing or, in the case of lower yielding bores, falling-head slug testing. Airlift recovery test results indicate aquifer transmissivities ranged between 1.9 and 210 m²/d, with the higher transmissivities from bores BWE02, BWE07 and BWE16, interpreted to lie within a main, north-south trending fractured aquifer zone, that also includes bores BWE01 and BWE10. Falling head test analyses, from the lower airlift rate bores BWE09, BWE12 and BWE18 gave hydraulic conductivities ranging between 3 x 10⁻³ and 1.3 x 10⁻¹ m/d. The results from the investigation were used to develop a conceptual hydrogeological model for the Project area, which was then used to construct a basic calibrated numerical flow model to estimate dewatering rates and drawdown impacts from the mining at Bombora.

Key findings and conclusions drawn by this investigation are as follows (GRM, 2019):

- A highly permeable fracture zone aquifer is present at Bombora, aligning approximately with the main gold mineralising zone, and extending to the north and south beyond the proposed mining areas (refer to Figure 5.1).
- The fracture zone aquifer is interpreted to have a higher permeability central zone, transitioning laterally to low permeability aquifer conditions in the surrounding bedrock. Permeabilities outside the main fracture zone aquifer are generally low, although cross faulting may potentially cause dilation of the main fracture zone in places.
- A significant number of dolerite dykes have been mapped in the project area and may potentially form barriers to downgradient flow. However, dykes can often have fractured chilled margins, allowing groundwater to migrate along them on the upgradient side.
- The groundwater quality at Bombora is hypersaline, slightly acidic and of sodium chloride type. The salinity ranges between 240,000 and 270,000 mg/L TDS, with pH ranging between 6.33 and 7.30. The sulphate concentration was elevated, ranging between 10,700 and 14,200 mg/L, due to playa lake evaporation and resulting gypsum precipitation. Manganese and iron concentrations are elevated, probably as a result of the acidic groundwater.
- The combined dewatering rates required to maintain dry conditions across all stages of mining developments may be up to around 50 to 60 L/s.
- The drawdown impact from mine dewatering may cause an elongated cone of depression to develop up to around 3 km to the north and south, and potentially 1.5 to 2 km laterally (east and west) of the Bombora deposit.

5.2 2025 Hydrogeological Field Investigation

5.2.1 Objectives

A detailed hydrogeological investigation was undertaken by AQ2 between March and July 2025 as part of a DFS level hydrogeological dewatering study to improve the hydrogeological understanding of the Bombora project area. The main aim of the groundwater exploration programme was to:

- Confirm the presence/absence and distribution of the targeted zones of enhanced permeability within potential water bearing structural features (i.e. fractures within slightly weathered and fresh bedrock, broken quartz veins and fractures at the contact between fresh rocks in the mineralised zone, fractures associated with the local and regional faults and chilled margins of lamprophyre dykes)
- Collect hydrogeological information, such as:
 - Lithology.
 - Weathering profiles.
 - Depth of water strikes.
 - Yield.
 - Groundwater quality (electrical conductivity, pH and temperature).
- Understand fracture distribution and permeability versus depth across the site.
- Install test production/dewatering bores to allow hydraulic testing of the aquifer to confirm local aquifer parameters and to more accurately determine dewatering pumping rates likely to be required during mining of the Bombora pits and underground.
- Establish a groundwater monitoring network in the mining area to provide pre-mining baseline, as well as life of mine groundwater monitoring.

Table 5.1 GRM 2019 Drilling and Monitoring Bore Details

Bore ID	Coordinates (MGA 2020)		Ground Elevation (m AHD)	Drilled Depth (m)	Cased Depth (m)	Top of Casing (TOC)		Slotted Interval (mbgl)	Maximum Airlift Yield (L/s)	EC (uS/cm)	pH	Static Water Level		Current Status
	Easting (m)	Northing (m)				(m abgl)	(mAHD)					(m bgl)	(m AHD)	
BWE01	458907	6600253	314.19	132	122	0.69	314.65	56-122	9	110,580	6.74	2.02	311.94	Operational
BWE02	458601	6600799	311.74	150	150	0.37	312.11	69-147	10+	134,600	6.95	1.42	310.32	Operational
BWE03	458812	6601243	311.76	150	150	0.97	312.73	90-150	~1	239,400	6.82	0.81	310.95	Operational
BWE04	459076	6600487	311.79	130	126	0.51	312.30	60-126	Dry	—	—	0.72	311.07	Operational
BWE05	458574	6601346	311.97	150	150	0.87	312.84	72-150	2	137,400	7.08	0.92	311.05	Operational
BWE06	458689	6601458	311.79	60	-	-	-	-	5+	107,600	6.76	-	-	Bore collapsed
BWE07	458609	6601537	311.78	150	150	0.41	312.19	72-150	10	102,000	6.91	0.90	310.88	Operational
BWE08	458934	6601712	311.73	150	148	0.70	312.43	70.5-148	0.04	95,400	6.67	0.67	311.06	Operational
BWE09	458464	6602072	313.93	200	199.4	0.55	314.52	97-199.4	0.4	168,400	6.97	2.50	311.47	Operational
BWE10	458594	6602479	314.25	150	148.5	0.60	314.87	70.5-148.5	8	201,000	6.8	2.68	311.59	Operational
BWE11	458786	6602277	313.62	150	149.4	0.68	314.29	71.4-149.4	0.6	180,600	7.11	2.91	310.70	Operational
BWE12	458678	6602492	315.26	60	60	0.84	316.05	24-60	0.1	158,600	6.83	4.49	310.72	Operational
BWE13	458783	6602183	314.36	50	50	0.66	314.93	24-50	Dry	—	—	3.40	310.87	Operational
BWE14	458761	6601668	311.75	50	50	0.66	312.41	20-50	5	86,000	6.96	0.91	310.84	Operational
BWE16	458606	6600929	311.71	50	50	0.97	312.68	20-50	15	139,600	6.87	0.22	311.49	Operational
BWE17	458852	6600744	312.66	96	24	0.97	313.63	Dec-24	8	146,200	6.97	0.41	312.25	Operational
BWE18	458850	6600459	314.87	60	60	0.63	315.48	24-60	Dry	—	—	3.17	311.68	Operational

Key: TOC= top of casing; m agl= metres above ground level, m bgl= metres below ground level, EC= electrical conductivity

Note: BWE15 was not drilled

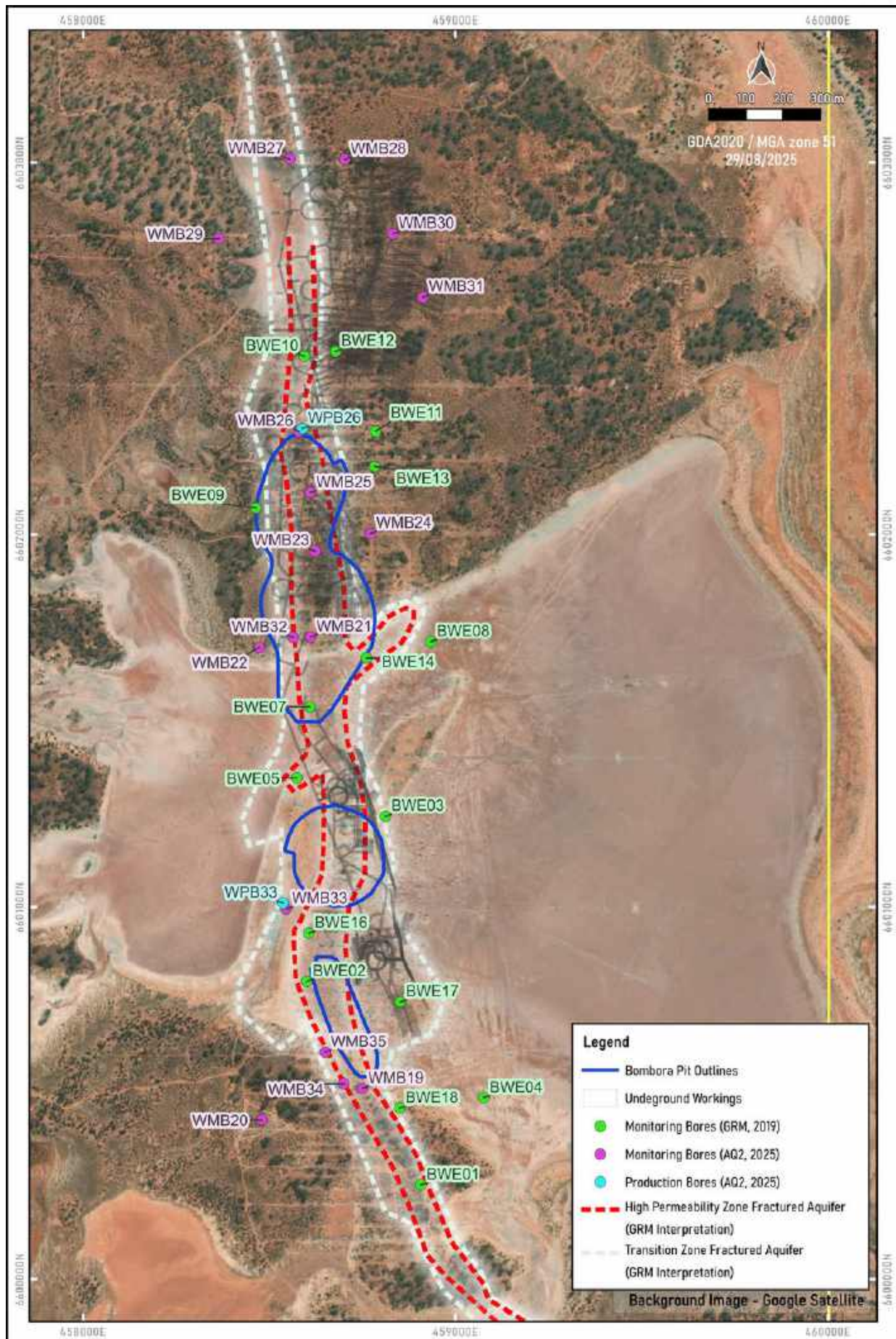


Figure 5.1 Bombora Deposit - Test Production and Monitoring Bore Locations

5.2.2 Drilling and Bore Construction

5.2.2.1 Drilling Methodology

A groundwater exploration drilling programme was carried out in 2025 in the Bombora area surrounding the three proposed open pits (1800, 1100 and 700) and the underground mine.

The drilling targets were selected based on data gathered in the previous drilling campaigns, including:

- Hydrogeological drilling undertaken by GRM in 2019.
- Diamond and RC drilling campaigns undertaken by Breaker and Ramelius.
- Mapped lithologies and structures.
- Proposed surface and underground mine plans.

The drilling programme was conducted from the 10th of March 2025 to the 11th of July 2025 with the drilling carried out by Caswell Drilling, who are a specialist water bore drilling company based in Perth WA. Bores were drilled using a dedicated water well drill rig. Hydrogeological direction of the drilling programme was carried out by AQ2.

Mud rotary drilling methods were used to drill through the near surface unconsolidated material, until competent rock was reached. Steel intermediate casing, (152 mm for monitoring bores and 305 mm for production bores), was installed in the unconsolidated zone and was set in place using cement grout. Drilling then progressed in competent rock using conventional air hammer techniques to final depth. Bore depth was selected based on the proposed depth of mining operations in the respective areas.

Monitoring bores had 50 mm ND blank and slotted PVC Class 18 casing installed and production bores had 203 mm ND blank and slotted PVC Class 18 casing installed. Slots (1 mm aperture) were placed below the water table, to intercept all water strikes. At each bore, the annulus was packed with gravel (1.6 to 3.2 mm graded) from the final depth to approximately 2 to 4 m above the slotted intervals. Above this a 2 to 3 m bentonite seal was placed, followed by backfilling with gravel pack (above the seal) to close to the surface. The bore annulus was then completed with a cement plug to ground level. The bores were completed with a lockable steel collar and a concrete plinth on surface. Similar headworks were also installed on all monitoring bores drilled in the 2019 GRM campaign, other than the collapsed BWE06, to allow them to be incorporated into the Bombora monitoring network.

5.2.2.2 Drilling Results

A total of 17 monitoring bores (WMB19 to WMB35) and 2 test production bores (WPB26 and WPB33) were drilled across the Project area. Bore depths ranged from 50 m (WMB33) to 200 m (WMB23, WMB24 and WMB25). Bore depths were selected based on the planned depth of mining operation in the respective areas, with the intention of having the bores penetrate to the base of the open pits. The locations of the test production and monitoring bores are shown in Figure 5.1. Construction details for the bores are summarised in Table 5.2, while bore completion data, including lithological and construction logs for the test investigation and monitoring bores, are presented in Appendix B.

Table 5.2 2025 Production and Monitoring Bore Details

Bore ID	Coordinates GDA2020 Zone 51 J		Ground Level (m AHD)	Drilled Depth (mbgl)	Cased Depth (mbgl)	TOC (magl)	TOC (mAHD)	Screened Interval (mbgl)	Final Airlift Rate (L/s)	Final pH (pH units)	Final Airlift EC (µS/cm)	SWL (mbgl)	SWL (mAHD)	First Water Strike (mbgl)	Main Fractures (mbgl)
	Eastings	Northings													
Monitoring Bores															
WMB19	458750	6600512	314.49	160	Open Hole	0.55	314.49	N/A	Seepage Only on Bore Completion			3.42	310.52	dry	
WMB20	458480	6600427	312.78	150	150	0.81	313.72	24-150	1.8	6.1	158,900	0.38	312.53	44	44, 56-57
WMB21	458611	6601725	313.71	169	Open Hole	0.62	314.24	N/A	4.4	6.67	166,800	2.34	311.28	14	14, 24,
WMB22	458473	6601697	312.94	160	160	0.86	313.83	38-200	2.5	6.98	197,200	1.07	311.9	40	40, 47-48, 53-54, 69-70
WMB23	458623	6601956	314.88	200	200	0.90	315.81	20-200	Seepage Only on Bore Completion					4.05	310.86
WMB24	458772	6602003	314.88	200	200	0.73	315.71	38-200	1	6.51	160,700	3.86	311.12	34	quartz veins
WMB25	458610	6602113	314.38	200	200	1.04	315.44	26-200	4.3	6.72	163,100	3.44	310.96	29	34, 43, 50-54
WMB26	458580	6602277	314.09	160	160	0.84	314.97	32-160	12.5	6.94	154,200	3.18	310.95	25	24-25, 31-34, 79-82, 87, 90, 95, 107
WMB27	458555	6603009	313.98	130	130	0.81	314.71	34-154	Dry on Bore Completion					3.01	310.89
WMB28	458703	6603008	314.39	160	160	1.11	315.46	40-160	1.5	6.74	184,000	3.66	310.69	36	
WMB29	458365	6602795	315.79	130	128.5	1.25	316.80	33-128.5	4.4	6.52	154,100	5.29	310.26	32	32, 49, 53
WMB30	458832	6602808	315.05	150	150	0.98	315.86	36-126	2.5	6.64	168,400	4.05	310.83	30	36
WMB31	458913	6602638	315.68	151	151	0.97	316.52	42-150	8.8	6.97	160,300	3.30	312.25	37	37-41, 47, 55
WMB32	458564	6601724	313.85	141	Open Hole	0.51	314.41		1.8	7.18	162,700	3.20	310.7	31	29-31
WMB33	458545	6600994	312.87	50	43	0.66	313.60	30-43	2.5	6.39	136,700	3.34	309.6	24	32-36
WMB34	458700	6600525	314.84	157	Open Hole	0.53	315.41		Dry on Bore Completion					4.33	310.55
WMB35	458650	6600609	312.89	161	160	0.85	313.81	28-160	0.9	7.01	208,800	1.28	311.68	29	29-30, 63
Production Bores															
WPB26	458589	6602285	313.78	160	160	0.58	314.37	28.4-156.4	15	6.25	159,000	2.01	311.78		40-45, 47-48
WPB33	458537	6601010	313.16	160	160	0.28	313.51	25-160	5	6.4	165,400	2.32	310.91	43	43-49

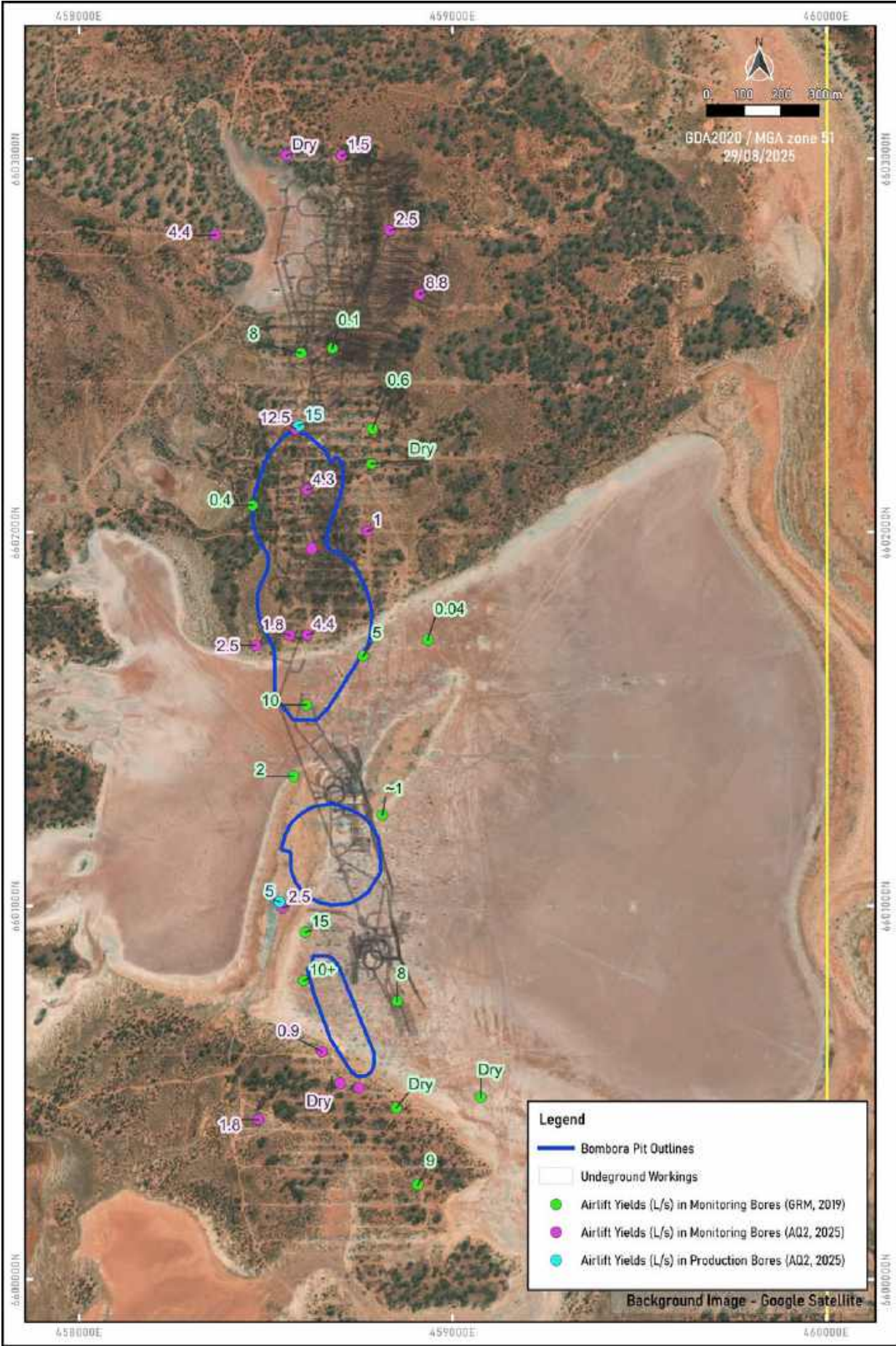


Figure 5.2 Bombora Deposit – Final Airlift Yields (L/s) during Drilling

Bores generally encountered a 5 m transported layer comprised of gravel, sand, silt and clay (but could vary from 3 to 10 m thickness), overlying an in-situ weathered profile of saprolite and saprock overlying fresh bedrock. The bedrock in the majority of the bores was dolerite from the Bombora Sill, while bores in the northern portion of the Project area encountered meta-basalt bedrock outside the sill area. The bores in the southern and central part of the Project area generally had shallower weathering profiles, with the base of the completely oxidised material generally being 6 to 15 m, while bores in the northern portion of the Project area had deeper weathering profiles, with the base of the completely oxidised ranging from 30 to 36 m. The exception to this was WMB33 and WPB33, drilled on the peninsula extending from the southern bank of Lake Roe, which encountered approximately 30 m of completely oxidised material, which was associated with the Peninsula Fault. Depth of weathering across the deposit does not appear to be affected by rock type. The fresh bedrock was generally encountered at 30 m depth, but varied between 15 and 58 mbgl.

Water strikes were recorded during drilling, with water strikes encountered at variable depth (i.e. between 14 and 44 mbgl), mainly within the weathered bedrock (saprock) and fresh fractured zone up to approximately 55 m depth. The airlift yields were also recorded during drilling and were generally between 1 and 4.4 L/s across the site and were associated with the moderately weathered and fractured zones (up to 55 mbgl). Two bores WMB26 and WMB31 had high airlift yields of 12.5 L/s and 8.8 L/s, respectively recorded during drilling, which were associated with fracturing around the chilled margins of the lamprophyre dyke (WMB26) and quartz veins in dolerite (WMB31).

There was no narrow highly permeable fractured zone aquifer (trending north-south and associated with the main gold mineralisation zone) evident as previously interpreted by GRM. Instead, the main aquifer is related to the transition zone between the weathered and fresh fractured bedrock, and the higher permeability depending on the intensity of cross cutting faults and lamprophyre dykes (especially increased in swarms). At all locations, there were no noticeable fractures or increases in airlift yields encountered below 55 m depth, therefore the permeabilities below the main fracture zone aquifer are generally low. Bores WMB19 and WMB34 located south of the 700 Pit targeted the known Peninsula Fault that was also encountered at WMB33 and BWE02 (and produces around 5 L/s). However, bores WMB19 and WMB34 were found being dry during drilling. This indicates that the Peninsula Fault itself is not particularly permeable, although cross faulting/lamprophyre dykes/quartz veins may potentially cause an increase in yields.

5.2.3 Hydraulic Testing

5.2.3.1 Test Pumping of Test Production Bores

Following construction and development of the 2 test production bores (WPB26 and WPB33), an aquifer testing programme was conducted by the test pumping contractor Matix Hydro during the period 22nd June to 9th July 2025, under supervision by an AQ2 hydrogeologist. This supervision was conducted remotely from Perth.

Pumping tests were undertaken on each of the two bores to:

- Calculate the hydraulic conductivity, transmissivity and storage of the weathered/fractured bedrock aquifer,
- Confirm the along-strike continuity of the bedrock fractures inferred from the pre-pumping static water levels,
- Confirm the presence of hydraulic boundaries in the aquifer, which may comprise barrier or recharge boundaries (e.g. low permeability surrounding basement rocks and zones of increased storage via fault zones, respectively); and
- Assess groundwater flow conditions during pumping (i.e. sustainable yield).

At each bore, the aquifer testing comprised:

- A step-rate test (SRT; 4 x 100 minute steps of progressively increasing pumping rates per step).
- A 72 hour (3 day) constant-rate test (CRT).
- Recovery measurements following the cessation of pumping (until groundwater levels were within 90% of the initial water level or after 12 hours of the conclusion of CRT – whichever occurred first).

Pumping test durations and rates of each bore are listed in Table 5.3. After the cessation of pumping, water level recovery was monitored at each production bore and its adjacent monitoring bore(s). It should be noted that the fourth step of the SRT at both WPB26 and WPB33 was cut short to 20 minutes and 35 minutes, respectively due to the cavitation from cascading water (owing to the excessive drawdown). At this point the pump was shut down.

During the tests, pumping rates were measured using an in-line flow meter. Water levels were measured in the test investigation and monitoring bores using a combination of pressure transducers (test bore and closest monitoring bore) and electrical water-level probe (for manual readings of distant monitoring bores).

The hypersaline discharge water was transferred via lay-flat pipe to a salt lake located near each of the tested bores to minimise potential impacts on the vegetated environment. It should be noted that Ramelius was allowed to discharge to the nearby lake (as per their agreement with DWER).

SRT data were used to make a preliminary assessment of bore yield and confirm the target pumping rate for the CRTs. The test data were also graphically analysed using the Hantush-Bierschenk method to estimate bore efficiency. Graphical plots of drawdown versus log time for SRT are presented in Figures 5.3 and 5.4. SRT results are presented in Appendix C.

Graphical plots of drawdown versus log time for the CRTs are presented in Figures 5.5 and 5.6, and also in Appendix C. Water level responses in the adjacent monitoring bores due to pumping are summarised in Table 5.4 and shown in Figures 5.7 and 5.8. The CRT and recovery test analysis results are also presented in Appendix C.

Table 5.3 Summary of Pumping Tests Conducted

Pumping Bore ID	Step Test				Constant Rate Test		
	Step Number	Duration (mins)	Pumping Rate (L/s)	Final Drawdown (m)	Duration (hours)	Pumping Rate (L/s)	Prod Bore Final Drawdown (m)
WPB26	1	100	4	8.65	71.5	7	38.68
	2	100	6	16.59			
	3	100	8	26.83			
	4	20	11	129.31			
WPB33	1	100	4	27.89	72	4.5	44.47
	2	100	5	29.65			
	3	35	6	96.27			

Table 5.4 Summary of Monitoring Bores Responses to Pumping Tests

Pumped Bore ID	Monitoring Bore ID	Distance from Pumped Bore (m)	SWL (mbtoc)	Final Water Level (mbtoc)	Final Drawdown in Monitoring Bore at the end of test (m)
WPB26	WPB26	0	3.026	41.71	38.68
	WMB26	8	3.51	16.59	13.08
	BWE10	192	3.18	3.93	0.75
	WMB25	175	4.15	11.24	7.09
	WMB32	561	3.37	4.38	1.01
	BWE11	206	3.23	4.89	1.66
	WMB31	485	4.16	4.36	0.20
	WMB28	721	4.70	4.93	0.23
	BWE09	245	2.85	4.12	1.27
	WMB23	333	4.64	6.71	2.07
	BWE12	227	5	6.93	1.93
	WMB22	600	1.59	2.45	0.86
	WMB24	342	4.12	5.84	1.72
WPB33	WPB33	0	3.09	47.55	44.47
	WMB33	17	2.38	4.76	2.38
	WMB35	423	2.56	3.40	0.84
	BWE17	413	1.33	1.55	0.22
	BWE16	107	0.45	1.56	1.11
	BWE05	337	0.86	1.87	1.01
	BWE02	220	0.90	2.05	1.15
	BWE03	360	1.18	1.50	0.32
	BWE01	843	2.43	2.57	0.14
	WMB20	570	2.90	3.15	0.25
	BWE07	530	0.85	1.29	0.44

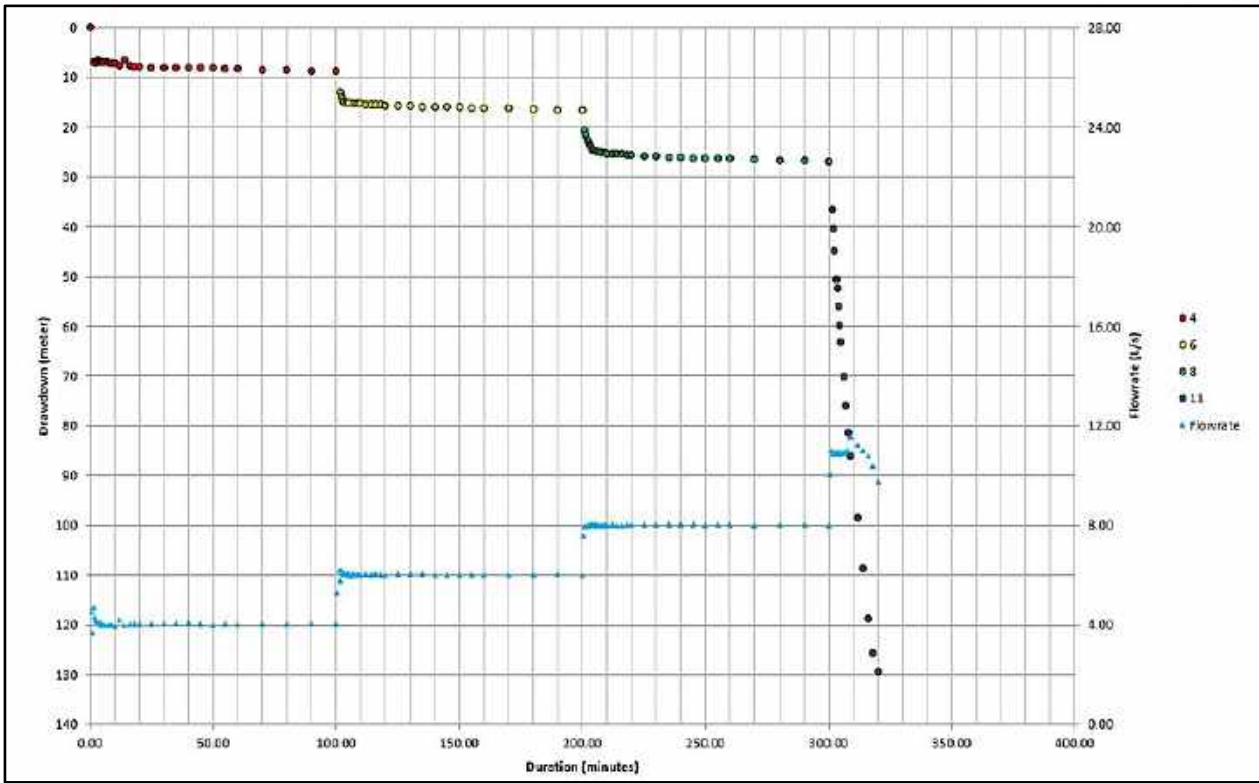


Figure 5.3 Bombora Deposit – Step Rate Test at WPB26

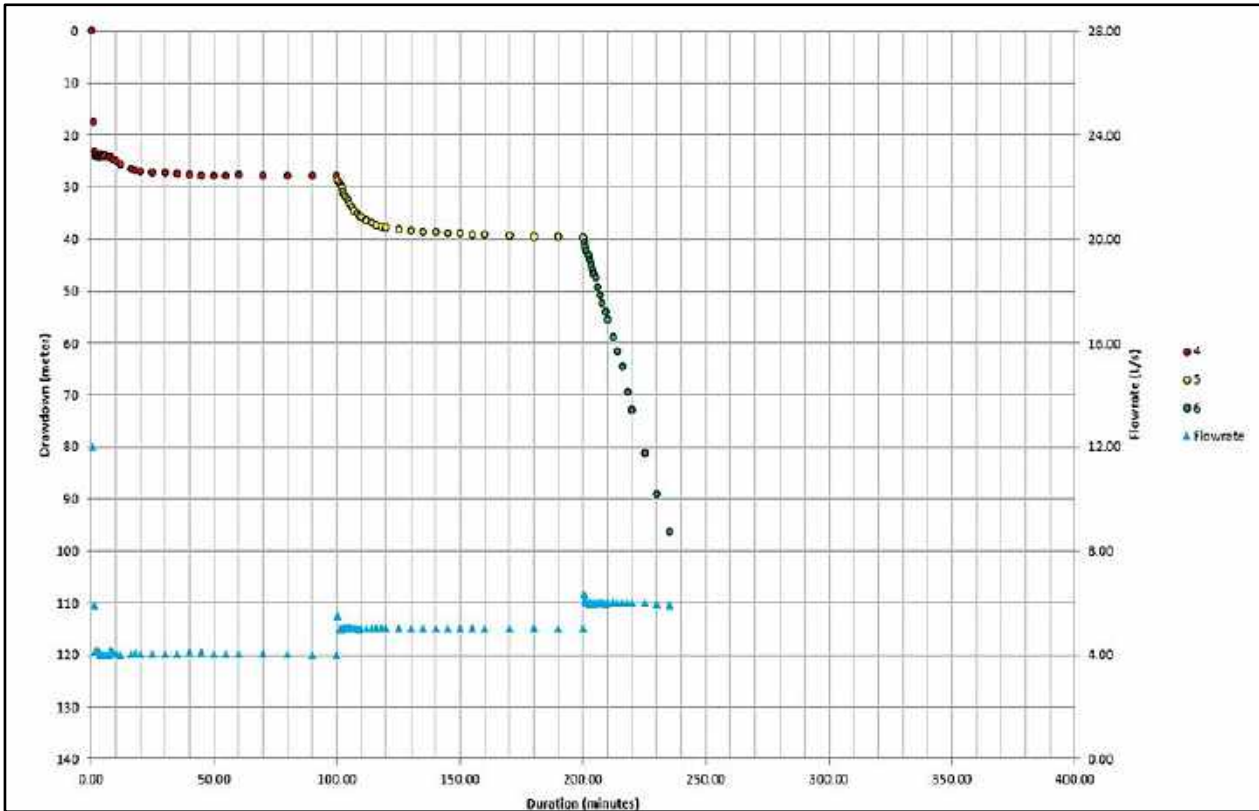


Figure 5.4 Bombora Deposit – Step Rate Test at WPB33

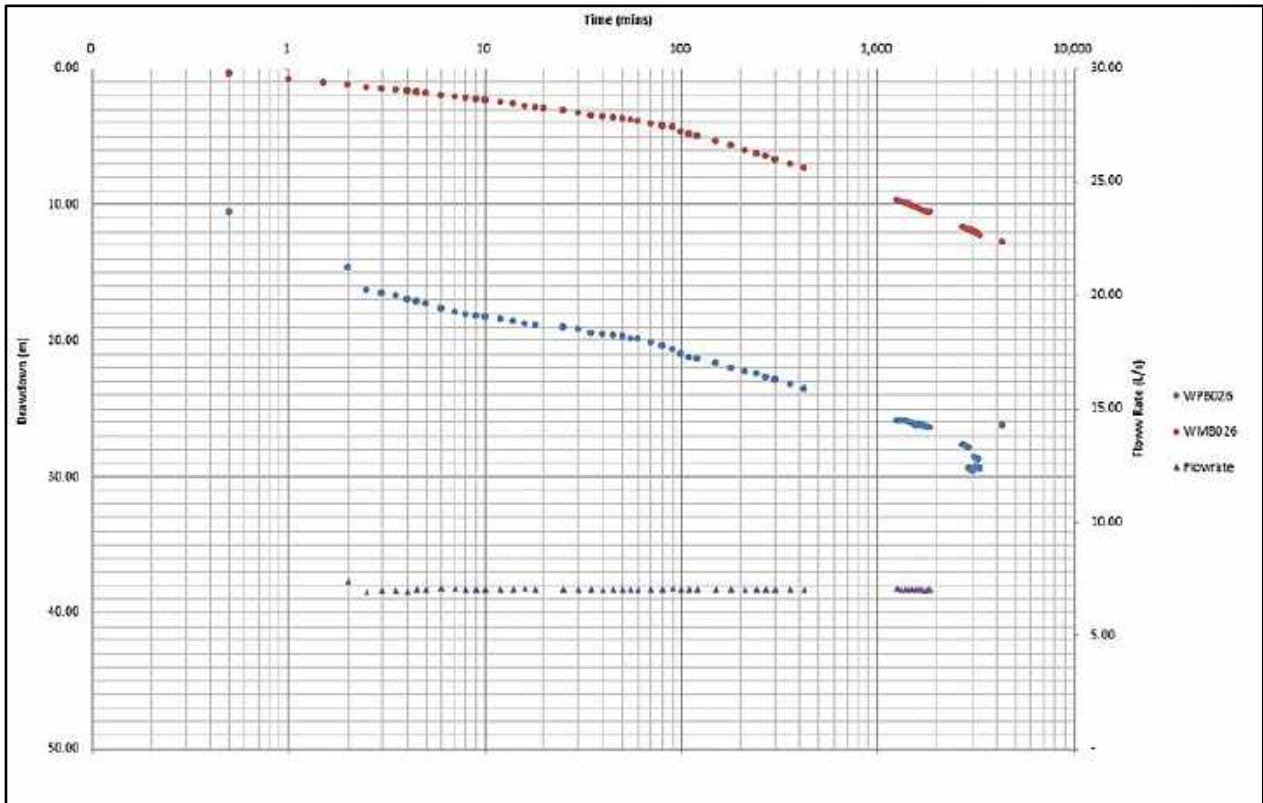


Figure 5.5 Bombora Deposit – Constant Rate Test at WPB26

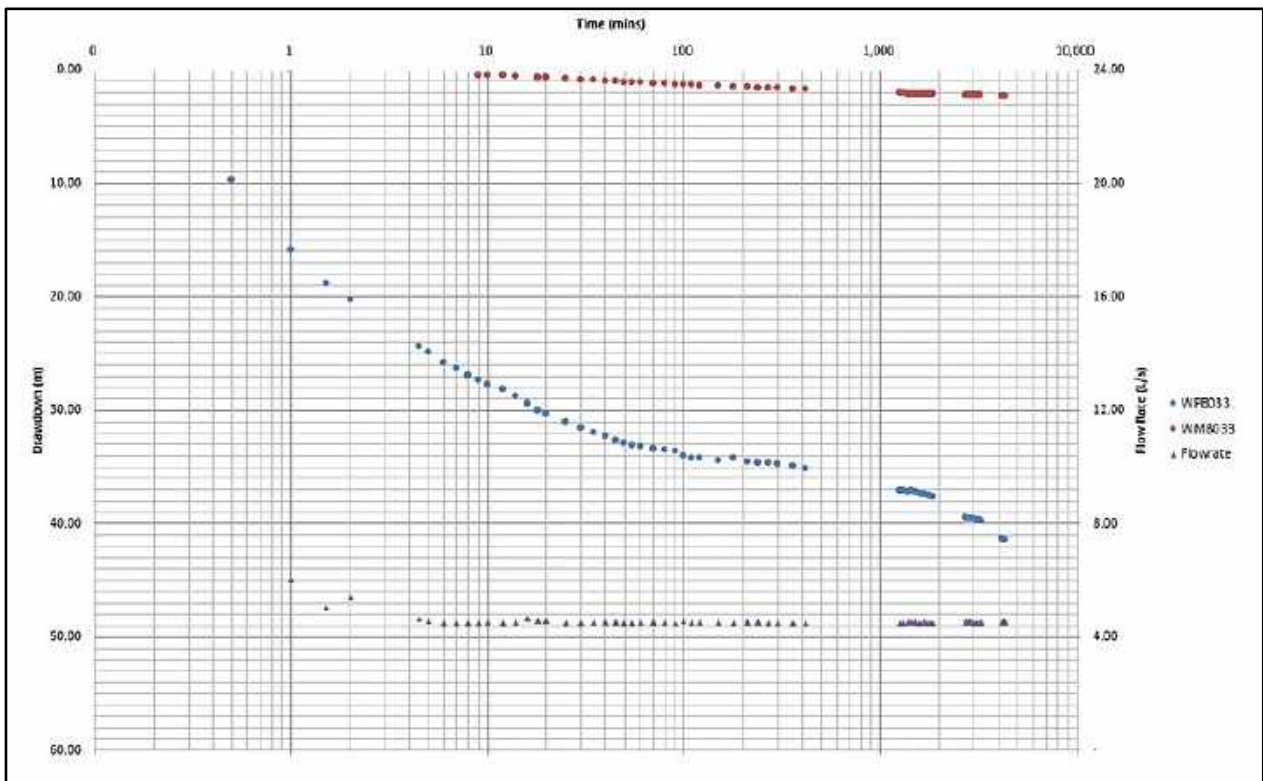


Figure 5.6 Bombora Deposit – Constant Rate Test at WPB33

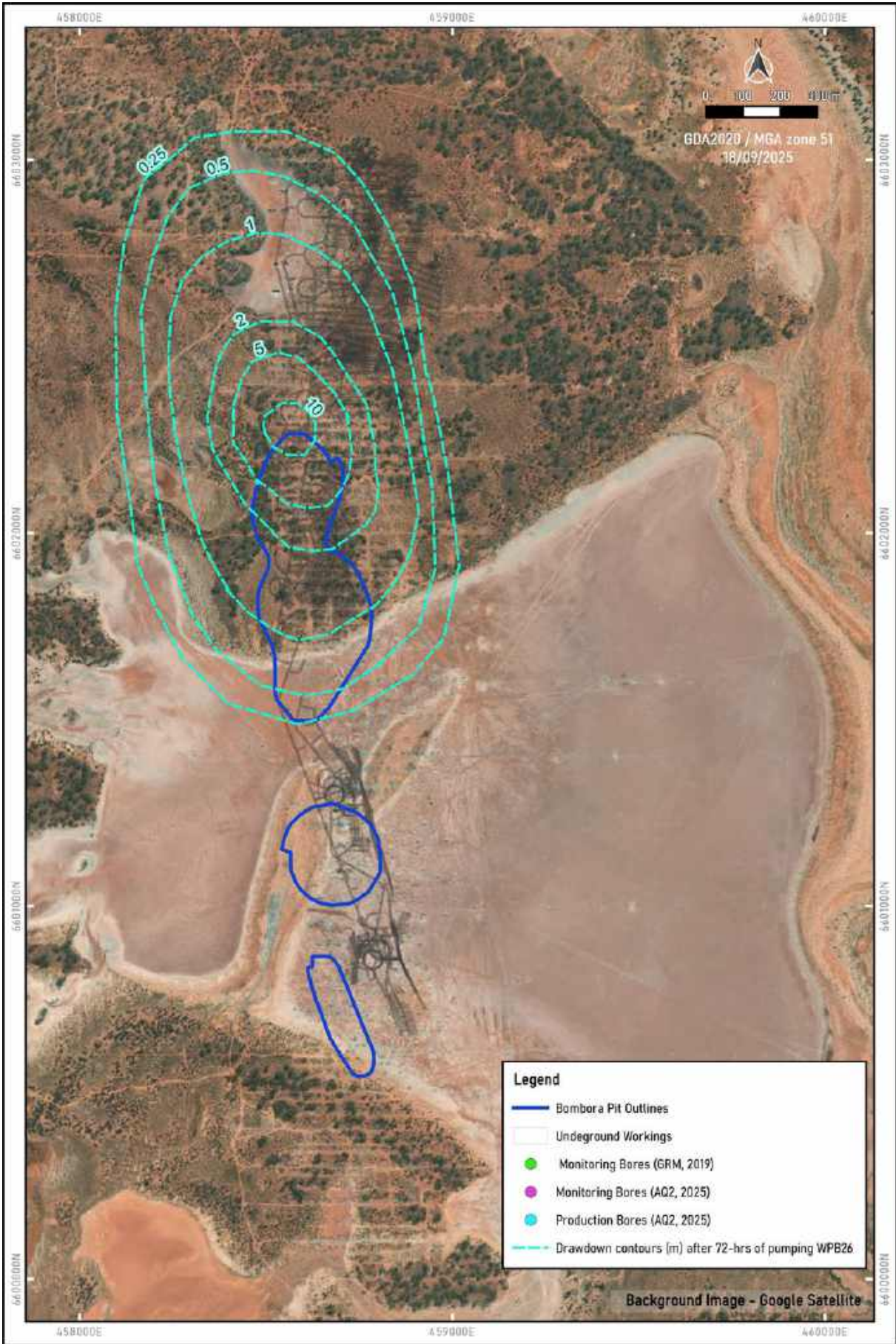


Figure 5.7 Drawdowns in Monitoring Bores after 72 hrs Constant Rate Test at WPB26

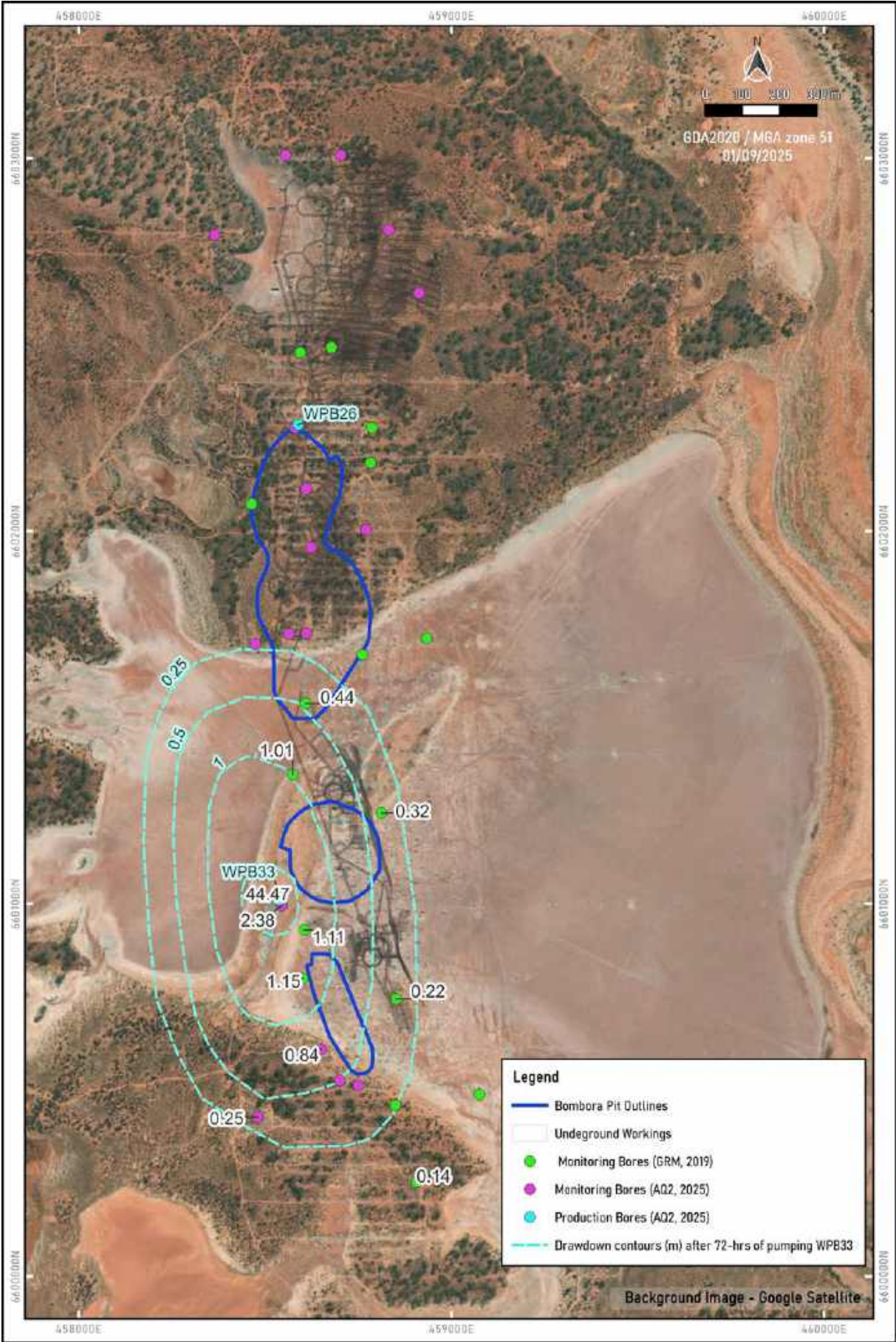


Figure 5.8 Drawdowns in Monitoring Bores after 72 hrs Constant Rate Test at WPB33

Bore WPB26, located immediately north of the proposed 1800 Pit, intersected fractures around the chilled margins of the lamprophyre dyke and quartz veins (i.e. fracture intervals 24–25 mbgl, 31–34 mbgl, 79–82 mbgl, 87, 90, 95, and 107 mbgl). The results from the SRT indicated that bore WPB26 is able to sustain a constant discharge rate of 7 L/s, providing water levels remain within the fractured zone (up to around 35 m depth). Once the water levels pass this point the drawdown rate significantly increases (as seen in the 4th step, refer to Figure 5.3), due to fracture sets becoming dewatered.

Bore WPB26 sustained a constant pumping rate of 7 L/s over the 71.5 hours tested with the final drawdown of 38.7 m recorded from a static water level of 3 mbtoc. A drawdown of 13.1 m was reported at the end of the test in the closest monitoring bore WMB26 (at a distance of 8 m from WPB26), suggesting a very good hydraulic connectivity with the pumped bore. Moreover, drawdowns were recorded in all 11 bores that were monitored throughout the test. This indicates good hydraulic connection within the weathered/fractured bedrock aquifer at a considerable distance (at least up to 720 m) away from the pumped bore (Table 5.3 and Figure 5.7). Bore BWE10 located approximately 190 m north from the WPB26 had a smaller than expected drawdown that could be due to localised discontinuity of the weathered/fractured aquifer.

On a semi-logarithmic scale (Figure 5.5), the production bore WPB26 data shows that the rate of drawdown remained relatively constant for the first 100 minutes of the CRT, after which the drawdown rate significantly increased for the remainder of the test duration. It was evident from the CRT data that drilling at WMB29, located ~600 m to the northeast, influenced the groundwater levels at the pumped bore WPB26 from 60 hours into the test onwards, resulting in greater drawdowns. This indicates a clear hydraulic connection between the fractures at WPB26 and WMB29. The sharp increase in the drawdown rate indicates the fractured bedrock aquifer having limited storage capacity. Recovery data (Appendix C) show a slow recovery, indicating that the upper fractures have been dewatered during the testing and groundwater “recharge” is limited.

Bore WPB33, located on the lake peninsula, was drilled to intersect the Peninsula Fault (i.e. brecciated zone from 40 to 45 mbgl and quartz veins to 48 mbgl were encountered within the fresh bedrock). The results from the SRT indicated that bore WPB33 is able to sustain a constant discharge rate of 4.5 L/s, providing water levels remain within the brecciated zone (up to around 48 m depth). Once the water levels pass this mark, the drawdown rate significantly increases (as seen in the 3rd step, refer to Figure 5.4).

Bore WPB33 sustained a constant pumping rate of 4.5 L/s over the 72 hours tested with the final drawdown of 44.5 m recorded from a static water level of 3.1 mbtoc. A drawdown of 2.4 m was reported at the end of the test in the closest monitoring bore WMB33 (at a distance of 17 m from WPB33). The smaller than expected drawdown in WMB33 is likely due to limited connectivity of this bore with the pumped bore, as WMB33 was installed within weathered bedrock only (brecciated zone from 32 to 36 m depth had extensive clayey matrix). However, drawdowns were recorded in the remaining 9 monitoring bores throughout the test, indicating good hydraulic connection within the weathered/fractured bedrock aquifer at a considerable distance (up to 840 m) away from the pumped bore (Table 5.3 and Figure 5.8). Greater water level responses were encountered in the bores (BWE02, BWE05, BWE07, BWE16) along the north-south trending fracture strike, where there is greater intensity of cross cutting faults, quartz veins and lamprophyre dykes, compared to drawdowns recorded in the less fractured/unfractured bedrock.

On a semi-logarithmic scale (Figure 5.6), the production bore WPB33 data show that the early time data have the effects of well-bore storage, and after 30 minutes of pumping there was a gradual reduction in the drawdown slope. This flatter curve was due to the fractured aquifer of double porosity type being ‘recharged’ from more distant fractures (that are interconnected) and/or from the aquifer matrix (from primary porosity). A sharp increase in the drawdown rate was recorded from around 1,000 minutes and continued for the remainder of the test duration, and indicated the fractured bedrock aquifer having limited storage capacity. Recovery data (Appendix C) show similar trends, with a steep recovery plot in early time data (high values of t/t') and a reduced rate of recovery in late time data.

Data collected during the aquifer testing was analysed using AQTESOLV software (HydroSOLVE Inc.) to infer representative hydraulic parameters of the tested aquifer (i.e. estimates of aquifer transmissivity and storativity), utilising different analysis methods to compare the results for both drawdown and recovery data. A summary of the data and analyses is presented in Table 5.5 and Appendix C.

It should be noted that most existing aquifer test analysis procedures assume that the:

- Aquifer has infinite areal extent.
- Aquifer is homogeneous, isotropic and of uniform thickness.
- Pumping well is fully or partially penetrating.
- Flow is unsteady.
- Water is released instantaneously from storage with decline of hydraulic head.

Under such assumptions of homogeneity, it is possible to devise graphical or analytical methods that can provide estimations of aquifer parameters.

It should also be noted that aquifer test analyses were undertaken using various type curve matching techniques based on the interpreted nature of the aquifer response. The most widely used methods are based on the semi-log /or log-log representation of the drawdown versus time (i.e. the Cooper-Jacob and Theis methods which were used in our assessment). The analysis methods are detailed in Kruseman and de Ridder (1994).

The aquifer transmissivity was calculated from the pumping tests and the transmissivity was divided by the assumed aquifer thickness to provide an estimate of permeability (hydraulic conductivity). Analysis of the late-time drawdown and recovery data from pumped bores WPB26 and WPB33 indicates that the average bulk transmissivity value of the weathered/fractured bedrock (transition zone) aquifer was calculated to be 22 m²/d. Based on an average aquifer thickness of 47 m, the average hydraulic conductivity is 0.47 m/d. The “late” time data was used, which is appropriate for estimations of transmissivity of the fractured aquifer and takes into account the impacts on the aquifer boundaries and limited aquifer storage. The derived transmissivity values are bulk values covering all of the material tested; none of the values apply to individual features (e.g. fractures or shears) of higher permeability. It is likely that the permeability of discrete fracture zones will be higher, but these bulk aquifer properties are appropriate for assessing “whole of pit” inflows.

Table 5.5 Summary of Estimated Aquifer Parameters –Test Production Bores

Pumping Bore	Aquifer Thickness (m)	Average Effective Transmissivity (T m ² /d)	Average Hydraulic Conductivity (k m/d)
WPB26	47	22	0.47
WPB33	45	17	0.4

5.2.3.2 Hydraulic Tests

Following the drilling and casing, hydraulic testing (airlift recovery and/or slug tests) were undertaken at 15 monitoring bores. The purpose of the hydraulic testing was to obtain local hydrogeological data to assess the near-bore aquifer permeability.

For the airlift recovery tests, the bores were airlifted as part of bore development (or until they ran dry). Monitoring of water levels was carried out throughout the pumping and after the pumping ceased. Water levels were measured using a pressure transducer (data logger). All test data collected during recovery

were analysed using standard curve-fitting analysis methods to ascertain aquifer properties (using the Jacob and Theis Recovery Methods).

Each slug test consisted of measuring the static water level in the bore, then introducing a near instantaneous change of water level by adding a slug of water into the bore or temporarily airlifting water out of the bore and then measuring the change in water level (i.e. rise and fall) over time, until the water level returned to its near original static water level. A pressure transducer was used to measure the water level changes over time, at 1 second intervals. The declining water levels were used for analysis of the permeability, utilising the Bower-Rice method.

The results of the hydraulic tests undertaken at each bore are summarised in Table 5.6 and presented in Appendix C.

Table 5.6 Summary of Hydraulic Testing - Monitoring Bores

Bore Number	Drilled Depth	Screened Interval (mbgl)	Static Water Level (mbgl)	Completion Final Airlift Rate (L/s)	Length of test (m)	Bulk Transmissivity (m ² /d)	Adopted aquifer thickness (m)	Bulk Permeability (m/d)	Fractures (mbgl)
WMB19	160	open	3.42	Dry	148	0.7	148	0.004	-
WMB20	150	24-150	1.19	1.8	126	5.3	13	0.41	44, 56-57
WMB21	169	open	2.85	4.4	157	3.5	145	0.024	14, 24,
WMB22	160	38-200	1.09	2.5	122	2.7	122	0.022	40, 47-48, 53-54, 69-70
WMB23	200	20-200	4.05	0	180	0.3	180	0.0015	
WMB24	200	38-200	3.86	1	162	0.7	162	0.005	quartz veins
WMB25	200	26-200	3.44	4.3	174	3.8	11	0.35	34, 43, 50-54
WMB27	130	34-154	3.01	Dry	120	0.4	120	0.003	
WMB28	160	40-160	3.66	1.5	120	1.4	120	0.01	
WMB29	130	33-128.5	5.04	4.4	95.5				32, 49, 53
WMB30	150	36-126	3.96	2.5	90	ND	ND	ND	36
WMB31	151	42-150	3.3	8.8	108	ND	ND	ND	37-41, 47, 55
WMB32	141	open	3.24	1.8	129	23 (upper) 3.9 (lower)	50 110	0.46 0.035	29-31
WMB34	157	open	3.47	Dry	145	0.1	145	0.001	17, 19, 21, 33-35, 38, 44, 49, 54
WMB35	161	28-160	1.28	0.9	132	0.3	132	0.002	29-30, 63

It is noted that the analysis methods calculate bulk aquifer transmissivity. Permeability was derived from the calculated transmissivity and measured aquifer thickness (in each bore). The aquifer thickness for bores that encountered fractures in the transition zone (i.e. weathered/ fractured bedrock) and produced higher airlift yields during drilling were measured from the first water strike to the base of the fractured zone. It is likely that the permeabilities of discrete fracture zones/sandy layers would be higher, but these bulk aquifer properties are appropriate for assessing "whole of pit" inflows. For the bores that had fewer or no fractures encountered and the airlift yields that were low, the aquifer thickness was estimated to be from the top of the fresh bedrock to the total depth of the bore.

The results show that permeability ranges between 0.001 to 0.5 m/d and are consistent with the results from GRM (2019) that were in the range of 0.003 to 0.2 m/d. The variability in permeability values indicate a highly heterogeneous aquifer (as expected in a fractured Archaean bedrock aquifer), likely to reflect the variable nature of the fractured rock and extent of weathering.

5.2.3.3 Summary of Aquifer Response to Pumping

Airlift yields of between 7 and 15 L/s were recorded during the installation of the two production bores WPB26 and WPB33. However, the results from the aquifer step rate tests conducted on these bores indicated that the airlift yields could not be sustained during the 72-hour constant rate tests. Consequently, in all the bores, the pumping rates at which the constant rate tests were undertaken, were reduced to approximately half of the airlift rates. The CRT data showed continuous drawdown of the groundwater levels throughout the durations of the CRTs, with water levels not reaching a state of equilibrium between aquifer inflow and pumping rates in any of the tests. **The lack of equilibrium in all test bores was as a result of the applied pumping rates being greater than the aquifer could deliver**, likely owing to boundary effects formed by a low-permeability unfractured bedrock limiting groundwater inflows in the long-term.

The weathered / fractured bedrock aquifer (transition zone) at the site is relatively transmissive, with groundwater predominantly occurring in localised geological structures (i.e. shear zones and fractured/broken zones) up to 55 m depth within zones of secondary porosity of the bedrock. There is a good hydraulic connection within the weathered/fractured bedrock aquifer at a considerable distance across the site. Slightly greater water level responses were encountered in the bores along the north-south trending fracture strike, where there is greater intensity of cross cutting faults, quartz veins and lamprophyre dykes, compared to drawdowns recorded in the less fractured/unfractured bedrock. Therefore, the long-term sustainability of this aquifer is constrained by its limited storage and low recharge.

5.2.4 Underground Mine Ground Conditions

The Bombora drill hole database (i.e. geological model, core photographs, rock quality designation (RQD) data, water related comments during drilling) and preliminary geotechnical assessment (Peter O'Bryan & Associates, 2024) were reviewed and the relevant data were viewed using Leapfrog (Hydro) software to assess the deep fresh bedrock aquifer (below 150 m depth). This was to further develop the conceptual hydrogeological model of at Bombora and to better understand potential groundwater inflows to the planned Bombora underground up to 550 m depth. No hydraulic testing (i.e. packer testing) was undertaken as part of this assessment as there was no evidence of significant permeability at depth within the bedrock aquifer.

Key findings and conclusions drawn by this data review are detailed below:

- Bedrock within the proposed underground mining areas essentially comprise fresh quartz dolerite, lamprophyre and dolerite.
- Quartz dolerite is generally extremely strong (UCS > 250 MPa), while lamprophyre is generally very strong (UCS 100 to 250 MPa).
- The RQD index is an indicator of rock mass conditions. From the engineering point of view, the degree of fracturing stands for rock quality. Within assessed geotechnical domains, the underground rock mass at Bombora is typically of good (or better) quality. Limited intervals of very poor quality rock are recorded across assessed domains, and these zones are generally related to drill intersections of discrete shear structures, often comprising broken rock and smooth chlorite infilled defect surfaces.
- From the hydrogeological point of view, the degree of fracturing may be regarded as a factor in evaluating rock mass permeability. The RQD data (from 150 m depth onwards), indicated that the fresh

bedrock across the Project is mostly massive (unfractured). There were some fractures identified in the northern part of the deposit. Most of assessed fractures occur between 300 to 450 mbgl with only minor isolated zones of fractures encountered below 450m depth.

- A review of diamond core photos indicated that all fractures were clean, tight, with no large wide fractures and with only localised Fe staining. There were some zones of intense, closely spaced fracturing, which often corresponded to veins (<1m in length). Overall, the bulk of the core had fractures spaced apart, with no evidence of any water movement.
- Overall, the permeability of the bedrock below 150 m depth is likely to be low to very low (in order of 10^{-3} to 10^{-4} m/d) and would decrease with increasing depth.

5.2.5 Water Levels

Groundwater levels in the Bombora area were recorded during the drilling and testing programme and levels from a final dip round are presented in Table 5.7. The depth to groundwater ranges from 0.2 m below ground level (bgl) to 5.4 m bgl, with shallower water levels recorded in the lake area (0.2 to 1.4 mbgl) and deeper water levels recorded on the land (1 to 5.4 mbgl).

Recent groundwater levels have been combined with surveyed project bore elevations to plot interpreted groundwater elevations and groundwater flow directions in and around the Bombora deposit. These are shown in Figure 5.9 and presented in Table 5.7. The interpreted groundwater levels suggest that the water table elevation ranges between 310 and 312.5 mAHD and is generally around 310.5 and 311.5 mAHD. Groundwater flow is under a very low gradient. The groundwater levels are a subdued representation of the topography, with groundwater flowing from higher areas to low areas and generally in directions towards the lake.

Time series data of water levels is not yet available. An on-going monitoring programme should be implemented to provide data on annual water level variations within the Project area. It is expected there will be some minor seasonal variation in groundwater levels.

Table 5.7 Summary of Groundwater Levels (mbtoc, mbgl and mAHD)

Bore ID	Static Water Levels (8-10 July 2025)		
	(mbtoc)	(mbgl)	(mAHD)
BWE01	2.71	2.02	311.94
BWE02	1.79	1.42	310.32
BWE03	1.78	0.81	310.95
BWE04	1.23	0.72	311.07
BWE05	1.79	0.92	311.05
BWE07	1.31	0.90	310.88
BWE08	1.37	0.67	311.06
BWE09	3.05	2.50	311.47
BWE10	3.28	2.68	311.59
BWE11	3.59	2.91	310.70
BWE12	5.33	4.49	310.72
BWE13	4.06	3.40	310.87
BWE14	1.57	0.91	310.84
BWE16	1.19	0.22	311.49
BWE17	1.38	0.41	312.25
BWE18	3.80	3.17	311.68
WMB19	3.97	3.42	310.52
WMB20	1.19	0.38	312.53
WMB21	2.96	2.34	311.28
WMB22	1.93	1.07	311.90
WMB23	4.95	4.05	310.86
WMB24	4.59	3.86	311.12
WMB25	4.48	3.44	310.96
WMB26	4.02	3.18	310.95
WMB27	3.82	3.01	310.89
WMB28	4.77	3.66	310.69
WMB29	6.54	5.29	310.26
WMB30	5.03	4.05	310.83
WMB31	4.27	3.30	312.25
WMB32	3.71	3.20	310.70
WMB33	4.00	3.34	309.60
WMB34	4.86	4.33	310.55
WMB35	2.13	1.28	311.68
WPB26	2.59	2.01	311.78
WPB33	2.60	2.32	310.91

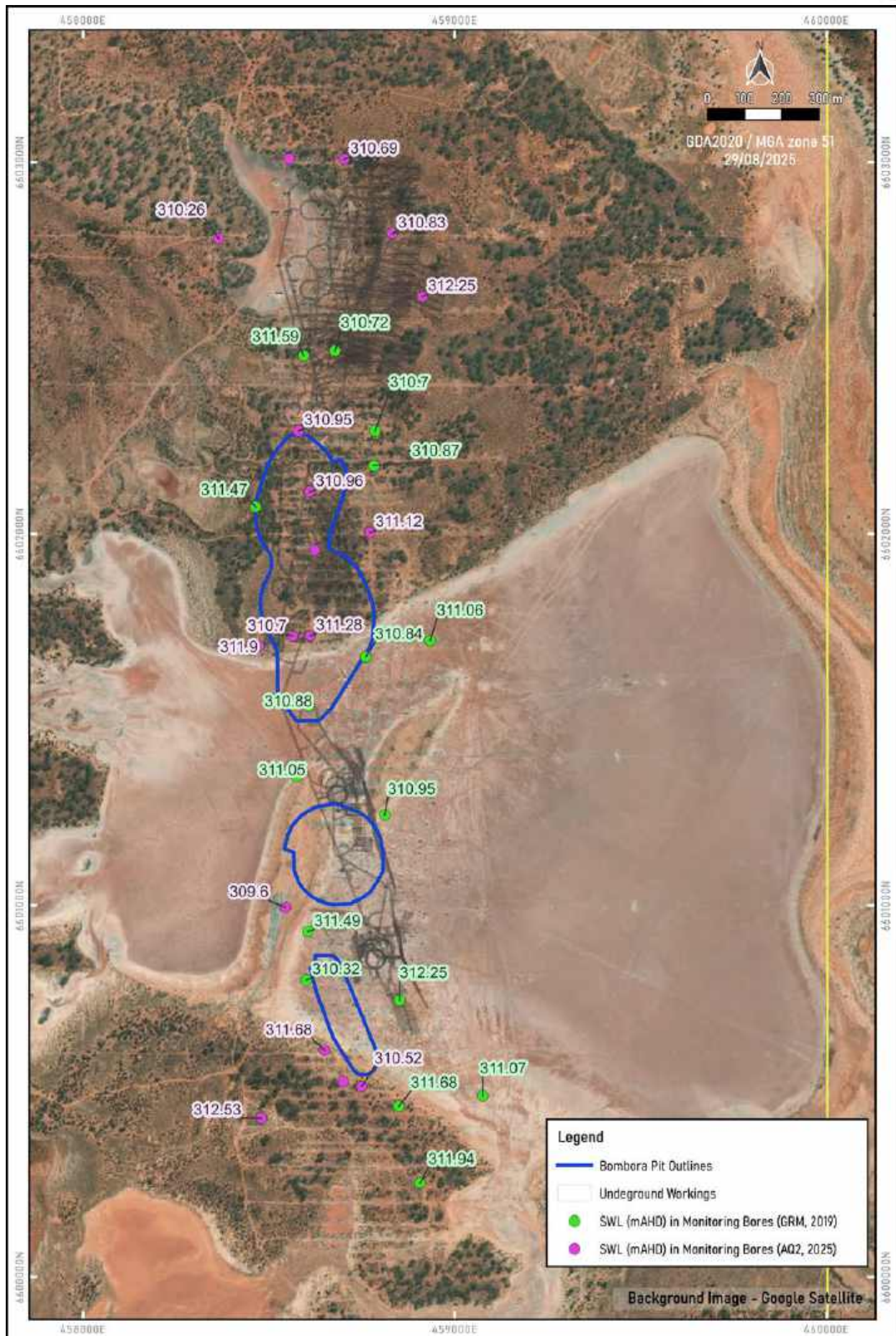


Figure 5.9 Bombora Deposit – Recent Groundwater Level Elevations

5.2.6 Groundwater Quality

Groundwater samples were collected for hydrochemical analyses from the following bores:

- The two test production bores WPB26 and WPB33 at the end of their respective constant rate pumping tests in July and June 2025. These gave the most representative samples of groundwater from the fractured aquifer that could be taken.
- Monitoring bore BWE29 at the end of its bore development by airlifting. Airlifted groundwater samples are not ideal as the groundwater is heavily oxidised during the airlifting and this can change the hydrochemistry. This sample was taken to give a wider spread of groundwater sampling across the Bombora deposit area.

The samples were analysed by SGS laboratories in Perth and the hydrochemical results are listed in Table 5.8 and presented in Appendix D.

This data represents the local Bombora groundwater quality and indicates the following:

- Groundwater is hypersaline with electrical conductivity (EC) values ranging from 200,000 $\mu\text{S}/\text{cm}$ (WPB26) to 210,000 $\mu\text{S}/\text{cm}$ (WPB33 and WMB29). Total dissolved solids (TDS) values were reported between 220,000 to 260,000 mg/L across the 3 bores, but these are considered to be erroneous as they are too high for the EC values measured. The laboratory EC values measured are reasonably consistent with the field EC values collected at the end of each bore's development, which ranged between 154,00 and 208,800 $\mu\text{S}/\text{cm}$ for the full depth bores (Table 5.2).
- Laboratory measurements of pH ranged from 6.8 to 7.1, indicating that the groundwater is mildly acidic to neutral. The laboratory pH values are generally consistent with the field pH values (Table 5.2) of 6.1 to 7.2, with the majority of groundwater sampled being mildly acidic.
- The groundwater is dominantly a sodium chloride type, with subsidiary high concentrations of magnesium and sulphate. It is also extremely hard, with total hardness between 30,000 to 37,000 mg/L CaCO_3 .
- The production and monitoring bores' hydrochemical results are plotted on an expanded Durov plot (Figure 5.10) and show that the sampled waters have a very low variation in chemical composition based on the calculated percentage equivalents of the major ions. All 3 samples plotted tightly together in the 9th quadrant, indicating 'end point' waters that are static and no longer interacting with their environment, with no evidence of recharge influence. This is typical of groundwater found in the Goldfields in areas well down the drainage systems and in a salt lake environment.
- Concentrations of metals were mostly low (below the limit of reporting), with only iron and manganese concentrations being elevated in some samples, together with lower levels of zinc and potassium.

The groundwater is hypersaline everywhere and is between 3 to 4 times the salinity of seawater, which has an electrical conductivity of around 55,000 $\mu\text{S}/\text{cm}$. Hypersaline groundwater is typically found in aquifers that are adjacent to and below alluvial flats and playa lakes, (such as Lake Roe), where salinities of up to 300,000 mg/L TDS have been recorded in the Kalgoorlie region. Overall, the groundwater at Bombora is of very poor quality, with only restricted beneficial use. It is suitable for mineral processing water supply where the industrial process used can cope with hypersaline water. The water is far too saline for any agricultural or domestic use.

Table 5.8 Bombora Bores Hydrochemistry Results

Determinands	Bore	WPB26	WPB33	WMB29
	Units / Sampling Date	07/07/25	28/06/25	11/07/25
pH	pH units	6.8	6.8	7.1
Electrical Conductivity @ 25 C	µS/cm	200,000	210,000	210,000
Total Dissolved Solids*	mg/L	220,000	240,000	260,000
Total Alkalinity as CaCO ₃	mg/L	110	36	51
Total Hardness	mg CaCO ₃ /L	30,000	33,000	37,000
Carbonate Alkalinity as CO ₃	mg/L	<5	<5	<5
Bicarbonate Alkalinity as HCO ₃	mg/L	130	44	62
Nitrite, NO ₂ as N	mg/L	<0.05	<0.05	<0.05
Nitrate, NO ₃ as N	mg/L	<0.05	2.6	<0.05
Ammonia, NH ₃ as N	mg/L	0.06	<0.05	0.12
Total Phosphorous as P	mg/L	0.07	<0.02	<0.02
Silica, SiO ₂	mg/L	0.93	6.5	6.3
Sulphate, SO ₄	mg/L	11,000	13,000	14,000
Chloride, Cl	mg/L	160,000	190,000	210,000
Calcium, Ca	mg/L	730	790	710
Potassium, K	mg/L	400	410	490
Magnesium, Mg	mg/L	6,900	7,500	8,600
Sodium, Na	mg/L	67,000	75,000	78,000
Aluminium	µg/L	<1000	<1000	<1000
Arsenic	µg/L	<100	<100	<100
Barium	µg/L	<100	<100	<100
Beryllium	µg/L	<20	<20	<20
Cadmium	µg/L	<10	<10	<10
Chromium	µg/L	<100	<100	<100
Cobalt	µg/L	<100	<100	<100
Copper	µg/L	<100	<100	410
Iron	µg/L	7,800	<1,000	<1,000
Lead	µg/L	<100	<100	<100
Manganese	µg/L	990	540	1,600
Mercury	µg/L	<0.05	<0.05	<0.05
Nickel	µg/L	<200	<200	<200
Selenium	µg/L	<200	<200	<200
Vanadium	µg/L	<100	<100	<100
Zinc	µg/L	290	310	280

* TDS considered to be erroneously high compared to electrical conductivity values

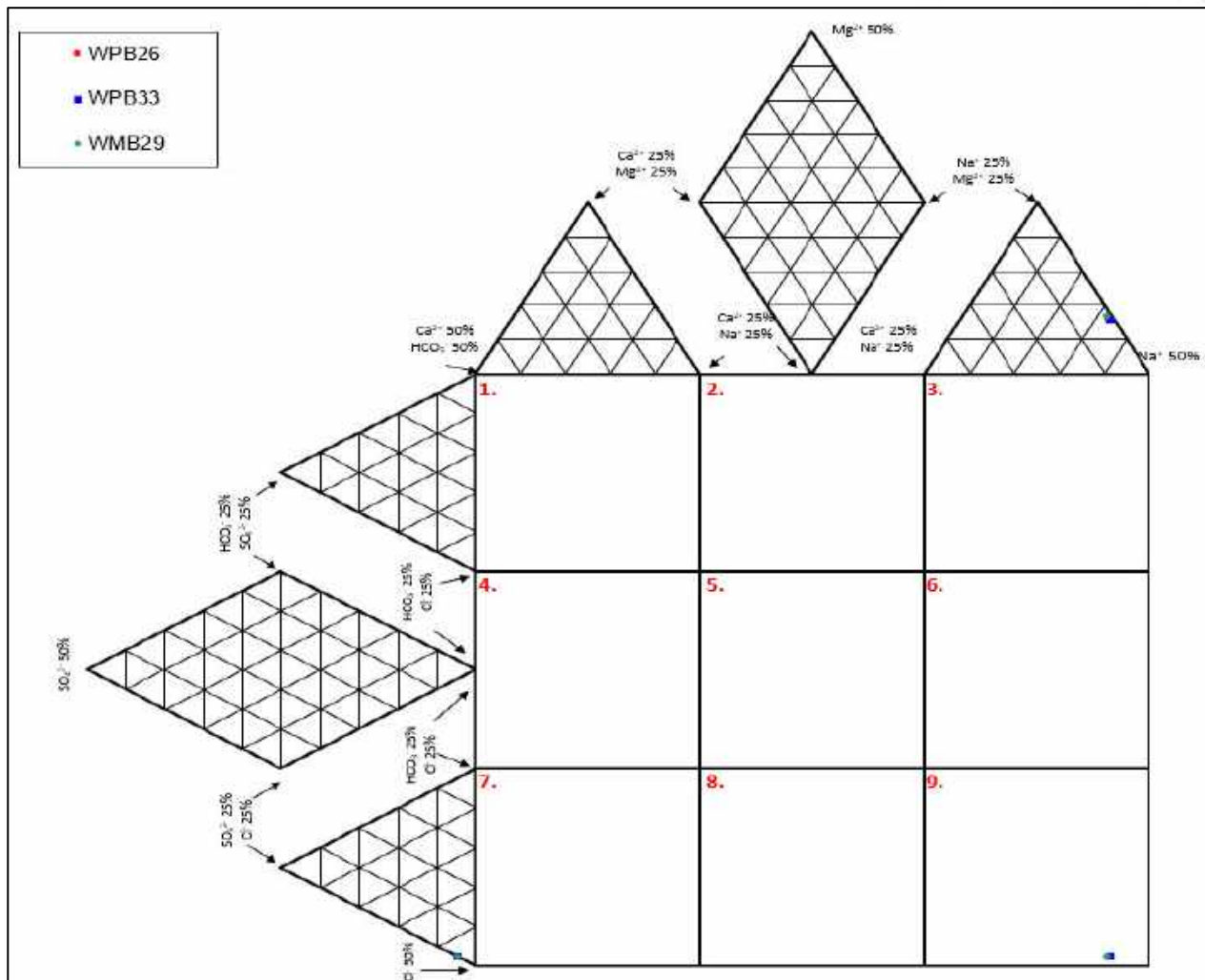


Figure 5.10 Bombora Deposit – Bombora Bores – Hydrochemistry on Expanded Durov Plot

5.3 Site Conceptual Hydrogeological Model

The current understanding of hydrogeological conditions in the Bombora area has been based on the review of all available literature in the region and site specific geological and hydrogeological data, including regional data and site-specific groundwater exploration drilling and hydrogeological investigation data.

The conceptual hydrogeological model for the immediate Bombora deposit area comprises the following key elements:

- The Bombora deposit is characterised by a generally low permeability environment. Aquifer potential (i.e. increased permeability) is limited to weathered /fractured basement (saprock / transition zone) to depth of up to 55 mbgl and discrete fracture zones within the otherwise massive bedrock. Higher permeability values depend upon the intensity of cross cutting faults and lamprophyre dykes (especially increased in swarms). The local faults (e.g. Peninsula Fault) are not considered particularly permeable, although cross faulting/lamprophyre dykes/quartz veins may potentially cause an increase in yields and provide a good hydraulic connection across the site. Below the transition zone aquifer (below 55 m depth), fresh bedrock was intersected with locally fractured zones (highly variable and weakly) that produced minor groundwater yields. The degree of fracturing decreased with increasing depth, with the fresh bedrock being generally massive (unfractured) from about 130 m depth.

- There is also a shallow surficial low permeability aquifer, which consists mainly of clay and silt, with occasionally sand and gravels (i.e. transported deposits). These sediments are generally less than 5 m thick (ranging from 3 to 10m in thickness) and when saturated (below water table) this aquifer is expected to have a permeability of less than 0.03 m/d, with higher permeability for limited sand and gravel lenses present. Slow downward seepage from this aquifer to the underlying weathered/fractured bedrock aquifer is likely to occur, feeding inflow to the open pit.
- While individual hydrostratigraphic units might be considered to be unconfined to semi-confined (e.g. the deeper basement rock aquifers will be partially confined by the low permeability saprolites), overall the aquifers can be considered as one bulk semi-unconfined aquifer system with variable permeability. There is likely to be some hydraulic connection within the units, allowing some groundwater throughflow.
- The summary of bedrock aquifer parameters is presented in Table 5.9 below.

Table 5.9 Summary of Estimated Aquifer Parameters

Aquifer	Average Effective Transmissivity	Average Bulk Permeability	Specific Yield
	(m ² /d)	(m/d)	(%)
Weathered / Fractured Fresh Bedrock (Transition zone up to 55 mbgl)	22	0.47	1
Fresh bedrock with minor fractures (up to 130 mbgl)	2.5	0.03	0.5
Fresh unfractured bedrock (130–200 mbgl)	0.5	0.003	0.5
Fresh unfractured bedrock (200–550 mbgl)	0.25	0.0005–0.001	0.5

This variability of permeability is primarily controlled by the presence of secondary porosity. High values are associated with fractures and shear zones which have been encountered in the bedrock. A decline in transmissivity (increase in the rate of drawdown) typically occurs in fractured rock aquifers with depth as the storage within the fractures is depleted as open fracture occurrence decreases.

- The groundwater levels across the deposits are between and 0.2 and 5.4 mbgl, and at elevations of between 310 and 312.5 mAHD. Groundwater flow is under a very low gradient. The groundwater levels are a subdued representation of the topography, with groundwater flowing generally in the directions towards the Lake Roe.
- Recharge to the aquifers is limited, as indicated by the hypersaline nature of the groundwater quality, and pit inflows are, and will be sustained by groundwater through flow. Groundwater throughflow will be principally through the main aquifer zones (fault/fractured zones) but with minor throughflow in the basement rocks aquifers.

The implications of this conceptual hydrogeological model, with respect to mine dewatering, are discussed in the following section.

6. ASSESSMENT OF DEWATERING REQUIREMENTS

The future groundwater inflow rates to the pits and underground and dewatering requirements at Bombora have been estimated, using an analytical groundwater flow model, based on the conceptual pit dewatering model, the proposed mine development plans, and considering prevailing water level and aquifer conditions.

The following sections:

- Outline the current mine plan and how the pits and underground were simulated in the model.
- Describe the pit and underground inflow models developed and used to confirm the modelling approach and define model geometry and aquifer parameters.
- Describe the analytical model and the model input parameters.
- Present model predictions in terms of individual pit inflows, underground inflows and total inflow volumes.

6.1 Current Mine Plan

Ramelius plans to develop the Bombora mine approximately to 2.5 km in length, which will consist of three open-cut pits (1800, 1100 and 700 pits) together with an underground mine over a total period of 9 years. Current proposed mining development schedules are presented in Figure 6.1, and are summarised in Table 6.1. Details of mining conditions for each open pit and underground are presented in Table 6.2. It should be noted that the underground mining consists of a number of mining areas with varying mine depths and timing. Thus, for the purpose of this assessment four underground areas have been selected and are shown in Figure 6.2.

Table 6.1 Bombora Mine Plan

Mining Pit	2028			2029				2030				2031	2032	2033	2034	2035	2036
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4
1800 Pit																	
1100 Pit																	
700 Pit																	
UG																	

Table 6.2 Mine Plan Stage Details

Pits	Start RL	Finish RL	Depth	Mine Life	Duration of dewatering
	(m AHD)	(m AHD)	(mbgl)	(months)	(months)
1800 Pit	315	200	115	24	105
1100 Pit	315	215	100	12	84
700 Pit	315	285	30	6	6
1800 UG Shallow		110	205	74	74
1800 UG Deep		-230	545	74	74
1100 UG		20	295	60	60
700 UG		-50	365	48	48

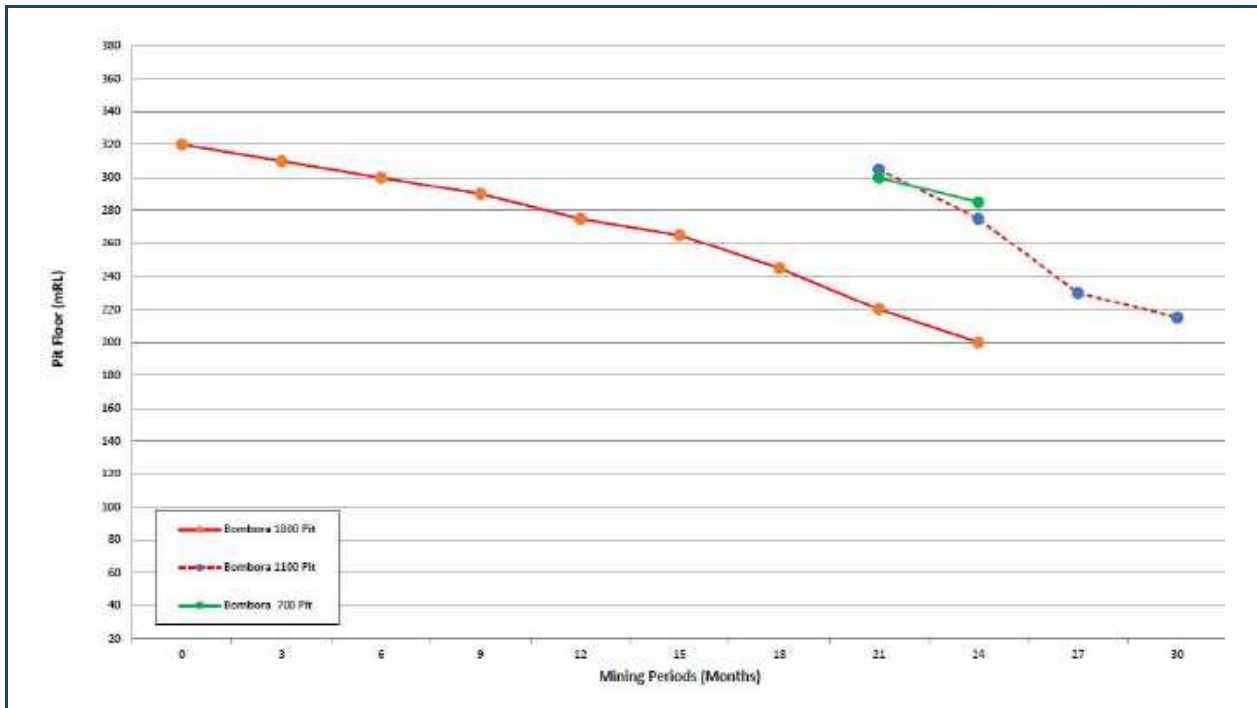


Figure 6.1 Current Proposed Bombora Open Pit Mining Development Schedules

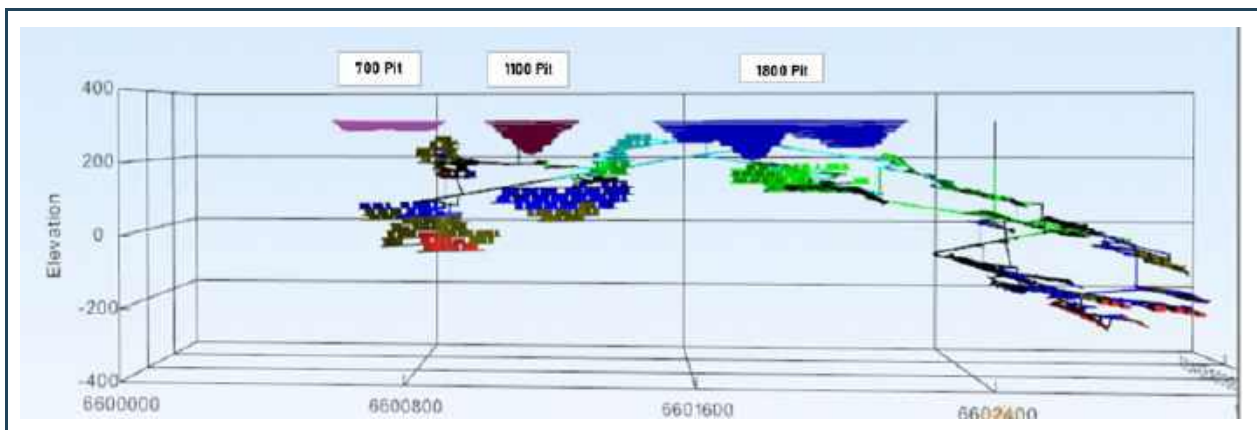


Figure 6.2 Long Section Through Bombora Pits and Underground

Mining of all open pits will be completed prior to the commencement of the underground mining operation. The proposed underground mine will be accessed from three portals located in the 1800 pit and the underground workings will extend some 750 m north of the 1800 pit and beneath the 1100 and 700 pits (Figure 6.2).

These proposed mine schedules were used to develop the simulated “pit shapes” used in pit inflow modelling (refer Section 6.3). Dewatering will only take place once mining is below the groundwater level. Advanced dewatering of the 1800 Pit, will result in parts of the 1100 and 700 Pits being dewatered ahead of mining.

6.2 Conceptual Pit Inflow Model

The following presents a description of a simplified conceptual pit inflow model derived from all available data (presented in Section 5) and AQ2's experience in similar hydrogeological environments. This conceptual model forms the basis for the pit inflow modelling undertaken and comprises the following key elements:

- The bedrock aquifer is underlain by essentially impermeable rocks at depth. While in practice, the aquifer is bounded laterally by very low permeability rocks outside the main mineralised/fractured zones, the conceptual model assumes an aquifer of infinite radial extent. As such, this is a conservative assumption, although it is noted that the proposed 9-year mine life and relatively low bulk permeability mean that the drawdown influence of dewatering will be constrained to a local area around the mine site.
- Two aquifer units, are modelled with:
 - Bulk transmissivity of 22 m²/d (i.e. bulk permeability of 0.5 m/d) for the weathered / fractured bedrock aquifer (a zone of moderate permeability) and specific yield of 1%.
 - Bulk transmissivity of 2.5 m²/d (i.e. bulk permeability of 0.03 m/d) for the fresh bedrock aquifer with locally fractured zones (highly variable, generally of low hydraulic conductivity when fresh) and specific yield of 0.5%.
 - A pre-mining water table of 3 m below surface across the model.
- Groundwater inflow to the pits will commence as soon as they are developed below the water table and will increase as the pits increase in size and depth over the life of mine.
- The potential impacts of localised higher permeability zones within the weathered / fractured bedrock aquifer are captured in the bulk transmissivity adopted for this aquifer. Chilled margins of lamprophyre dykes have been identified within the Bombora deposit and have possible locally higher permeability (i.e. fractures) that could increase groundwater inflow to the pits. It is likely that these fracture zones are local and of low storage, thus the increased groundwater inflow will be short lived.
- Given the proximity of the 1800, 1100 and 700 Pits to one another and the conceptual hydrogeological model, there will be significant hydraulic connection between the pits and all pits will tend to act as one large pit (in terms of intersecting groundwater flow).
- There is no direct aquifer recharge to the mine area during the mine life. Recharge to the aquifers is limited, as indicated by the hypersaline nature of the groundwater quality, and pit inflows are, and will be sustained by groundwater through flow. However, at the lake area some groundwater recharge may occur by infiltration of wet season surface water runoff to the shallow surficial aquifer, followed by leakage to the deep aquifer. The groundwater quality discussed in Section 5.2.6 indicates a very slow recharge process to the deep aquifer.

6.3 Pit Inflow Model

6.3.1 Modelling Approach

An analytical modelling approach was adopted to simulate groundwater inflows and provide estimates of pit dewatering requirements. The approach predicts groundwater inflow to the pit from aquifers surrounding the pit over set time periods.

Like all models, this approach makes a number of simplifying assumptions (principally that the aquifer system is homogeneous and isotropic) and model predictions cannot be considered to be precise. However, this approach does allow for the broad estimation of pit inflows based on limited data and has historically proven to be very close to observed inflows. At other nearby mines in the Goldfields, this modelling approach has provided predicted dewatering rates comparable with those derived from more complex (and more time consuming and expensive) numerical modelling.

Notwithstanding the above, there are inherent constraints to any modelling (due to limited aquifer distribution data) and it is generally considered that predicted dewatering requirements should be considered (at best) **to be plus or minus 25%.**

The model used is a two-dimensional analytical model based on the Theim and Dupuit-Forchheimer equations for flow to a large diameter well. Key steps in the model approach are as follows:

- Average aquifer parameters are applied to each equivalent well (representing stages of the pit).
- The aquifer systems present at Bombora are lumped into two single aquifer units with bulk average aquifer transmissivity for each unit (refer to Section 6.2).
- The pit, or various sections of the pit, are represented by a series of large diameter “equivalent wells” of similar area and depth at various time steps, representing various stages of pit development.
- The model is used to calculate the pumping rate required to maintain pumping water levels in each equivalent well at or below the base of each equivalent well (pit base) at the end of each time step. For each time-step, the groundwater level is lowered to the base of the pit active during that time-step and the inflows calculated at the end of the time step.
- The results provide a good approximation of the inflows to the pit.

6.3.2 Model Setup

The Project area was divided into three discrete model areas for each three pits (1800, 1100 and 700 Pits). Figure 6.3 shows long section through the Bombora area and the vertical pit shape (and depths of the final equivalent wells representing the various sections of each pit), simulated in the model. The distances of the equivalent wells representing the pits were derived from the plan areas.

Pit inflows were then simulated as follows:

- In all models, the inflows do not take into account short duration (higher) inflows associated with discrete, low storage structures (i.e. faults, shears, fractures). Individual structures could have **burst flows of between 5 and 15 L/s, but for limited time periods.** The short duration higher inflows will not significantly modify average long term inflows.
- The starting groundwater level in each pit model was set at:
 - 311 mAHD at 1800 Pit.
 - 290 mAHD at 1100 Pit, assuming that by the time mining of 1100 Pit starts, the groundwater level is likely to have dropped by 22 m due to dewatering of the adjacent 1800 Pit.
 - 297 mAHD at 700 Pit (i.e. 15 m below the pre-mining water levels), assuming that advanced dewatering of the adjacent 1800 Pit will result in part of the 700 Pit being dewatered ahead of mining.
- The effective base of the weathered / fractured bedrock aquifer was assumed to be at 265 mAHD (i.e. 55 mbgl), while the base of the fresh bedrock was assumed to be at 190 mAHD (i.e. 130 mbgl) approximately 10 m below the base of the deepest pit (i.e. 1800 Pit).
- Aquifer parameters (permeability and specific yield) for each modelled pit were adopted based on the conceptual model described in Section 6.1.

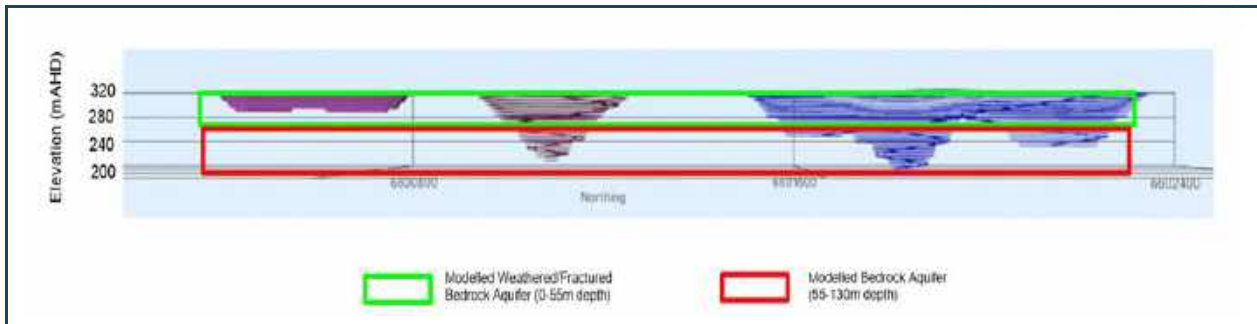


Figure 6.3 Long Section Through Bombora Pits Showing Modelled Vertical Pit Shape

6.3.3 Predicted Pit Inflows

Table 6.3 summarises the pit inflow predictions (i.e. base case) for required dewatering rates over the open pit mining (Year 1 to Year 3). The base case model runs use average values for aquifer permeability (as determined from hydraulic testing) and are considered the most reliable based on available data.

Table 6.3 Summary of Pit Inflow Predictions

Mining Schedule	Mining Year	Mining Months	Bombora 1800 Pit			Bombora 1100 Pit			Bombora 700 Pit			Total Inflows (All Pits) (L/s)
			Upper Aquifer (L/s)	Lower Aquifer (L/s)	Total (L/s)	Upper Aquifer (L/s)	Lower Aquifer (L/s)	Total (L/s)	Upper Aquifer (L/s)	Lower Aquifer (L/s)	Total (L/s)	
FY2028 Q1	1	0-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY2028 Q2		4-6	2.9	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	3
FY2028 Q3		7-9	11.2	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	11
FY2028 Q4		10-12	15.1	0.0	15.1	0.0	0.0	0.0	0.0	0.0	0.0	15
FY2029 Q1	2	13-15	17.5	0.0	17.5	0.0	0.0	0.0	0.0	0.0	0.0	17
FY2029 Q2		16-18	16.2	0.0	16.2	0.0	0.0	0.0	0.0	0.0	0.0	16
FY2029 Q3		19-21	15.6	3.0	18.6	0.0	0.0	0.0	0.0	0.0	0.0	19
FY2029 Q4		22-24	15.1	2.9	18.0	0.0	0.0	0.0	0.0	0.0	0.0	18
FY2030 Q1	3	25-27	14.7	2.3	17.1	0.0	0.0	0.0	3.9	0.0	3.9	21
FY2030 Q2		28-30	14.4	2.2	16.6	3.6	0.0	3.6	0.0	0.0	0.0	20
FY2030 Q3		31-33	14.1	2.2	16.2	4.6	2.7	7.3	0.0	0.0	0.0	24
FY2030 Q4		34-36	13.8	2.1	15.9	4.3	2.0	6.3	0.0	0.0	0.0	22

Salient points of the estimated inflows are as followed:

- The base case models predict total groundwater inflows to the pits of between 3 L/s (260kL/d) to 24 L/s (2,100 kL/d), averaging about 17 L/s (1,500 kL/d).
- Potential total groundwater inflows to the pits will possibly be as high as:
 - up to 19 L/s at the end of mining 1800 Pit (Year 2).
 - up to 7 L/s at the end of mining 1100 Pit (Year 3).
 - up to 4 L/s at the end of mining 700 Pit (Q1 Year 3).

- It should be noted, however, that the above predictions take no account of evaporative losses from the pit wall (from seepage faces) or from the pit base (sumps and ponded areas). Net inflows (i.e. those requiring dewatering pumping) could be only 50 to 60% of those predicted (especially during the summer period). **Therefore, actual dewatering abstraction (from pit sumps) is likely to be less than predicted (in order of 2 to 10 L/s).**
- It should also be noted that the above does not account for any surface water runoff, which may report to the pits during high rainfall events (i.e. pit floor, pit walls and area of pit crest within flood protection bunding). In an average rainfall year, potential evaporation far exceeds rainfall and while there may be some minor runoff to the pits during a rainfall event, on average there should be no net recharge to the pits. However, there could be significant runoff to the pits during extreme rainfall events which would need to be pumped from the pits along with groundwater inflows. Thus, total inflows (and dewatering requirements) will, at times, be in excess of the predicted groundwater inflow.

These estimated pumping rates can be compared to dewatering rates achieved historically from open pits in the Kalgoorlie region, where mining occurs on or adjacent to the salt lake, with no presence of palaeochannel, indicate dewatering at rates between **6 and 29 L/s (Johnson et al (1999)).**

6.4 Predicted Inflows to Underground Workings

6.4.1 Modelling Approach

The same model used to predict pit inflows (refer to Section 6.4) was modified to predict groundwater inflows to the planned underground development. An analytical modelling approach was adopted to simulate groundwater inflows from aquifers surrounding the mine workings and provide estimates of underground dewatering requirements.

The model is a simple analytical groundwater flow model based on the Dupuit-Forcheimer and Theim Equations for groundwater flow to a large diameter well. Key steps in the model are as follows:

- The mine workings are represented by a large diameter “equivalent well” of similar area and depth as the final underground mine workings.
- The model is used to calculate the pumping rate required to maintain pumping water levels in the equivalent well at or below the base of the mine workings. The results provide a good approximation of the total groundwater inflows to the mine workings.
- The Project area was divided into four discrete model areas for each underground section (i.e. 1800 UG Shallow, 1800 UG Deep, 1100 UG and 700 UG). Figure 6.4 shows long section through the Bombora area and the vertical pit shape (and depths of the final equivalent wells representing the various sections of each underground area), simulated in the model. The distances of the equivalent wells representing the pits were derived from the plan areas.
- It noted that the planned underground workings are adjacent to the planned pits and underground mine inflows will be influenced by drawdowns around the pits. That is, inflows to the underground workings cannot be considered in isolation from pit inflows. Taking the above into account, it was assumed that the 1800 and 1100 Pits will need to be maintained dry throughout the LOM (i.e. local water level will be effectively lowered to the level of the base of the pit) and that the pits will intercept most/all groundwater inflows.
- Average aquifer parameters are adopted (refer to Table 5.9).

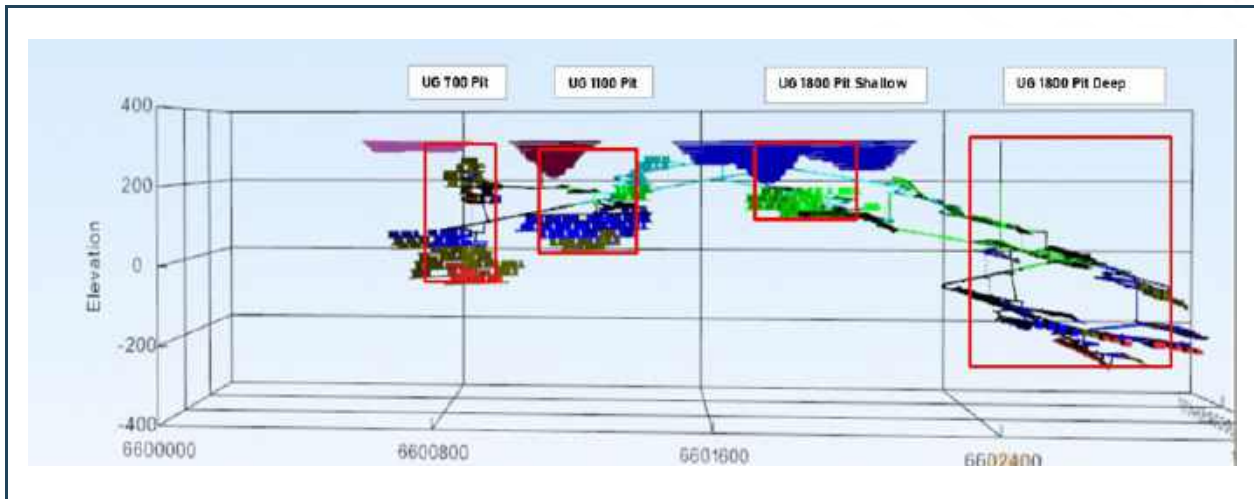


Figure 6.4 S-N Long Section Through Bombora Underground Showing Modelled Vertical Pit Shape

6.4.2 Predicted Underground Inflows

Table 6.3 summarise the pit and underground inflow predictions (i.e. base case) for required dewatering rates over the underground mining (Year 4 to Year 9).

Table 6.4 Summary of Underground Inflow Predictions

Year	Mine Months	Bombora UG					Total Inflows (UG and Pits)
		UG 1800 Pit Shallow	UG 1800 Pit Deep	UG 1100 Pit	UG 700 Pit	Total (L/s)	Total(L/s)
4	34-48	2.2		2.9		5.1	23.3
5	49-60	2.7	6.5	2.0		11.2	28.6
6	61-72	2.2	6.3	1.7	1.9	12.1	32.0
7	73-84	2.0	6.9	1.7	1.8	12.4	31.7
8	85-96	1.8	5.7	1.6	1.7	10.8	29.5
9	97-108	1.7	5.0		1.5	8.2	26.5

Total inflows to the underground mine workings are in order of 5 to 12.5 L/s, however for each separate underground area (i.e. nearby 700, 1100 and 1800 Pits) groundwater inflows are predicted to be between 1.5 L/s and 7 L/s (2 L/s on average for the shallower underground workings and 5 to 7 L/s for the deep underground workings).

6.5 Predicted Total Mine Inflows

It should be noted that Bombora 1800 and 1100 Pits will have to be kept dry to allow the underground mining (i.e. local water level will be effectively lowered to the level of the base of the pits). Therefore, 1800 and 1100 Pits will be pumped over the life of mine, with 700 Pit being pumped later in Year 3 of underground mining (i.e. Year 6 of mine life).

Total groundwater inflows (all open pits and underground areas) are predicted to be up to 32 L/s (in Year 6 and 7) and are summarised in Table 6.5 and presented in Figure 6.4.

The key aquifer parameter in determining pit and underground inflows is aquifer permeability. There is always some inherent uncertainty in any model prediction, particularly in fractured rock aquifers. The base case predictions adopted conservative approaches and can be considered as high case (i.e. “worse case” for water management perspective). However, it is generally considered that predicted dewatering requirements should be considered to be plus or minus 25%.

Table 6.5 Predicted Total Groundwater Inflows to Pits and Underground

Mining Schedule	Mining Year	Mining Months	Bombora 1800 Pit	Bombora 1100 Pit	Bombora 700 Pit	Bombora Underground	Total Inflows (All Pits & UG)
			Total (L/s)	Total (L/s)	Total (L/s)	Total (L/s)	(L/s)
FY2028 Q1	1	0-3	0.0	0.0	0.0	0.0	0
FY2028 Q2		4-6	2.9	0.0	0.0	0.0	3
FY2028 Q3		7-9	11.2	0.0	0.0	0.0	11
FY2028 Q4		10-12	15.1	0.0	0.0	0.0	15
FY2029 Q1	2	13-15	17.5	0.0	0.0	0.0	17
FY2029 Q2		16-18	16.2	0.0	0.0	0.0	16
FY2029 Q3		19-21	18.6	0.0	0.0	0.0	19
FY2029 Q4		22-24	18.0	0.0	0.0	0.0	18
FY2030 Q1	3	25-27	17.1	0.0	3.9	0.0	21
FY2030 Q2		28-30	16.6	3.6	0.0	0.0	20
FY2030 Q3		31-33	16.2	7.3	0.0	0.0	24
FY2030 Q4		34-36	15.9	6.3	0.0	0.0	22
FY2031 Q1-Q4	4	37-48	14.3	3.9	0.0	5.1	23
FY2032 Q1-Q4	5	49-60	13.8	3.6	0.0	11.2	29
FY2033 Q1-Q4	6	61-72	13.3	3.4	3.2	12.1	32
FY2034 Q1-Q4	7	73-84	13.0	3.3	3.0	12.4	32
FY2035 Q1-Q4	8	85-96	12.7	3.2	2.8	10.8	30
FY2036 Q1-Q4	9	97-108	12.4	3.2	2.7	8.2	27

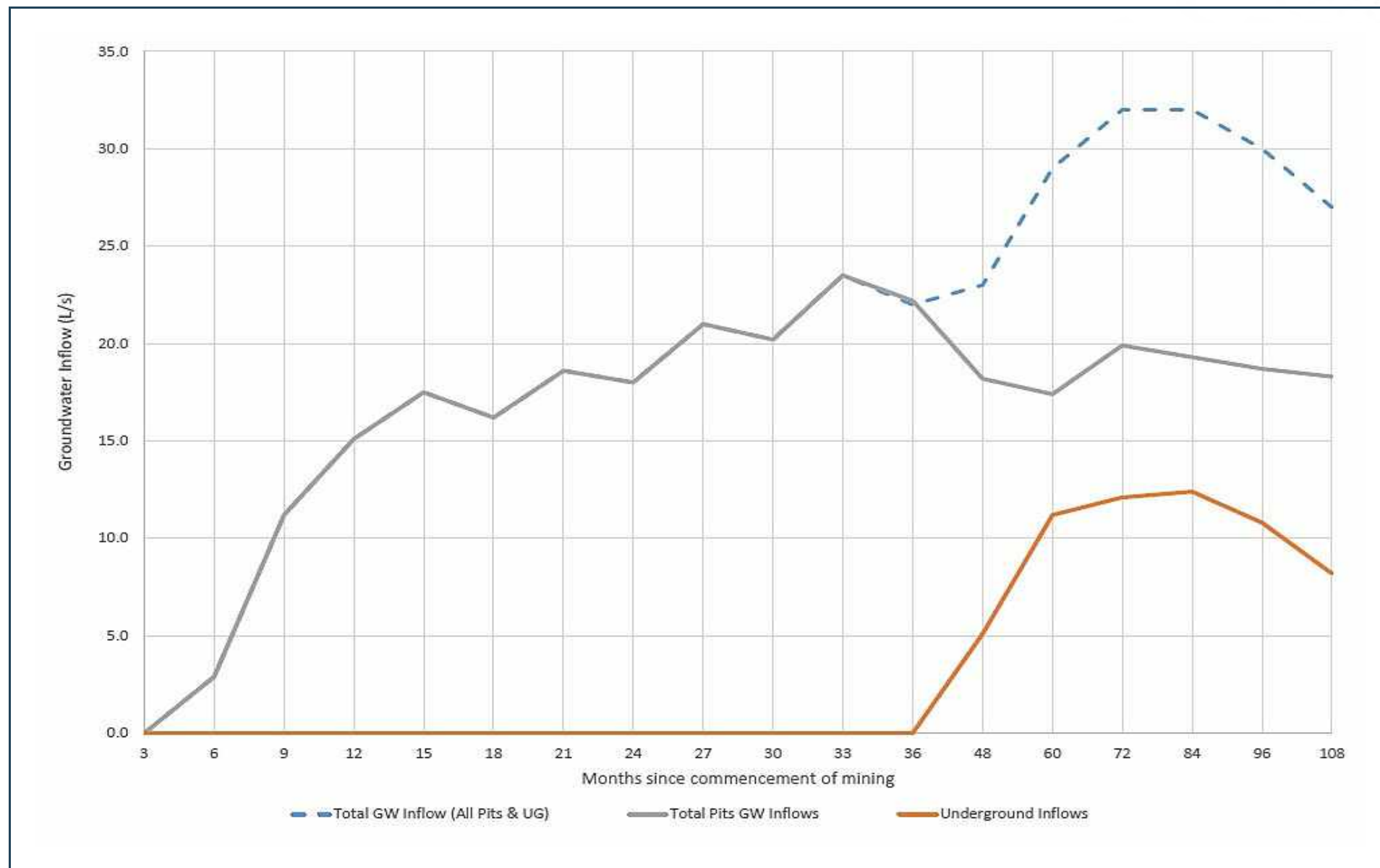


Figure 6.5 Predicted Life of Mine Groundwater Inflows

7. RECOMMENDED DEWATERING MANAGEMENT APPROACH

Given that predicted groundwater inflows into the 1800, 1100 and 700 Pits are relatively low (Section 6), the most practical and cost-effective water management (dewatering) strategy will be to manage all net pit inflows including any rainfall runoff inflows with pit floor sump pumping at each pit. It should be noted that due to the generally low permeability environment, the local bedrock aquifer is highly unlikely to sustain borehole pumping and the use of pit-perimeter dewatering bores will not be feasible (i.e. pumping yields from bores would be low and the bores would have a small radius of influence).

Pit sump pumps would be sized to accommodate runoff from peak rainfall events. As such, sump pumps would only pump irregularly during normal operation (as individual pump capacity would exceed groundwater inflows). Pit sumps would pump to evaporation ponds on site where water can be used for dust suppression and other non-potable mine site uses as required. There should not be any discharge of the surplus dewatering into the environment.

Underground dewatering should be achieved through a series of sumps at increasing depths as the mine progresses. This can easily be managed by standard “off-the-shelf” mine dewatering pumping equipment. Sump pumping capacity (far in excess of the pumping capacity to manage groundwater inflows) will be required to manage runoff to the open pits and the box-cut following high rainfall events.

In terms of further investigation work required to improve the reliability of inflow predictions and reduce potential water risks, there is little practical work that we can recommend other than:

- Monitor pit inflows as these provide the best guide to what will happen at depth below the pits.
- During underground development, consider cover drilling ahead of any new drive into areas of suspected faulting or shearing. The cover holes will provide advanced warning of any potential “burst” and also help to dewater/depressurise any such wet structures.
- If pore pressure is considered a potential geotechnical risk, install underground piezometers in lateral drill-holes at various mine levels to allow for the derivation of pore pressures acting on drive walls, backs and floors.

8. ASSESSMENT OF POTENTIAL IMPACT OF DEWATERING

8.1 Predicted Extent of Drawdowns

Due to the low permeability of the ground in the Project area, drawdown extents from dewatering of the Bombora open pits and underground are not anticipated to be extensive.

The maximum extent of the drawdown (radius of influence) has been calculated using the analytical model derived from the Cooper-Jacob equation below:

$$r_o = \sqrt{\frac{2.25 * k * h_o * t}{S_y}}$$

where: r_o = radius of maximum extent of cone of drawdown (m)

k = hydraulic conductivity (m/d)

h_o = height of SWL above base of aquifer (m)

t = time since pumping or inflow started (days)

S_y = specific yield (unitless).

This analytical model adopted parameters based on conceptual model referred in Section 5. The predicted maximum extent of drawdowns (i.e. the distance where there is no lowering of water table or potentiometric surface) in response to active dewatering depends upon the depth of mining, the permeability of the aquifer material and the duration of mining. The model predicts the maximum distance that drawdown extends in response to active dewatering at Bombora is **up to 4 km along the weathered / fracture zones and less than 2 km in areas of no fracturing** with a lower bulk permeability. It should be borne in mind that this distance is based on the prevailing aquifer conditions extending over that full distance; in reality, in a basement rock aquifer environment, aquifers are unlikely to be that extensive and some types of barriers would be expected (i.e. dyke intrusions, or changes in geology), thus reducing the extent of drawdown. The **4 km distance should therefore be seen as a theoretical maximum.**

In addition, a simple analytical model based on the Theis equation (refer to Kruseman and de Ridder, 1994 for more details) was used to predict drawdowns along and across the fracture zones as a result of dewatering pumping for 1, 2 and 3 years (open pit mining) and 9 years (LOM). Cumulative drawdown impacts at Bombora due to combined abstractions have been assessed based on a simple interference drawdown assessment (addition) and the cumulative drawdown contours after 1, 2, 3 and 9 years are shown in **Figures 8.1 to 8.4. The predicted maximum extent of the 1 m drawdown contour is approximately up to 2.7 km (from the edge of the pits) at the end of mining.**

It should also be pointed out that the weathered / fractured bedrock aquifer (transition zone) was modelled using the bulk permeability of 0.5 m/d (i.e. 5×10^{-6} m/s), which is considered to be free draining (while dewatering of the fresh bedrock aquifer below). In the low permeability rocks (i.e. below 55 mbgl), the area affected by dewatering would not extend far from the dewatering stress (i.e. far from pit wall into the aquifer) and there may be some high hydrostatic pressure behind the pit walls (subject to geotechnical analysis, depressurisation of the pit walls may be required, at least in susceptible areas).

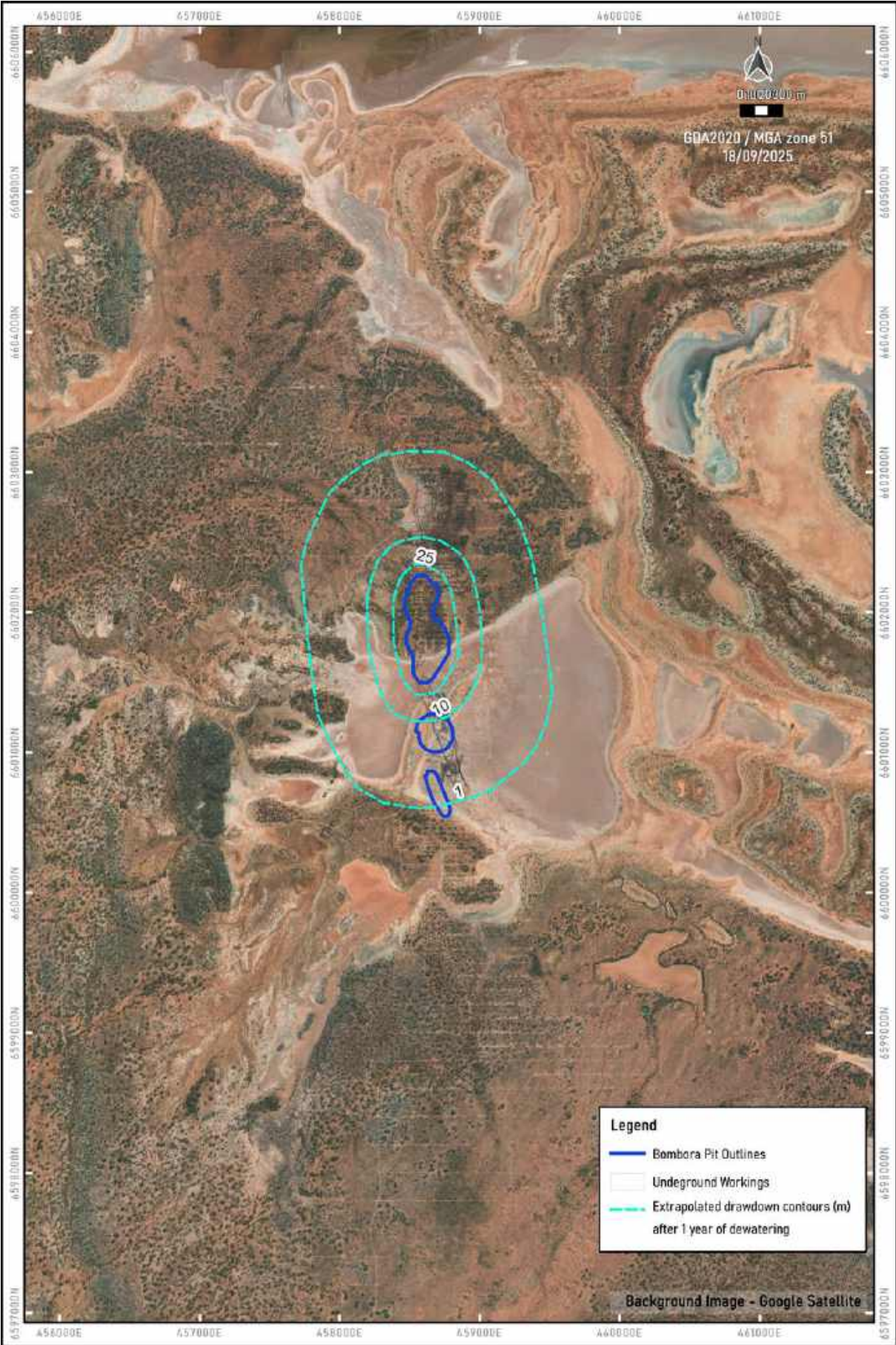


Figure 8.1 Predicted Long Term Cumulative Drawdowns After 1 Year of Dewatering

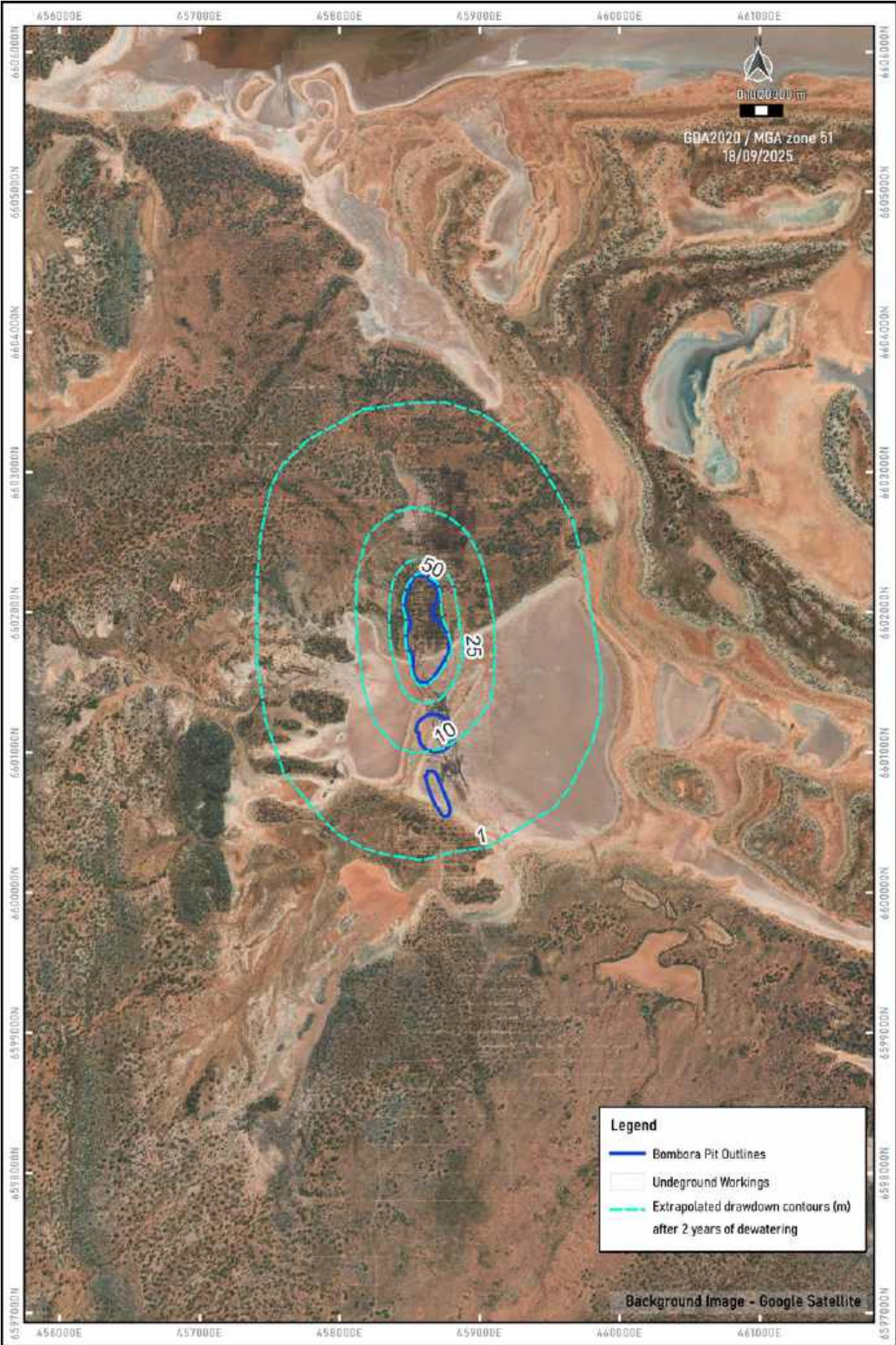


Figure 8.2 Predicted Long Term Cumulative Drawdowns After 2 Years of Dewatering

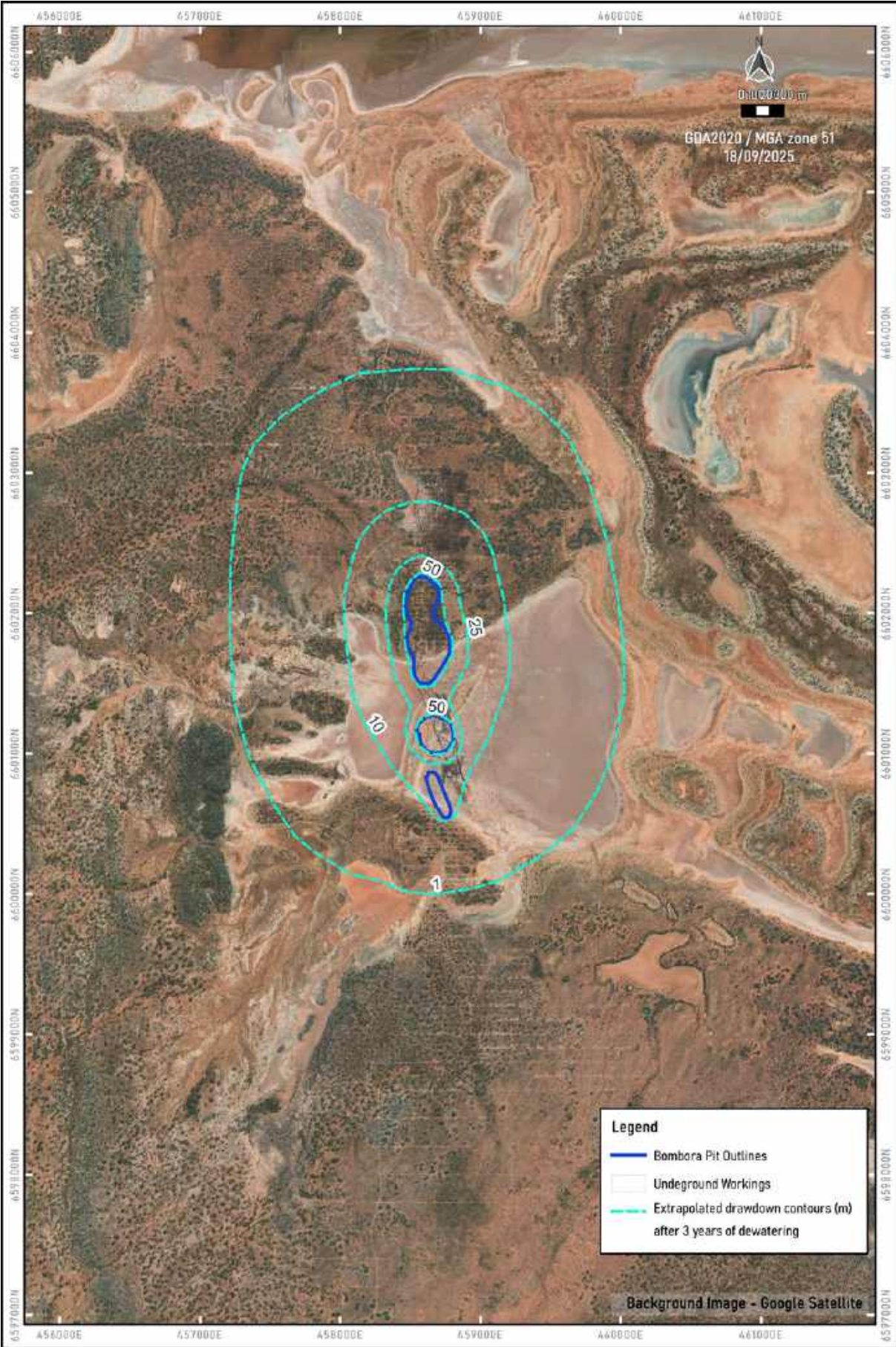


Figure 8.3 Predicted Long Term Cumulative Drawdowns After 3 Years of Dewatering

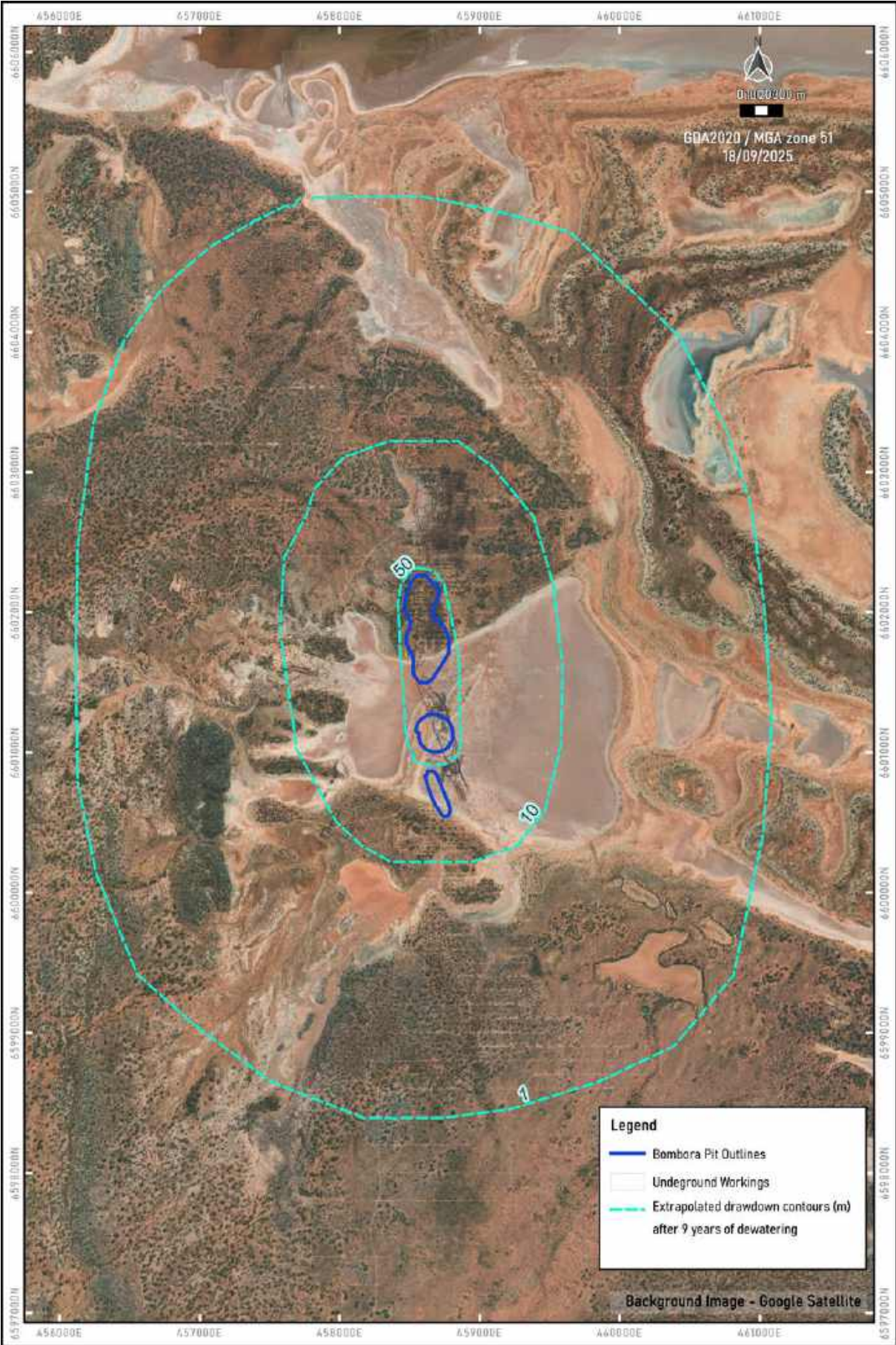


Figure 8.4 Predicted Long Term Cumulative Drawdowns After 9 Years of Dewatering

8.2 Potential Impacts

Potential impacts caused by dewatering abstraction from the Bombora pits and underground mining on hydrogeological processes are discussed below.

8.2.1 Aquifers

The predicted dewatering abstraction from the weathered / fractured bedrock aquifers is highly unlikely to have any adverse impacts on the water supply potential of the overall aquifer system outside of the immediate mining area.

Groundwater at the Project is hypersaline (**more than 140,000 mg/L TDS**). As the beneficial use of the groundwater is ore processing and mine water usage, any decrease in water quality (if evident) is unlikely to have any environmental impact.

8.2.2 Impact on Existing Other Groundwater Users

Based on the data available through the DWER databases (Section 4.3), the nearest other weathered/fractured bedrock aquifer groundwater user is located approximately 14 km to the south from the Project (Figure 4.4), therefore no groundwater users are likely to be impacted by the proposed Project dewatering.

8.2.3 Impact on Groundwater Dependent Ecosystems

There are no known GDEs within the predicted maximum radius of the cone of depression (i.e. drawdowns up to 4 km), thus the proposed groundwater abstraction from the project area is highly unlikely to have any adverse impacts on any GDEs. **The local groundwater is saline and does not support any groundwater dependent ecosystems.** There are no known subterranean fauna in the area and local vegetation is likely to rely on sporadic rainfall and overland water flow events (i.e. supported by fresh soil moisture in the vadose zone above the local water table.)

9. PROPOSED GROUNDWATER MONITORING

A detailed proposed management framework for the Bombora mine will be outlined in the Groundwater Operating Strategy (GWOS), which will be prepared and submitted to DWER to support a 5C licence application (i.e. together with this H2 Level Assessment report). The GWOS includes a groundwater monitoring programme that is designed to assess aquifer performance, the potential impacts of proposed groundwater abstraction and specify operational requirements. GWOS data will be compiled in regular monitoring reports and the monitoring programme will be amended as necessary.

The following two monitoring schedules are proposed as part of the GWOS (Table 9.1), which cover periods of active and inactive mining and dewatering:

- Active mining and dewatering – when groundwater is abstracted from the water source for dewatering purposes, an extensive monitoring programme is undertaken.
- Inactive dewatering and mining (Care and Maintenance) - when there is no dewatering pumping, due to temporary shutdown of mining operations or the mine is placed in Care of Maintenance status, limited monitoring only is required.

Table 9.1 Proposed Groundwater Monitoring Programme

Monitoring Site Location	Data Requirement	Frequency
Active Dewatering and Mining		
Mining pits & UG (when active)	Groundwater Abstraction Volume (cumulative flow readings)	Monthly
	Field Water Quality – pH, EC, temp	Quarterly
	Laboratory Analysis (Comprehensive Component Analysis*)	Annually
Monitoring Bores	Water levels	Monthly
Care and Maintenance		
Mining pits (when inactive)	Pit water level	Annually
	Field Water Quality – pH, EC and temp	Annually
Monitoring Bores	Water levels	Annually

* pH, Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (as CaCO₃), Total Alkalinity (as CaCO₃), carbonate (CO₃), bicarbonate (HCO₃), calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), ammonia (NH₃), phosphate (PO₄), chloride (Cl), sulphate (SO₄), nitrate (NO₃), silica (SiO₂), aluminium (Al), iron (Fe), manganese (Mn), arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se) and zinc (Zn).

10. SUMMARY AND CONCLUSIONS

Ramelius Resources are currently undertaking a Definitive Feasibility Study for the Roe Gold Project, associated with the Bombora gold deposit, located approximately 100 km east of Kalgoorlie and about 45 km southwest of Ramelius' Rebecca Gold Project.

Ramelius plans to develop Bombora mine to approximately 2.5 km in length, which will consist of three open-cut pits (1800, 1100 and 700 Pits) together with an underground mine over a total period of 9 years. Mining of all open pits will be completed prior to the commencement of the underground mining operation. The proposed underground mine will be accessed from three portals located in the 1800 pit and the underground workings will extend some 750 m north of the 1800 pit and beneath the 1100 and 700 pits. Parts of all 3 pits lie within one of the larger salt lakes of the Lake Roe system, with the southern half of the underground mine beneath it.

To enable optimal resource recovery, the mining at Bombora will occur below the groundwater level and hence, dewatering of the open-cut pits and underground workings is required to provide dry mining conditions. Any dewatering volumes abstracted from the Bombora mine is planned to be used on-site for dust suppression and construction purposes, with any excess water being discharged into the evaporation ponds located at Bombora. There will be no discharge of surplus dewatering into the environment (i.e. Lake Roe). Mineral processing is planned to take place at Rebecca, with ore being transported from Roe to it. A 65 km long haul road is planned to be constructed to link the Rebecca and Roe Project sites together.

A hydrogeological drilling investigation was carried out. A total of 17 monitoring bores (WMB19 to WMB35) and 2 test production bores (WPB26 and WPB33) were drilled across the Project area. Bore depths ranged from 50 m (WMB33) to 200 m (WMB23, WMB24 and WMB25). Bore depths were selected based on the planned depth of mining operation in the respective areas, with the intention of having the bores penetrate to the base of the open pits. Following their completion, the 2 test production bores were test pumped to determine aquifer parameters. In addition, all of the installed monitoring bores had hydraulic tests carried out on them.

Using the testing and drilling data, a conceptual hydrogeological model was formulated. Pit and underground inflows (and thus dewatering requirements) were then predicted for Bombora using analytical groundwater flow models and using aquifer parameters derived from both literature historical dewatering records and recent field investigation. The key outcomes of this assessment are:

- Total groundwater inflows (all open pits and underground areas) up to 32 L/s (in Year 6 and 7).
- Total inflows from the open pits between 3 L/s and 24 L/s:
 - up to 19 L/s at the end of mining 1800 Pit (Year 2).
 - up to 7 L/s at the end of mining 1100 Pit (Year 3).
 - Up to 4 L/s at the end of mining 700 Pit (Q1 Year 3).
- Total inflows to the underground mine workings are in order of 5 to 12.5 L/s, however for each separate underground area (i.e. nearby 700, 1100 and 1800 Pits) groundwater inflows are predicted to be between 1.5 L/s and 7 L/s (i.e. 2 L/s on average for the shallower underground workings and 5 to 7 L/s for the deep underground workings).
- The 1800 and 1100 Pits will have to be kept dry to allow the underground mining (i.e. local water level will be effectively lowered to the level of the base of the pits). Therefore, 1800 and 1100 Pits will be pumped over the life of mine, with the 700 Pit being pumped later in Year 3 of underground mining (i.e. Year 6 of mine life).
- The above open pit inflow predictions take no account of evaporative losses from the pit wall (from seepage faces) or from the pit base (sumps and ponded areas). Net inflows (from the pit sumps) are likely to be less than predicted.

- The above open pit rates do not account for any surface water runoff, which may report to the pits during high rainfall events (i.e. pit floor, pit walls and area of pit crest within flood protection bunding). Thus, total inflows (and dewatering requirements) will, at times, be in excess of the predicted groundwater inflow (but only in the short term).
- The most practical and cost-effective water management (dewatering) strategy will be to manage all inflows including any rainfall runoff inflows with pit floor sump pumping at each pit. It should be noted that the local bedrock aquifer is highly unlikely to sustain borehole pumping and the use of pit-perimeter dewatering bores will not be feasible.
- Underground dewatering should be achieved through a series of sumps at increasing depths as the mine progresses. This can easily be managed by standard “off-the-shelf” mine dewatering pumping equipment. Sump pumping capacity (far in excess of the pumping capacity to manage groundwater inflows) will be required to manage runoff to the open pits and the box-cut following high rainfall events.
- The extent of the cone of depression in the groundwater level due to dewatering depends on the depth of mining and the duration of pumping. Regional drawdowns will be constrained by the low permeability of the bedrock away from the immediate mine area. The maximum theoretical extent of the drawdowns is likely to be constrained to within 4 km of the mine.
- The predicted drawdown extent is unlikely to impact on any other groundwater users (the closest other GWL user is approximately 14 km away from the Bombora mine). There are also no known groundwater dependent ecosystems within the radius of the influence of dewatering pumping.
- A groundwater monitoring programme as a part of the proposed project has been designed to assess potential aquifer-impacts and operational requirements.

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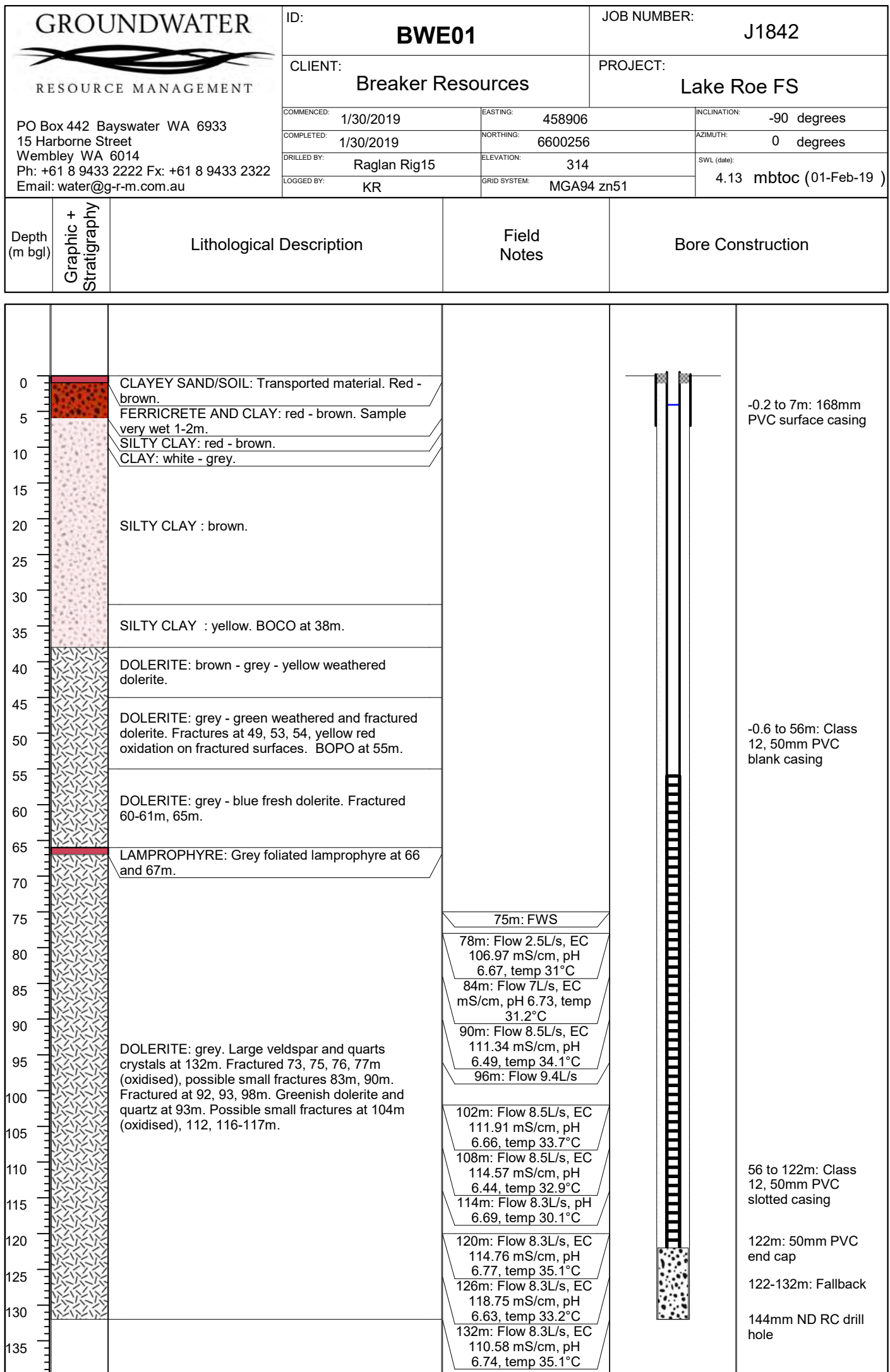
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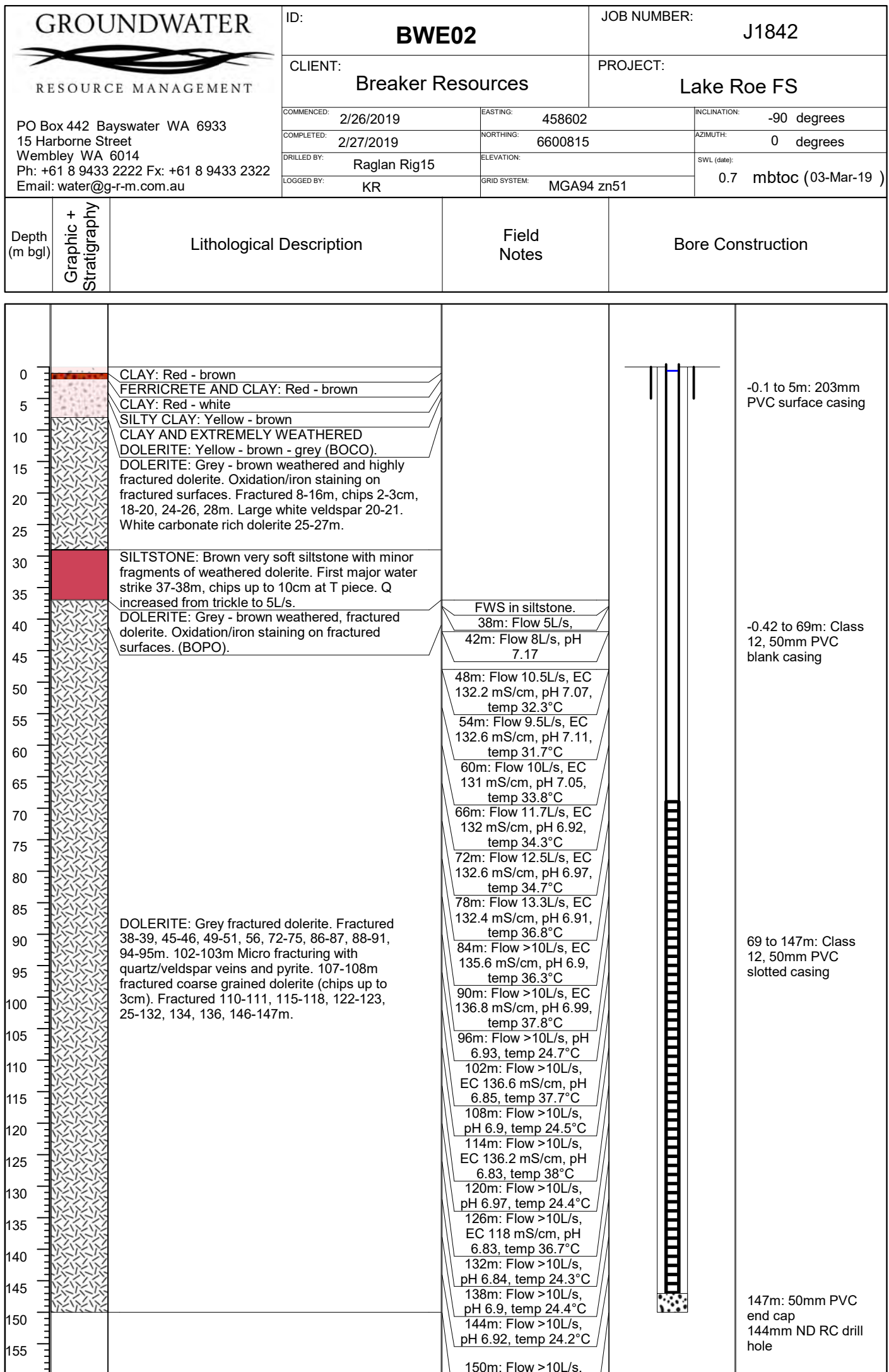
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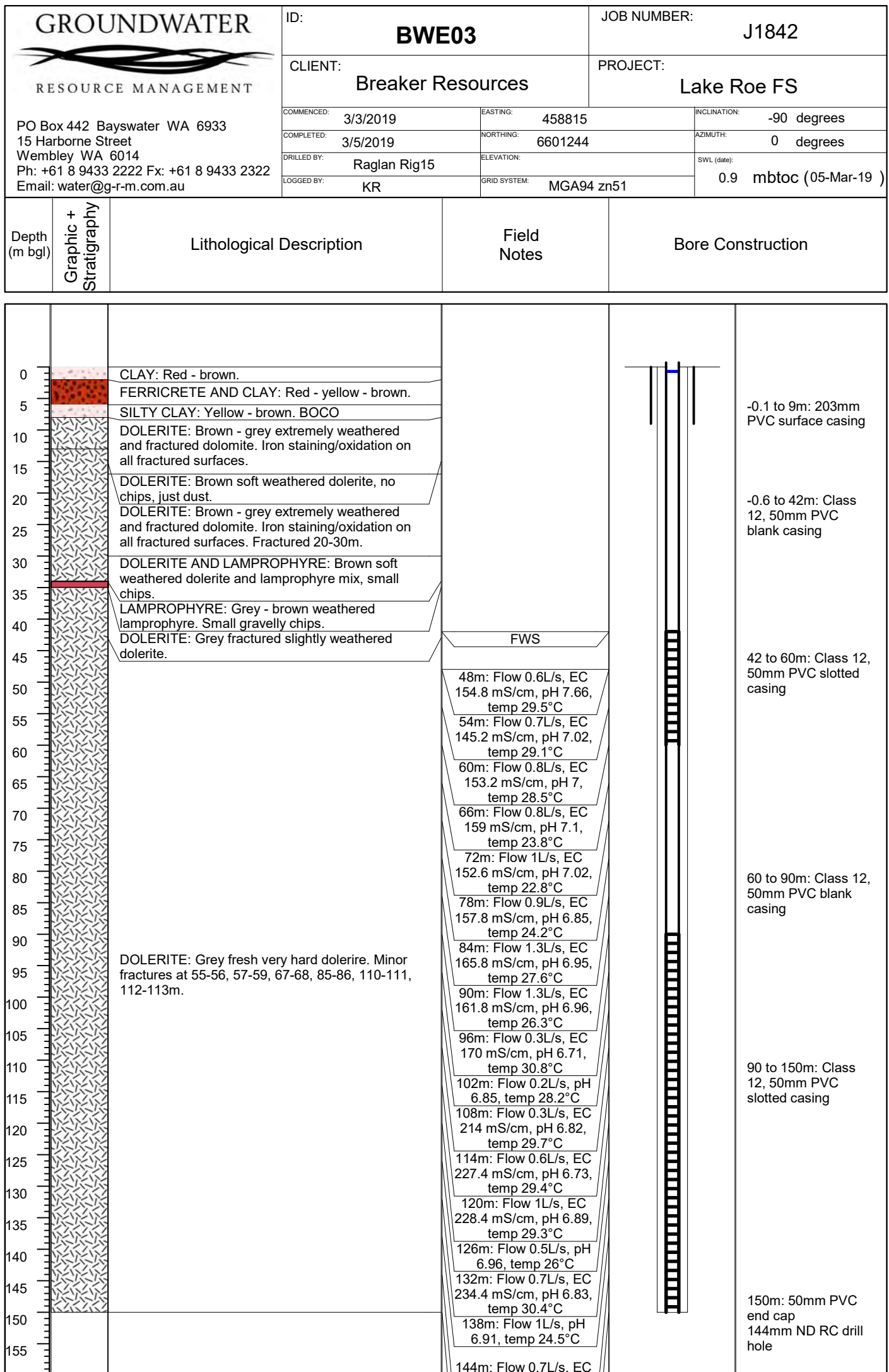
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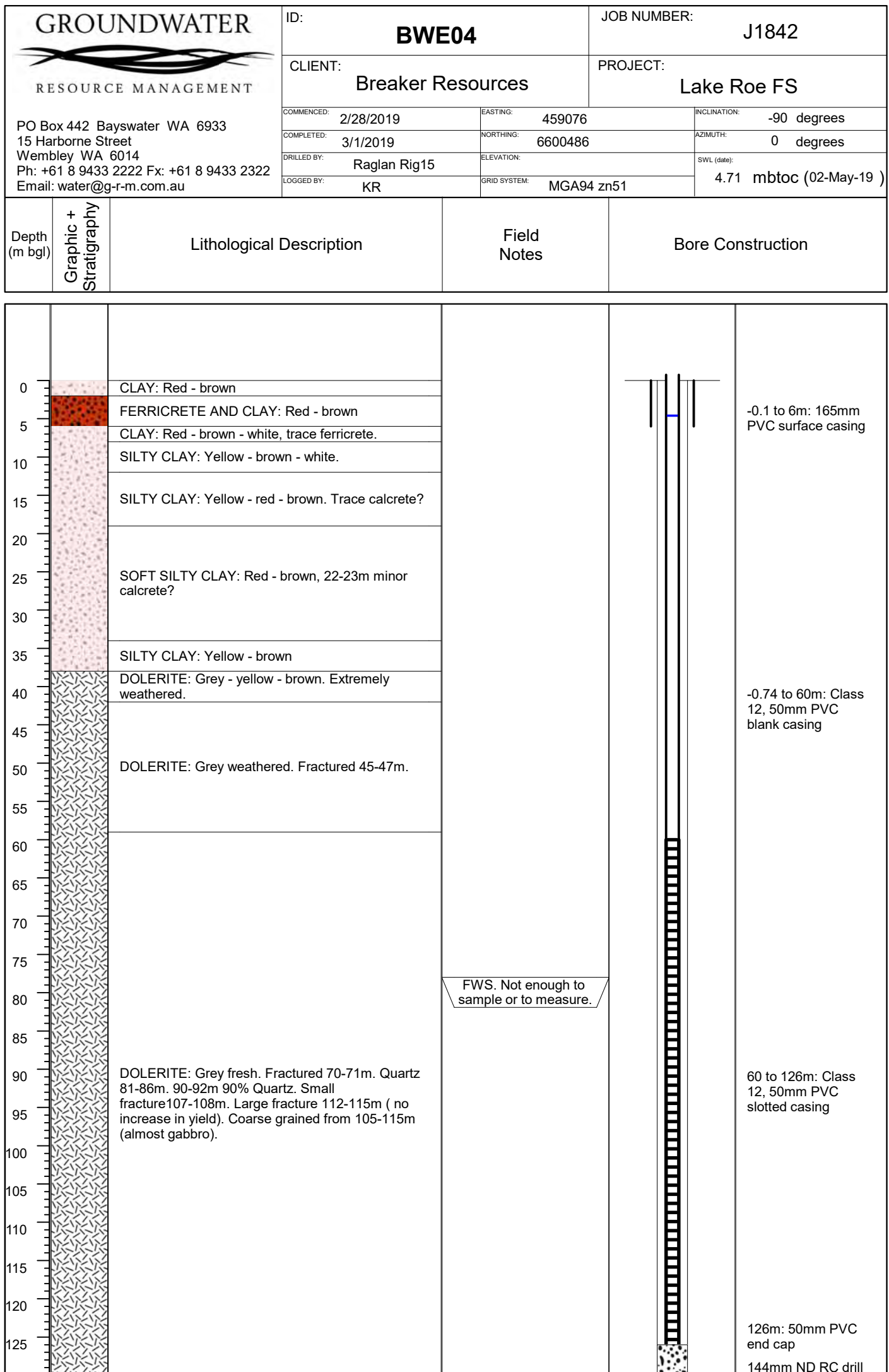
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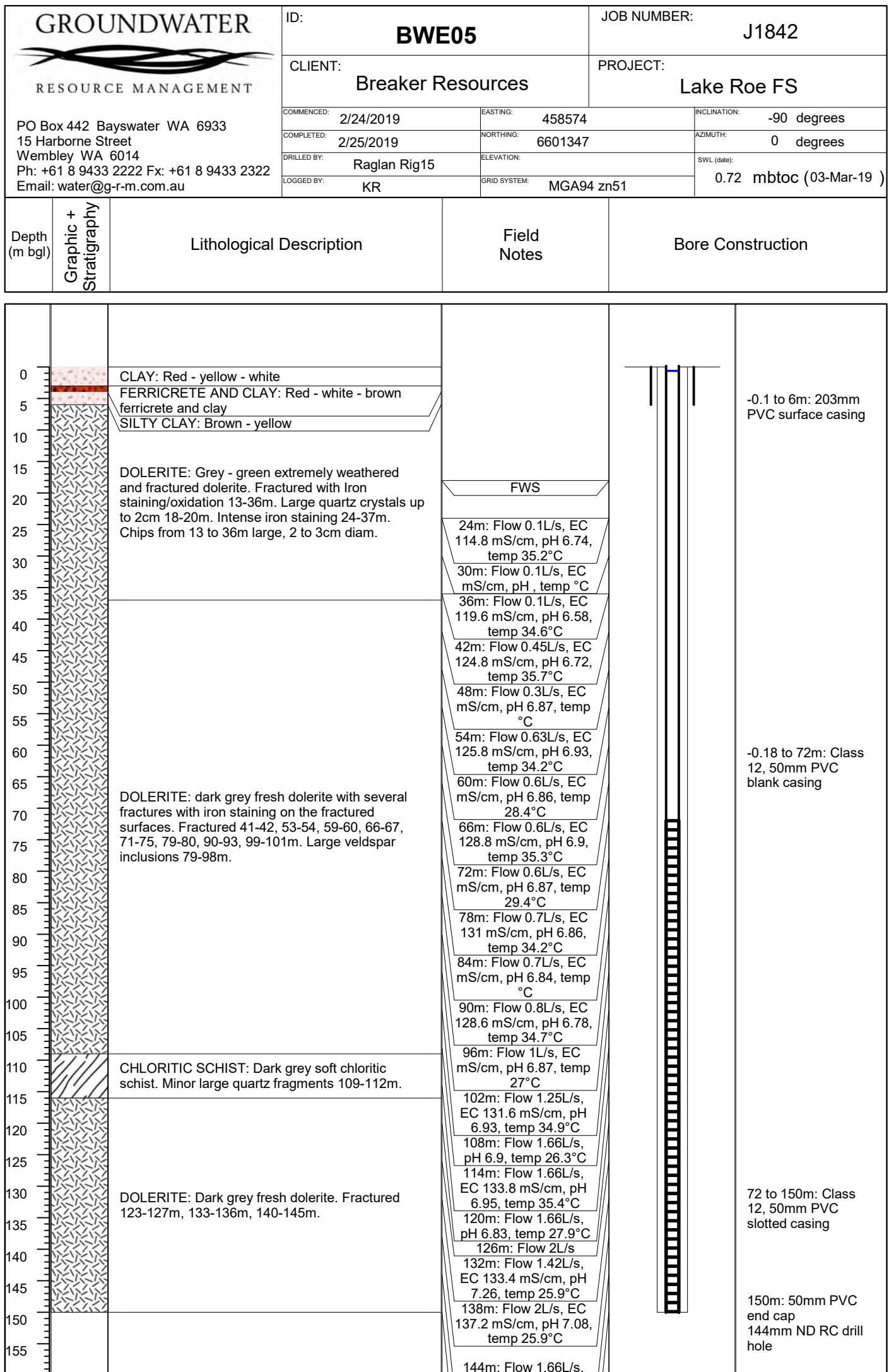
APPENDIX A
BORE LOGS (GRM, 2019)

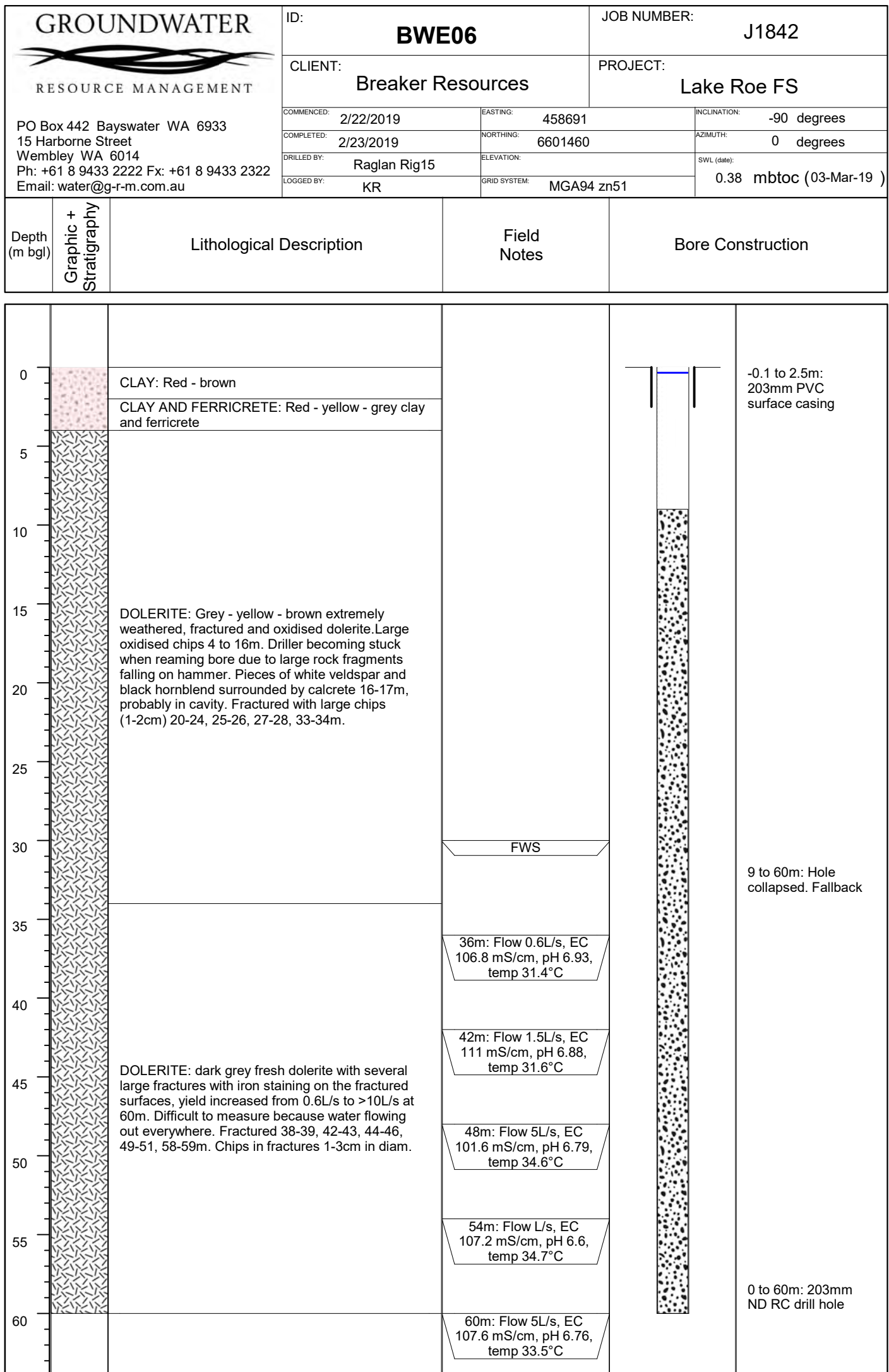


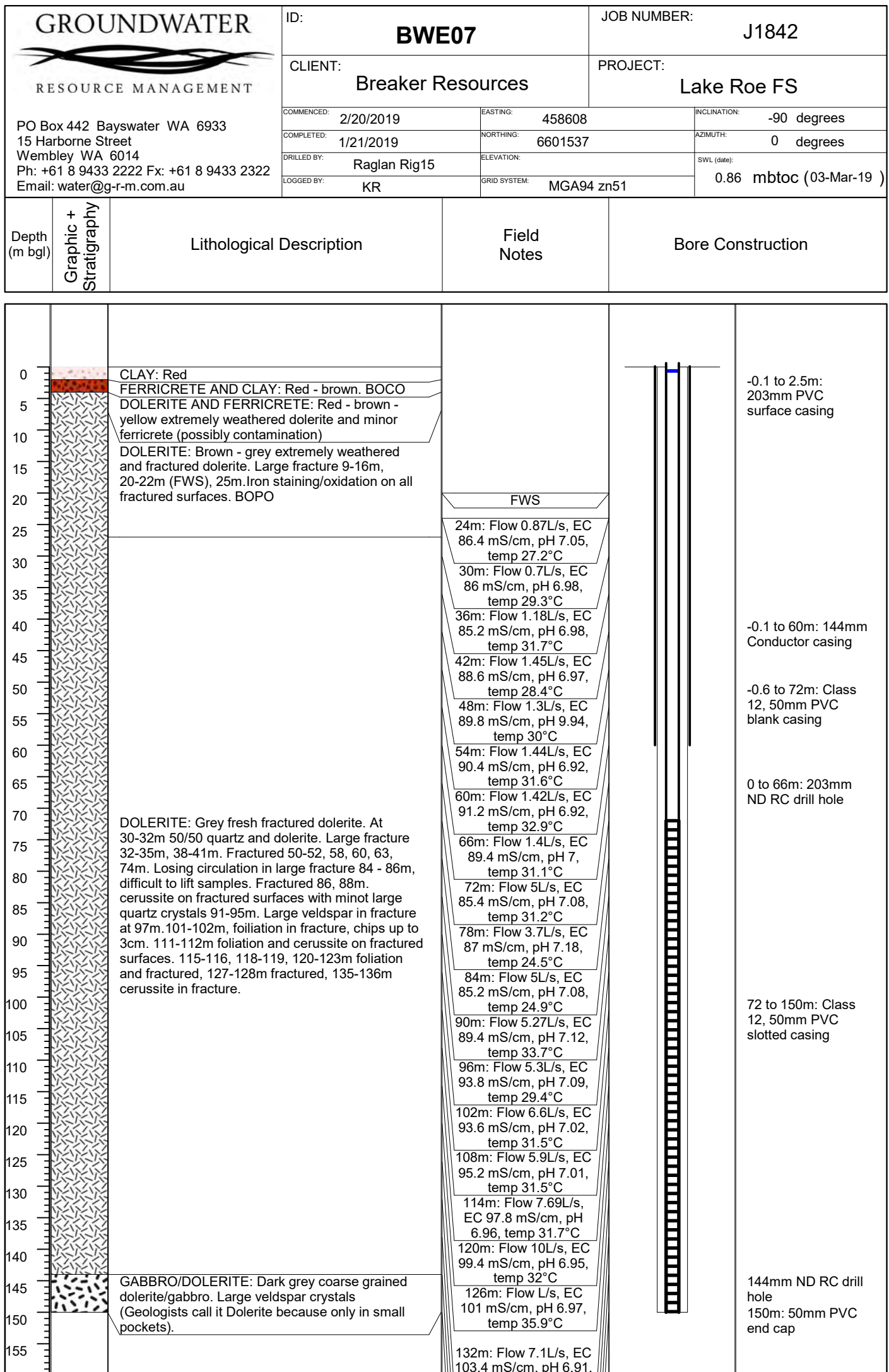




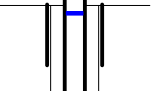


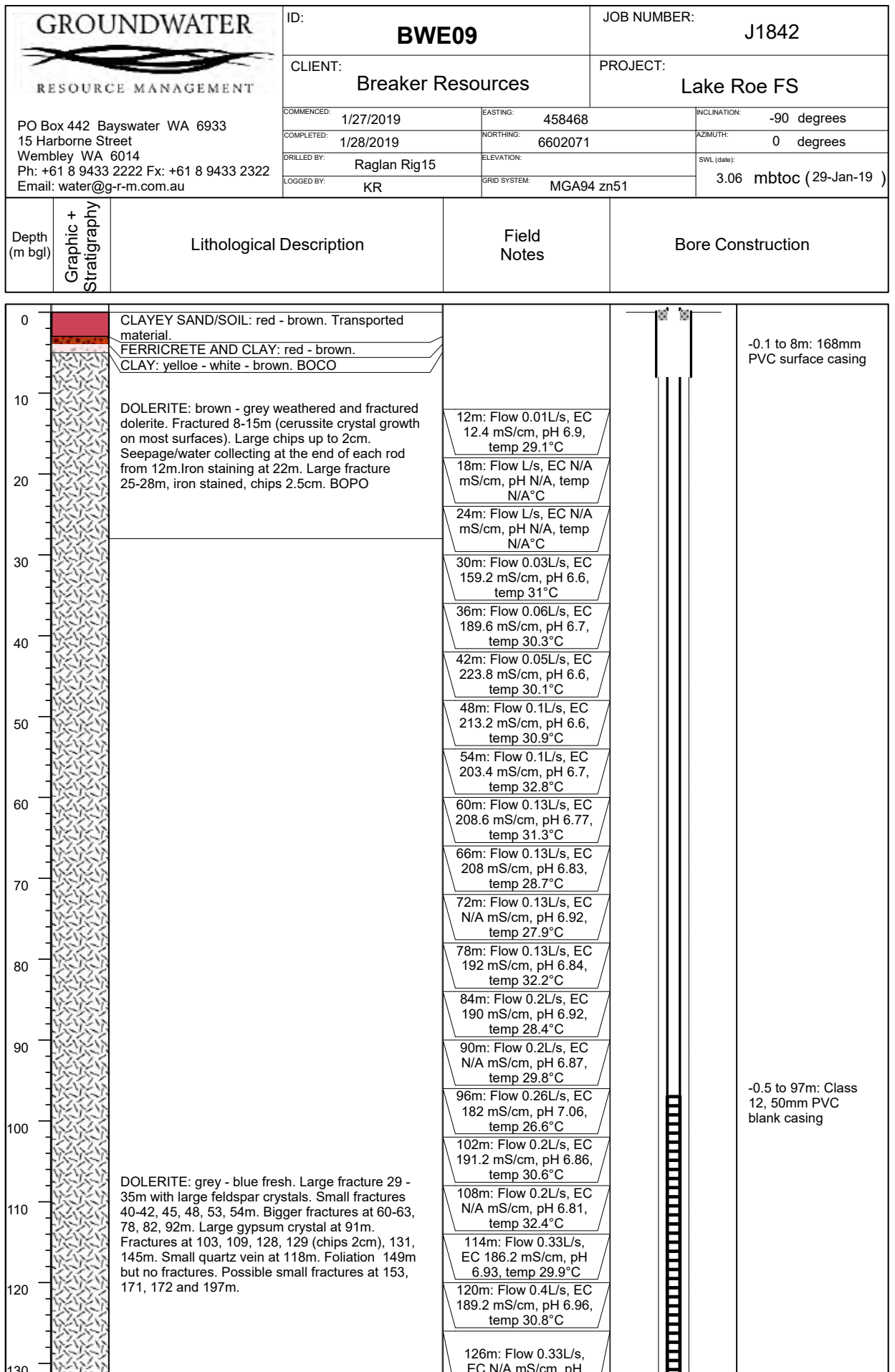




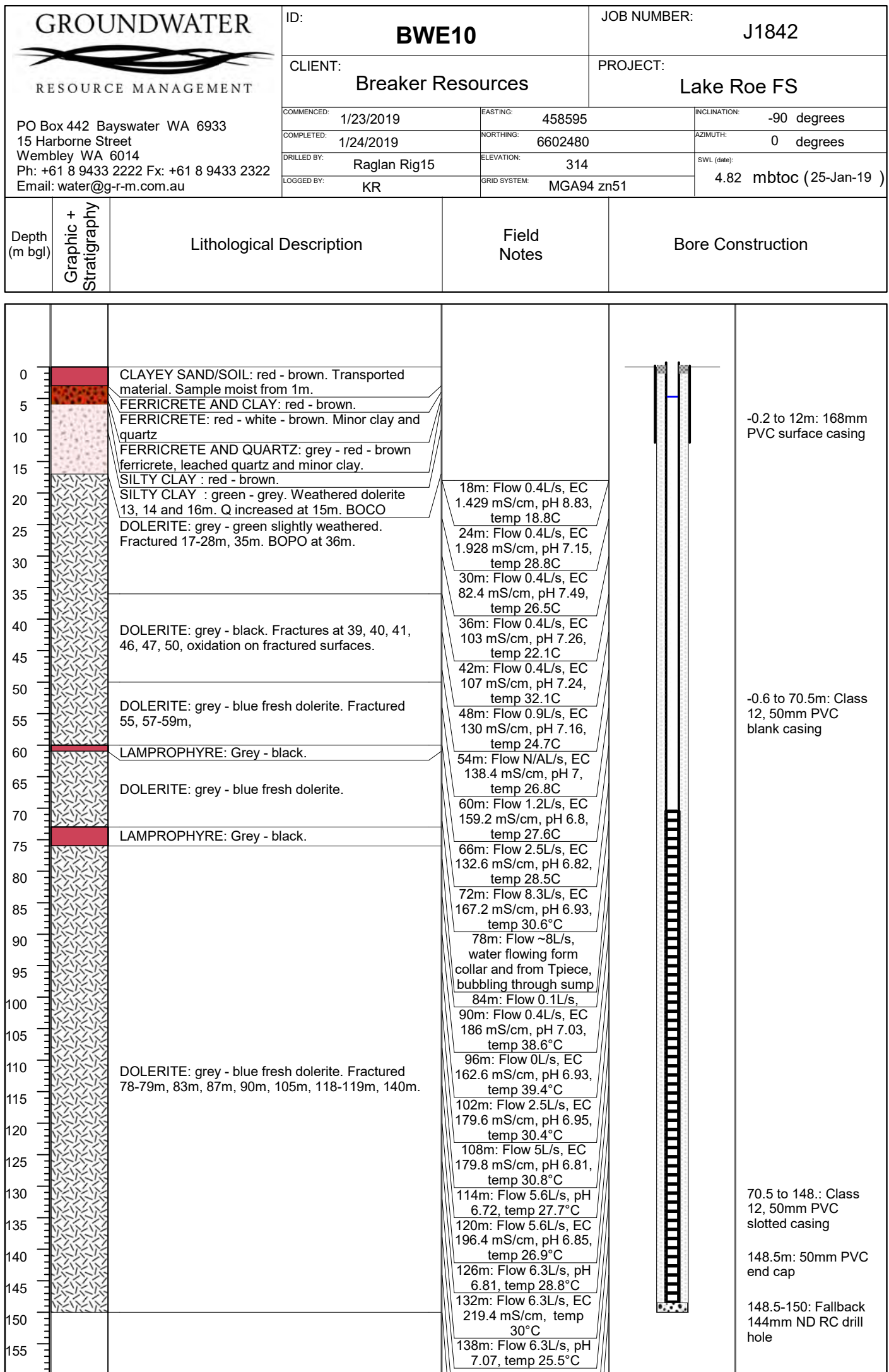


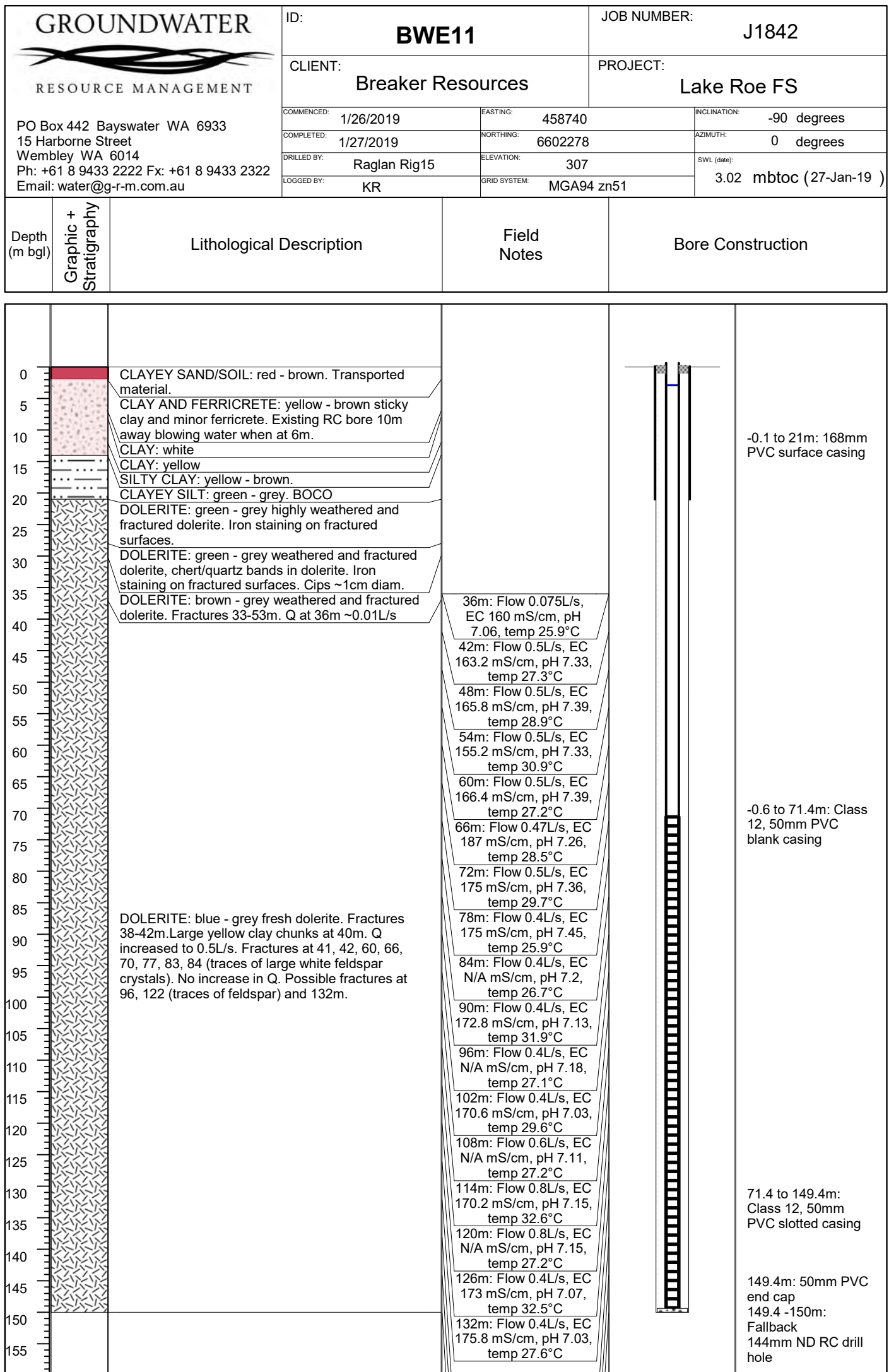
 PO Box 442 Bayswater WA 6933 15 Harborne Street Wembley WA 6014 Ph: +61 8 9433 2222 Fx: +61 8 9433 2322 Email: water@g-r-m.com.au		ID: BWE08		JOB NUMBER: J1842	
		CLIENT: Breaker Resources		PROJECT: Lake Roe FS	
COMMENCED: 2/18/2019		EASTING: 458933		INCLINATION: -90 degrees	
COMPLETED: 2/19/2019		NORTHING: 6601711		AZIMUTH: 0 degrees	
DRILLED BY: Raglan Rig15		ELEVATION:		SWL (date): 0.96 mbtoc (03-Mar-19)	
LOGGED BY: KR		GRID SYSTEM: MGA94 zn51			

Depth (m bgl)	Graphic + Stratigraphy	Lithological Description	Field Notes	Bore Construction	
0		CLAY: Red - brown, wet samples.			-0.1 to 6m: 168mm PVC surface casing
5		CLAY AND FERRICRETE: red - brown.			
		CLAY: Yellow - brown - white clay			
10		CLAY AND DOLERITE: grey - green - brown clay and extremely weathered dolerite. BOCO at 16m.			
15					
20		DOLERITE: grey - green weathered and fractured dolerite. Fractures at 25-30, 33m yellow red oxidation on fractured surfaces. BOPO at 33m.	FWS at 34m, not enough to sample or to measure yield. Muddy trickle rest of bore.		
25					
30					
35					
40					
45					
50					
55					
60					
65					
70					
75					
80					
85		DOLERITE: Grey fresh dolerite. Fractured 35-37, 40, 44, 49m pyrite, 53, 74-pyrite, 76, 77, 87, 96, 103, 113, 118, 124, 137-139, 142, 146, 148m. Fractured with foliation at 87m, 103m, 146m. Pyrite on fractured surfaces at 103m.			
90					
95					
100					
105					
110					
115			114m: Flow 0.04L/s, EC 92 mS/cm, pH 6.45, temp 31.2°C		
120					
125					
130					
135					
140					
145					
150			150m: Flow 0.03L/s, EC 95.4 mS/cm, pH 6.67, temp 31.4°C		70 to 148m: Class 12, 50mm PVC slotted casing 148m: 50mm PVC end cap 144mm ND RC drill hole
155					



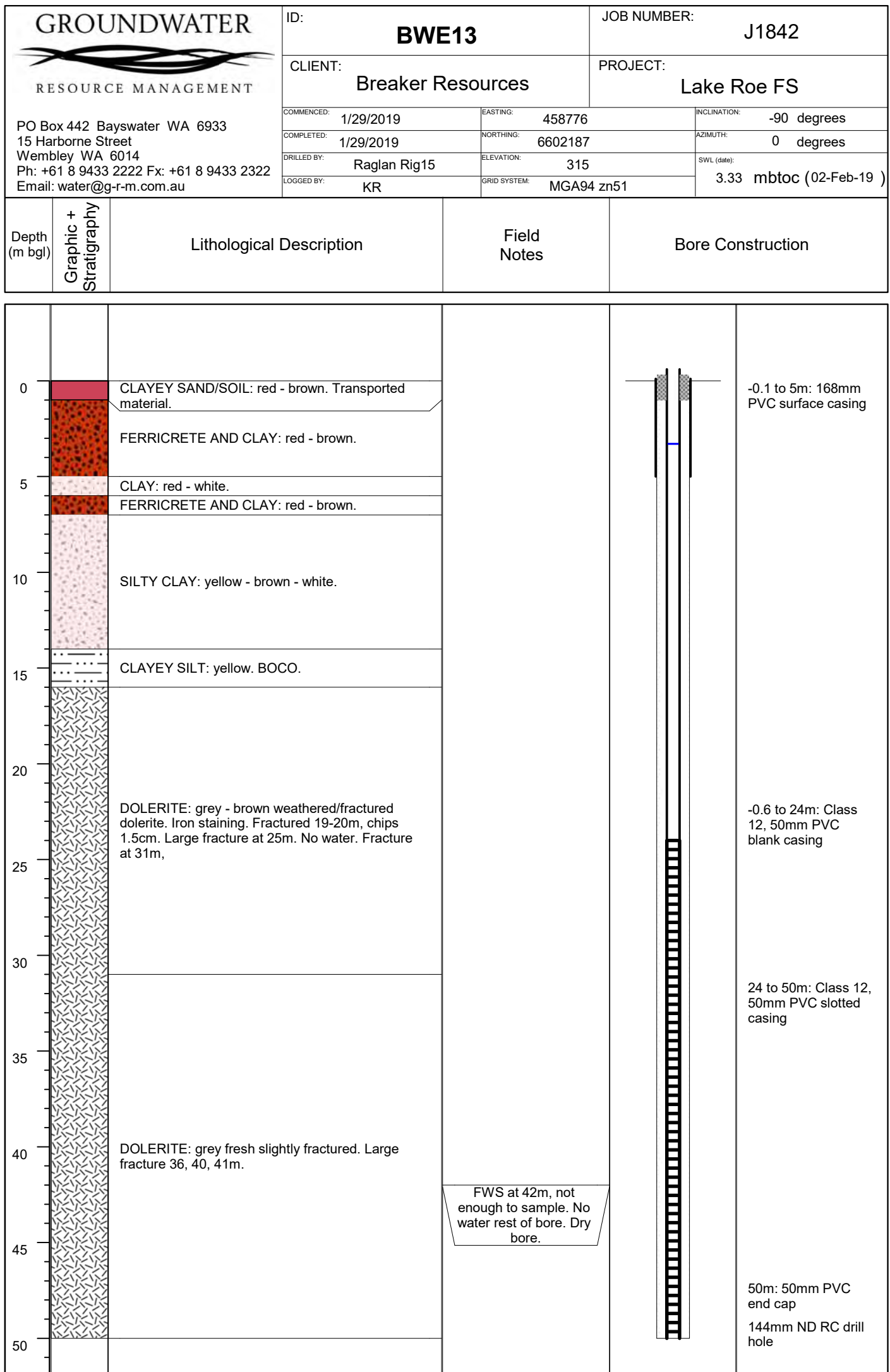
 PO Box 442 Bayswater WA 6933 15 Harborne Street Wembley WA 6014 Ph: +61 8 9433 2222 Fx: +61 8 9433 2322 Email: water@g-r-m.com.au		ID: BWE09		JOB NUMBER: J1842	
		CLIENT: Breaker Resources		PROJECT: Lake Roe FS	
		COMMENCED: 1/27/2019	EASTING: 458468	INCLINATION: -90 degrees	
		COMPLETED: 1/28/2019	NORTHING: 6602071	AZIMUTH: 0 degrees	
		DRILLED BY: Raglan Rig15	ELEVATION:	SWL (date): 3.06 mbtoc (29-Jan-19)	
LOGGED BY: KR	GRID SYSTEM: MGA94 zn51				
Depth (m bgl)	Graphic + Stratigraphy	Lithological Description	Field Notes	Bore Construction	
140			6.98, temp 25.5°C 132m: Flow 0.4L/s, EC 186.8 mS/cm, pH 6.9, temp 28.4°C 138m: Flow 0.4L/s, EC 194.2 mS/cm, pH 6.91, temp 28.3°C 144m: Flow 0.45L/s, EC 166.2 mS/cm, pH 0.21, temp 25.8°C 150m: Flow 0.4L/s, EC 177.8 mS/cm, pH 7.09, temp 25.9°C 156m: Flow 0.45L/s, EC N/A mS/cm, pH 7.05, temp 25.7°C 162m: Flow 0.4L/s, EC 177.6 mS/cm, pH 6.99, temp 26.6°C 168m: Flow 0.1L/s, EC 177.2 mS/cm, pH 7.09, temp 26.9°C 174m: Flow 0.2L/s, EC N/A mS/cm, pH 7.08, temp 27.2°C 180m: Flow 0.3L/s, EC 174.8 mS/cm, pH 6.97, temp 26.3°C 186m: Flow 0.4L/s, EC N/A mS/cm, pH 7.04, temp 26.7°C 192m: Flow 0.3L/s, EC 174.2 mS/cm, pH 7.04, temp 26.8°C 198m: Flow 0.3L/s, EC N/A mS/cm, pH 7.16, temp 26.8°C 200m: Flow 0.3L/s, EC 168.4 mS/cm, pH 6.97, temp 28.1°C		97 to 199.4m: Class 12, 50mm PVC slotted casing 199m: 50mm PVC end cap 199 -200m: Fallback 144mm ND RC drill hole
150					
160					
170					
180					
190					
200					
210					

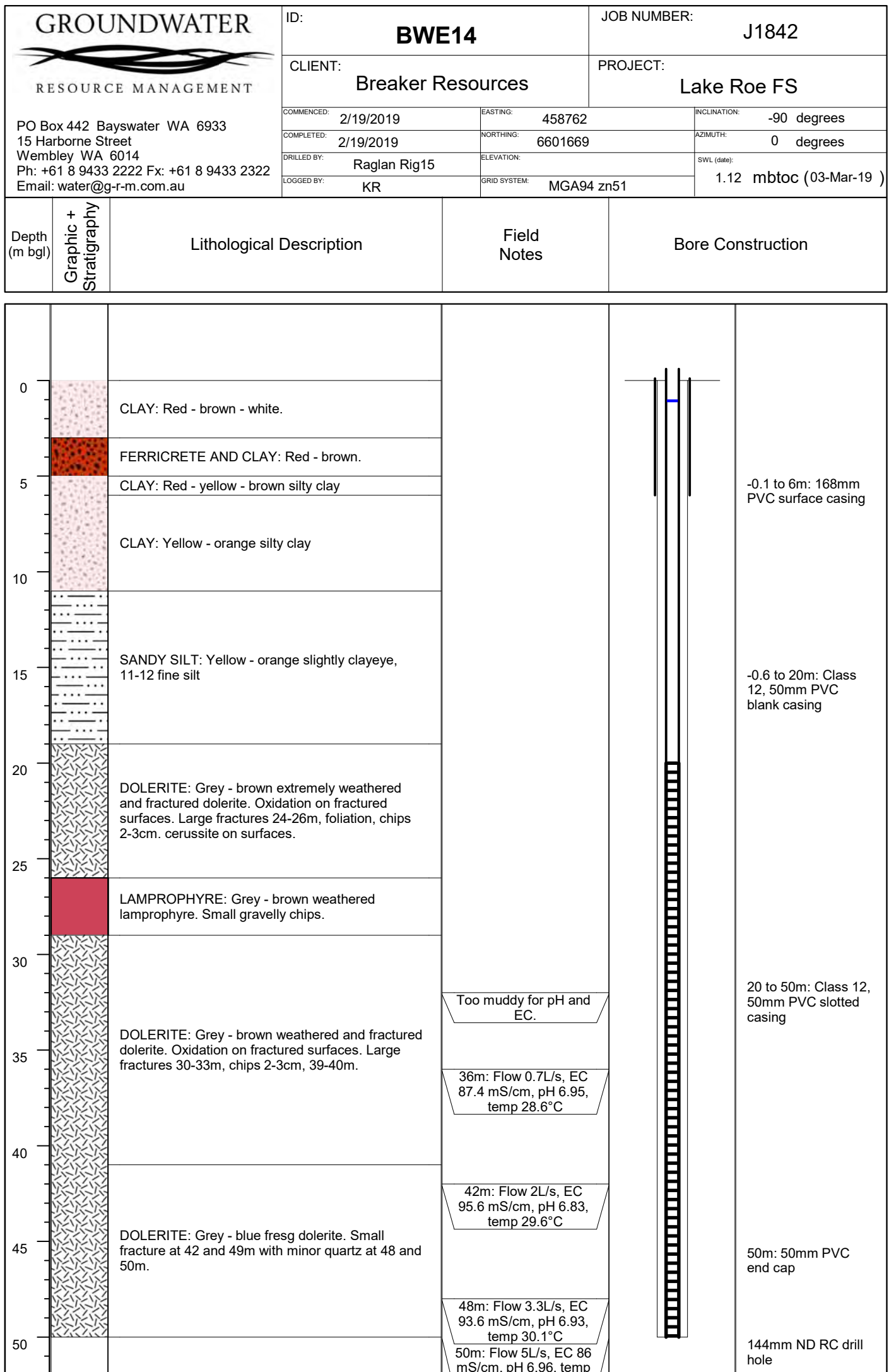


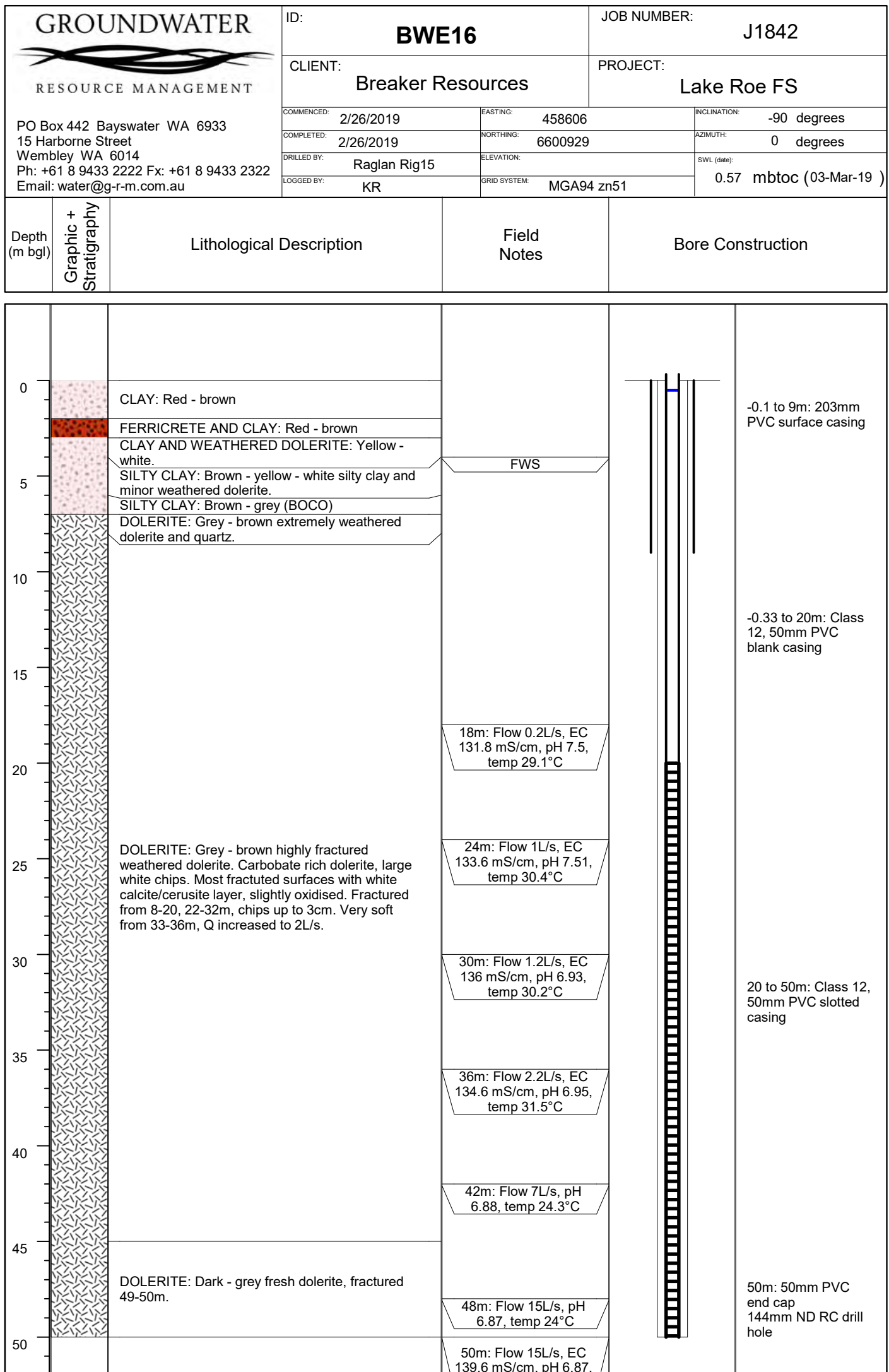


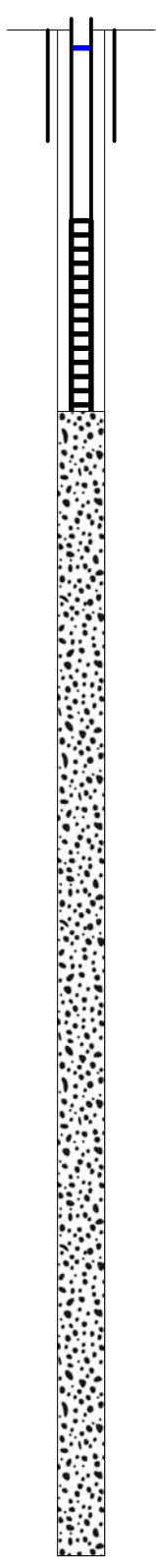
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		COMPLETED: 1/29/2019	NORTHING: 6602487	AZIMUTH: 0 degrees	
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LOGGED BY: KR		GRID SYSTEM: MGA94 zn51			

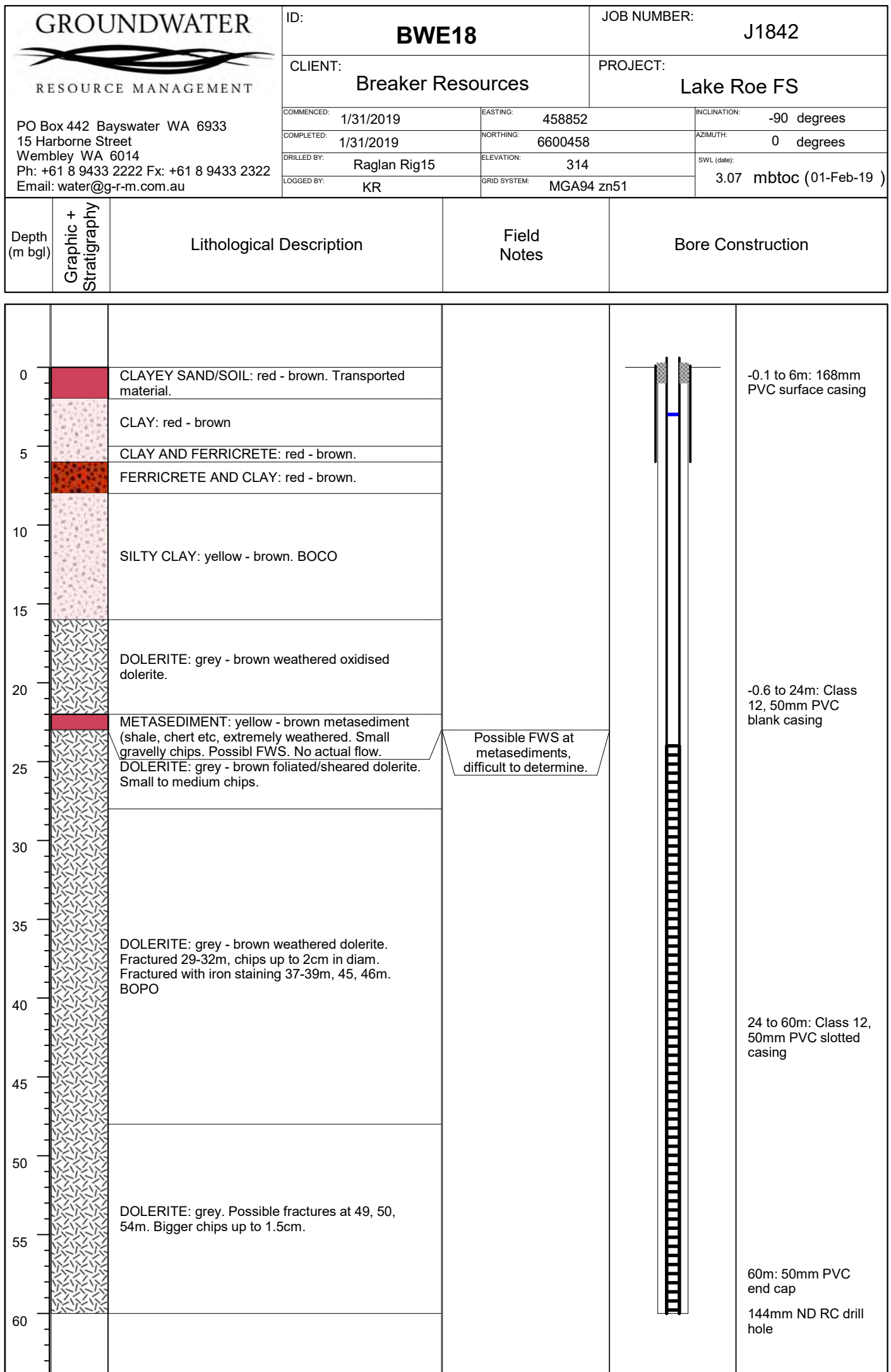
Depth (m bgl)	Graphic + Stratigraphy	Lithological Description	Field Notes	Bore Construction
0		CLAYEY SAND/SOIL: red - brown. Transported material.		-0.1 to 24.5m: 168mm PVC surface casing
		SANDY CLAY: white - red. FWS 3m, not enough for a sample		
5		FERRICRETE AND CLAY: red - brown.		-0.55 to 24m: Class 12, 50mm PVC blank casing
		CLAY: red - brown clay and minor ferricrete.		
		CLAY: white - brown		
10		SILTY CLAY: yellow - brown		
15		CLAY AND DOLERITE: yellow - brown clay and extremely weathered dolerite. BOCO		24 to 60m: Class 12, 50mm PVC slotted casing 60m: 50mm PVC end cap 144mm ND RC drill hole
20		DOLERITE: brown - grey extremely weathered and fractured dolomite. Large quartz fragments up to 2cm. Cerussite and iron staining on most fractured surfaces. 37-38m extra large chips. No water. BOPO		
25				
30				
35			36m: mud flow, not possible to sample.	
40				
45			42m: Flow 0.1L/s, EC 155.4 mS/cm, pH 7.05, temp 31.5°C	
50			48m: Flow 0.08L/s, EC 164.2 mS/cm, pH 6.75, temp 29.5°C	
55			54m: Flow 0.08L/s, EC 163 mS/cm, pH 6.85, temp 30.5°C	
60			60m: Flow 0.1L/s, EC 158.8 mS/cm, pH 6.83, temp 28.1°C	



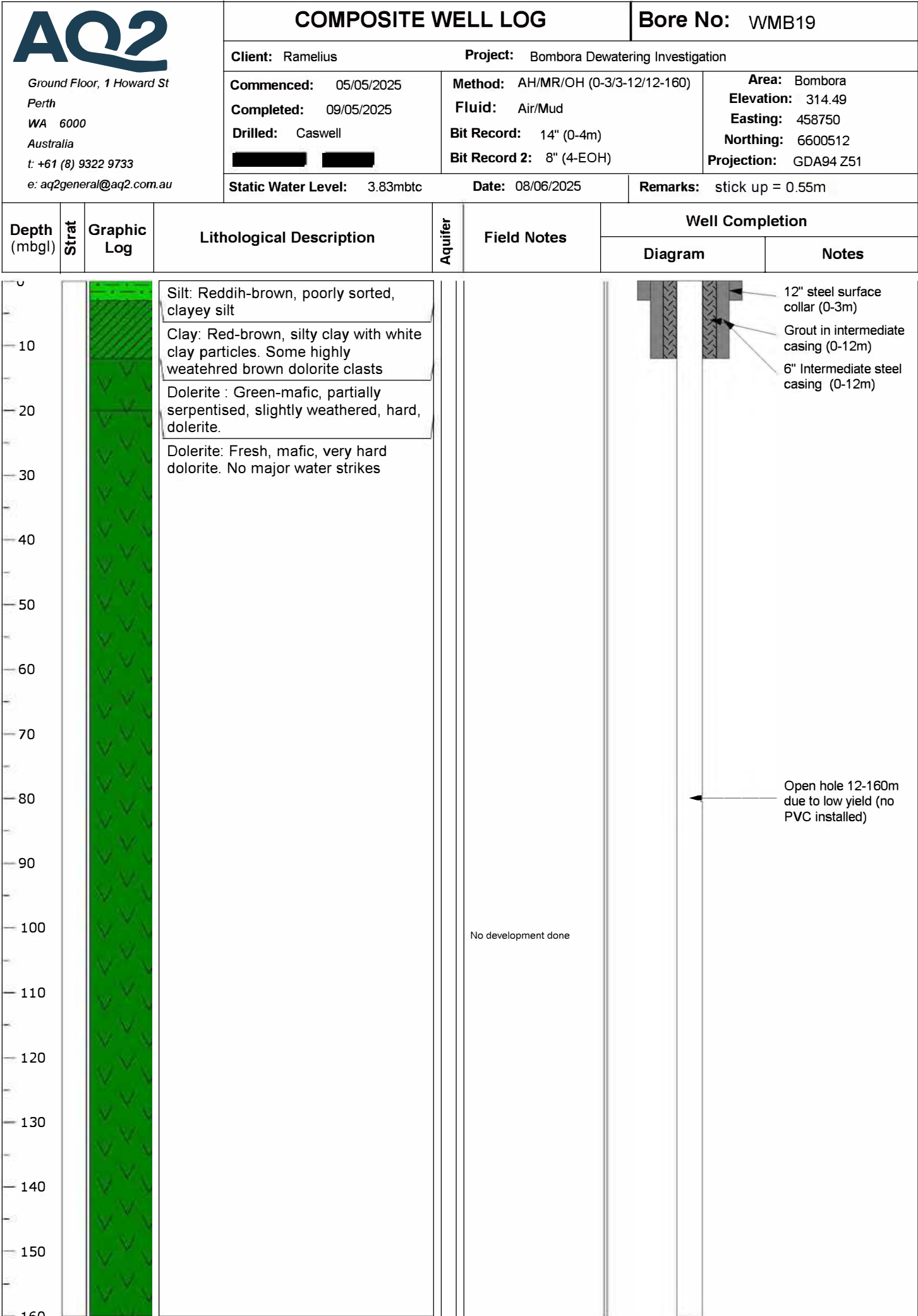




 PO Box 442 Bayswater WA 6933 15 Harborne Street Wembley WA 6014 Ph: +61 8 9433 2222 Fx: +61 8 9433 2322 Email: water@g-r-m.com.au		ID: BWE17		JOB NUMBER: J1842	
		CLIENT: Breaker Resources		PROJECT: Lake Roe FS	
		COMMENCED: 3/1/2019	EASTING: 458856	INCLINATION: -90 degrees	
		COMPLETED: 3/3/2019	NORTHING: 6600761	AZIMUTH: 0 degrees	
		DRILLED BY: Raglan Rig15	ELEVATION:	SWL (date): 1.27 mbtoc (04-Mar-19)	
		LOGGED BY: KR	GRID SYSTEM: MGA94 zn51		
Depth (m bgl)	Graphic + Stratigraphy	Lithological Description	Field Notes	Bore Construction	
0		CLAY: Red - brown.		 -0.1 to 7m: 165mm PVC surface casing -0.7 to 12m: Class 12, 50mm PVC blank casing 12 to 24m: Class 12, 50mm PVC slotted casing 24m: 50mm PVC end cap	
5		FERRICRETE AND CLAY: Red - grey - brown.			
		SILTY CLAY; Yellow - brown.			
10		DOLERITE: Grey - brown extremely weathered/fractured dolerite. Oxidised/iron staining on most fractured surfaces. Large fracture 15-17m.			
15					
20		SILTSTONE AND DOLERITE: Brown - grey, weathered dolerite. Small chips.			
25		DOLERITE: Brown - grey highly weathered and fractured dolerite. Oxidised/iron staining. Dolerite gravel. Large fracture 23-24m.	FWS. Not enough to sample or to measure. Muddy trickle		
		LAMPROPHYRE: Grey - brown weathered lamprophyre. Small gravelly chips.			
30		DOLERITE: Brown - grey highly weathered and fractured dolerite. Oxidised/iron staining. Possible cavity at 33-34m (layered calcite ?).	30m: Flow 0.8L/s, EC 118 mS/cm, pH 7.19, temp 33.7°C		
35			36m: Flow 1.8L/s, pH 6.74, temp 2°C		
40			42m: Flow 2L/s,		
45		DOLERITE: Grey weathered slightly oxidised fractured broken gravelly dolerite. 37-38m very coarse grained. 43-44m, 54-58m, very soft, no chips, just fine dust. Difficult drilling with bore collapsing.	48m: Flow 6L/s, EC 147.4 mS/cm, pH 6.82, temp 26.2°C		
50			54m: Flow >6L/s, EC 150.4 mS/cm, pH 6.87, temp 26.8°C		
55					
60			66m: Flow >10L/s, EC 149.0 mS/cm, pH 6.8, temp 27.3°C		
65			72m: Flow 0L/s,		
70					
75					
80		DOLERITE: Dark grey fresh. Small chips. No fractures.	84m: Flow 0L/s,		
85					
90			90m: Flow 7L/s,		
95					
				24 to 96m: Fallback	
				144mm ND RC drill hole	



APPENDIX B
Bore Logs (AQ2, 2025)





Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB20

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 15/06/2025

Method: AH/MR/OH (0-6/6-23/23-150)

Area: Bombora

Completed: 19/06/2025

Fluid: Air/Mud

Elevation: 312.78

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458480

Bit Record 2: 8" (4-EOH)

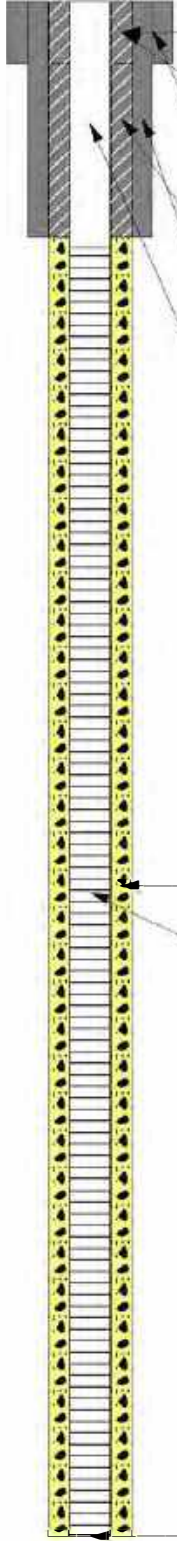
Northing: 6600427

Projection: GDA94 Z51

Static Water Level: 2.3mbtc

Date: 04/07/2025

Remarks: stick up = 0.81m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Clay: Dark red clayey silt, very clay rich, poorly sorted, some fine sand			 Cement plug (0-6m) Cement grout to set in surface collar - with tremie line (0-6m) 12" steel surface collar (0-6m) Cement grout to set in intermediate casing - with tremie line (0-23m) 6" Intermediate steel casing (0-23m) DN50 PN18 PVC Casing - Blank (0-24m) 3.2 - 6.4 mm gravel pack (2-150m) DN50 PN18 PVC Casing - 1mm slotted (24-150m) DN50 PN18 PVC Casing - End Cap	
10			Clay: Dark russet red clay, mottled yellow green in places, plastic, poorly sorted, silty				
20			Clay: Moderate yellowish brown clay, soft to firm, with relict chips of dolorite				
30			Dolorite: Dark green/grey, weathered dolorite, weathered to mid brown, SAPROCK				
40			Dolorite: Dark green/grey dolorite, fresh, competent, metamorphosed				
50							
60							
70					1.2L/s, -, -µS/cm, - pH, °C		
80					1.2L/s, 168,400µS/cm, 6.1 pH, 20.1°C		
90					1.5L/s, 168,600µS/cm, 6.3 pH, 19.8°C		
100					1.2L/s, 164,100µS/cm, 6.1 pH, 20.1°C		
110					1.2L/s, 168,100µS/cm, 6.3 pH, 21°C		
120					1.8L/s, 159,500µS/cm, 6.1 pH, 22.1°C		
130					1.5L/s, 163,500µS/cm, 6.1 pH, 23.1°C		
140					1.8L/s, 159,300µS/cm, 6 pH, 24.5°C		
150					1.8L/s, 162,900µS/cm, 6.1 pH, 22.6°C		
					1.8L/s, µS/cm, pH, °C		
					1.6L/s, µS/cm, pH, °C		
					1.8L/s, µS/cm, pH, °C		
					1.8L/s, µS/cm, pH, °C		
					1.8L/s, µS/cm, pH, °C		
					Airlift: 1.23L/s, µS/cm, 6.53 pH, 21.3°C		



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB21

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 13/04/2025

Method: AH/OH (0-6/6-12/12-169)

Area: Bombora

Completed: 03/05/2025

Fluid: Air/Mud

Elevation: 313.71

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458611

Bit Record 2: 8" (4-EOH)

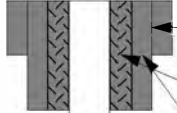
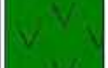
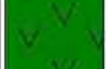
Northing: 6601725

Projection: GDA94 Z51

Static Water Level: 2.96mbtc

Date: 17/06/2025

Remarks: stick up = 0.62m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, slightly sandy, clayey silt.				12" steel surface collar (0-6m) Grout in intermediate casing (SG 1.64) (0-12m) 6" Intermediate steel casing (0-12m)
10			Dolerite : Green-mafic, partially serpentised, highly weathered dolerite with abundant quartz. Large quartz clasts at 12m. Water strike at 12 m.		0.8L/s, $\mu\text{S/cm}$, 8.7 pH, 23.8°C		
20			Dolerite : Fresh, mafic, very hard dolerite. Fracture encountered at 24m, with associated increase in weathered dolerite clasts. Yield: ~3.8-4.4l/s. Prominent quartz veins encountered at 64-66m. Some minor quartz throughout remaining profile		3.1L/s, $\mu\text{S/cm}$, 7.64 pH, 23.6°C		
30					3.8L/s, $\mu\text{S/cm}$, 7.01 pH, 23.7°C		
40					3.8L/s, $\mu\text{S/cm}$, 6.8 pH, 24.4°C		
50					3.9L/s, $\mu\text{S/cm}$, 6.83 pH, 24.4°C		
60					3.9L/s, $\mu\text{S/cm}$, 6.85 pH, 24.5°C		
70					3.9L/s, $\mu\text{S/cm}$, 6.86 pH, 25°C		
80					3.9L/s, $\mu\text{S/cm}$, 6.82 pH, 24.8°C		
90					3.9L/s, $\mu\text{S/cm}$, 6.82 pH, 24.2°C		
100					3.9L/s, $\mu\text{S/cm}$, 6.9 pH, 24.1°C		
110					3.9L/s, $\mu\text{S/cm}$, 6.88 pH, 23.8°C		
120					3.9L/s, $\mu\text{S/cm}$, 6.83 pH, 22.3°C		
130					3.9L/s, $\mu\text{S/cm}$, 6.77 pH, 24.2°C		
140					3.9L/s, $\mu\text{S/cm}$, 6.64 pH, 23.8°C		
150					3.9L/s, $\mu\text{S/cm}$, 6.62 pH, 23.5°C		
160					3.9L/s, $\mu\text{S/cm}$, 6.39 pH, 23.5°C		
170					3.9L/s, $\mu\text{S/cm}$, 6.29 pH, 25.2°C		
180					3.9L/s, $\mu\text{S/cm}$, 6.66 pH, 23.1°C		
190					3.9L/s, $\mu\text{S/cm}$, 6.71 pH, 23.5°C		
200					4.4L/s, $\mu\text{S/cm}$, 6.75 pH, 23.9°C		
210					4.4L/s, $\mu\text{S/cm}$, 6.67 pH, 22.2°C		
220					4.4L/s, $\mu\text{S/cm}$, 6.82 pH, 21.8°C		
230					4.4L/s, $\mu\text{S/cm}$, 6.65 pH, 21.6°C		
240					4.4L/s, $\mu\text{S/cm}$, 6.67 pH, 22.1°C		
250					4.4L/s, $\mu\text{S/cm}$, - pH, -°C		
260					4.4L/s, $\mu\text{S/cm}$, - pH, -°C		
270					No development done		

Not installed - left open hole due to low yields 169m (no PVC installed)



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB22

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 23/04/2025

Method: AH/OH (0-6/6-13/13-160)

Area: Bombora

Completed: 07/05/2025

Fluid: Air/Mud

Elevation: 312.94

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458473

Bit Record 2: 8" (4-EOH)

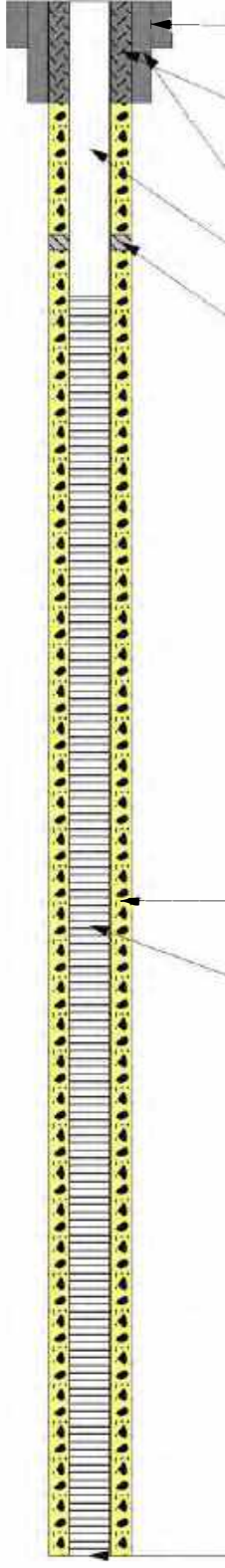
Northing: 6601697

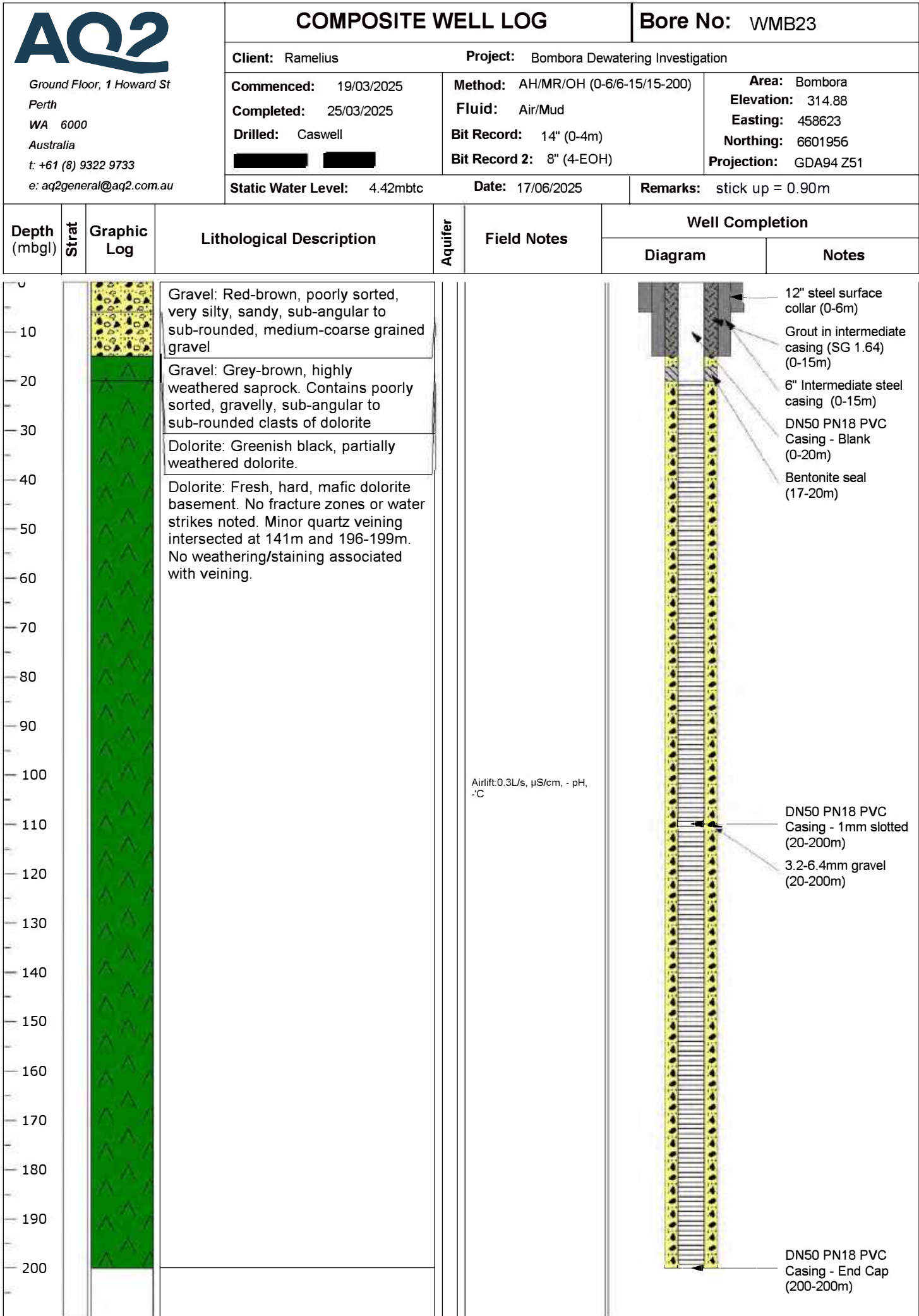
Projection: GDA94 Z51

Static Water Level: 2.77mbtc

Date: 09/06/2025

Remarks: stick up = 0.86m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Reddish-brown, poorly sorted, clayey silt				12" steel surface collar (0-6m) Grout in intermediate casing (SG 1.64) (0-13m) 6" Intermediate steel casing (0-13m) DN50 PN18 PVC Casing - Blank (0-38m) Bentonite seal (30-32m) 3.2-6.4mm gravel (32-200m) DN50 PN18 PVC Casing - 1mm slotted (38-200m) DN50 PN18 PVC Casing - End Cap (200-200m)
10			Clay: Greyish-white, clayey, highly weathered saprock. Some highly weathered dolerite clasts				
20			Dolerite: Grey-black, very slightly serpentinised, very hard, partially weathered dolerite.				
30							
40			Dolerite: Fresh, mafic, very hard dolerite. Minor fractures at 42m, 48m and 96m.		0.5L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		
50					1.23L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		
60					1.81L/s, $\mu\text{S/cm}$, 6.29 pH, 22.8 $^{\circ}\text{C}$		
70					2.53L/s, $\mu\text{S/cm}$, 6.24 pH, 21.6 $^{\circ}\text{C}$		
80					2.53L/s, $\mu\text{S/cm}$, 6.3 pH, 25.2 $^{\circ}\text{C}$		
90					2.53L/s, $\mu\text{S/cm}$, 6.62 pH, 21.3 $^{\circ}\text{C}$		
100					2.53L/s, $\mu\text{S/cm}$, 6.23 pH, 21.3 $^{\circ}\text{C}$		
110					2.53L/s, $\mu\text{S/cm}$, 6.41 pH, 21.4 $^{\circ}\text{C}$		
120					2.53L/s, $\mu\text{S/cm}$, 7.01 pH, 21.6 $^{\circ}\text{C}$		
130					2.53L/s, $\mu\text{S/cm}$, 7.04 pH, 21.8 $^{\circ}\text{C}$		
140					2.53L/s, $\mu\text{S/cm}$, 6.98 pH, 22.2 $^{\circ}\text{C}$		
150					2.94L/s, $\mu\text{S/cm}$, 6.99 pH, 23.3 $^{\circ}\text{C}$		
160					2.69L/s, $\mu\text{S/cm}$, 6.99 pH, 23.1 $^{\circ}\text{C}$		
170					2.69L/s, $\mu\text{S/cm}$, 7.11 pH, 23.4 $^{\circ}\text{C}$		
180					2.69L/s, $\mu\text{S/cm}$, 7.12 pH, 22.8 $^{\circ}\text{C}$		
190					2.69L/s, $\mu\text{S/cm}$, 7.18 pH, 22.6 $^{\circ}\text{C}$		
200					2.53L/s, $\mu\text{S/cm}$, 7.17 pH, 21.8 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 7.01 pH, 21.6 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 6.73 pH, 22.2 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 6.88 pH, 22.3 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 7.07 pH, 24.4 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 7.01 pH, 24.5 $^{\circ}\text{C}$		
					2.53L/s, $\mu\text{S/cm}$, 6.98 pH, 24.1 $^{\circ}\text{C}$		
					Airlift: 1.23L/s, $\mu\text{S/cm}$, 6.55 pH, 20.4 $^{\circ}\text{C}$		





Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB24

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 27/03/2025

Method: AH/MR/OH (0-6/6-23/23-200)

Area: Bombora

Completed: 05/04/2025

Fluid: Air/Mud

Elevation: 314.88

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458772

Bit Record 2: 8" (4-EOH)

Northing: 6602003

Projection: GDA94 Z51

Static Water Level: 3.9mbtc

Date: 17/06/2025

Remarks: stick up = 0.73m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, very slightly sandy, clayey silt				12" steel surface collar (0-6m) Grout in intermediate casing (SG 1.64) (0-23m) 6" Intermediate steel casing (0-23m) DN50 PN18 PVC Casing - Blank (0-38m) Bentonite seal (32-35m)
10			Clay: Grey-green-white, soft, silty clay with medium-coarse sand. Sand content increasing with depth				
20			Dolorite: Grey-green-mafic, partially serpentinised, weathered dolorite.				
30			Dolorite: Fresh, mafic dolorite with quartz noted at 99-100m, 110-116m, 139m, 144-146m, 180-181m and 197-200m. Quartz very hard. Fractures at 25m and 30-31m (major water strikes), 134m and 144-146m.		0.02L/s, µS/cm, - pH, -°C		
40					0.07L/s, µS/cm, 5.76 pH, 33.7°C		
50					0.07L/s, µS/cm, - pH, -°C		
60					0.07L/s, µS/cm, 6.19 pH, 34.1°C		
70					0.07L/s, µS/cm, - pH, -°C		
80					0.07L/s, µS/cm, 6.68 pH, 36.2°C		
90					0.07L/s, µS/cm, - pH, -°C		
100					0.1L/s, µS/cm, 6.33 pH, 30.4°C		
110					0.15L/s, µS/cm, 6.24 pH, 33.9°C		
120					0.15L/s, µS/cm, 6.65 pH, 32.6°C		
130					0.22L/s, µS/cm, 6.69 pH, 29.6°C		
140					0.22L/s, µS/cm, 6.59 pH, 33.9°C		
150					0.22L/s, µS/cm, 6.42 pH, 30.5°C		
160					0.4L/s, µS/cm, 6.24 pH, 29.1°C		
170					0.4L/s, µS/cm, 6.39 pH, 26.5°C		
180					0.4L/s, µS/cm, 6.59 pH, 25.5°C		
190					0.4L/s, µS/cm, 6.85 pH, 20.3°C		
200					0.5L/s, µS/cm, 6.71 pH, 18.5°C		
					0.5L/s, µS/cm, 6.64 pH, 19.4°C		
					0.6L/s, µS/cm, 6.59 pH, 22.2°C		
					0.67L/s, µS/cm, 6.51 pH, 24.2°C		
					0.63L/s, µS/cm, 7.13 pH, 28.3°C		
					0.63L/s, µS/cm, 7.02 pH, 26.7°C		
					0.74L/s, µS/cm, 7.11 pH, 30.7°C		
					0.78L/s, µS/cm, 6.39 pH, 37.2°C		
					0.78L/s, µS/cm, 6.45 pH, 37.6°C		
					0.78L/s, µS/cm, 6.37 pH, 33.6°C		
					0.99L/s, µS/cm, 6.51 pH, 20.1°C		
					Airlift: 0.54L/s, µS/cm, 6.49 pH, 15.7°C		



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB25

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 08/04/2025

Method: AH/MR/OH (0-6/6-12/12-200)

Area: Bombora

Completed: 23/04/2025

Fluid: Air/Mud

Elevation: 314.38

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458610

Bit Record 2: 8" (4-EOH)

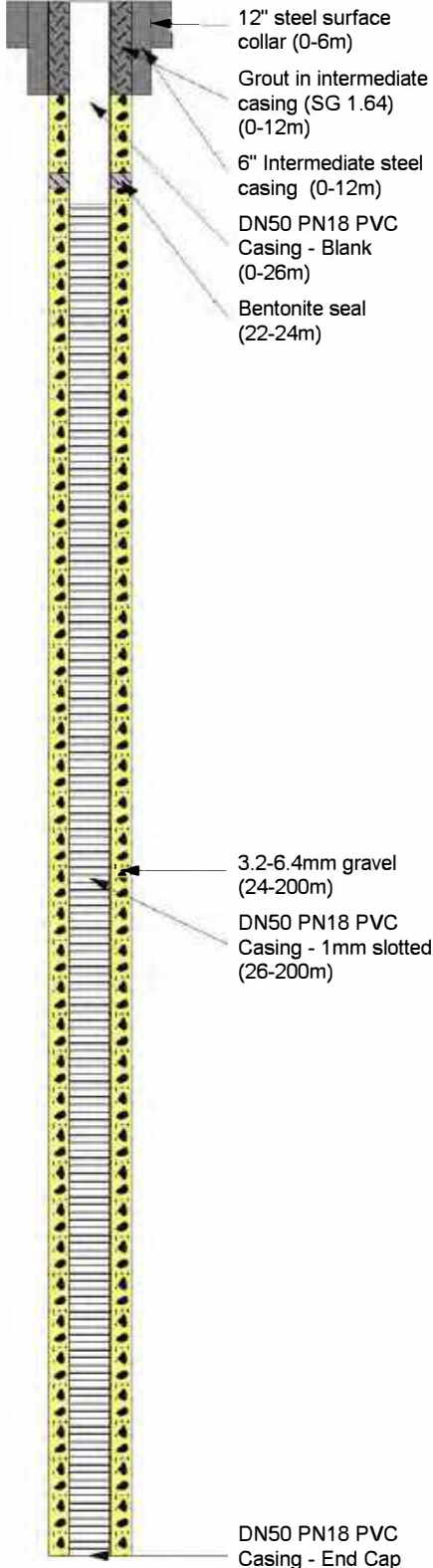
Northing: 6602113

Projection: GDA94 Z51

Static Water Level: 3.79mbtc

Date: 17/06/2025

Remarks: stick up = 1.04m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, slightly sandy, clayey silt.				
10			Clay: Red-brown, silty clay with white clay particles. Some highly weathred brown dolorite clasts				
20			Dolerite : Green-mafic, partially serpentinised, slightly weathered, hard, dolorite.				
30			Dolerite : Fresh, mafic, very hard dolorite. Prominent quartz veins encountered at 112 and 147m . Fractures encountered at 29,34, 43, 50, 52 and 54m. Main water strikes were at 34 and 43 meters		0.2L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		
40					0.78L/s, $\mu\text{S/cm}$, 6.2 pH, 25 $^{\circ}\text{C}$		
50					0.63L/s, $\mu\text{S/cm}$, 5.75 pH, 26.4 $^{\circ}\text{C}$		
60					3.59L/s, $\mu\text{S/cm}$, 6.31 pH, 24.2 $^{\circ}\text{C}$		
70					3.78L/s, $\mu\text{S/cm}$, 6.97 pH, 24.4 $^{\circ}\text{C}$		
80					3.78L/s, $\mu\text{S/cm}$, 7.12 pH, 24.8 $^{\circ}\text{C}$		
90					3.78L/s, $\mu\text{S/cm}$, 7.12 pH, 25.2 $^{\circ}\text{C}$		
100					3.78L/s, $\mu\text{S/cm}$, 7.11 pH, 24.8 $^{\circ}\text{C}$		
110					3.99L/s, $\mu\text{S/cm}$, 7.12 pH, 24.8 $^{\circ}\text{C}$		
120					3.89L/s, $\mu\text{S/cm}$, 7.13 pH, 24.8 $^{\circ}\text{C}$		
130					3.78L/s, $\mu\text{S/cm}$, 7.18 pH, 24.1 $^{\circ}\text{C}$		
140					3.78L/s, $\mu\text{S/cm}$, 7.19 pH, 24.1 $^{\circ}\text{C}$		
150					3.78L/s, $\mu\text{S/cm}$, 7.19 pH, 22 $^{\circ}\text{C}$		
160					3.78L/s, $\mu\text{S/cm}$, 7.17 pH, 22 $^{\circ}\text{C}$		
170					3.89L/s, $\mu\text{S/cm}$, 6.62 pH, 21.8 $^{\circ}\text{C}$		
180					3.99L/s, $\mu\text{S/cm}$, 6.03 pH, 21.6 $^{\circ}\text{C}$		
190					3.99L/s, $\mu\text{S/cm}$, 6.66 pH, 22.2 $^{\circ}\text{C}$		
200					3.59L/s, $\mu\text{S/cm}$, 6.86 pH, 22.6 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 6.92 pH, 22.8 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 7.09 pH, 23.3 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 7.09 pH, 23.1 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 7.08 pH, 23.1 $^{\circ}\text{C}$		
					2.86L/s, $\mu\text{S/cm}$, 6.74 pH, 22.8 $^{\circ}\text{C}$		
					3.39L/s, $\mu\text{S/cm}$, 6.66 pH, 23.1 $^{\circ}\text{C}$		
					3.12L/s, $\mu\text{S/cm}$, 7.03 pH, 23.9 $^{\circ}\text{C}$		
					3.39L/s, $\mu\text{S/cm}$, 7.09 pH, 22.6 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 7.06 pH, 22.4 $^{\circ}\text{C}$		
					3.89L/s, $\mu\text{S/cm}$, 6.21 pH, 21.8 $^{\circ}\text{C}$		
					4.31L/s, $\mu\text{S/cm}$, 6.72 pH, 21.6 $^{\circ}\text{C}$		
					Airlift: 2.3L/s, $\mu\text{S/cm}$, 6.8 pH, 22.6 $^{\circ}\text{C}$		



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB26

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 12/03/2025

Method: AH/MR/OH (0-8/8-13/13-160)

Area: Bombora

Completed: 26/03/2025

Fluid: Air/Mud

Elevation: 314.09

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458580

Bit Record 2: 8" (4-EOH)

Northing: 6602277

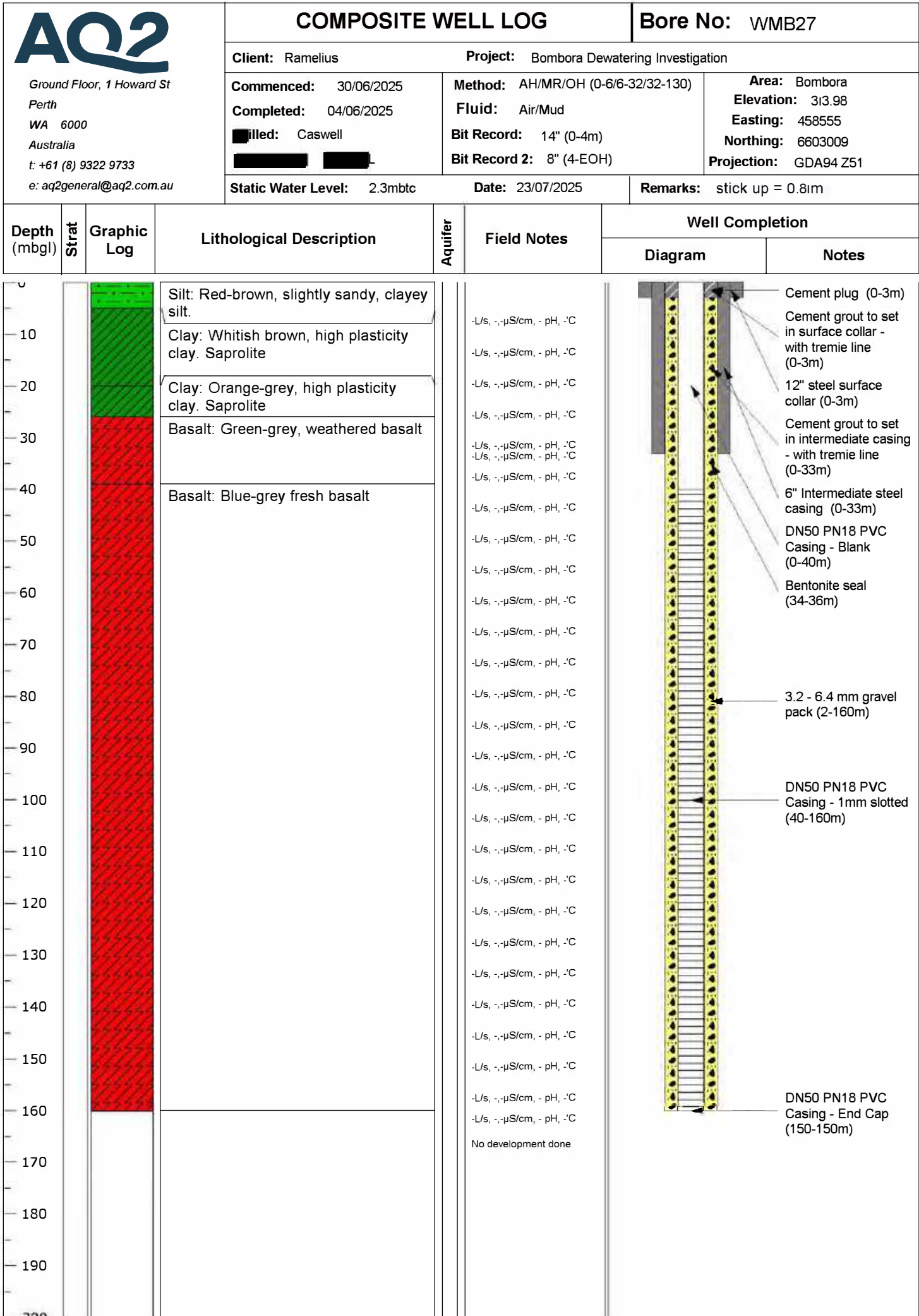
Projection: GDA94 Z51

Static Water Level: 4.17mbtc

Date: 08/06/2025

Remarks: stick up = 0.84m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Gravel: Red-brown, poorly sorted, very silty, sandy, sub-angular to sub-rounded, medium-coarse grained gravel		0.2L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		12" steel surface collar (0-4m) Grout in intermediate casing (SG 1.64) (0-13m) 6" Intermediate steel casing (0-13m) DN50 PN18 PVC Casing - Blank (0-32m) Bentonite seal (26-29m)
10			Gravel : Grey-green-brown, poorly sorted, very gravelly, silty clay. Gravel is sub-angular to sub-rounded, weathered dolerite clasts		0.5L/s, $\mu\text{S/cm}$, 7.08 pH, 20.2 $^{\circ}\text{C}$		
20			Dolerite: Green-grey-mafic, partially serpentised, slightly weathered dolerite		4L/s, $\mu\text{S/cm}$, 6.49 pH, 19.4 $^{\circ}\text{C}$		
30			Dolerite: Fresh, hard, mafic dolerite basement. Quartz noted at 33-35m, 60m, 63m, 70m, 94m, 117-118m, 127-131m, 133-135m, 153-154m. Fractures encountered at 25m (broken, weathered chips), 31m, 34m, 79m, 80m, 82m, 87m, 90m, 95m and 107m. WMB26 located within the lamprohyres dyke zone. Lamprohyre dykes weather easily, behave somewhat like karst and are known to store lots of water.		-L/s, $\mu\text{S/cm}$, 6.26 pH, 19.2 $^{\circ}\text{C}$		
40					6L/s, $\mu\text{S/cm}$, 6.39 pH, 19.1 $^{\circ}\text{C}$		
50					-L/s, $\mu\text{S/cm}$, 6.31 pH, 19.9 $^{\circ}\text{C}$		
60					8L/s, $\mu\text{S/cm}$, 6.29 pH, 19.8 $^{\circ}\text{C}$		
70					-L/s, $\mu\text{S/cm}$, 6.3 pH, 19.2 $^{\circ}\text{C}$		
80					8L/s, $\mu\text{S/cm}$, 6.04 pH, 19.3 $^{\circ}\text{C}$		
90					-L/s, $\mu\text{S/cm}$, 6.01 pH, 21.6 $^{\circ}\text{C}$		
100					8L/s, $\mu\text{S/cm}$, 5.79 pH, 22.4 $^{\circ}\text{C}$		
110					-L/s, $\mu\text{S/cm}$, 5.84 pH, 22.1 $^{\circ}\text{C}$		
120					8.5L/s, $\mu\text{S/cm}$, 5.86 pH, 23.8 $^{\circ}\text{C}$		
130					-L/s, $\mu\text{S/cm}$, 5.89 pH, 23.3 $^{\circ}\text{C}$		3.2-6.4mm gravel (29-160m) DN50 PN18 PVC Casing - 1mm slotted (32-160m)
140					10L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		
150					10L/s, $\mu\text{S/cm}$, 5.92 pH, 23.3 $^{\circ}\text{C}$		
160					-L/s, $\mu\text{S/cm}$, 6.13 pH, 16.7 $^{\circ}\text{C}$		
170					12L/s, $\mu\text{S/cm}$, 6.45 pH, 19.1 $^{\circ}\text{C}$		
					12L/s, $\mu\text{S/cm}$, 6.89 pH, 24.4 $^{\circ}\text{C}$		
					12L/s, $\mu\text{S/cm}$, 6.95 pH, 34.2 $^{\circ}\text{C}$		
					12.5L/s, $\mu\text{S/cm}$, 6.85 pH, 36.3 $^{\circ}\text{C}$		
					12.5L/s, $\mu\text{S/cm}$, 6.91 pH, 37.2 $^{\circ}\text{C}$		
					12.5L/s, $\mu\text{S/cm}$, 6.9 pH, 36.8 $^{\circ}\text{C}$		
					12.5L/s, $\mu\text{S/cm}$, 6.93 pH, 37.2 $^{\circ}\text{C}$		
					12.5L/s, $\mu\text{S/cm}$, 6.94 pH, 41.9 $^{\circ}\text{C}$		
					Airlift: 1.3L/s, $\mu\text{S/cm}$, - pH, 24.8 $^{\circ}\text{C}$		DN50 PN18 PVC Casing - End Cap (160-160m)





Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB28

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 25/06/2025

Method: AH/MR/OH (0-3, 3-33, 33-160)

Area: Bombora

Completed: 30/06/2025

Fluid: Air/Mud

Elevation: 314.39

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458703

Bit Record 2: 8" (4-EOH)

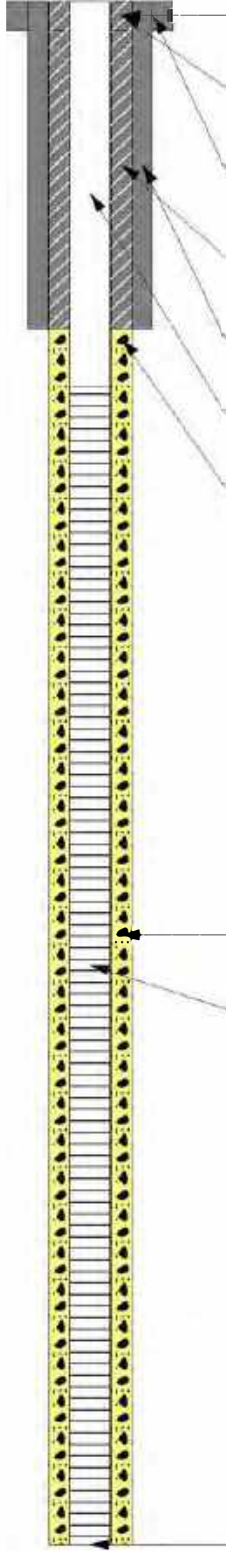
Northing: 6603008

Projection: GDA94 Z51

Static Water Level: 2.3mbtc

Date: 07/07/2025

Remarks: stick up = 1.11m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, slightly sandy, clayey silt.		-L/s, -, -µS/cm, - pH, -°C		Cement plug (0-3m)
10			Clay: Yellow/grey, plastic, poorly sorted, silty, minor ferrungious clasts		-L/s, -, -µS/cm, - pH, -°C		Cement grout to set in surface collar - with tremie line (0-3m)
20					-L/s, -, -µS/cm, - pH, -°C		12" steel surface collar (0-3m)
30			Clay: Dark green/grey, high plasticity clay. Saprolite		-L/s, -, -µS/cm, - pH, -°C		Cement grout to set in intermediate casing - with tremie line (0-33m)
40			Dolorite: Dark green/grey, weathered dolorite, weathered to mid brown, saprock.		-L/s, -, -µS/cm, - pH, -°C 0L/s, 784,400µS/cm, - pH, -°C		6" Intermediate steel casing (0-33m)
50			Dolorite: Dark green/grey dolorite, fresh, competent, metamorphosed		0L/s, 862,200µS/cm, - pH, -°C		DN50 PN18 PVC Casing - Blank (0-40m)
60					0.1L/s, 974,400µS/cm, 5.82 pH, 13.3°C		Bentonite seal (34-36m)
70					0.2L/s, 983,300µS/cm, 4.62 pH, 10.1°C		
80					0.3L/s, 158,000µS/cm, 5.72 pH, 7.9°C		
90					0.4L/s, 178,000µS/cm, 6.41 pH, 8.2°C		
100					0.4L/s, 171,000µS/cm, 6.23 pH, 14.8°C		
110					0.5L/s, 167,000µS/cm, 6.37 pH, 9.1°C		
120					0.8L/s, 164,000µS/cm, 6.81 pH, 11°C		
130					1L/s, 191,000µS/cm, 6.38 pH, 10.5°C		3.2 - 6.4 mm gravel pack (2-160m)
140					1.2L/s, 184,000µS/cm, 3.94 pH, 18.9°C		DN50 PN18 PVC Casing - 1mm slotted (40-160m)
150					1.2L/s, 190,000µS/cm, 6.01 pH, 11.1°C		
160					1.4L/s, 186,000µS/cm, 5.58 pH, 13.5°C		
170					1.5L/s, 171,000µS/cm, 6.7 pH, 12.9°C		
					1.5L/s, 172,000µS/cm, 6.6 pH, 12.6°C		
					1.5L/s, 186,000µS/cm, 6.68 pH, 12.9°C		
					1.5L/s, 192,000µS/cm, 5.81 pH, 17.2°C		
					1.5L/s, 187,000µS/cm, 6.7 pH, 12.3°C		
					1.5L/s, 181,000µS/cm, 6.78 pH, 12.7°C		
					1.5L/s, 194,000µS/cm, 6.74 pH, 12.3°C		
					1.5L/s, 181,000µS/cm, 6.74 pH, 11.4°C		
					Airlift: 0.6L/s, µS/cm, 5.26 pH, 16.8°C		DN50 PN18 PVC Casing - End Cap (160m)



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB29

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 04/07/2025

Method: AH/MR/OH (0-3/3-31/31-130)

Area: Bombora

Completed: 08/07/2025

Fluid: Air/Mud

Elevation: 315.79

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458365

Bit Record 2: 8" (4-EOH)

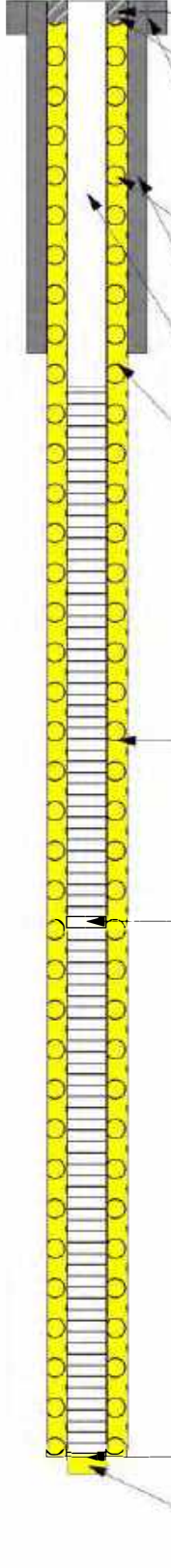
Northing: 6602795

Projection: GDA94 Z51

Static Water Level: 2.3mbtc

Date: 23/07/2025

Remarks: stick up = 1.25m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, slightly sandy, clayey silt.		-L/s, -, -µS/cm, - pH, -°C		Cement plug (0-2m)
10			Clay: Orangish-brown, high plasticity clay. Saprolite		-L/s, -, -µS/cm, - pH, -°C		Cement grout to set in surface collar - with tremie line (0-3m)
20			Gravel: Grey-green-brown, poorly sorted, very gravelly, silty clay. Gravel is sub-angular to sub-rounded, weathered basalt clasts		-L/s, -, -µS/cm, - pH, -°C		12" steel surface collar (0-3m)
30			Basalt: Green-grey, weathered basalt. Seepage at 32m		-L/s, -, -µS/cm, - pH, -°C		Cement grout to set in intermediate casing - with tremie line (0-31m)
40			Basalt: Blue-grey fresh basalt. Minor water strike at 49m. Main water strike at 53m (4.42 l/s)		-L/s, -, -µS/cm, - pH, -°C		6" Intermediate steel casing (0-31m)
50					0.3L/s, -, -µS/cm, - pH, -°C		DN50 PN18 PVC Casing - Blank (0-34m)
60					0.3L/s, 15,680µS/cm, 6.1 pH, 18.6°C		Bentonite seal (31-33m)
70					2L/s, 16,140µS/cm, 6.25 pH, 18.8°C		
80					4.42L/s, 16,010µS/cm, 6.01 pH, 18.8°C		
90					4.42L/s, 16,280µS/cm, 5.3 pH, 18.5°C		
100					4.42L/s, 17,550µS/cm, 6.29 pH, 19.4°C		DN50 PN18 PVC Casing - Blank (2-128.5m)
110					4.42L/s, 17,240µS/cm, 6.51 pH, 19.6°C		
120					4.42L/s, 17,160µS/cm, 6.4 pH, 20.4°C		
130					4.42L/s, 15,760µS/cm, 6.62 pH, 22.6°C		DN50 PN18 PVC Casing - 1mm slotted (34-128.5m)
					4.42L/s, 17,200µS/cm, 6.42 pH, 22.2°C		
					4.42L/s, 17,420µS/cm, 6.55 pH, 22.5°C		
					4.42L/s, 17,140µS/cm, 6.21 pH, 22.6°C		
					4.42L/s, 17,420µS/cm, 6.35 pH, 20.8°C		
					4.42L/s, 17,390µS/cm, 6.59 pH, 21.5°C		
					4.42L/s, 17,470µS/cm, 6.68 pH, 20.9°C		
					4.42L/s, 18,000µS/cm, 6.65 pH, 18.5°C		DN50 PN18 PVC Casing - End Cap (128.5m)
					4.42L/s, 17,980µS/cm, 6.52 pH, 19°C		
					Airlift: 0.45L/s, 15,100µS/cm, 6.13 pH, 19.5°C		3.2 - 6.4 mm gravel pack (128.5-130m)



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB31

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 03/04/2025

Method: AH/MR/OH (0-6/6-31/31-151)

Area: Bombora

Completed: 07/04/2025

Fluid: Air/Mud

Elevation: 315.05

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458913

Bit Record 2: 8" (4-EOH)

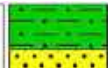
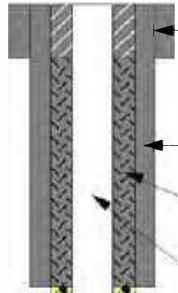
Northing: 6602638

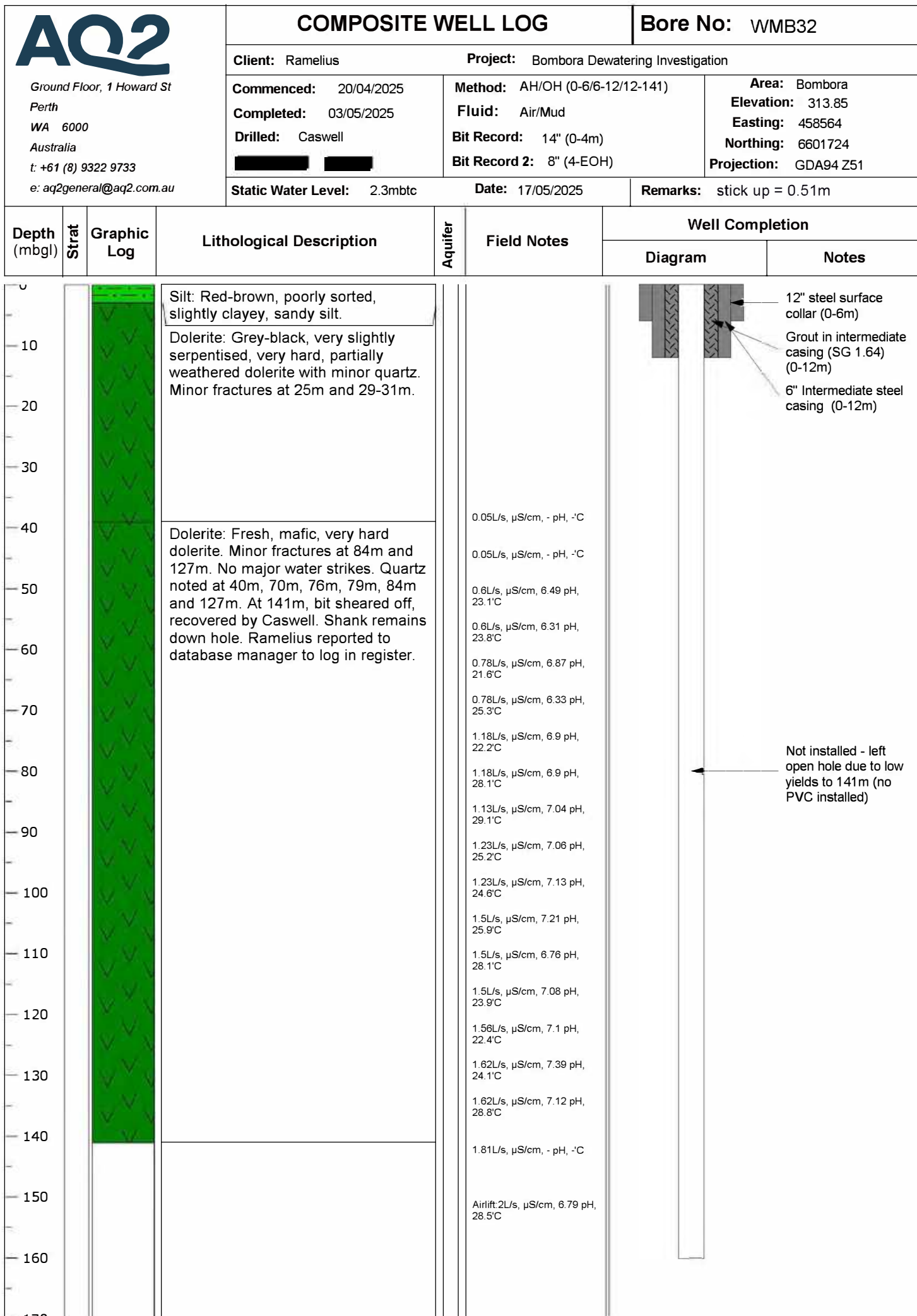
Projection: GDA94 Z51

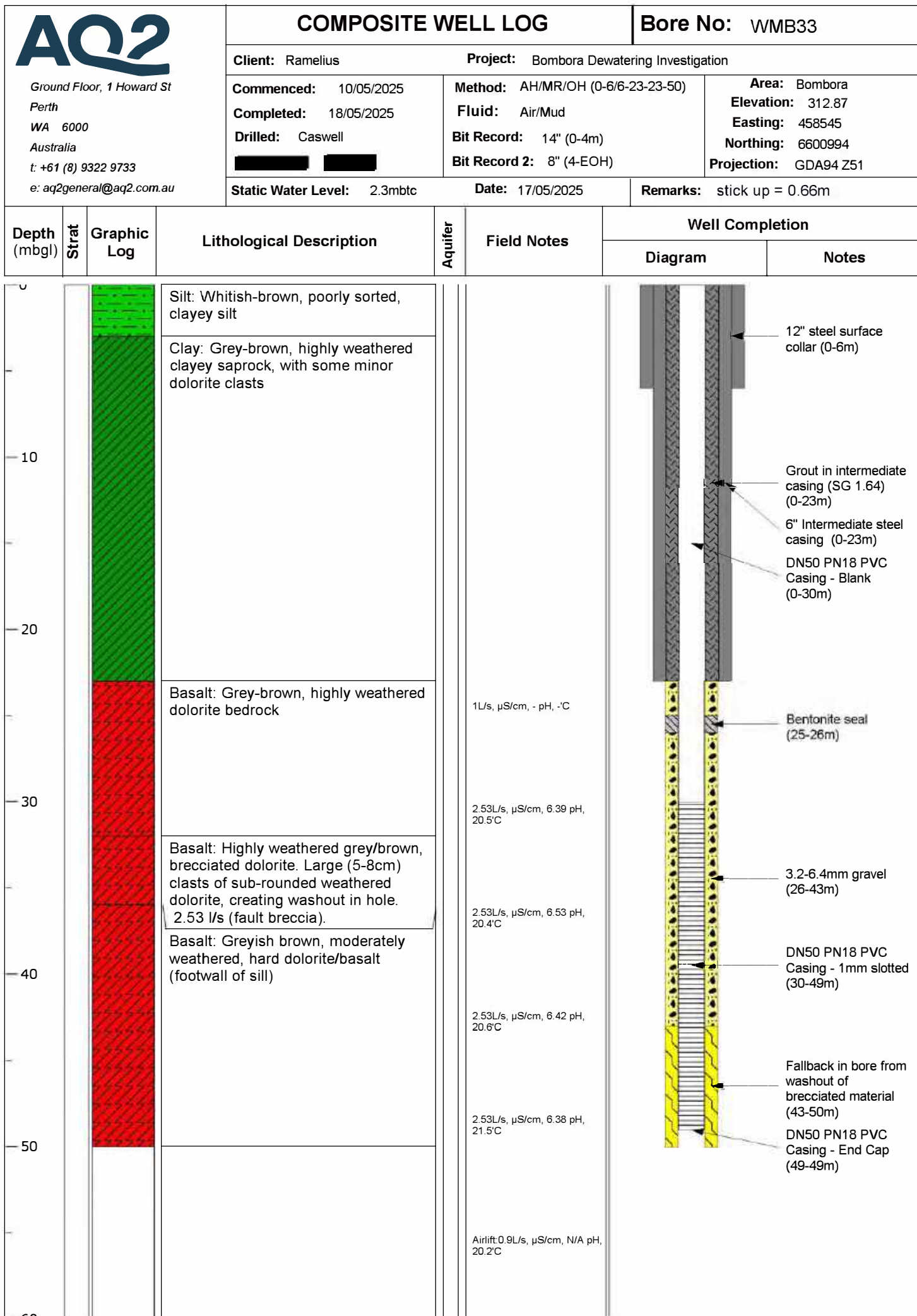
Static Water Level: 5.49mbtc

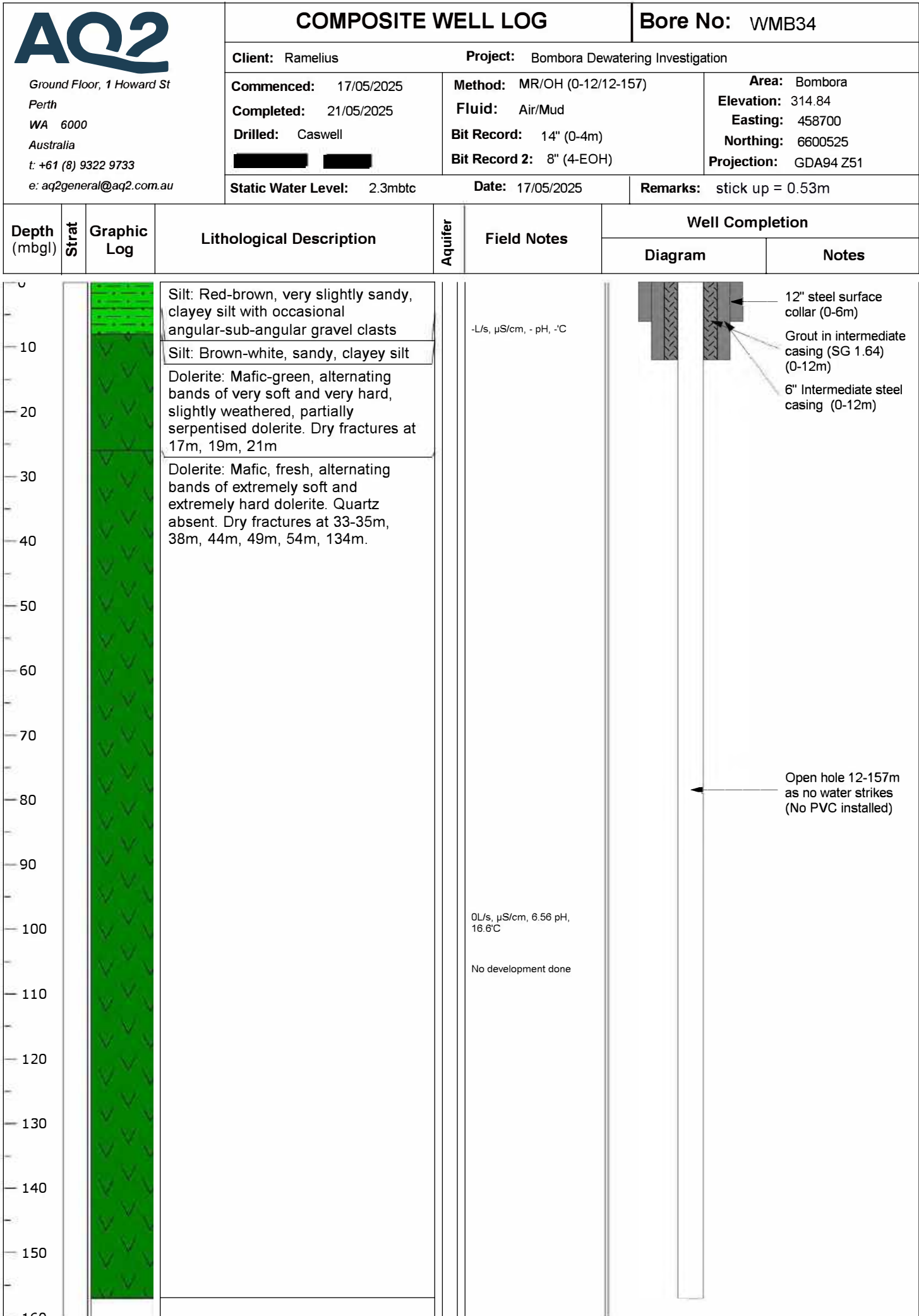
Date: 17/06/2025

Remarks: stick up = 0.98m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, slightly sandy, clayey silt.				12" steel surface collar (0-6m)
10			Sand : Red-purple, slightly silty, very clayey, quartz rich sand				6" Intermediate steel casing (0-31m)
20			Clay: Red-purple-brown, silty clay with abundant angular quartz granules at 14-15m				Grout in intermediate casing (SG 1.64) (18-31m)
30			Clay: Grey-brown, sticky, slightly silty clay.				DN50 PN18 PVC Casing - Blank (0-42m)
40			Dolerite : Green-mafic, partially serpentinised, slightly weathered, very hard, quartz rich dolerite. Major water bearing fractures at 31m, 37m, 40m and 41m.		0.3L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		Bentonite seal (36-39m)
50			Dolerite : Fresh, mafic, very hard dolerite with abundant quartz throughout. Major water bearing fractures at 47m and 55m.		0.99L/s, $\mu\text{S/cm}$, 6.87 pH, 30.9 $^{\circ}\text{C}$		
60					6.26L/s, $\mu\text{S/cm}$, 7.52 pH, 26.7 $^{\circ}\text{C}$		
70					6.26L/s, $\mu\text{S/cm}$, 7.32 pH, 29.4 $^{\circ}\text{C}$		
80					6.26L/s, $\mu\text{S/cm}$, 7.2 pH, 33 $^{\circ}\text{C}$		
90					6.97L/s, $\mu\text{S/cm}$, 7.07 pH, 36.1 $^{\circ}\text{C}$		
100					6.97L/s, $\mu\text{S/cm}$, 7.04 pH, 29.1 $^{\circ}\text{C}$		
110					6.97L/s, $\mu\text{S/cm}$, 6.93 pH, 29.1 $^{\circ}\text{C}$		
120					6.97L/s, $\mu\text{S/cm}$, 7.14 pH, 24.8 $^{\circ}\text{C}$		
130					6.97L/s, $\mu\text{S/cm}$, 7.03 pH, 36.8 $^{\circ}\text{C}$		
140					8.84L/s, $\mu\text{S/cm}$, 7.11 pH, 25.5 $^{\circ}\text{C}$		
150					7.72L/s, $\mu\text{S/cm}$, 7.02 pH, 29.1 $^{\circ}\text{C}$		
160					7.72L/s, $\mu\text{S/cm}$, 7.14 pH, 25.2 $^{\circ}\text{C}$		
170					8.84L/s, $\mu\text{S/cm}$, - pH, - $^{\circ}\text{C}$		
180					8.84L/s, $\mu\text{S/cm}$, 7.21 pH, 26.7 $^{\circ}\text{C}$		
190					8.84L/s, $\mu\text{S/cm}$, 7.35 pH, 25.4 $^{\circ}\text{C}$		
200					8.84L/s, $\mu\text{S/cm}$, 7.36 pH, 22.2 $^{\circ}\text{C}$		
210					8.51L/s, $\mu\text{S/cm}$, 7.19 pH, 21.6 $^{\circ}\text{C}$		
220					8.51L/s, $\mu\text{S/cm}$, 7.24 pH, 22.9 $^{\circ}\text{C}$		
230					6.97L/s, $\mu\text{S/cm}$, 6.97 pH, 12.8 $^{\circ}\text{C}$		
240					Airlift: 1.45L/s, $\mu\text{S/cm}$, 6.8 pH, 22.3 $^{\circ}\text{C}$		
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Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WMB35

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 21/05/2025

Method: MR/OH (0-7/7-161)

Area: Bombora

Completed: 27/05/2025

Fluid: Air/Mud

Elevation: 312.89

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458650

Bit Record 2: 8" (4-EOH)

Northing: 6600609

Projection: GDA94 Z51

Static Water Level: 2.46mbtc

Date: 17/06/2025

Remarks: stick up = 0.85m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, silty clay				12" steel surface collar (0-3m)
10			Clay : White-brown, clayey silt with increasing dolerite/quartz gravel content with depth.				Grout in intermediate casing (SG 1.64) (0-8.5m)
20			Dolerite: Mafic-green, partially serpentised, highly weathered dolerite				6" Intermediate steel casing (0-8.5m)
30			Dolerite: Mafic, slightly weathered dolerite				DN50 PN18 PVC Casing - Blank (0-28m)
40			Dolerite: Fresh, very hard dolerite with a large fracture at 29-30m, and a fracture/abundant quartz at 63m		0.1L/s, $\mu\text{S/cm}$, - pH, -°C		Bentonite seal (24-25m)
50					0.2L/s, $\mu\text{S/cm}$, - pH, -°C		
60					0.2L/s, $\mu\text{S/cm}$, - pH, -°C		
70					0.2L/s, $\mu\text{S/cm}$, - pH, -°C		
80					0.2L/s, $\mu\text{S/cm}$, - pH, -°C		
90					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
100					0.8L/s, $\mu\text{S/cm}$, 6.29 pH, 6°C		
110					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
120					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
130					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
140					0.8L/s, $\mu\text{S/cm}$, 6.9 pH, 20.9°C		
150					0.8L/s, $\mu\text{S/cm}$, 6.74 pH, 22.4°C		3.2-6.4mm gravel (25-160m)
160					0.8L/s, $\mu\text{S/cm}$, 6.81 pH, 20.8°C		DN50 PN18 PVC Casing - 1mm slotted (28-160m)
170					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
					0.8L/s, $\mu\text{S/cm}$, 7.14 pH, 25.8°C		
					0.8L/s, $\mu\text{S/cm}$, 7.22 pH, 21.9°C		
					0.8L/s, $\mu\text{S/cm}$, - pH, -°C		
					0.8L/s, $\mu\text{S/cm}$, 6.79 pH, 14.7°C		
					0.8L/s, $\mu\text{S/cm}$, 6.86 pH, 10.3°C		
					0.8L/s, $\mu\text{S/cm}$, 6.91 pH, 19.8°C		
					0.8L/s, $\mu\text{S/cm}$, 7.07 pH, 14.2°C		
					0.9L/s, $\mu\text{S/cm}$, 7.22 pH, 16.3°C		
					0.9L/s, $\mu\text{S/cm}$, 7.01 pH, 22.4°C		DN50 PN18 PVC Casing - End Cap (160-160m)
					Airlift 0.45L/s, $\mu\text{S/cm}$, 5.31 pH, 17°C		



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WPB26

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 30/05/2025

Method: AH/MR/OH (0-6/6-11/11-160)

Area: Bombora

Completed: 07/06/2025

Fluid: Air/Mud

Elevation: 313.78

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458589

Bit Record 2: 8" (4-EOH)

Northing: 6602285

Projection: GDA94 Z51

Static Water Level: 2.14mbtc

Date: 12/06/2025

Remarks: stick up = 0.58m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Gravel: Red-brown, poorly sorted, very silty, sandy, sub-angular to sub-rounded, medium-coarse grained gravel Gravel : Grey-green-brown, poorly sorted, very gravelly, silty clay. Gravel is sub-angular to sub-rounded, weathered dolerite clasts Dolorite: Green-grey-mafic, partially serpentised, slightly weathered dolerite Dolorite: Fresh, hard, mafic dolerite basement. Quartz noted at various intervals. Gypsum also seen occasionally.				16" steel surface collar (0-6m) Grout in intermediate casing (SG 1.64) (0-11m) 12" Intermediate steel casing (0-11m) 8" Class 18 PVC plain casing (0-28.4m) Bentonite seal in annulus (21-24m) 3.2 - 6.4 mm gravel pack (24-160m) 8" Class 18 PVC slotted casing with 1 mm slots (28.4-156.4m) 8" Class 18 PVC plain casing as 3 m bore sump (156.4-159.4m)
10					3.89L/s, $\mu\text{S/cm}$, 6.64 pH, 23.3°C		
20					11.18L/s, $\mu\text{S/cm}$, 6.77 pH, 22.4°C		
30					11.18L/s, $\mu\text{S/cm}$, 6.91 pH, 22.7°C		
40					8.51L/s, $\mu\text{S/cm}$, 6.98 pH, 21.8°C		
50					8.51L/s, $\mu\text{S/cm}$, 6.75 pH, 21.7°C		
60					8.51L/s, $\mu\text{S/cm}$, 6.66 pH, 21.7°C		
70					5.81L/s, $\mu\text{S/cm}$, 6.93 pH, 21.6°C		
80					7.72L/s, $\mu\text{S/cm}$, 6.94 pH, 21.3°C		
90					10.24L/s, $\mu\text{S/cm}$, 6.15 pH, 20.5°C		
100					10.24L/s, $\mu\text{S/cm}$, 6.61 pH, 21.1°C		
110					14.3L/s, $\mu\text{S/cm}$, 6.54 pH, 22.9°C		
120					14.3L/s, $\mu\text{S/cm}$, 6.73 pH, 22.6°C		
130					14.3L/s, $\mu\text{S/cm}$, 5.64 pH, 21.5°C		
140					15L/s, $\mu\text{S/cm}$, 6.63 pH, 22.4°C		
150					15L/s, $\mu\text{S/cm}$, 6.71 pH, 22.6°C		
160					15L/s, $\mu\text{S/cm}$, 6.82 pH, 22.5°C		
170					15L/s, $\mu\text{S/cm}$, 8.82 pH, 21.2°C		
					15L/s, $\mu\text{S/cm}$, 6.11 pH, 20.5°C		
					15L/s, $\mu\text{S/cm}$, 6.34 pH, 20.3°C		
					15L/s, $\mu\text{S/cm}$, 6.13 pH, 20.2°C		
					15L/s, $\mu\text{S/cm}$, 6.15 pH, 21.1°C		
					15L/s, $\mu\text{S/cm}$, 6.07 pH, 20.7°C		
					15L/s, $\mu\text{S/cm}$, 6.25 pH, 21.2°C		
					Airlift: 7L/s, $\mu\text{S/cm}$, 6.6 pH, 22.8°C		



Ground Floor, 1 Howard St
Perth
WA 6000
Australia
t: +61 (8) 9322 9733
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Bore No: WPB33

Client: Ramelius

Project: Bombora Dewatering Investigation

Commenced: 08/06/2025

Method: MR/OH/OH (0-8/8-30/30-160)

Area: Bombora

Completed: 14/06/2025

Fluid: Air/Mud

Elevation: 313.16

Drilled: Caswell

Bit Record: 14" (0-4m)

Easting: 458537

Bit Record 2: 8" (4-EOH)

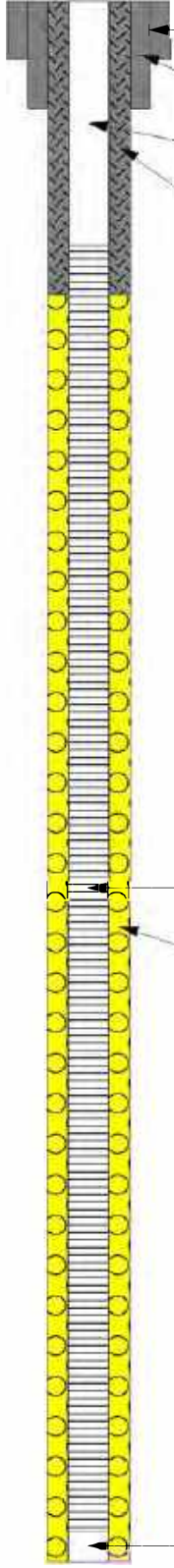
Northing: 6601010

Projection: GDA94 Z51

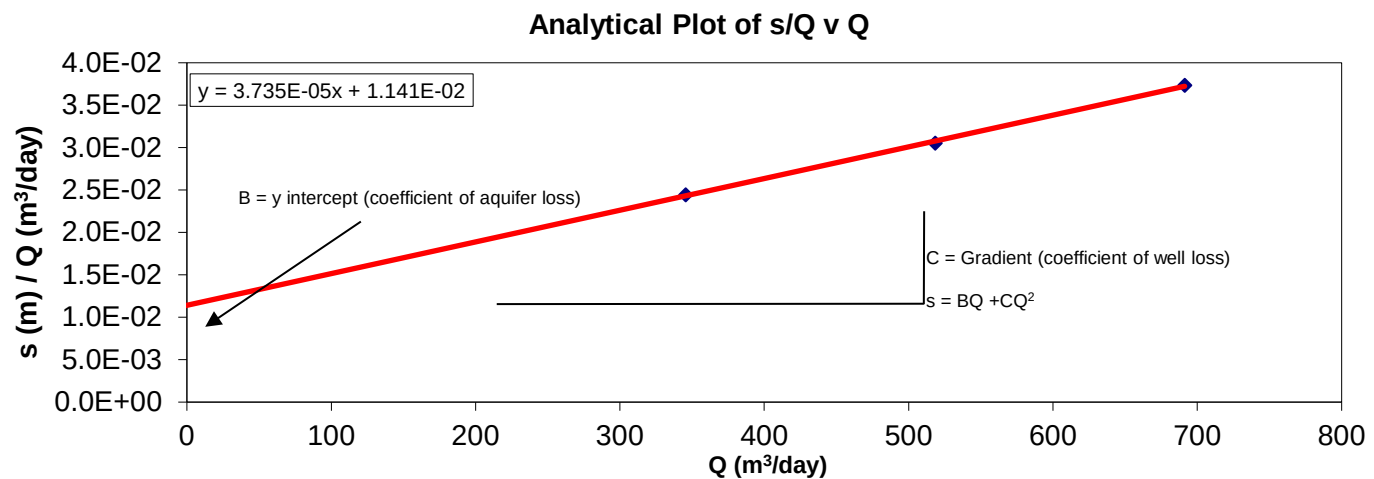
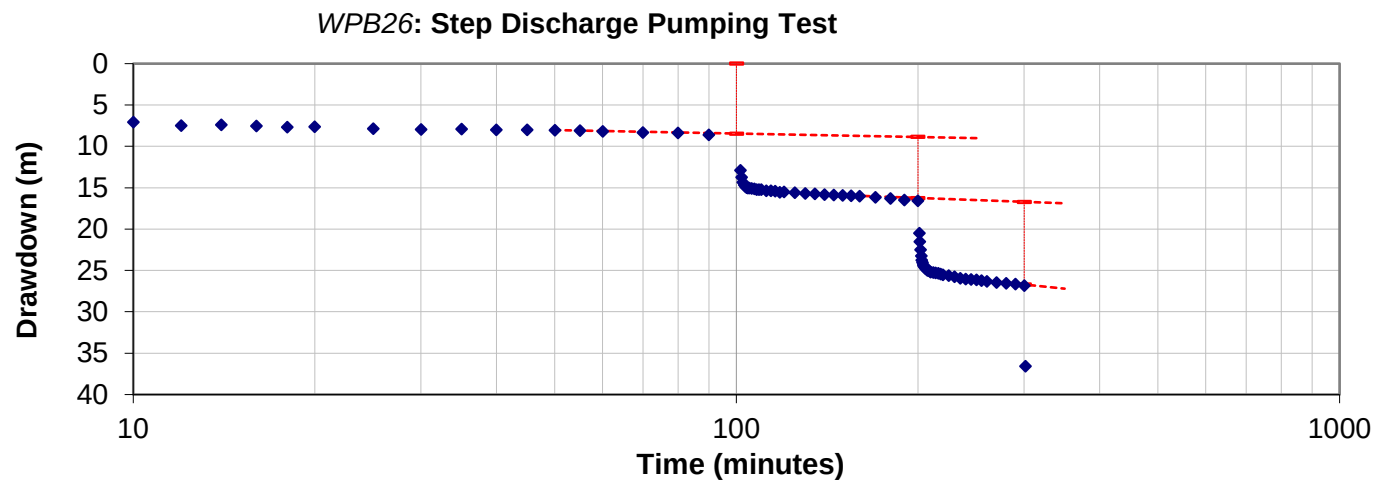
Static Water Level: 2.3mbtc

Date: 17/05/2025

Remarks: stick up = 0.28m

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Silt: Red-brown, poorly sorted, very silty, sandy, fine to medium grained gravel Alluvium				16" steel surface collar (0-6m) 12" Intermediate steel casing (0-11m) 8" Class 18 PVC plain casing (0-25m) Grout in intermediate casing (SG 1.64) (0-30m)
10			Clay: Buff brown Clay, containing clasts of meta Basalt				
20			Basalt: Dark green grey to black meta Basalt, brecciated zone from 40 to 45, with quartz veining from 47 to 48 mbgl.				
30					5 to 7L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
40							
50					1 to 3L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
60					3 to 5L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
70					3.4L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
80					3.4L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
90					3.4L/s, $\mu\text{S/cm}$, 6.8 pH, 16.4 $^{\circ}\text{C}$		
100					3L/s, $\mu\text{S/cm}$, 6.4 pH, 17 $^{\circ}\text{C}$		
110					3.4L/s, $\mu\text{S/cm}$, - pH, $^{\circ}\text{C}$		
120					3.4L/s, $\mu\text{S/cm}$, 6.5 pH, 16.2 $^{\circ}\text{C}$		
130					3.4L/s, $\mu\text{S/cm}$, 6.8 pH, 18.4 $^{\circ}\text{C}$		
140					3.4L/s, $\mu\text{S/cm}$, 6.9 pH, 16.9 $^{\circ}\text{C}$		
150					2.9L/s, $\mu\text{S/cm}$, 6.8 pH, 17.2 $^{\circ}\text{C}$		
160					3L/s, $\mu\text{S/cm}$, 6.9 pH, 15.7 $^{\circ}\text{C}$		
					3.4L/s, $\mu\text{S/cm}$, 6.8 pH, 16.2 $^{\circ}\text{C}$		
					3.4L/s, $\mu\text{S/cm}$, 6.4 pH, 17.8 $^{\circ}\text{C}$		
					3.4L/s, $\mu\text{S/cm}$, 6.7 pH, 16.7 $^{\circ}\text{C}$		
					3.4L/s, $\mu\text{S/cm}$, 6.4 pH, 16.1 $^{\circ}\text{C}$		
					3.4L/s, $\mu\text{S/cm}$, 6.5 pH, 17 $^{\circ}\text{C}$		
					2.5L/s, $\mu\text{S/cm}$, 6.4 pH, 16.2 $^{\circ}\text{C}$		
					2.5L/s, $\mu\text{S/cm}$, 6.4 pH, 16.8 $^{\circ}\text{C}$		
							8" Class 18 PVC slotted casing with 1 mm slots (25-157m) 3.2 - 6.4 mm gravel pack (2-160m)
							8" Class 18 PVC plain casing as 3 m bore sump (157-160m)

APPENDIX C
RESULTS OF HYDRAULIC TESTING



$s_{w(n)} = BQ_n + CQ_n^P$ (Rorabaugh's equation)
 Where: B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
 C = Gradient (coefficient of turbulent flow loss or apparent well loss)
 s = Drawdown in the borehole
 P = Value determined using Rorabaugh's method of superposition

Components of Jacob's (1947) equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively. They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

- Please note:*
1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
 2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

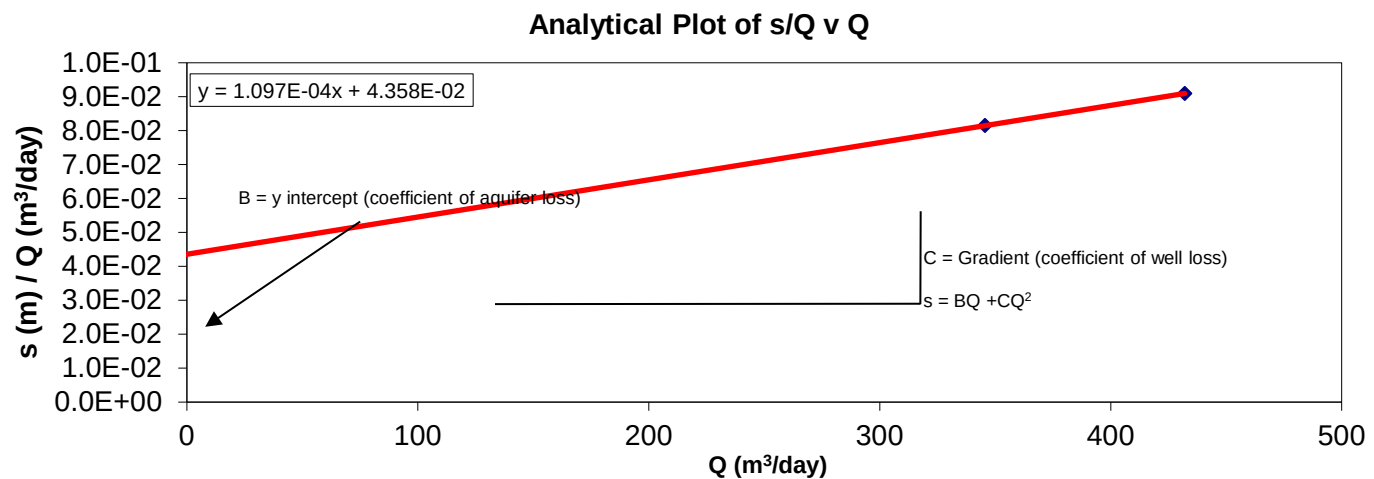
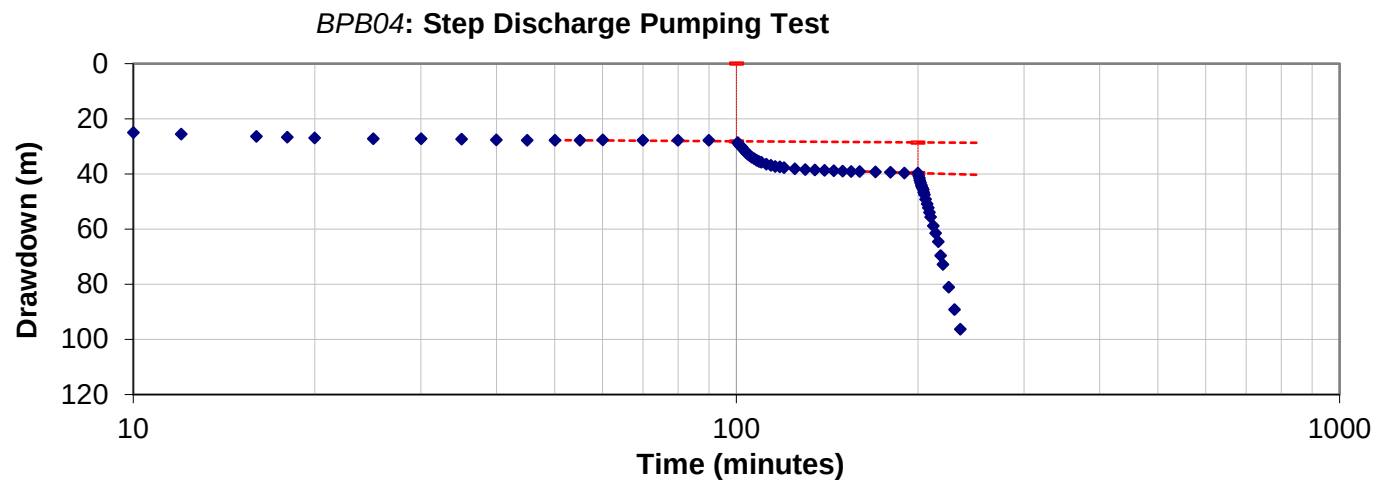
$$E_w = (BQ / (BQ + CQ^P)) \times 100$$

E_w or Well Efficiency represents the proportion of drawdown caused by laminar flow

From plot of s/Q v Q (trend line equation):
 Intercept (B) 1.141E-02
 Gradient (C) 3.735E-05

ANALYSIS TABLE

Calculation of well efficiency and comparison of observed and predicted drawdowns							
Step (60 minute duration)	Discharge (l/s)	Discharge (Q) (m³/d)	Measured Incremental Drawdown (metres)	Corrected Drawdown (metres)	Predicted Drawdown (metres)	s/Q	Apparent Efficiency (E_w) %
1	4.0	346	8.45	8.45	8.41	2.44E-02	46.9
2	6.0	518	7.38	15.83	15.95	3.05E-02	37.1
3	8.0	691	9.99	25.82	25.73	3.74E-02	30.7
4							



$s_{w(n)} = BQ_n + CQ_n^P$ (Rorabaugh's equation)
 Where: B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
 C = Gradient (coefficient of turbulent flow loss or apparent well loss)
 s = Drawdown in the borehole
 P = Value determined using Rorabaugh's method of superposition

Components of Jacob's (1947) equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively. They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

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$$E_w = (BQ / (BQ + CQ^P)) \times 100$$

E_w or Well Efficiency represents the proportion of drawdown caused by laminar flow

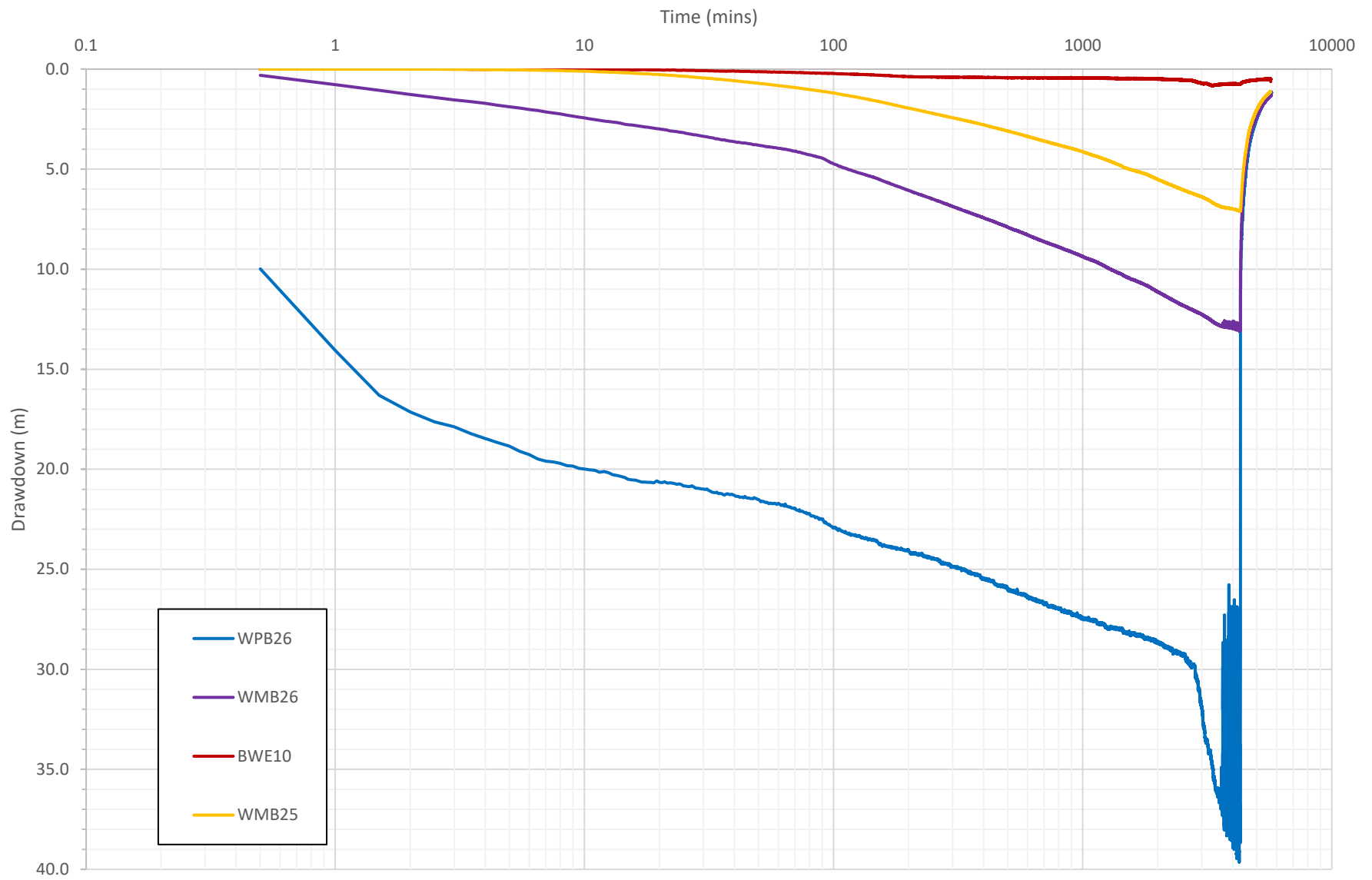
From plot of s/Q v Q (trend line equation):

Intercept (B) 4.358E-02
 Gradient (C) 1.097E-04

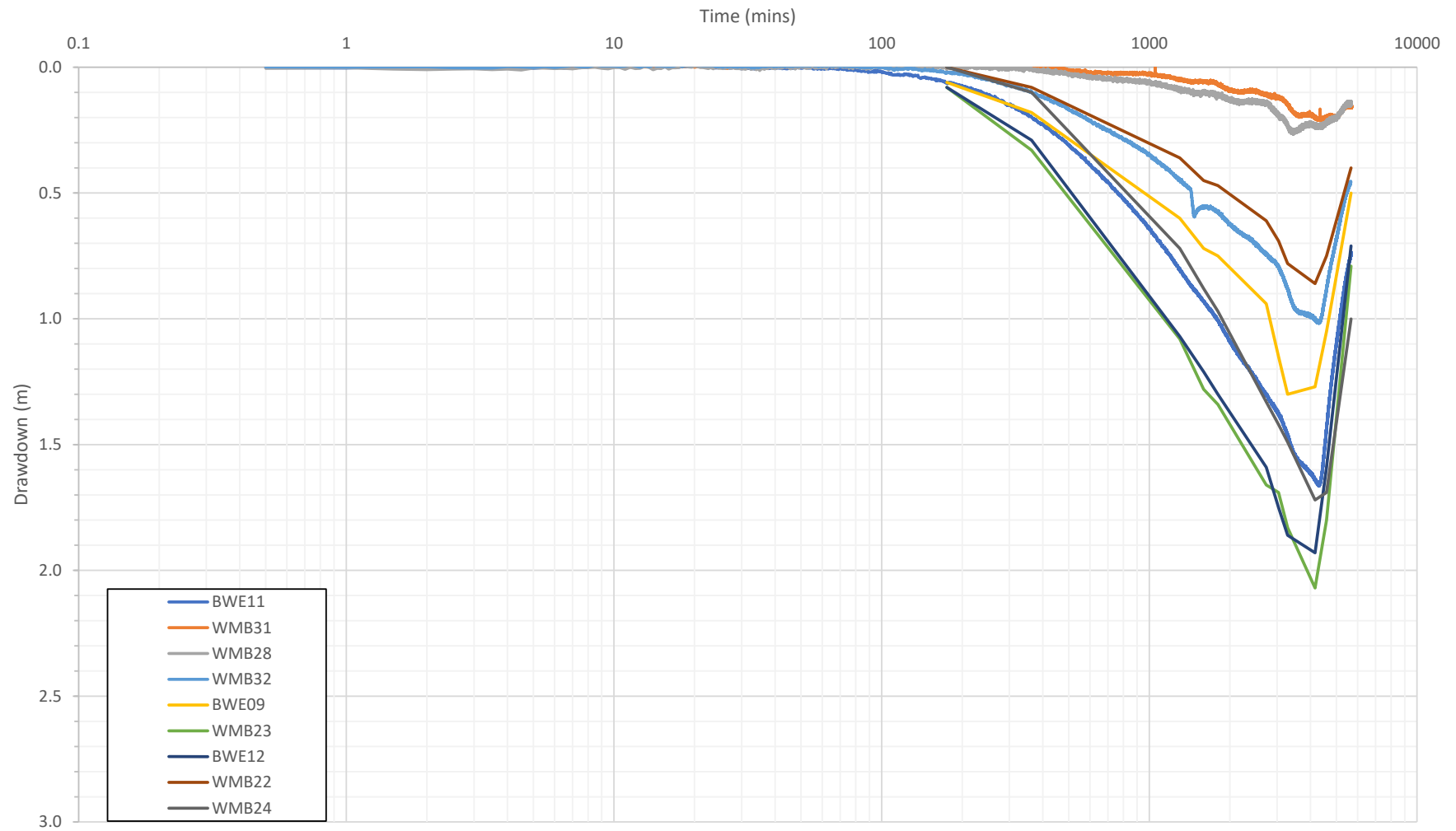
ANALYSIS TABLE

Calculation of well efficiency and comparison of observed and predicted drawdowns							
Step (60 minute duration)	Discharge (l/s)	Discharge (Q) (m³/d)	Measured Incremental Drawdown (metres)	Corrected Drawdown (metres)	Predicted Drawdown (metres)	s/Q	Apparent Efficiency (E_w) %
1	4.0	346	28.16	28.16	28.16	8.15E-02	53.5
2	5.0	432	11.13	39.29	39.29	9.10E-02	47.9
3							
4							

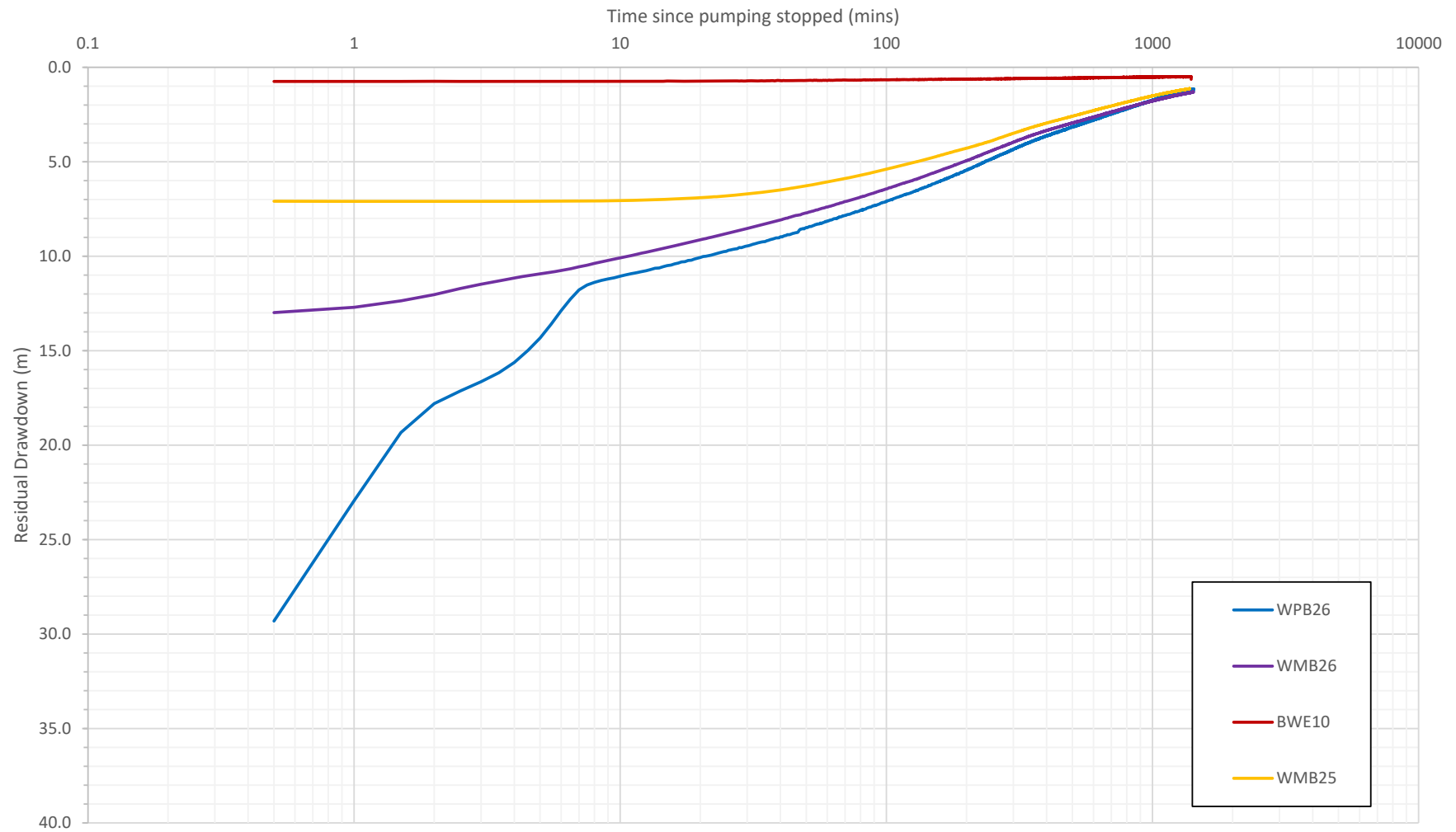
Bombora Constant Rate Tests: WPB26



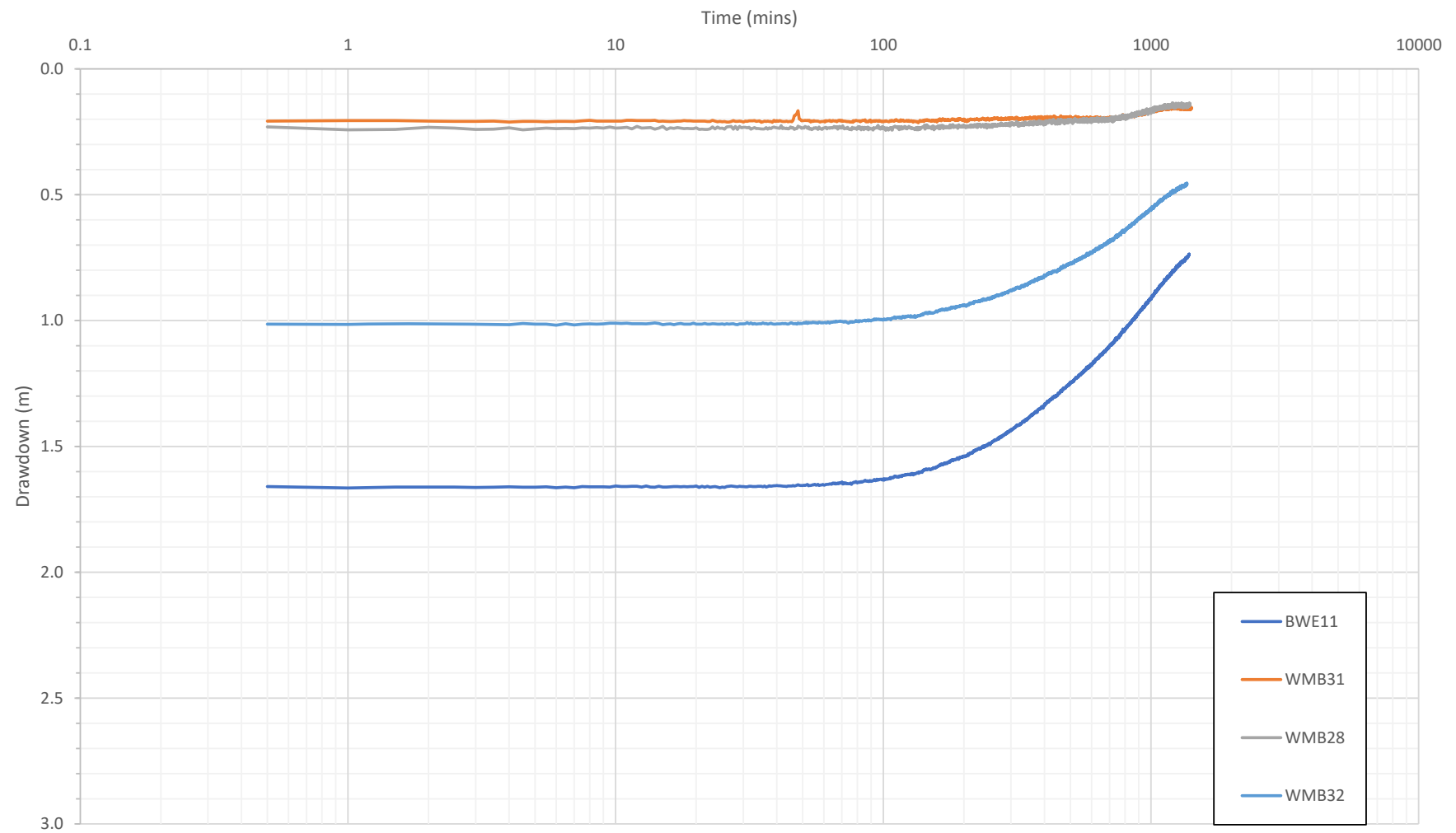
Bombora Constant Rate Tests: WPB26



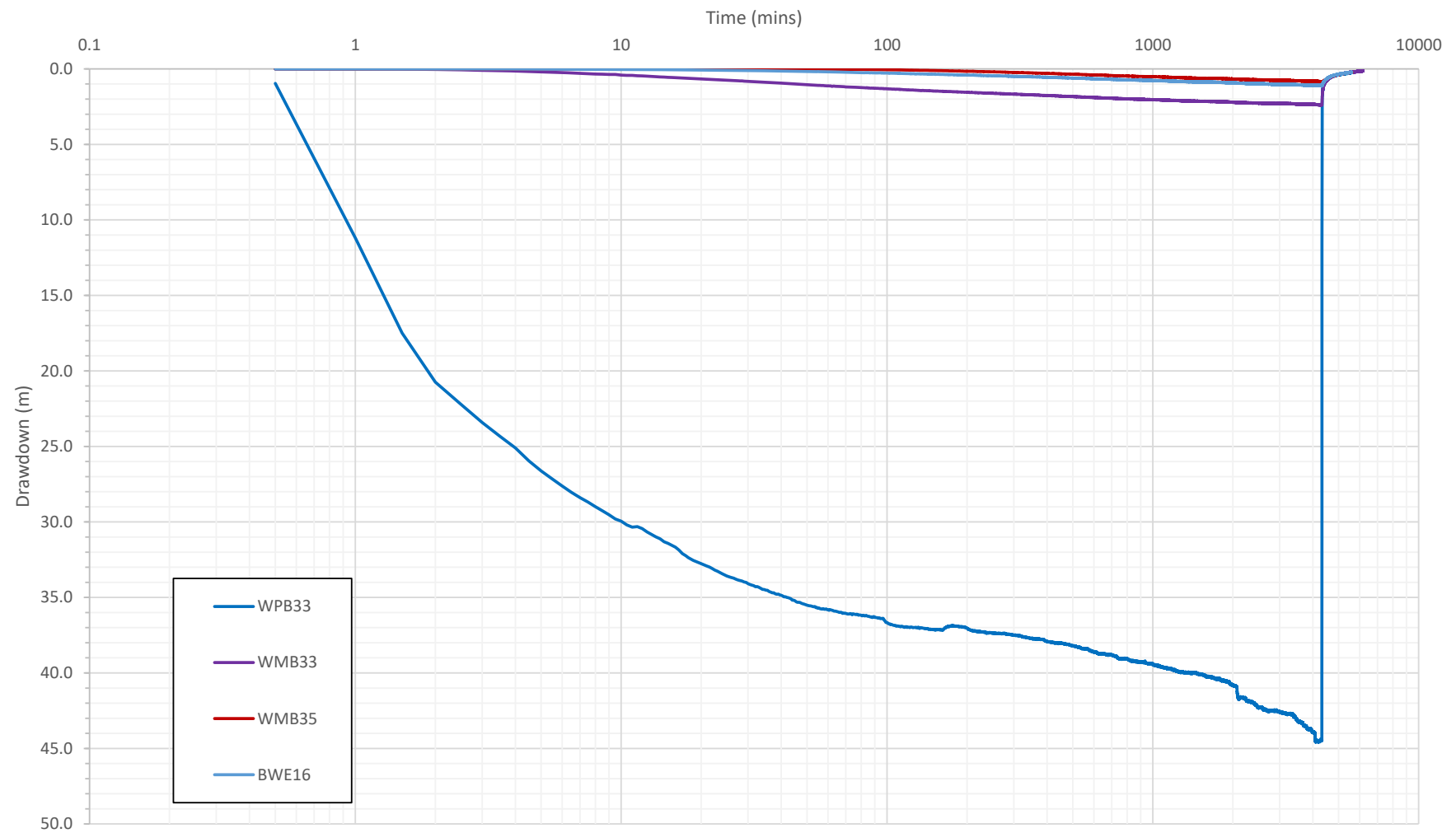
Bombora Recovery Test: WPB26



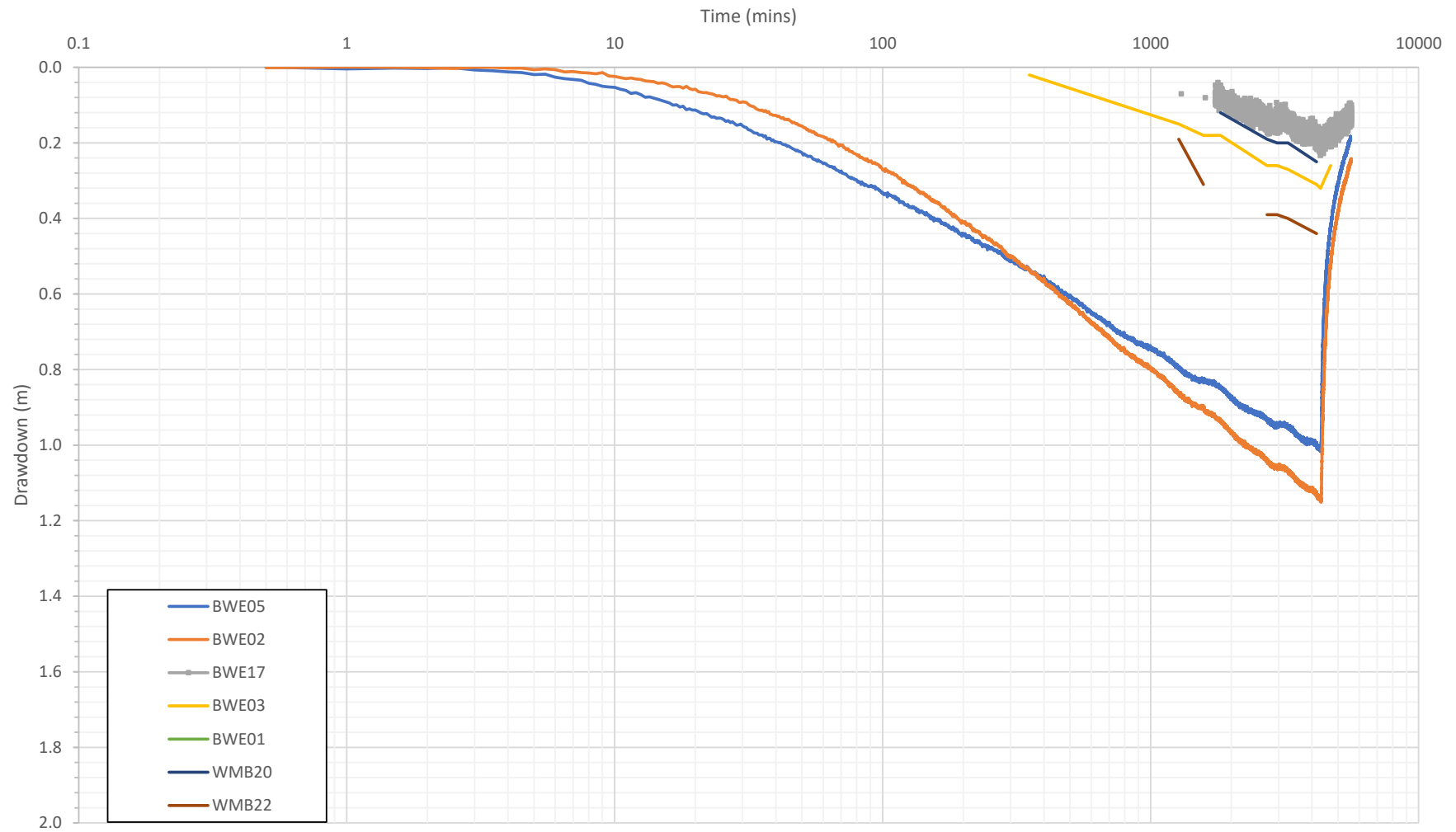
Bombora Recovery Test: WPB26



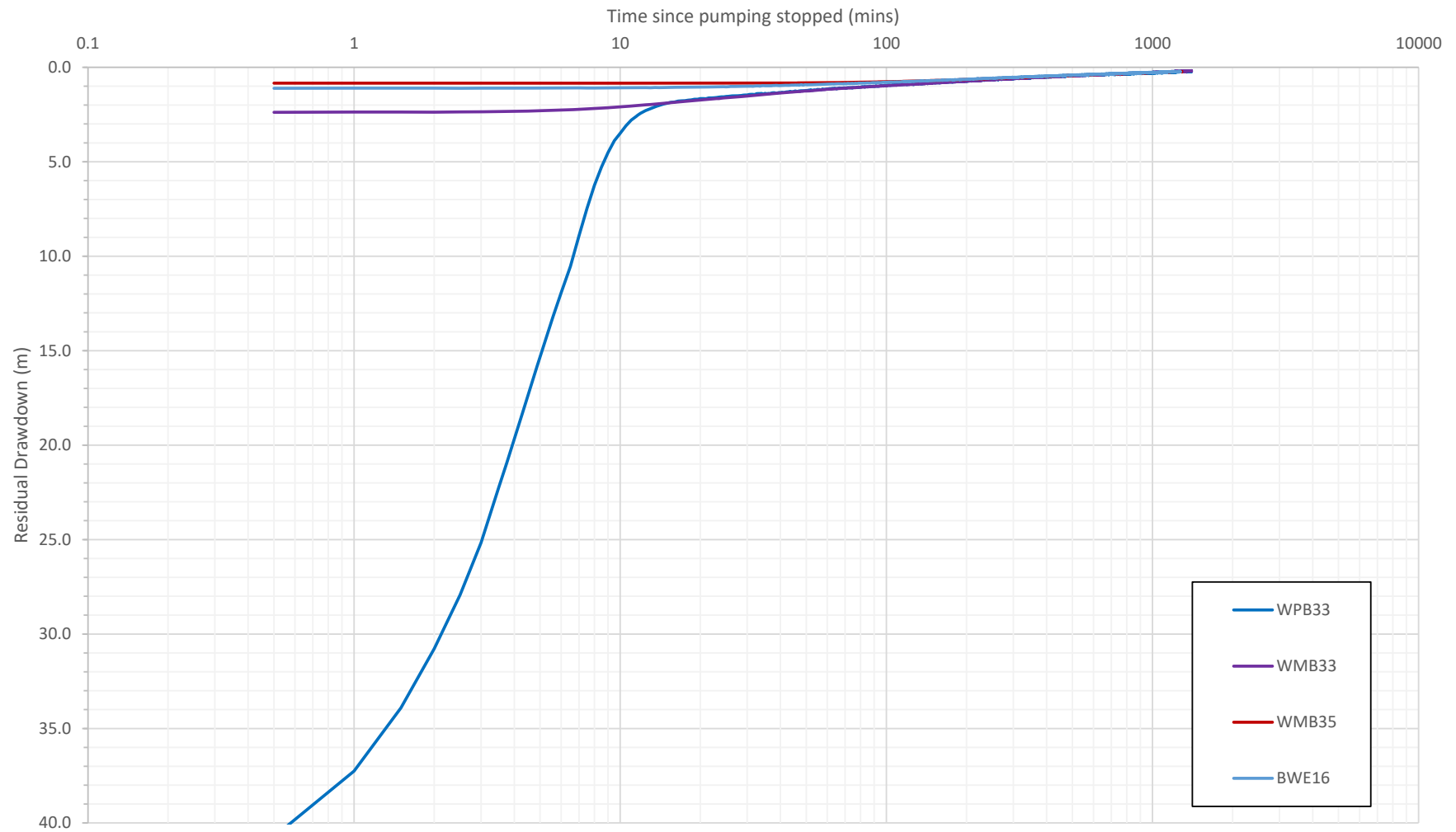
Bombora Constant Rate Test: WPB33



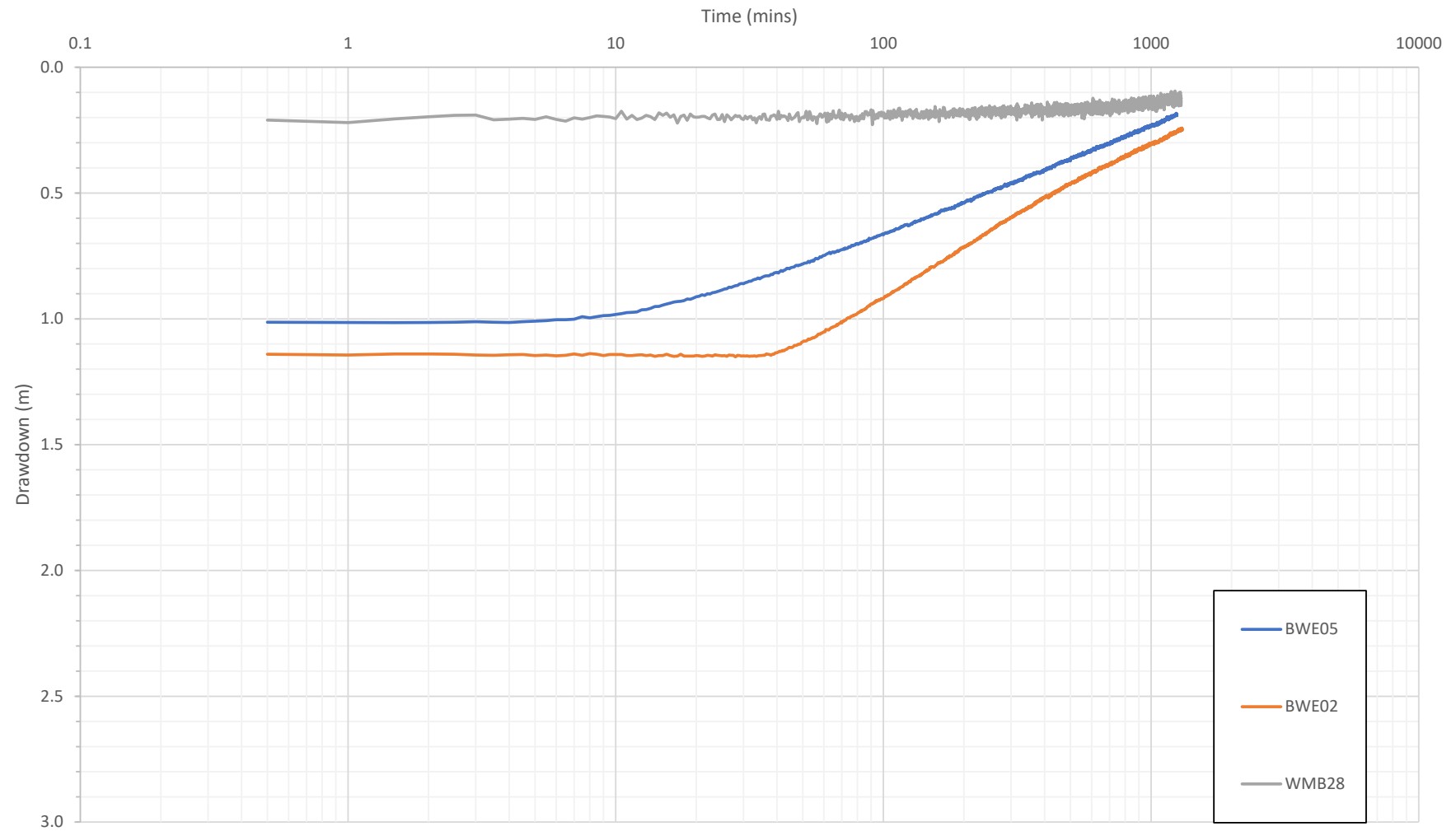
Bombora Constant Rate Test: WPB33

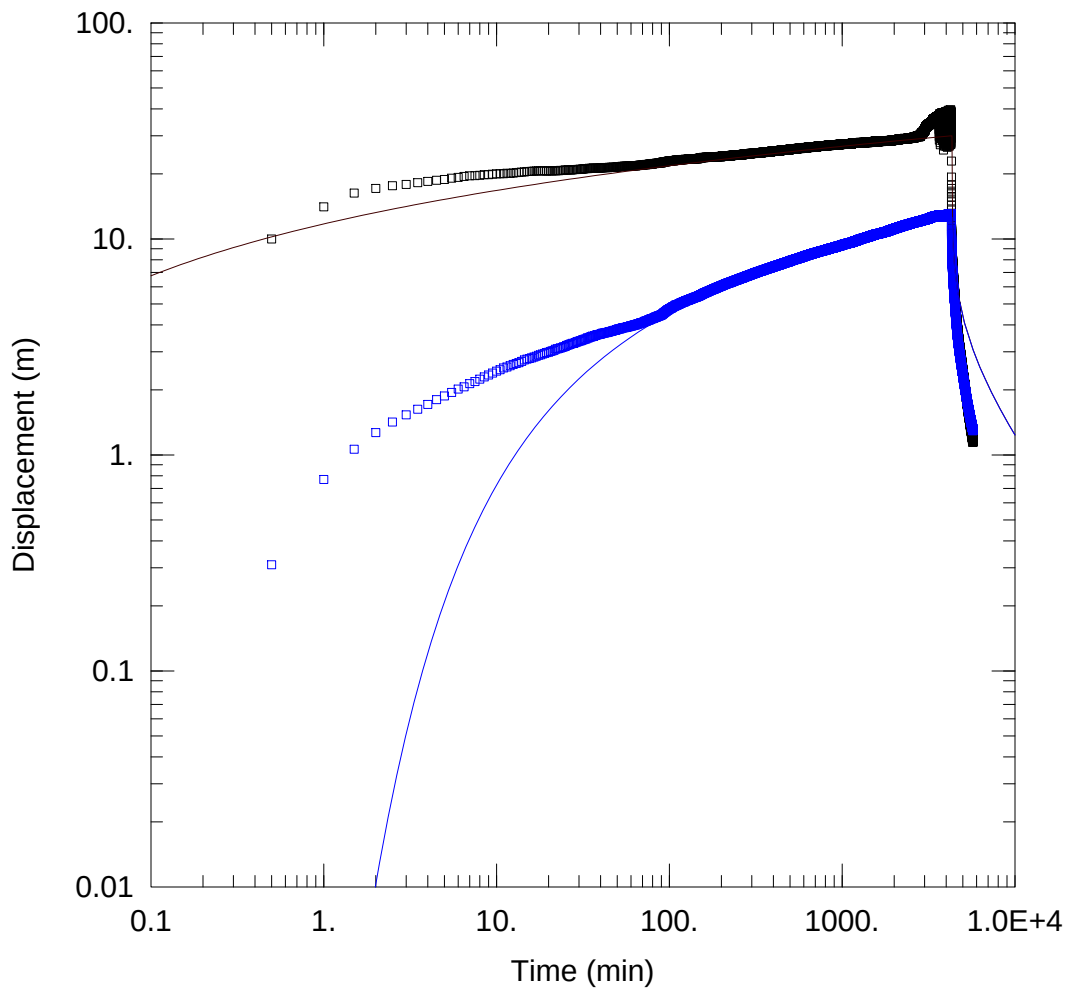


Bombora Recovery Test: WPB33



Bombora Recovery Test: WPB33





PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

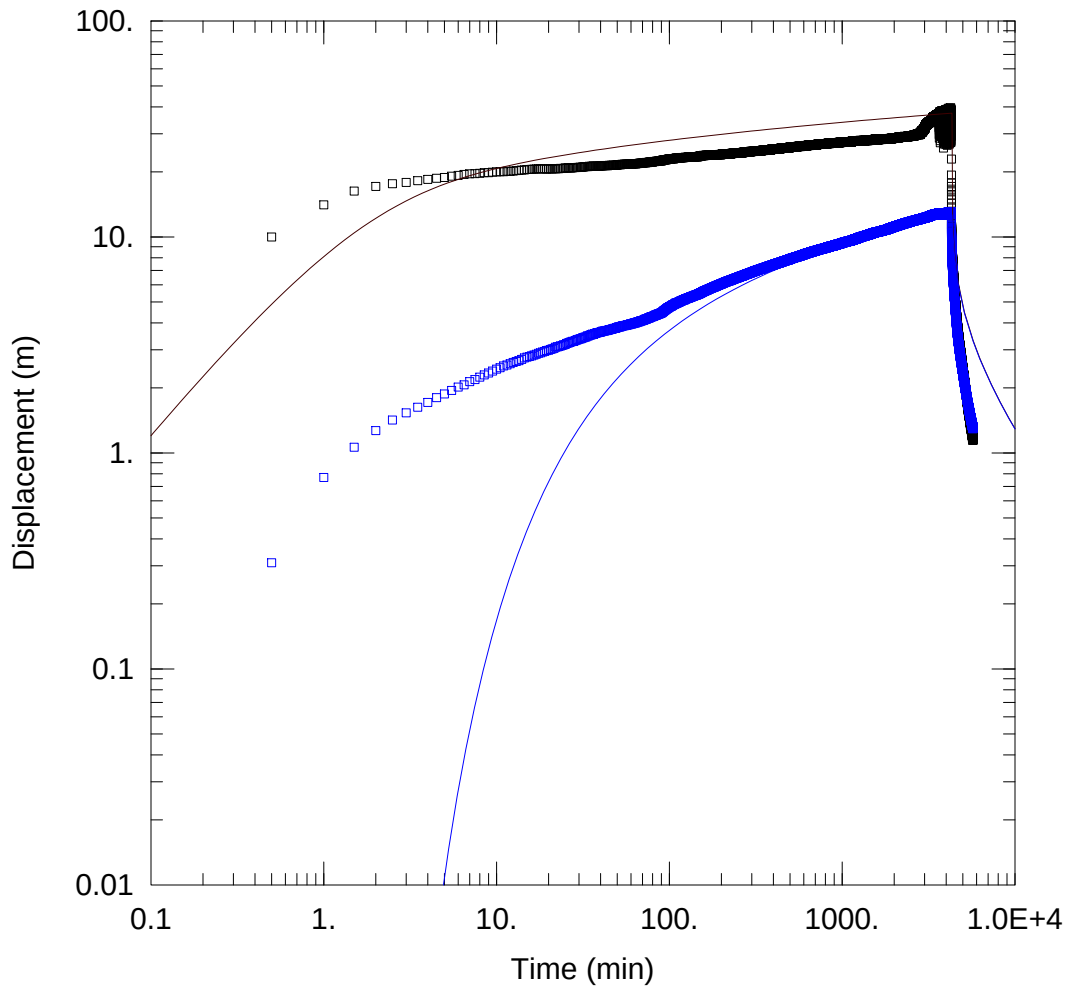
WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB26	458580	6602287	WPB26	458580	6602287
			WMB26	458580	6602280

SOLUTION

Aquifer Model: Confined
 $T = 22. \text{ m}^2/\text{day}$
 $Kz/Kr = 1.$

Solution Method: Theis
 $S = 0.00953$
 $b = 50. \text{ m}$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB26	458580	6602287	WPB26	458580	6602287
			WMB26	458580	6602280

SOLUTION

Aquifer Model: Confined

Solution Method: Barker

$K = 0.3787$ m/day

$S_s = 0.0003549$

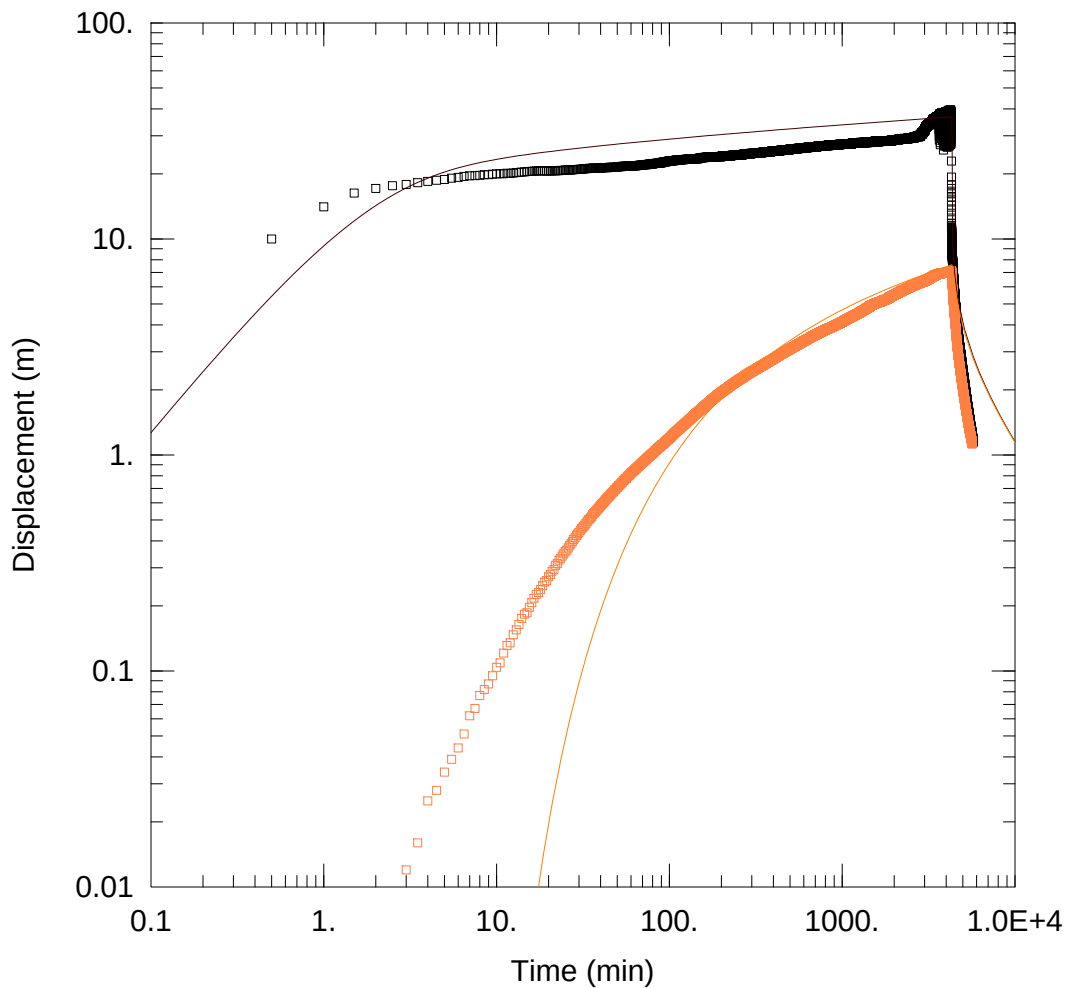
$n = 2.064$

$b = 50.$ m

$S_w = 0.$

$r(w) = 0.13$ m

$r(c) = 0.1$ m



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB26	458580	6602287	WPB26	458580	6602287
			WMB25	458595	6602120

SOLUTION

Aquifer Model: Confined

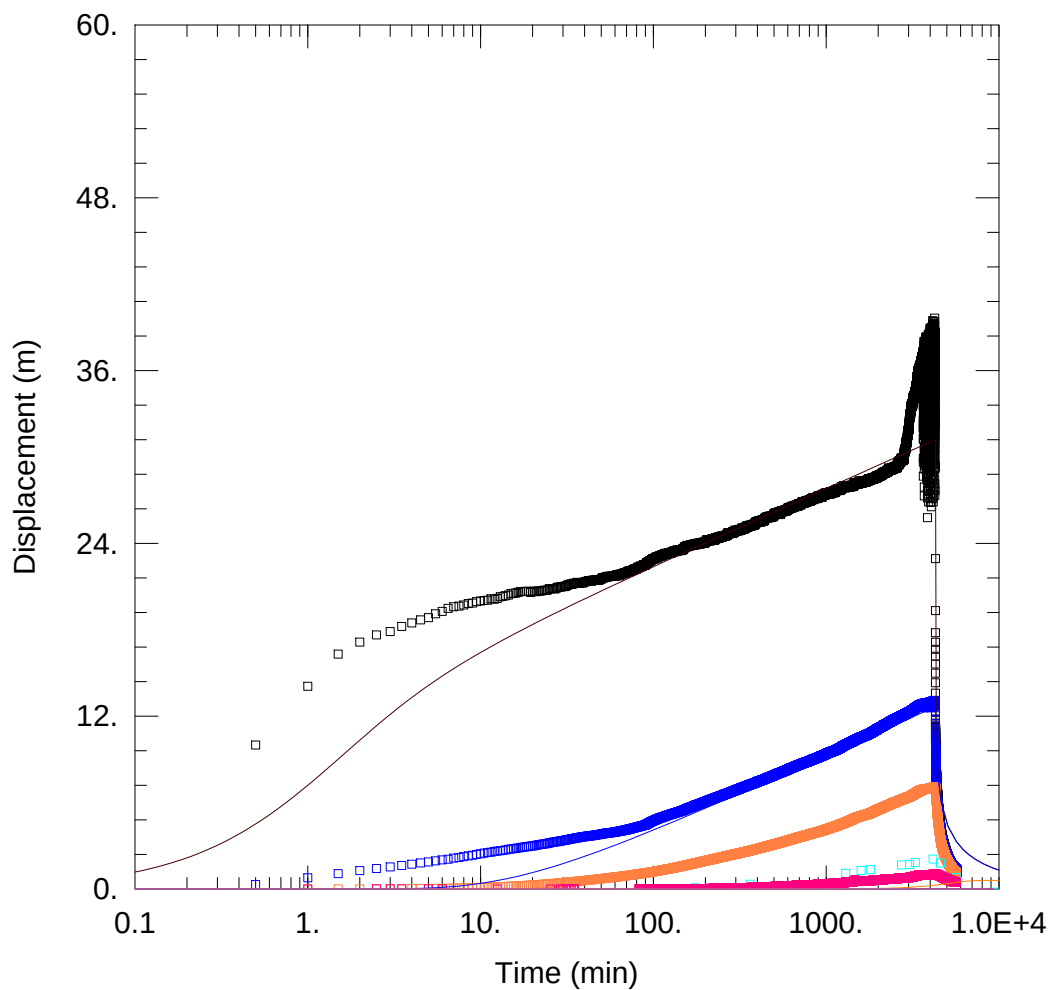
Solution Method: Papadopoulos-Cooper

$T = 23.63 \text{ m}^2/\text{day}$

$S = 0.0001383$

$r(w) = 0.13 \text{ m}$

$r(c) = 0.1 \text{ m}$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WPB26	458580	6602287

Observation Wells

Well Name	X (m)	Y (m)
□ WPB26	458580	6602287
□ WMB26	458580	6602280
□ WMB25	458595	6602120
□ WMB23	458625	6601955
□ WMB32	458568	6601717

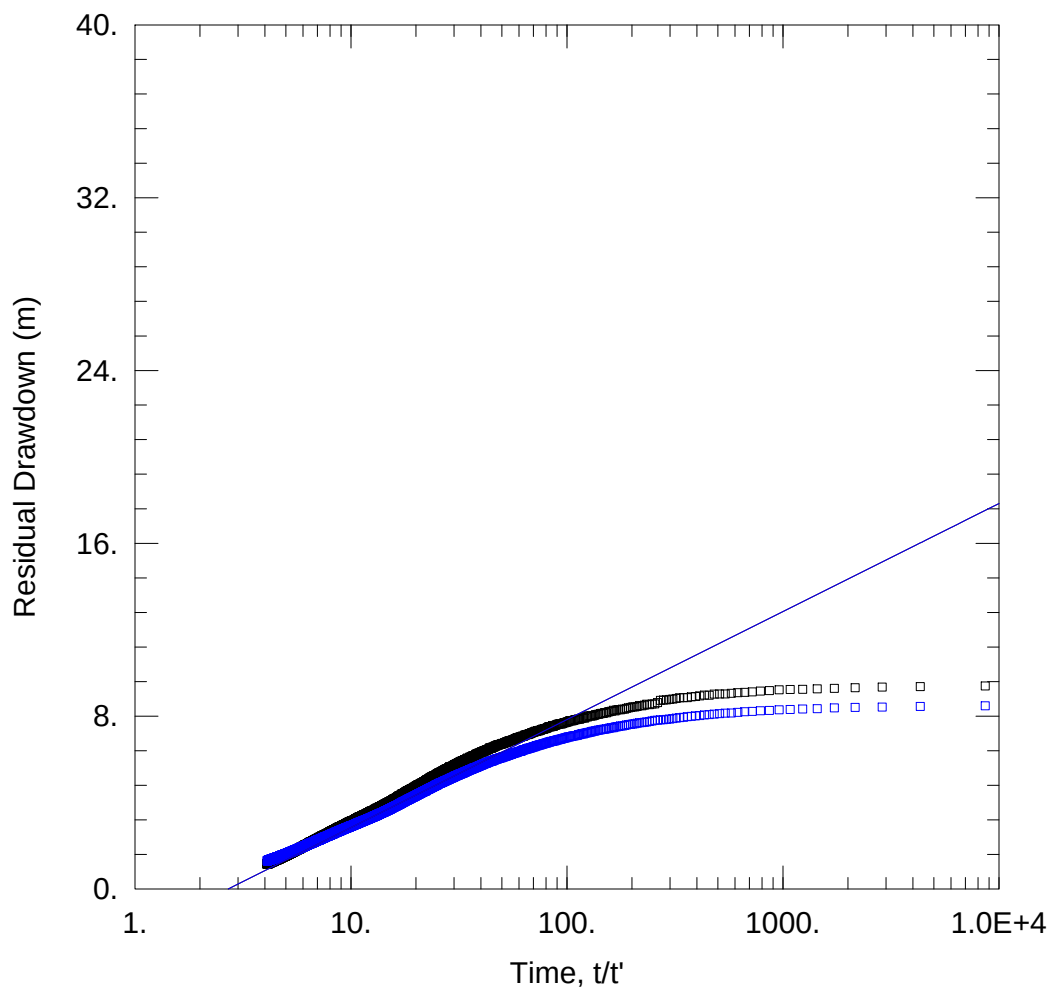
SOLUTION

Aquifer Model: Confined

Solution Method: Papadopoulos-Cooper

$T = 20.67 \text{ m}^2/\text{day}$
 $r(w) = 0.13 \text{ m}$

$S = 0.01236$
 $r(c) = 0.1 \text{ m}$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB26	458580	6602287	WPB26	458580	6602287
			WMB26	458580	6602280

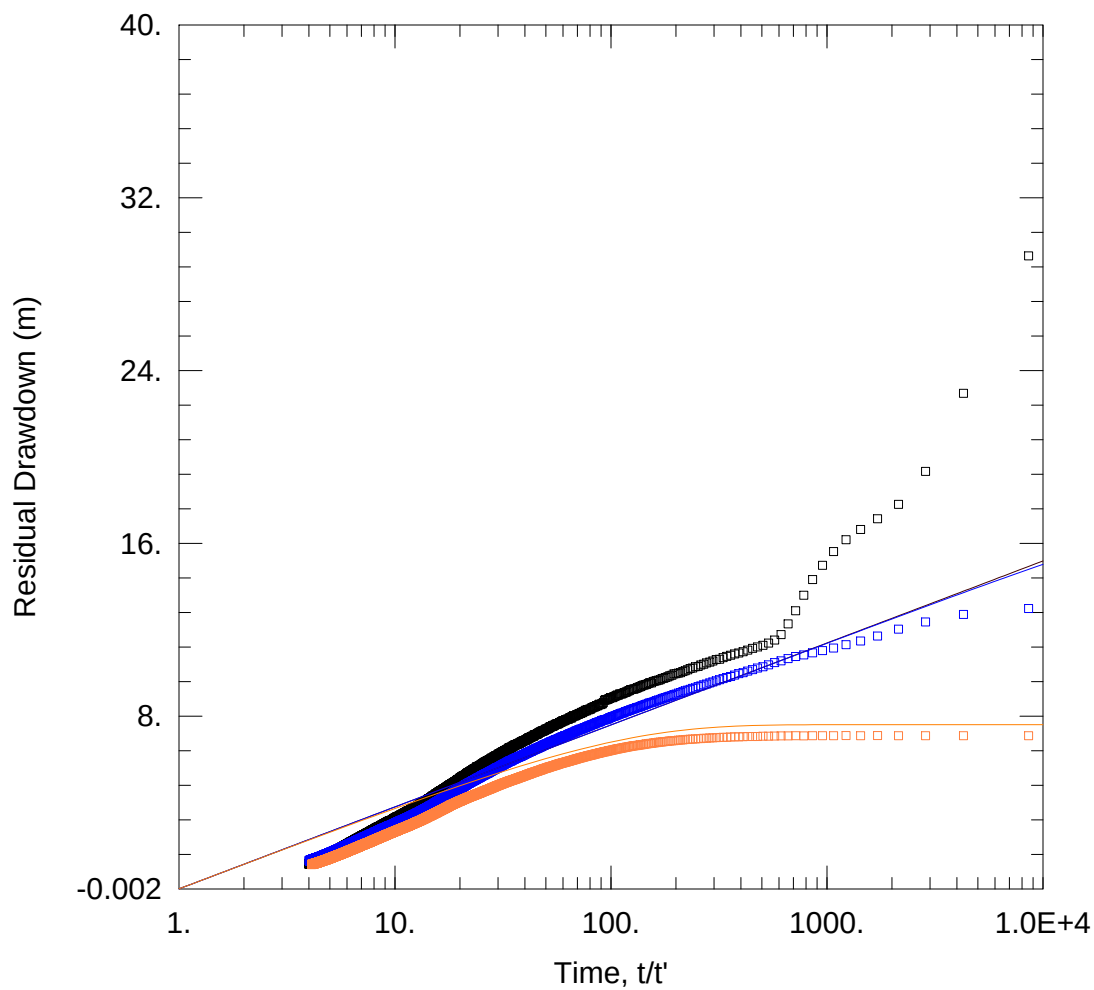
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 22.17 \text{ m}^2/\text{day}$

$S/S' = 2.707$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB26

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WPB26	458580	6602287

Observation Wells

Well Name	X (m)	Y (m)
□ WPB26	458580	6602287
□ WMB26	458580	6602280
□ WMB25	458595	6602120

SOLUTION

Aquifer Model: Confined

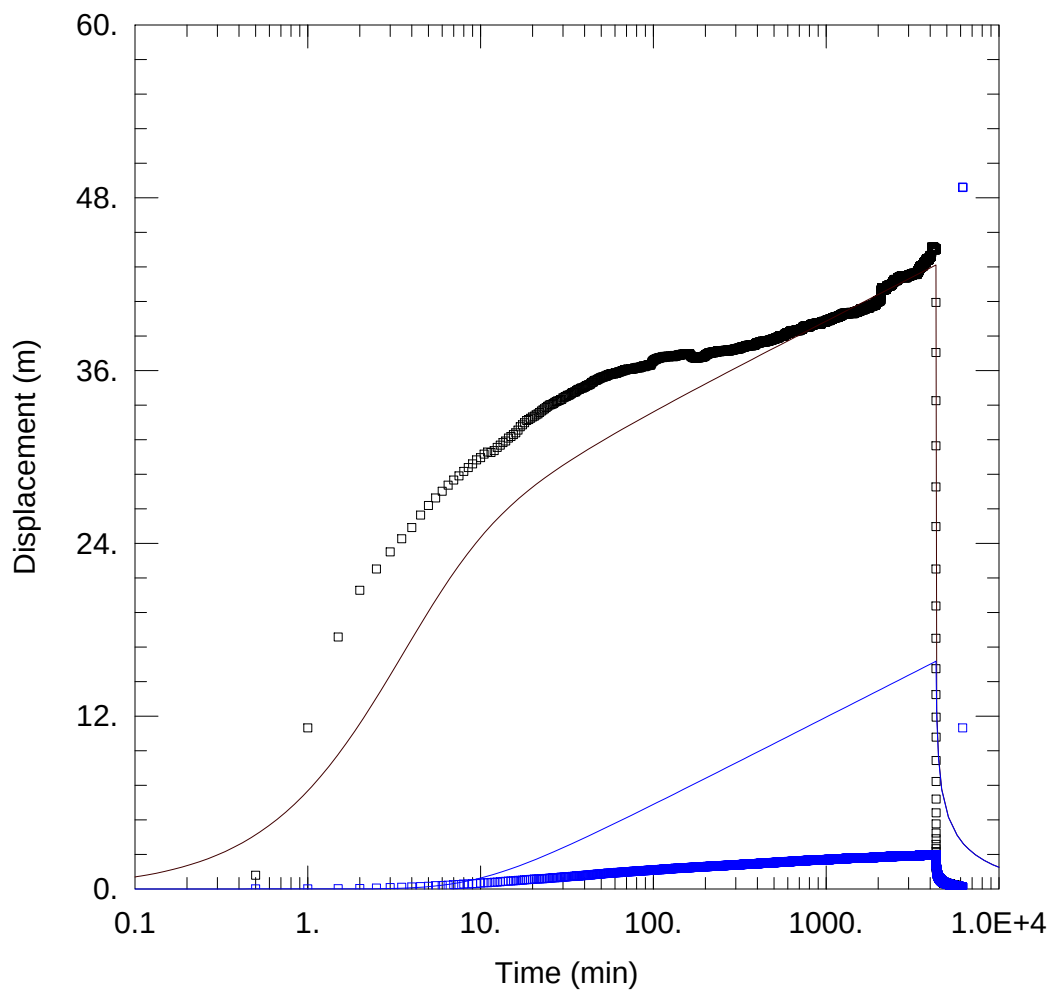
Solution Method: Theis

$T = 29.2 \text{ m}^2/\text{day}$

$S = 6.951\text{E-}5$

$Kz/Kr = 1.$

$b = 50. \text{ m}$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB33

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB33	458537	6601011	WPB33	458537	6601011
			WMB33	458545	6600995

SOLUTION

Aquifer Model: Confined

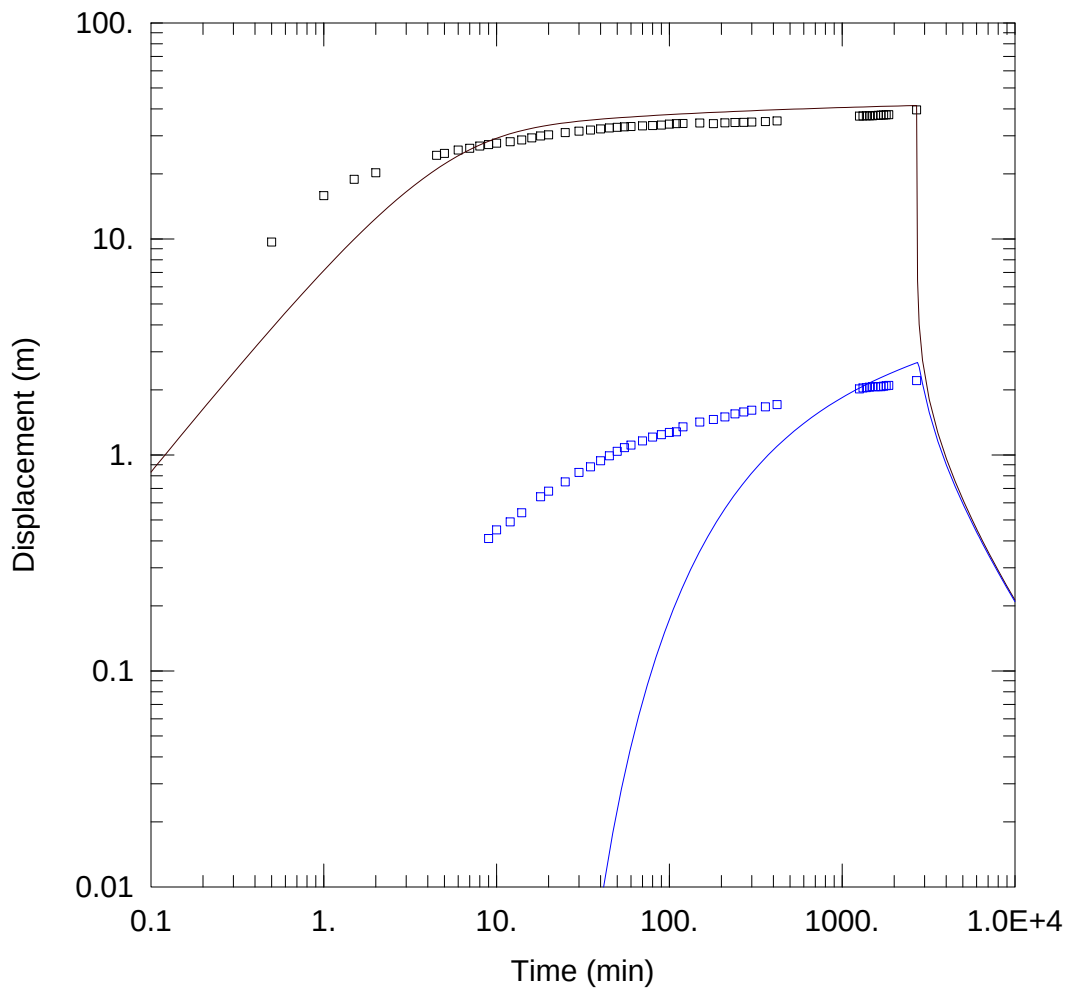
Solution Method: Papadopoulos-Cooper

$T = 11.66 \text{ m}^2/\text{day}$

$S = 0.0006335$

$r(w) = 0.1 \text{ m}$

$r(c) = 0.1 \text{ m}$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB33

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB33	458537	6601011	WPB33	458537	6601011
			WMB33	458545	6600995

SOLUTION

Aquifer Model: Confined

Solution Method: Barker

$K = 0.5188$ m/day

$S_s = 0.000627$

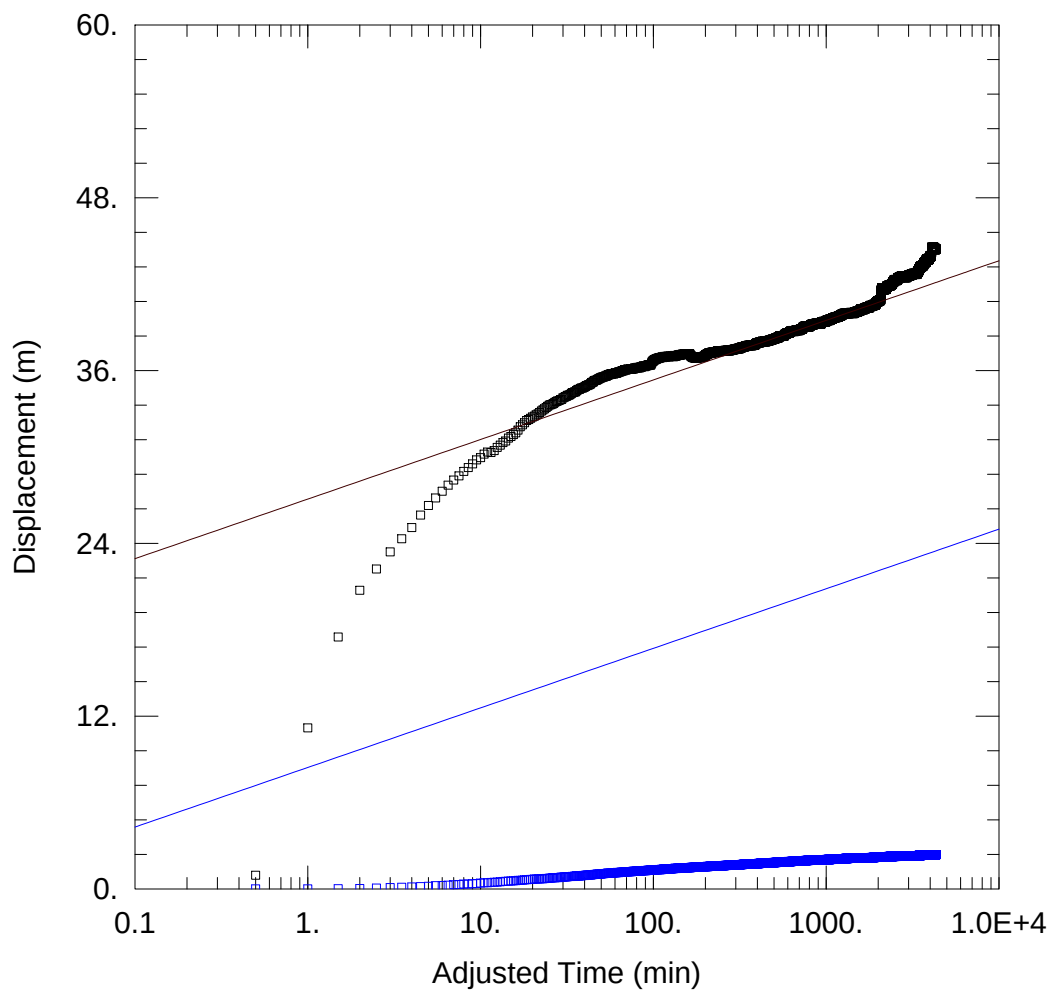
$n = 2.356$

$b = 50.$ m

$S_w = 0.$

$r(w) = 0.1$ m

$r(c) = 0.1$ m



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB33

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WPB33	458537	6601011

Observation Wells

Well Name	X (m)	Y (m)
WPB33	458537	6601011
WMB33	458545	6600995

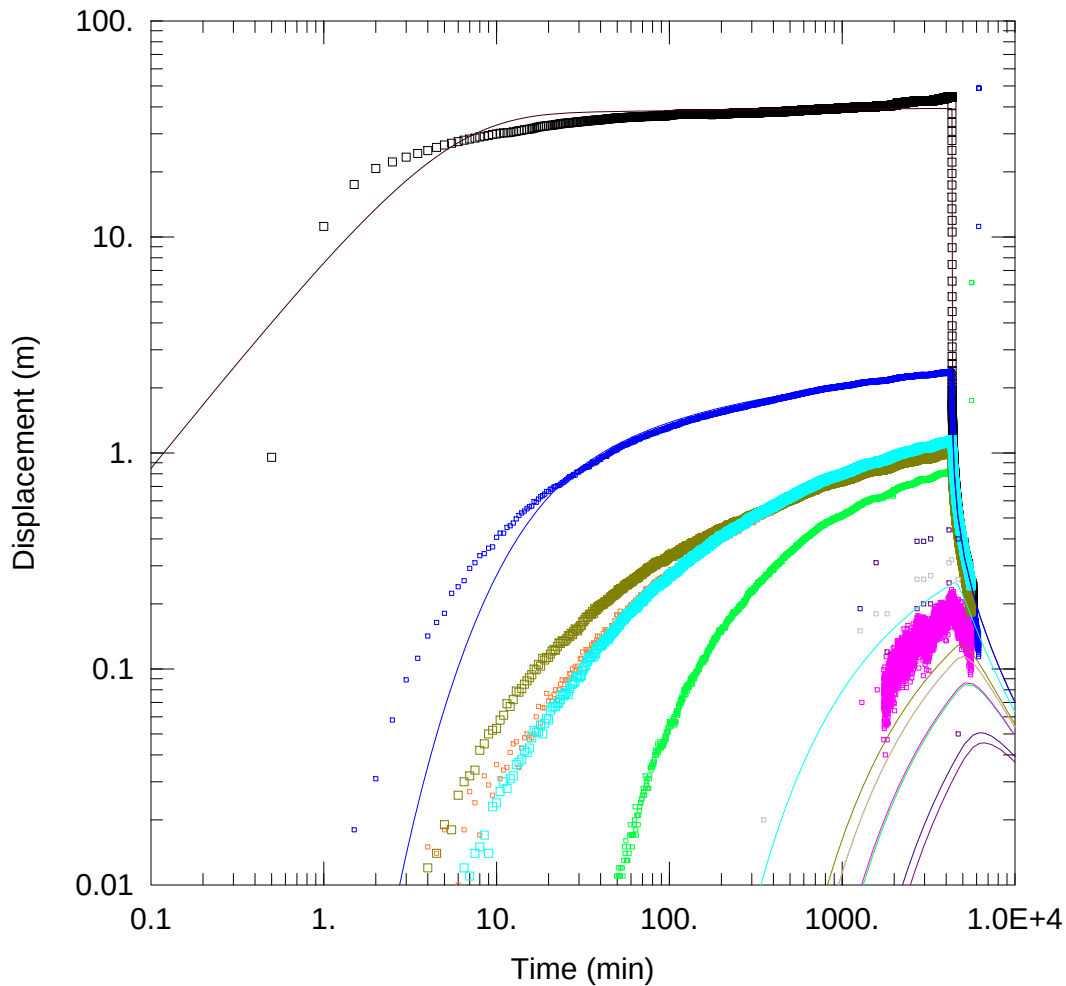
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

$T = 17.22 \text{ m}^2/\text{day}$

$S = 7.684\text{E-}7$



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB33

AQUIFER DATA

Saturated Thickness: 50. m Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB33	458537	6601011	WPB33	458537	6601011
			WMB33	458545	6600995
			WMB35	458650	6600610
			BWE17	458850.56	6600742.91
			BWE16	458811.14	6601241.64
			BWE05	458572.64	6601344.26
			BWE02	458600.39	6600797.69
			BWE03	458811.2	6601241.75
			WMB20	458440	6600465
			BWE07	458607.97	6601535.12

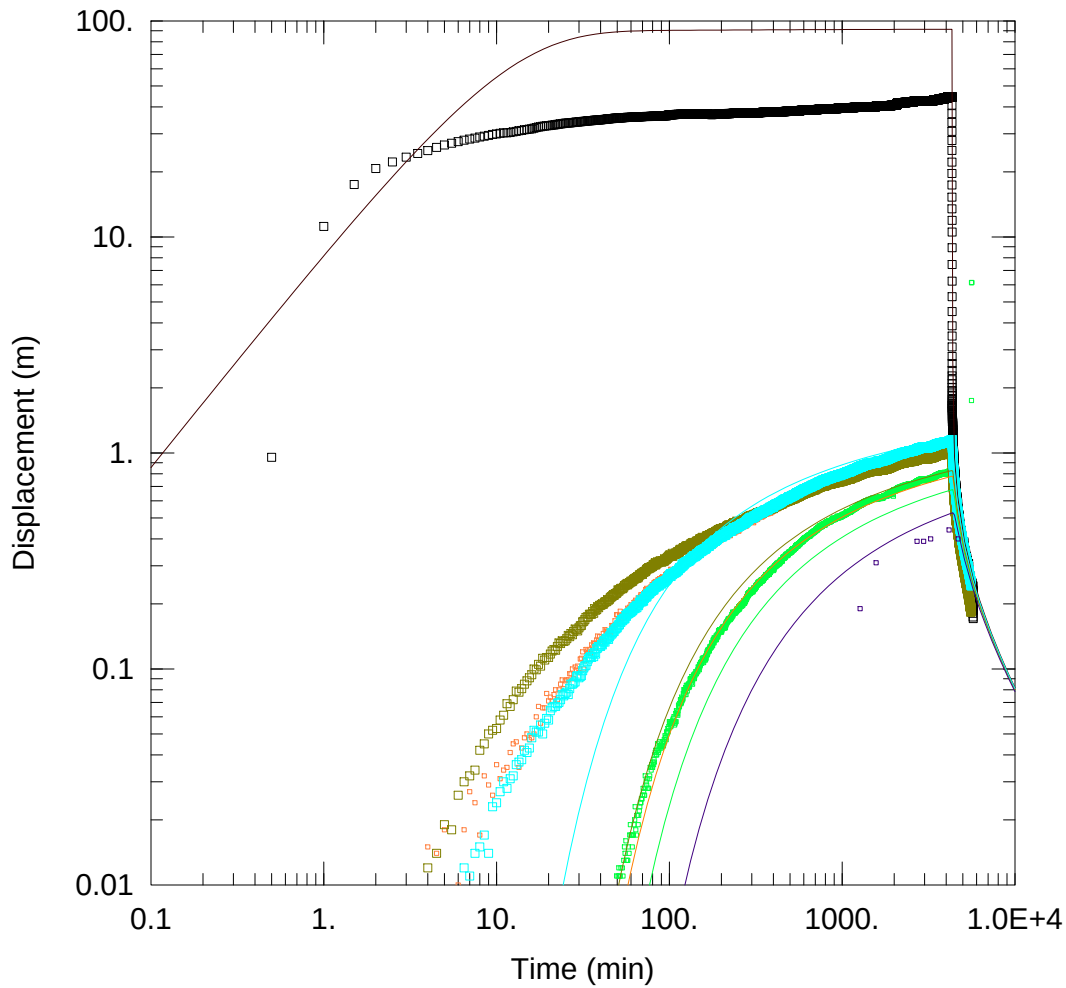
SOLUTION

Aquifer Model: Confined

Solution Method: Barker

$K = 0.5205$ m/day
 $n = 2.509$
 $Sw = 0.$
 $r(c) = 0.1$ m

$Ss = 2.217E-5$
 $b = 180.$ m
 $r(w) = 0.1$ m



PROJECT INFORMATION

Company: AQ2
 Client: Ramelius
 Project: 514F
 Location: Lake Roe
 Test Well: WPB33

AQUIFER DATA

Saturated Thickness: 50. m

Anisotropy Ratio (K_z/K_r): 2.5E+4

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
WPB33	458537	6601011	WPB33	458537	6601011
			WMB35	458650	6600610
			BWE16	458811.14	6601241.64
			BWE05	458572.64	6601344.26
			BWE02	458600.39	6600797.69
			BWE07	458607.97	6601535.12

SOLUTION

Aquifer Model: Confined

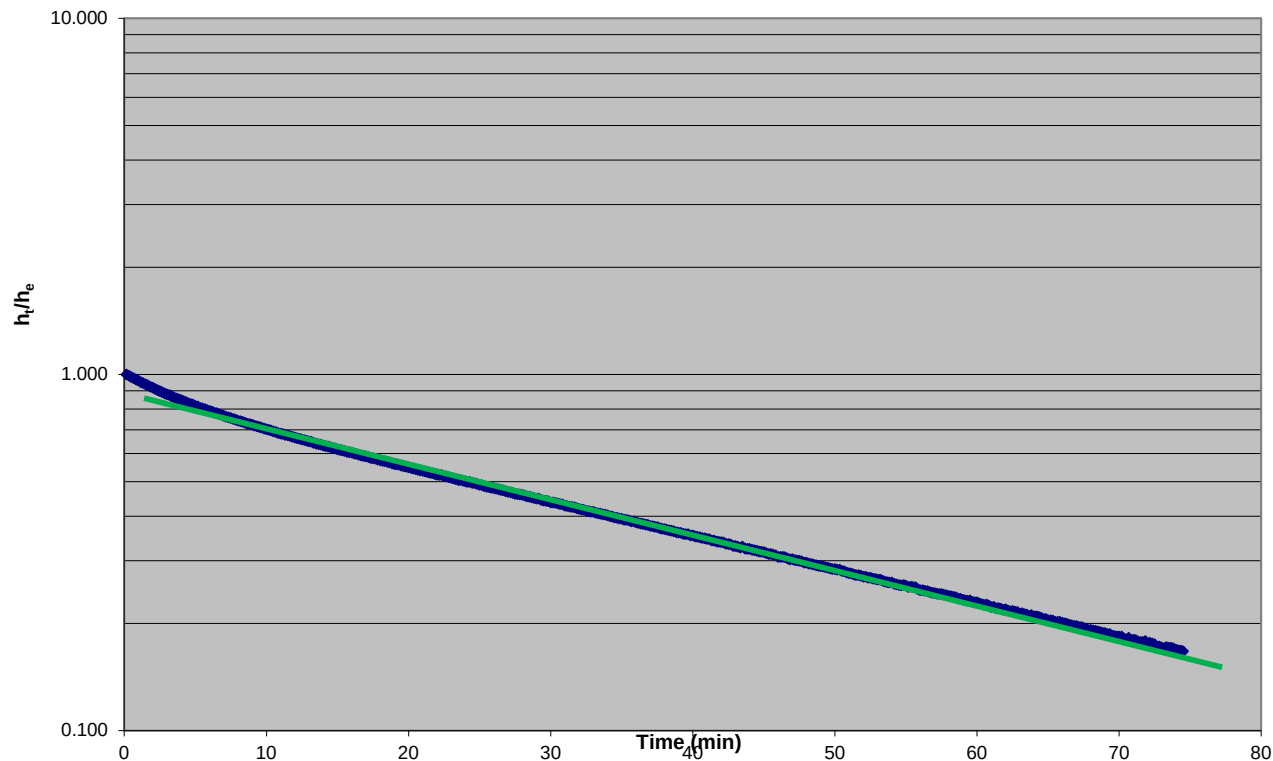
Solution Method: Barker

$K = 0.4225$ m/day
 $n = 2.509$
 $S_w = 0.$
 $r(c) = 0.1$ m

$S_s = 1.229E-6$
 $b = 50.$ m
 $r(w) = 0.1$ m

Bore No:	WMB19	Test No:	1	Job No:	514F F3	Date:	17-May-25	Logged by:	KM
Borehole co-ordinates: Easting:		458750	Northing:		6600525	Collar elevation (m):		TBC	
Depth to top of test section (m):		12	Length of test section, L (m):		148	Radius of borehole, r (m):		0.076	
Depth of static water level, H_w (m):		27.41	Radius of standpipe or casing, r_c (m):		0.076				
Excess head, h_e (m):		3.57							

Head - time graph (slope of graph is S)

**Calculations:**

	Early Time	Late Time
h₁	0.70	0.40
t₁	10.0	33.00
h₂	0.20	0.20
t₂	66.0	66.00
S	9.7E-03	9.1E-03
k (m/s)	5.04E-08	4.73E-08

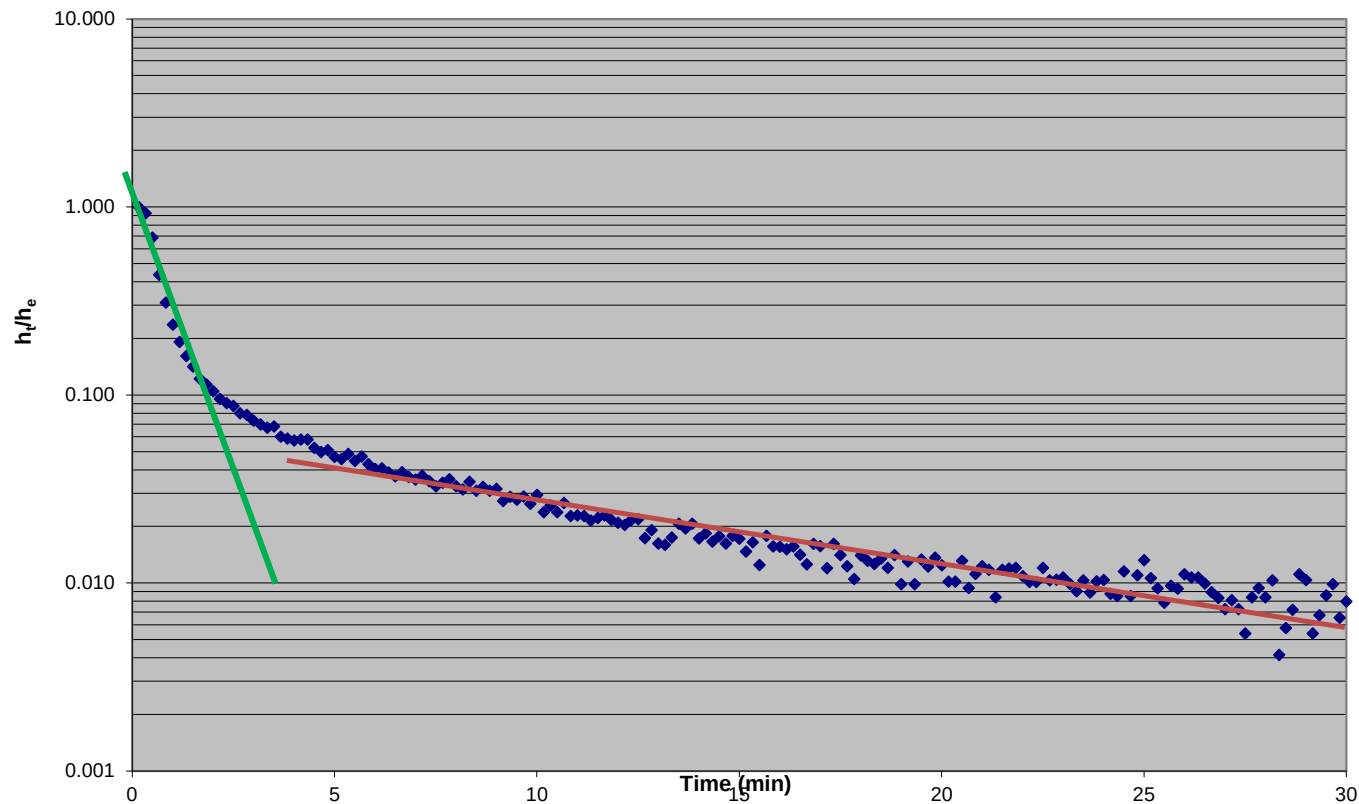
m/d **4.36E-03** **4.09E-03**
T (m²/d) 6.45E-01 6.05E-01
 Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log(h_1/h_2))/(t_2 - t_1)$,
 (ie slope of plot, t in mins)

K	0.0044	0.004
T	0.645	0.61

Notes: WMB19 is open hole from 12-160m, no PVC or gravel pack installed. Open hole section is through fresh, dolerite bedrock. No major or minor water strikes encountered during drilling.

Bore No:	WMB31	Test No:	1	Job No:	514F F3	Date:	25-Apr-25	Logged by:	
Borehole co-ordinates: Easting:	458568	Northing:	6601717	Collar elevation (m):	TBC				
Depth to top of test section (m):	24	Length of test section, L (m):	126	Radius of borehole, r (m):	0.076	Radius of standpipe or casing, r _c (m):	0.025		
Depth of static water level, H _w (m):	2.64								
Excess head, h _e (m):	1.23								

Head - time graph (slope of graph is S)



Calculations:

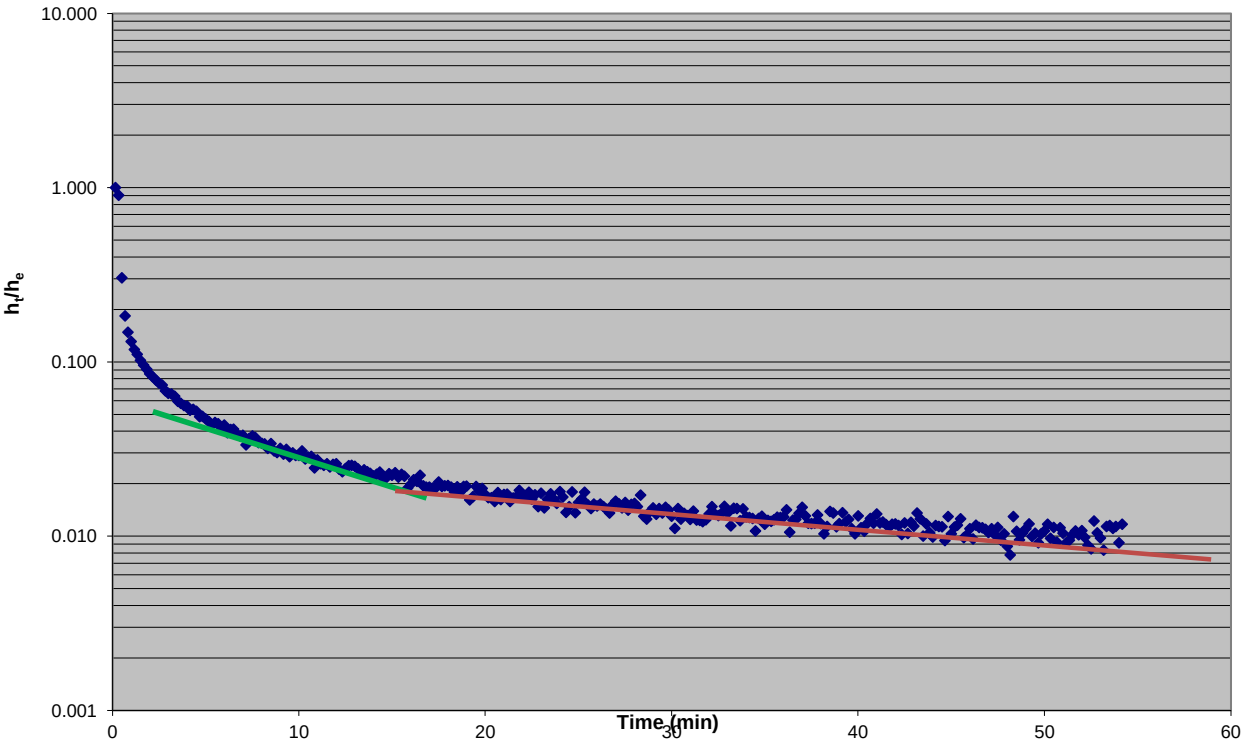
	Early Time	Late Time
h ₁	1.00	0.029
t ₁	0.2	10.00
h ₂	0.24	0.010
t ₂	1.0	22.16
S	7.4E-01	3.8E-02
k (m/s)	4.87E-07	2.51E-08

m/d	4.21E-02	2.17E-03
T (m ² /d)	5.30E+00	2.73E-01
Permeability, k = 0.133 x S x (rc ² /L), (m/s)		
where S = (log (h ₁ /h ₂))/(t ₂ - t ₁),		
(ie slope of plot, t in mins)		
K	0.0421	0.0022
T	5.299	0.27

Notes: BWE32 is open hole from 12-141m, no PVC or gravel pack installed. Open hole section is through fresh, dolerite bedrock.

Bore No:	BWE32	Test No:	1	Job No:	514F F3	Date:	25-Apr-25	Logged by:	KM
Borehole co-ordinates: Easting:	458625	Northing:	6601720	Collar elevation (m):	TBC				
Depth to top of test section (m):	12				Length of test section, L (m):	157			
Depth of static water level, H _w (m):	33.59				Radius of borehole, r (m):	0.076			
Excess head, h _e (m):	1.97				Radius of standpipe or casing, r _c (m):	0.076			

Head - time graph (slope of graph is S)



Calculations:

	Early Time	Late Time
h ₁	0.05	0.02
t ₁	4.5	17.00
h ₂	0.02	0.009
t ₂	12.2	54.00
S	5.2E-02	9.4E-03
k (m/s)	2.54E-07	4.59E-08

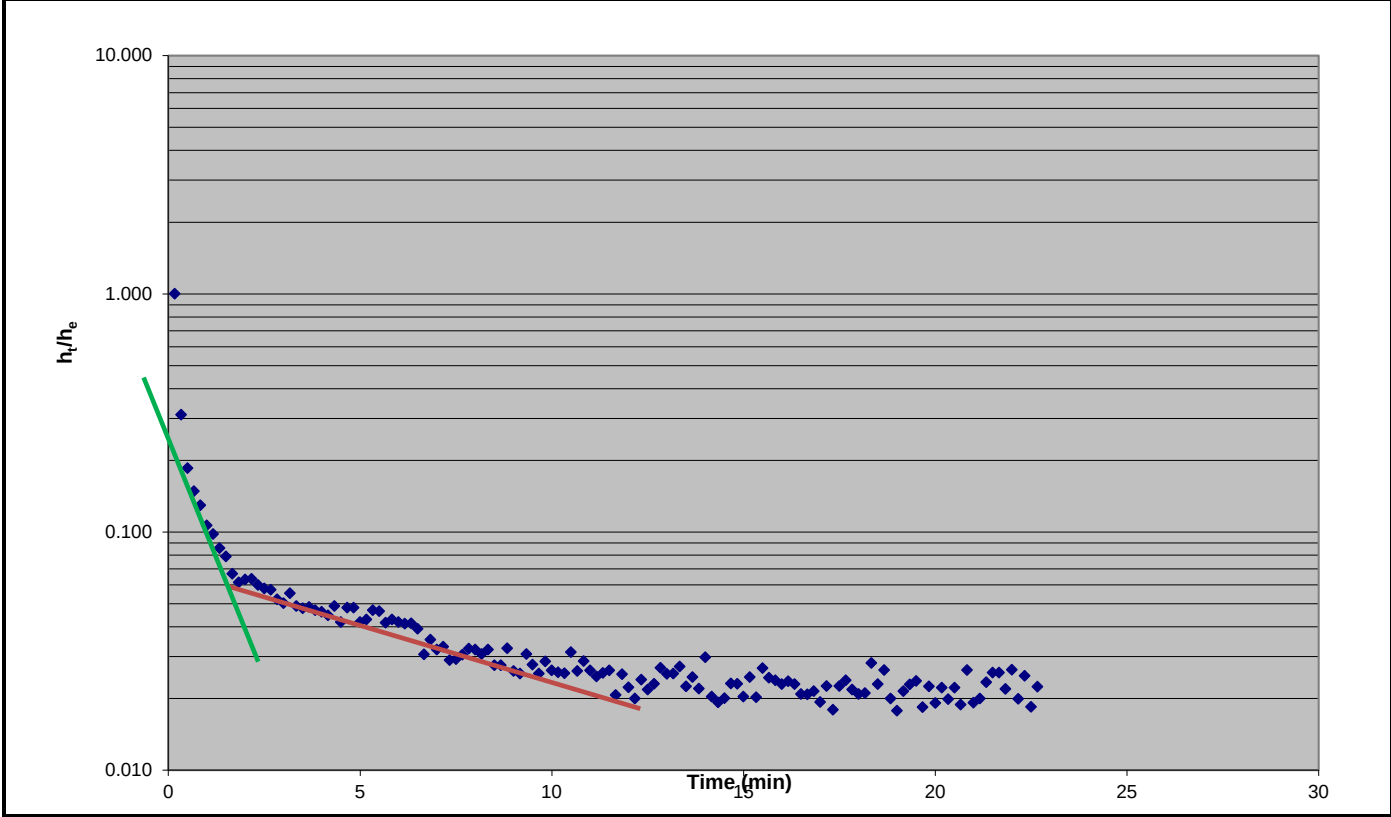
m/d 2.20E-02 3.96E-03
T (m²/d) 3.45E+00 6.22E-01
Permeability, k = 0.133 x S x (rc²/L), (m/sec)
where S = (log (h₁/h₂))/(t₂ - t₁),
(ie slope of plot, t in mins)

K	0.0220	0.0040
T	3.448	0.62

Notes: BWE21 is open hole from 12-169m, no PVC or gravel pack installed. Open hole section is through fresh, dolerite bedrock.

Bore No: WMB22		Test No: 1		Job No: 514F F3		Date: 25-Apr-25		Logged by: KM	
Borehole co-ordinates: Easting: 458568		Northing: 6601717		Collar elevation (m): TBC					
Depth to top of test section (m): 38				Length of test section, L (m): 122					
Depth of static water level, H _w (m): 2.71				Radius of borehole, r (m): 0.076					
Excess head, h _e (m): 0.82				Radius of standpipe or casing, r _c (m): 0.025					

Head - time graph (slope of graph is S)



Calculations:

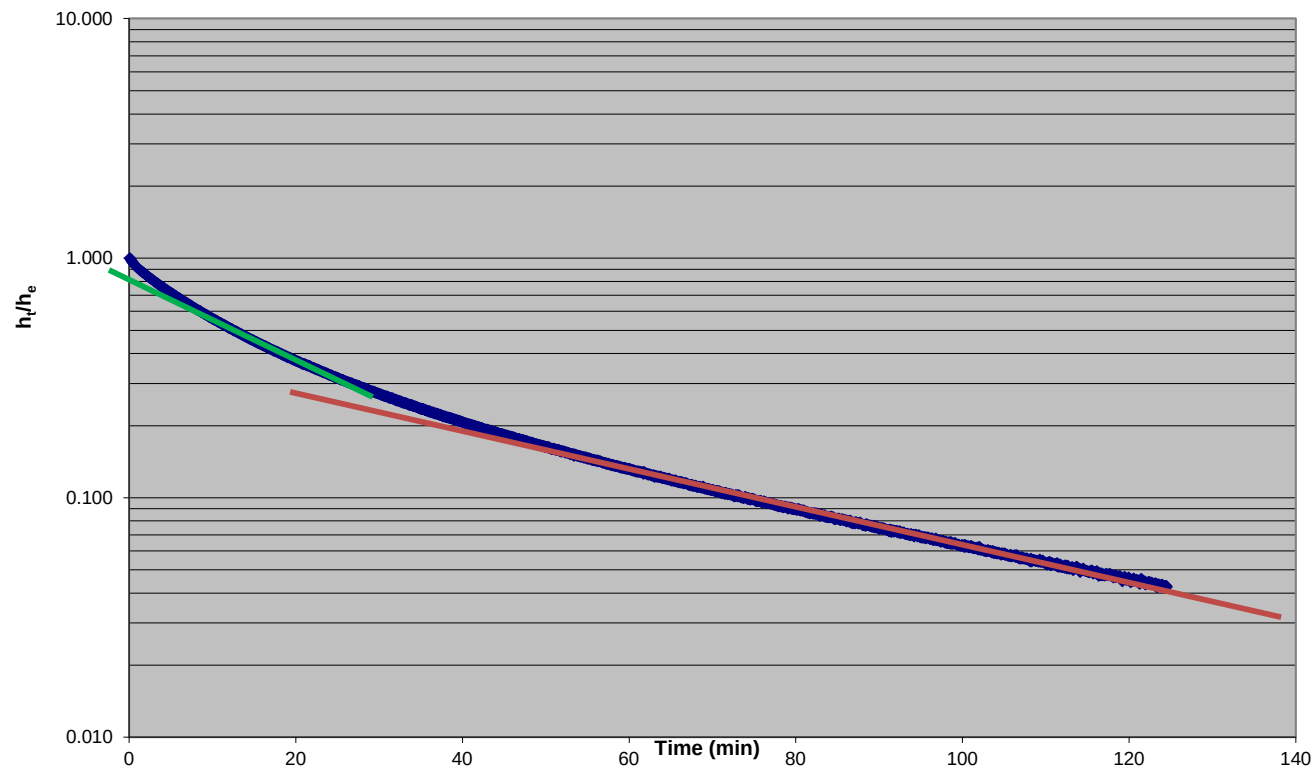
	Early Time	Late Time
h ₁	0.19	0.07
t ₁	0.5	1.66
h ₂	0.07	0.030
t ₂	1.7	7.16
S	3.7E-01	6.7E-02
k (m/s)	2.55E-07	4.56E-08

m/d 2.20E-02 3.94E-03
T (m2/d) 2.68E+00 4.81E-01
Permeability, k = 0.133 x S x (rc2/L), (m/sec)
where S = (log (h1/h2))/(t2 - t1),
(ie slope of plot, t in mins)

K	0.0220	0.0039
T	2.685	0.48

Bore No:	BWE23	Test No:	1	Job No:	514F F3	Date:	2-Apr-25	Logged by:	KM
Borehole co-ordinates: Easting:		458625	Northing:		6601955	Collar elevation (m):		TBC	
Depth to top of test section (m):		20	Length of test section, L (m):		180	Radius of borehole, r (m):		0.076	
Depth of static water level, H_w (m):		4.33	Radius of standpipe or casing, r_c (m):		0.025				
Excess head, h_e (m):		4.52							

Head - time graph (slope of graph is S)

**Calculations:**

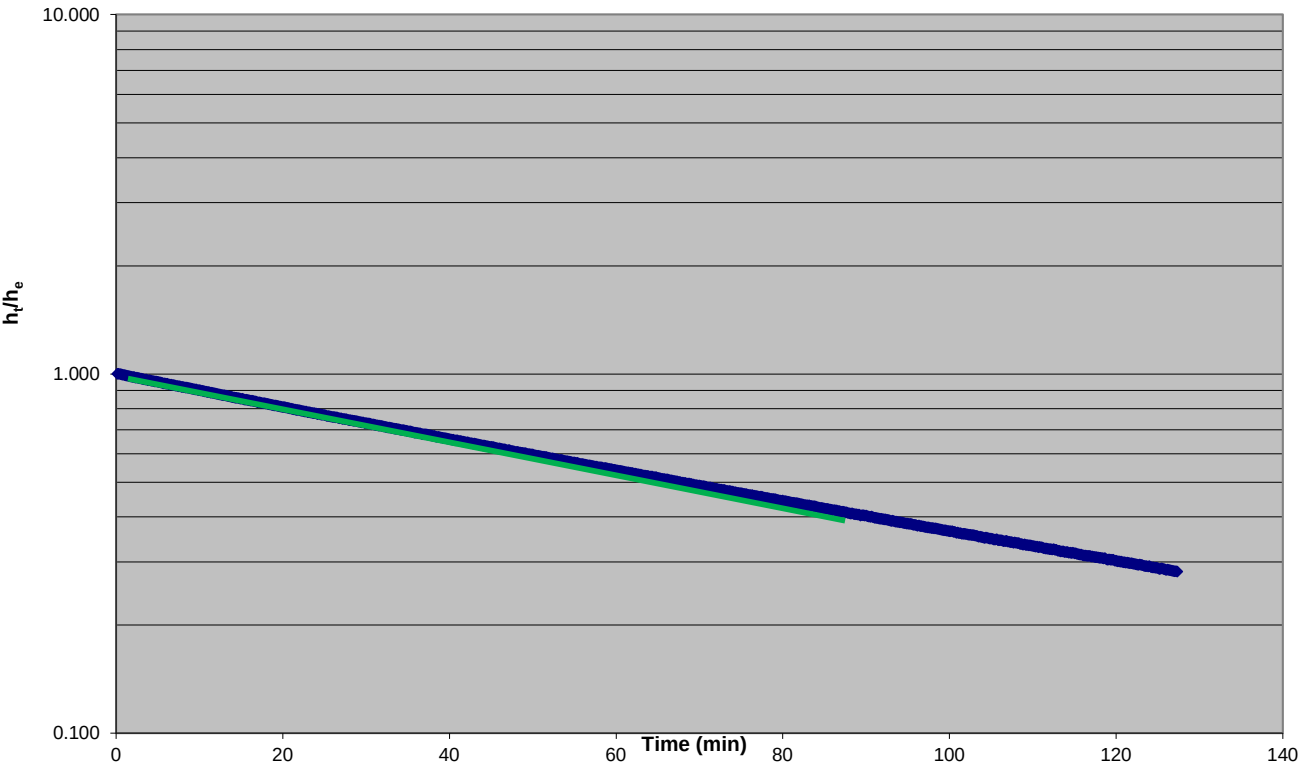
	Early Time	Late Time
h_1	1.00	0.15
t_1	0.083	52.30
h_2	0.63	0.05
t_2	7.66	108.60
S	2.6E-02	8.5E-03
k (m/s)	1.22E-08	3.91E-09

K (m/d) 0.00106 0.00034
T (m²/d) 0.19 0.06
 Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log(h_1/h_2))/(t_2 - t_1)$,
 (ie slope of plot, t in mins)

Notes: BWE23 is screened in fresh dolerite bedrock. Yields reported as 0 L/s when drilling. Very few water bearing fractures encountered in bedrock at this location.

Bore No:	WMB24	Test No:	1	Job No:	514F F3	Date:	28-Mar-25	Logged by:	GL
Borehole co-ordinates: Easting:	458772	Northing:	6602280	Collar elevation (m):	314.8954				
Depth to top of test section (m):	38				Length of test section, L (m):	162			
Depth of static water level, H _w (m):	4.59				Radius of borehole, r (m):	0.076			
Excess head, h _e (m):	3.75				Radius of standpipe or casing, r _c (m):	0.025			

Head - time graph (slope of graph is S)



Calculations:

Early Time

h ₁	1.00	
t ₁	0.17	
h ₂	0.40	
t ₂	4.00	
S	1.0E-01	
k (m/s)	5.33E-08	

K (m/d) 0.0046

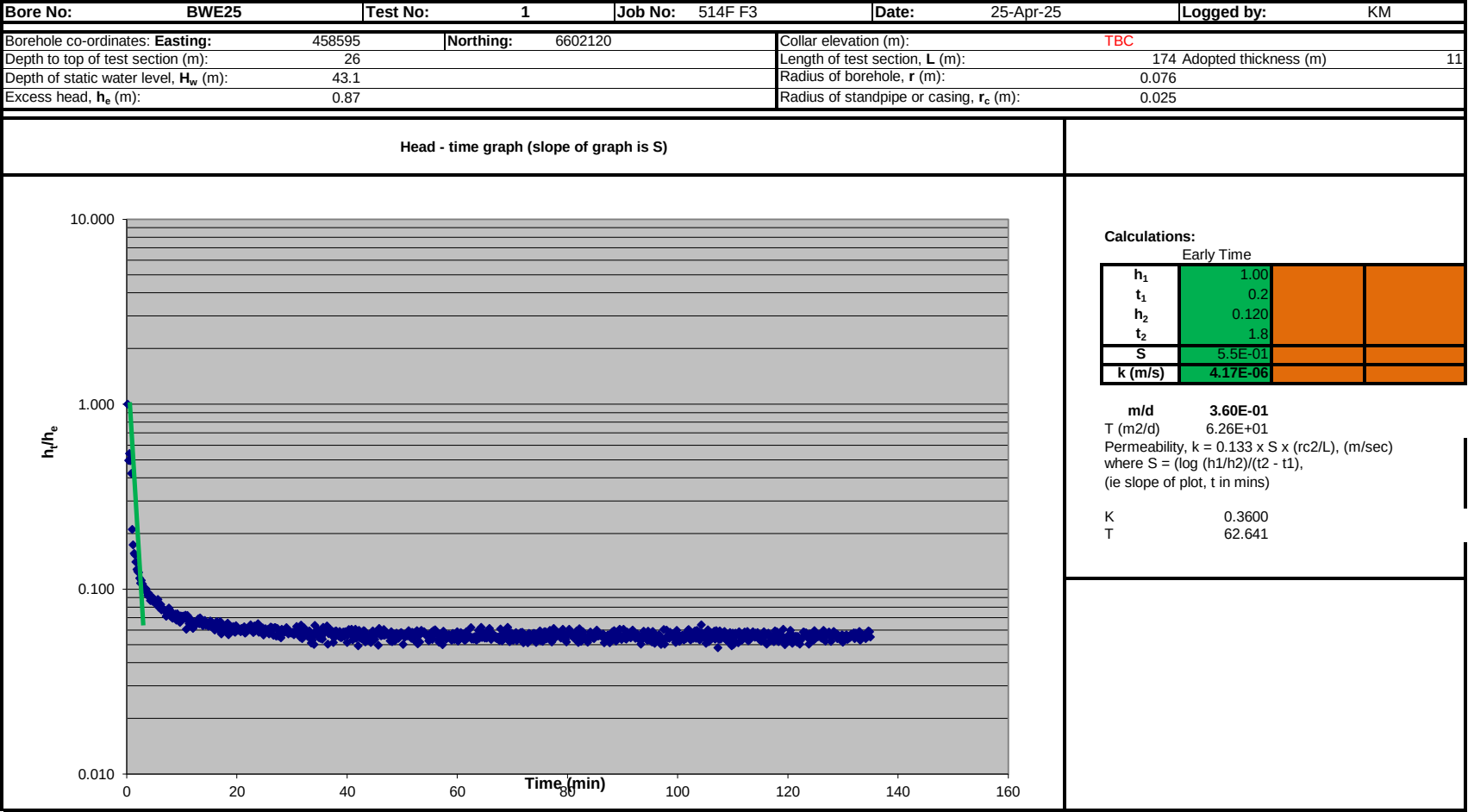
T (m²/d) 0.7

Permeability, k = 0.133 x S x (rc²/L), (m/sec)

where S = (log (h₁/h₂))/(t₂ - t₁),

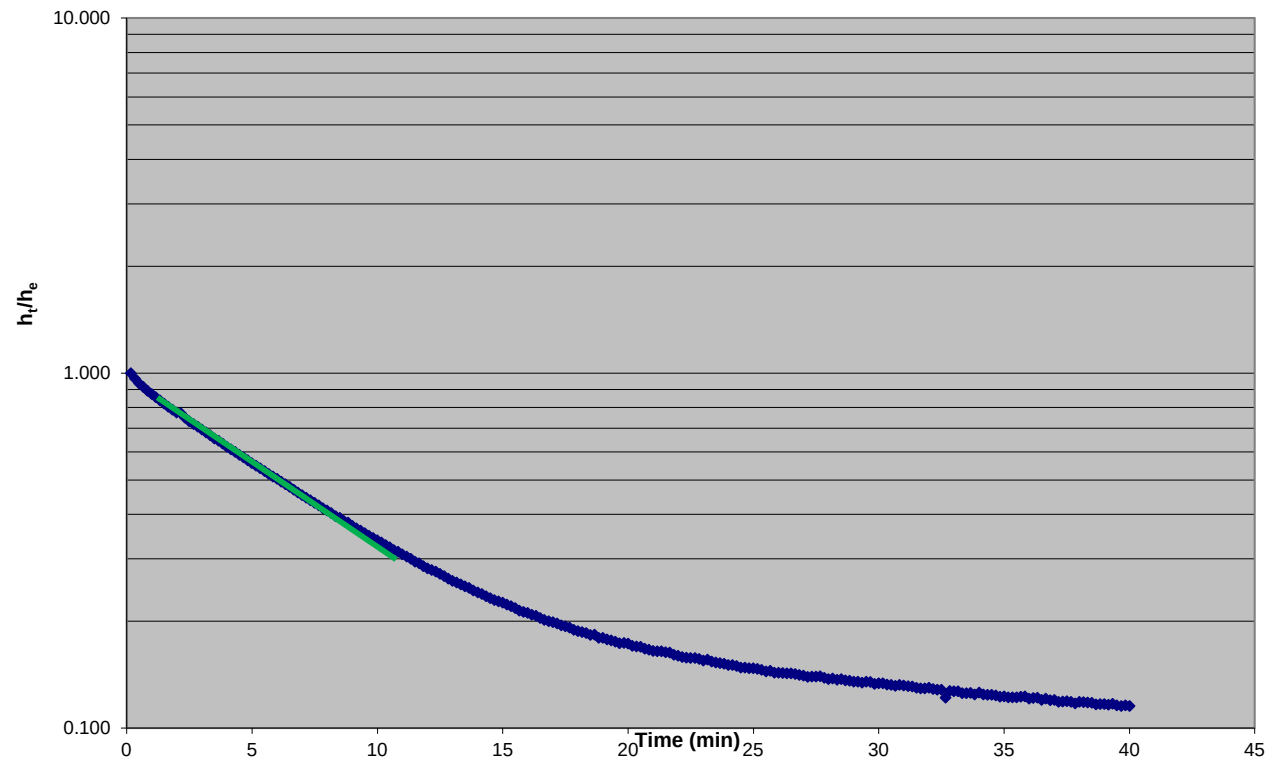
(ie slope of plot, t in mins)

Notes: BWE24 is screened within the fresh bedrock aquifer / dolerite basement.



Bore No:	WMB27	Test No:	1	Job No:	514F F3	Date:	10-Jul-25	Logged by:	GL
Borehole co-ordinates: Easting:		458540	Northing:		6603000	Collar elevation (m):		TBC	
Depth to top of test section (m):		34	Length of test section, L (m):		120	Radius of borehole, r (m):		0.076	
Depth of static water level, H_w (m):		3.82	Radius of standpipe or casing, r_c (m):		0.025				
Excess head, h_e (m):		3.25							

Head - time graph (slope of graph is S)

**Calculations:**

Early Time

h₁	1.00	
t₁	0.2	
h₂	0.40	
t₂	8.2	
S	5.0E-02	
k (m/s)	3.45E-08	

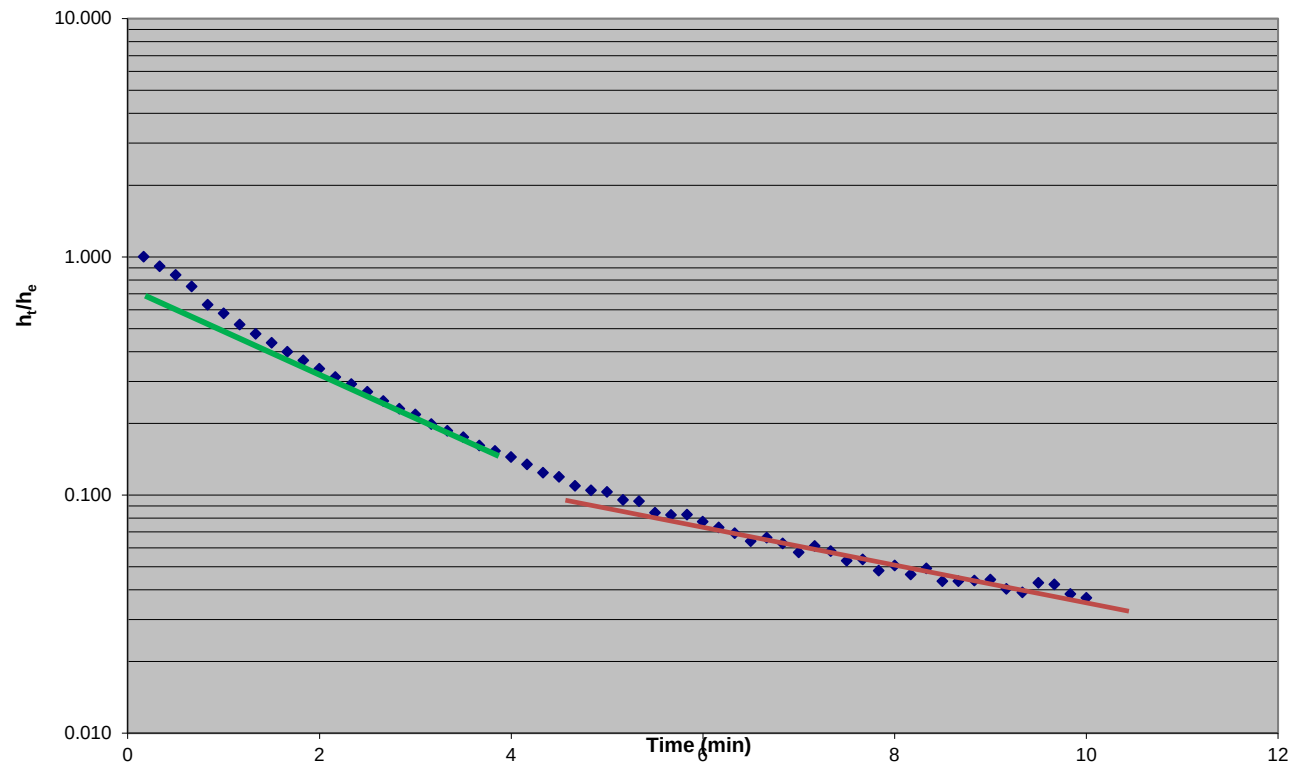
m/d 2.98E-03**T (m²/d)** 3.57E-01Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)where $S = (\log(h_1/h_2))/(t_2 - t_1)$,

(ie slope of plot, t in mins)

K 0.0030**T** 0.357**Notes:** Cased in fresh bedrock

Bore No:	WMB28	Test No:	1	Job No:	514F F3	Date:	10-Jul-25	Logged by:	GL
Borehole co-ordinates: Easting:		458690	Northing:		6603000	Collar elevation (m):		TBC	
Depth to top of test section (m):		40	Length of test section, L (m):		120	Radius of borehole, r (m):		0.076	
Depth of static water level, H_w (m):		4.77	Radius of standpipe or casing, r_c (m):		0.025				
Excess head, h_e (m):		1.02							

Head - time graph (slope of graph is S)

**Calculations:**

	Early Time	Late Time
h₁	0.47	0.08
t₁	1.3	5.50
h₂	0.13	0.04
t₂	4.2	10.00
S	2.0E-01	7.4E-02
k (m/s)	1.37E-07	5.16E-08

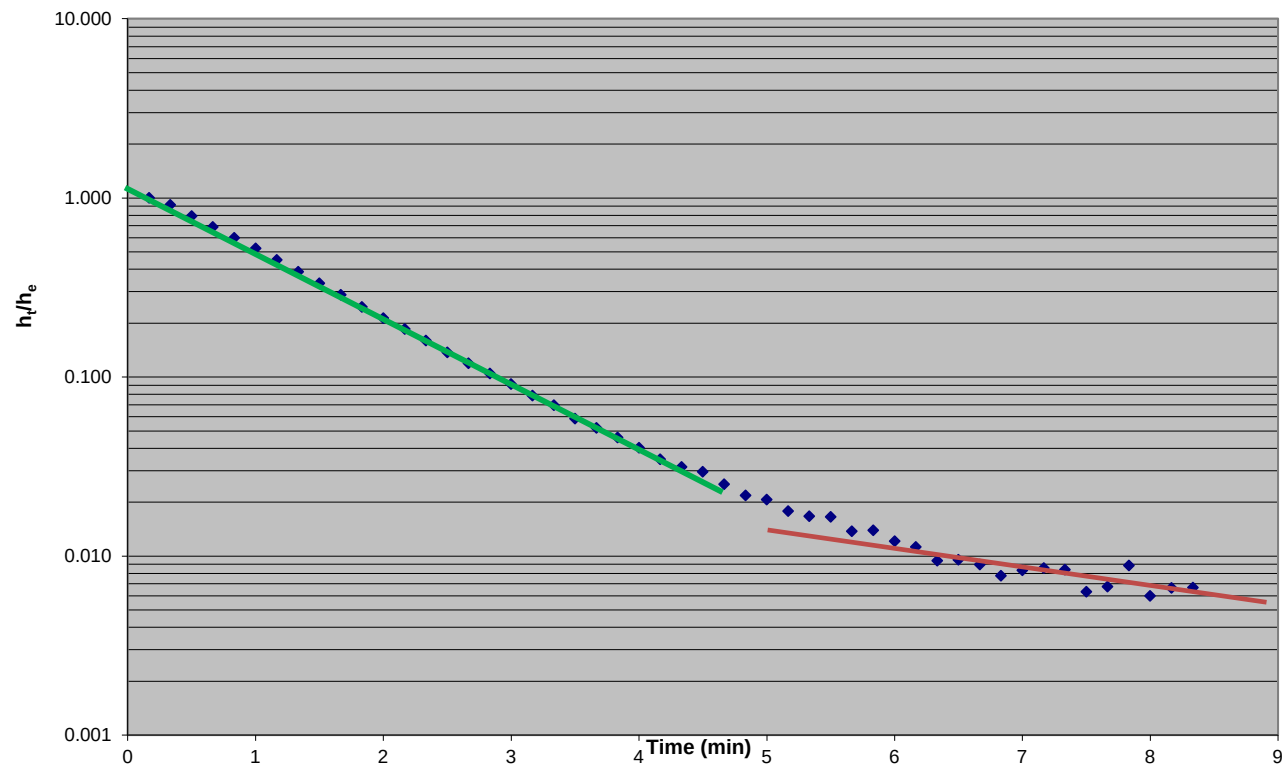
m/d **1.18E-02** **4.45E-03**
T (m²/d) 1.42E+00 5.34E-01
 Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log(h_1/h_2)/(t_2 - t_1))$,
 (ie slope of plot, t in mins)

K	0.0118	0.004
T	1.416	0.53

Notes: Cased in fresh bedrock

Bore No:	BWE32	Test No:	1	Job No:	514F F3	Date:	25-Apr-25	Logged by:	KM
Borehole co-ordinates: Easting:		458568	Northing:		6601717	Collar elevation (m):		TBC	
Depth to top of test section (m):		12				Length of test section, L (m):		129	
Depth of static water level, H_w (m):		22.04				Radius of borehole, r (m):		0.076	
Excess head, h_e (m):		2.76				Radius of standpipe or casing, r_c (m):		0.076	

Head - time graph (slope of graph is S)



Calculations:

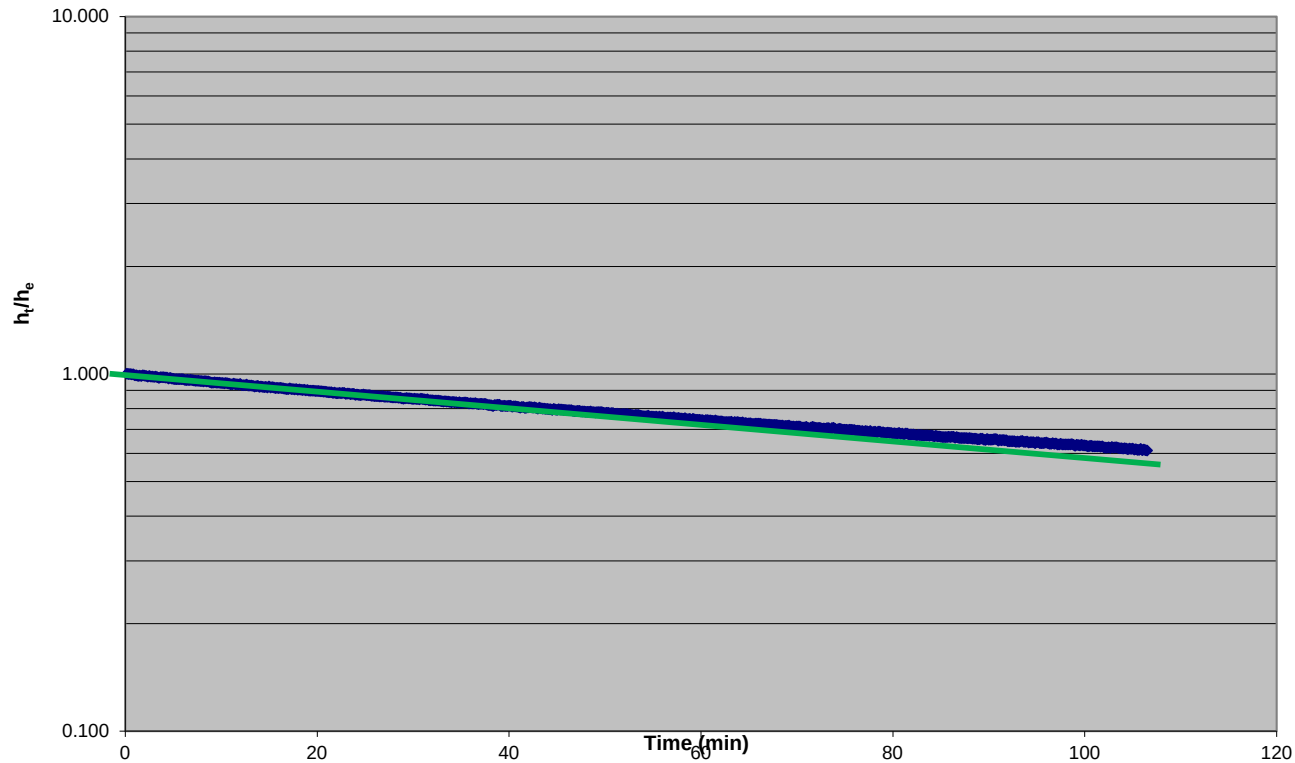
	Early Time	Late Time
h_1	1.00	0.009
t_1	0.2	6.30
h_2	0.03	0.007
t_2	4.5	8.10
S	3.5E-01	6.1E-02
k (m/s)	2.11E-06	3.61E-07

m/d 1.82E-01 3.12E-02
 T (m²/d) 2.35E+01 4.02E+00
 Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log(h_1/h_2))/(t_2 - t_1)$,
 (ie slope of plot, t in mins)

K	0.1822	0.031
T	23.507	4.02

Bore No:	WMB34	Test No:	1	Job No:	514F F3	Date:	25-Apr-25	Logged by:	KM
Borehole co-ordinates: Easting:		458568		Northing:		6601717		Collar elevation (m): TBC	
Depth to top of test section (m):		12		Length of test section, L (m):		145		Radius of borehole, r (m): 0.076	
Depth of static water level, H_w (m):		4.18		Radius of standpipe or casing, r_c (m):		0.076			
Excess head, h_e (m):		1.09							

Head - time graph (slope of graph is S)



no recovery?

Calculations:

Early Time

h ₁	1.00	
t ₁	0.2	
h ₂	0.61	
t ₂	105.5	
S	2.0E-03	
k (m/s)	1.08E-08	

m/d 9.33E-04

T (m²/d) 1.35E-01

Permeability, k = 0.133 x S x (rc²/L), (m/sec)

where S = (log (h₁/h₂))/(t₂ - t₁),

(ie slope of plot, t in mins)

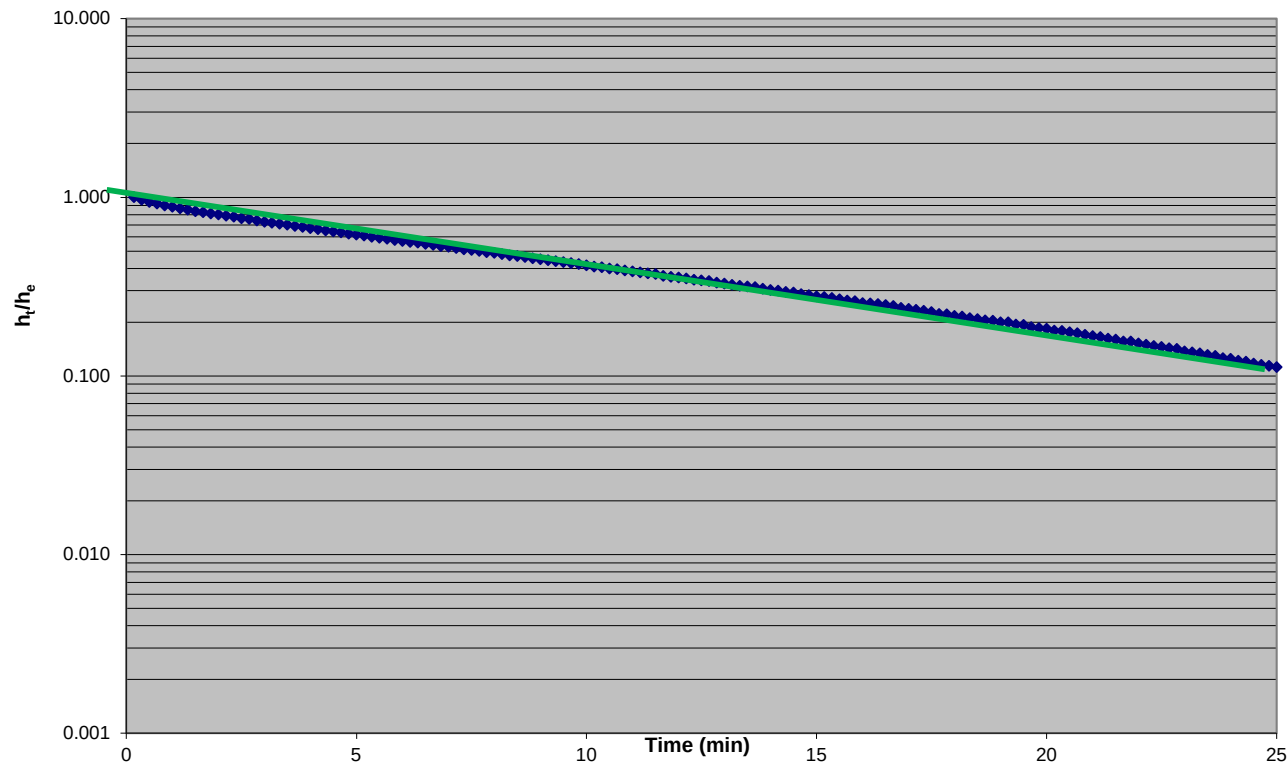
K 0.0009

T 0.135

Notes: BWE34 is open hole

Bore No:	WMB35	Test No:	1	Job No:	514F F3	Date:	25-Apr-25	Logged by:	KM
Borehole co-ordinates: Easting:		458568	Northing:		6601717	Collar elevation (m):		TBC	
Depth to top of test section (m):		25	Length of test section, L (m):		132	Radius of borehole, r (m):		0.076	
Depth of static water level, H_w (m):		1.28	Radius of standpipe or casing, r_c (m):		0.025				
Excess head, h_e (m):		2.07							

Head - time graph (slope of graph is S)



no recovery?

Calculations:

Early Time		
h₁	1.00	
t₁	0.2	
h₂	0.20	
t₂	19.0	
S	3.7E-02	
k (m/s)	2.34E-08	

m/d 2.02E-03
T (m²/d) 2.66E-01
 Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log(h_1/h_2)/(t_2 - t_1))$,
 (ie slope of plot, t in mins)

K 0.0020
T 0.266

APPENDIX D
RESULTS OF CHEMICAL ANALYSES



ANALYTICAL REPORT



Accreditation No. 2562

CLIENT DETAILS

Contact [REDACTED]
Client AQ2
Address PO BOX 976
SOUTH PERTH WA 6951

LABORATORY DETAILS

Manager [REDACTED]
Laboratory SGS Perth Environmental
Address 28 Reid Rd
Perth Airport WA 6105

Telephone (08) 9373 3500
Facsimile (08) 9373 3556
Email [REDACTED]

Project **Bombora**
Order Number **514F Task F3**
Samples 3

SGS Reference **PE184380 R0**
Date Received 15 Jul 2025
Date Reported 23 Jul 2025

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(898).

Nitrate and Nitrite: Samples analysed outside holding time.

PH in Water: Samples received and analysed outside holding time.

TDS: Samples received and analysed out of holding time.

The upper limit for Conductivity in Water is 100,000 uS/cm. Any result above this is an estimate. This will also cause the TDS on EC ratio to bias high.

Metals: Dissolved Al, Mn & Zn : Spike recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).

Metals: LORs raised due to high conductivity.

TDS: EC of samples is over 100, 000us so TDS gravimetric results will be biased high.



ANALYTICAL REPORT

PE184380 R0

		Sample Number	PE184380.001	PE184380.002	PE184380.003
		Sample Matrix	Water	Water	Water
		Sample Date	7/7/25 14:05	28/6/25 9:00	11/7/25 10:10
		Sample Name	WPB 26	WPB 33	WPB 29
Parameter	Units	LOR			

pH in water Method: AN101 Tested: 15/7/2025

pH**	pH Units	0.1	6.8	6.8	7.1

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 15/7/2025

Conductivity @ 25 C	µS/cm	2	200000	210000	210000

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 16/7/2025

Total Dissolved Solids Dried at 175-185°C	mg/L	10	220000	240000	260000

Alkalinity Method: AN135 Tested: 15/7/2025

Bicarbonate Alkalinity as HCO ₃	mg/L	5	130	44	62
Carbonate Alkalinity as CO ₃	mg/L	5	<5	<5	<5
Total Alkalinity as CaCO ₃	mg/L	5	110	36	51

Sulfate in water Method: AN275 Tested: 18/7/2025

Sulfate, SO ₄	mg/L	1	11000	13000	14000

Chloride by Discrete Analyser in Water Method: AN274 Tested: 18/7/2025

Chloride, Cl	mg/L	1	160000	190000	210000



ANALYTICAL REPORT

PE184380 R0

		Sample Number	PE184380.001	PE184380.002	PE184380.003
		Sample Matrix	Water	Water	Water
		Sample Date	7/7/25 14:05	28/6/25 9:00	11/7/25 10:10
		Sample Name	WPB 26	WPB 33	WPB 29
Parameter	Units	LOR			

Mercury (dissolved) in Water Method: AN311(Perth)/AN312 Tested: 21/7/2025

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005

Reactive Silica by Discrete Analyser Method: AN270 Tested: 16/7/2025

Reactive Silica, SiO ₂	mg/L	0.1	0.93	6.5	6.3



QC SUMMARY

PE184380 R0

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-(AU)-[ENV]AN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Bicarbonate Alkalinity as HCO ₃	LB231941	mg/L	5	<5		
Carbonate Alkalinity as CO ₃	LB231941	mg/L	5	<5		
Total Alkalinity as CaCO ₃	LB231941	mg/L	5	<5	2 - 9%	101%

Ammonia Nitrogen by FIA Method: ME-(AU)-[ENV]AN261/AN262

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ammonia Nitrogen, NH ₃ as N	LB231925	mg/L	0.05	<0.05	5%	91%

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB231990	mg/L	1	<1	0 - 4%	97 - 98%	107%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB231942	µS/cm	2	<2	0%	99%

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311(Perth)/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB232054	mg/L	0.00005	<5e-005	61%	111%	99%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Calcium, Ca	LB231915	mg/L	0.2	<0.2	0%	93%	92%
Magnesium, Mg	LB231915	mg/L	0.1	<0.1	2%	96%	97%
Potassium, K	LB231915	mg/L	0.1	<0.1	0%	99%	
Sodium, Na	LB231915	mg/L	0.5	<0.5	1%	98%	
Total Hardness by Calculation	LB231915	mg CaCO ₃ /L	1	<1			



QC SUMMARY

PE184380 R0

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: ME-(AU)-[ENV]AN258

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrite Nitrogen, NO ₂ as N	LB231925	mg/L	0.05	<0.05	0%	95%
Nitrate Nitrogen, NO ₃ as N	LB231925	mg/L	0.05	<0.05	0%	NA

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB231942	pH Units	0.1	5.7	0%	100%

Reactive Silica by Discrete Analyser Method: ME-(AU)-[ENV]AN270

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Reactive Silica, SiO ₂	LB231905	mg/L	0.1	<0.10	0 - 2%	100%	98%

Sulfate in water Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulfate, SO ₄	LB231990	mg/L	1	<1	0 - 6%	94 - 99%	74%

TKN Kjeldahl Digestion by Discrete Analyser Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB231966	mg/L	0.05	<0.05	6%	104%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB231909	mg/L	10	<10	2%	98%	96%	NA
	LB231944	mg/L	10	<10	0 - 1%	98%		0%



QC SUMMARY

PE184380 R0

MB blank results are compared to the Limit of Reporting

LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.

DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Total Phosphorus by Kjeldahl Digestion DA in Water Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion) as P	LB231966	mg/L	0.02	<0.02	0%	112%

Trace Metals (Dissolved) in Water by ICPMS TQe Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium	LB231932	µg/L	5	<5		109%	-54%
Arsenic	LB231932	µg/L	0.5	<0.5	0%	101%	91%
Barium	LB231932	µg/L	0.5	<0.2		101%	95%
Beryllium	LB231932	µg/L	0.1	<0.1		103%	102%
Cadmium	LB231932	µg/L	0.05	<0.05	2%	103%	102%
Chromium	LB231932	µg/L	0.5	<0.5	3%	104%	117%
Cobalt	LB231932	µg/L	0.5	<0.5		105%	104%
Copper	LB231932	µg/L	0.5	<0.5	0%	106%	100%
Iron	LB231932	µg/L	5	<5	1%	101%	86%
Lead	LB231932	µg/L	0.5	<0.5	2%	104%	114%
Manganese	LB231932	µg/L	1	<1		114%	309%
Nickel	LB231932	µg/L	1	<1	0%	106%	107%
Selenium	LB231932	µg/L	1	<1		100%	88%
Vanadium	LB231932	µg/L	0.5	<0.5		104%	93%
Zinc	LB231932	µg/L	1	<1	1%	110%	-43%



METHOD SUMMARY

PE184380 R0

METHOD

METHODOLOGY SUMMARY

AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as $\mu\text{mhos/cm}$ or $\mu\text{S/cm}$ @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN106	Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present, measured by the conductivity, are present as NaCl.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN113	The Total Dissolved Solids residue may also be ignited at 550 C and volatile TDS (Organic TDS) and non-volatile TDS (Inorganic) can be determined.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN258	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.
AN262	Ammonia in solution is reacted with o-phthalaldehyde (OPA) to form a fluorescent compound. The reaction product is detected by a fluorimeter and the response is measured via FIA using a photomultiplier detector. The response is directly proportional to the concentration of ammonia in the sample.
AN270	Reactive forms of silicon in acid solution below pH 2 react with ammonium molybdate ions to form a yellow silicomolybdate which is then reduced with ascorbic acid to produce a blue silicomolybdate complex. Oxalic acid is added to destroy any molybdophosphoric acid. Colourimetric determination by Discrete Analyser.
AN274	Chloride by Discrete Analyse: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN275	Sulfate by Discrete Analyse: sulfate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulfate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN279/AN293(Sydney)	The sample is digested with Sulphuric acid, K ₂ SO ₄ and CuSO ₄ . All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.



METHOD SUMMARY

PE184380 R0

METHOD

METHODOLOGY SUMMARY

AN281

An unfiltered water or soil sample is first digested in a block digester with sulfuric acid, K₂SO₄ and CuSO₄. The ammonia produced following digestion is then measured colourimetrically using the Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.

AN311(Perth)/AN312

Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.

AN318

Determination of elements at trace level in waters by ICP-MS technique, referenced to USEPA 6020B and USEPA 200.8 (5.4).

AN320

Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.

AN320

Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.

Calculation

Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO₂ D.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
***	Indicates that both * and ** apply.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.

Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the "Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.

Note that in terms of units of radioactivity:

- 1 Bq is equivalent to 27 pCi
- 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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Bombora Project Lake Roe Flood Depth Assessment

Prepared for:

Ramelius Resources

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AQ2 Pty Ltd
Ground Floor, 1 Howard Street
Perth WA 6000 Australia
Tel +61 8 9322 9733
www.aq2.com.au

DOCUMENT STATUS

Version	Purpose of Document		Review Date
A	For client comment		08/04/2025
B	Final		11/04/2025
C	Mine Plan Revised		04/12/2025
D	Evaporation Ponds Sizing Revised		02/02/2026

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1. BACKGROUND

The Ramelius Resources proposed Roe Mining Project is located approximately 100 km due east of Kalgoorlie and about 45 km southwest of Ramelius Resources' Lake Rebecca Project in the Goldfields Region of Western Australia (refer Figure 1.1). The Project is proposed to consist of the Bombora open cut pits and (potentially) the Kopai Crescent open cut pits. Both mining areas are located in proximity to Lake Roe, with the Kopai Crescent pit footprint extending partially over the lake basin. Both areas are likely to be prone to flooding from water ponding within Lake Roe following large rainfall events.

For the purposes of this report, the proposed mining disturbance footprint area is collectively referred to as the "Project Area". An overview of the proposed Project Area (Project disturbance footprint) is provided in Figure 1.2, with the Project predominantly focused on mining and processing activities at the Bombora site with satellite pits potentially supplying ore from Kopai Crescent.

Within the Bombora Project Area, the area within the proposed abandonment bund comprising the three open cut pits and associated waste dumps and haul roads is referred to as the "Mining Area" within this report (refer Figure 1.4). The proposed Bombora Mining Area is situated on an embayment of Lake Roe and comprises three separate open pits — referred to as the North Pit, Central Pit, and South Pit. These pits are located within the lakebed such that it is likely to be prone to inundation following significant rainfall events. The Mining Area also spans the length of one of the Lake Roe embayments and would prevent runoff which reports to the embayment from the southwest from reaching the main body of the lake.

As part of the assessment to establish the requirement for mine flood protection, AQ2 completed a 2D flood model to characterise the flood behaviours within the lake and a water balance model to predict the lake's flood levels for different recurrence intervals.

Given the location of the Project within a salt lake environment, the design of the flood protection bund may need to consider both overland flow from the external catchment and the storage of rainfall within the local lake sub-area and the greater Lake Roe system. The blockage of the lake embayment by the Bombora Mining Area may also result in different flood levels on either side of the Mining Area. This has been assessed in a flood assessment focussed around the Bombora Mining Area.

The report also assesses the areas required to manage surplus water generated during mining operations, with guidance on the required sizing of purpose-built evaporation ponds provided in this report.



Figure 1.1 Project Location

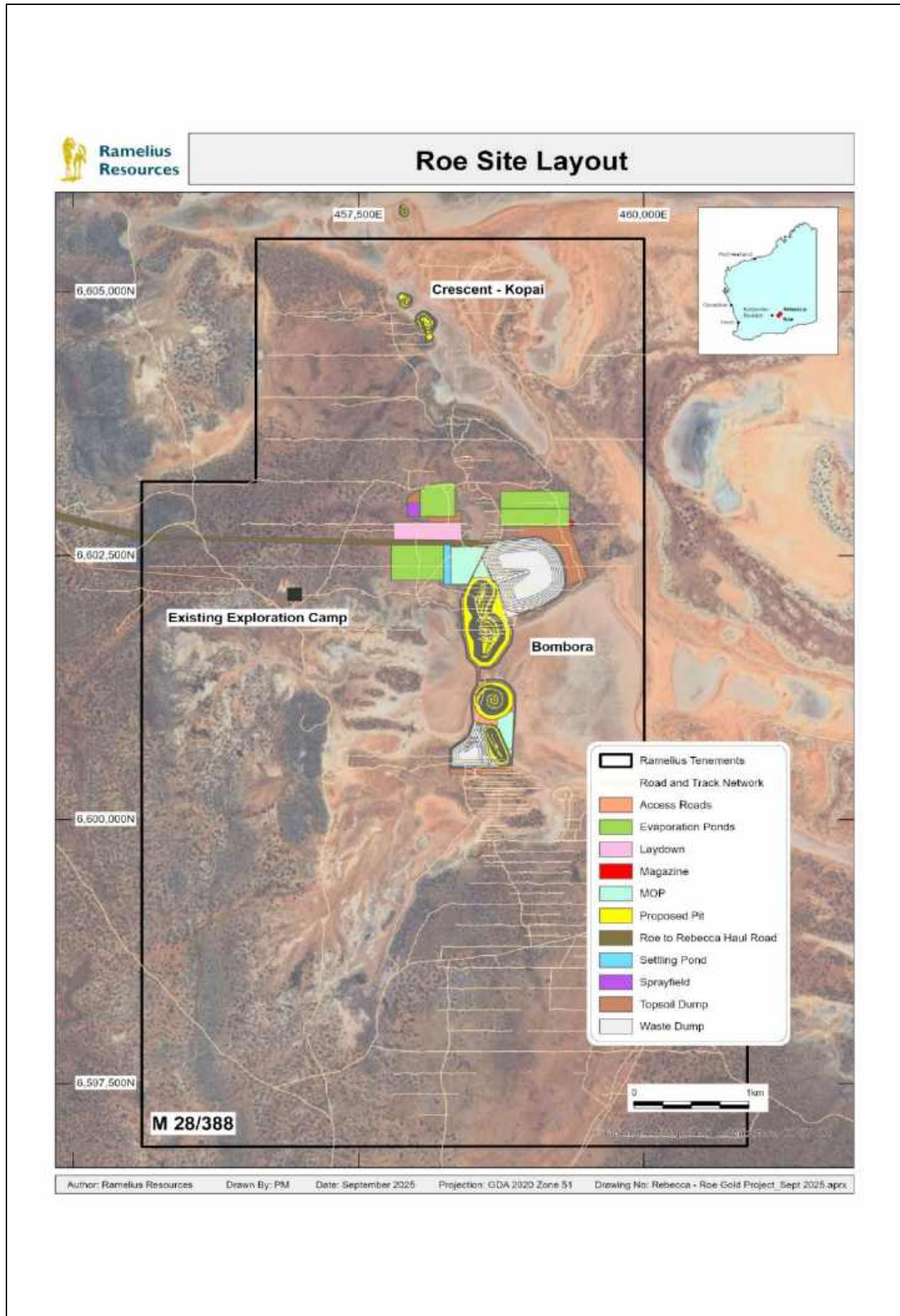


Figure 1.2 Project Layout (Source: Ramelius)



Figure 1.3 Project Area



Figure 1.4 Mining Area Footprint

2. HYDROLOGY OVERVIEW

The area colloquially referred to as Lake Roe is a complex of interconnected smaller lake sub-areas which span approximately 90 km in length (west to east), situated within a broader paleo-drainage system that historically had flowed from northwest to southeast (refer Figure 2.1). As the elevation gradient of the paleo-drainage system has reduced with time and the climate dried, the system has become a chain of salt lakes, which become terminal drainage points under most runoff events.

The region lies within an arid zone characterised by large dryland creek systems and highly variable hydrological conditions, which range from prolonged droughts to episodic flood events. These extremes influence the region's physical, chemical, and biological characteristics.

2.1 Climate

The Project area is classified as a semi-arid climate with dry, hot summers and cool mild winters. There are a number of regional weather stations which collect rainfall data, with a map of the closest stations shown in Figure 2.2. The location and data availability from each of these weather stations is summarised in Table 2.1.

Table 2.1 Regional Weather Stations

Weather Station	Lake Roe Distance (km)	Direction from Lake Roe	Data Collection Period
Karonie	30	South	1915-1986
Cowarna Downs	40	South-southwest	1968-2020
Kalgoorlie Airport	100	West	1939-2025
Gindalbie	95	Northwest	1918-2025

Cowarna Downs station is the closest weather station with a medium length of rainfall record (40 years). SILO data from Cowarna Downs station (BOM Station ID 12220) was considered the most representative analogue of the climatic conditions of the Lake Roe area based on proximity and observed data availability for assessments focused on the medium-term conditions within the lake (such as the calibration of the lake water balance model). The station is situated approximately 40 km south-southwest of Lake Roe, with rainfall records available between 1970s to 2010. A SILO rainfall dataset was obtained between 1970 and October 2024.

It was noted that the Cowarna Downs station SILO dataset:

- Likely best represents Lake Roe's rainfall for 1970–2010, when actual measurements were taken at the weather station.
- Includes rainfall data outside the years of measurement at Cowarna Downs, which would be interpolated from nearby stations and is likely to be less representative of Lake Roe catchment's rainfall.
- Is developed using SILO's interpolation techniques to derive temperature and evaporation values as this was not recorded at the Cowarna Downs station. The nearest station this data was recorded was at Kalgoorlie 110 km away.

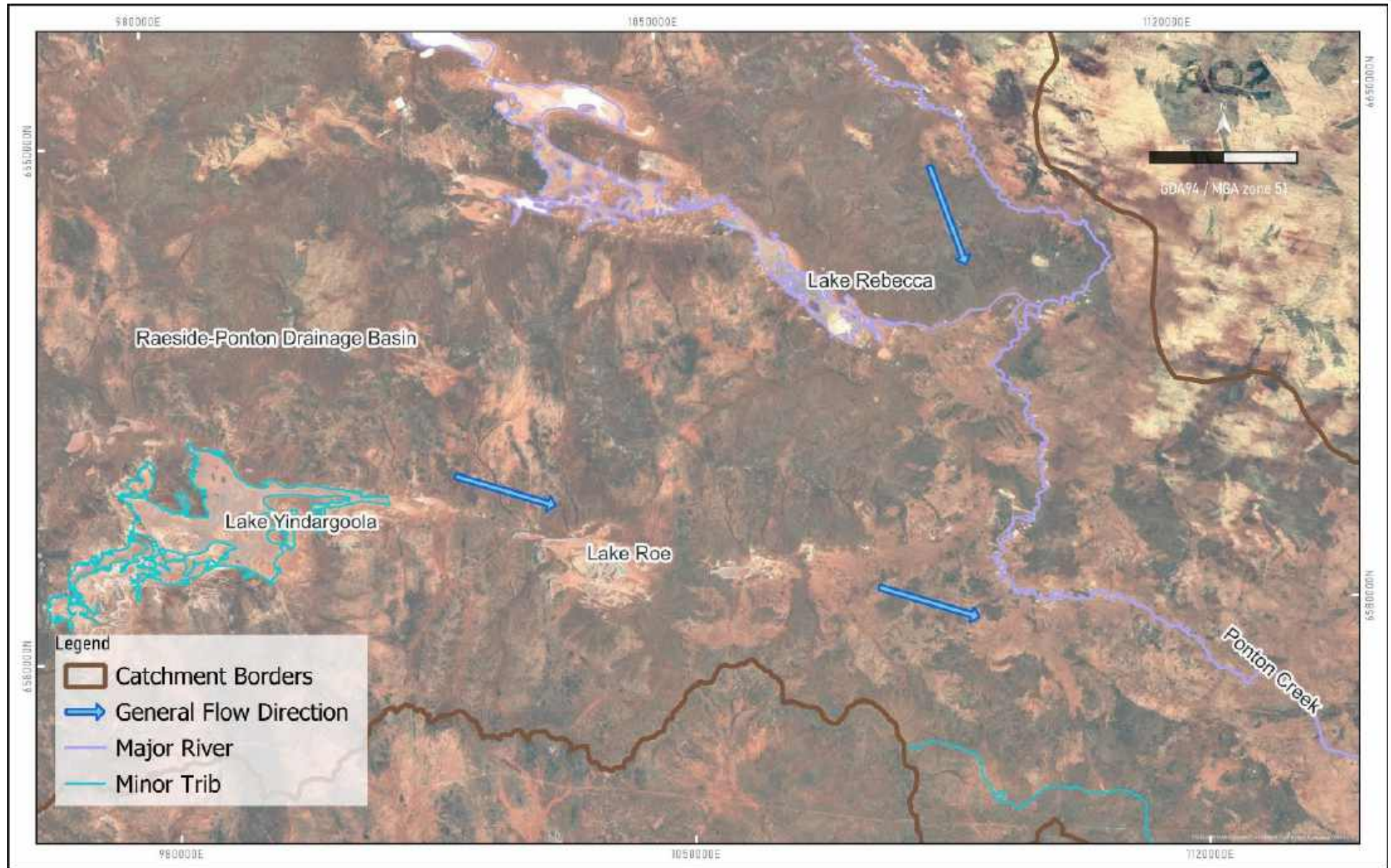


Figure 2.1 Regional Hydrology



Figure 2.2 Regional Weather Stations

Gindalbie Station (BOM Station ID 12247), located 95 km northwest of Lake Roe, is the closest station with a long-term record to the project, but it was considered too distant to be a realistic reflection of the rainfall that actually fell at Lake Roe in the past. This weather station has recorded rainfall events which are greater in magnitude than rainfall events recorded at either the Karonie or Cowarna Downs weather stations. Given the longer duration rainfall record (and larger rainfall events), the Gindalbie Weather Station rainfall data has been used to derive synthetic rainfall data for use in the lake water balance (discussed further below). Even though the weather station is located ~100 km from the lake, there are no topographic/climatic reasons why the rainfall patterns recorded at Gindalbie could not occur at Lake Roe.

A summary of the Cowarna Downs station SILO dataset is as follows:

- Long-term average annual rainfall of 260.7 mm.
- Annual average Class A pan evaporation rate of 2,420 mm and an annual average Morton's shallow lake evaporation rate of 1,560 mm (from SILO interpolation at Cowarna Downs).
- Long-term average maximum temperature of 26°C.
- Monthly average rainfall, Class A pan evaporation, Morton's shallow lake evaporation, maximum and minimum temperature (1970–2024) as shown in Figure 2.3.
- Daily rainfall sequence as shown in Figure 2.4.



Figure 2.3 Cowarna Downs Monthly Average Climate Characteristics (1970–2024)

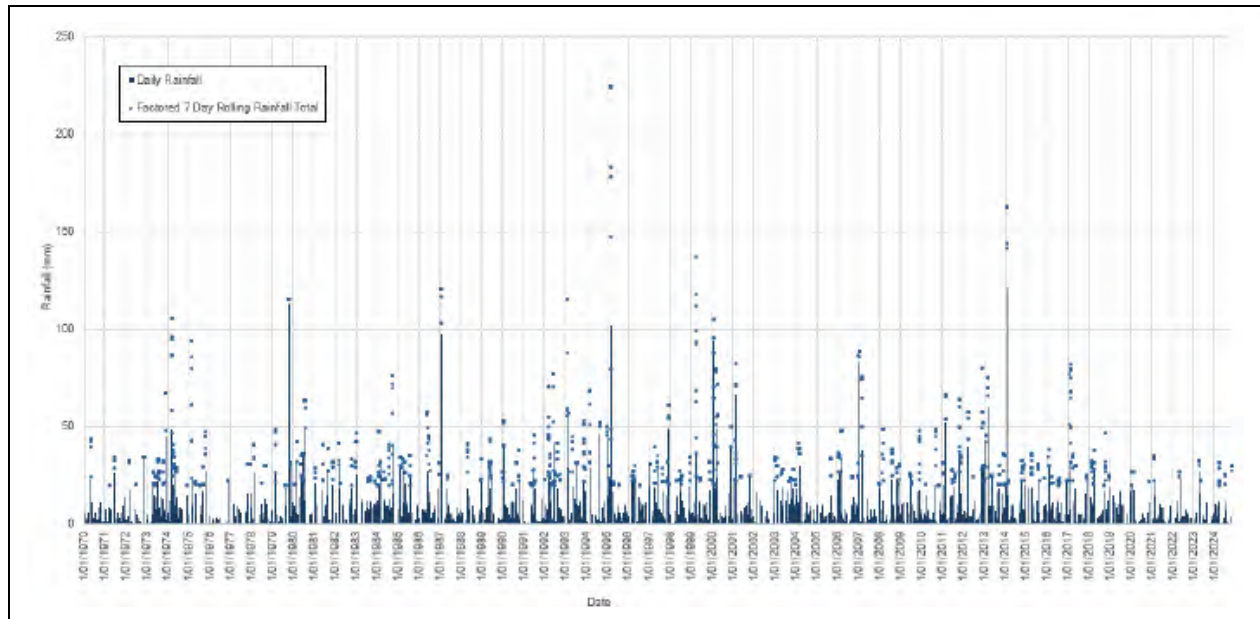


Figure 2.4 Cowarna Downs Rainfall Metrics (1970–2024)

2.2 Design Rainfall

2.2.1 Probability Terminology

Australian Rainfall and Runoff (ARR) (Ball, et. Al 2019) recommends the use of Annual Exceedance Probability (AEP), defining flood probability, so has been adopted throughout this report. AEP is defined as the probability or likelihood of an event occurring or being exceeded within any given year, usually expressed as a percentage. This new terminology supersedes the Annual Recurrence Interval (ARI) terminology adopted in the earlier revision of ARR (Institution of Engineers, Australia 1987). The relationship between ARI and AEP is defined below.

$$AEP = 1 - \exp\left(\frac{-1}{ARI}\right)$$

For example, a 1 in 100 ARI event would occur on average once every 100 years and has 1% chance of occurring in particular year (i.e., 1% AEP), while a 1 in 50 ARI event has 2% chance of occurring (2% AEP).

The likelihood of a flood event exceeding an AEP design criterion over the operational lifetime of the Bombora operation (in the order of 10 years) was calculated. The exceedance probability is computed using the following equation (as per ARR):

$$p = 1 - \exp\left(-\frac{L}{Y}\right)$$

Where:

Y = the return period of a given flood event (ARI)

L = the design life in years

P = the exceedance probability during the design life

The likelihood of an event (rainfall or flooding event) exceeding different AEP magnitudes over 10 years is summarised in Table 2.2. Note that there is still a 10% probability of an event exceeding a 1% AEP magnitude occurring over a 10-year project life.

Table 2.2 Exceedance Probability

Mine Life (years)	Probability of Exceedance (%) for AEP							
	39.4% (2yr ARI)	18.1% (5yr ARI)	10% (10yr ARI)	5% (20yr ARI)	2% (50yr ARI)	1% (100yr ARI)	500yr	1000yr
10	99%	86%	63%	39%	18%	10%	2%	1%

2.2.2 Intensity-Frequency-Duration Data

Intensity-Frequency-Duration (IFD) data for the Project were extracted from the BoM website from the 2016 datasets. The 2016 IFD data is presented in Table 2.3. As recommended by the latest ARR guidance, the design IFD rainfall depths used were increased by a factor of 20% to reflect the input of climate change on rainfall depths (on the basis of the IFD being derived from historic rainfall data and reflecting projections of impacts to future rainfall depths). The Long-Term (2080 period) Medium RCP4.5 model projection was used as the basis for selection of the climate change multiplier.

Table 2.3 Intensity - Frequency - Duration Rainfall Data

Duration	63.20%	50%	20%	10%	5%	2%	1%	0.2%	0.1%
9 hour	29.3	34.8	55	69.1	85.6	110	131	155	225
12 hour	31.5	37.3	59.3	74.8	93	120	144	170	246
18 hour	34.5	41.0	65.8	83.4	104	135	162	192	278.
24 hour	36.6	43.7	70.2	89.5	112	146	174	207	301
30 hour	38.4	45.8	74.1	94.7	120	155	186	219	314
36 hour	39.9	47.5	77.2	99.0	126	163	196	228	327
48 hour	42.01	50.1	81.9	105	134	175	209	245	351
72 hour	44.75	53.4	87.9	114	146	189	227	267	387
96 hour	46.4	55.6	91.7	119	152	197	237	282	410
120 hour	47.7	57.1	94.2	122	156	202	241	290	423

2.2.3 Probable Maximum Precipitation (PMP)

As part of this study, an assessment has been completed that considers the risk of flooding/within the lake sub-areas during a PMP event. Consistent with the other flood events that have been considered in this study which are related to flooding due to storage of runoff within the lake, the PMP event used for this study is the 72-hour rainfall event.

The BoM has developed several methods for estimating the PMP rainfall depth depending on storm duration for the Project region. To determine the appropriate PMP rainfall intensity for the site, two methods were used to estimate the design rainfall depth: the GTSMR (Generalised Tropical Storm Methodology for Regions) and the GSAM (Generalised Short-Duration Method). The PMP rainfall depths generated by the GTSMR method were adopted for this assessment, as they were significantly larger and more consistent with the rainfall depths for rare rainfall events estimated by the IFD curves. A summary of the GTSMR generated PMP rainfall depths for a point location and for a Lake Roe catchment-wide application (considering a reduction in average rainfall depth over a large catchment) are summarised in Table 2.4.

Table 2.4 Probable Maximum Precipitation

PMP Calculation	72hr Rainfall (mm)
Point Location	1215
Catchment area ~1500 km ²	650

2.2.4 Lake Roe Inflow Catchment

Lake Roe commands a 1,300 km² catchment draining predominantly from the north and south of the lake (refer Figure 2.5). Within this catchment are a number of drainage lines, with these drainage lines contributing runoff to different sub-areas of the lake. The hydrological response within the lake is influenced by the size of the catchment to each lake sub-area and the relative storage capacity of each of the sub-areas.

To the west of the Lake Roe catchment area (as defined for this assessment) lies another chain of salt lakes. For this assessment, it is assumed that runoff from catchments reporting to this chain of salts lakes terminates at the salt lakes and does not contribute runoff through the paleo-drainage system to Lake Roe under any magnitude runoff event. The likelihood of this occurring has not been assessed for this project, but any assessment would require much more extensive, detailed terrain data to do so.



Figure 2.5 Lake Roe Adopted Catchment Area

3. LAKE HYDRAULIC CONCEPTUALISATION

The flow behaviour within Lake Roe between different lake sub-areas has been assessed to assist in determining how to prepare a lake water balance model for the project. The conceptualisation has been completed on the following basis:

- Define catchment areas for the main drainages reporting to different parts of the lake.
- Define runoff hydrographs for flood events reporting to the lake from the sub-catchment areas for a design storm event using a hydrological model (RORB).
- Simulate the hydraulics of the flow through the lake sub-areas to characterise how the lake sub-areas become connected, where local saddles between the sub-areas constrain flow between the lake sub-areas. This has been achieved by simulating the sub-catchment inflow hydrographs within a 2D hydraulic flood model.
- Estimate water level inundation within Lake Roe for a single design rainfall event (in particular, close to the Bombora Project area), assuming the lake is dry at the commencement of the design storm event.

The approach to the above points is summarised in more detail in the sections below, with the observations used to develop the lake water balance model (discussed in Section 4). The lake water balance model is required as the flood frequency due to the storage of runoff within the lake requires consideration of antecedent rainfall conditions and different duration events. For example, does the 1% AEP wettest year result in a higher level of flooding than a 1% AEP 72-hour event, or are two 10% AEP events in quick succession equally as likely as a 1% AEP event and result in a higher flood elevation.

3.1 Sub-Catchment Definition

Using a combination of detailed 1m LiDAR elevation data, publicly available elevation data and aerial photography information, catchment areas for the main drainage lines reporting to Lake Roe were defined. The sub-catchment areas defined for Lake Roe are shown in Figure 3.1.

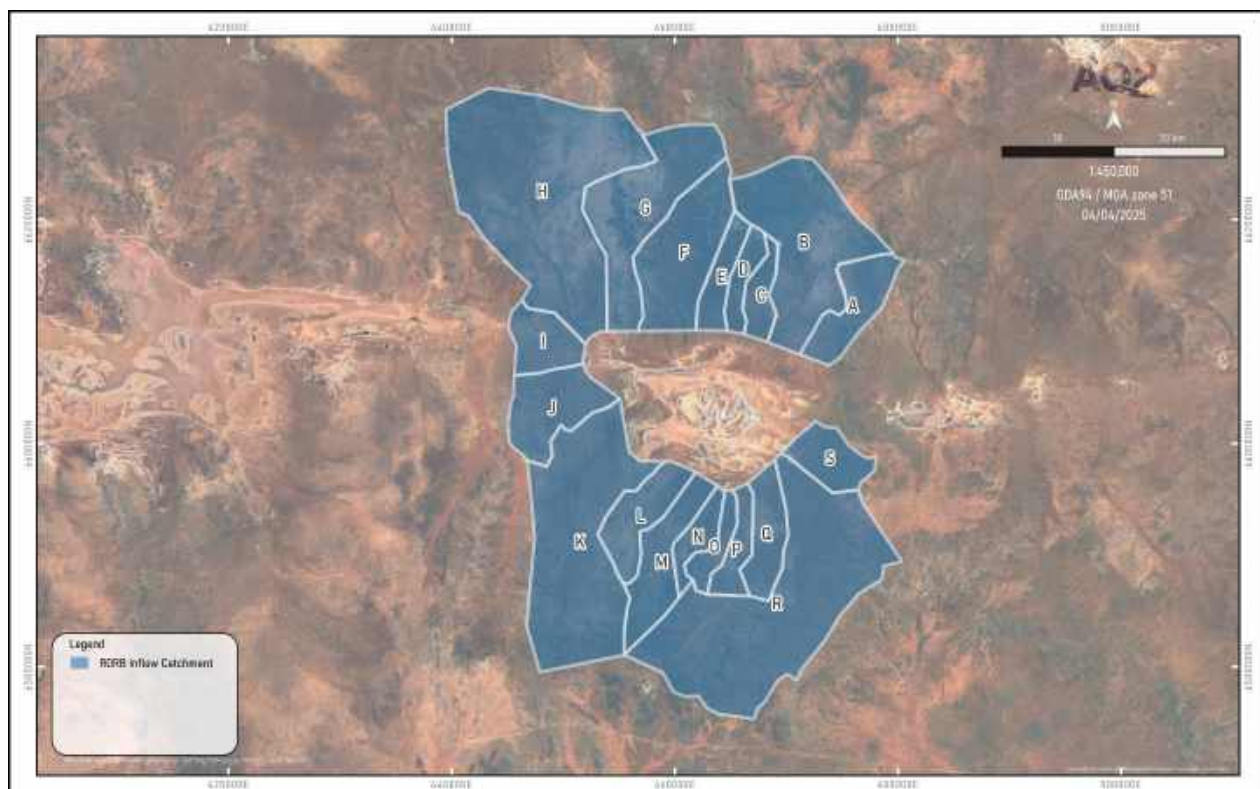


Figure 3.1 Lake Roe Sub-Catchment Areas

3.2 Catchment Runoff Estimation

The runoff behaviour from the sub-catchments to the lake has been simulated by preparing a RORB hydrology model to quantify runoff volumes and rates using the following steps:

- RORB hydrology models were developed for a representative large and small sub-catchment to estimate flow hydrographs and runoff volumes for the 20% AEP, 1% AEP and PMP rainfall events from different sized catchments. Catchments B and I (refer Figure 3.1) were selected for the RORB models to represent a large and small catchment, respectively.
- A separate single design rainfall hyetograph (rainfall intensity temporal pattern during a storm) was selected for a 72-hour storm event for each of the 20% AEP, 1% AEP and PMP rainfall events using ARR defined design temporal patterns.
 - As detailed in Section 2.2.2, climate change factors were applied to the IFD rainfall depths. No factors were applied to the PMP rainfall depth to account for climate change.
 - Rainfall losses were applied to the design hydrographs within the RORB model. The following losses were adopted:
 - 20% AEP and 1% AEP – Runoff Coefficient 35% (based on Flavell 2012b).
 - PMP – Continuing Loss 3mm/hr (as per ARR 2019 Guidelines, Book 8 Section 4.3.4.3.).
 - The adopted Runoff Coefficients include an allowance for increased rainfall losses due to the impact of climate change (due to drier soil conditions). The adopted runoff coefficients stated above for the 20% AEP and 1% AEP events have been reduced by 10% from ARR recommended regional values to reflect this. No changes to the PMP values were applied to account for climate change.
- The key parameters within the RORB models (K_c and m), which assist in defining the attenuation of runoff through the drainage lines were adopted as follows:
 - K_c was calculated using equation 7.6.25 from chapter 6.2.1.5 of Book 7 of Australian Rainfall and Runoff (ARR, 2019) for the arid interior. The calculated K_c value for Catchment B was 6.27, the K_c value for Catchment I was 3.15.
 - The exponent “ m ” is the RORB parameter that describes the nonlinearity of a catchment's storage routing. The standard value used for ungauged catchments of 0.8 was adopted (Laurenson et al 2010).
- The resulting runoff hydrographs (runoff rate with time) from Catchment B (large catchment) and Catchment I (small catchment) were used as the basis to estimate runoff hydrographs for the other sub-catchments. The other sub-catchments were classified as either large or small, and hydrographs defined by scaling the flow rate based on their relative catchment size to Catchments B and I (as applicable).

Note that the exact storm and hydrograph selected are largely unimportant for this assessment for the following reasons:

- The rainfall hyetograph and runoff hydrographs that were defined are used within the 2D flood model (discussed below), which in turn is used to characterise the flow characteristics within the Lake Roe sub-areas. The 2D flood model is not directly used to define the flood levels.
- The adopted rainfall loss model adopted was an initial loss – proportional loss model. All rainfall hyetographs result in the same volume of water running off the sub-catchment areas.
- Similarly, the choice of model K_c and m values is largely unimportant for this assessment.

Further note that the adoption of the climate change multipliers which were applied to rainfall and rainfall loss inputs were conservatively chosen from 2080 climate change projections.

3.3 Flood Modelling Setup

The flood response within Lake Roe was simulated by creating a 2D flood model using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) Version 6.7 Beta (USACE 2025). The 2D model was developed to predict inundation extents resulting from the 20%, 1% AEP and PMP rainfall events, with only the 1% and PMP results shown in this section for brevity

The basis for the 2D model is the 1m LiDAR elevation data provided to AQ2 by Ramelius Resources on 26 February 2025. Figure 3.2 shows the provided terrain data and the 2D model domain applied. This modelling scenario represents the Baseline (pre-development) flooding conditions, in which the proposed mining development has not occurred.

The general 2D model build details are as follows, with a model setup shown spatially in Figure 3.3:

- A computational mesh spacing of 100 m x 100 m was applied to the 2D flow area.
- A refined mesh spacing of 20 m x 20 m was applied at the location of the lake -sub areas.
- A roughness coefficient of 0.06 was adopted across the model domain as a representative/ average roughness coefficient across the full model domain.
- Nineteen inflow boundaries (A–S) were established around the model boundary, with each boundary corresponding to a delineated catchment as discussed above and shown in Figure 3.1.
- An outflow boundary condition was applied to the eastern edge of Lake Roe, corresponding to a low point in a saddle which may allow outflow of water from the lake to the downstream paleo-drainage system (should the lake water level rise high enough).
- A 72-hour rain-on-grid storm was incorporated into the HEC-RAS model to simulate the direct rainfall across the area within the model domain. The same storm hyetograph and rainfall losses as defined for the RORB model were applied.
- An adaptive times step was assigned using a maximum Courant Number of 2.0.
- A simulation period of 168 hours (7 days) was applied to the model to allow sufficient time for the runoff from the upstream catchments to reach Lake Roe, drain through the lake network and redistribute the runoff between the lake sub-areas.

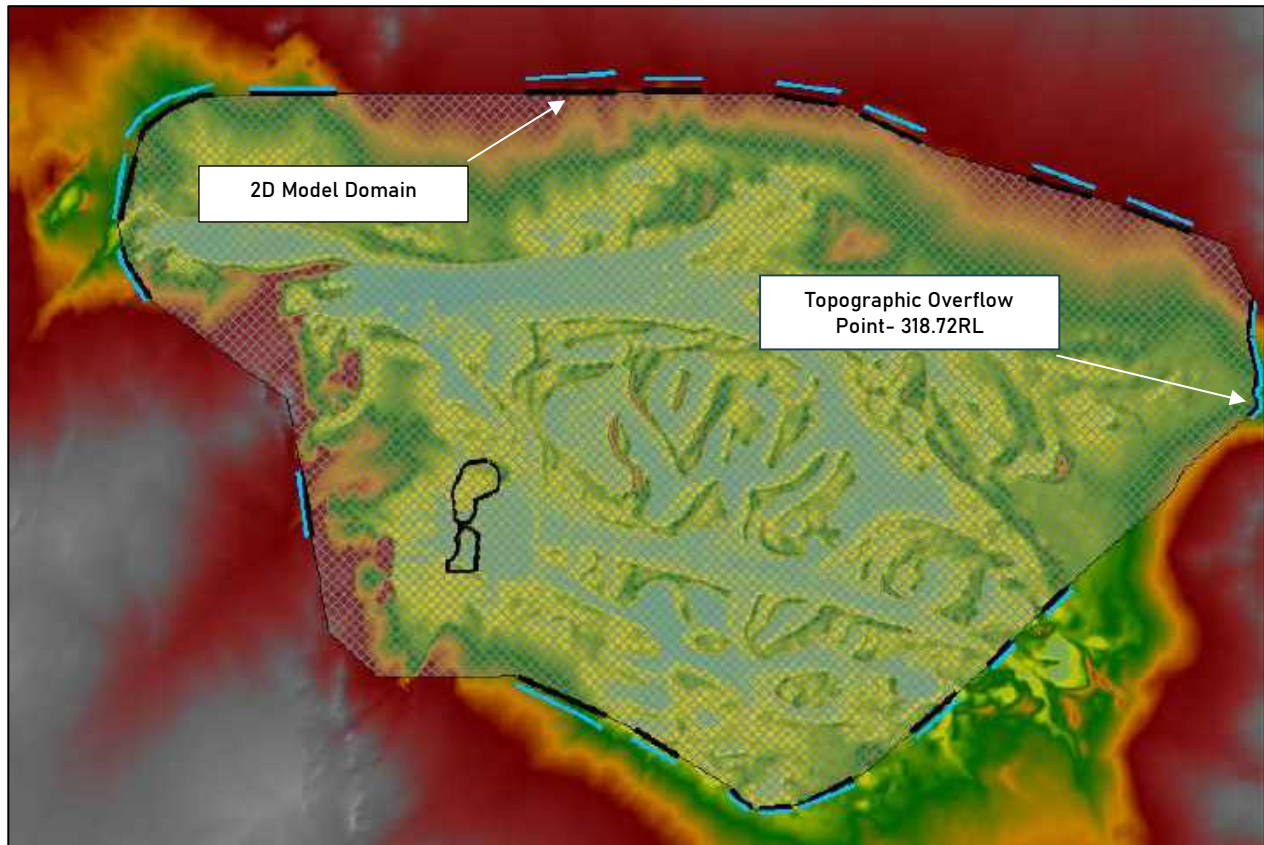


Figure 3.2 Model Terrain Data



Figure 3.3 2D Model Setup

3.4 Baseline Flood Modelling Results and Observations

Results from the flood modelling exercises are shown in the following figures:

- Figure 3.4 – the predicted maximum flood depths from the adopted 1% AEP rainfall event. Note that these maps represent the maximum flood depths predicted throughout the simulation period for each model grid cell.
- Figure 3.5 – the predicted maximum water surface elevation from the adopted 1% AEP rainfall event across the simulation period for each model grid cell across the lake.
- Figure 3.6 – the predicted maximum flood depths from the adopted PMP rainfall event across the simulation period for each model grid cell across the lake.
- Figure 3.7 – the predicted maximum water surface elevation from the adopted PMP rainfall event across the simulation period for each model grid cell across the lake.

The following key observations were made from the 1% AEP flood modelling results:

- The runoff volume from this event was large enough for most of the lake sub-areas to become hydraulically connected. As such, over time, the water surface elevation across the majority of the lake area becomes the same.
 - Note that following the 20% AEP event, the main sub-areas of the lake are also predicted to become connected, and therefore, it has been assumed that for all large runoff events, there will be sufficient runoff to connect all of the main lake sub-areas together.
- Reviewing the results as the lake fills during the simulation period, it was clear that intermediate high-points between lake sub-areas need to be overtopped before water can be transferred through the lake system. The runoff from the larger catchments (such as H, K and R) fill the lake sub-areas which they immediately report to before runoff spills over and reports to the central parts of the lake. In smaller, more frequent runoff events than those simulated, there may be insufficient runoff for inundation to spill to the central lake sub-areas.
- The predicted flood elevation from the 1% AEP 72-hour rainfall event is 314.5 mRL across the major lake sub-areas (including those adjacent to Bombora).
 - The flood levels predicted within the L1 lake sub-area in the northwest corner of Lake Roe is marginally higher than the other lake sub-areas. This is because a relatively large catchment reports to a relatively small storage volume in this sub-area, and the outflow to the remainder of the lake is hydraulically constrained. The energy loss required to transfer runoff from this sub-area to the main lake area results in a WSE elevation of 314.6 mRL, some 0.1 m above the flood level in the remainder of the lake.
 - Note that, as discussed earlier in the report, the response from the 1% AEP 72-hour rainfall event does not necessarily represent the 1% AEP flood depth (which is estimated by the water balance model).
- This inundation level is below the water surface elevation required for Lake Roe water to overtop to the east, and therefore, all runoff is contained within the Lake Roe footprint.

The following key observations were made from the PMP flood modelling results:

- A significantly larger portion of the lake area is inundated by the runoff, and a single large lake would form.
- The predicted water level in the lake from the PMP rainfall event is 319.60 mRL.
- The lake overtops to the east at this water level, which is 0.9 m above the overflow point (318.7 mRL).
- The elevation of the lake overflow point will somewhat control the maximum flood level which is possible in Lake Roe. If larger volumes of water reported to the lake, additional water will flow to the east and away from the lake.

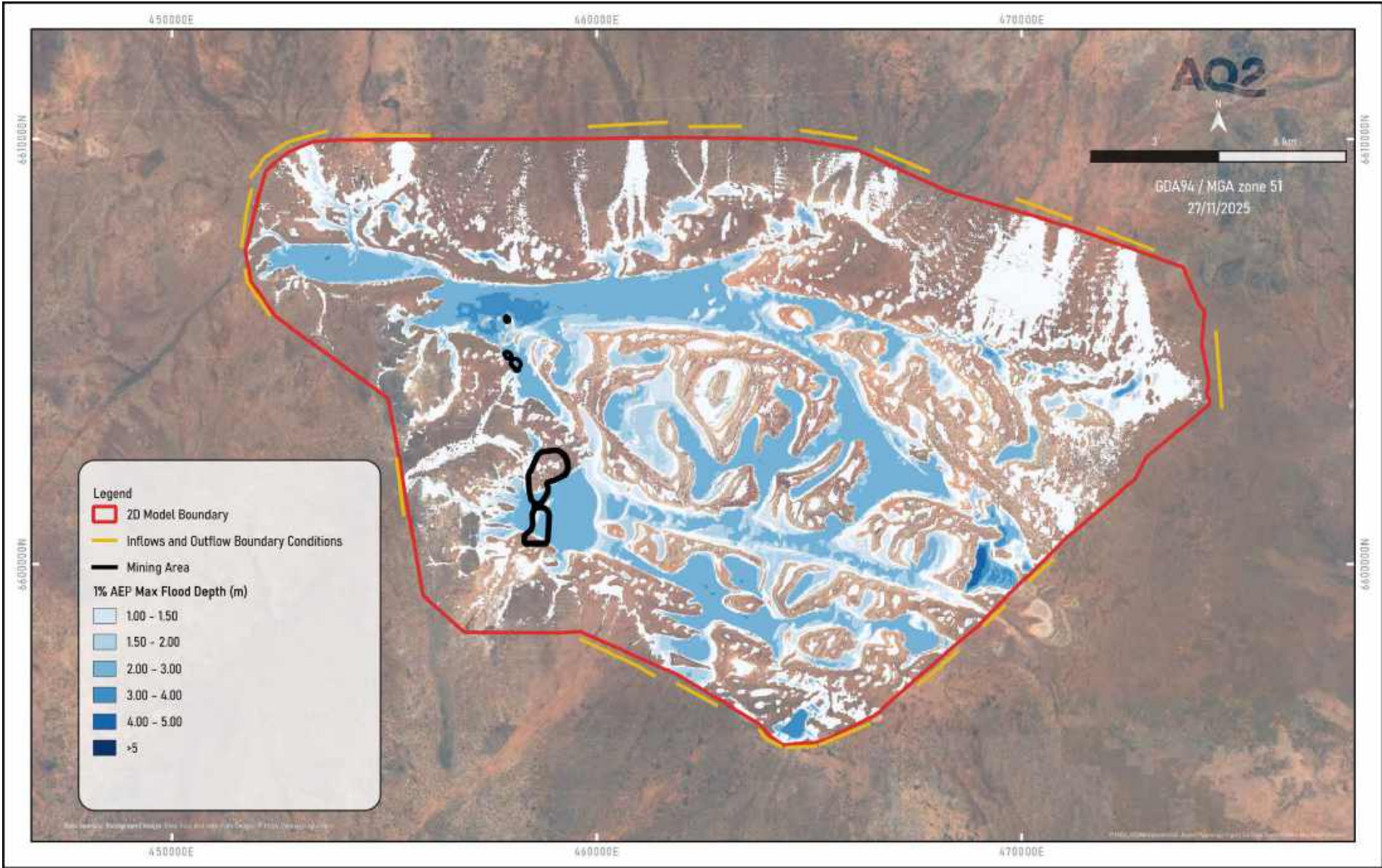


Figure 3.4 Maximum Flood Depth Map (1% AEP Rainfall Event)

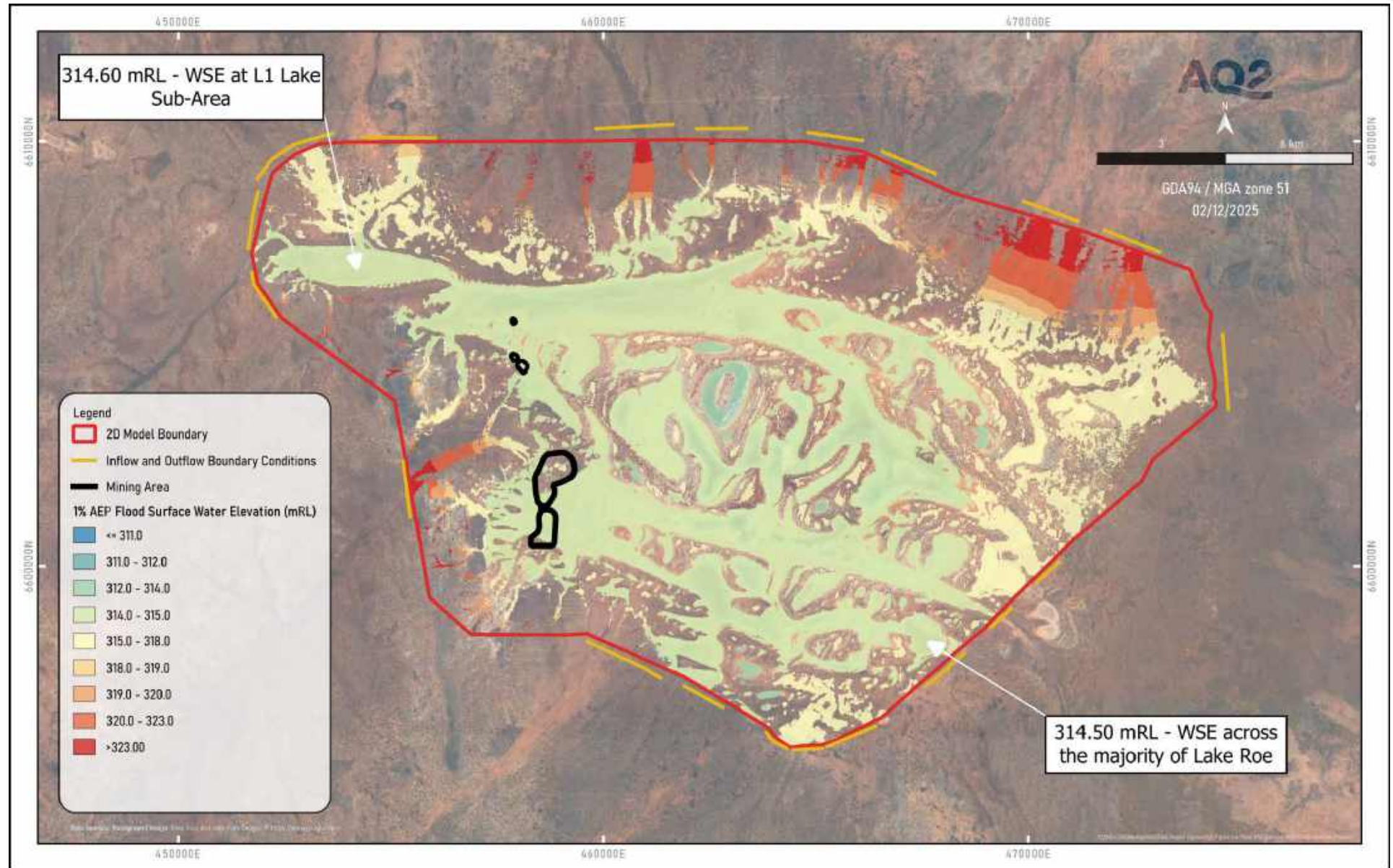


Figure 3.5 Maximum Flood WSE Map (1% AEP Rainfall Event)

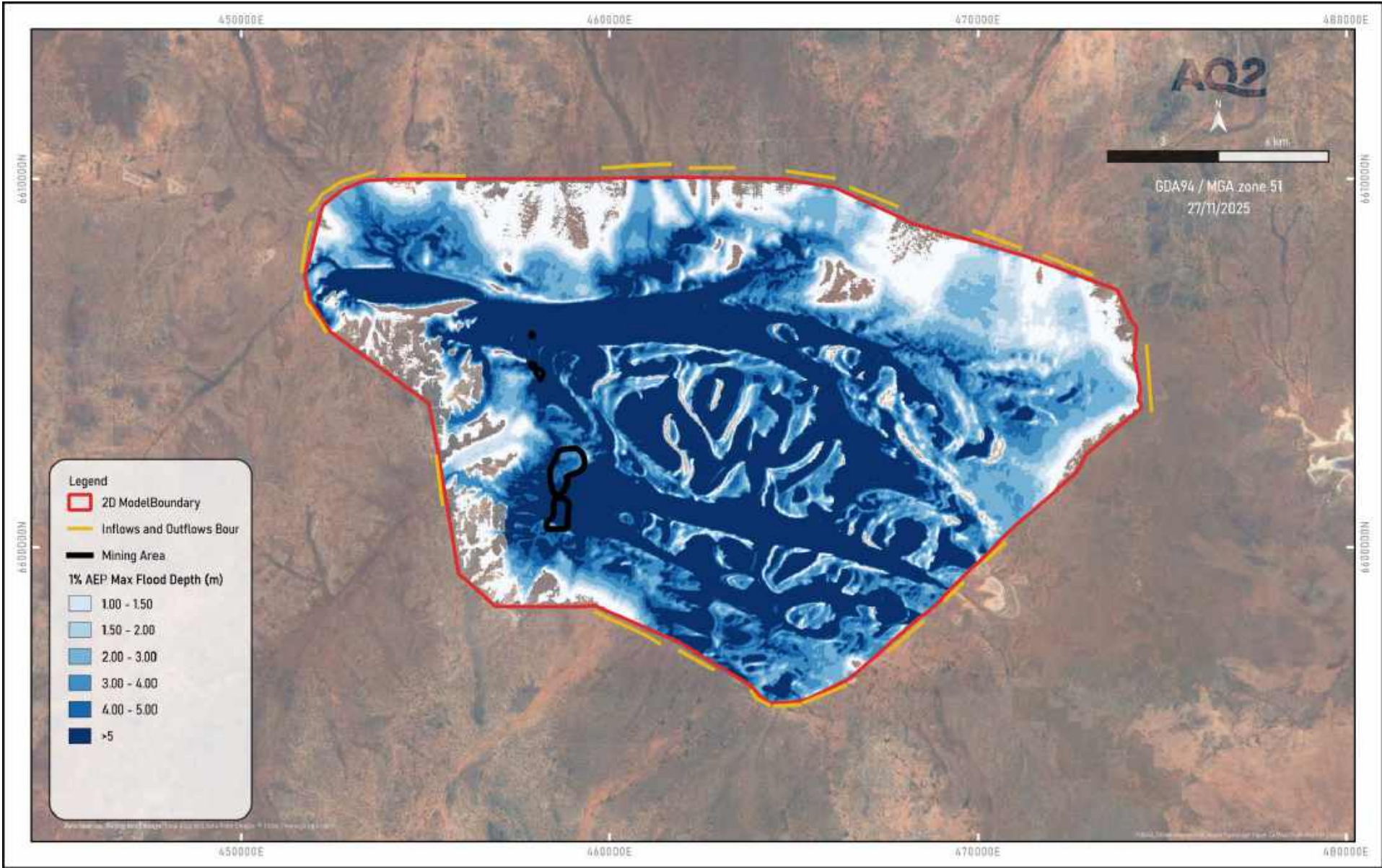


Figure 3.6 Maximum Flood Depth Map (PMP Rainfall Event)

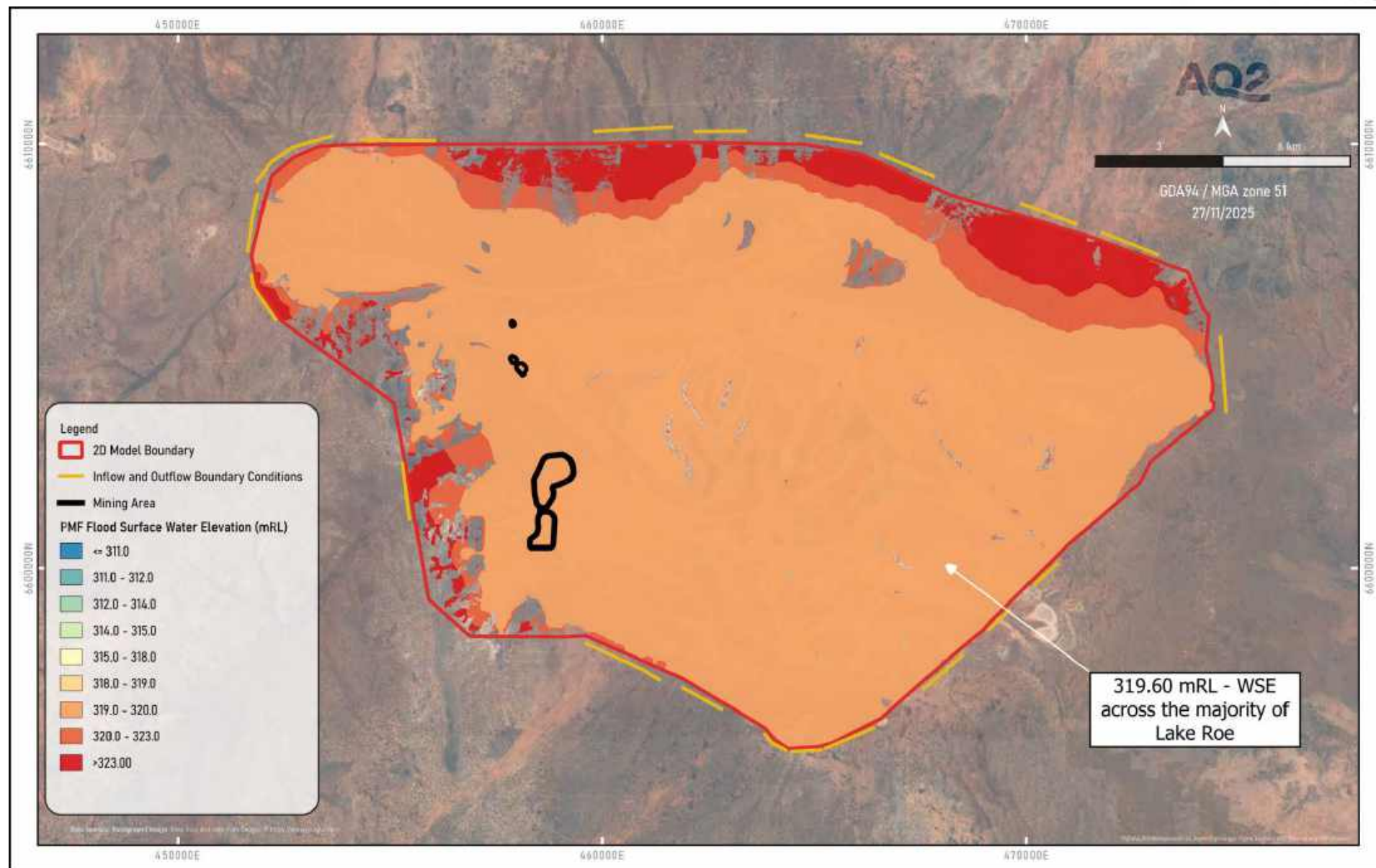


Figure 3.7 Maximum Flood WSE Map (PMP Rainfall Event)

4. LAKE WATER BALANCE

A water balance for Lake Roe has been completed to produce a simulated time series of lake water levels which could be used to allow the recurrence interval of flood levels within Lake Roe to be estimated. The water balance assessment has used the following approach:

- Using the observations from the 2D flood model, Lake Roe has been divided into 9 separate lake sub-areas (refer Figure 4.1).
- The water balance model simulates runoff reporting to each of these sub-areas and the subsequent recession of water from them.
- The water balance was coarsely calibrated to approximate observations of lake flooding from aerial imagery.
- The calibrated water balance model was run with a long-term synthetic rainfall data series (1,000-year duration) derived from rainfall data observed from a nearby weather station.
- A flood frequency analysis was completed of the resultant annual maximum flood level predictions in Lake Roe to provide an estimate of the flood levels at different recurrence intervals.

4.1 Water Balance Inputs and Assumptions

The water balance is summarised as follows:

- Lake Roe has been split into 9 different sub-areas based on the position of localised low points, catchment inflows and bounding low saddles between the sub-areas.
- For each sub-area, the following specific information has been derived:
 - Lake sub-area stage/volume/area relationship (from the provided LiDAR data).
 - Surface water catchment area draining the to the sub-area.
 - Elevation of the saddles which sperate the sub-area from adjacent sub-areas.
 - The approximate area of the “lakebed” which has been defined with different rainfall loss characteristics compared to the broader catchment area reporting to the sub-area.
- The water balance calculations are completed at constant time intervals using the following fundamental equation:
 - $\text{Inflow} - \text{Outflow} = \text{Change in Storage Volume}$
- The time interval for calculations is 6 hours. This interval is required for model stability given the large volumes of water that are moving through the model.
- At each calculation time interval, the model calculates the water level and inundation area within each sub-area based on the stored water volume at that time-step. The water level and inundation area drive other calculations within the water balance.
- The sub-area water level is used to drive the logic related to the distribution of runoff across the lake between different sub-areas. Once the storage volume within a given sub-area rises above the elevation of any of its bounding saddles, the model simulates water transfer to the adjacent sub-area(s). A portion of the water above the saddle point is transferred during successive time steps to keep the model stable (consistent with the calculation timestep).
- The inundation area of the lake is used to drive the following processes:
 - Direct rainfall on the lake surface (the model assumes 100% of rainfall on the inundation area reports to the lake).
 - Area over which evaporation losses occur from the lake surface.
 - Area over which infiltration losses occur from the lake.

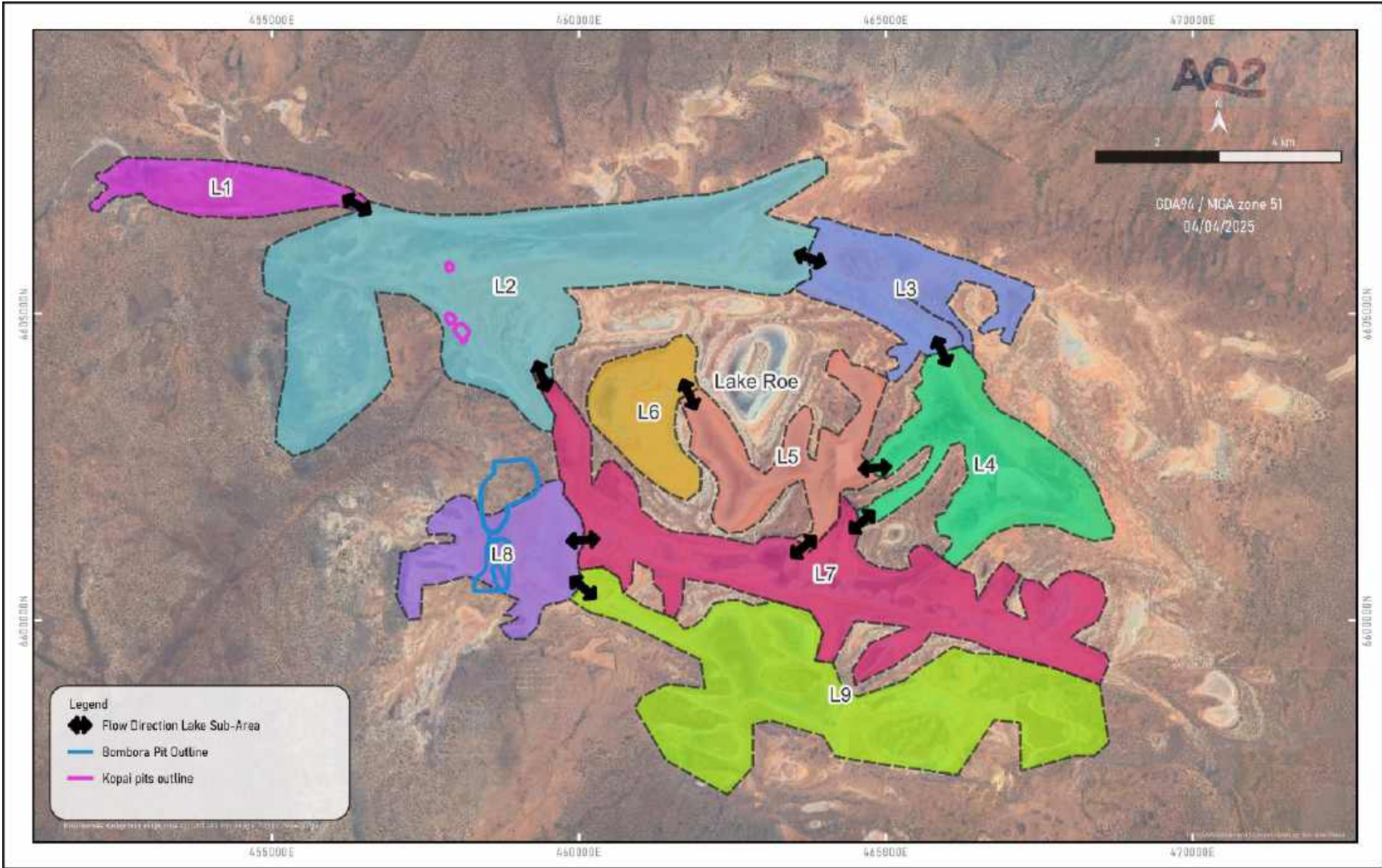


Figure 4.1 Water Balance Overview

4.1.1 Satellite Imagery Assessment

The Lake Roe inundation extents and frequency were estimated between 1993 and 2024 using satellite data, specifically true colour imagery and Normalized Difference Water Index (NDWI) data from Sentinel, Landsat and Google Earth. Data availability and aerial image quality varied considerably throughout the 1990 to 2024 study period. The inundation extents were compared to the Digital Elevation Model (DEM) of the lake to estimate ponding depths with time.

Confidence in the estimated inundated depths (from observed satellite imagery) varies, but is typically low, and the date of recorded imagery may not coincide with the date of the actual peak inundation extent. Frequent Sentinel data between 2017 and 2024 provides the most reliable period for analyses. Between 2013 and 2017, Landsat (satellite) data are inconsistent with some gaps due to Lake Roe's eastern area falling on a different tile without imagery and satellite imagery strips (Landsat 7) giving an incomplete picture. Pre-2013, imagery from Landsat is less frequent, with data pre-2008 missing for extended periods and/or has insufficient resolution to confidently interpret. Notably, there is a Landsat data gap from late 2011 to early 2013, meaning that any lake inundation due to rainfall events during 2012 are not estimated.

The following observations were made at Lake Roe during the satellite imagery assessment:

- Catchment runoff responses causing at least some inundation in Lake Roe were generally observed when rainfall exceeded approximately 25 mm.
- In small inundation events where widespread flooding across the full lake is not prevalent (i.e., following rainfall depths in the order of 25 mm), the water levels Pan A were estimated. Appendix A presents the estimates of inundation water levels from satellite observations within salt pans B and D for reference.
- Visible widespread inundation across constituent salt pans was typically observed when a rainfall event occurred over multiple days, with total rainfall over the event exceeding 50 mm.

4.1.2 Parameter Selections

Based on the observations from the satellite imagery and the model calibration exercise, the runoff parameters shown which (subjectively) best approximate the observations are summarised in Table 4.1. A plot of the observed lake water levels and the model predictions of lake water levels are presented in Figure 4.2.

Table 4.1 Water Balance Rainfall Loss Parameters

Parameter	Catchment		
	Lake Catchment	Dry Lakebed	Inundated Lake Area
Initial Loss	50 mm	25 mm	0 mm
Runoff Coefficient	25%	70%	100%
Initial Loss Recovery	5 mm/d	2.5 mm/d	0 mm/d

The calibration exercise showed that runoff behaviour was reasonably well predicted by the model, particularly during the 2005 to 2017 period, noting:

- The inherent uncertainty in the estimations of water levels in the lake from the satellite imagery given the flatness of the lake beds and the difficulty in distinguishing between salt and water on the lake bed.
- The SILO rainfall record for Cowarna Downs includes interpolated rainfall data post 2010. When SILO interpolates rainfall data in areas where weather stations are sparse and rainfall is spatially highly

variable, the interpolates tends to show rainfall occurring more frequently but with fewer large rainfall events, which is potentially why the model couldn't match the observed inundation depths post-2017.

- To simplify the calibration assessment, a stage-volume curve for the full lake was developed and used to convert the full volume within the lake (i.e., the sum of the water storage in all sub-areas) into a water level, assuming the same water level occurs across the lake. During smaller flow events, all of the lake sub-areas may not be hydraulically connected and the water level in each sub-area may be different.
- The calibration is based on water levels. The stage-volume curve for the lake is such that a relatively small amount of runoff volume is required to cause inundation up to RL312.5m, such that it is harder to replicate the lower inundation depths.

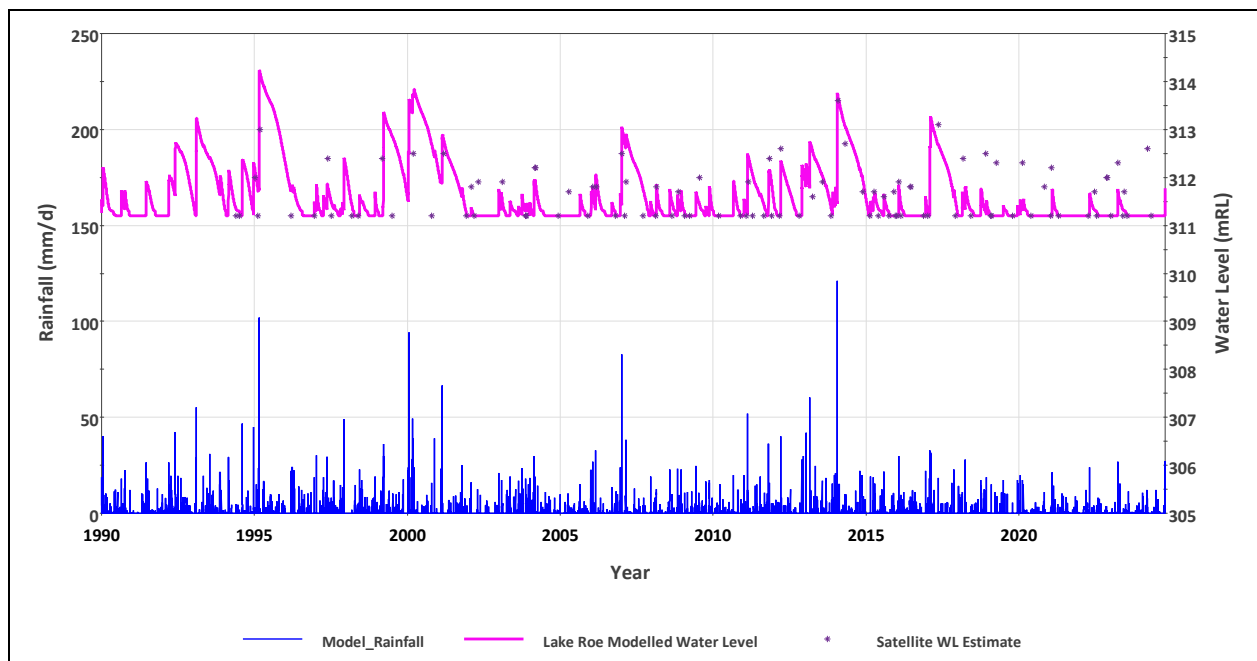


Figure 4.2 Calibrated Water Level Predictions vs Estimated Water Levels from Satellite Observations

4.2 Long-Term Synthetic Rainfall Water Balance Model

4.2.1 Introduction

A long-term water balance was run, with the purpose of developing this model to provide water balance results using a longer rainfall record which would be able to simulate the potential inundation depths from large, rare rainfall events, considering antecedent rainfall conditions (and therefore antecedent water stored in the lake sub-areas). Although the expected life expectancy of the Bombora project is in the order of 10 years, The long-term model was run using a 1,000 year rainfall sequence, even though the project life for Bombora is in the order of 10 years. This is because any 10-year rainfall sequence within the record is as equally likely to occur as any other 10-year period.

4.2.2 Synthetic Rainfall Record

The synthetic rainfall generator programmed into the GoldSim model is based on historic daily rainfall records from Gindalbie Rainfall Station. Rainfall records sourced from the Bureau of Meteorology (BOM) between 1918 and 2024 were used. The BOM rainfall dataset was incomplete over this period, with missing data patched using the online SILO enhanced climate database service to provide a continuous record. The output from SILO is formed using records from nearby weather stations.

The 106 years of daily rainfall data was used as an input to the eWater program Stochastic Climate Library (SCL). The SCL uses historic rainfall data as an input and produces a synthetic rainfall data set for the required duration, which is a statistical fit to observed rainfall. For this project, 1,000 years of daily rainfall was produced by the program.

The synthetic daily rainfall data time series that was produced for the model is not reproduced within this report for brevity; a comparison of the summary statistics for the Gindalbie data and the synthetic rainfall data generated are shown in Table 4.2.

Table 4.2 Input Rainfall Data Summary Statistics (Annual)

Annual Statistic	Annual Rainfall Depth – Gindalbie	Annual Rainfall Depth – Synthetic
Median	218 mm	223 mm
Mean	235 mm	235 mm
Maximum	674 mm	960 mm
Minimum	48 mm	12 mm
90 th Percentile	402 mm	384 mm
75 th Percentile	291 mm	296 mm
25 th Percentile	161 mm	152 mm
10 th Percentile	96 mm	100 mm

Within the GoldSim model, the synthetic rainfall dataset has been increased to account for climate change, consistent with the approach adopted within the 2D modelling. As per ARR guidelines (Ball, et. al, 2019) the rainfall records have been increased by a factor of 20% to account for increases in rainfall depths during large rainfall events as predicted by Long Term (2080 period) medium Representative Concentration Pathways 4.5 (RCP4.5). The 2080 projection period has been adopted conservatively for climate change impacts to rainfall, as the project is likely to have been completed well in advance of 2080.

4.2.3 Rainfall Loss Parameters

The rainfall loss parameters derived in the calibration model were adopted for the long-term water balance model. However, a factor to reflect the impact of climate change on likely runoff rates was applied. Although rainfall depths are predicted to increase with climate change, increased temperatures (and therefore evaporation) and periods between rainfall events within the WA arid interior region are predicted to result in an increase in rainfall losses during rainfall events. The applied ROCs within the model were reduced by 10% to reflect the impact of climate change on runoff generation.

4.2.4 Model Results

The results from the long-term synthetic rainfall model run are shown in Figure 4.3. The results indicate the following:

- Widespread inundation only occurs when the flood depths within the lake exceed the elevation of the saddle points between lake sub-areas. These saddle points are typically between RL312.5 m and RL313 m.
- Inundation of the lake with more than approximately 3m of water above the lowest point in the lake (i.e., a flood level exceeding RL314 m) happens about once every ~50 years.
- Flooding exceeding RL315 m is predicted to occur about 5 times over the 1,000-year period (i.e., once every 200 years).

- Prolonged inundation (lasting multiple years) happens rarely, but continuous ponding of up to 4 years has been predicted to occur on occasion in the model. Sustained ponding requires multiple large runoff events to occur in close succession.
- The greatest inundation level predicted (RL317 m) would result in 5.8m of flood depth at the deepest point of the lake. On the basis of a typical recession rate of 10 mm/d, it would take in the order of 1.6 years for the lake to recede to a completely dry state (if no further rainfall were to occur in that period).

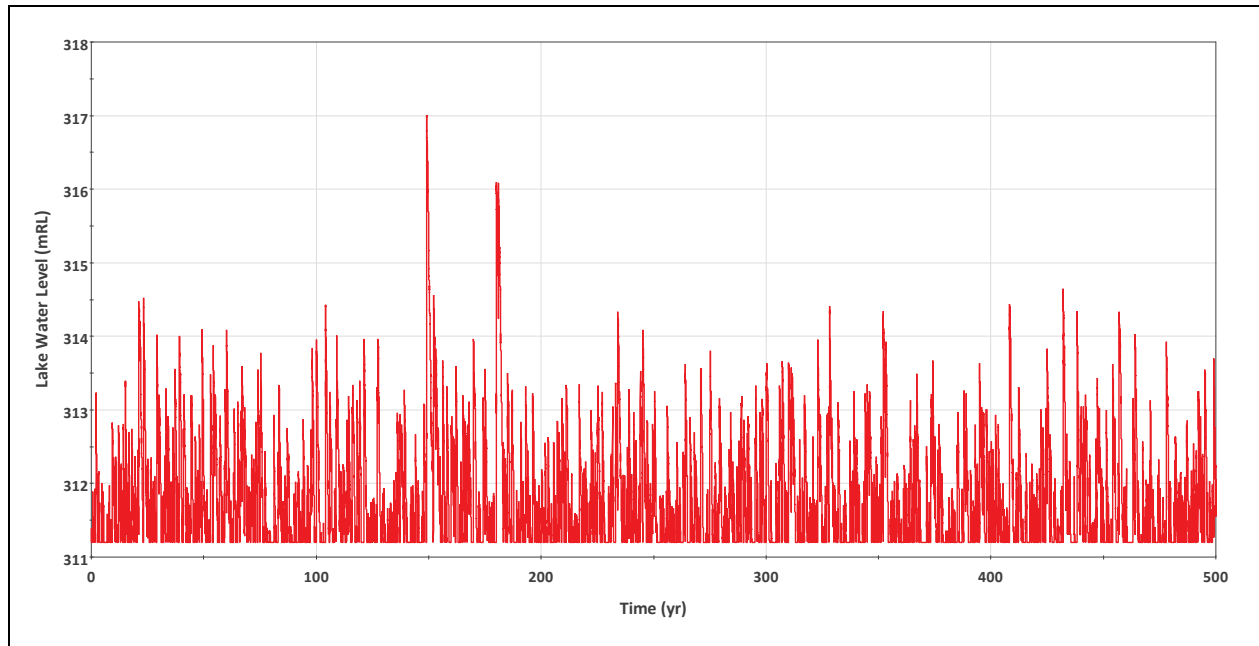


Figure 4.3 Long-Term Model Results (Year 0 to Year 500)

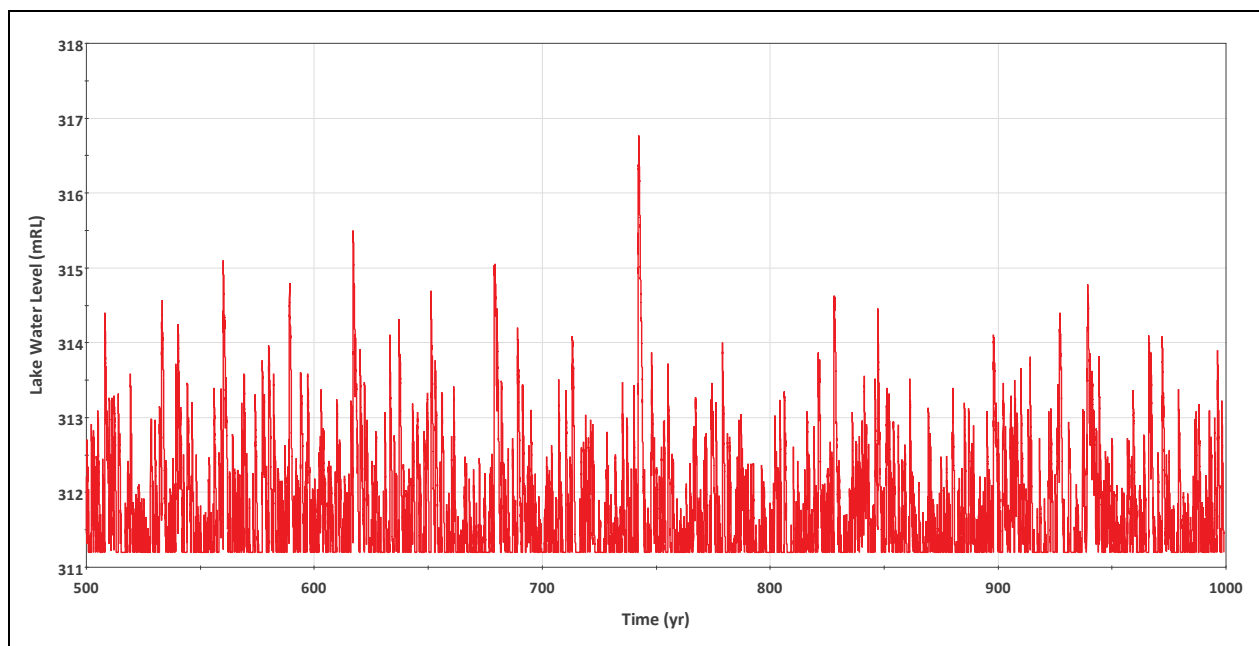


Figure 4.4 Long-Term Model Results (Year 500 to Year 1000)

4.2.5 Flood Frequency Analysis

An annual maximum lake water level series was developed from the long-term water balance model, assuming a water year spanning from October to October. The annual maximum series was used in the Flike software to complete a FFA of the lake water level.

A Log-Pearson Type III curve was fitted to the modelled data, with the assessment censoring all water levels below a ~1 in 10-year (10%) AEP flood event. Although the curve provided a reasonable fit to the observed flood level data, it was noticed that there appears to be a step change in the flood elevation data between 1 in 100-year AEP event and the 1 in 200-year AEP event.

A summary of the FFA results is provided in Table 4.3, which indicates both the Expected (best estimate) Flood Depths and the 90th Percentile Confidence Level Flood Depths. The results indicate that a 1 in 100-year AEP (1%) flood depth in the lake is predicted to be 315.08 mRL. This compares with the 1% AEP 2D model flood estimate of 314.5 mRL from a 72-hr storm event.

Table 4.3 FFA Results – Flood Depth Recurrence Interval

AEP (1 in Y)	Expected Flood Depth (mRL)	90%-ile Flood Depth (mRL)
5	312.85	313
10	313.51	313.6
20	314.06	314.2
50	314.67	314.9
100	315.08	315.3
200	315.46	315.7
500	315.92	316.2
1000	316.24	316.6

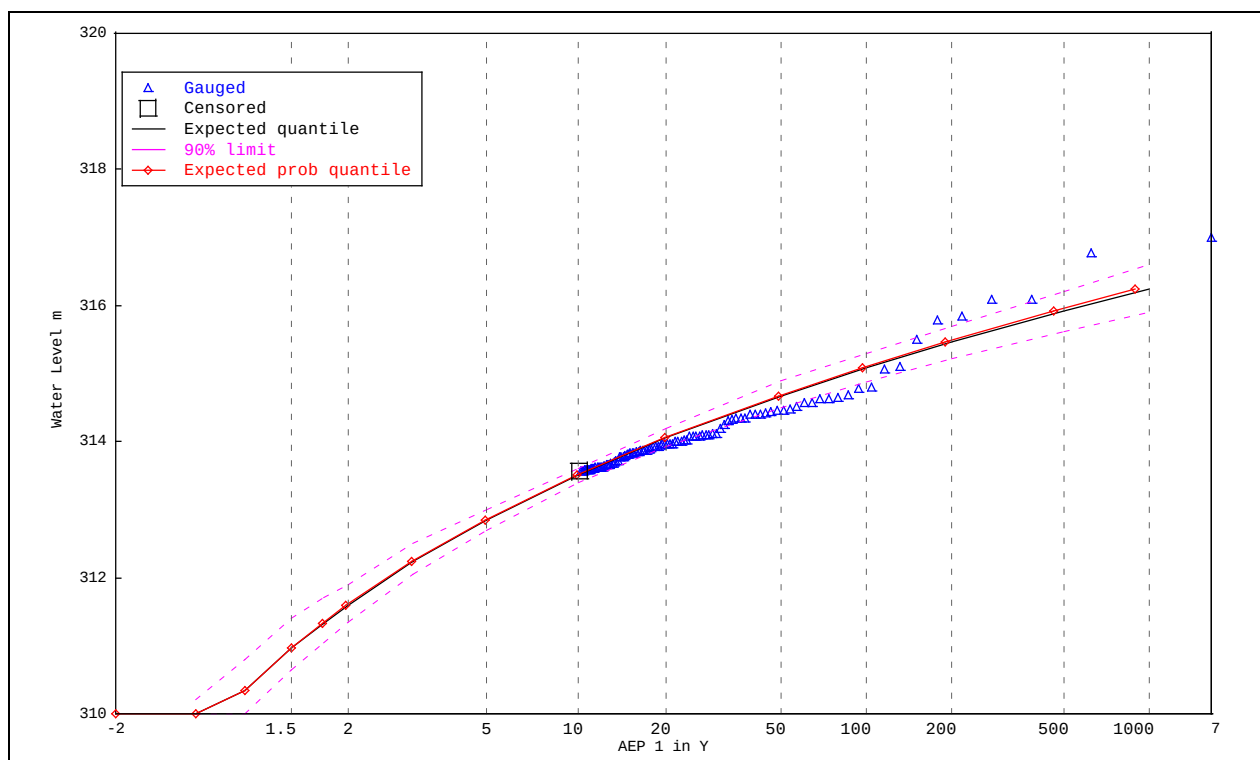


Figure 4.5 Flood Frequency Analysis – Log Pearson Type III

4.3 Discussion

Based on the FFA results of the water balance model predictions (and the initial 2D flood model predictions) the Project Area appears to be at risk of flooding, and a flood protection bund is likely to be required to prevent flood ingress to the Mining Area. To protect the Project from flood ingress, a flood bund around the Mining Area will be required. The flood protection bund will need to span the length of the L8 lake section, which may stop water from transferring across L8. The assessments completed above do not consider the potential for variable water levels on either side of the Mining Area.

4.4 Water Balance Limitations

The following main limitations should be noted with respect to the water balance approach:

- Calibration of the model assumed that the rainfall measurements at Cowarna Downs represented rainfall patterns at Lake Roe. The SILO Cowarna Downs data is interpolated between 2010 and 2024, such that the rainfall during that period is less likely to be representative. This is likely the reason for the model not being able to replicate water level observations during this period.
- The model assumes that rainfall intensity is even across the full catchment area of Lake Roe. Given the large catchment area reporting to the lake, this is unlikely to occur during a real storm. Some catchment areas would receive more rain than others.
- The logic within the model simplifies what is a complicated hydrological process and adopts common rainfall loss parameters across all catchments, even though it is likely that the runoff responses from different catchments would differ.
- The “observed” lake inundation levels were based on a subjective assessment of satellite images and NDWI data derived from the satellites. It is difficult to estimate the extent of inundation within the lake accurately from these images and observed inundation levels do not generally coincide with when the peak water levels in the lake would have occurred. It is assumed that the observed water level at a point in the lake represents the water level across the full lake extent (even though this is unlikely at shallow inundation depths).
- The response to a rainfall event within the water balance is immediate, whereas in reality, runoff from the catchment may continue to drain to the lake for a number of days after the rainfall event.
- Any impacts of increased salinity within the ponded lake water on evaporation loss rates has not been accounted for within the model.
- A constant seepage loss rate has been applied within the model. Potentially, the rate of seepage may be elevated at higher inundation depths due to increased pressure (depth) head at the lakebed and the likelihood of higher permeability sediments along the banks of the lake.
- As discussed above, the water balance model does not account for any potential impact of the mine development across the lakebed on the lake flood levels. A further 2D model assessment has been completed (refer below) to estimate the potential impact of the Mining Area encroachment on the flood levels on either side of the Mining Area.

5. FLOOD PROTECTION ASSESSMENT

The lake water balance assessment of Lake Roe flood levels has assumed that the flood water within Lake Roe will distribute across the lake areas to a common elevation unimpeded by the Project development. To protect the Mining Area footprint from inundation, a flood protection bund will be required around the perimeter of the Mining Area. The flood protection bund would span the length of lake area L8 and has the potential to cause different flood levels on the west and east sides of the Mining Area. A 2D flood model with the Mining Area blocking the L8 section of the lake has been completed to assess the potential flood depths (and therefore the flood protection bunding requirement) in more detail.

Note that the flood levels at Kopai / Crescent would be unaffected by the Bombora development across the L8 lake area.

5.1 Flood Model Assessment

The Baseline 2D HECRAS Flood Model was modified to raise the elevation of the terrain within the Mining Area to create the effect of blocking the ability for water to transfer across the L8 section of the lake. The flood model was run for both the 1% AEP and PMP rainfall events to identify the potential flood levels within the L8 part of Lake Roe.

The “Post-Development” model build and hydraulic inputs to the flood model were identical to the Baseline flood model, except for the raised terrain within the Mining Area and the requirement for additional break-lines around this terrain modification.

The results from the Post-Development flood model indicate the following:

- During the 1% AEP rainfall event, the maximum flood level is predicted to remain at approximately 314.5 mRL on the eastern side of the Mining Area, consistent with the Baseline flood model water level predictions across Lake Roe (refer Figure 5.1 and Figure 5.2).
- The predicted maximum flood level on the western side of the Mining Area is 315.5 mRL during the 1% AEP rainfall event (in the order of 1 m higher than the predicted Baseline flood level from the 2D model).
- When flood levels on the western side of the Mining Area are predicted to reach 315.5 mRL, water from the western side of the Mining Area is predicted to flow around the southern side of the Mining Area footprint and report to the eastern side of the lake (refer Figure 5.3). For surface water to flow around this southern path, a series of small dunes needs to be overtopped, with the crest of these dunes at approximately 315.0 mRL.
- The predicted maximum flood depth following a PMP rainfall event does not change from the Baseline scenario (319.6 mRL). The model predicts that lake flood levels will be sufficient for water levels on either side of the Mining Area to equilibrate the maximum flood depths by flowing around the southern side of the Mining Area.

Note that these results represent the flood depths in Lake Roe following a 1% AEP rainfall event and do not necessarily represent the 1% AEP flood level. The Baseline 1% AEP flood levels for the lake have been determined using a FFA of the lake water balance model results (as discussed in Section 4). Based on the results of the FFA and the 2D model results outlined in this section, the following levels have been adopted as the 1% AEP flood levels within the lake:

- West side of the Mining Area within Lake L8: 315.5 mRL. This has been derived from the Post-Development 2D model flood results.
- East side of the Mining Area: 315.1 mRL. This has been derived from the FFA of the water balance results.
- Flood level in L2, where the Kopai and Crescent pits are located: 315.1 mRL. This has been derived from the FFA of the water balance results.

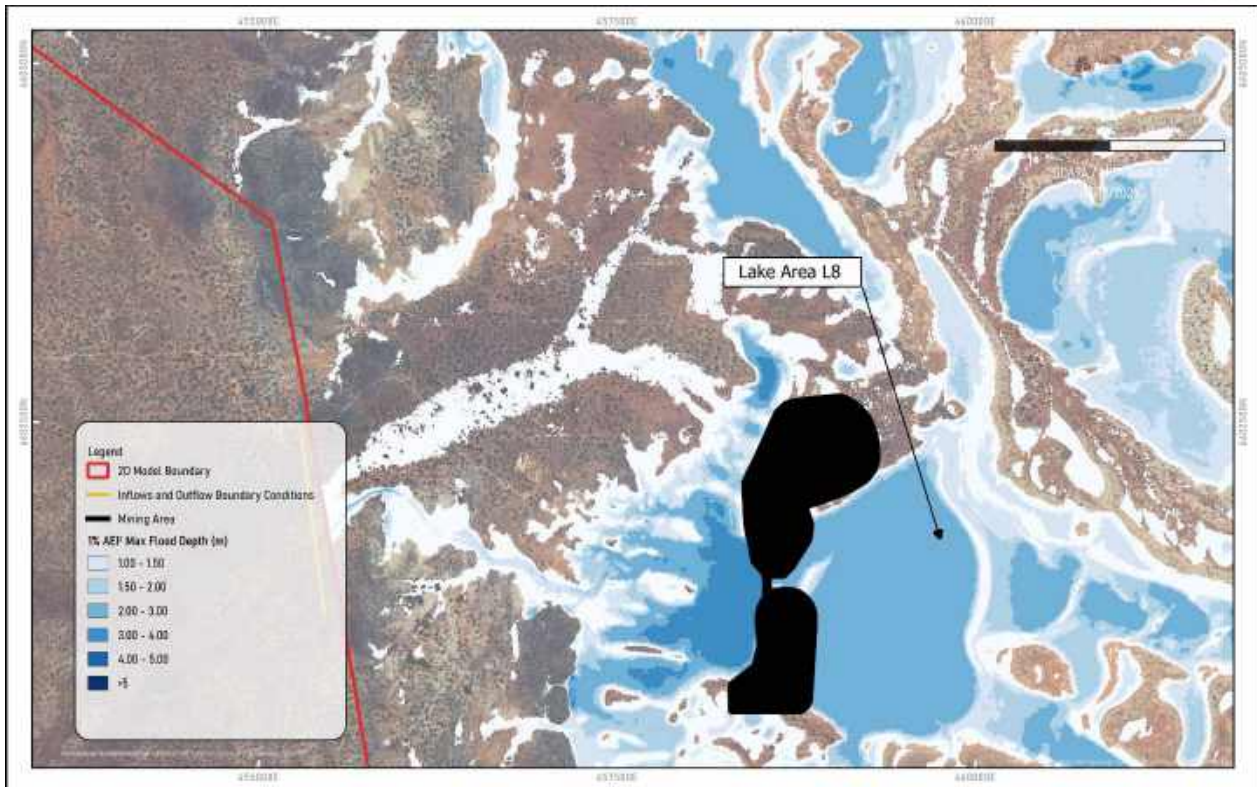


Figure 5.1 Post-Development Scenario Maximum Flood Depth (1% AEP Event)

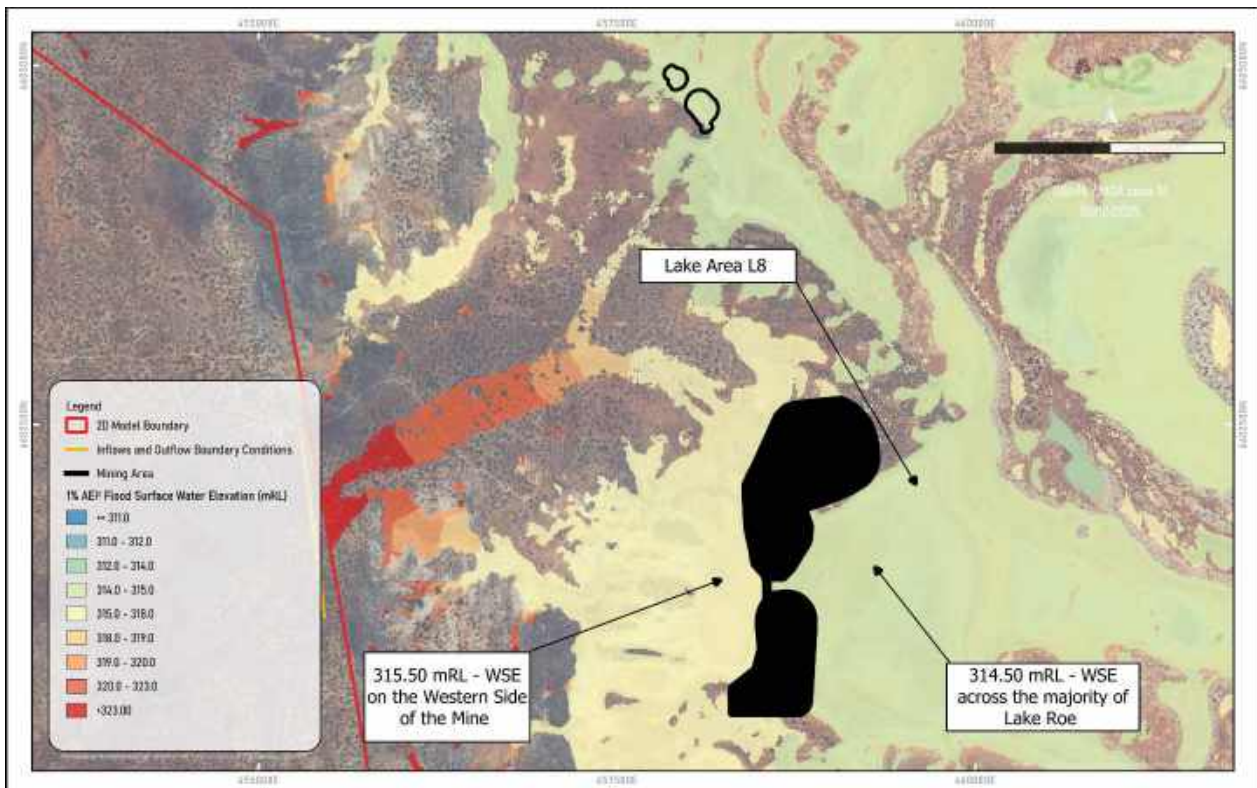


Figure 5.2 Post-Development Scenario Maximum Water Surface Elevation (1% AEP Event)



Figure 5.3 Runoff Draining Around the Mining Area

5.2 Flood Protection Bund

A flood protection bund will be required to protect the Mining Area from potential flooding within Lake Roe. The flood protection bund would be required to be installed around the perimeter of Mining Area where the existing ground surface is below the predicted flood level. It is recommended that the flood protection bund is designed to protect the Mining Area from a 1% AEP flood event (which has a 10% chance of occurring over a 10-year mine life). A profile plot of the ground surface elevation around the perimeter of the Mining Area is shown in Figure 5.4 for the reference chainages shown in Figure 5.5.

Given the uncertainty in the assessments completed, plus the potential increased flood water results as a result of wave action and wind layout, a minimum freeboard of 1 m is recommended for the flood protection bund above the predicted flood levels. Therefore, the flood bund crest elevation is recommended to be 316.1 mRL on the eastern side of the Mining Area and 316.5 mRL on the western side of the Mining Area.

The crest elevation of any flood protection bunding around the Kopai/Crescent pits would be recommended to be 316.1 mRL.

Ramelius could consider the following further management measures to reduce the crest elevation on the western side of the Mining Area to 316.1 mRL:

- Installation of culverts beneath the haul road crossing the lake could be installed to assist equilibrate the flood levels on either side of the Mining Area.
- Construction of a diversion drain around the southern side of the Mining Area by removing sections of the intermediate dunes to create a flow path between the west and east.

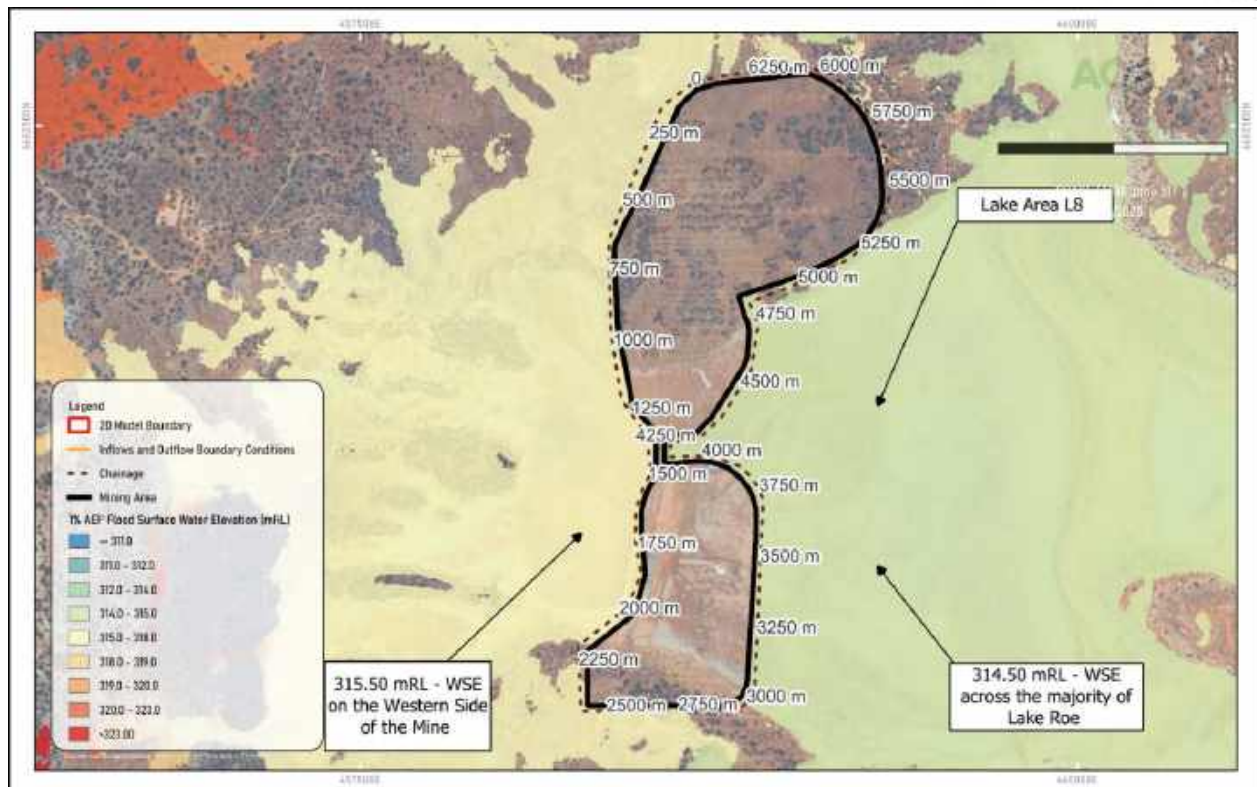


Figure 5.4 Profile Chainage

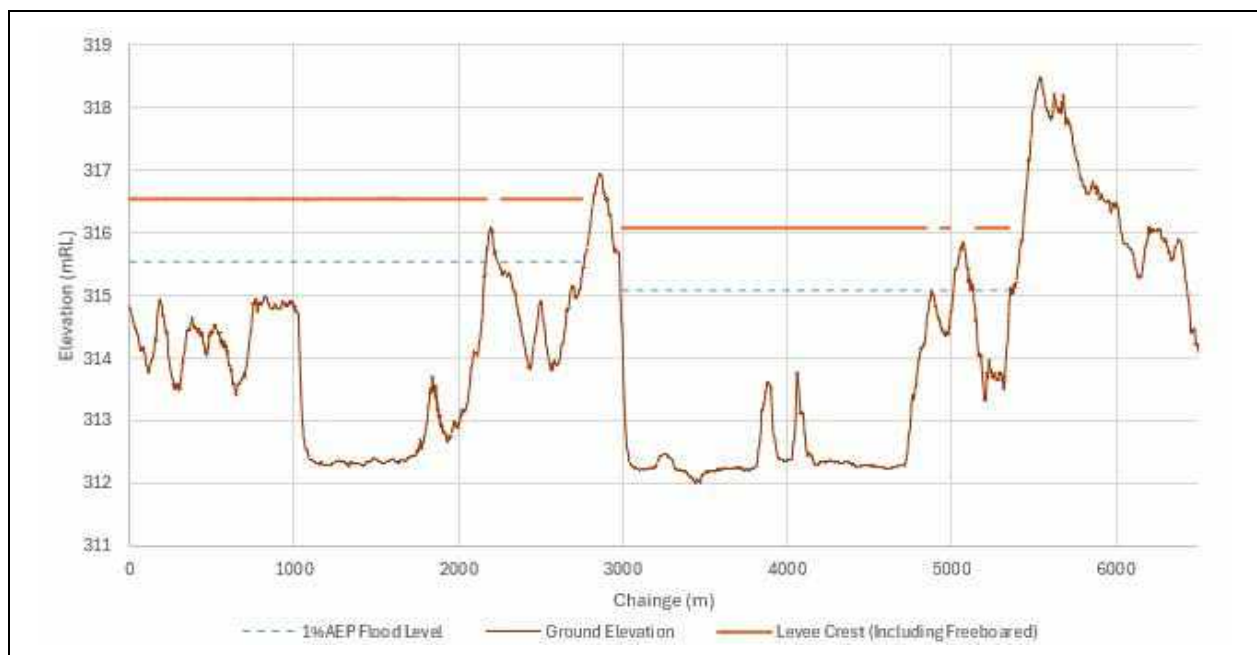


Figure 5.5 1% AEP Flood Profile around Mining Area

5.3 Other Considerations

In addition to the risk of flooding to the Mining Area due to flooding of Lake Roe, localised catchment runoff may also impact the broader Project Area. A map showing the localised natural flow paths within the Project Area is provided in Figure 5.6, with flow paths overlying the 1% AEP Baseline flood model predictions.

The main drainage path through the Project Area is due to runoff conveyed from Catchment K2, a sub-catchment to Catchment K. The full catchment area of Catchment K is shown in Figure 5.7, with the main drainage path from Catchment K (sub-catchment K1) reporting to Lake Roe to the west of the Project Area. However, flood modelling has indicated that during large flow events, there is the potential that sub-catchment K1 overtops and would contribute flow to Catchment K2. The 2D flood model predicts that in the order of $\sim 10 \text{ m}^3/\text{s}$ may contribute to K2 in the 1% AEP event, with no flow contributing to K2 in smaller runoff events. The amount of flow which may contribute to K2 from K1 is sensitive to model parameters and therefore a nominal allowance for $20 \text{ m}^3/\text{s}$ of flow from this catchment in the 1% AEP event is recommended to be made in the design of any surface water management measures.

Design flow rates from Catchment K2 at Point A (refer Figure 5.6) have been estimated using the Regional Flood Frequency Procedure (RFFP) method (Flavell 2012) and are shown in Table 5.1, which includes the additional $20 \text{ m}^3/\text{s}$ allowance in the 1% AEP event for overflow from Catchment K1. From Point A, the dominant flow direction for Catchment K runoff is in a southeast direction through the laydown area. Runoff is predicted to report to a number of small salt pans within the Project Area footprint.

To manage these flow rates, the following could be considered:

- Diversion of Catchment K2 to the north upstream of Point A (where there is already a potential breakout flow path to the north).
- Diversion along the northern side of the Laydown area to the northern salt pan.
- Management of flows through the Laydown area and to the Settling Pond, with flow through or around the Settling Pond to report to the salt pan to the south of the Settling Pond.

Table 5.1 Catchment K2: Design Flow Rates

Storm Event	Flow [m^3/s]
50% AEP	0.3
20% AEP	1.0
10% AEP	1.9
5% AEP	3.1
2% AEP	4.8
1% AEP *	26.7

* Also includes $20 \text{ m}^3/\text{s}$ inflow from Catchment K1

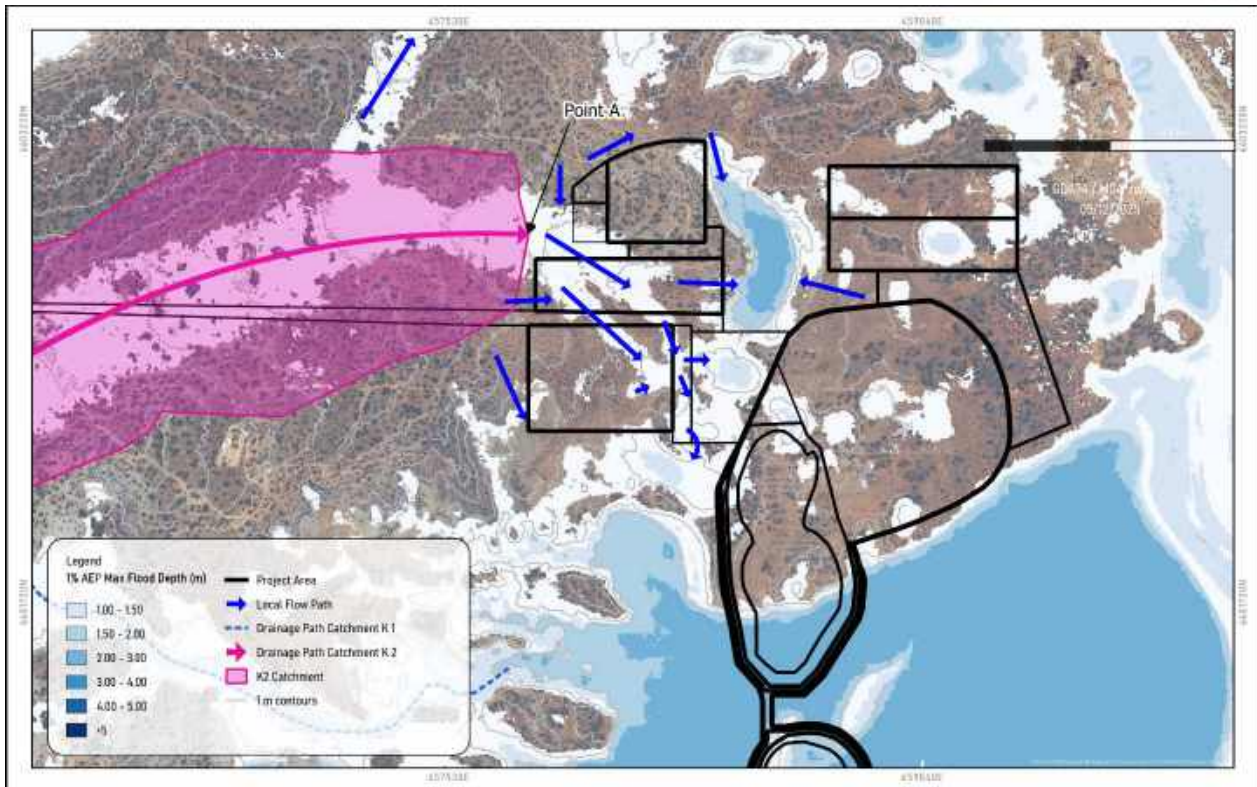


Figure 5.6 Project Area: Localised Drainage

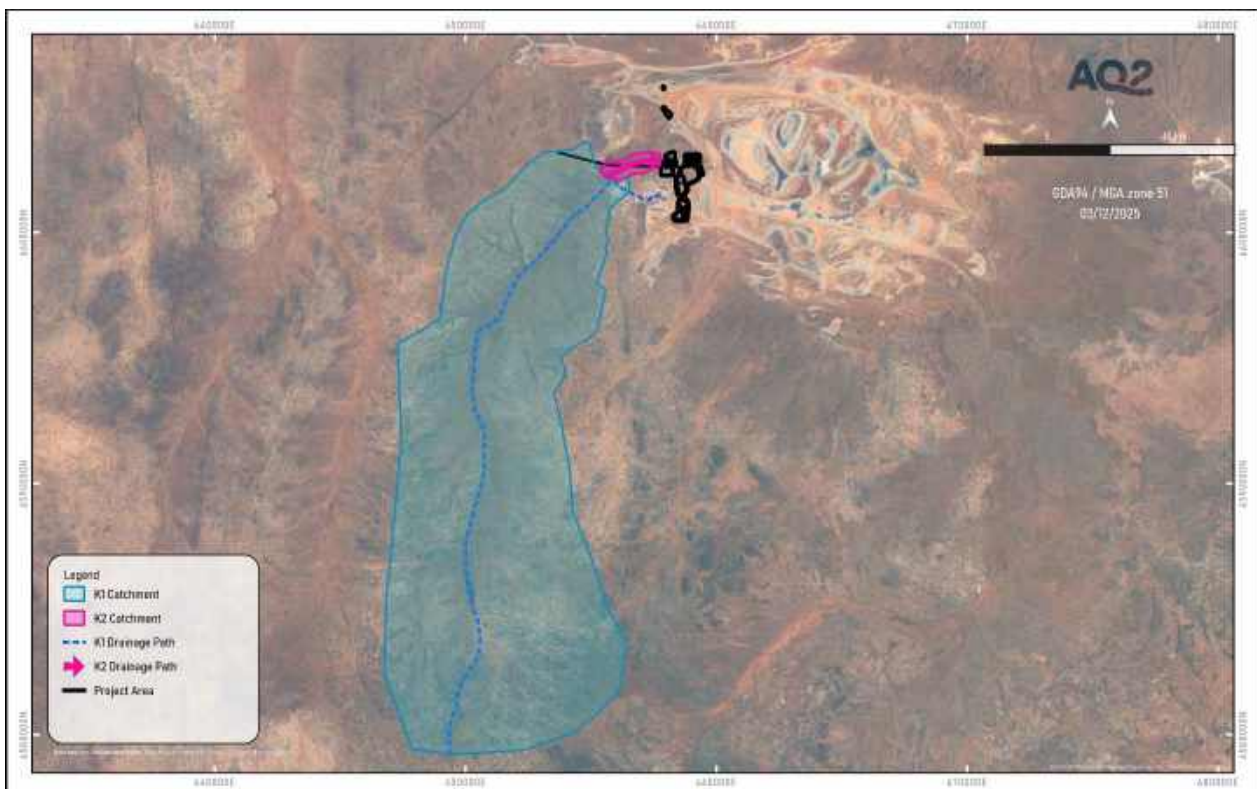


Figure 5.7 Catchment K Extents

5.4 Closure Considerations

Post closure, the largest hydrological risks are related to the potential for preferential drainage pathways to occur into the pit void which could fill in preference to the lake. If a flood protection bund is required to prevent inflow from a PMF event into the pit voids, it is recommended that the bund crest elevation be set at 319.6 m RL.

The layout of the post-closure bund could be different to the operational flood protection bund. For closure, it is recommended that separate bunds protect the southern and northern pit areas. Not only will this reduce the material required to construct the bund, by constructing separate bunds a passage for surface water to flow between the pit footprints and equilibrate flow levels across the lake will be provided.

2D flood modelling was completed for a scenario where a gap between the north and south pit is provided, with a nominal gap of 50 m or 100 m. The model results predict pre-mining flow velocity in Lake L8 of around 0.1 m/s in a 1% AEP event. Flow velocities in the lake through the passage between the pits are predicted to be 1.0 m/s for the 100 m gap and 1.2 m/s for the 50 m gap. This represents a tenfold increase over baseline conditions and is therefore an increased potential for erosion of the lakebed in this area post-closure.

6. EVAPORATION PONDS

The Project proposes to use evaporation ponds to manage the potential surplus water that may be generated during mine operations due to pit dewatering requirements. During mine operations, the dewatering generated will be used to meet mine water demands as a priority, with any remaining dewatering directed to the evaporation ponds.

A hydrogeological assessment to estimate the potential dewatering requirements for the Bombora project was completed by AQ2 (AQ2 2025). The assessment predicted that groundwater inflows to the open-cut pit and underground mine workings would increase as the mine develops, reaching up to 15 L/s at peak. Inflows are predicted to be approximately 5 L/s during the first two years of mine development, increasing to 5–10 L/s in years three to four and 10–15 L/s from year five onwards.

The evaporation ponds will contain hypersaline dewatering discharge, and a freeboard allowance on the ponds is required to be determined to reduce the likelihood of the ponds overtopping in the event of a large, rare rainfall event occurring during operation.

The following assessment estimates the evaporation pond surface area required to manage discharge throughout the different stages of mine development.

6.1 Methodology

A simple water balance calculation was completed using a monthly calculation time-step to account for seasonal variations in evaporation rates and the resulting changes to pond water storage. The water balance assumes the only inflows to the evaporation pond are the dewatering discharge and the only losses are evaporation and, in certain cases, seepage into the underlying ground.

6.2 Assumptions for the Water Balance Calculations.

The following assumptions were made when completing the water balance assessment of the required evaporation pond for different rates of surplus discharge:

- The Morton's shallow lake evaporation rates from SILO, as outlined in Section 2.1, were used for losses from the evaporation ponds' surface area. A nominal reduction to the evaporation rates was applied to reflect likely reduced evaporation rates due to the likely high salinity of the dewatering discharge. A multiplier of 0.9 was nominally applied to reduce the evaporation rates.
- Two different seepage rates from the base of the evaporation pond were modelled (0 mm/day and 3 mm/day).
- For each monthly simulation timestep, the water balance calculates the change in pond storage volume by adding inflows (dewatering discharge) and subtracting evaporative losses and seepage losses, enabling the progression of storage levels to be tracked throughout the simulation period.

6.3 Results and Discussion

The water balance calculations were completed for a range of surplus discharge rates in increments of 5 L/s. Table 6.1 Evaporation Pond Area by Operational Stages summarises the estimated evaporation pond areas required for a range of discharge rates, and varying seepage rates.

Table 6.1 Evaporation Pond Area by Operational Stage

Discharge Rate Flow [L/s]	Seepage Rate 0 mm/day	Seepage Rate 3 mm/day
5	115,000 m ²	65,000 m ²
10	150,000 m ²	100,000 m ²
15	220,000 m ²	150,000 m ²
20	300,000 m ²	200,000 m ²

The following observations are made:

- Pond sizes in the order 65,000 m² to 115,000 m² would be required during initial stages of the project.
- Area of the ponds would need to increase to up to 220,000 m² for the largest surplus water rates over the life of the project.
- Seasonal variability in evaporation causes annual fluctuations in evaporation pond water levels of approximately 0.5 m (i.e., for a constant inflow rate, water volumes would be higher during winter compared to summer). If the evaporation ponds were required to maintain sufficient freeboard to house the direct rainfall on the ponds from a 72-hour 1% AEP design rainfall event, a minimum of 300 mm of operational freeboard is required to be maintained in the ponds over and above the storage levels (refer to Section 2.2.2).

7. SUMMARY

AQ2 has completed a flood assessment of Lake Roe to define flood risks and flood protection requirements for the Bombora Project. A summary of the work completed and findings is as follows:

- Hydrological models for three representative catchment areas reporting to Lake Roe were developed to estimate representative hydrographs for inflow to the lake for 20%, 1% and PMP rainfall events. Nominal rainfall hyetographs were used to develop the hydrographs on the basis that the peak flow rate estimated within the hydrograph was less important than the volume of water reporting to the lake.
- The representative hydrographs developed were scaled by relative catchment area to develop lake inflow hydrographs for all catchments reporting to Lake Roe.
- A 2D flood model for the lake area was prepared and run for the 20%, 1% and PMP rainfall events. The 2D flood model results were used to identify flow behaviours within the lake and to conceptualise how the lake fills during flood events to guide the development of a lake water balance model. The 2D flood model estimated a PMF level in the lake of 319.6 mRL.
- A water balance model was prepared for Lake Roe, which involved:
 - Dividing the lake into 9 separate sub-lake areas, each separated from other lake sub-areas but with its own dedicated stage/volume/area curve.
 - Developing a “calibration” rainfall sequence and a long-term synthetic rainfall sequence for use in the model.
 - Reviewing satellite images to estimate past flood levels to allow calibration of the model.
 - Using lake seepage loss estimates which were made during previous assessments to estimate losses from through the lakebed following inundation events.
 - Sourcing SILO evaporation data which should be representative of evaporative losses from a shallow lake.
 - Creating a rainfall loss function to simulate volumetric runoff from the catchments to the lake following the simulated rainfall sequences. The parameters defining the rainfall loss function were selected to ensure that the “calibration” model run approximated the inundation extents estimated from the satellite imagery.
 - Running the model with the calibrated rainfall loss parameters to produce predictions of runoff over a 1,000-year period.
- The predicted peak water levels from the water balance model were used for the basis of a flood frequency analysis (FFA). The FFA provided estimates of flood levels within the lake at different recurrence intervals. The predicted flood depth within the lake for a 1% AEP (100-year ARI) event was estimated to be 315.08 mRL.
- The proposed Bombora mine development blocks flood water from being able to be distributed across the L8 portion of Lake Roe, such that flood levels on the western side of the development may differ from the flood depths estimated by the FFA. A post-development 2D flood model was prepared to estimate the flood levels on the western side of the development. The flood model estimated the flood level to be 315.5 mRL for a 1% AEP event.
- Based on the assessments, flood protection bund elevations to protect the Bombora Mining Area during mine operations were recommended to be 316.1 mRL on the eastern side of the development and 315.5 mRL on the western side to provide protection from the 1% AEP event (including freeboard allowance).

- The post-closure landform is proposed to include a gap between the northern and southern parts of the Bombora development which would allow flood depths to equalise between the western and eastern parts of the L8 portion of Lake Roe (and therefore reduce the flood protection bund requirements). The flow velocities through the proposed channel have the potential to be significantly higher than what the lake bed would naturally experience and the potential erosive consequences of this should be considered when designing the post-closure landform.

8. REFERENCES

AQ2 2025, Roe Gold Project: Bombora Hydrogeological Dewatering Assessment, unpublished report prepared for Ramelius Resources. AQ2 document number 514F_033c, issued September 2025.

Bureau of Meteorology (BOM) 2016. Design Rainfall Data System [Online Resource: <http://www.bom.gov.au/water/designRainfalls/revised-ifd>

Flavell, D. 2012, "Design flood estimation in Western Australia", Australian Journal of Water Resources.

Australian Rainfall and Runoff (ARR) 2019, Book 8: Estimation of Very Rare to Extreme Floods, Chapter 4.3.4.3.

Knight Piesold-Lake Rebecca Gold Project Tailings Storage Facility and Associated Infrastructure Pre-Feasibility Study Surface Water General Arrangement Plan (Lake Roe Mining Area). Report Number: PE801-00402/03. Figure 9.3.

APPENDIX A
LAKE ROE HYDRAULIC BEHAVIOUR DESK STUDY

Memo

To	[REDACTED]	Company	Ramelius Resources
From	[REDACTED]	Job No.	514C
Date	09/12/2024	Doc No.	010b
Subject	Lake Roe Hydraulic Behaviour Desk Study		

[REDACTED]

Please find below our assessment of the ponding behaviour in the vicinity of the proposed Roe Mining Project.

1. BACKGROUND

Ramelius Resources' proposed Roe Mining Project is located in the Goldfields Region of Western Australia, approximately 100 km due east of Kalgoorlie and circa 45 km southwest of the Rebecca Gold Project. The Project is proposed to consist of the Bombora open-cut pits and underground mine, and Kopai Crescent open-cut pits. Both proposed mining areas are proximal to Lake Roe, with the pit footprint extending partially over the Lake Roe basin.

As part of the assessment for potential pit dewatering requirements, Ramelius has asked AQ2 to complete following:

- Characterise the ponding within Lake Roe with respect to frequency and duration of inundation.
- Estimate potential seepage rates from the lake to the underlying groundwater during ponding events.

To understand the hydrological behaviour at Lake Roe, the following was completed:

- Climate characteristics such as daily rainfall, evaporation, and temperature data were defined.
- Inundation events were identified from satellite imagery between 1993 and 2024.
- Inundation events and rainfall records were correlated to identify the climate drivers for inundation.
- Areas which are prone inundation were identified.
- Seepage analysis for the salt pans for different inundation events.
- Potential discharge location(s) for surplus dewatering were assessed, by estimating the rate at which ponded water can lose water to evaporation at different locations.

In addition to this assessment, the following additional works are being completed and will be reported separately:

- Dewatering inflow assessment to the proposed mine pits.
- 2D flood model of Lake Roe to simulate ponding locations and flood distribution throughout Lake Roe from different runoff events.
- A Lake Roe water balance model to estimate flood levels for different design recurrence intervals.

2. CLIMATE

Nearby rainfall, evaporation and temperature climate data were assessed to aid in characterising Lake Roe's hydrological behaviour. The climate data used for this analysis was obtained from the Scientific Information for Land Owners project (SILO) (Jeffrey et al. 2001), as it provides temporally complete daily climate parameters from 1889 to the present, for any location in Australia to the closest 0.05° latitude/longitude (decimal degrees). SILO compiles all valid data for the input location and spatially interpolates, patches, and calculates long-term averages from nearby raw observational data to provide a complete dataset.

SILO data from Cowarna Downs station (BOM Station ID 12220) was considered the most representative analogue of the climatic conditions of the Lake Roe area based on proximity and observed data availability. The station is situated 40 km southwest of Lake Roe's centre (refer Figure 2.1), with rainfall records available between 1970s to 2010. A SILO rainfall dataset was obtained between 1970 and October 2024.

It was noted the Cowarna Downs station SILO dataset:

- Likely best represents Lake Roe's rainfall for 1970–2010, when actual measurements were taken at the weather station.
- Rainfall data outside these years would be interpolated from nearby stations and is likely to be less representative of Lake Roe catchment's rainfall.
- Used SILO's interpolation techniques to derive temperature and evaporation values as this was not recorded at the Cowarna Downs station. The nearest station this data was recorded was at Kalgoorlie 110 kms away.

The closest long-term weather station to the Lake Roe Project Area where rainfall has been recorded is Karonie weather station (BOM Station ID 12041), located approximately south-south-west 25 km away from Lake Roe's centre point; however, there are no observed data from 1990s onwards. Gindalbie station (BOM Station ID 12247), located 95 km northwest, has the largest timespan of observed data, but it was considered too distant to be a realistic analogue of Lake Roe's weather conditions. This weather station had recorded rainfall peaks which were greater in magnitude than Karonie and Cowarna Downs.

A summary of the Cowarna Downs station SILO dataset is as follows:

- Grid reference for the Cowarna Downs station location: -31.00933 degrees south and 122.35564 degrees east.
- Spanned period of 1970s to October 2024.
- Long-term average annual rainfall of 260.7 mm.
- Annual average Class A pan evaporation rate of 2,420 mm and an annual average Morton's shallow lake evaporation rate of 1,560 mm (from SILO interpolation at Cowarna Downs).
- Long-term average maximum temperature of 26 °C.
- Monthly average rainfall, Class A pan evaporation, Morton's shallow lake evaporation, maximum and minimum temperature (1970–2024) as shown in Figure 2.3.

The installation of a weather station at the site would be useful to provide site specific data for rainfall, evaporation and wind speed and direction.

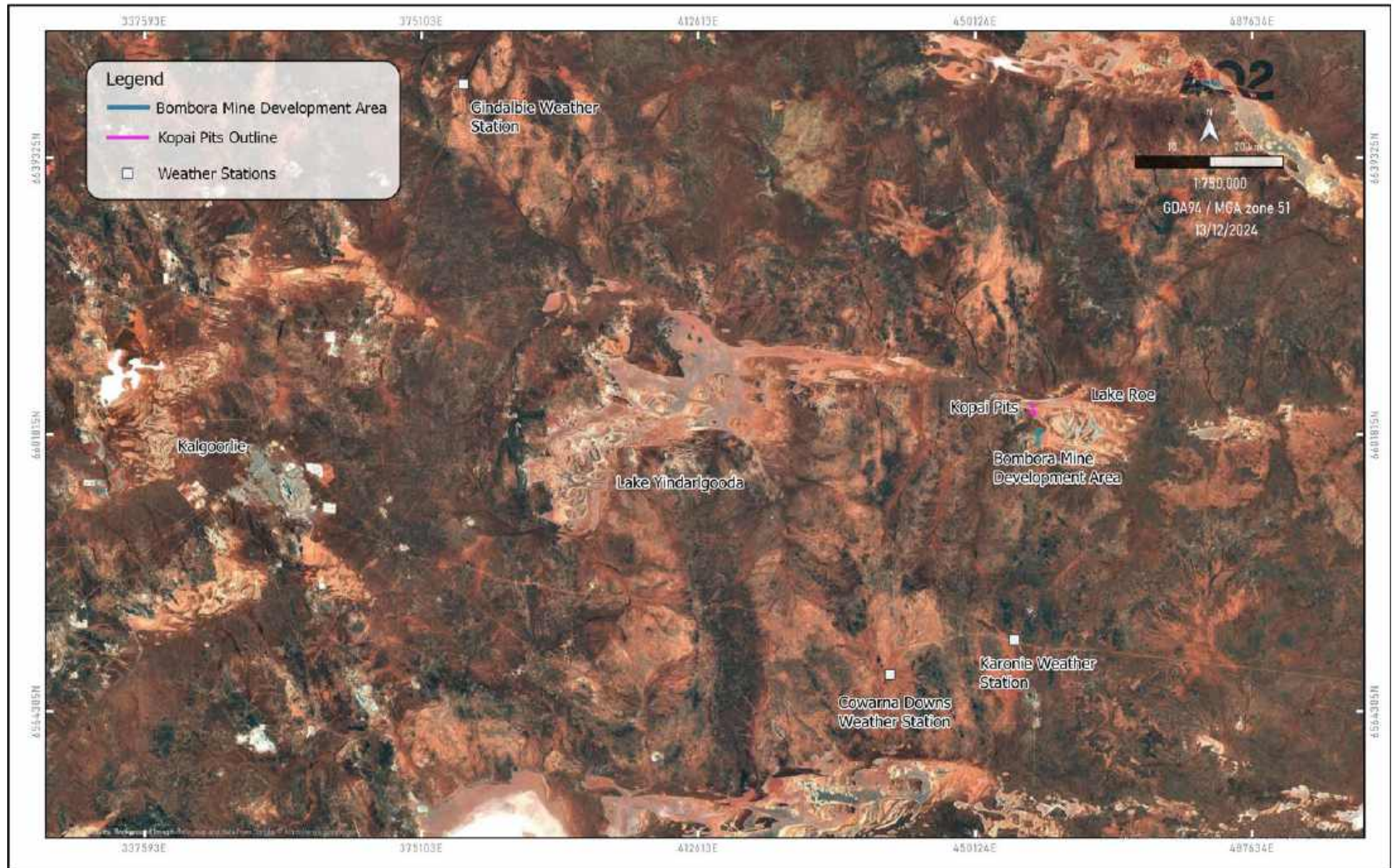


Figure 2.1 Regional Map of the Eastern Goldfields, including Lake Roe, Cowarna Downs, and Kalgoorlie

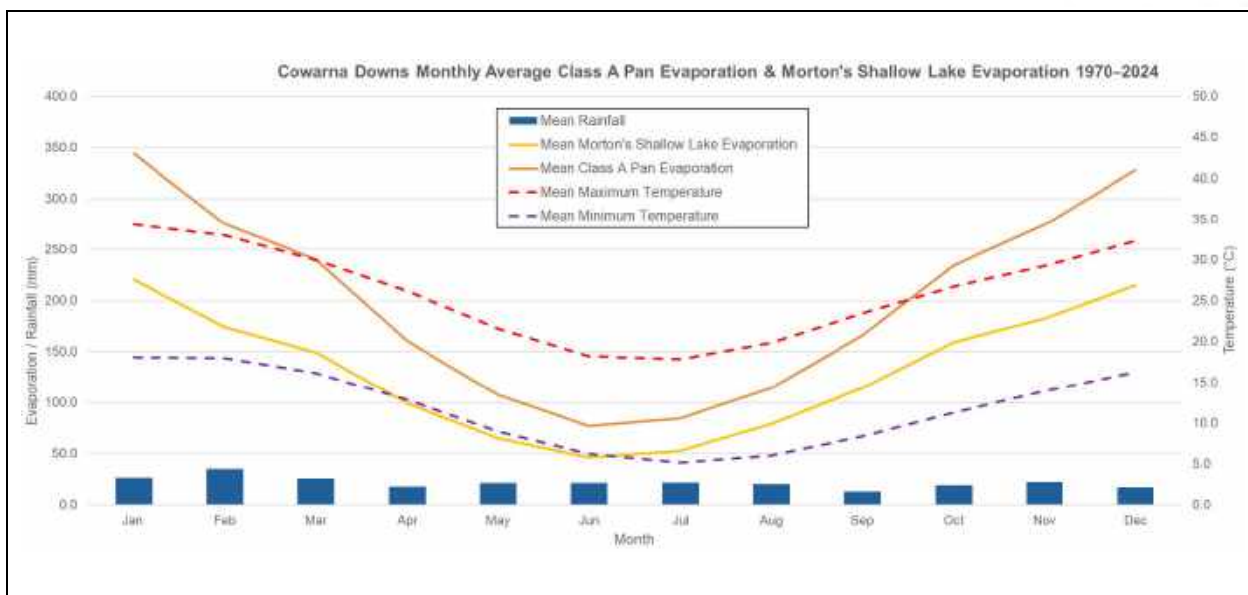


Figure 2.2 Cowarna Downs Monthly Average Climate Characteristics (1970–2024)

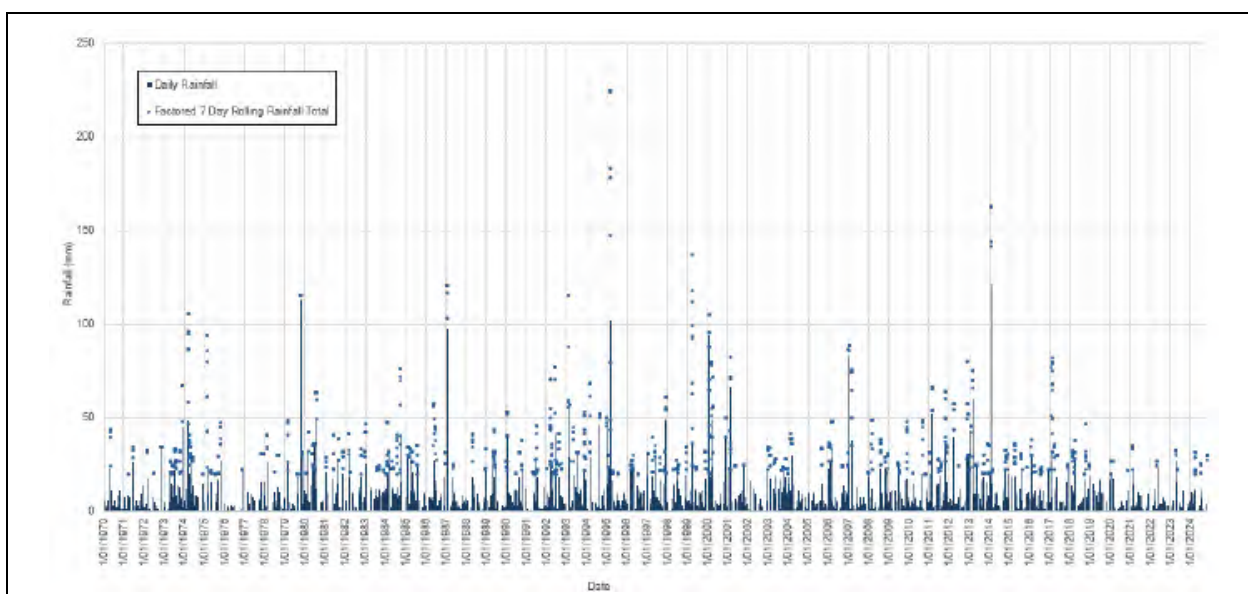


Figure 2.3 Cowarna Downs Rainfall Metrics (1970–2024)

3. SATELLITE IMAGERY ASSESSMENT

The Lake Roe inundation extents and frequency were estimated between 1993 and 2024 using satellite data, specifically true colour imagery and Normalized Difference Water Index (NDWI) data from Sentinel, Landsat and Google Earth. Data availability and aerial image quality varied considerably throughout the 1990 to 2024 study period. The inundation extents were compared to the Digital Elevation Model (DEM) of the lake to estimate ponding depths with time.

As shown in Figure 3.1, Lake Roe consists of a series of small salt pans that appear to be separated by (relatively) high points, some of which appear to be sand dunes, based on assessment of aerial imagery and LiDAR surface elevation data. Each of the small salt pans have a local low point where water may pool.

Figure 3.1 denotes the nominal names used within this study for some salt pans relevant to the assessment. The main catchment reporting to the lake comes from the western side of the lake, with other, smaller catchments reporting to the lake around the lake perimeter. Following large enough inflow events, the individual salt pans may become hydraulically connected.

Confidence in the estimated inundated depths (from observed satellite imagery) varies, and the date of recorded imagery may not coincide with the date of the actual peak inundation extent. Frequent Sentinel data between 2017 and 2024 provides the most reliable period for analyses. Between 2013 and 2017, Landsat (satellite) data are inconsistent with some gaps due to Lake Roe's eastern area falling on a different tile without imagery and satellite imagery strips (Landsat 7) giving an incomplete picture. Pre-2013, imagery from Landsat is less frequent, with data pre-2008 missing for extended periods and/or has insufficient resolution to confidently interpret. Notably, there is a Landsat data gap from late 2011 to early 2013, meaning that any lake inundation due to rainfall events during 2012 are not estimated.

3.1 Inundation Observations

The following observations were made at Lake Roe during the satellite imagery assessment:

- Catchment runoff responses causing at least some inundation in Lake Roe were generally observed when rainfall exceeded approximately 25 mm.
- In small inundation events where widespread flooding across the full lake is not prevalent (i.e., following rainfall depths in the order of 25 mm), the water levels Pan A were estimated. Appendix A presents the estimates of inundation water levels from satellite observations within salt pans B and D for reference.
- Visible widespread inundation across constituent salt pans was typically observed when a rainfall event occurred over multiple days, with total rainfall over the event exceeding 50 mm. Widespread inundation due to a large, singular rainfall day event could not be concluded as there were not any events where daily rainfall exceeded 50 mm within the rainfall data, notwithstanding this may be possible.
- The magnitude of inundation (water level) can vary between constituent salt pans; however, when widespread inundation is observed, the timing of the inundation is generally consistent across the lake.
- Rainfall in early 1995 and 2014 presents the largest rainfall events within the observation period, and these correlated with observations of large inundation events.
- Inundation responses in Lake Roe were generally observed 1 to 3 days after initial rainfall was recorded (noting that satellite observations are not available on a daily basis).

There is a level of uncertainty when correlating satellite observations and rainfall recorded at Cowarna Downs given the distance between the weather station and the lake. Rainfall is highly temporally and spatially variable in the Goldfields and it is likely the rainfall that occurs within the Lake Roe catchment differs from that recorded at Cowarna Downs. Larger events are likely to be more widespread than smaller events, but there is still likely to be a difference between the rainfall recorded at Cowarna Downs and the effective rainfall on the Lake Roe catchment (given the size of the Lake Roe and the Lake Roe, it is likely that rainfall will be variable over the catchment and lake as well). Given the limited spatial availability of rainfall records in the Goldfields, Cowarna Downs is still considered to best represent the rainfall that may have occurred within the Lake Roe catchment.

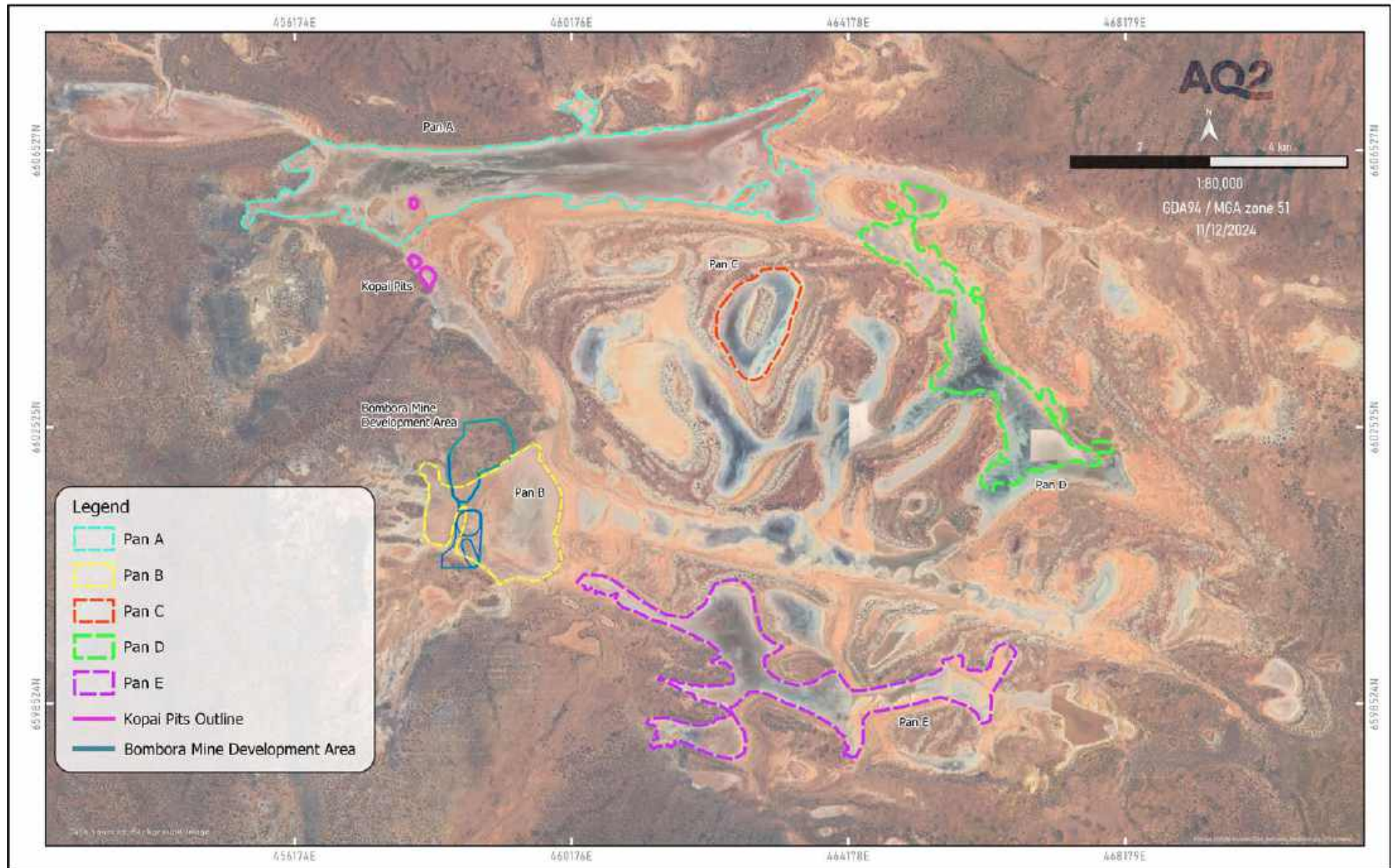


Figure 3.1 Lake Roe Study Area

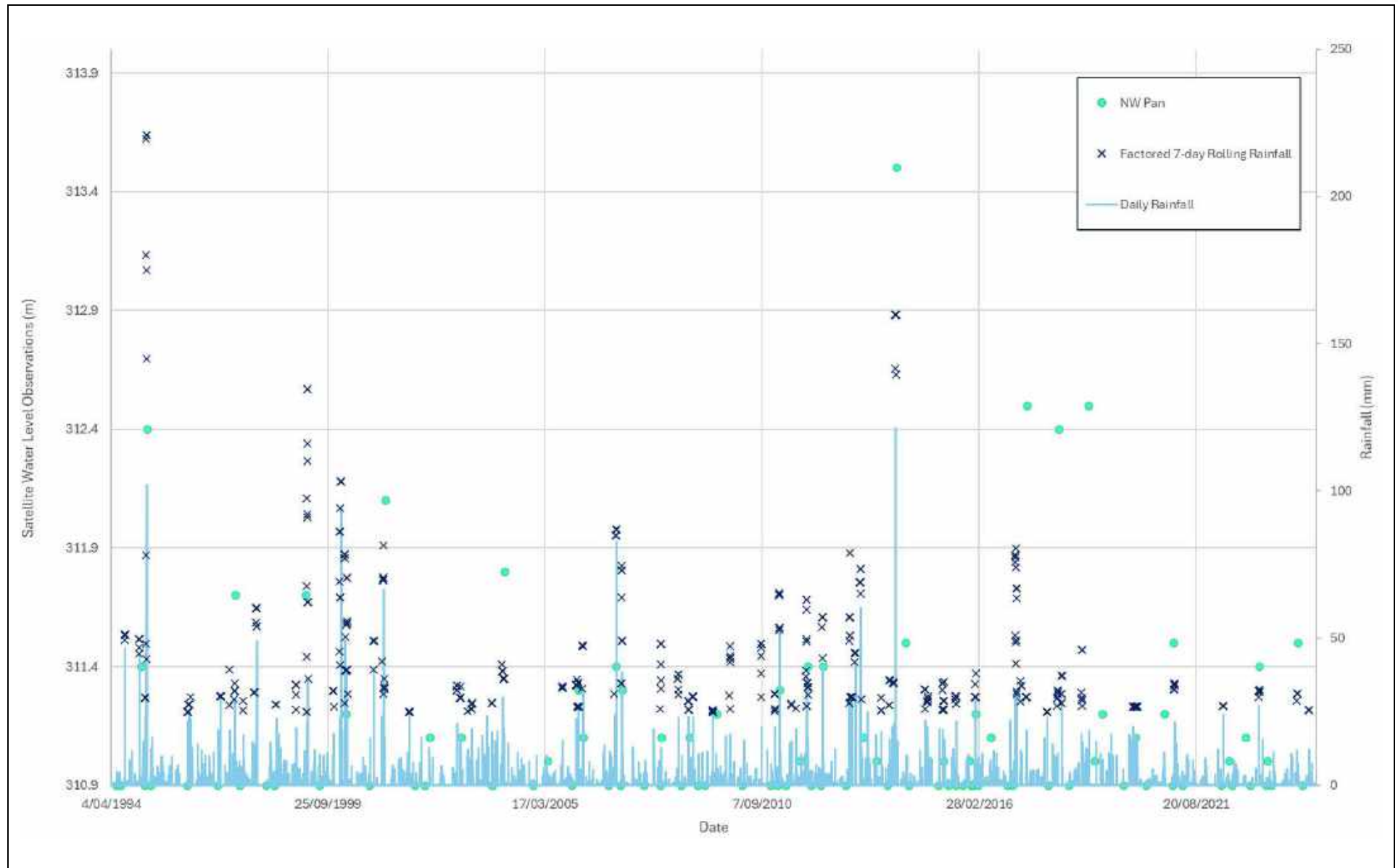


Figure 3.2 Lake Roe Inundation Depths (Pan A) vs Rainfall Data

3.2 Correlations to Intensity–Frequency–Duration (IFD) data

The observed rainfall events since 1993 were correlated with the available Bureau of Meteorology (BoM) intensity–frequency–duration (IFD) data for Cowarna Downs. The 63.2% AEP event (which approximates a large rainfall event which you would expect would happen every year) rainfall depths over 1–3 days of 31.1–38 mm (refer Table 3.1) correlates with the rainfall that results in smaller inundation events observed at Lake Roe in most years.

Larger, rarer rainfall events recorded typically since 1992 at Cowarna Downs (32 years inclusively), seemed to have occurred more frequently than the IFD data would suggest. This is shown in Figure 3.3, where factored rolling rainfall totals from the Cowarna Downs rainfall record are compared to the IFD curves. The plot indicates that, for example, there were 5 x 24-hr (1,440 minutes) duration rainfall events which exceeded the 5% AEP curve where it would be expected that ~2 events of this magnitude may occur in a 32 year period (noting the IFD curves presented do not account for climate change and are typically 10–15% less than what current climate conditions would suggest).

In the last 32 years, there were also 5–6 large inundation events observed in satellite imagery (equating to a 15–20% probability of occurring in a given year). Based on the IFD data, it would be expected that large inundation events would require more than 60 mm of rainfall to occur, which is close to what has been estimated from the inundation estimations (50 mm).

Table 3.1 Cowarna Downs intensity–frequency–duration (IFD) data

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
24-hour	1,440	31.1	37	58.6	76.2	96.1	125	150
30-hour	1,800	32.6	38.9	61.8	80.8	102	133	160
36-hour	2,160	33.8	40.4	64.5	84.5	107	140	168
48-hour	2,880	35.7	42.6	68.5	90.2	115	150	180
72-hour	4,320	38	45.5	73.7	97.5	125	163	195
96-hour	5,760	39.5	47.3	76.9	102	131	170	204
120-hour	7,200	40.5	48.6	79	105	134	174	209
144-hour	8,640	41.4	49.7	80.5	106	136	177	212
168-hour	10,080	42.1	50.5	81.6	108	137	178	213

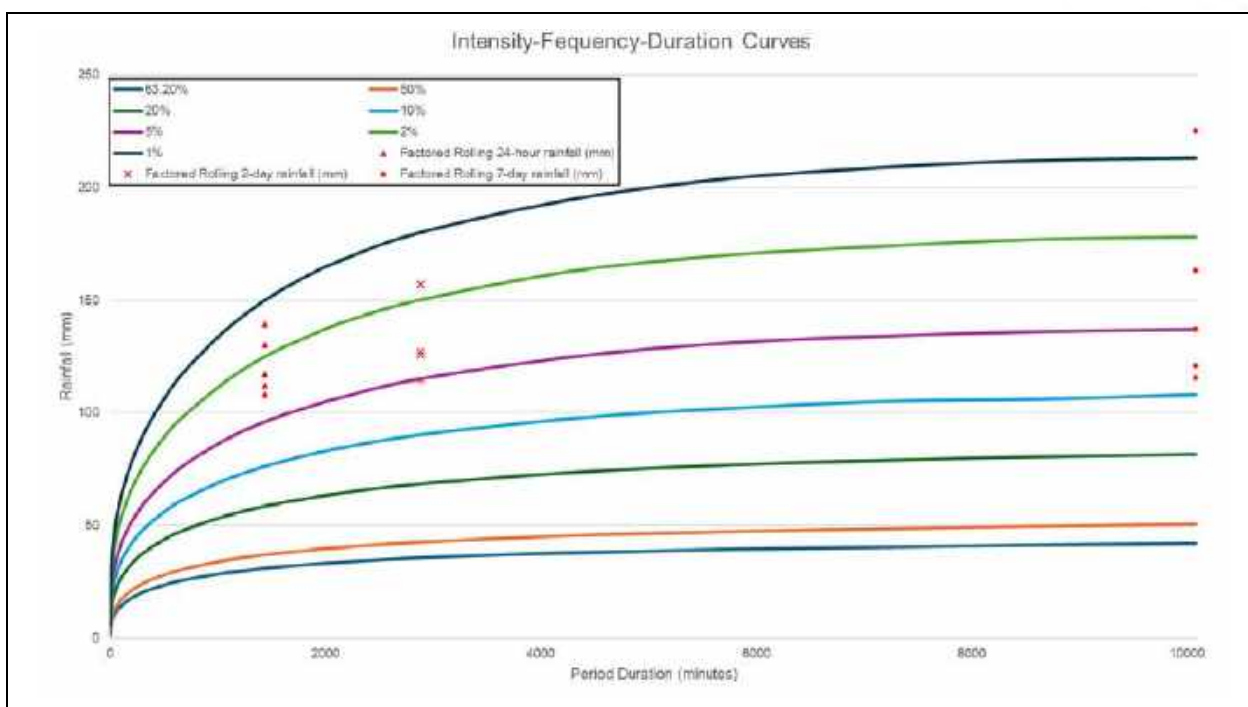


Figure 3.3 Cowarna Downs Intensity-Frequency-Duration (IFD) and Rolling Rainfall Data

4. SEEPAGE ASSESSMENT

Water level recession curves at Lake Roe were predicted following inundation events using a 1D water balance calculation and compared to the observed recession of standing water in the lake from the satellite imagery assessment. As shown in Figure 4.1, Figure 4.2 and Figure 4.3, three key inundation events were identified for assessment in years 1995, 2014 and 2017. The assessment was used to assess the potential seepage from the lake to the subsurface. During the circa 32 years period examined, Lake Roe hosted standing water for various lengths of time (typically in the order of months) after large rainfall events. The water level recession observed from satellite aerial imagery within Lake Roe is assumed to be driven by evaporation and (potentially) seepage into or from the subsurface; Figure 4.4, Figure 4.5 and Figure 4.6 show aerial true colour imagery of the May 2017 flood event's recession

The completed assessment is summarised as follows:

- A stage vs area relationship was derived for different salt pans from the provided LiDAR data.
- Satellite imagery was reviewed to identify periods of significant inundation within the salt pans, nominally years 1995, 2014 and 2017 were chosen as the best data for assessment.
- The inundation area within the salt pans was estimated during period that the lake level recedes when satellite imagery was available (typically in the order of weekly images, but many were unable to be used due to clouds, poor quality etc.).
- The stage area relationship was used to derive estimates of lake water levels with time during the recession period.
- A 1D water level balance calculation was completed using the following formula:

$$\text{Water Level} = \text{Water Level}_{\text{previous}} \mp \text{Rainfall} - \text{Evaporation} - \text{Seepage}$$
- The daily 1D water balance calculation used the following:
 - The water balance was set to start at the peak lake water observed following the rainfall event.
 - Daily evaporation losses from the lake in the 1D water balance calculation have been predicted using Morton's shallow lake evaporation estimates sourced from the SILO database for the site. These evaporation estimates vary on a daily basis based on meteorological observations.

- If a small rain event occurred during the water level recession period, the depth of rainfall was added to the running water level total. This assumed that no catchment runoff reported to the lake, with only incident rainfall on the lake surface reporting to the lake. If large rainfall events did occur during the recession, then the observations weren't used as the additional inflow would not be accounted for in the method prescribed above.
- A nominal seepage loss rate was applied and adjusted such that the modelled recession approximates the observed recession.

The seepage rate that enables water level predictions to approximate the observed recession of standing water within Lake Roe is approximately 3 mm/day. Noting:

- It was difficult to interpret when Lake Roe was completely dry in the satellite imagery due to image quality, partial (or full) cloud cover and the frequency of imagery capture. The appearance of a salt crust on the lake floor in satellite photography was determined not to be a reliable indicator of the entire lake system being fully dry, as, on occasions, these observations concurred with periods where NDWI imagery indicates standing water.
- It is interpreted that groundwater does not contribute to inflow into the Lake Roe, and surface water recession / periodic standing water within the claypan(s) is solely accounted for by evaporative losses and seepage.
- There is a degree of uncertainty in the evaporation losses applied and in the estimation of lake inundation depths. Additionally, there is uncertainty in what the rainfall which falls on the lake is compared to what was measured at Cowarna Downs.

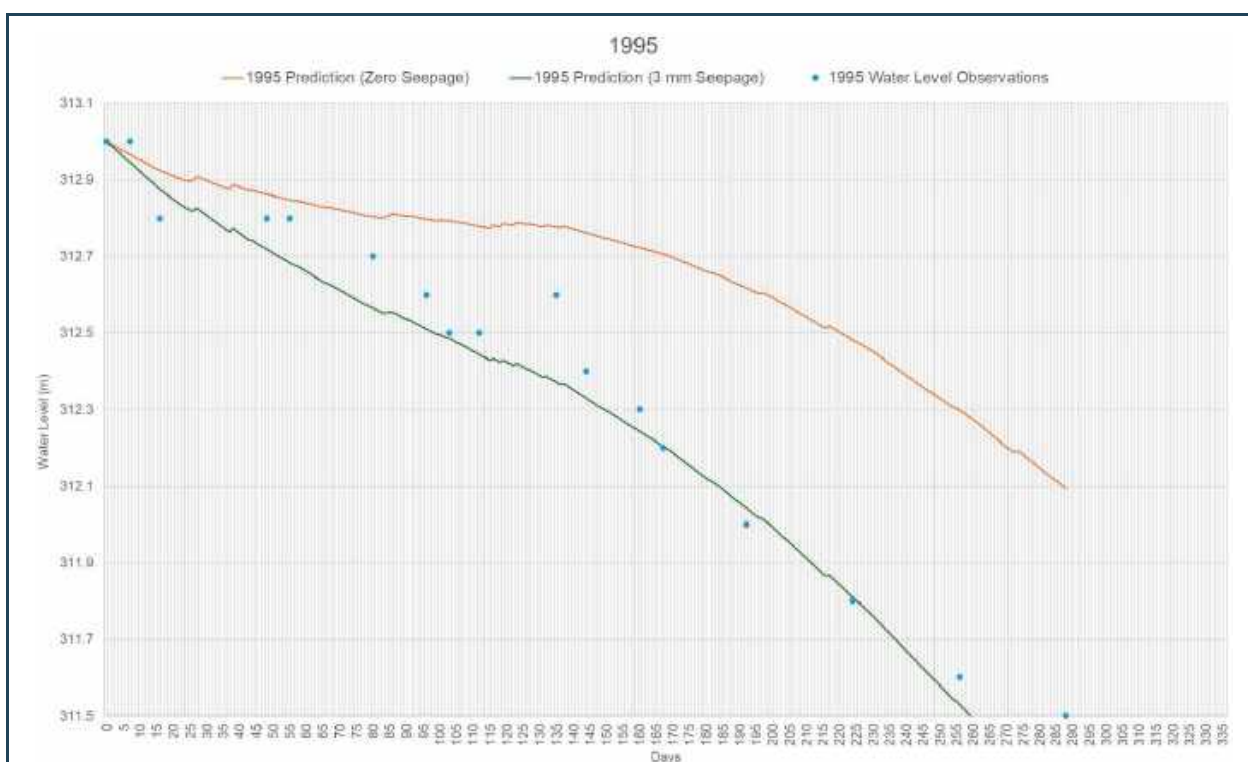


Figure 4.1 Observed vs Predicted Flood Recession Curves (March 1995)

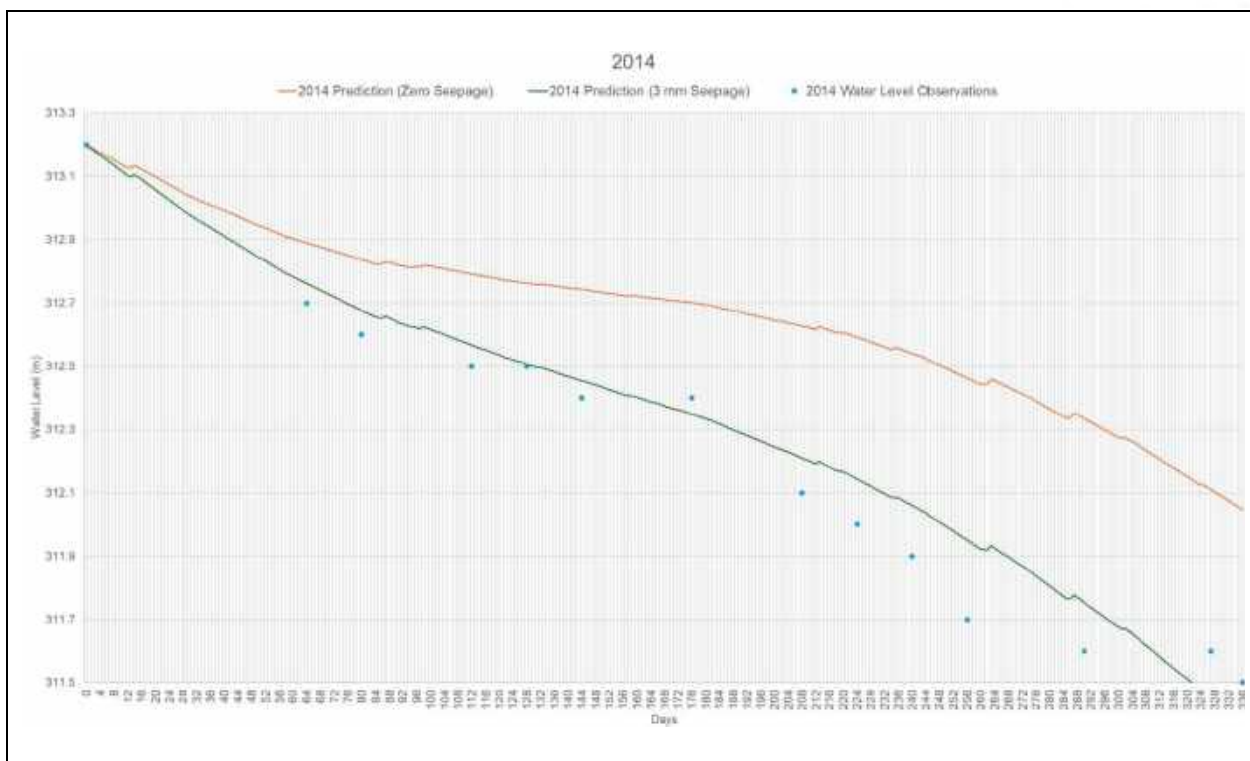


Figure 4.2 Observed vs Predicted Flood Recession Curves (January 2014)

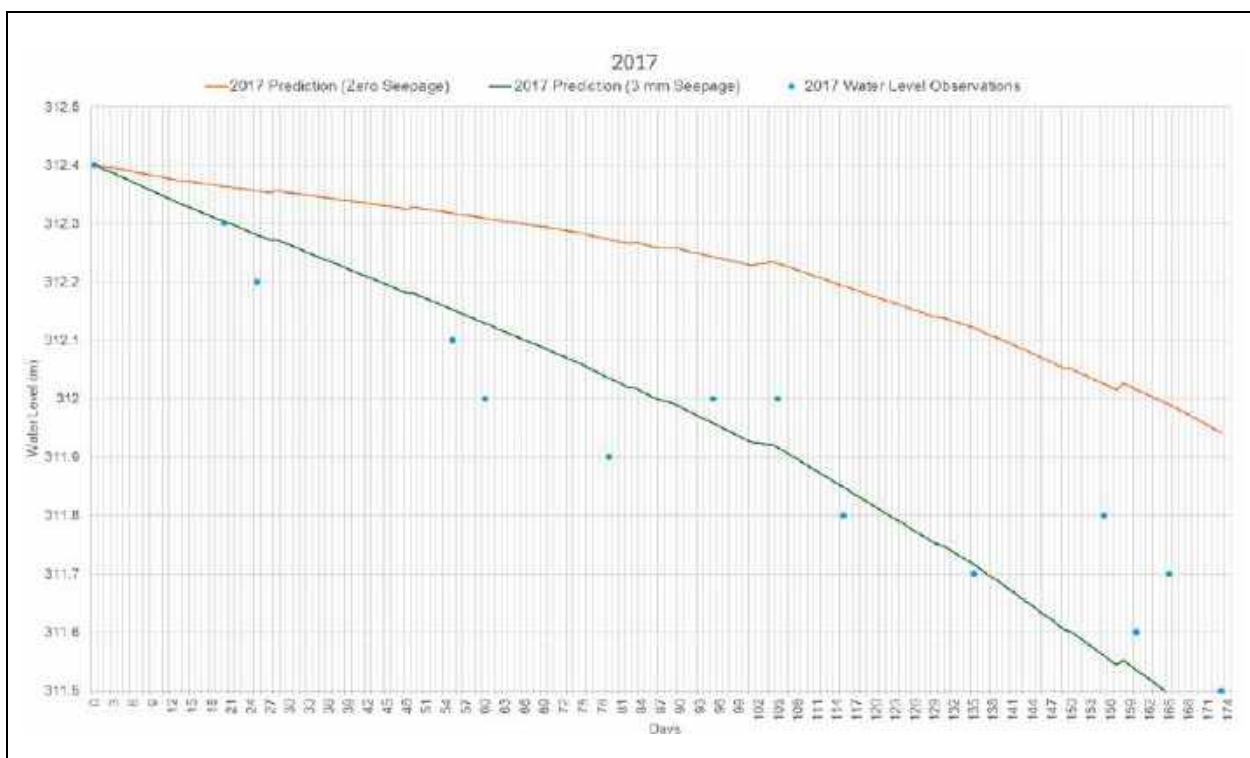


Figure 4.3 Observed vs Predicted Flood Recession Curves (May 2017)



Figure 4.4 True colour imagery for May 2017 flood event's peak inundation on 18 May 2017

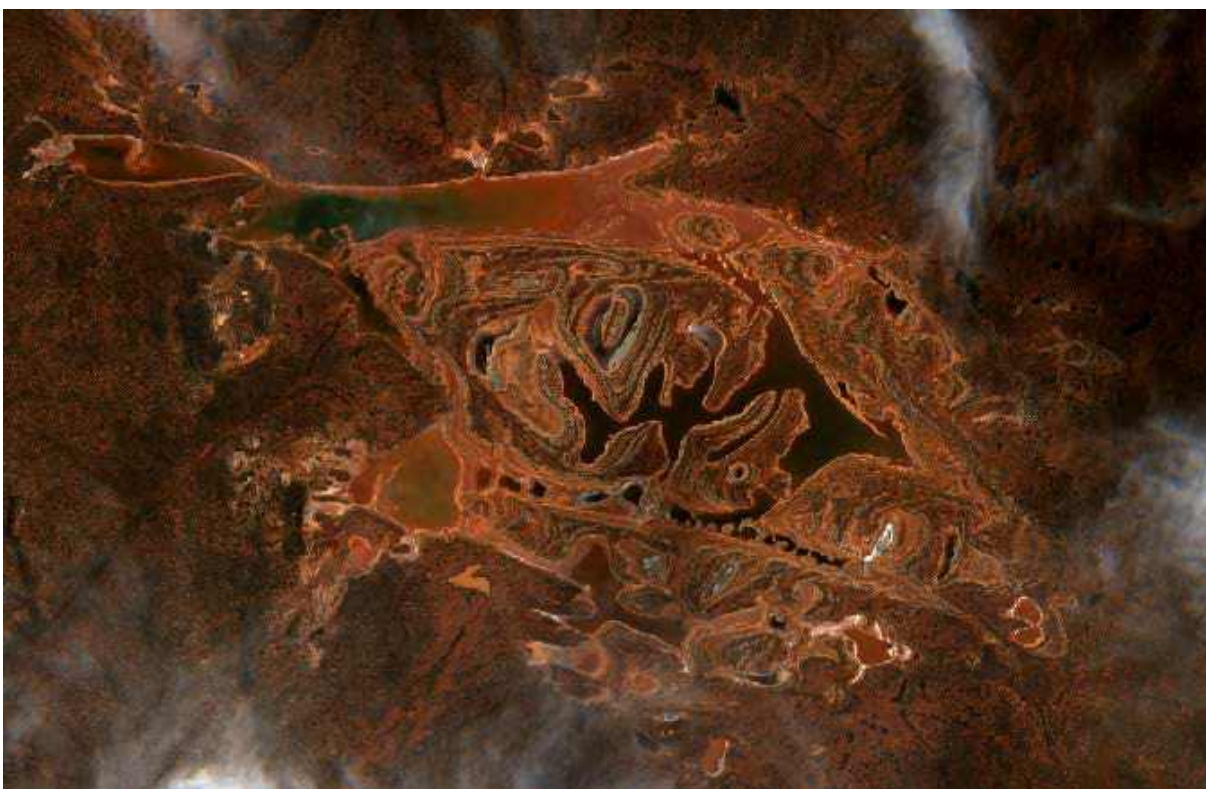


Figure 4.5 True colour imagery for May 2017 flood event's partial recession on 07 June 2017



Figure 4.6 True colour imagery for 30 October 2017 flood event – recession

5. POTENTIAL DEWATERING DISCHARGE LOCATIONS

A number of potential locations to receive surplus dewatering have been identified and are shown in Figure 3.1. These locations have chiefly been identified for their proximity to the project area. For each of the potential receiving salt pans, the following has been estimated using the DTM/aerial imagery:

- Maximum storage/inundation elevation – it is assumed that any salt pan could only be filled to either:
 - 0.5 m below the vegetated shoreline of the salt pan.
 - 0.2 m minimum below the point at which the salt pan overtops to the adjacent salt pan (to confine the impact to a single pan).
- Maximum inundation surface area of the salt pan at the maximum inundation elevation.
- Maximum inundation storage volume of the salt pan at the maximum inundation elevation.
- Evaporative loss from the maximum lake surface based on Morton's Shallow Lake Evaporation rate in July, with a nominal reduction in this evaporation rate of 30% adopted to approximate the impact the salinity of the dewatering discharge may have on the evaporation rates.
 - Note that higher evaporation losses would occur during other months, such that the estimates of loss rates are conservative. If there is sufficient balancing storage in the salt pan, the annual average evaporation rate could be applied (rather than the July evaporation rate).

A summary of these characteristics for each salt pan is provided in Table 3.2. The assessment assumes no ponded rainfall within the lake. The advantages / disadvantages of the identified discharge locations are as follows:

- Option A (Pan A) – This pan is close to the proposed Kopai Pit development and provides a large area for storage/evaporation of surplus dewatering. The main disadvantage of this option is that the largest surface water catchments to Lake Roe discharge into this salt pan, and there is the potential

that accumulated salt will flow into the downstream pans during large runoff events (i.e., the impact won't be contained to the one pan). Additionally, the discharge of dewatering to this lake may result in recirculation to the Roe Pits, given their proximity to the lake.

- Option B (Pan B) – This pan is close to Bombora Pit development and would contain the surplus discharge to a smaller area compared to Option A. Similar to Option A though, the southwest pan commands a significant upstream catchment, and there is therefore the potential for accumulated salts to be transported to salt pans to the east. Additionally, the discharge of dewatering to this lake may result in recirculation to the Bombora Pits, given their proximity to the lake likely via the Lake Roe N-S fracture zone
- Option C (Pan C) – There is a number of salt pans which appear to be hydraulically isolated from the remainder of Lake Roe by sand dunes, including a roundly shaped pan, the smallest of the four options. Additionally, a cluster of pans situated between Pan B and Pan D have been discounted due to limited volume, all individually smaller than Pan C. These are located further away from the mining areas than Option A and B but may allow impact to be localised to pan. The choice of pan could be based on the rate of dewatering that needs to be managed, with different potential evaporative losses achievable at each pan based on their available surface area. Pan C has been nominally assessed for this option.
- Option D (Pan D) – Pan D could be filled to a depth of approximately 312 mRL (refer Figure 3.1), which is 0.2 m below the elevation of the saddle which separates Pan A and Pan D, to isolate impacts from discharge to this pan. Option D is the pan most isolated and furthest from both the Bombora Mine Development area and Kopai Pits. Option D is the main pan at the most downstream part of Lake Roe.
- Option E (Pan E) – An initial review of Pan E was completed but a comparison of lake shore elevations to the overflow point between consecutive salt pans indicated that it wouldn't be feasible to discharge to one salt pan and fill multiple areas. As such, the available evaporation area for Pan E was too small to consider further.

Environmentally, Option C is the preferred option for discharge as it would isolate the impact of dewatering discharge to the isolation Pan C (subject to confirmation that Pan C has no environmental value which differs from the rest of the lake). However, Option C provides the lowest potential for ongoing loss from the ponded water due to evaporation.

If impact containment is not a priority for the dewatering discharge, Option A may be preferred as it has the highest likelihood of accumulated salt being washed downstream into other parts of the lake during runoff events.

Discharge to Pan D is the furthest discharge option so may be the highest capital cost for discharge, but the benefit is the ponded water is furthest from the mine voids so has the lowest chance of recirculation into the pits.

Further assessments of discharge locations should consider the likely magnitude and duration of discharges to the lake, as well as the potential storage volume in each of the considered discharge locations. A water balance of the pan area could be completed, considering the stage/volume/area relationship of each of the pan options, to predict how each of the pans may fill with time.

Table 5.1 Dewatering Discharge Options

Target	Invert RL	Shoreline RL	Overflow Point RL	Max Inundation RL	Area (km ²)	Loss Potential m ³ /day	Loss Potential l/s
Option A	310.9	313	312.2	312.0	7.1	8,500	98
Option B	311.6	312.6	312.4	312.1	2.5	3,000	35
Option C	310.7	313.5	313.6	313.0	1.1	1,000	16
Option D	311.5	313	312.2	312.0	3.1	3,700	43

6. SUMMARY

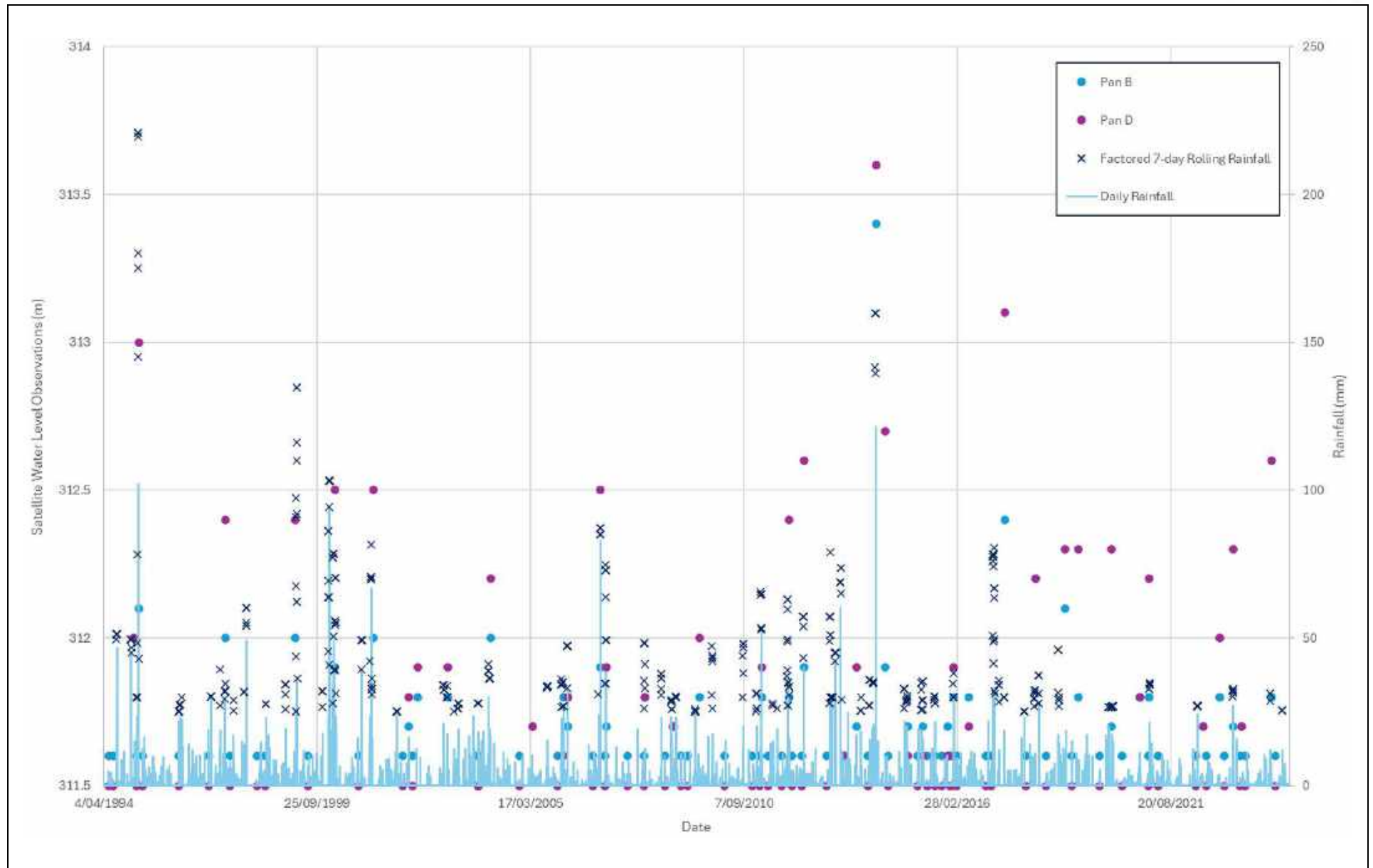
AQ2 has completed an assessment of available climate data sources for Lake Roe area, a satellite imagery assessment of inundation and other hydraulic behaviour, estimations of potential discharge volumes, and a seepage assessment. Key findings are as follows:

- Pan A, adjacent to Kopai Pits, has been observed to hold runoff in most years. Significant inundation is observed to occur in the order of once every 5 years.
- Following significant inundation events, the lake may hold water for months.
- Seepage rate analyses indicate that in the order of 3 mm/day of seepage may occur from the lake bed when it is inundated.
- Five locations were considered for the discharge of surplus water from the project. Environmentally, Pan C is considered the most favourable, as it would confine the discharge to a single part of the lake. However, Pan C has the smallest surface area and therefore the lowest potential to lose discharged water via evaporation (in the order of 15-20L/s).
- Option D is furthest from the project area and allows for the containment of discharge in the most downstream part of the chain of salt pans that make up the Lake Roe system.
- Further assessment work should be completed on the discharge options when surplus water magnitudes and duration of discharge are estimated.

We trust that this assessment meets your requirements. Please contact us should you require further information.

Author: SF/JS (06/12/2024)
 Checked: MN (06/12/2024)
 Reviewed: MN (06/12/2024)

Attached: Lake Roe Inundation Depths (Pans B and D)



Lake Roe Inundation depths (Pans B and D)



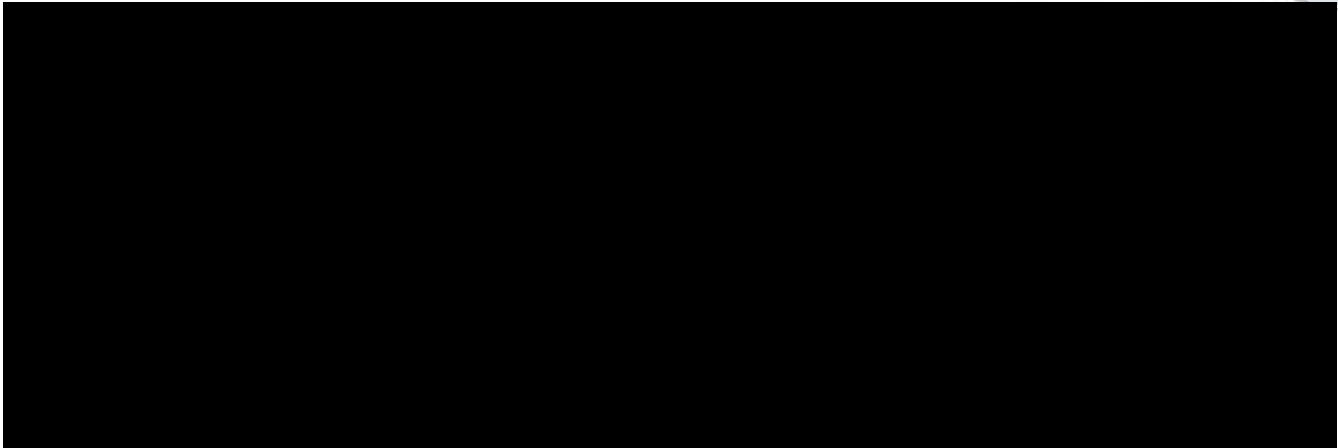
Bombora Project Lake Roe Flood Depth Assessment

Prepared for:

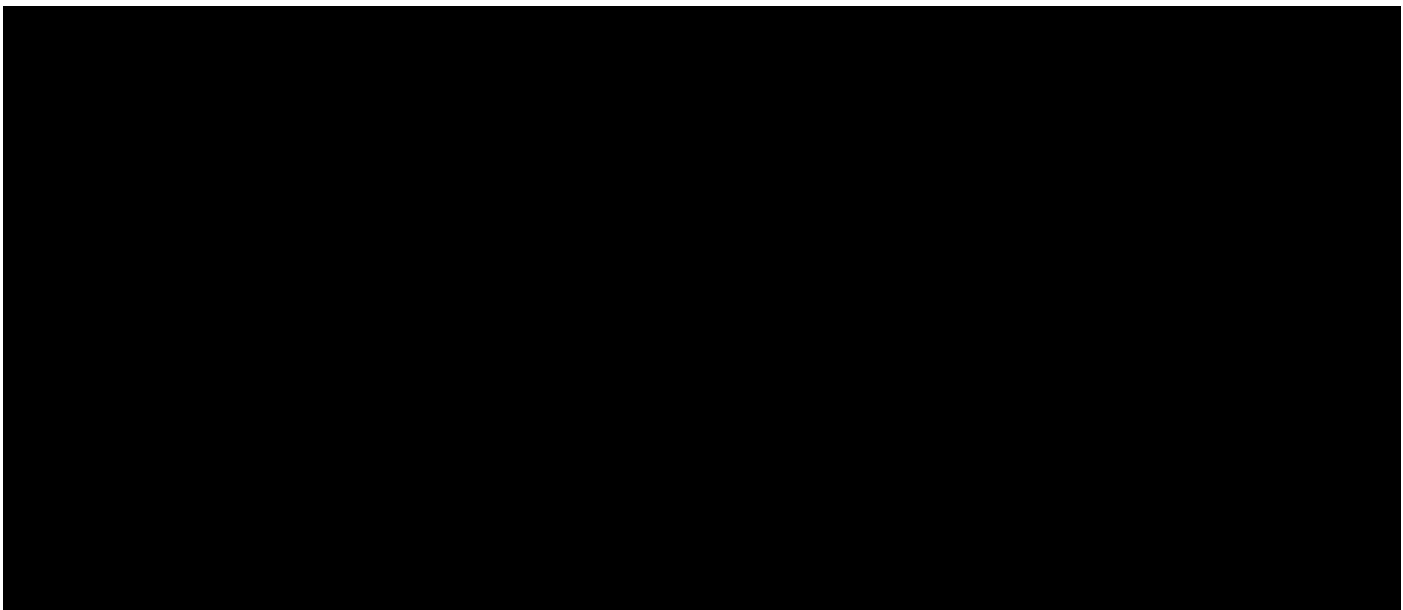
Ramelius Resources

April 2025

AQ2 Pty Ltd
Ground Floor, 1 Howard Street
Perth WA 6000 Australia
Tel +61 8 9322 9733
www.aq2.com.au



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1. BACKGROUND

The proposed Roe Mining Project is located approximately 100 km due east of Kalgoorlie and about 45 km southwest of Ramelius Resources' Lake Rebecca Project in the Goldfields Region of Western Australia (refer Figure 1.1). The Project is proposed to consist of the Bombora and (potentially) Kopai Crescent open cut pits. Both pits are located in proximity to Lake Roe, with the Kopai Crescent pit footprint extending partially over the lake basin. Both areas are likely to be prone to flooding from water ponding within Lake Roe following large rainfall events.

To reduce the risk of flooding to the pits from runoff within Lake Roe, it is likely that a flood protection levee will be required around the perimeter of the pit areas (at a minimum). The following assessment has been completed to provide estimates of the level of flood protection provided by different flood levee elevations by estimating flood inundation elevations for different flood recurrence intervals.

As part of the assessment to establish the elevation of the flood protection bund, AQ2 completed a 2D flood model to characterise the flood behaviours within the lake and a water balance model to predict the lake's flood levels for different recurrence intervals.

The proposed Bombora Project footprint is located in the southwest corner of Lake Roe. An overview of the proposed Project layout is presented in Figure 1.2. The proposed Project is situated on a sub-area of Lake Roe and comprises three separate open pits—referred to as the North Pit, Central Pit, and South Pit. These pits are located within a low-lying landscape that is prone to inundation during significant rainfall events. A layout plan showing the location and relative position of the pits is provided in Figure 1.3.

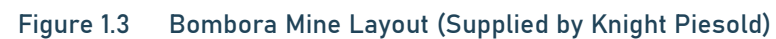
Given the location of the Project within a salt lake environment, the design of the flood protection bund may need to consider both overland flow from the external catchment and the storage of rainfall within the local lake sub-area and the greater Lake Roe system.



Figure 1.1 Project Location



Figure 1.2 Bombora and Kopai Mine Location



2. HYDROLOGY OVERVIEW

The area colloquially referred to as Lake Roe is a complex of interconnected smaller lake sub-areas which span approximately 90 km in length (west to east), situated within a broader paleo-drainage system that historically had flowed from northwest to southeast. As the elevation gradient of the paleo-drainage system has reduced with time and the climate dried, the system has become a number of salt lakes which become terminal drainage points under most runoff events.

The region lies within an arid zone characterised by large dryland creek systems and highly variable hydrological conditions which range from prolonged droughts to episodic flood events. These extremes influence the region's physical, chemical, and biological characteristics.

2.1 Climate and Rainfall Measurements

The Project area is classified as a semi-arid climate with dry, hot summers and cool mild winters. As shown in Figure 2.2, there are a number of regional weather stations which collect rainfall data. The location and data availability from each of these weather stations is summarised in Table 2.1.

Table 2.1 Regional Weather Stations

Weather Station	Lake Roe Distance (km)	Direction from Lake Roe	Data Collection Period
Karonie	30	South	1915-1986
Cowarna Downs	40	South-southwest	1968-2020
Kalgoorlie Airport	100	West	1939-2025
Gindalbie	95	Northwest	1918-2025

Cowarna Downs station is the closest station with a medium length of rainfall record (40 years). SILO data from Cowarna Downs station (BOM Station ID 12220) was considered the most representative analogue of the climatic conditions of the Lake Roe area based on proximity and observed data availability for assessments focussed on the medium-term conditions within the lake (such as the calibration of the lake water balance model). The station is situated approximately 40 km south-southwest of Lake Roe, with rainfall records available between 1970s to 2010. A SILO rainfall dataset was obtained between 1970 and October 2024.

It was noted the Cowarna Downs station SILO dataset:

- Likely best represents Lake Roe's rainfall for 1970–2010, when actual measurements were taken at the weather station.
- Rainfall data outside these years would be interpolated from nearby stations and is likely to be less representative of Lake Roe catchment's rainfall.
- Used SILO's interpolation techniques to derive temperature and evaporation values as this was not recorded at the Cowarna Downs station. The nearest station this data was recorded was at Kalgoorlie 110 kms away.

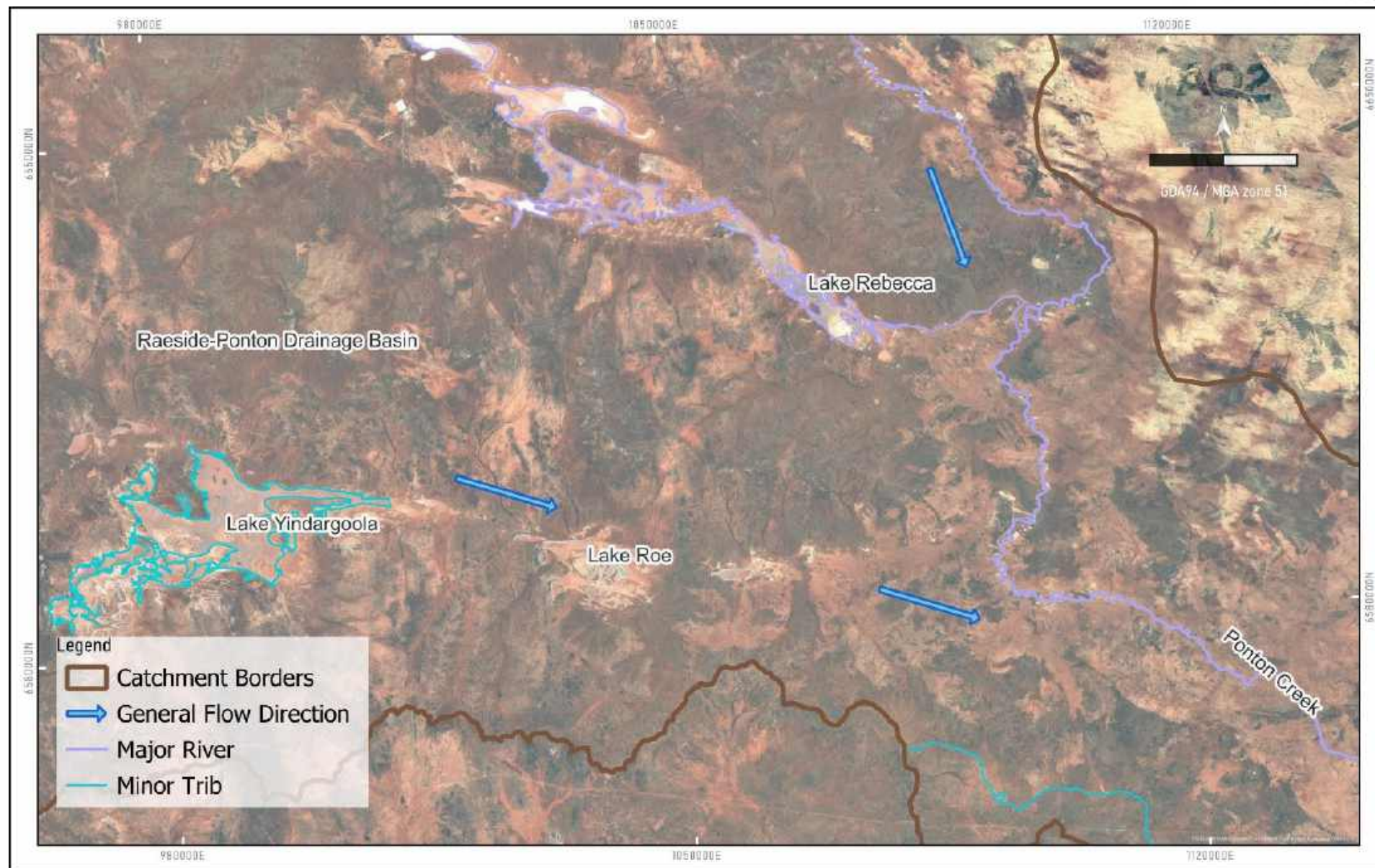


Figure 2.1 Regional Hydrology



Figure 2.2 Regional Weather Stations

Gindalbie Station (BOM Station ID 12247), located 95 km northwest of Lake Roe, is the closest station with a long-term record to the project, but it was considered too distant to be a realistic reflection of the rainfall which actually fell at Lake Roe in the past. This weather station has recorded rainfall events which are greater in magnitude than rainfall events recorded at either the Karonie or Cowarna Downs weather stations. Given the longer duration rainfall record (and larger rainfall events), the Gindalbie Weather Station rainfall data has been used to derive synthetic rainfall data for use in the lake water balance (discussed further below). Even though the weather station is located ~100km from the lake, there are no topographic/climatic reasons why those rainfall patterns could not occur at Lake Roe.

A summary of the Cowarna Downs station SILO dataset is as follows:

- Long-term average annual rainfall of 260.7 mm.
- Annual average Class A pan evaporation rate of 2,420 mm and an annual average Morton's shallow lake evaporation rate of 1,560 mm (from SILO interpolation at Cowarna Downs).
- Long-term average maximum temperature of 26 °C.
- Monthly average rainfall, Class A pan evaporation, Morton's shallow lake evaporation, maximum and minimum temperature (1970–2024) as shown in Figure 2.3.
- Daily rainfall sequence as shown in Figure 2.4.

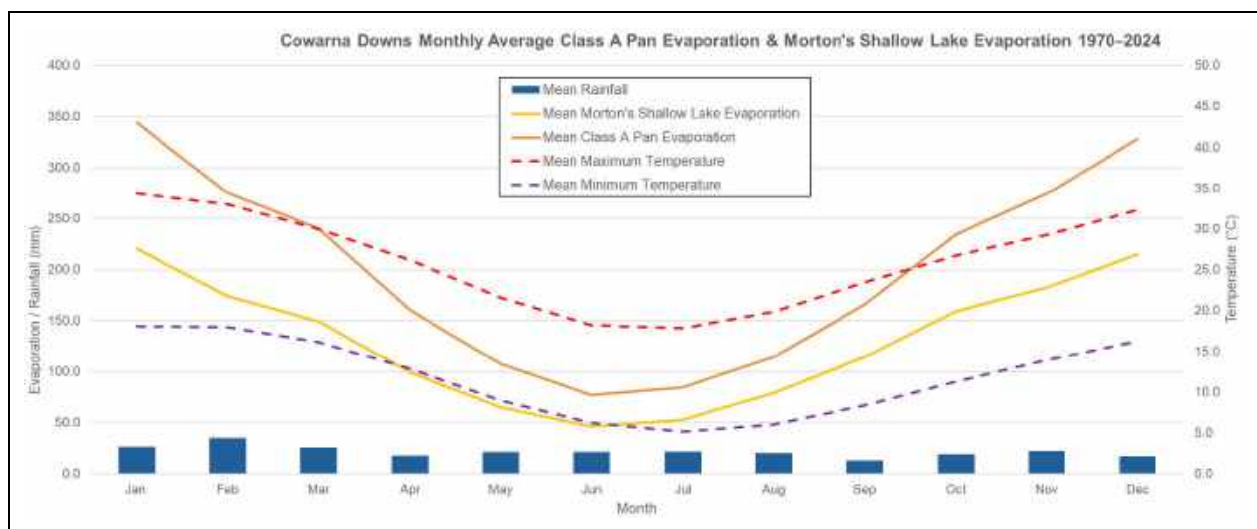


Figure 2.3 Cowarna Downs Monthly Average Climate Characteristics (1970–2024)

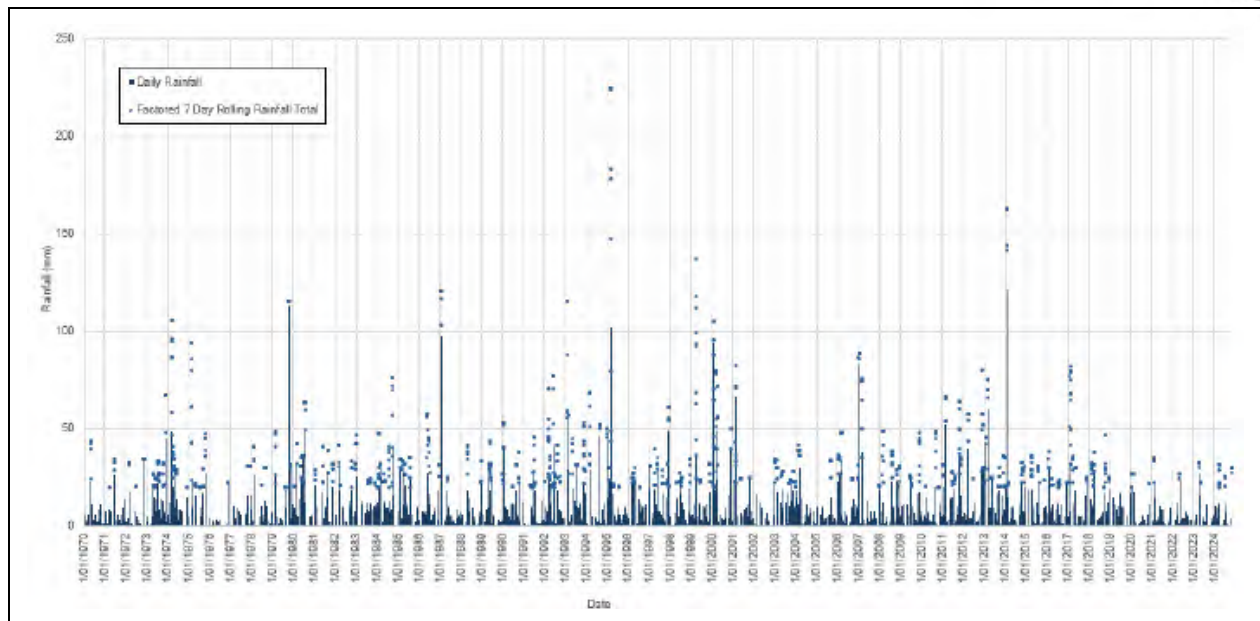


Figure 2.4 Cowarna Downs Rainfall Metrics (1970–2024)

2.2 Design Rainfall

2.2.1 Probability Terminology

Australian Rainfall and Runoff (ARR) (Ball, et. Al 2019) recommends the use of Annual Exceedance Probability (AEP) defining flood probability, so has been adopted throughout this report. AEP is defined as the probability or likelihood of an event occurring or being exceeded within any given year, usually expressed as a percentage. This new terminology supersedes the Annual Recurrence Interval (ARI) terminology adopted in the earlier revision of ARR (Institution of Engineers, Australia 1987). The relationship between ARI and AEP is defined below.

$$AEP = 1 - \exp\left(\frac{-1}{ARI}\right)$$

For example, a 1 in 100 ARI event would occur on average once every 100 years and has 1% chance of occurring in particular year (i.e. 1% AEP), while a 1 in 50 ARI event has 2% chance of occurring (2% AEP).

The likelihood of a flood event exceeding an AEP design criterion over the operational lifetime of the Bombora operation (in the order of 10 years) was calculated. The exceedance probability is computed using the following equation (as per ARR):

$$p = 1 - \exp\left(-\frac{L}{Y}\right)$$

Where:

Y = the return period of a given flood event (ARI)

L = the design life in years

P = the exceedance probability during the design life

The likelihood of an event (rainfall or flooding event) exceeding different AEP magnitudes over 10 years is summarised in Table 2.2. Note that there is still a 10% probability of an event exceeding a 1% AEP magnitude occurring over a 10-year project life.

Table 2.2 Exceedance Probability

Mine Life (years)	Probability of Exceedance (%) for AEP							
	39.4% (2yr ARI)	18.1% (5yr ARI)	10% (10yr ARI)	5% (20yr ARI)	2% (50yr ARI)	1% (100yr ARI)	500yr	1000yr
10	99%	86%	63%	39%	18%	10%	2%	1%

2.2.2 Intensity-Frequency-Duration Data

Intensity-Frequency-Duration (IFD) data for the Project was extracted from the BoM website from the 2016 datasets. The 2016 IFD data is presented in Table 2. Given the flooding mechanism of most concern for this project is inundation caused by storage of runoff volume within Lake Roe, longer duration rainfall events are likely to be the most relevant for the assessments. Throughout this report, the 72-hour rainfall event has been used for the assessments. The 1% AEP rainfall depth from a 72-hour event is predicted to be 191 mm.

Table 2 Intensity - Frequency - Duration Rainfall Data

Duration	63.20%	50%	20%	10%	5%	2%	1%	0.2%	0.1%
9 hour	24	28.5	44.2	56.6	70.2	90.3	108	158	158
12 hour	26	30.8	48.1	61.8	76.9	99.2	119	174	204
18 hour	28.8	34.2	53.8	69.5	87.1	113	135	198	232
24 hour	30.8	36.7	57.9	75.2	94.8	123	147	216	253
30 hour	32.3	38.5	61	79.6	101	131	157	227	264
36 hour	33.5	39.9	63.6	83.2	106	137	165	237	275
48 hour	35.3	42.1	67.5	88.7	113	147	176	254	295
72 hour	37.6	44.9	72.5	95.7	123	159	191	279	325
96 hour	39	46.7	75.6	99.9	128	166	199	295	345
120 hour	40.1	48	77.6	103	131	170	203	304	356

2.2.3 Probable Maximum Precipitation (PMP)

As part of this study, an assessment has been completed that considers the risk of flooding/within the lake sub-areas during a PMP event. Consistent with the other flood events which have been considered in this study, the PMP event used for this study is the 72-hour rainfall event.

The BoM has developed several methods for estimating the PMP rainfall depth depending on storm duration for the Project region. To determine the appropriate PMP rainfall intensity for the site, two methods were reviewed: the GTSMR (Generalised Tropical Storm Methodology for Regions) and the (GSAM Generalised Short-Duration Method). This was necessary as the mine site is located within the transition zone between the GTSMR and GSAM regions. Calculations were carried out using both approaches, including the GSAM summer and autumn scenarios. Both methods were completed with the rainfall depths from the GTSMR considered the most appropriate for this assessment, as they were significantly larger and more consistent with the rainfall depths for rare rainfall events estimated by the IFD curves. A summary of the PMP rainfall depths for a point location and for a catchment-wide application (considering a reduction in average rainfall depth over a large catchment) are summarised in Table 2.3.

Table 2.3 Probable Maximum Precipitation

ARI	72hr Rainfall (mm)
PMP (Point Location)	1215
PMP (1500 km ²)	650

2.2.4 Lake Roe Inflow Catchment

Lake Roe commands a 1,300 km² catchment draining predominantly from the north and south of the lake (refer Figure 2.5). Within this catchment are a number of drainage lines, with these drainage lines contribute runoff to different sub-areas of the lake. The hydrological response within the lake is influenced by the size of the catchment to each lake sub-area and the relative storage capacity of each of the sub-areas.

To the west of the catchment area that has been defined for Lake Roe for this assessment lies another chain of salt lakes. For this assessment, it is assumed that runoff from catchments reporting to this chain of salts lakes terminates at the salt lakes and does not contribute runoff through the paleo-drainage system to Lake Roe under any magnitude runoff event. The likelihood of this occurring has not been assessed for this project, but would require much more extensive detailed terrain data to do so.



Figure 2.5 Lake Roe Adopted Full Catchment Area

3. LAKE HYDRAULIC CONCEPTUALISATION

The flow behaviour within Lake Roe between different lake sub-areas has been assessed to assist in determining how to prepare a lake water balance model for the project. The conceptualisation has been completed on the following basis:

- Define catchment areas for the main drainages reporting to different parts of the lake.
- Define runoff hydrographs for flood events reporting to the lake from the sub-catchment areas for a design storm event using a hydrological model (RORB).
- Simulate the hydraulics of the flow through the lake sub-areas to characterise how the lake sub-areas become connected, where local saddles between the sub-areas constrain flow between the lake sub-areas. This has been achieved by simulating the sub-catchment inflow hydrographs within a 2D hydraulic flood model.
- Estimate water level inundation within Lake Roe for a single design rainfall event (in particular close to the Bombora Project area), assuming the lake is dry at the commencement of the design storm event.

The approach to the above points is summarised in more detail in the sections below, with the observations used to develop the lake water balance model (discussed in Section 4). The lake water balance model is required as the flood frequency due to the storage of runoff within the lake requires consideration of antecedent rainfall conditions and different duration events. For example, does the 1% AEP wettest year result in a higher level of flooding than a 1% AEP 72-hour event, or are two 10% AEP events in quick succession equally as likely as a 1% AEP event and result in a higher flood elevation.

3.1 Sub-Catchment Definition

Using a combination of detailed 1m LiDAR elevation data, publicly available elevation data and aerial photography information, catchment areas for the main drainage lines reporting to Lake Roe were defined. The sub-catchment areas defined for Lake Roe are shown in Figure 3.1.

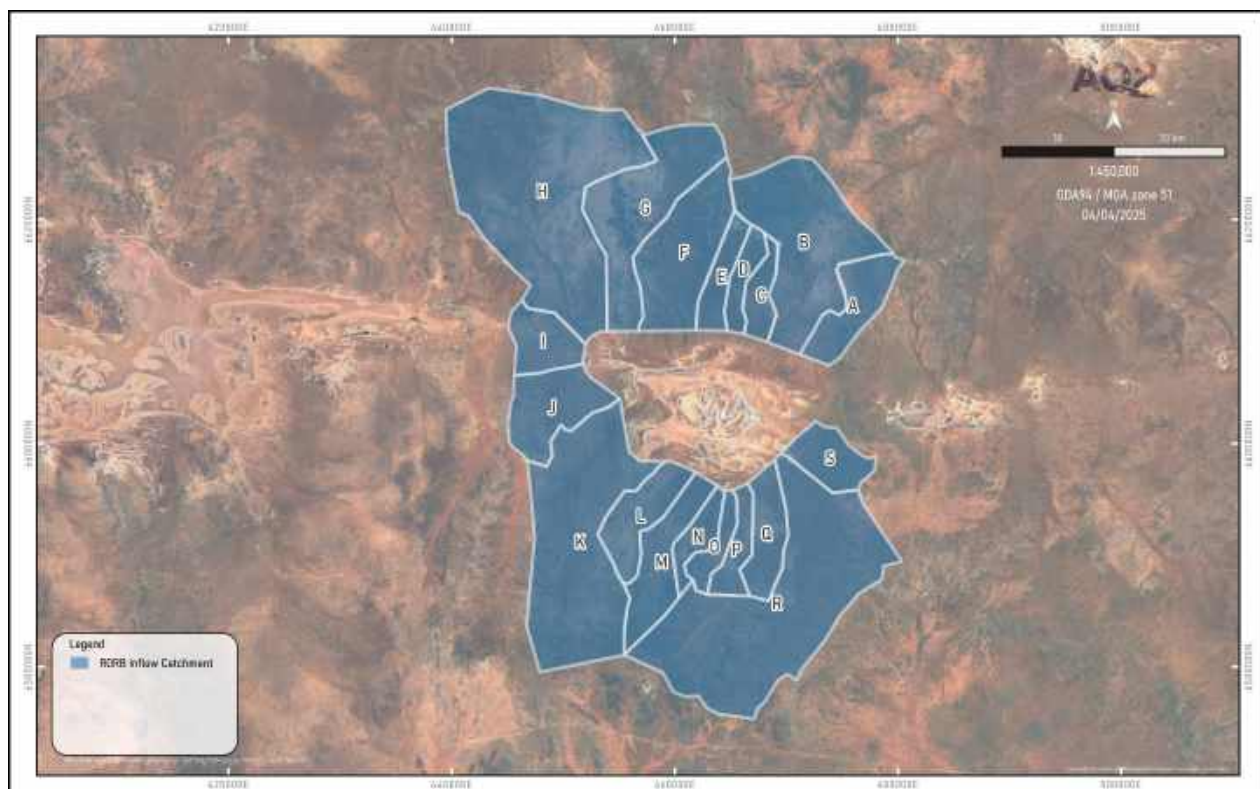


Figure 3.1 Lake Roe Sub-Catchment Areas

3.2 Catchment Runoff Estimation

The runoff behaviour from the sub-catchments to the lake has been simulated by preparing a RORB hydrology model to quantify runoff volumes and rates using the following steps:

- RORB hydrology models were developed for a representative large and small sub-catchment to estimate flow hydrographs and runoff volumes for the 20% AEP, 1% AEP and PMP rainfall events from different sized catchments. Catchments B and I (refer Figure 3.1) were selected for the RORB models to represent a large and small catchment respectively.
- A separate single design rainfall hyetograph (rainfall intensity temporal pattern during a storm) was selected for a 72-hour storm event for each of the 20% AEP, 1% AEP and PMP rainfall events using ARR defined design temporal patterns.
 - As recommended by the latest ARR guidance, the design IFD rainfall depths used to define the 20% AEP and 1% AEP events were increased by a factor of 20% to reflect the input of climate change on rainfall depths (on the basis of the IFDs being derived from historic rainfall data and to reflect projections of impacts to future rainfall depths). No factors were applied to the PMP rainfall depths to account for climate change. The Long-Term (2080 period) Medium RCP4.5 model projection was used as the basis for selection of the climate change multiplier.
- Rainfall losses were applied to the design hydrographs within the RORB model. The following losses were adopted:
 - 20% AEP and 1% AEP – Runoff Coefficient 35% (based on Flavell 2012b).
 - PMP – Continuing Loss 3mm/hr (as per ARR 2019 Guidelines, Book 8 Section 4.3.4.3).
 - The adopted Runoff Coefficients include an allowance for increased rainfall losses due to the impact of climate change (due to drier soil conditions). The adopted runoff coefficients stated above for the 20% AEP and 1% AEP events have been reduced by 10% from ARR recommended regional values to reflect this. No changes to the PMP values were applied to account for climate change.
- The key parameters within the RORB models (K_c and m), which assist in defining the attenuation of runoff through the drainage lines were adopted as follows:
 - K_c was calculated using equation 7.6.25 from chapter 6.2.1.5 of Book 7 of Australian Rainfall and Runoff (ARR, 2019) for the arid interior. The calculated K_c value for Catchment B was 6.27, the K_c value for Catchment I was 3.15.
 - The exponent “ m ” is the RORB parameter that describes the nonlinearity of a catchment’s storage routing. The standard value used for ungauged catchments of 0.8 was adopted (Laurenson et al 2010).
- The resulting runoff hydrographs (runoff rate with time) from Catchment B (large catchment) and Catchment I (small catchment) were used as the basis to estimate runoff hydrographs for the other sub-catchments. The other sub-catchments were classified as either large or small, and hydrographs defined by scaling the flow rate based on their relative catchment size to Catchments B and I (as applicable).

Note that the exact storm and hydrograph selected are largely unimportant for this assessment for the following reasons:

- The rainfall hyetograph and runoff hydrographs that were defined are used within the 2D flood model (discussed below), which in turn is used to characterise the flow characteristics within the Lake Roe sub-areas. The 2D flood model is not directly used to define the flood levels.
- The adopted rainfall loss model adopted was an initial loss – proportional loss model. All rainfall hyetographs result in the same volume of water running off the sub-catchment areas.
- Similarly, the choice of model K_c and m values is largely unimportant for this assessment.

Further note that the adoption of the climate change multipliers which were applied to rainfall and rainfall loss inputs were conservatively chosen from 2080 climate change projections.

3.3 Flood Modelling Setup

The flood response within Lake Roe was simulated by creating a 2D flood model using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) Version 6.7 Beta (USACE 2025). The 2D model was developed to predict inundation extents resulting from the 20%, 1% AEP and PMP rainfall events, with only the 1% and PMP results shown in this section for brevity.

The basis for the 2D model is the 1m LiDAR elevation data provided to AQ2 by Ramelius Resources on 26 February 2025. Figure 3.2 shows the provided terrain data and the 2D model domain applied.

The general 2D model build details are as follows, with a model setup shown spatially in Figure 3.3:

- A computational mesh spacing of 100 m x 100 m was applied to the 2D flow area.
- A refined mesh spacing of 20 m x 20 m was applied at the location of the lake -sub areas.
- A roughness coefficient of 0.06 was adopted across the model domain as a representative/ average roughness coefficient across the full model domain.
- Nineteen inflow boundaries (A–S) were established around the model boundary, with each boundary corresponding to a delineated catchment as discussed above and shown in Figure 3.1.
- An outflow boundary condition was applied to the eastern edge of Lake Roe, corresponding to a low point in a saddle which may allow outflow of water from the lake to the downstream paleo-drainage system (should the lake water level rise high enough).
- A 72-hour rain-on-grid storm was incorporated into the HEC-RAS model to simulate the direct rainfall across the area within the model domain. The same storm hyetograph and rainfall losses as defined for the RORB model were applied.
- An adaptive times step was assigned using a maximum Courant Number of 2.0.
- A simulation period of 168 hours (7-days) was applied to the model to allow sufficient time for the runoff from the upstream catchments to reach Lake Roe, drain through the lake network and redistribute the runoff between the lake sub-areas.

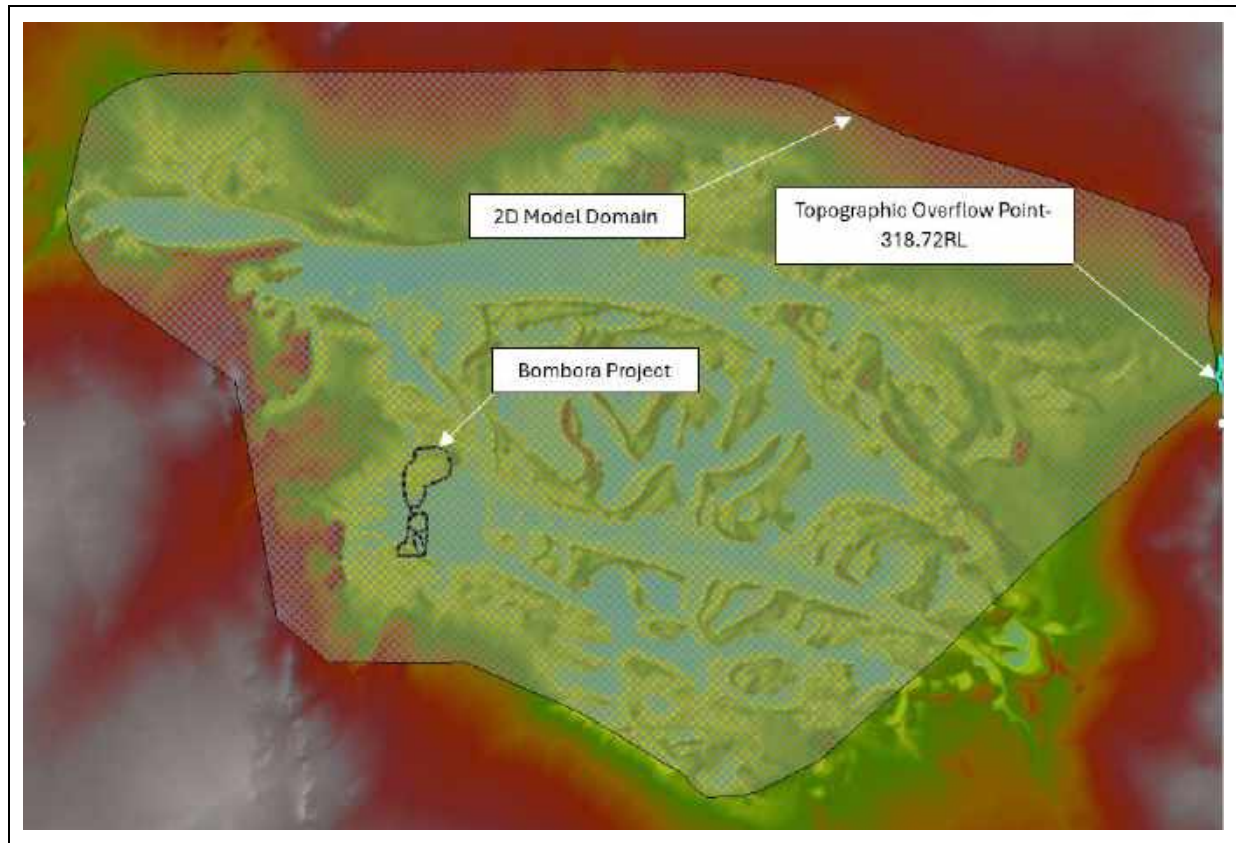


Figure 3.2 Model Terrain Data



Figure 3.3 2D Model Setup

3.4 Flood Modelling Results and Observations

Results from the flood modelling exercises are shown in the following figures:

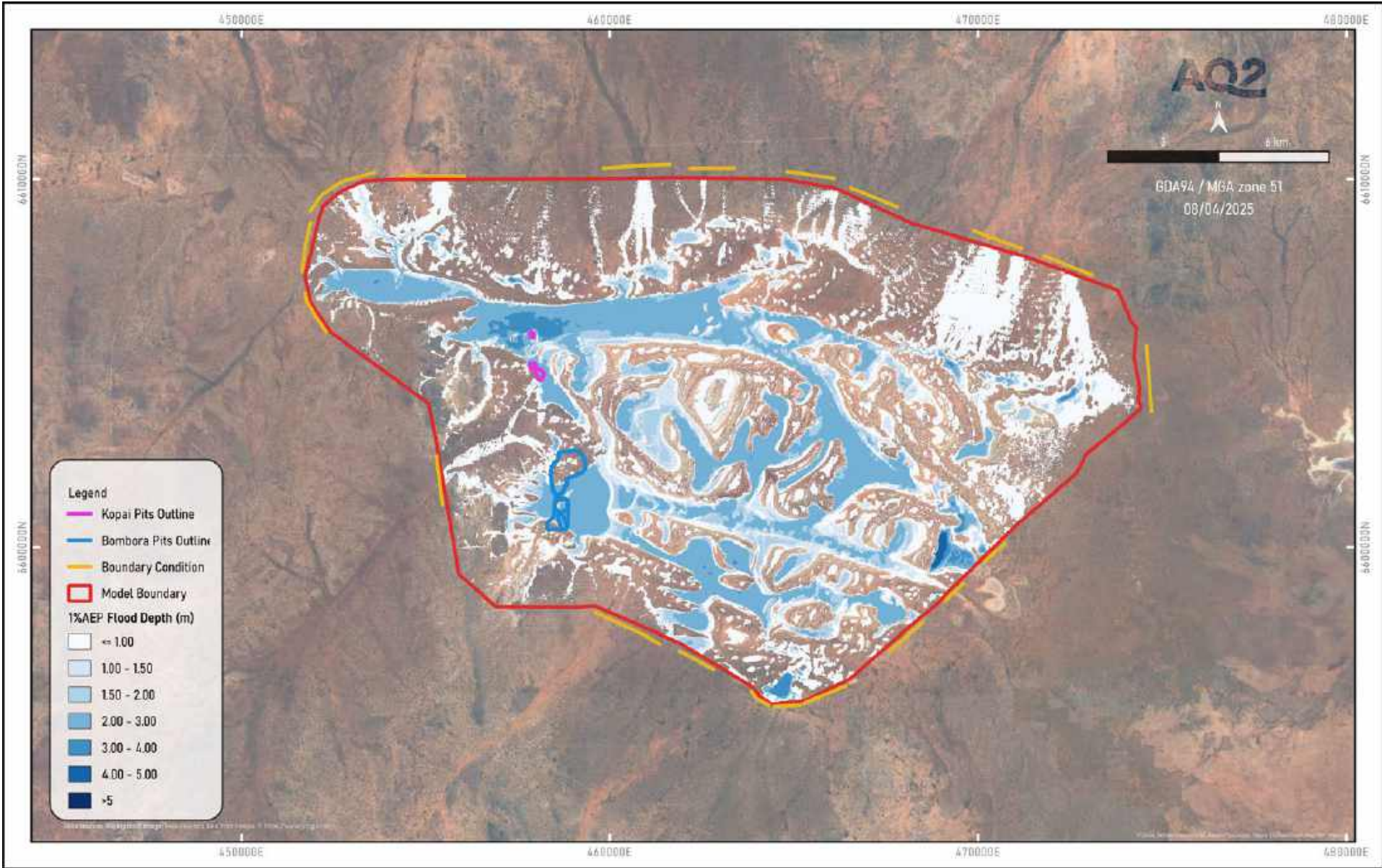
- Figure 3.4 – the predicted maximum flood depths from the adopted 1% AEP rainfall event. Note that these maps represent the maximum flood depths predicted throughout the simulation period for each model grid cell.
- Figure 3.5 – the predicted maximum water surface elevation from the adopted 1% AEP rainfall event across the simulation period for each model grid cell across the lake.
- Figure 3.6 – the predicted maximum flood depths from the adopted PMP rainfall event across the simulation period for each model grid cell across the lake.
- Figure 3.7 – the predicted maximum water surface elevation from the adopted PMP rainfall event across the simulation period for each model grid cell across the lake.

The following key observations were made from the 1% AEP flood modelling results:

- The runoff volume from this event was large enough for most of the lake sub-areas to become hydraulically connected. As such, over time, the water surface elevation across the majority of the lake area becomes the same.
 - Note that following the 20% AEP event the main sub-areas of the lake also are predicted to become connected, and therefore it has been assumed that for all large runoff events there will be sufficient runoff to connect all of the main lake sub-areas together.
- Reviewing the results as the lake fills during simulation period, it was clear that intermediate high-points between lake sub-areas need to be overtopped before water can be transferred through the lake system. The runoff from the larger catchments (such as H, K and R) fill the lake sub-areas which they immediately report before runoff spills over and reports to central parts of the lake. In smaller, more frequent runoff events than those simulated, there may be insufficient runoff for inundation to spill to the central lake sub-areas,
- The predicted flood elevation from the 1% AEP 72-hour rainfall event is 314.5 mRL across the major lake sub-areas (including those adjacent to Bombora).
 - The lake sub-area in the northwest corner of Lake Roe is marginally higher than the other lake sub-areas. This is because a relatively large catchment reports to a relatively small storage volume in this sub-area, and the outflow to the remainder of the lake is hydraulically constrained. The energy loss required to transfer runoff from this sub-area to the main lake area results in a WSE elevation of 314.6 mRL, some 0.1 m above the flood level in the remainder of the lake. This should be considered when reviewing any potential flood protection levees for the Kopai Crescent Project.
 - Note that as discussed earlier in the report, the response from the 1% AEP 72-hour rainfall event does not necessarily represent the 1% AEP flood depth (which is estimated by the water balance model).
- This inundation level is below the water surface elevation required for Lake Roe water to overtop to the east, and therefore all runoff is contained within the Lake Roe footprint.

The following key observations were made from the PMP flood modelling results:

- A significantly larger portion of the lake area is inundated by the runoff, and a single large lake would form.
- The predicted water level in the lake from the PMP rainfall event is 319.1 mRL.
- The lake overtops to the east at this water level, which is 0.4 m above the overflow point (318.7 mRL).
- The elevation of the lake overflow point will somewhat control the maximum flood level which is possible in Lake Roe. If larger volumes of water report to the lake, additional water will flow to the east and away from the lake.



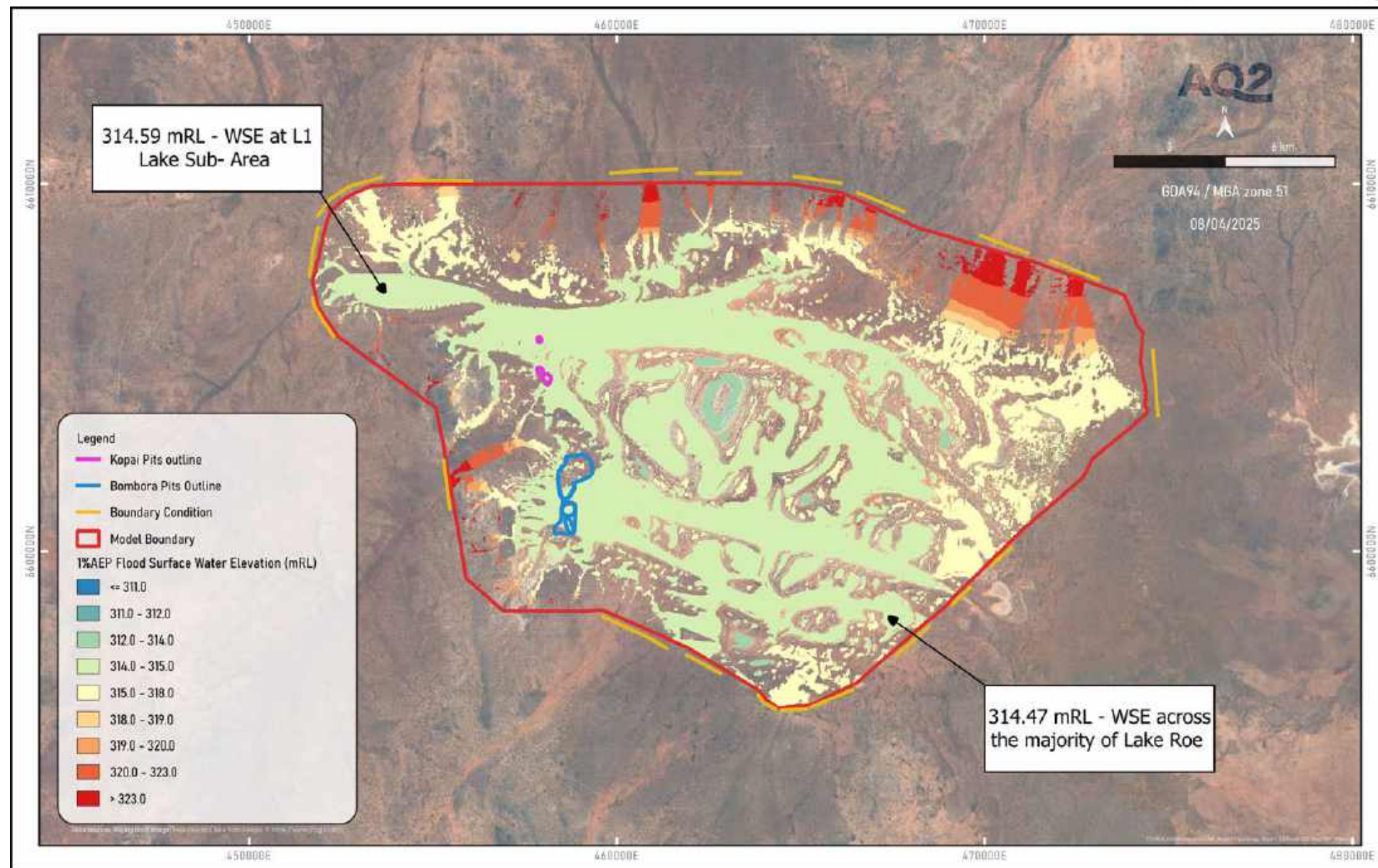


Figure 3.5 Maximum Flood WSE Map (1% AEP Rainfall Event)

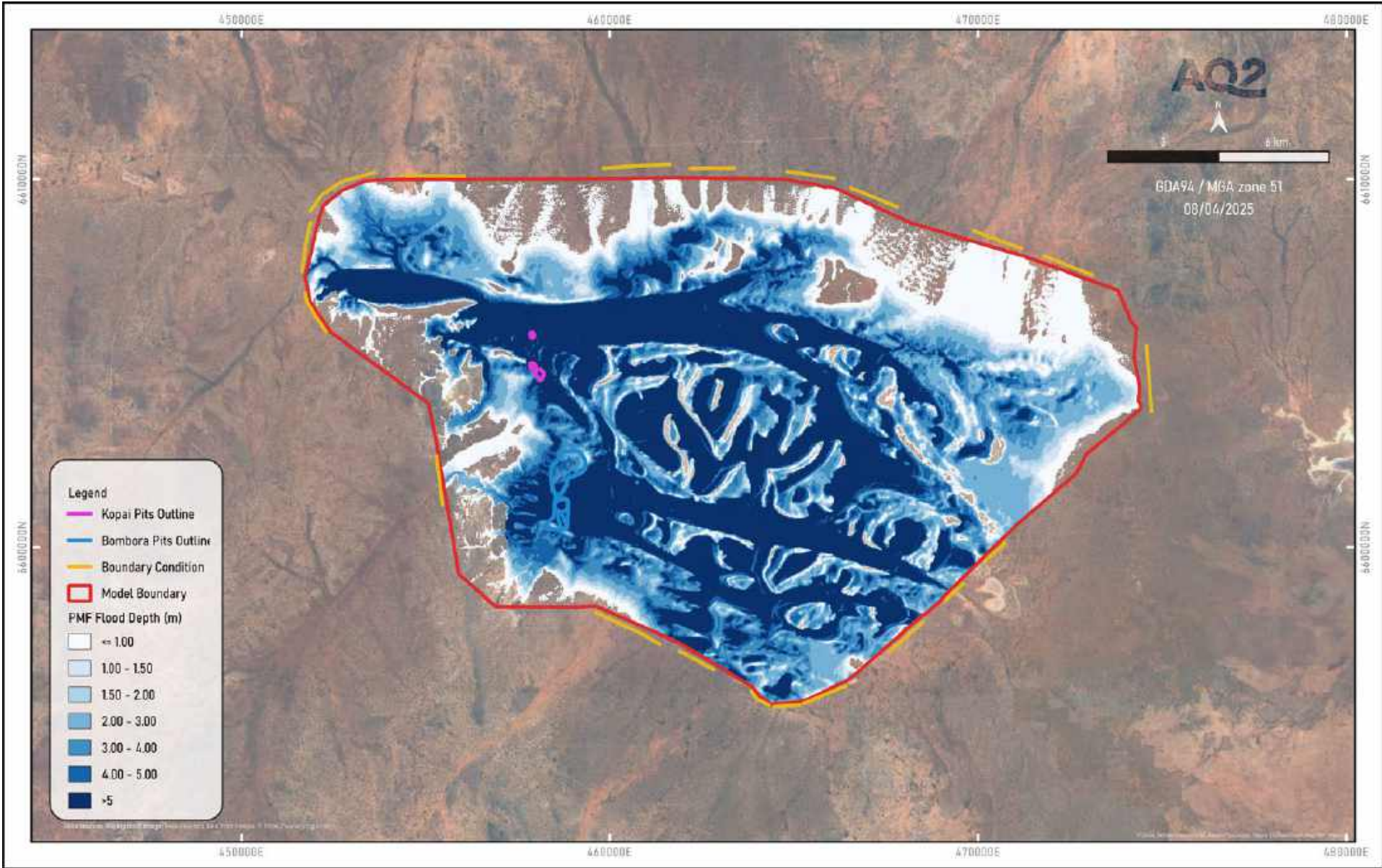
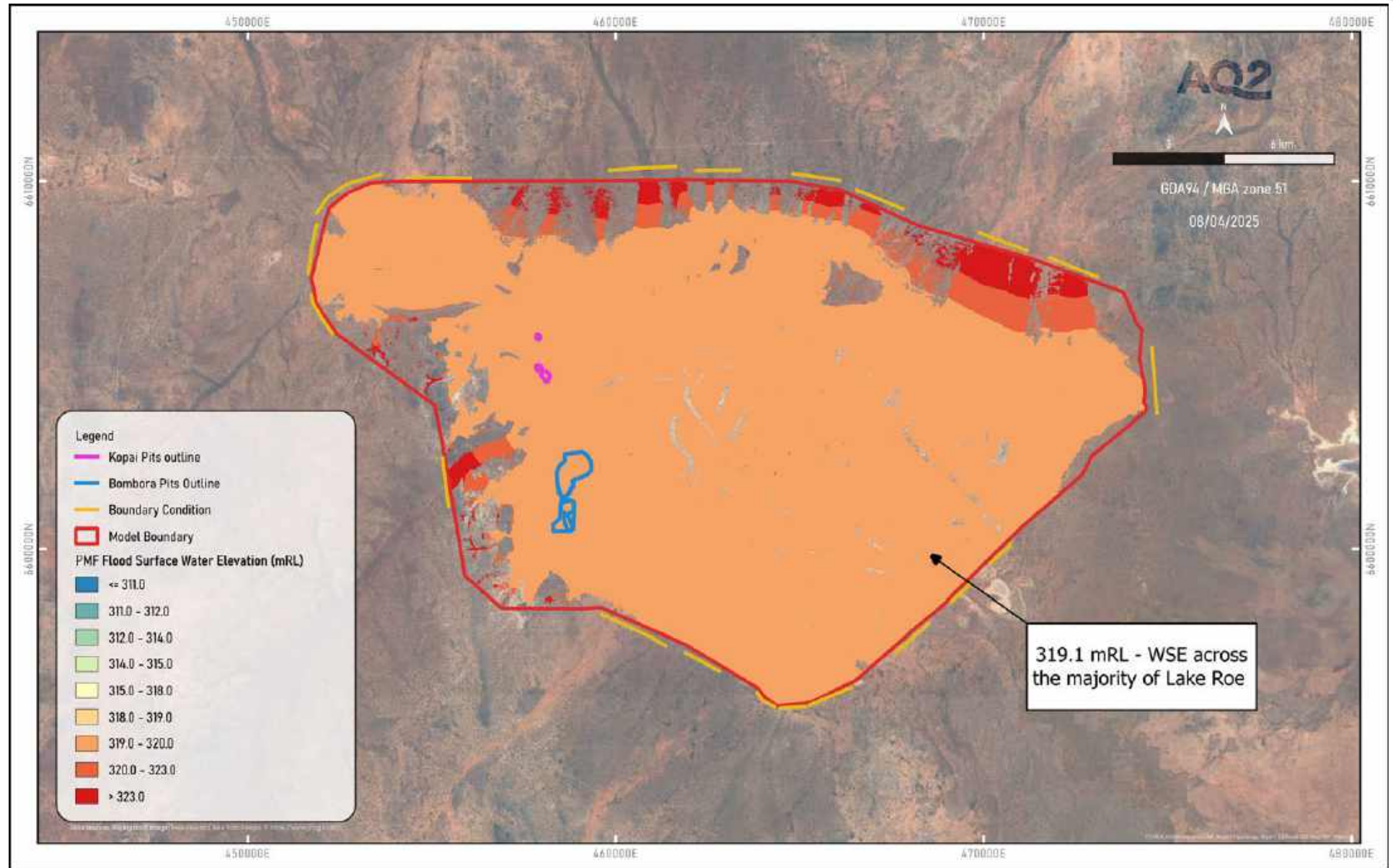


Figure 3.6 Maximum Flood Depth Map (PMP Rainfall Event)



4. LAKE WATER BALANCE

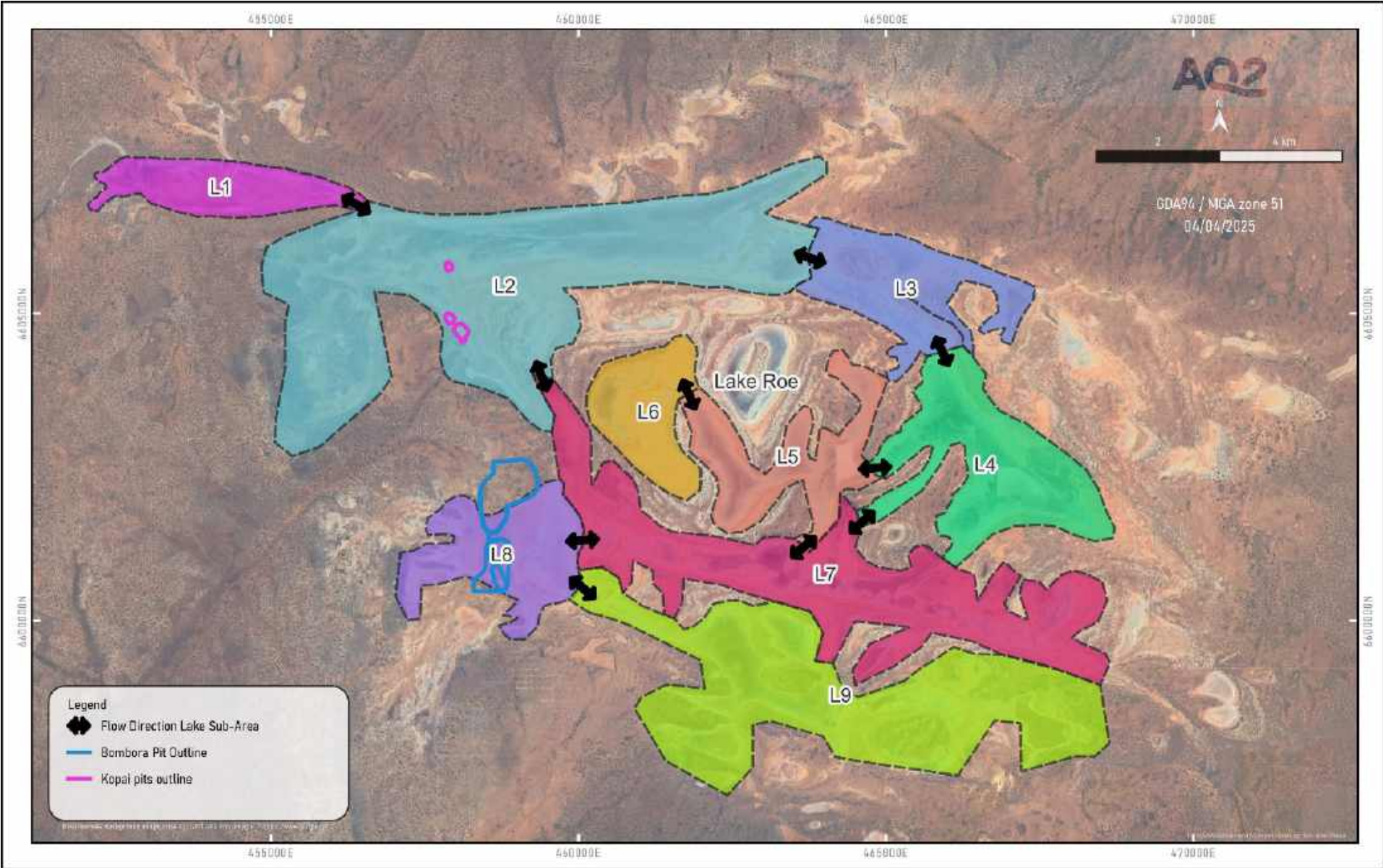
A water balance for Lake Roe has been completed to produce a simulated time series of lake water levels which could be used to allow the recurrence interval of flood levels within Lake Roe to be estimated. The water balance assessment has used the following approach:

- Using the observations from the 2D flood model, Lake Roe has been divided into 9 separate lake sub-areas (refer Figure 4.1).
- The water balance model simulates runoff reporting to each of these sub-areas and the subsequent recession of water from them.
- The water balance was coarsely calibrated to approximate observations of lake flooding from aerial imagery.
- The calibrated water balance model was run with a long-term synthetic rainfall data series (1,000-year duration) derived from rainfall data observed from a nearby weather station.
- A flood frequency analysis was completed of the resultant annual maximum flood level predictions in Lake Roe to provide an estimate of the flood levels at different recurrence intervals.

4.1 Water Balance Inputs and Assumptions

The water balance is summarised as follows:

- Lake Roe has been split into 9 different sub-areas based on the position of localised low points, catchment inflows and bounding low saddles between the sub-areas.
- For each sub-area, the following specific information has been derived:
 - Lake sub-area stage/volume/area relationship (from the provided LiDAR data).
 - Surface water catchment area draining the to the sub-area.
 - Elevation of the saddles which sperate the sub-area from adjacent sub-areas.
 - The approximate area of the “lakebed” which has been defined with different rainfall loss characteristics compared to the broader catchment area reporting to the sub-area.
- The water balance calculations are completed at constant time intervals using the following fundamental equation:
 - $\text{Inflow} - \text{Outflow} = \text{Change in Storage Volume}$
- The time interval for calculations is 6 hours. This interval is required for model stability given the large volumes of water that are moving through the model.
- At each calculation time interval, the model calculates the water level and inundation area within each sub-area based on the stored water volume at that time-step. The water level and inundation area drive other calculations within the water balance.
- The sub-area water level is used to drive the logic related to the distribution of runoff across the lake between different sub-areas. Once the storage volume within a given sub-area rises above the elevation of any of its bounding saddles, the model simulates water transfer to the adjacent sub-area(s). A portion of the water above the saddle point is transferred during successive time steps to keep the model stable (consistent with the calculation timestep).
- The inundation area of the lake is used to drive the following processes:
 - Direct rainfall on the lake surface (the model assumes 100% of rainfall on the inundation area reports to the lake).
 - Area over which evaporation losses occur from the lake surface.
 - Area over which infiltration losses occur from the lake.



4.1.1 Satellite Imagery Assessment

The Lake Roe inundation extents and frequency were estimated between 1993 and 2024 using satellite data, specifically true colour imagery and Normalized Difference Water Index (NDWI) data from Sentinel, Landsat and Google Earth. Data availability and aerial image quality varied considerably throughout the 1990 to 2024 study period. The inundation extents were compared to the Digital Elevation Model (DEM) of the lake to estimate ponding depths with time.

Confidence in the estimated inundated depths (from observed satellite imagery) varies, but is typically low, and the date of recorded imagery may not coincide with the date of the actual peak inundation extent. Frequent Sentinel data between 2017 and 2024 provides the most reliable period for analyses. Between 2013 and 2017, Landsat (satellite) data are inconsistent with some gaps due to Lake Roe's eastern area falling on a different tile without imagery and satellite imagery strips (Landsat 7) giving an incomplete picture. Pre-2013, imagery from Landsat is less frequent, with data pre-2008 missing for extended periods and/or has insufficient resolution to confidently interpret. Notably, there is a Landsat data gap from late 2011 to early 2013, meaning that any lake inundation due to rainfall events during 2012 are not estimated.

The following observations were made at Lake Roe during the satellite imagery assessment:

- Catchment runoff responses causing at least some inundation in Lake Roe were generally observed when rainfall exceeded approximately 25 mm.
- In small inundation events where widespread flooding across the full lake is not prevalent (i.e., following rainfall depths in the order of 25 mm), the water levels Pan A were estimated. Appendix A presents the estimates of inundation water levels from satellite observations within salt pans B and D for reference.
- Visible widespread inundation across constituent salt pans was typically observed when a rainfall event occurred over multiple days, with total rainfall over the event exceeding 50 mm.

4.1.2 Parameter Selections

Based on the observations from the satellite imagery and the model calibration exercise, the runoff parameters shown which (subjectively) best approximate the observations are summarised in Table 4.1. A plot of the observed lake water levels and the model predictions of lake water levels are presented in Figure 4.2.

Table 4.1 Water Balance Rainfall Loss Parameters

Parameter	Catchment		
	Lake Catchment	Dry Lakebed	Inundated Lake Area
Initial Loss	50 mm	25 mm	0 mm
Runoff Coefficient	25%	70%	100%
Initial Loss Recovery	5 mm/d	2.5 mm/d	0 mm/d

The calibration exercise showed that runoff behaviour was reasonably well predicted by the model, particularly during the 2005 to 2017 period, noting:

- The inherent uncertainty in the estimations of water levels in the lake from the satellite imagery given the flatness of the lake beds and the difficulty in distinguishing between salt and water on the lake bed.
- The SILO rainfall record for Cowarna Downs includes interpolated rainfall data post 2010. When SILO interpolates rainfall data in areas where weather stations are sparse and rainfall is spatially highly

variable, the interpolates tends to show rainfall occurring more frequently but with fewer large rainfall events, which is potentially why the model couldn't match the observed inundation depths post-2017.

- To simplify the calibration assessment, a stage-volume curve for the full lake was developed and used to convert the full volume within the lake (i.e., the sum of the water storage in all sub-areas) into a water level, assuming the same water level occurs across the lake. During smaller flow events, all of the lake sub-areas may not be hydraulically connected and the water level in each sub-area may be different.
- The calibration is based on water levels. The stage-volume curve for the lake is such that a relatively small amount of runoff volume is required to cause inundation up to RL312.5m, such that it is harder to replicate the lower inundation depths.

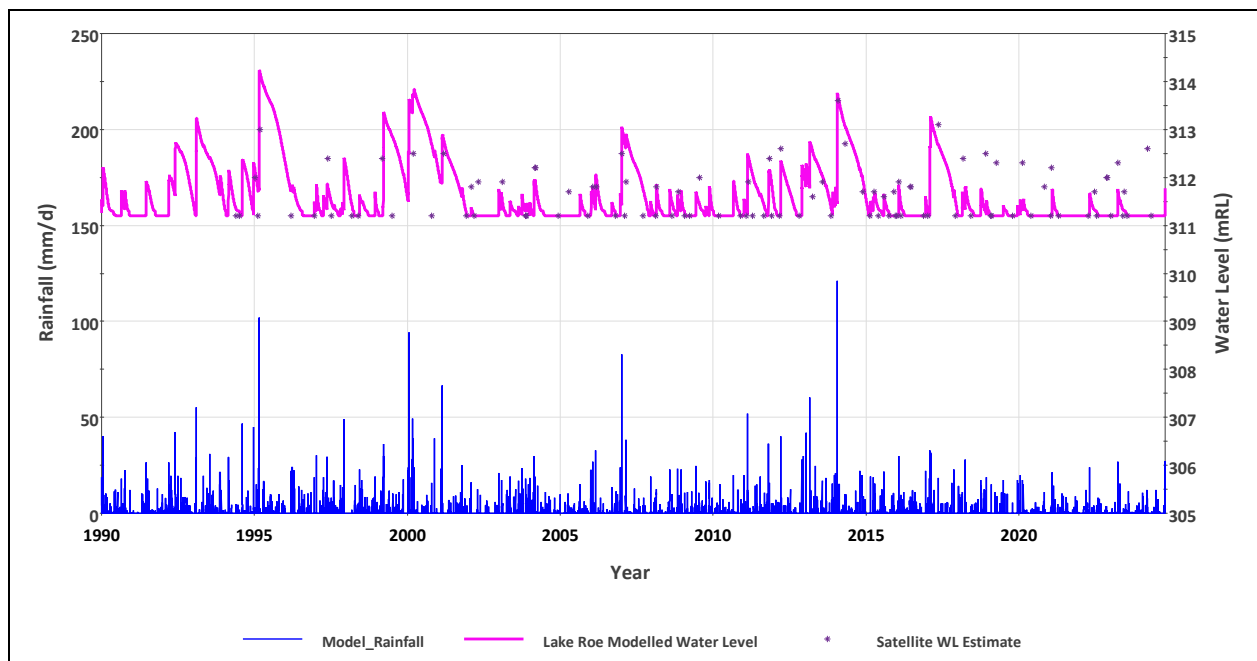


Figure 4.2 Calibrated Water Level Predictions vs Estimated Water Levels from Satellite Observations

4.2 Long-Term Synthetic Rainfall Water Balance Model

4.2.1 Introduction

A long-term water balance was run, with the purpose of developing this model to provide water balance results using a longer rainfall record which would be able to simulate the potential inundation depths from large, rare rainfall events considering antecedent rainfall conditions (and therefore antecedent water stored in the lake sub-areas). Although the expected life expectancy of the Bombora project is in the order of 10 years, The long-term model was run using a 1,000 year rainfall sequence, even though the project life for Bombora is in the order of 10 years. This is because any 10-year rainfall sequence within the record is as equally likely to occur as any other 10-year period.

4.2.2 Synthetic Rainfall Record

The synthetic rainfall generator programmed into the GoldSim model is based on historic daily rainfall records from Gindalbie Rainfall Station. Rainfall records sourced from the Bureau of Meteorology (BOM) between 1918 and 2024 were used. The BOM rainfall dataset was incomplete over this period, with missing data patched using the online SILO enhanced climate database service to provide a continuous record. The output from SILO is formed using records from nearby weather stations.

The 106 years of daily rainfall data was used as an input to the eWater program Stochastic Climate Library (SCL). The SCL uses historic rainfall data as an input and produces a synthetic rainfall data set for the required duration, which is a statistical fit to observed rainfall. For this project, 1,000 years of daily rainfall was produced by the program.

The synthetic daily rainfall data time series that was produced for the model is not reproduced within this report for brevity; a comparison of the summary statistics for the Gindalbie data and the synthetic rainfall data generated are shown in Table 4.2.

Table 4.2 Input Rainfall Data Summary Statistics (Annual)

Annual Statistic	Annual Rainfall Depth – Gindalbie	Annual Rainfall Depth – Synthetic
Median	218mm	223mm
Mean	235mm	235mm
Maximum	674mm	960mm
Minimum	48mm	12mm
90 th Percentile	402mm	384mm
75 th Percentile	291mm	296mm
25 th Percentile	161mm	152mm
10 th Percentile	96mm	100mm

Within the GoldSim model, the synthetic rainfall dataset has been increased to account for climate change, consistent with the approach adopted within the 2D modelling. As per ARR guidelines (Ball, et. al, 2019) the rainfall records have been increased by a factor of 20% to account for increases in rainfall depths during large rainfall events as predicted by Long Term (2080 period) medium Representative Concentration Pathways 4.5 (RCP4.5). The 2080 projection period has been adopted conservatively for climate change impacts to rainfall, as the project is likely to have been completed well in advance of 2080.

4.2.3 Rainfall Loss Parameters

The rainfall loss parameters derived in the calibration model were adopted for long-term water balance model. However, a factor to reflect the impact of climate change on likely runoff rates was applied. Although rainfall depths are predicted to increase with climate change, increased temperatures (and therefore evaporation) and periods between rainfall events within the WA arid interior region are predicted to result in an increase in rainfall losses during rainfall events. The applied ROCs within the model were reduced by 10% to reflect the impact of climate change on runoff generation.

4.2.4 Model Results

The results from the long-term synthetic rainfall model run are shown in Figure 4.3. The results indicate the following:

- Widespread inundation only occurs when the flood depths within the lake exceed the elevation of the saddle points between lake sub-areas. These saddle points are typically between RL312.5m and RL313m.
- Inundation of the lake with more than approximately 3m of water above the lowest point in the lake (i.e., a flood level exceeding RL314m) happens about once every ~50 years.
- Flooding exceeding RL315m is predicted to occur about 5 times over the 1,000-year period (i.e., once every 200 years)

- Prolonged inundation (lasting multiple years) happens rarely, but continuous ponding of up to 4 years has been predicted to occur on occasion in the model. Sustained ponding requires multiple large runoff events to occur in close succession.
- The greatest inundation level predicted (RL317m) would result in 5.8m of flood depth at the deepest point of the lake. On the basis of a typical recession rate of 10mm/d, it would take in the order of 1.6 years for the lake to recede to a completely dry state (if no further rainfall were to occur in that period).

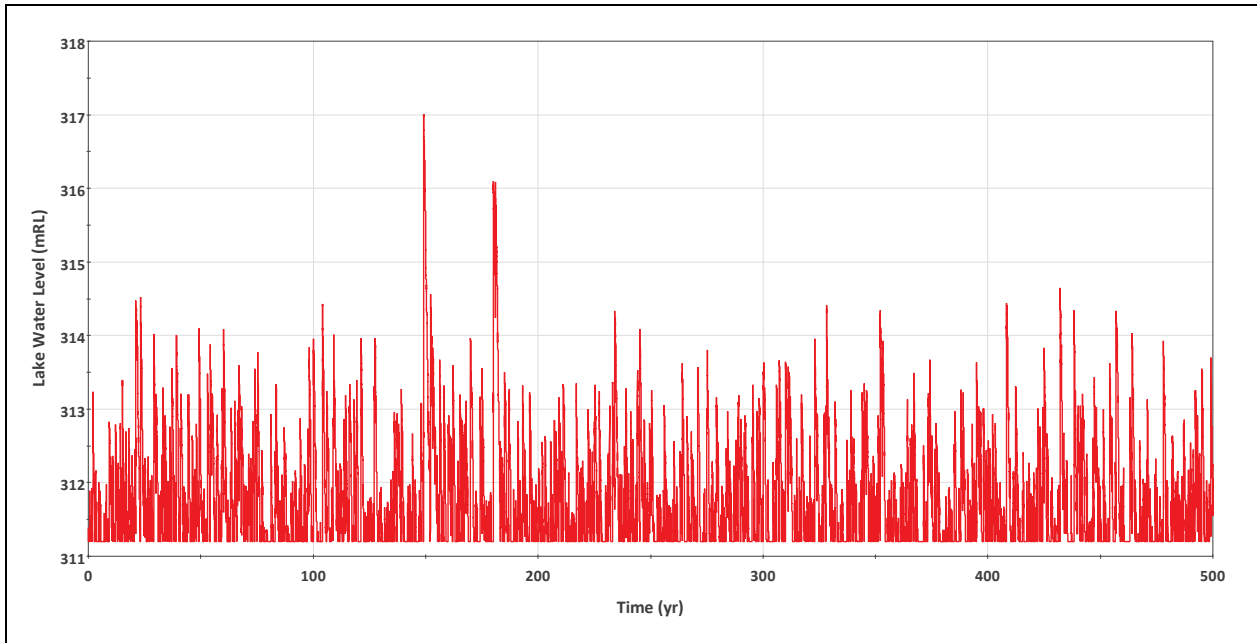


Figure 4.3 Long-Term Model Results (Year 0 to Year 500)

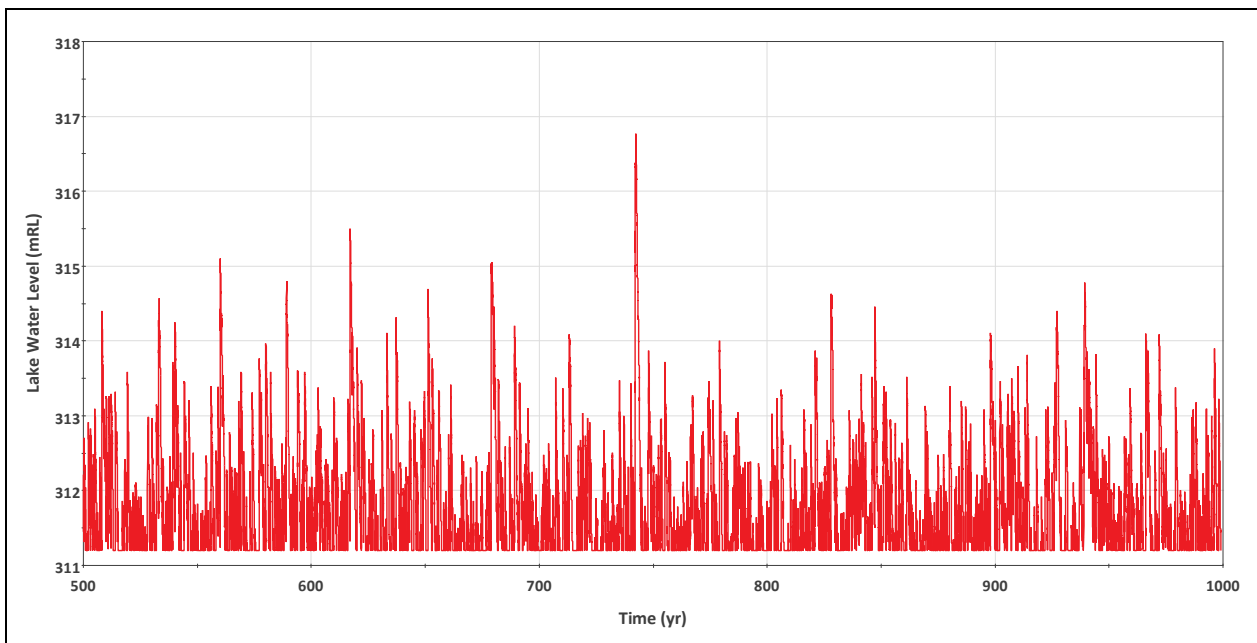


Figure 4.4 Long-Term Model Results (Year 500 to Year 1000)

4.2.5 Flood Frequency Analysis

An annual maximum lake water level series was developed from the long-term water balance model assuming a water year spanning from October to October. The annual maximum series was used in the Flike software to complete a FFA of lake water level.

A Log-Pearson Type III curve was fitted to the modelled data, with the assessment censoring all water levels below a ~1 in 10-year (10%) AEP flood event. Although the curve provided a reasonable fit to the observed flood level data, it was noticed that there appears to be a step change in the flood elevation data between 1 in 100-year AEP event and the 1 in 200-year AEP event.

A summary of the FFA results is provided in Table 4.3, which indicates both the Expected (best estimate) Flood Depths and the 90th Percentile Confidence Level Flood Depths. The results indicate that a 1 in 100-year AEP (1%) flood depth in the lake is predicted to be 315.08 mRL. This compares with the 1% AEP 2D model flood estimate of 314.5 mRL from a 72-hr storm event.

Table 4.3 FFA Results – Flood Depth Recurrence Interval

AEP (1 in Y)	Expected Flood Depth (mRL)	90%-ile Flood Depth (mRL)
5	312.85	313
10	313.51	313.6
20	314.06	314.2
50	314.67	314.9
100	315.08	315.3
200	315.46	315.7
500	315.92	316.2
1000	316.24	316.6

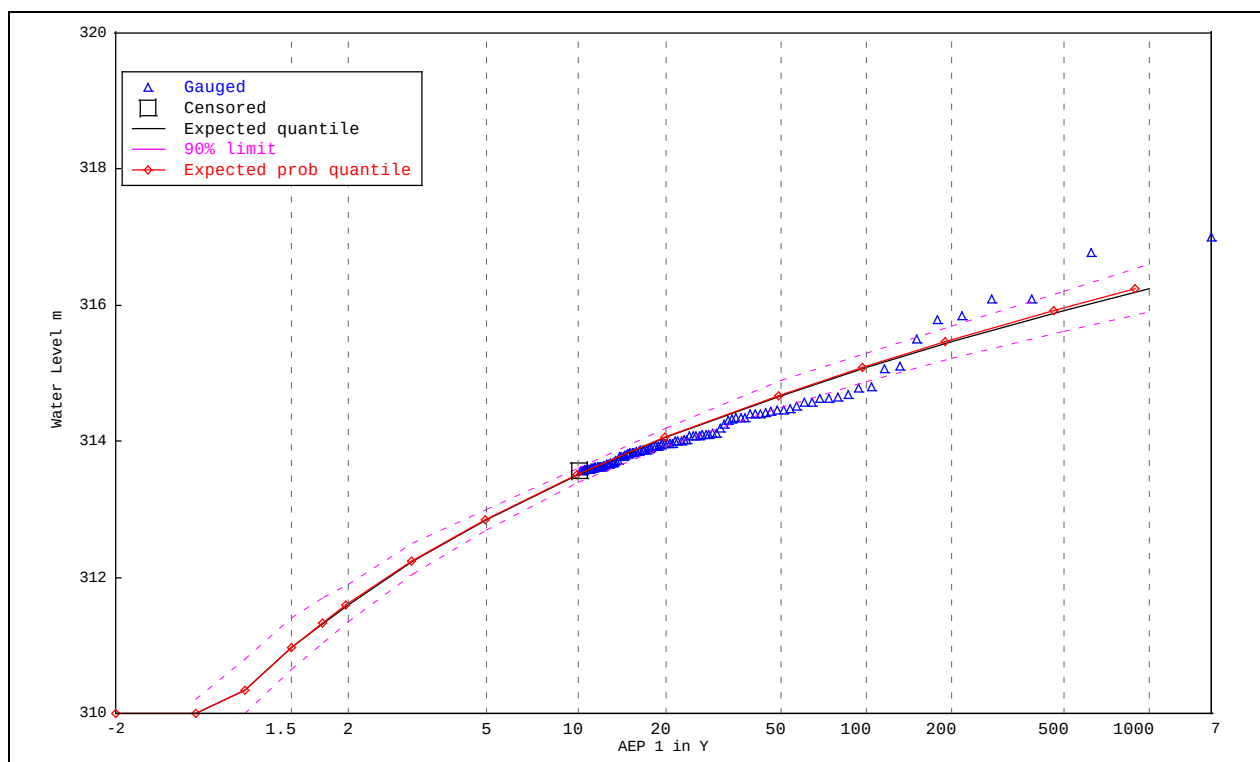


Figure 4.5 Flood Frequency Analysis – Log Pearson Type III

4.2.6 Flood Protection Requirements

The flood protection design requirements for the open cut pit at Bombora (and for Kopai Crescent) should be based on the level of risk which is acceptable to the project during operation of the mine. On the basis that the project is likely to have a low tolerance to risk and the probability of different events over the project life span (refer Table 2.2) it is recommended that the 1% AEP flood depth be used as the basis for sizing flood levee protection around the pit. From the FFA completed, the 1% AEP flood depth within the lake is predicted to be in the order of 315.1 mRL.

The operational flood protection levee crest elevation should also include freeboard to account for factors including uncertainty in the hydrological assessment, potential waves on the lake surface and prevailing winds pushing water to one side of the lake. A nominal 1 m freeboard is recommended on top of the estimated 1% AEP flood level estimated by the FFA. Therefore, the recommended crest elevation for the operational flood protection levee is 316.1mRL.

For reference, the lake inundation elevation following a PMP rainfall event was estimated to be 319.1 mRL.

An overview of the proposed pit layouts is provided in Figure 4.6, showing three separate open cut pits (Northern, Central and Southern pits). Ground elevation profiles for each of the perimeter pit crests are plotted in Figure 4.7 to Figure 4.9, along with the 1% AEP flood level and the proposed pit flood levee elevation (including the freeboard allowance). To achieve a flood protection levee of 316.1 mRL would require in the order of 4 m of fill across the proposed development area which is within the lakebed.

As discussed in Section 3.4, the 2D hydraulic flood model indicates that water levels in lake sub-area L1 are higher than in the remaining lake sub-areas because of the rate of water transfer required from L1 to L2 and the restrictive channel which connections the two lake sub-areas. As such, we recommend that the flood protection levee crest elevation for Kopai Crescent mine area is 0.1 m higher at 316.2 mRL, if this project were to be considered in the future.

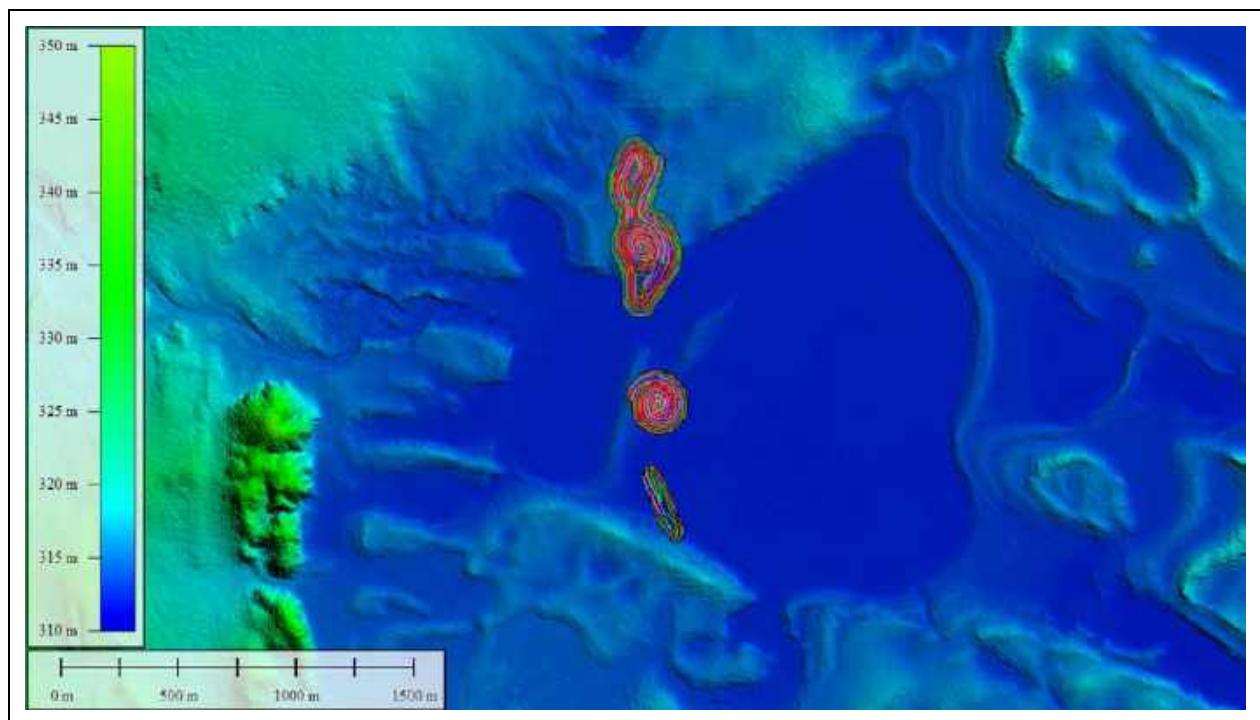


Figure 4.6 Bombora Pit Footprints

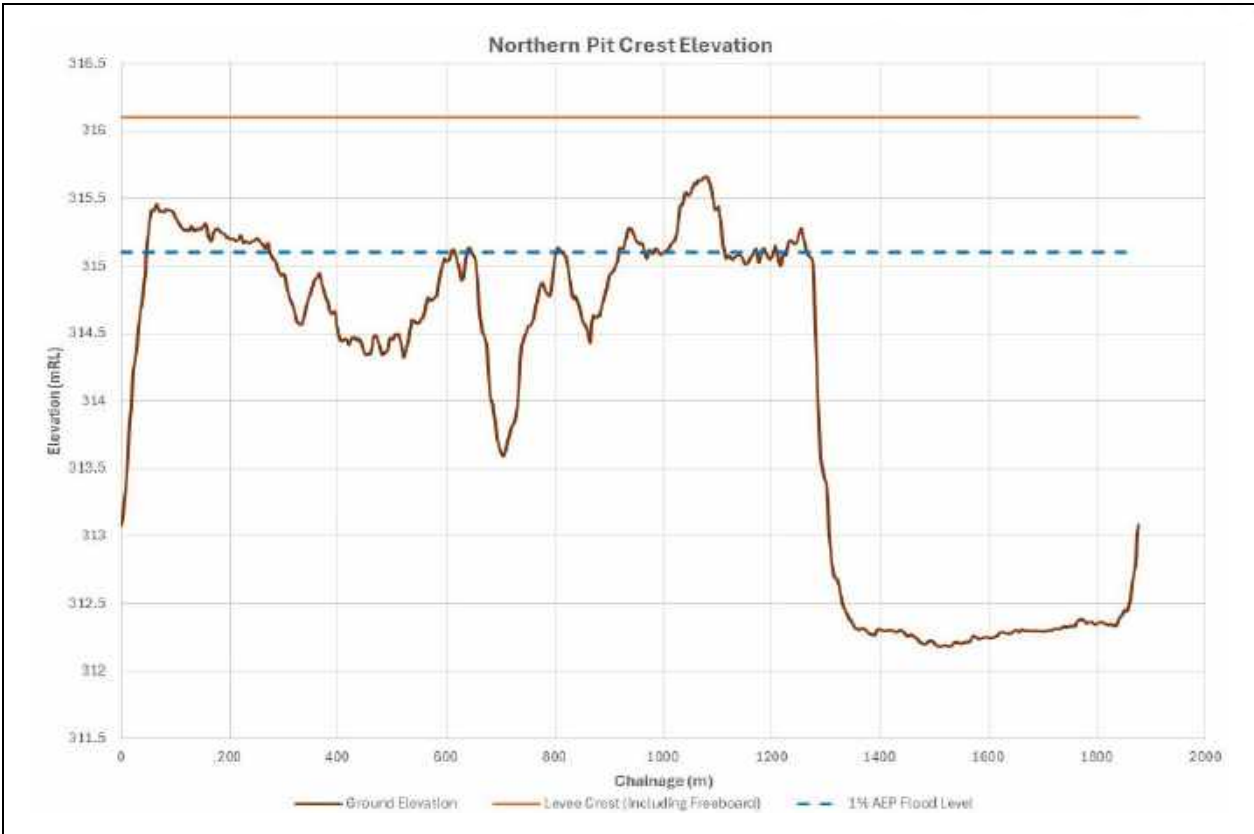


Figure 4.7 Northern Pit - Flood Levee Crest

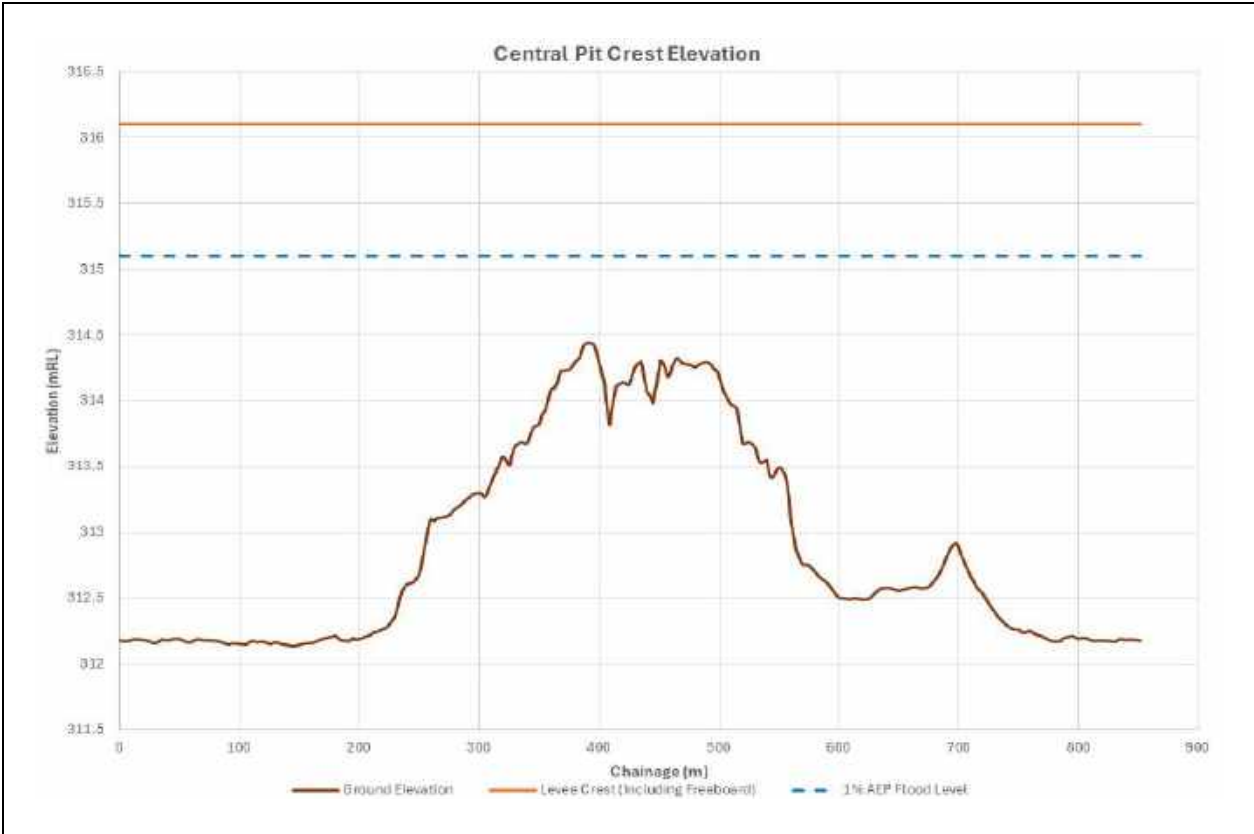


Figure 4.8 Central Pit - Flood Levee Crest

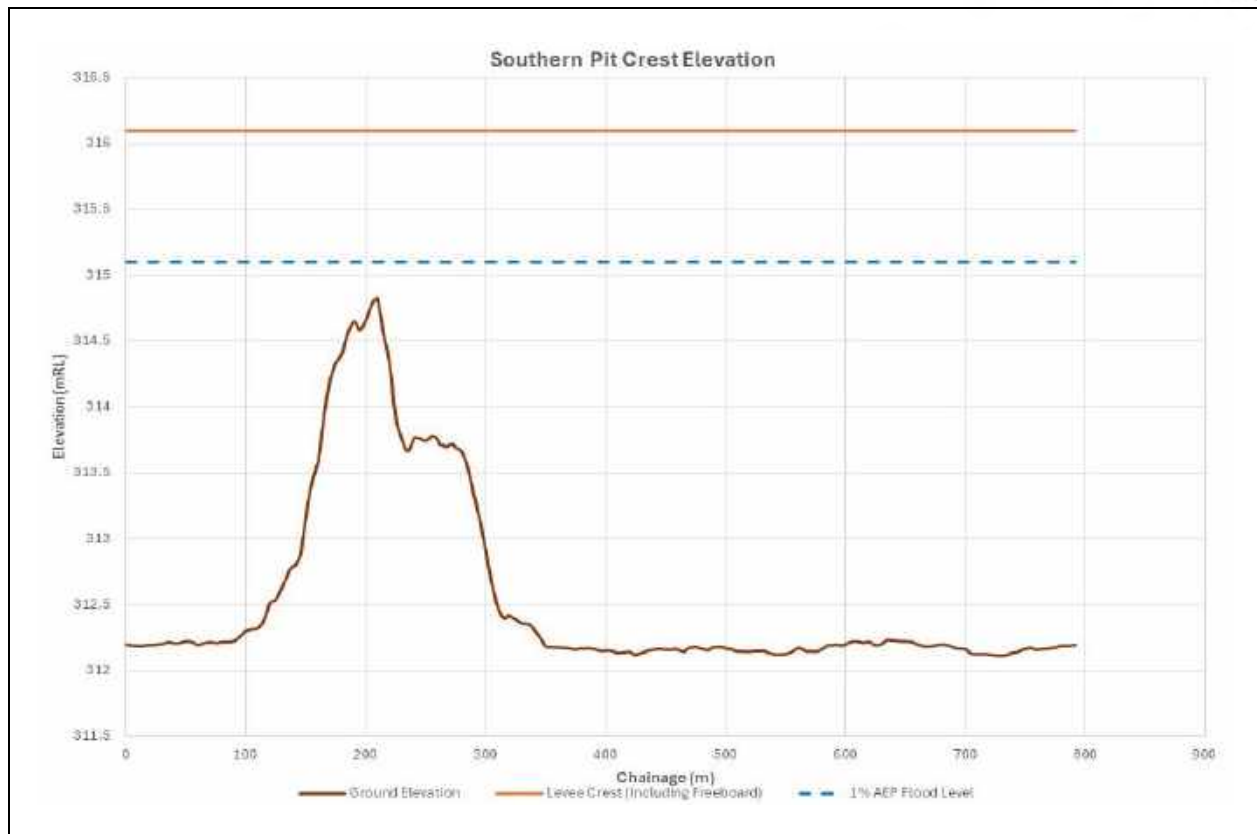


Figure 4.9 Southern Pit - Flood Levee Crest

4.3 Water Balance Limitations

The following main limitations should be noted with respect to the water balance approach:

- Calibration of the model assumed that the rainfall measurements at Cowarna Downs were representation of rainfall patterns at Lake Roe. The SILO Cowarna Downs data is interpolated between 2010 and 2024, such that the rainfall during that period is less likely to be representative. This is likely the reason for the model not being able to replicate water level observations during this period.
- The model assumes that rainfall intensity is even across the full catchment area of Lake Roe. Given the large catchment area reporting to the lake, this is unlikely to occur during a real storm. Some catchment areas would receive more rain than others.
- The logic within the model simplifies what is a complicated hydrological process and adopts common rainfall loss parameters across all catchments, even though it is likely that the runoff responses from different catchments would differ.
- The “observed” lake inundation levels were based on a subjective assessment of satellite images and NDWI data derived from the satellites. It is difficult to estimate the extent of inundation within the lake accurately from these images and observed inundation levels do not generally coincide with when the peak water levels in the lake would have occurred. It is assumed that the observed water level at a point in the lake represents the water level across the full lake extent (even though this is unlikely at shallow inundation depths).
- The response to a rainfall event within the water balance is immediate, whereas in reality, runoff from the catchment may continue to drain to the lake for a number of days after the rainfall event.
- Any impacts of increased salinity within the ponded lake water on evaporation loss rates has not been accounted for within the model.

- A constant seepage loss rate has been applied within the model. Potentially, the rate of seepage may be elevated at higher inundation depths due to increased pressure (depth) head at the lakebed and the likelihood of higher permeability sediments along the banks of the lake.

4.4 Summary

AQ2 has completed a flood assessment of Lake Roe to define flood risks and flood protection requirements for the Bombora Project. AQ2 completed the flood assessment by conducting the following steps:

- Defining catchment areas for Lake Roe.
- Developing hydrological models for three representative catchment areas reporting to Lake Roe to develop representative hydrographs for inflow to the lake for 20%, 1% and PMP rainfall events. Nominal rainfall hyetographs were used to develop the hydrographs on the basis that the peak flow rate estimated within the hydrograph was less important than the volume of water reporting to the lake.
- Scaling the representative hydrographs by catchment area to develop hydrographs for all catchments reporting to the lake.
- Running a 2D flood model for the lake area for 20%, 1% and PMP rainfall events. Each of these model runs was completed for a single design rainfall event.
- Using the 2D flood model to identify flow behaviours within the lake to conceptualise the development of a water balance model for the lake.
- Develop a water balance model for the lake, which involved:
 - Dividing the lake into 9 separate sub-lake areas, each separated from other lake sub-areas but with its own dedicated stage/volume/area curve.
 - Developing a “calibration” rainfall sequence and a long-term synthetic rainfall sequence for use in the model.
 - Reviewing satellite images to estimate past flood levels to allow calibration of the model.
 - Using lake seepage loss estimates which were made during previous assessments to estimate losses from through the lakebed following inundation events.
 - Sourcing SILO evaporation data which should be representative of evaporative losses from a shallow lake.
 - Creating a rainfall loss function to simulate volumetric runoff from the catchments to the lake following the simulated rainfall sequences. The parameters defining the rainfall loss function were selected to ensure that the “calibration” model run approximated the inundation extents estimated from the satellite imagery.
 - Running the model with the calibrated rainfall loss parameters to produce predictions of runoff over a 1,000-year period.
- Using the peak water level predictions from the model to complete a flood frequency analysis which provided estimates of flood levels within the lake at different recurrence intervals.
- Providing recommended flood levee crest elevations to protect the Bombora pit areas.

To provide protection to the pit from a 1% AEP flood event (which has a 10% chance of occurring over a 10-year mine life), a flood levee crest of 316.1mRL (including a 1m freeboard) is recommended.

5. REFERENCES

Bureau of Meteorology (BOM) 2016. Design Rainfall Data System [Online Resource: <http://www.bom.gov.au/water/designRainfalls/revised-ifd>]

Flavell, D. 2012, "Design flood estimation in Western Australia", Australian Journal of Water Resources.

Australian Rainfall and Runoff (ARR) 2019, Book 8: Estimation of Very Rare to Extreme Floods, Chapter 4.3.4.3.

Knight Piesold-Lake Rebecca Gold Project Tailings Storage Facility and Associated Infrastructure Pre-Feasibility Study Surface Water General Arrangement Plan (Lake Roe Mining Area). Report Number: PE801-00402/03. Figure 9.3.

APPENDIX A
LAKE ROE HYDRAULIC BEHAVIOUR DESK STUDY

Memo

To	██████████	Company	Ramelius Resources
From	██████████	Job No.	514C
Date	09/12/2024	Doc No.	010a
Subject	Lake Roe Hydraulic Behaviour Desk Study		

Dear Helen,

Please find below our assessment of the ponding behaviour in the vicinity of the proposed Roe Mining Project.

1. BACKGROUND

Ramelius Resources' proposed Roe Mining Project is located in the Goldfields Region of Western Australia, approximately 100 km due east of Kalgoorlie and circa 45 km southwest of the Rebecca Gold Project. The Project is proposed to consist of the Bombora and Kopai Crescent open-cut pits. Both proposed pits are proximal to Lake Roe, with the Kopai Crescent pit footprint extending partially over the Lake Roe basin.

As part of the assessment for potential pit dewatering requirements, Ramelius has asked AQ2 to complete following:

- Characterise the ponding within Lake Roe with respect to frequency and duration of inundation.
- Estimate potential seepage rates from the lake to the underlying groundwater during ponding events.

To understand the hydrological behaviour at Lake Roe, the following was completed:

- Climate characteristics such as daily rainfall, evaporation, and temperature data were defined.
- Inundation events were identified from satellite imagery between 1993 and 2024.
- Inundation events and rainfall records were correlated to identify the climate drivers for inundation.
- Areas which are prone inundation were identified.
- Seepage analysis for the salt pans for different inundation events.
- Potential discharge location(s) for surplus dewatering were assessed, by estimating the rate at which ponded water can lose water to evaporation at different locations.

2. CLIMATE

Nearby rainfall, evaporation and temperature climate data were assessed to aid in characterising Lake Roe's hydrological behaviour. The climate data used for this analysis was obtained from the Scientific Information for Land Owners project (SILO) (Jeffrey et al. 2001), as it provides temporally complete daily climate parameters from 1889 to the present, for any location in Australia to the closest 0.05° latitude/longitude (decimal degrees). SILO compiles all valid data for the input location and spatially

interpolates, patches, and calculates long-term averages from nearby raw observational data to provide a complete dataset.

SILO data from Cowarna Downs station (BOM Station ID 12220) was considered the most representative analogue of the climatic conditions of the Lake Roe area based on proximity and observed data availability. The station is situated 40 km southwest of Lake Roe's centre (refer Figure 2.1), with rainfall records available between 1970s to 2010. A SILO rainfall dataset was obtained between 1970 and October 2024.

It was noted the Cowarna Downs station SILO dataset:

- Likely best represents Lake Roe's rainfall for 1970–2010, when actual measurements were taken at the weather station.
- Rainfall data outside these years would be interpolated from nearby stations and is likely to be less representative of Lake Roe catchment's rainfall.
- Used SILO's interpolation techniques to derive temperature and evaporation values as this was not recorded at the Cowarna Downs station. The nearest station this data was recorded was at Kalgoorlie 110 kms away.

The closest long-term weather station to the Lake Roe Project Area where rainfall has been recorded is Karonie weather station (BOM Station ID 12041), located approximately south-south-west 25 km away from Lake Roe's centre point; however, there are no observed data from 1990s onwards. Gindalbie station (BOM Station ID 12247), located 95 km northwest, has the largest timespan of observed data, but it was considered too distant to be a realistic analogue of Lake Roe's weather conditions. This weather station had recorded rainfall peaks which were greater in magnitude than Karonie and Cowarna Downs.

A summary of the Cowarna Downs station SILO dataset is as follows:

- Grid reference for the Cowarna Downs station location: -31.00933 degrees south and 122.35564 degrees east.
- Spanned period of 1970s to October 2024.
- Long-term average annual rainfall of 260.7 mm.
- Annual average Class A pan evaporation rate of 2,420 mm and an annual average Morton's shallow lake evaporation rate of 1,560 mm (from SILO interpolation at Cowarna Downs).
- Long-term average maximum temperature of 26 °C.
- Monthly average rainfall, Class A pan evaporation, Morton's shallow lake evaporation, maximum and minimum temperature (1970–2024) as shown in Figure 2.3.



Figure 2.1 Regional Map of the Eastern Goldfields, including Lake Roe, Cowarna Downs, and Kalgoorlie

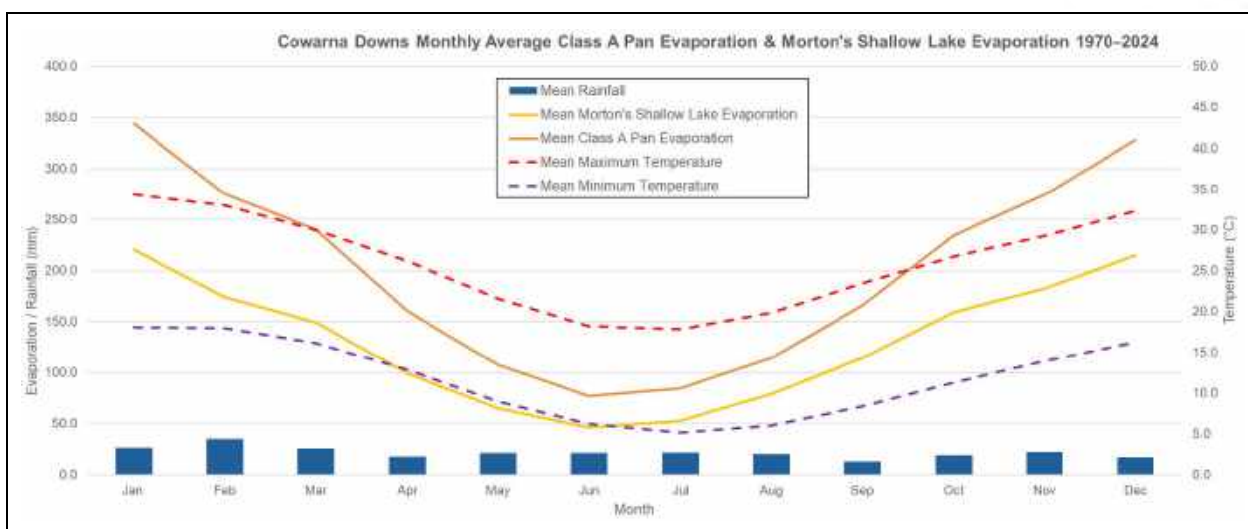


Figure 2.2 Cowarna Downs Monthly Average Climate Characteristics (1970–2024)

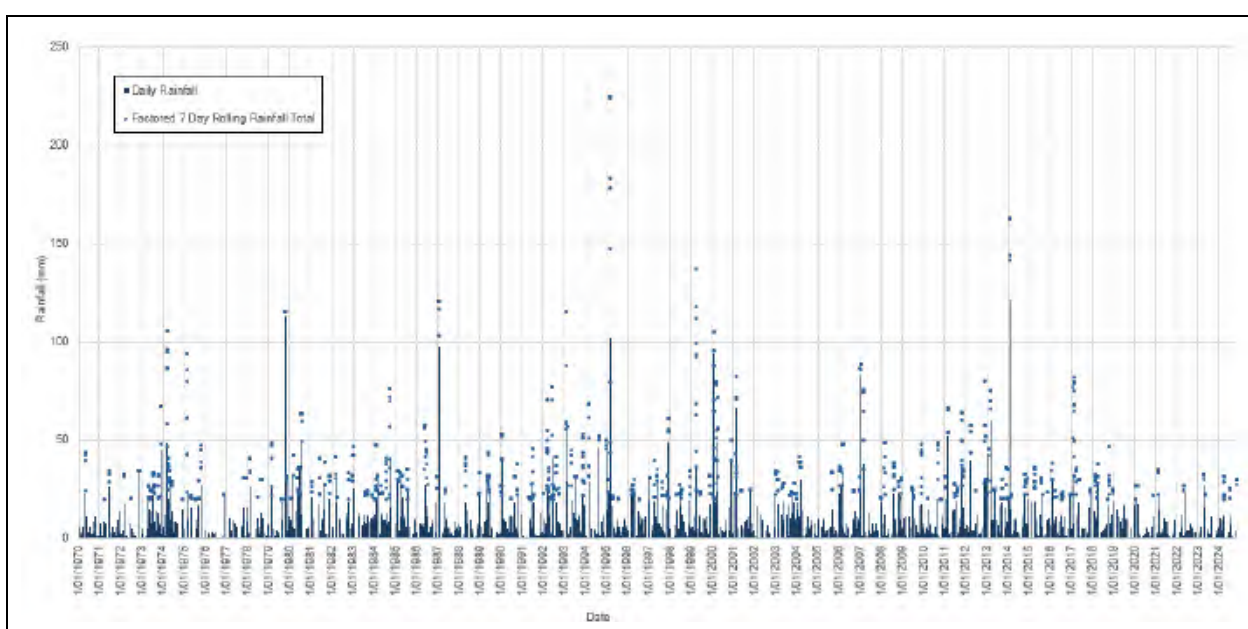


Figure 2.3 Cowarna Downs Rainfall Metrics (1970–2024)

3. SATELLITE IMAGERY ASSESSMENT

The Lake Roe inundation extents and frequency were estimated between 1993 and 2024 using satellite data, specifically true colour imagery and Normalized Difference Water Index (NDWI) data from Sentinel, Landsat and Google Earth. Data availability and aerial image quality varied considerably throughout the 1990 to 2024 study period. The inundation extents were compared to the Digital Elevation Model (DEM) of the lake to estimate ponding depths with time.

As shown in Figure 3.1, Lake Roe consists of a series of small salt pans that appear to be separated by (relatively) high points, some of which appear to be sand dunes, based on assessment of aerial imagery and LiDAR surface elevation data. Each of the small salt pans have a local low point where water may pool.

Figure 3.1 denotes the nominal names used within this study for some salt pans relevant to the assessment. The main catchment reporting to the lake comes from the western side of the lake, with

other, smaller catchments reporting to the lake around the lake perimeter. Following large enough inflow events, the individual salt pans may become hydraulically connected.

Confidence in the estimated inundated depths (from observed satellite imagery) varies, and the date of recorded imagery may not coincide with the date of the actual peak inundation extent. Frequent Sentinel data between 2017 and 2024 provides the most reliable period for analyses. Between 2013 and 2017, Landsat (satellite) data are inconsistent with some gaps due to Lake Roe's eastern area falling on a different tile without imagery and satellite imagery strips (Landsat 7) giving an incomplete picture. Pre-2013, imagery from Landsat is less frequent, with data pre-2008 missing for extended periods and/or has insufficient resolution to confidently interpret. Notably, there is a Landsat data gap from late 2011 to early 2013, meaning that any lake inundation due to rainfall events during 2012 are not estimated.

3.1 Inundation Observations

The following observations were made at Lake Roe during the satellite imagery assessment:

- Catchment runoff responses causing at least some inundation in Lake Roe were generally observed when rainfall exceeded approximately 25 mm.
- In small inundation events where widespread flooding across the full lake is not prevalent (i.e., following rainfall depths in the order of 25 mm), the water levels Pan A were estimated. Appendix A presents the estimates of inundation water levels from satellite observations within salt pans B and D for reference.
- Visible widespread inundation across constituent salt pans was typically observed when a rainfall event occurred over multiple days, with total rainfall over the event exceeding 50 mm. Widespread inundation due to a large, singular rainfall day event could not be concluded as there were not any events where daily rainfall exceeded 50 mm within the rainfall data, notwithstanding this may be possible.
- The magnitude of inundation (water level) can vary between constituent salt pans; however, when widespread inundation is observed, the timing of the inundation is generally consistent across the lake.
- Rainfall in early 1995 and 2014 presents the largest rainfall events within the observation period, and these correlated with observations of large inundation events.
- Inundation responses in Lake Roe were generally observed 1 to 3 days after initial rainfall was recorded (noting that satellite observations are not available on a daily basis).

There is a level of uncertainty when correlating satellite observations and rainfall recorded at Cowarna Downs given the distance between the weather station and the lake. Rainfall is highly temporally and spatially variable in the Goldfields and it is likely the rainfall that occurs within the Lake Roe catchment differs from that recorded at Cowarna Downs. Larger events are likely to be more widespread than smaller events, but there is still likely to be a difference between the rainfall recorded at Cowarna Downs and the effective rainfall on the Lake Roe catchment (given the size of the Lake Roe and the Lake Roe, it is likely that rainfall will be variable over the catchment and lake as well). Given the limited spatial availability of rainfall records in the Goldfields, Cowarna Downs is still considered to best represent the rainfall that may have occurred within the Lake Roe catchment.



Figure 3.1 Lake Roe Study Area

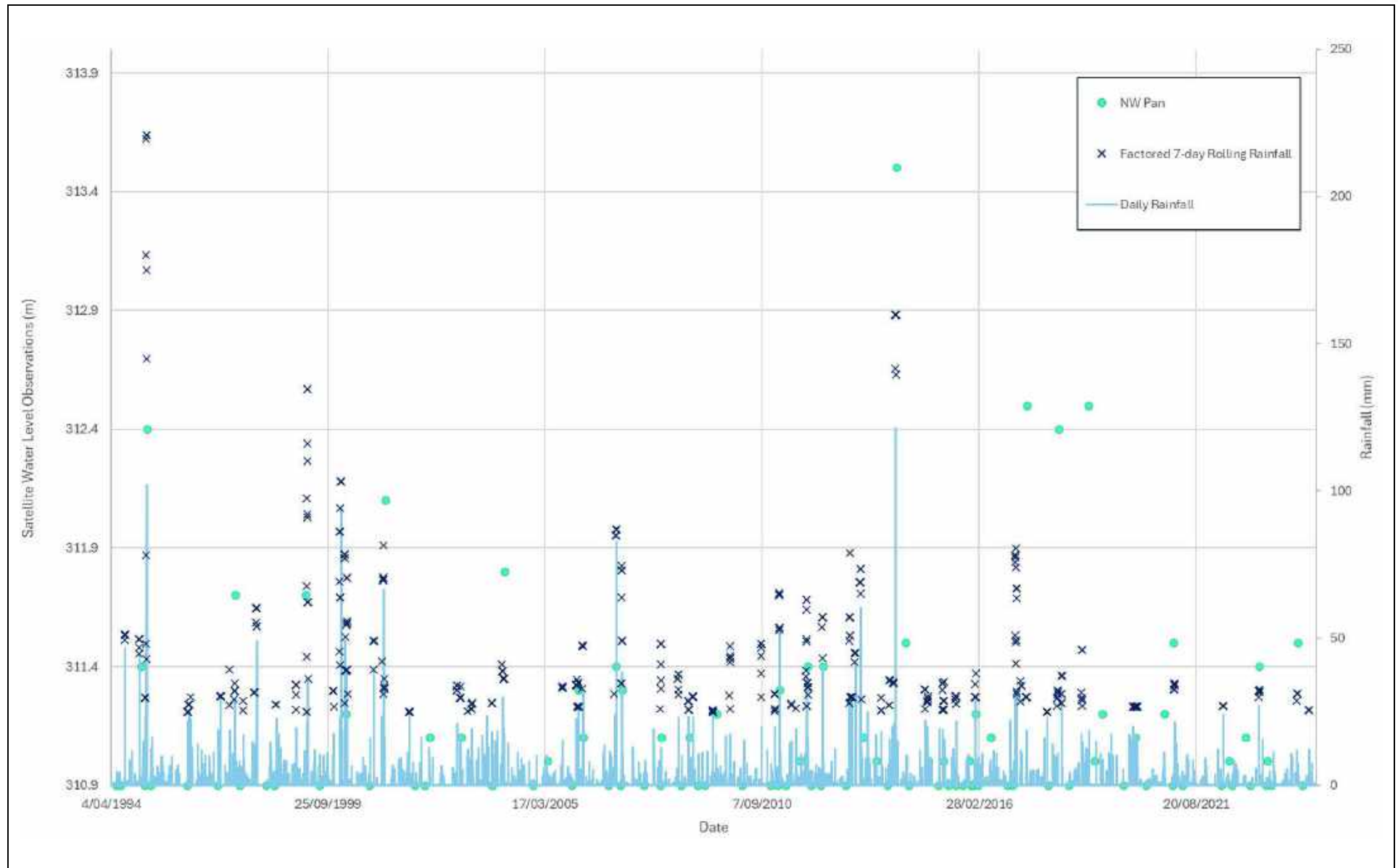


Figure 3.2 Lake Roe Inundation Depths (Pan A) vs Rainfall Data

3.2 Correlations to Intensity–Frequency–Duration (IFD) data

The observed rainfall events since 1993 were correlated with the available Bureau of Meteorology (BoM) intensity–frequency–duration (IFD) data for Cowarna Downs. The 63.2% AEP event (which approximates a large rainfall event which you would expect would happen every year) rainfall depths over 1–3 days of 31.1–38 mm (refer Table 3.1) correlates with the rainfall that results in smaller inundation events observed at Lake Roe in most years.

Larger, rarer rainfall events recorded typically since 1992 at Cowarna Downs (32 years inclusively), seemed to have occurred more frequently than the IFD data would suggest. This is shown in Figure 3.3, where factored rolling rainfall totals from the Cowarna Downs rainfall record are compared to the IFD curves. The plot indicates that, for example, there were 5 x 24-hr (1,440 minutes) duration rainfall events which exceeded the 5% AEP curve where it would be expected that ~2 events of this magnitude may occur in a 32 year period (noting the IFD curves presented do not account for climate change and are typically 10–15% less than what current climate conditions would suggest).

In the last 32 years, there were also 5–6 large inundation events observed in satellite imagery (equating to a 15–20% probability of occurring in a given year). Based on the IFD data, it would be expected that large inundation events would require more than 60 mm of rainfall to occur, which is close to what has been estimated from the inundation estimations (50 mm).

Table 3.1 Cowarna Downs intensity–frequency–duration (IFD) data

Duration	Duration in min	Annual Exceedance Probability (AEP)						
		63.20%	50%	20%	10%	5%	2%	1%
24-hour	1,440	31.1	37	58.6	76.2	96.1	125	150
30-hour	1,800	32.6	38.9	61.8	80.8	102	133	160
36-hour	2,160	33.8	40.4	64.5	84.5	107	140	168
48-hour	2,880	35.7	42.6	68.5	90.2	115	150	180
72-hour	4,320	38	45.5	73.7	97.5	125	163	195
96-hour	5,760	39.5	47.3	76.9	102	131	170	204
120-hour	7,200	40.5	48.6	79	105	134	174	209
144-hour	8,640	41.4	49.7	80.5	106	136	177	212
168-hour	10,080	42.1	50.5	81.6	108	137	178	213

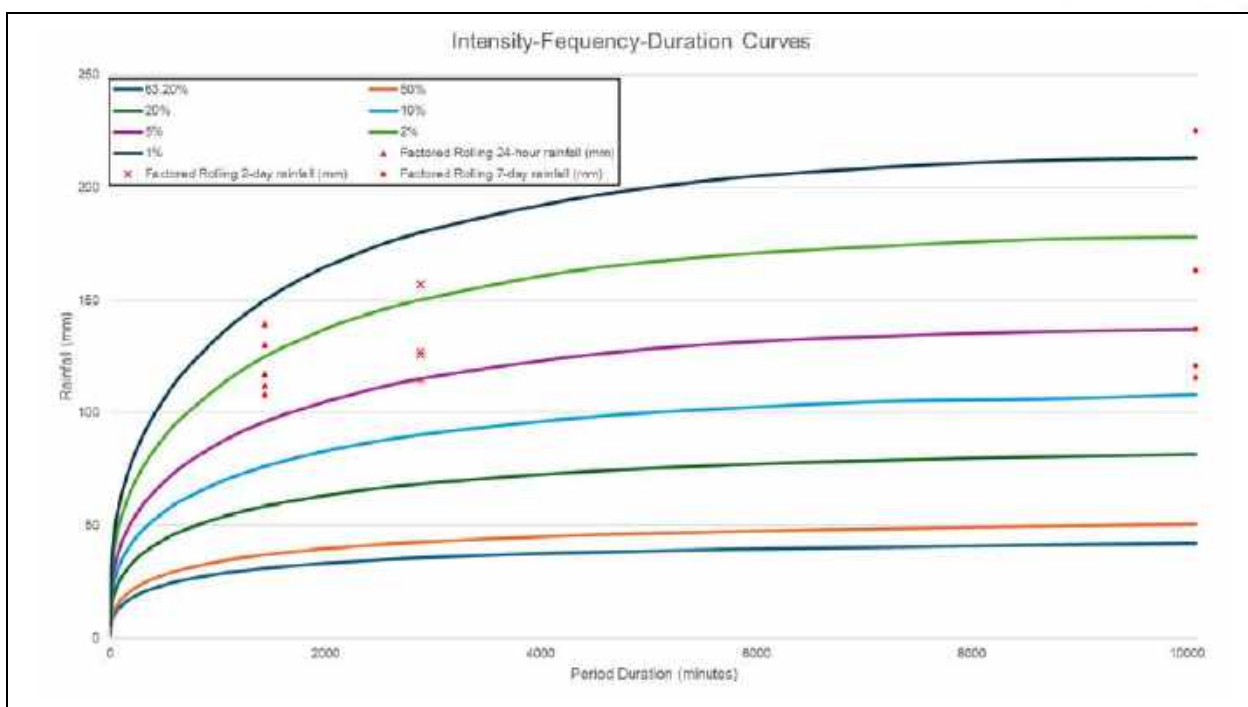


Figure 3.3 Cowarna Downs Intensity-Frequency-Duration (IFD) and Rolling Rainfall Data

4. SEEPAGE ASSESSMENT

Water level recession curves at Lake Roe were predicted following inundation events using a 1D water balance calculation and compared to the observed recession of standing water in the lake from the satellite imagery assessment. As shown in Figure 4.1, Figure 4.2 and Figure 4.3, three key inundation events were identified for assessment in years 1995, 2014 and 2017. The assessment was used to assess the potential seepage from the lake to the subsurface. During the circa 32 years period examined, Lake Roe hosted standing water for various lengths of time (typically in the order of months) after large rainfall events. The water level recession observed from satellite aerial imagery within Lake Roe is assumed to be driven by evaporation and (potentially) seepage into or from the subsurface.

The completed assessment is summarised as follows:

- A stage vs area relationship was derived for different salt pans from the provided LiDAR data.
- Satellite imagery was reviewed to identify periods of significant inundation within the salt pans, nominally years 1995, 2014 and 2017 were chosen as the best data for assessment.
- The inundation area within the salt pans was estimated during period that the lake level recedes when satellite imagery was available (typically in the order of weekly images, but many were unable to be used due to clouds, poor quality etc.).
- The stage area relationship was used to derive estimates of lake water levels with time during the recession period.
- A 1D water level balance calculation was completed using the following formula:

$$\text{Water Level} = \text{Water Level}_{\text{previous}} \mp \text{Rainfall} - \text{Evaporation} - \text{Seepage}$$
- The daily 1D water balance calculation used the following:
 - The water balance was set to start at the peak lake water observed following the rainfall event.
 - Daily evaporation losses from the lake in the 1D water balance calculation have been predicted using Morton's shallow lake evaporation estimates sourced from the SILO database for the site. These evaporation estimates vary on a daily basis based on meteorological observations.

- If a small rain event occurred during the water level recession period, the depth of rainfall was added to the running water level total. This assumed that no catchment runoff reported to the lake, with only incident rainfall on the lake surface reporting to the lake. If large rainfall events did occur during the recession, then the observations weren't used.
- A nominal seepage loss rate was applied and adjusted such that the modelled recession approximates the observed recession.

The seepage rate that enables water level predictions to approximate the observed recession of standing water within Lake Roe is approximately 3 mm/day. Noting:

- It was difficult to interpret when Lake Roe was completely dry in the satellite imagery due to image quality, partial (or full) cloud cover and the frequency of imagery capture. The appearance of a salt crust on the lake floor in satellite photography was determined not to be a reliable indicator of the entire lake system being fully dry, as, on occasions, these observations concurred with periods where NDWI imagery indicates standing water.
- It is interpreted that groundwater does not contribute to inflow into the Lake Roe, and surface water recession / periodic standing water within the claypan(s) is solely accounted for by evaporative losses and seepage.
- There is a degree of uncertainty in the evaporation losses applied and in the estimation of lake inundation depths. Additionally, there is uncertainty in what the rainfall which falls on the lake is compared to what was measured at Cowarna Downs.

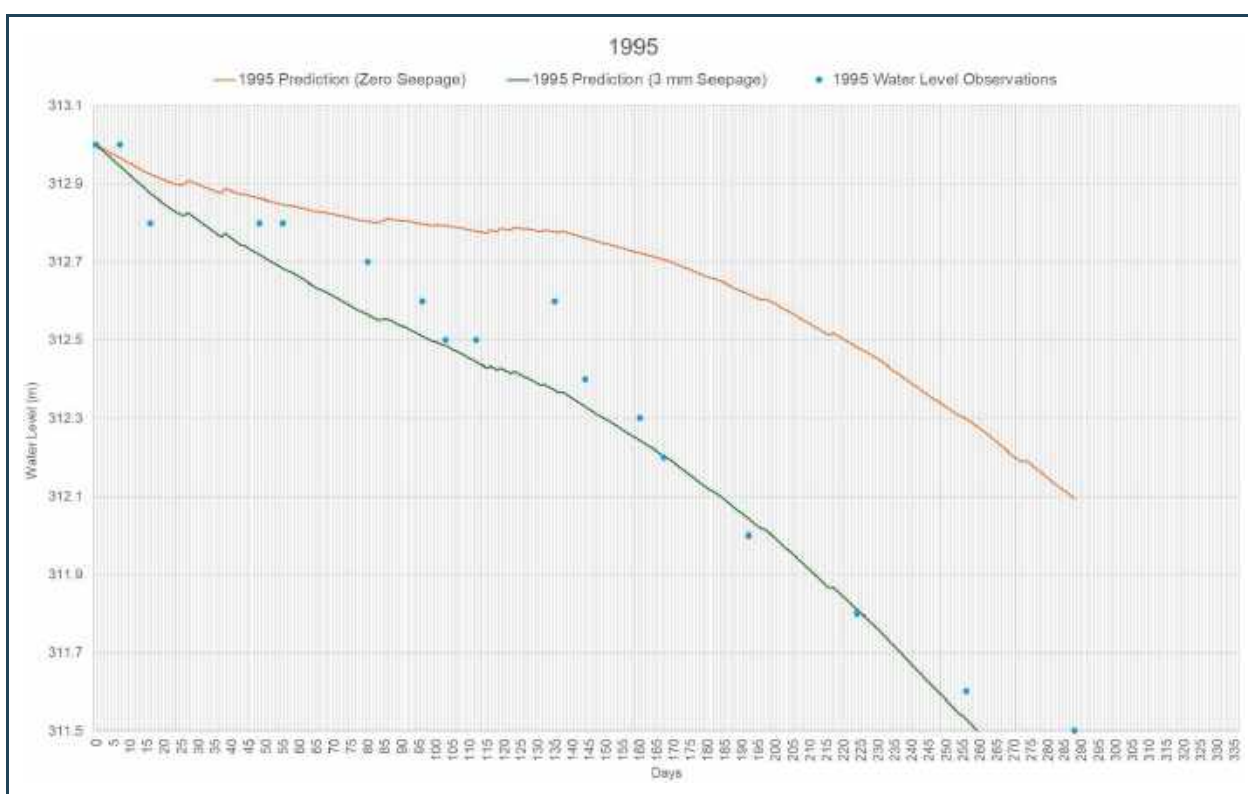


Figure 4.1 Observed vs Predicted Flood Recession Curves (March 1995)

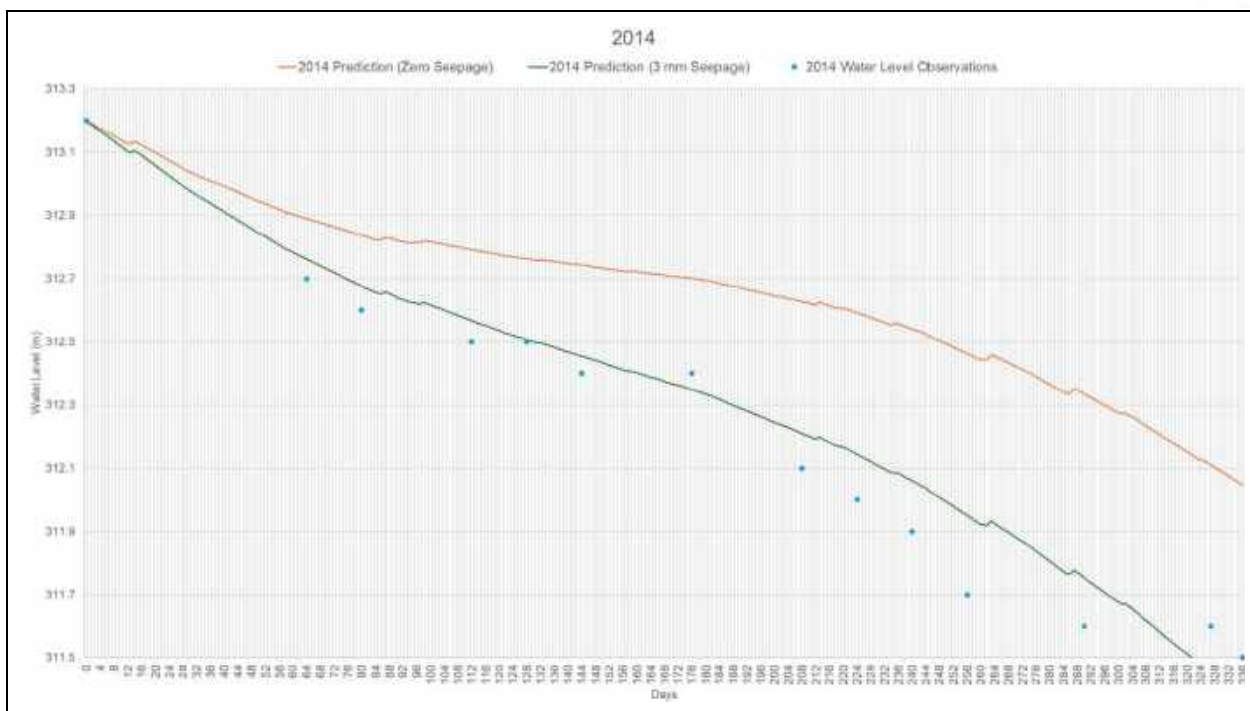


Figure 4.2 Observed vs Predicted Flood Recession Curves (January 2014)

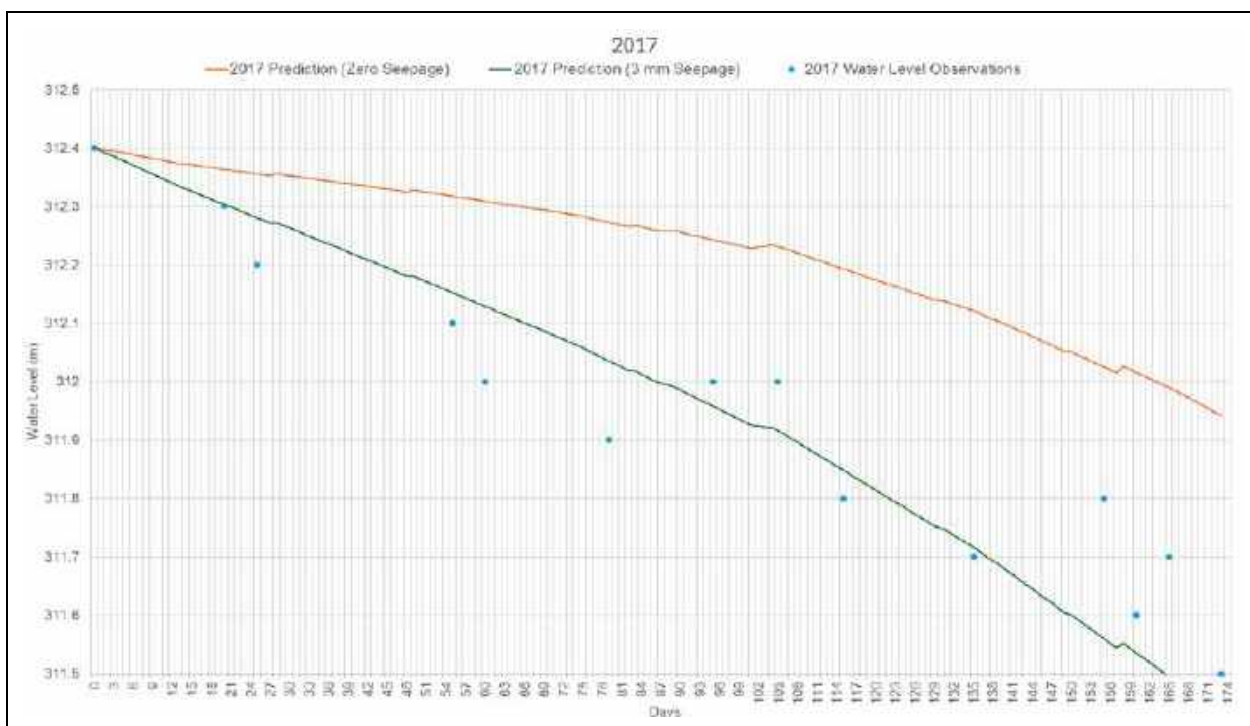


Figure 4.3 Observed vs Predicted Flood Recession Curves (May 2017)

5. POTENTIAL DEWATERING DISCHARGE LOCATIONS

A number of potential locations to receive surplus dewatering have been identified and are shown in Figure 3.1. These locations have chiefly been identified for their proximity to the project area. For each of the potential receiving salt pans, the following has been estimated using the DTM/aerial imagery:

- Maximum storage/inundation elevation – it is assumed that any salt pan could only be filled to either:
 - 0.5 m below the vegetated shoreline of the salt pan.
 - 0.2 m minimum below the point at which the salt pan overtops to the adjacent salt pan (to confine the impact to a single pan).
- Maximum inundation surface area of the salt pan at the maximum inundation elevation.
- Maximum inundation storage volume of the salt pan at the maximum inundation elevation.
- Evaporative loss from the maximum lake surface based on Morton's Shallow Lake Evaporation rate in July, with a nominal reduction in this evaporation rate of 30% adopted to approximate the impact the salinity of the dewatering discharge may have on the evaporation rates.
 - Note that higher evaporation losses would occur during other months, such that the estimates of loss rates are conservative. If there is sufficient balancing storage in the salt pan, the annual average evaporation rate could be applied (rather than the July evaporation rate).

A summary of these characteristics for each salt pan is provided in Table 3.2. The advantages / disadvantages of the identified discharge locations are as follows:

- Option A (Pan A) – This pan is close to the proposed Kopai Pit development and provides a large area for storage/evaporation of surplus dewatering. The main disadvantage of this option is that the largest surface water catchments to Lake Roe discharge into this salt pan, and there is the potential that accumulated salt will flow into the downstream pans during large runoff events (i.e., the impact won't be contained to the one pan). Additionally, the discharge of dewatering to this lake may result in recirculation to the Roe Pits, given their proximity to the lake.
- Option B (Pan B) – This pan is close to Bombora Pit development and would contain the surplus discharge to a smaller area compared to Option A. Similar to Option A though, the southwest pan commands a significant upstream catchment, and there is therefore the potential for accumulated salts to be transported to salt pans to the east. Additionally, the discharge of dewatering to this lake may result in recirculation to the Bombora Pits, given their proximity to the lake.
- Option C – there are a number of salt pans which appear to be hydraulically isolated from the remainder of Lake Roe by sand dunes, including a roundly shaped pan. These are located further away from the mining areas than Option A and B but may allow impact to be localised to pan. The choice of pan could be based on the rate of dewatering that needs to be managed, with different potential evaporative losses achievable at each pan based on their available surface area. Pan C has been nominally assessed for this option.

Environmentally, Option C is the preferred option for discharge as it would isolate the impact of dewatering discharge to the isolation Pan C (subject to confirmation that Pan C has no environmental value which differs from the rest of the lake). However, Option C provides the lowest potential for ongoing loss from the ponded water due to evaporation.

If impact containment is not a priority for the dewatering discharge, Option A may be preferred as it has the highest likelihood of accumulated salt being washed downstream into other parts of the lake during runoff events.

Discharge to Pan D wasn't considered due to distance from the operations but could also be considered if the preferred area of impact was the furthest point downstream in the lake chain.

Further assessments of discharge locations should consider the likely magnitude and duration of discharges to the lake, as well as the potential storage volume in each of the considered discharge locations. A water balance of the pan area could be completed, taking into account the stage/volume/area relationship of each of the pan options, to predict how each of the pans may fill with time.

Table 5.1 Dewatering Discharge Options

Target	Invert RL	Shoreline RL	Overflow Point RL	Max Inundation RL	Area (km ²)	Loss Potential m ³ /day	Loss Potential l/s
Option A	310.9	313	312.2	312.0	7.1	8,500	98
Option B	311.6	312.6	312.4	312.1	2.5	3,000	35
Option C	310.7	313.5	313.6	313	1.1	1,000	16

Notes:

Loss potential rounded to nearest 1000 m³/day

6. SUMMARY

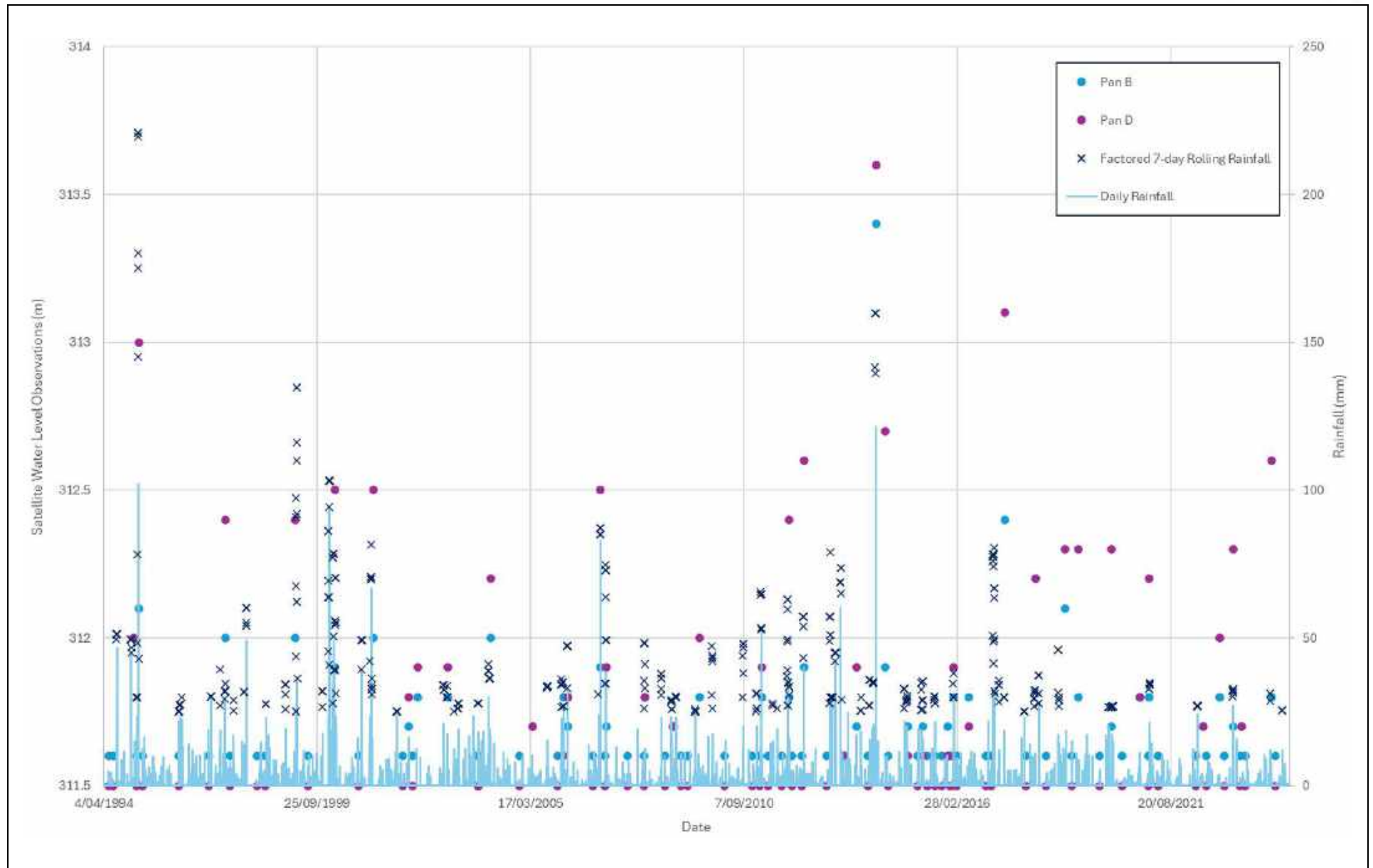
AQ2 has completed an assessment of available climate data sources for Lake Roe area, a satellite imagery assessment of inundation and other hydraulic behaviour, estimations of potential discharge volumes, and a seepage assessment. Key findings are as follows:

- Pan A, adjacent to Kopai Pits, has been observed to hold runoff in most years. Significant inundation is observed to occur in the order of once every 5 years.
- Following significant inundation events, the lake may hold water for months.
- Seepage rate analyses indicate that in the order of 3 mm/day of seepage may occur from the lake bed when it is inundated.
- Three locations were considered for the discharge of surplus water from the project. Environmentally, Pan C is considered the most favourable, as it would confine the discharge to a single part of the lake. However, Pan C has the smallest surface area and therefore the lowest potential to lose discharged water via evaporation (in the order of 15-20L/s).
- Further assessment work should be completed on the discharge options when surplus water magnitudes and duration of discharge are estimated.

We trust that this assessment meets your requirements. Please contact us should you require further information.

Author: SF/JS (06/12/2024)
 Checked: MN (06/12/2024)
 Reviewed: MN (09/12/2024)

Attached: Lake Roe Inundation Depths (Pans B and D)



Lake Roe Inundation depths (Pans B and D)



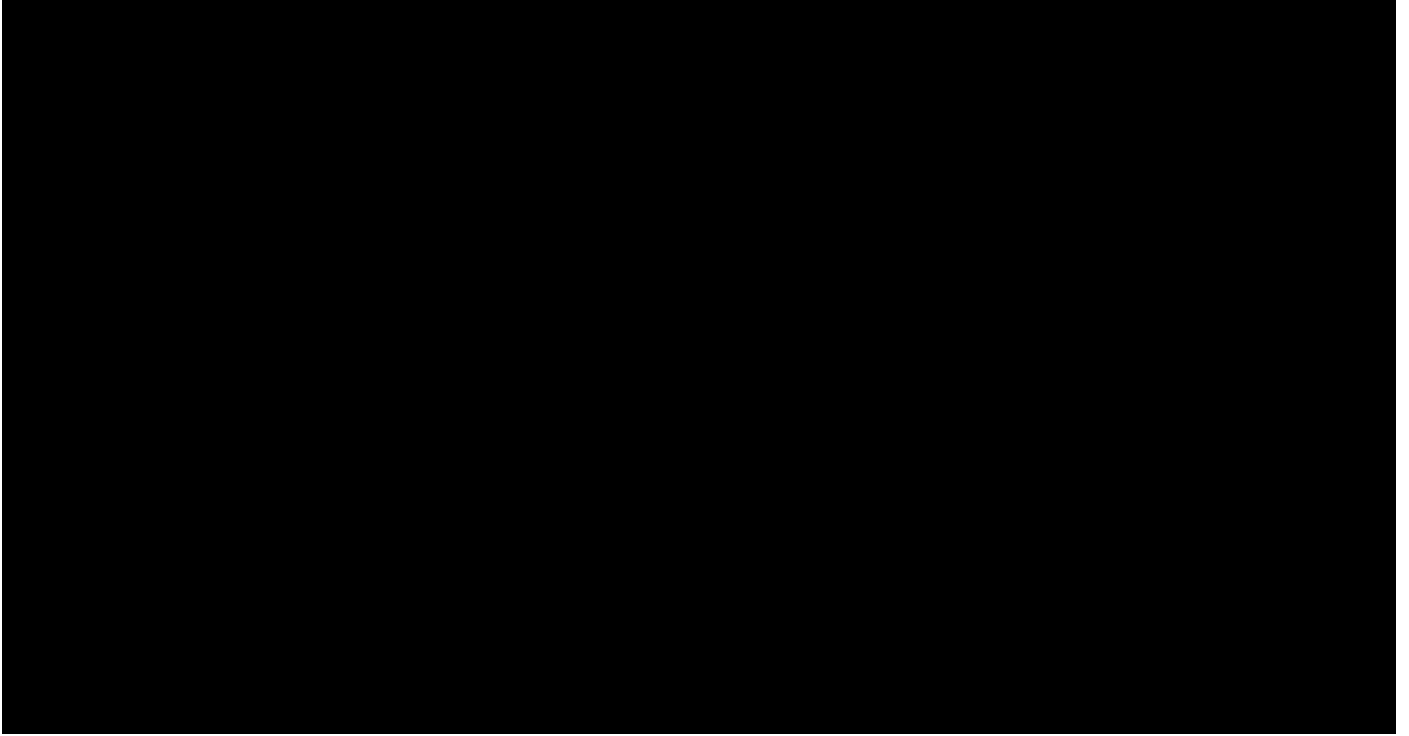
LAKE ROE GOLD PROJECT - BASELINE SOILS ASSESSMENT

PREPARED FOR **BREAKER RESOURCES**

2019

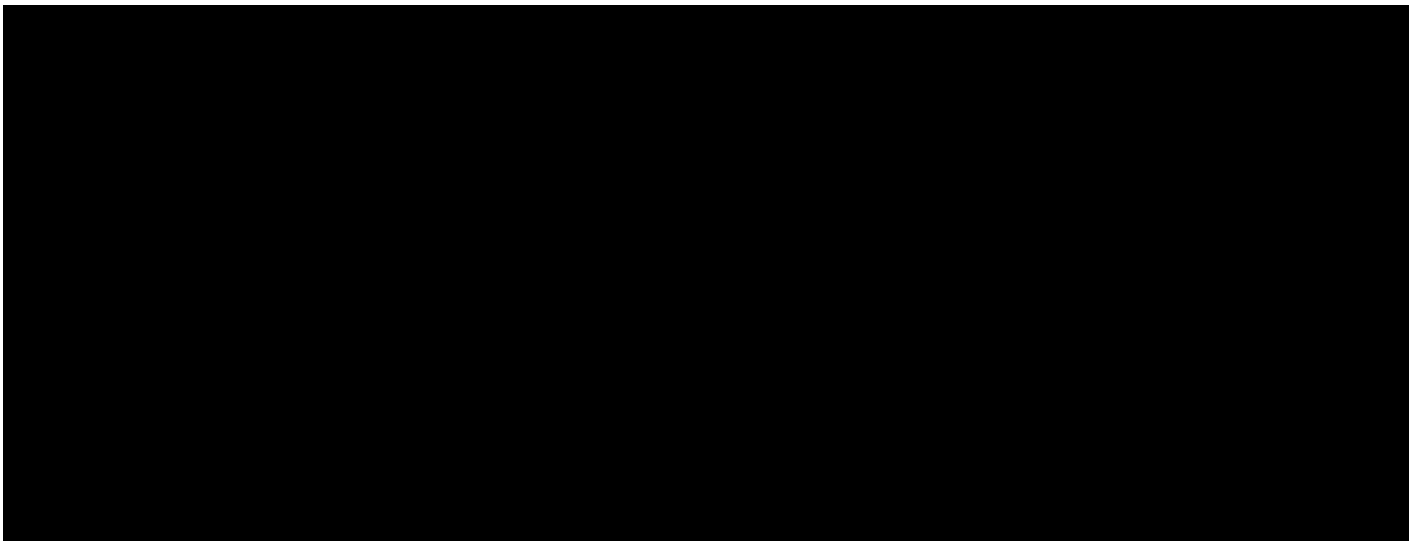
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PERTH

41 Bishop Street, JOLIMONT, WA 6014
TEL: +61 (08) 9388 8799



Executive Summary

Breaker Resources NL (Breaker) propose to develop the Bombara gold deposit (the Project) into an operational mine, following successful exploration drilling campaigns. The Project is located approximately 100 km east of Kalgoorlie, in the Eastern Goldfields region of Western Australia, and lies across a portion of Lake Roe, a large, naturally saline playa. The Study Area is represented by tenement MLA5 (3749 ha), which includes the proposed development envelope (999 ha) and the proposed pit (55 ha). Stantec Australia Pty Ltd (Stantec) were appointed by Breaker to undertake a Baseline Soil Assessment of the Study Area as part of the baseline environmental studies for the Project.

Forty soil samples were collected in total, encompassing two depth intervals (0 to 10 cm and 10 to 30 cm) at 20 locations within the Study Area. The chemical and physical properties of the samples were assessed at either the Stantec in-house Laboratory or ALS Environmental Laboratories.

The soils within the Study Area were variable with ten soil resource groups identified, characterised and indicatively mapped. These soil resource groups were refined into seven Soil Management Units (SMU) which have been mapped and recommendations for management provided. There were substantial differences in physical characteristics (texture, stability, soil strength and water retention) between soils of the Study Area, and in chemical characteristics, particularly salinity and sodicity. This variation is natural and when soils are left *in-situ*, none of these characteristics reported are of environmental concern. However, once disturbed and moved some of these characteristics can present problems and limit the potential re-use in rehabilitation.

There was significant variation in the stability of soils from the Study Area ranging from stable and therefore suitable for re-use, to highly unstable and dispersive. The material from three of the SMU's is not recommended for re-use primarily due to issues with instability. Some of the SMU's also had chemical characteristics that have the potential to restrict plant growth and negatively impact surrounding environments (e.g. extremely saline and/or sodic). These soils have been recommended to be segregated from the more favourable soils.

Soils with partial or variable stability are not recommended to be re-spread on slopes due to erosion risks and should only be used in areas with similar soil chemical properties so that potential transport of sediment and/or leachates is not likely to change background levels in surrounding areas.

Currently, the chemical characteristics of water and sediment from Lake Roe have not been determined hence the potential impact of transported soil and/or leachates entering the lake system can not be assessed. This is proposed to be addressed in an Aquatic Ecology Baseline Study expected to be conducted in 2019. Until the characteristics of the lake ecosystem are known, a conservative soil management approach is recommended that minimises the likelihood of soil material and leachates from entering the lake or peripheral wetlands.

Abbreviations

ABC	Ambient background concentration
ACL	Added contaminant limit
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ASRIS	Australian Soil Resource Information System
BCM	Billion cubic metres
BoM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DER	Department of Environmental Regulation
DIIS	Department of Industry, Innovation and Science
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines and Petroleum
dS/m	deciSiemens per metre
EC	Electric conductivity
eCEC	Effective cation exchange capacity
EIL	Environmental Investigation Level
ePAW	Effective plant-available water
ESP	Exchangeable sodium percentage
GAI	Geochemical Abundance Index
GIL	Groundwater investigation level
GIS	Geographical Information Systems
ha	Hectare
ISQG	Interim sediment quality guidelines
IBRA	Interim Biogeographic Regionalisation for Australia
K _{sat}	Saturated hydraulic conductivity
kg	Kilogram
km	Kilometres
kPa	Kilopascals
LOR	Limit of Reporting
LSL	Lower storage limit
mbgl	Metres below ground level
meq/100g	Milliequivalents per 100 grams of soil
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre

m	Metre
mm	Millimetres
mm/hr	Millimetres per hour
MOR	Modulus of Rupture
NEPM	National Environmental Protection Measure
PAN	Plant-available nutrients
PAW	Plant-available water
pH _{Ca}	Soil pH measured in a 0.01M calcium chloride solution suspension
pH _w	Soil pH measured in a 1:5 soil water suspension
PSD	Particle size distribution
QAQC	Quality Assurance and Quality Control
RL	Relative Level
RPD	Relative percent difference
SAP	Sampling Analysis Plan
SLA	Soil-landform association
Stantec	Stantec Australia Pty Ltd
TDS	Total dissolved solids
µS/cm	microSiemens per centimetre
USL	Upper storage limit

Glossary

Aggregate (or ped)	A cluster of primary particles separated from adjoining peds by natural planes of weakness, voids (cracks) or cutans.
Clay	The fraction of mineral soil finer than 0.002 mm (2 µm).
Coarse fragments	Particles greater than 2 mm in size.
Consistence	The strength of cohesion and adhesion in soil.
Electrical conductivity	The ability of a soil to conduct an electrical charge, related closely to the salinity of a soil.
Exchangeable sodium percentage	When sodium cations (Na ⁺) dominate the total exchangeable cations on soil exchange surfaces. Soil with Na ⁺ cations in excess of more than 6% are deemed sodic.
Massive soil structure	Coherent soil, no soil structure, separates into fragments when displaced. Large force often required to break soil matrix.
Modulus of Rupture (MOR)	This test is a measure of soil strength and identifies the tendency of a soil to hard-set as a direct result of soil slaking and dispersion.
Organic carbon	Carbon residue retained by the soil in humus form. Can influence many physical, chemical and biological soil properties. Synonymous with organic matter (OM).
Plant-available water	The ability of a soil to hold that part of the water that can be absorbed by plant roots. Available water is the difference between field capacity and permanent wilting point.
Single grain structure	Loose, incoherent mass of individual particles. Soil separates into individual particles when displaced.
Soil pH	The negative logarithm of the hydrogen ion concentration of a soil solution. The degree of acidity or alkalinity of a soil expressed in terms of the pH scale, from 2 to 10.
Soil structure	The distinctness, size, shape and arrangement of soil aggregates (or peds) and voids within a soil profile. Can be classed as 'apedal', having no observable peds, or 'pedal', having observable peds.
Soil strength	The resistance of a soil to breaking or deformation. 'Hardsetting' refers to a high soil strength upon drying.
Soil texture	The size distribution of individual particles of a soil.
Subsoil	The layer of soil below the topsoil or A horizons, often of finer texture (i.e. more clayey), denser and stronger in colour. Generally considered to be the 'B-horizon' above partially weathered or un-weathered material.

Breaker Resources

Lake Roe Gold Project - Baseline Soils Assessment

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1. Introduction

Breaker Resources NL (Breaker) are proposing to develop the Lake Roe Gold Project (the Project), which comprises the Bombara gold deposit, into an operational mine, following successful exploration drilling campaigns. The Project is located approximately 100 kilometres (km) east of Kalgoorlie in the Eastern Goldfield's region of Western Australia (WA) and is situated on the south-western edge of Lake Roe, a large, naturally saline playa (**Figure 1-1**). The Study Area comprises tenement MLA5 (3,749 hectares (ha)), which includes the proposed development envelope (999 ha) and the proposed pit (55 ha) (**Figure 1-2**).

In August 2018 Stantec Australia Pty Ltd (Stantec) completed a desktop assessment for Breaker, investigating the environmental and hydrogeological aspects of the Project (Stantec 2018). Based on the findings and recommendations from the desktop assessment, Stantec was commissioned to undertake a Baseline Soils Assessment.

1.1 Report Scope and Objectives

This baseline soil assessment was conducted as part of a program of environmental baseline studies at Lake Roe which had the overall objectives:

- to gain a holistic ecological understanding of the Lake Roe environment;
- to identify potential threatening processes and risks associated with the project and provide suitable mitigation measures; and
- to utilise these findings to support future environmental approvals for the Project.

Specifically, this assessment of soils within the Study Area, aimed to provide information that can be used to assist in soil management for future mining operations. Specific components of this assessment include:

- review relevant, available information on the characteristics of soils associated with the Study Area;
- assess the physical and chemical characteristics of topsoil (0 to 10 centimetres (cm)) and subsoil (10 to 30 cm) materials within the Study Area;
- map soil-landform associations and soil resources within the Study Area;
- develop a preliminary soil inventory detailing volumes and characteristics of soil resources (depending on availability of disturbance footprint information);
- provide preliminary recommendations for soil stripping, handling and stockpiling, and associated rehabilitation parameters;
- provide preliminary recommendations for the optimal and prioritised use of available soil resources; and
- provide a preliminary impact assessment relating to the proposed disturbance of soil within the Development Area.

The assessment of materials has been conducted in accordance with the following guidelines:

- Department of Mines and Petroleum (DMP) Draft Guidance - Materials Characterisation Baseline Data Requirements for Mining Proposals (DMP 2016); and
- Department of Industry, Innovation and Science (DIIS) Leading Practice Sustainable Development Program for the Mining Industry (DIIS 2016).

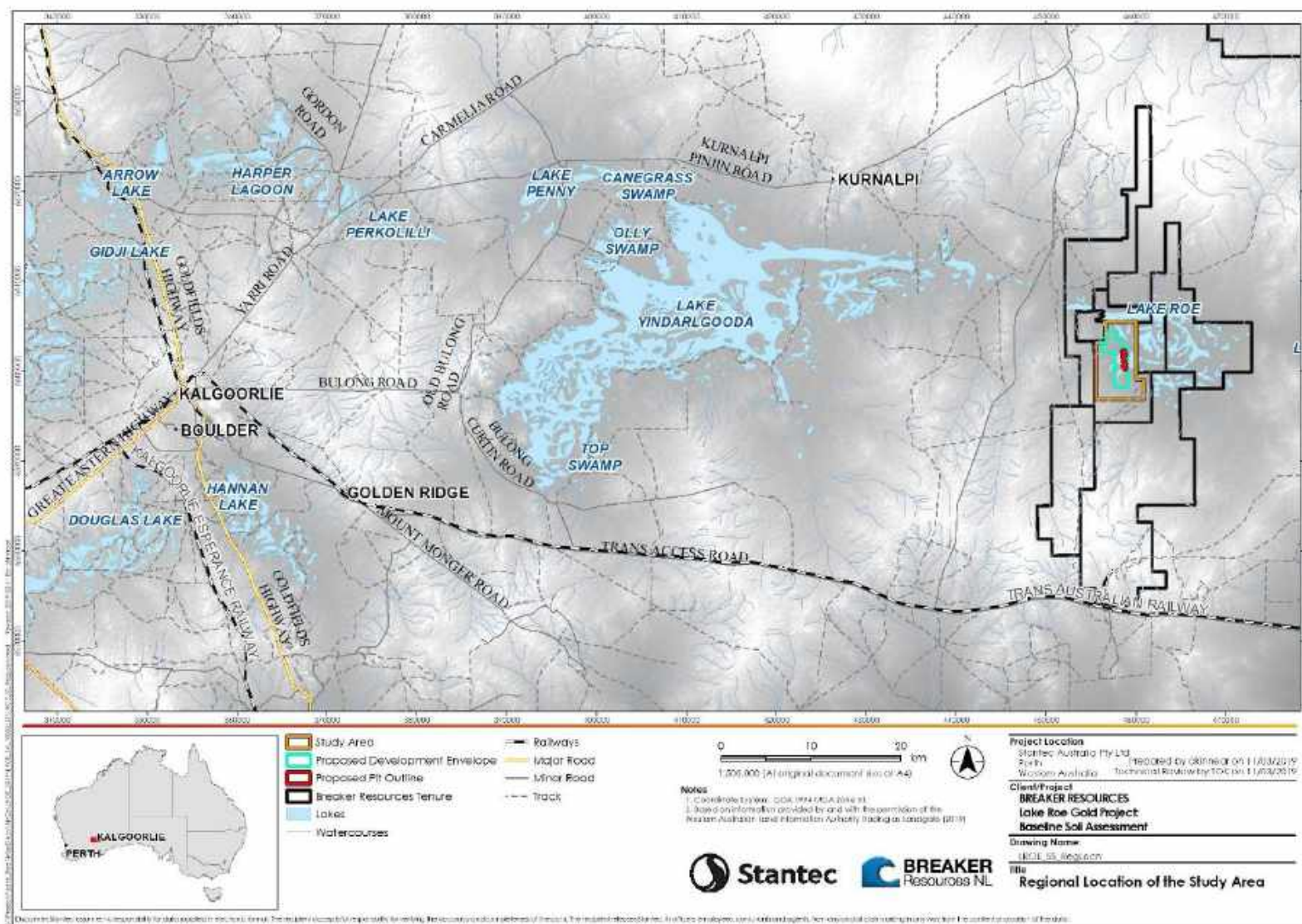


Figure 1-1: Regional location of Lake Roe and the Study Area

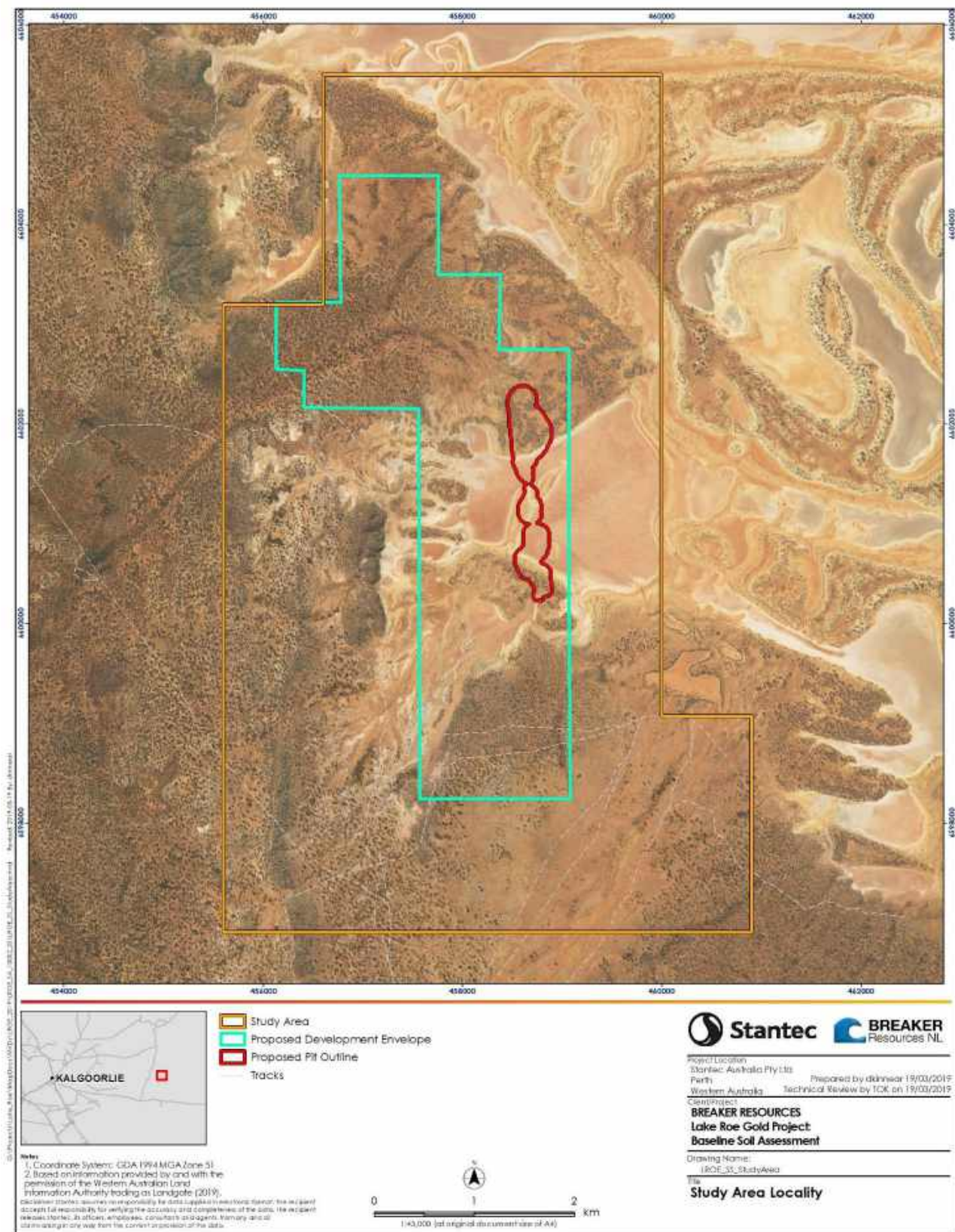


Figure 1-2: Baseline soils assessment Study Area

2. Background Information

2.1 Biogeographical Context and Land Use

The Project is located within the Eastern Goldfields (C003) subregion of the Coolgardie bioregion, as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (Thackway and Cresswell 1995). The subregion is characterised by gently undulating plains interrupted in the west by low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite. The underlying strata are eroded and covered with Tertiary sand and gravel soils, scattered exposures of bedrock, and plains of calcareous earths. A series of large salt lakes in the western half of the subregion are the remnants of an ancient major drainage system (Cowan 2001a).

Eucalypt woodlands dominate the Coolgardie Botanical District, becoming open with saltbush-bluebush (*Atriplex-Maireana*) understorey on the more calcareous soils. Patches of shrub steppe occur adjoining the Great Victoria Desert and scrub-heath and *Casuarina* thickets on sandplains (Beard 1990).

The primary land uses within the Eastern Goldfields subregion comprise of Unallocated Crown Land (UCL), Crown Reserves, native grazing pastures, cultivation and conservation reserves (Cowan 2001b). The Study Area also occurs within the Yindi Pastoral Lease (PL N09512) and the Goldfields Groundwater Area GWA21. As the subregion is rich in mineral deposits, especially gold and nickel, exploration and mining are prevalent (Kern 1996a). Historically, the township of Kurnalpi, 65 km northwest of the Study Area, was a thriving gold centre from the late 1800's to the early 1900's but has since been abandoned.

2.2 Climate

The Study Area is located within the north eastern Goldfields region of Western Australia, and has an arid climate, characterised by hot summers and cool winters (Pringle *et al.* 1994a). Temperatures range from below zero in winter to greater than 40°C during summer. Rainfall in the region is variable, with a long-term (1939 to 2019) annual average of 268 mm. Evaporation in the area is high at approximately 2400 mm per year (Johnston *et al.* 1999), exceeding rainfall in all months.

Long-term climate data (1939 to 2019) is available from the nearest Bureau of Meteorology (BoM) weather station at Kalgoorlie-Boulder Airport (Station 12038), which is approximately 100 km west of the Study Area. Mean maximum monthly temperatures typically peak above 30°C in January (**Figure 2-1**), with mean minimum monthly temperature close to 5°C in July (BoM 2019). February is usually the wettest month, with rainfall related to ex-tropical cyclone activity from the Pilbara region.

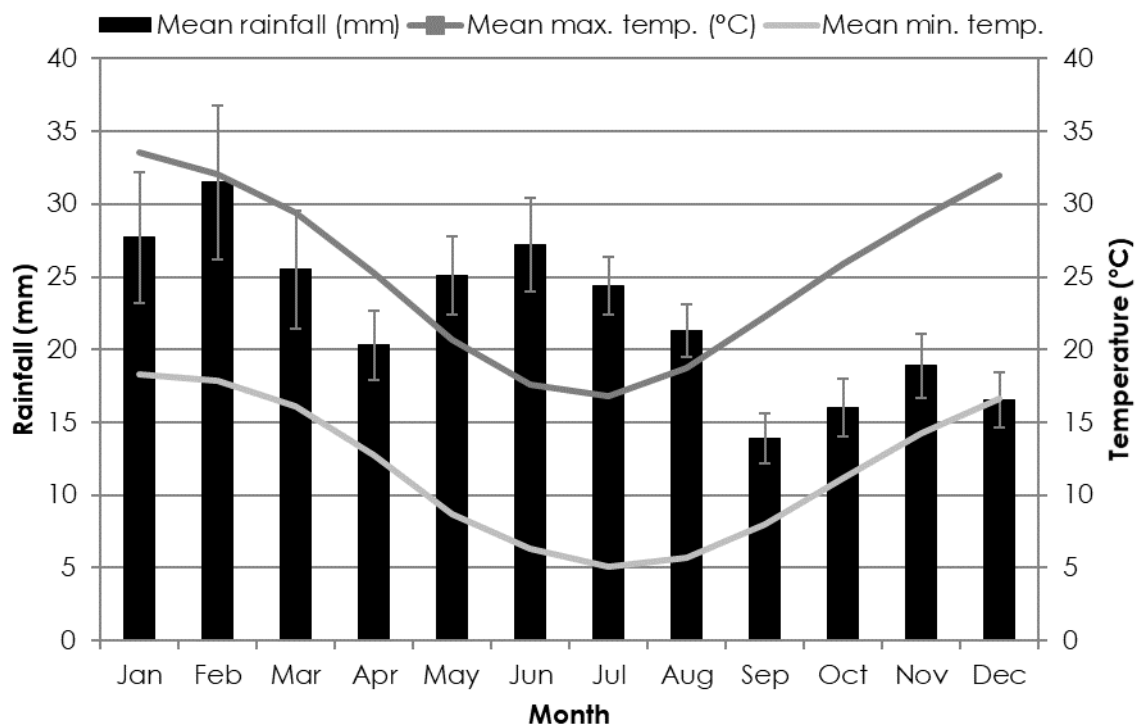


Figure 2-1: Long term climate data (1939-2019) recorded at Kalgoorlie-Boulder Airport Weather Station (Station Number 012038)

2.3 Regional and Local Geology

2.3.1 Regional Geology

The Project is situated in the Eastern Goldfields geological province of the Yilgarn Craton which forms a large section of the Western Shield geotectonic unit (Pilgrim 1979). It is characterised by gently undulating plains interrupted in the west by low hills and ridges of Archaean greenstones, and in the east by a horst of Proterozoic basic granulite (Cowan 2001a).

Topographic relief is low, and the underlying strata are eroded flat and covered with Tertiary sand and gravel soils, scattered exposures of bedrock and plains of calcareous earths (Kern 1996a). Early Tertiary sediments are preserved in the palaeochannels within an infilled palaeodrainage system, concealed by thick sequences of Cainozoic deposits (Johnston *et al.* 1999). The regional bedrock geology of the Study Area is presented in **Figure 2-2**.

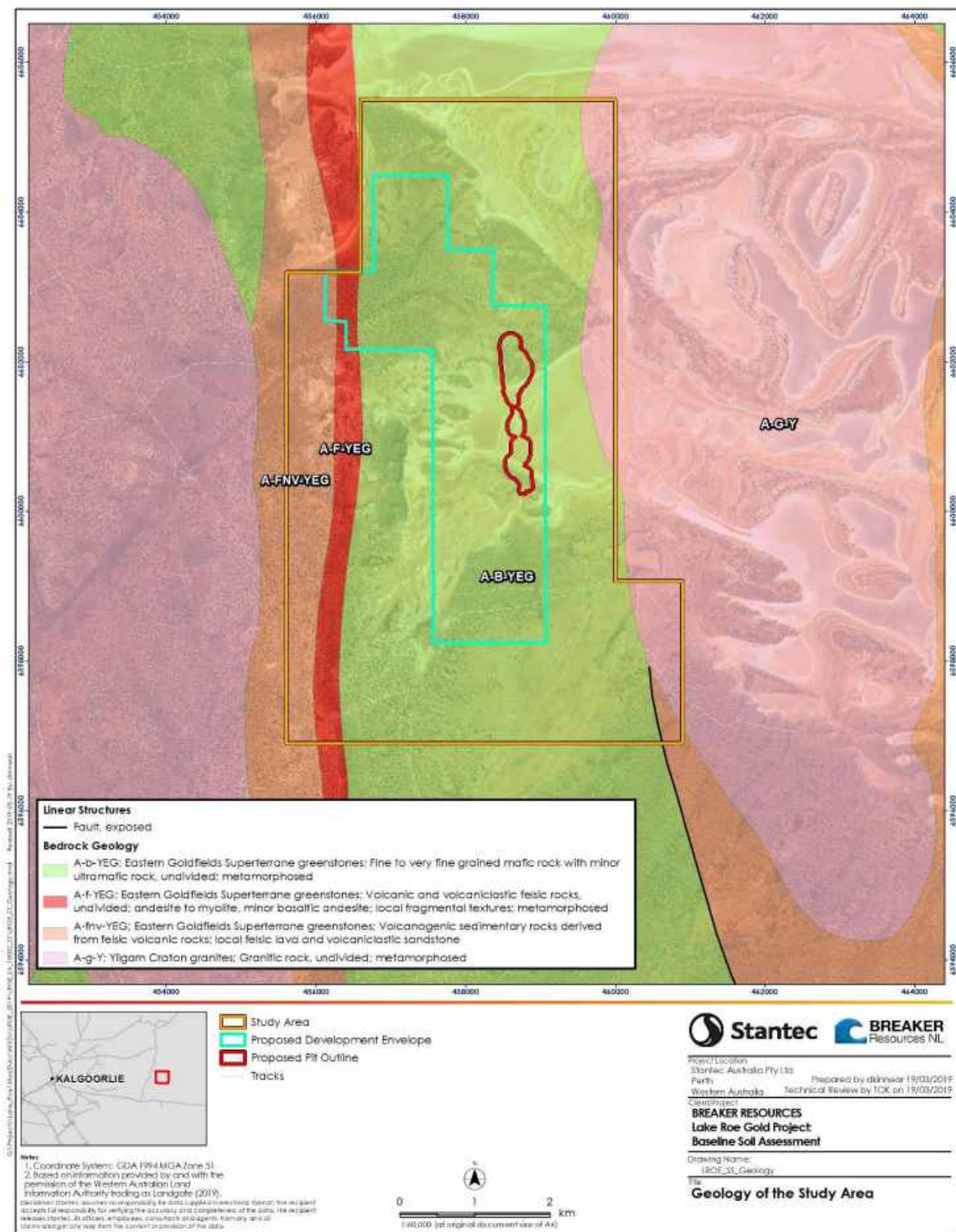


Figure 2-2: Regional bedrock geology of the Study Area

2.3.2 Local Geology

The local geology of the Project area has been provided by Breaker in the form of a pit-scale geological map showing the spatial distribution of key lithological and structural elements at 300 mRL (approximately 15 m below ground level). The resource is located on the eastern limb of the Bombora Antiform, within differentiated mafic, volcanic and intrusive rocks (principally basalt and dolerite), bounded to the east and west by mafic sediments (black shale). An unnamed syenite pluton is located to the east of the deposit, beneath, and extending beyond the extent of Lake Roe.

Structurally, the package that comprises the mine sequence is bounded to the east and west by various splays (branches) of the Claypan Fault, understood to be high strain, ductile features (mylonite to the east) unlikely to provide substantial permeability or groundwater storage.

A series of north/south to north northwest/south southeast striking, vertical shears and thrust faults have been identified within the mineable sequence, along with a series of east northeast/west southwest vertical structures that offset the entire mine sequence. Towards the southern end of the current pit shell, definition of structure is reasonably dense, while at the northern end of the pit, structural definition appears to be lean. A series of gently northerly dipping quartz reefs/veins occur through the northern half of the current pit shell. Details of the thickness and general character of these reefs are not available.

The depth of weathering in the mafic rocks is quite variable with drill hole logs indicating regolith clays ranging in depths between 2 m and approximately 30 m, with deeper clay profiles likely correlating to increased fracture densities. Drill hole logs indicate the residual clays over the syenite to the east of the pit, may be as deep as 84 m. An enhanced weathering profile over the syenite may geomorphologically be the cause of the topographically low terrain that Lake Roe occupies.

The depth of transported material in the vicinity of the Project area is generally less than 15 m, while the thickness of lake clays associated with the playa, generally range from 2 to 10 m based on interpretation of the available drill hole logs.

2.4 Surface Hydrology

2.4.1 Surface Hydrology

The Study Area lies along the south western margin of Lake Roe, which is part of the Roe Palaeodrainage system (Kern 1996b). The headwaters of this system drain in an easterly direction, from west of Kalgoorlie to Lake Yindarlgooda and Lake Roe. Due to their extensive size, and the semi-arid climate, these salt lakes remain largely disconnected, with endorheic (internal) drainage patterns (Hammer 1986).

Salt lakes along the drainage system consist of clay, silt and sand, interbedded with evaporite minerals such as gypsum and halite (Campagna 2007). The playas are naturally saline, although are surrounded by numerous, smaller peripheral claypans that are often freshwater. While typically dry, major flood events are known to occur infrequently, associated with intense winter rains or cyclonic events.

The salt lakes can accommodate large inflows, although exhibit substantial fluctuations in water depth and water quality over the course of the hydroperiod. Salinity concentrations tend to range from less than 10,000 mg/L (total dissolved solids) during the initial stages of flooding, to over 300,000 mg/L towards the end of the hydroperiod (Gregory 2007, Williams 1998). The drying cycle of salt lakes can also be rapid, as a result of high evaporation rates (Timms *et al.* 2006).

2.5 Land Systems

Land systems are defined as an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation (Tille 2006). An assessment of land systems provides an indication of the occurrence and distribution of vegetation types within and surrounding the Study Area (Pringle *et al.* 1994). Land systems across the Goldfields have been mapped by the Natural Resources Assessment Group of the Department of Primary Industries and Regional Development (formerly the Department of Agriculture) and provides a comprehensive description of biophysical resources within the goldfields (Pringle *et al.* 1994).

The Study Area lies predominantly within the Mx43 land system (69.6%), of gently undulating valley plains, while to a lesser extent it also occurs within the Carnegie land system (30.4%), comprising salt lakes and saline alluvial plains (**Table 2-1; Figure 2-3**).

Table 2-1: Land systems within the Study Area and their extent

Land system	Description	Extent within the Eastern Goldfields subregion (ha)	Extent within the Study Area (ha)	Proportion within Study Area (%)
Carnegie System	Salt lakes with fringing saline alluvial plains, kopi dunes and sandy banks, supporting halophytic shrublands and Acacia tall shrublands.	23,597.98	1,140.85	30.4
Mx43	Gently undulating valley plains and pediments; some outcrop of basic rock.	1,498,900.11	2,608.45	69.6
Total	-	1,522,498.09	3,749.30	100

2.6 Soil, Mine Waste and Tailings Characteristics

There are no previous studies related to soil or waste characterisation, or acid metalliferous drainage assessment within the Study Area. At the time of writing this report a mine waste characterisation assessment was being conducted by Stantec.

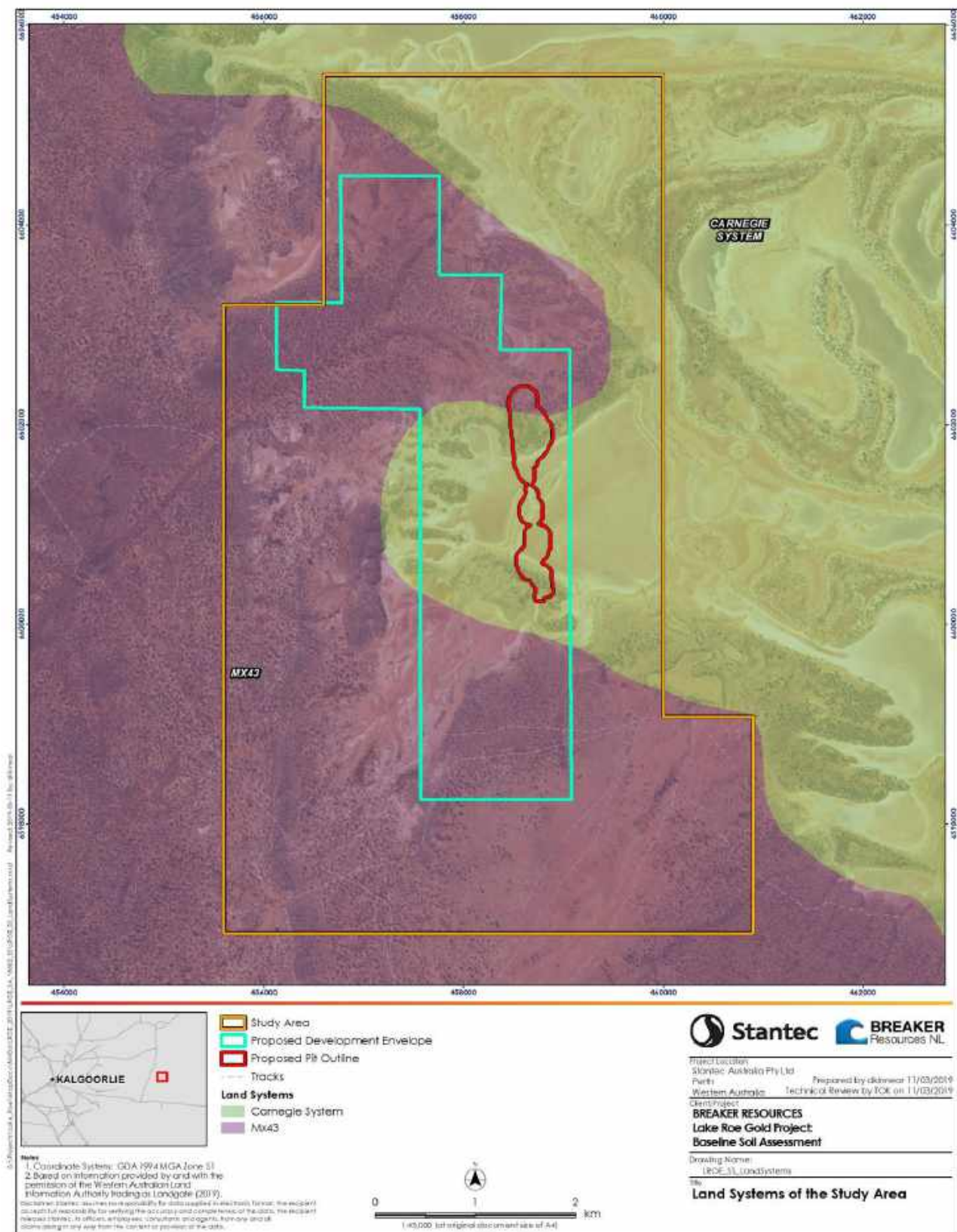


Figure 2-3: Land Systems within the Study Area

3. Methods

3.1 Sample Collection

The soil sampling program of the Study Area was conducted by Stantec in November 2018 at the same time as the Fauna assessment was being conducted. This involved:

- hand sampling to collect soil samples from two depths (0 to 10 cm and 10 to 30 cm) from 20 locations within the study area, (**Table 3-1, Figure 3-1**).

No samples were collected from the lake itself nor from the immediate banks of the Lake. Water quality from Lake Roe will be analysed as part of the Aquatic Ecology Baseline Assessment which is proposed to be conducted in 2019 by Stantec.

Ten soil resource groups were determined based on initial observations in the field, inspection of the soil samples and by comparing existing aerial imagery and maps within the Study Area (**Table 3-1, Figure 3-2**).

Table 3-1: Summary of samples collected

Sample Site Location ID	Soil Resource Group	Number of locations	Number of samples
S01, S17	Sandy Shrubland	2	4
S02, S16	Mallee Sand	2	4
S09, S11	Mallee Sand – Disturbed	2	4
S19, S20	Woodland Clay	2	4
S06, S07, S08, S12, S15, S03	Woodland	6	12
S04	Gypsum Dune	1	2
S05	Samphire Clay	1	2
S13, S14	Sheoak Sand	2	4
S10	Wetland – Disturbed	1	2
S18	Drainage	1	2
Total	10	20	40

3.2 Test work and Procedures

Laboratory testwork was conducted at the Stantec in-house laboratory for the majority of soil physical testing. Samples were sent to ALS Environmental Laboratory for remaining physical, chemical and geochemical analysis. A summary of testwork conducted on each sample is provided in **Appendix A**, with detailed soil descriptions for the samples provided in **Appendix B**.

All laboratory results for the samples are provided in **Appendix C**, with primary laboratory reports from ALS provided in **Appendix D**. All soil testwork procedures are developed in accordance with standard analytical procedures to assess soil erodibility and soil properties related to the support of plant growth (Rayment & Lyons 2011). Descriptions of procedures and methods of assessment are described in **Appendix E**.

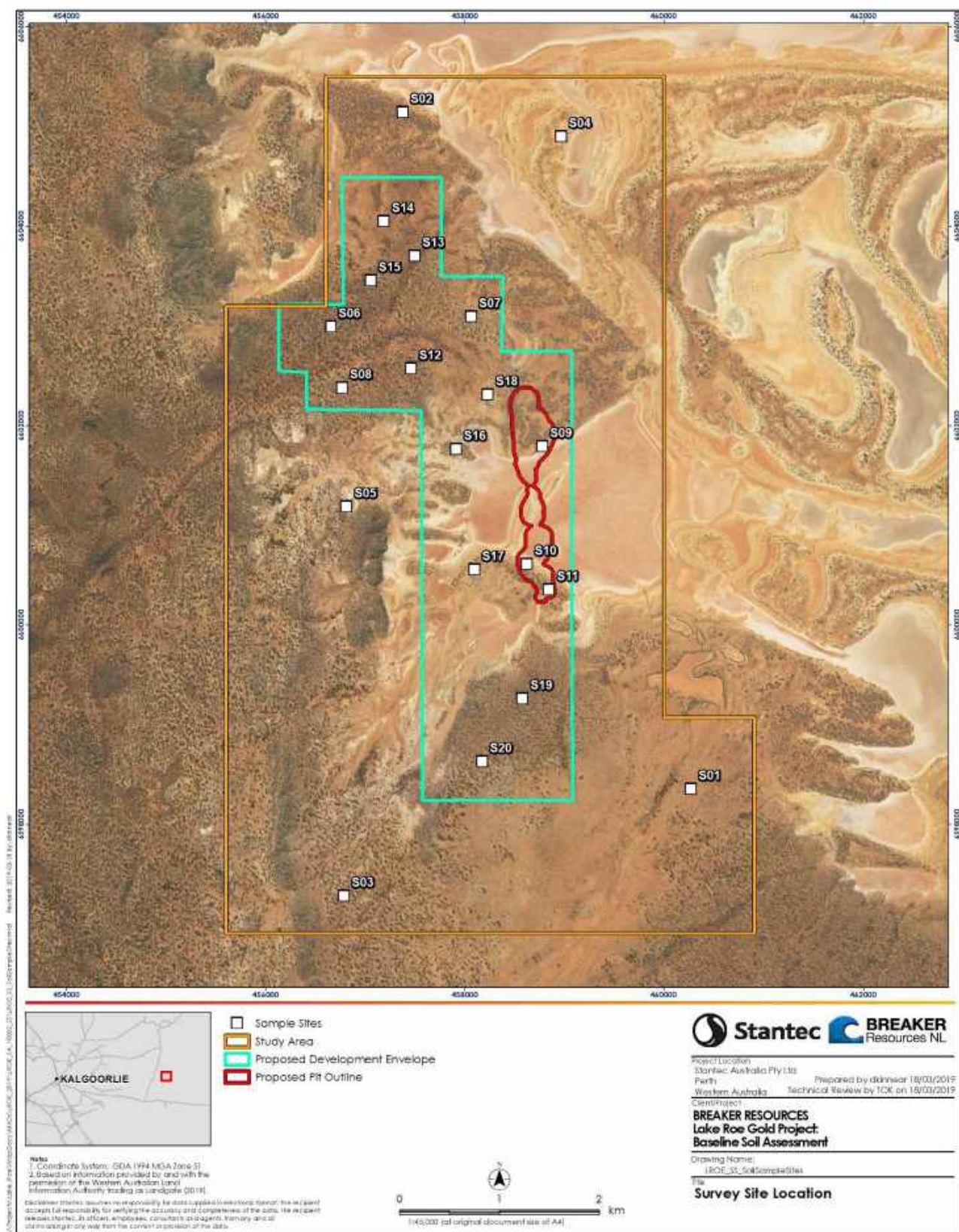


Figure 3-1: Soil sample locations within the Study Area

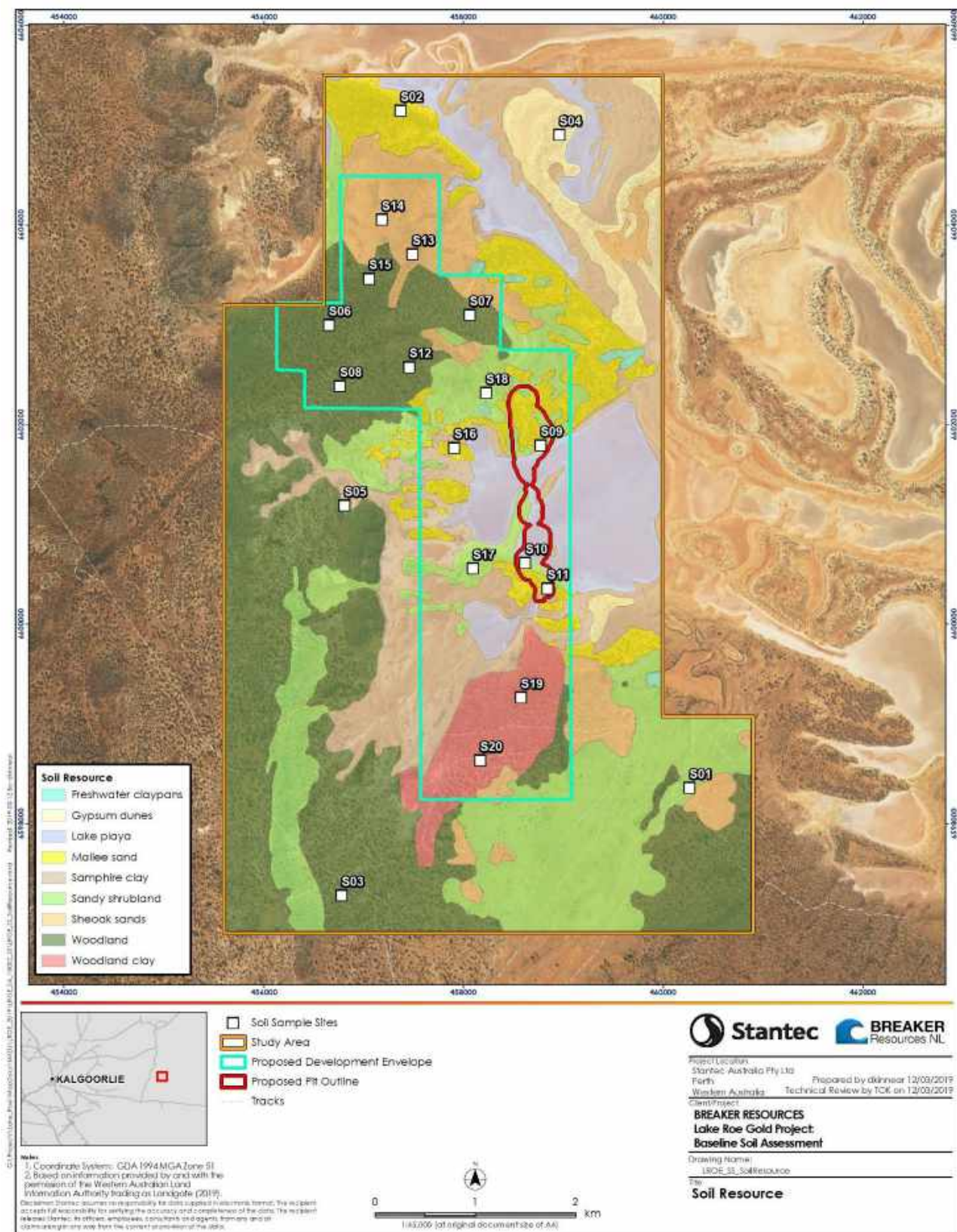


Figure 3-2: Soil resource groups within the Study Area

4. Results

4.1 Field observations

The descriptions and photographs of the 20 soil sample locations within the Study Area (3,479 ha) are provided in **Appendix B**. The physical and chemical characteristics of the ten soil resource groups from within the Study Area are described in subsequent sections.

4.2 Physical Characteristics

4.2.1 Texture and Particle Size

Hand texturing was completed on the soil sized fraction (<2 mm) of all samples. The resulting textural classifications varied across the Study Area and included light, medium and heavy clays, sandy loam and sandy clay loams (**Appendix C Table C-1**). Analysis of the particle size distribution (PSD) was undertaken on fourteen samples. All were dominated by the sand fraction (66 to 88%) with some clay (4 to 39%) and silt (5 to 27%) (**Figure 4-1**).

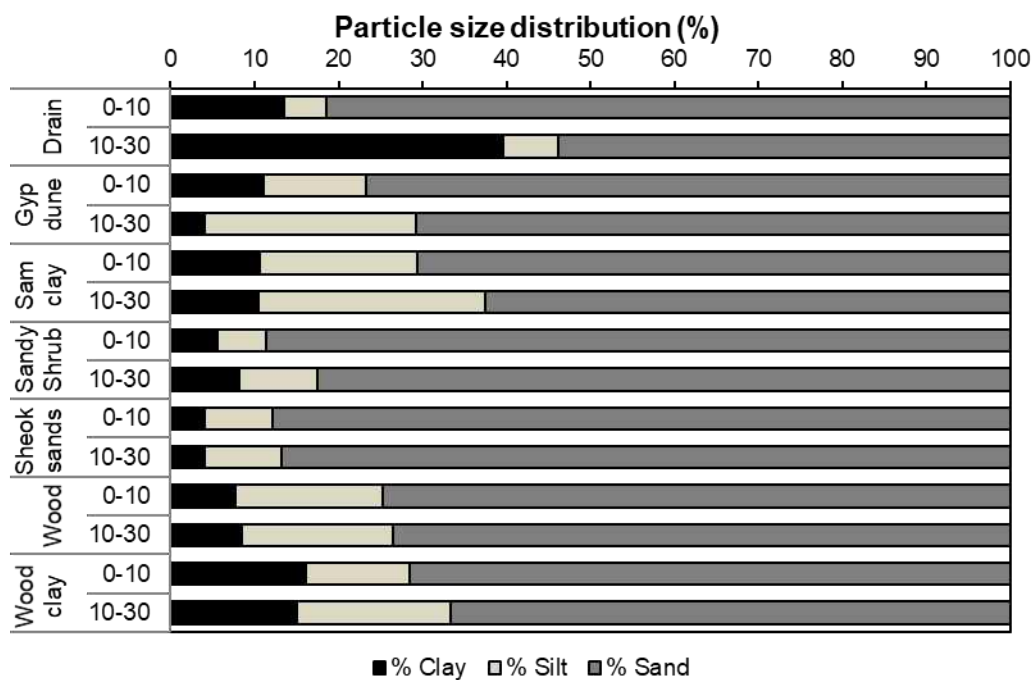


Figure 4-1: Particle size distribution of the soil fraction (<2 mm) of samples from the Study Area

The coarse fraction (>2 mm) content of the soil samples across the Study Area was highly variable (**Figure 4-2**) and ranged from 0 to 77% (**Appendix Table C-1**). With the exception of the Samphire Clay soil (S05) and the Wetland (S10), the subsurface soil had equal or slightly higher coarse fraction content than the surface soils (**Figure 4-2**). The predominant size of the coarse fraction was 2 to 19 mm in all samples (**Figure 4-3**).

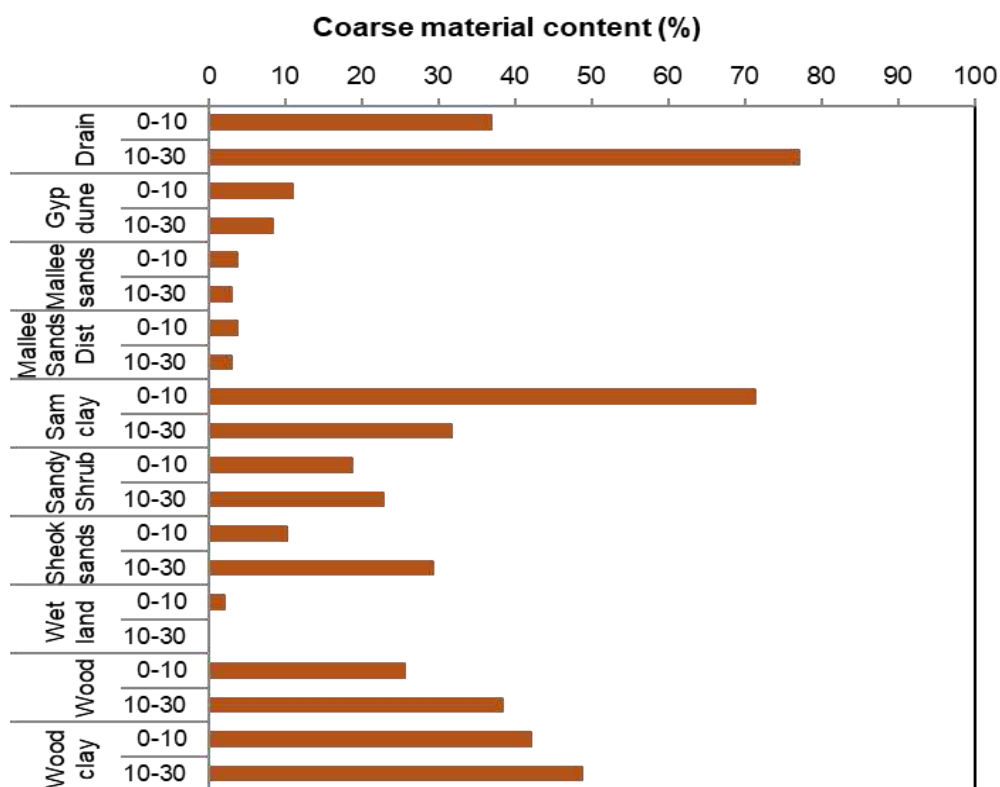


Figure 4-2: Coarse material content (>2 mm) for soil from the Study Area as a proportion of the whole soil

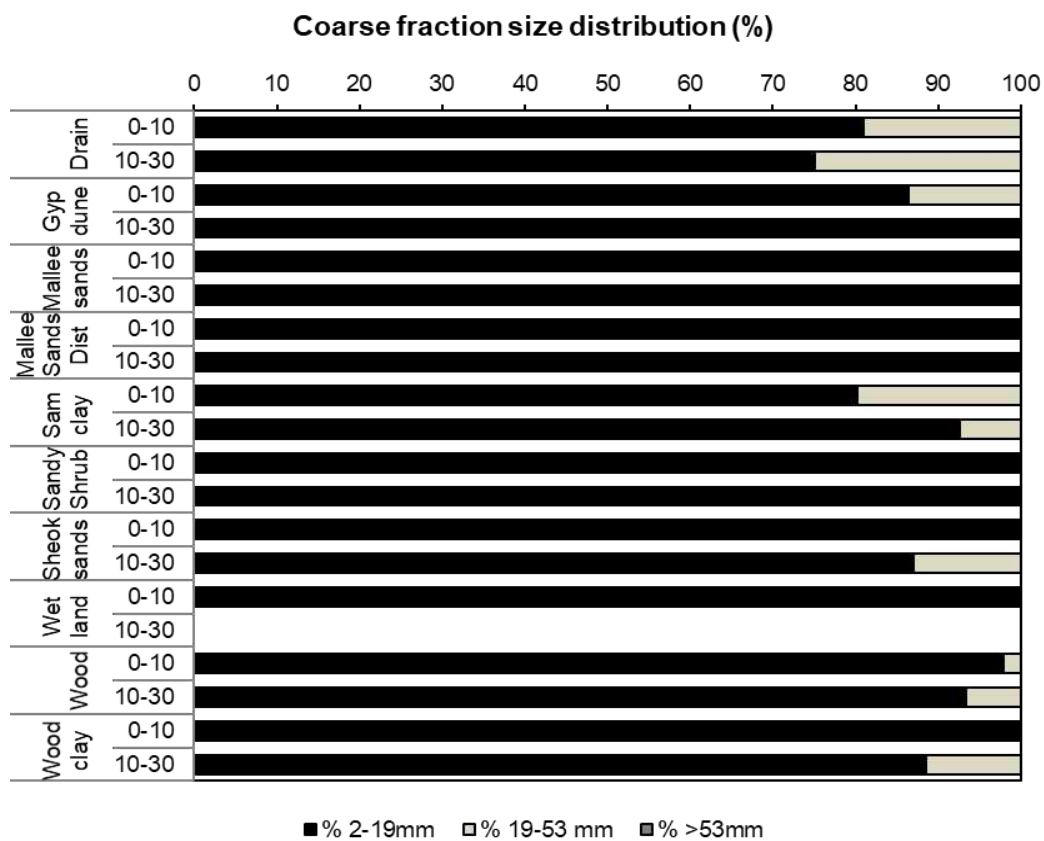


Figure 4-3: Size distribution within the coarse fraction (>2 mm) of samples from the Study Area

4.2.2 Structural Stability

The samples from the Study Area were highly variable in soil structural stability characteristics with samples ranging from unstable and likely to be problematic (Class 1 and 2) to stable (Class 6 and 7) (Table 4-1).

Both surface and subsurface soil from the Drainage flat and Samphire clay areas (Location S18 and S05) disturbed wetland area (S10) were classified as unstable (Class a 1 or 2). In other soil resource groups, stability varied between partially stable and unstable. Unstable samples were reported at one depth in one sample location, S03 and S02, for Woodland and Sandy shrubland respectively and at two locations in Sheoak Sands, (S13 and S14) and Woodland clay (S19 and S20) resource groups.

Table 4-1: Structural stability classification for soil samples within the Study Area

Soil Resource Group	Sample ID	Depth (cm)	Emerson Class ¹	Description
Drainage Flat	S18	0 to 10	1	Problematic: Unstable, likely to slake and to completely disperse
		10 to 30	1	
Gypsum Dune	S04	0 to 10	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
		10 to 30	7	Stable: aggregate swells but does not slake.
Mallee Sand	S02	0 to 10	3b	Partially stable: Likely to slake and potential to disperse
		10 to 30	3b	
	S16	0 to 10	5	Partially Stable: likely to slake, unlikely to disperse
		10 to 30	3b	Partially stable: Likely to slake and potential to disperse
Mallee Sand Disturbed	S09	0 to 10	3b	Partially stable: Aggregate slakes but does not disperse, remoulded soil partly disperses
		10 to 30	3b	
	S11	0 to 10	3a	Partially stable: Likely to slake and likely to disperse
		10 to 30	3b	Partially stable: Likely to slake and potential to disperse
Samphire Clay	S05	0 to 10	2	Unstable: Likely to slake and to disperse
		10 to 30	2	
Sandy Shrubland	S01	0 to 10	1	Problematic: Unstable, likely to slake and to completely disperse
		10 to 30	3a	Partially stable: Likely to slake and likely to disperse
	S17	0 to 10	5	Partially stable: Likely to slake, unlikely to disperse.
		10 to 30	3b	Partially stable: Likely to slake and potential to disperse
Sheoak Sands	S13	0 to 10	3b	Partially stable: Likely to slake and potential to disperse
		10 to 30	2	Unstable: Likely to slake and to disperse
	S14	0 to 10	2	Unstable: Likely to slake and to disperse
		10 to 30	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
Wetland, Disturbed	S10	0 to 10	6	Partially Stable: Likely to slake, unlikely to disperse
		10 to 30	6	
Woodland	S03	0 to 10	2	Unstable: Likely to slake and to disperse
		10 to 30	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
	S06	0 to 10	3b	Partially stable: Likely to slake and potential to disperse

Soil Resource Group	Sample ID	Depth (cm)	Emerson Class ¹	Description
		10 to 30	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
	S07	0 to 10	3b	Partially stable: Likely to slake and potential to disperse
		10 to 30	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
	S08	0 to 10	3b	Partially stable: Likely to slake and potential to disperse
		10 to 30	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
	S12	0 to 10	3a	Partially stable: Likely to slake and likely to disperse
		10 to 30	3b	Partially stable: Likely to slake and potential to disperse
	S15	0 to 10	4	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
		10 to 30	4	
	Woodland Clay	S19	0 to 10	Unstable: Likely to slake and to disperse
			10 to 30	Partially stable: Likely to slake, unlikely to disperse, carbonates present.
		S20	0 to 10	Unstable: Likely to slake and to disperse
			10 to 30	Partially stable: Likely to slake, unlikely to disperse, carbonates present.

4.2.3 Material Strength

The soil strength, as determined by the modulus of rupture analysis (MOR) was low in the majority of samples (**Figure 4-4**). Nine individual samples exceeded the 60 kPa MOR threshold considered to indicate high soil strength (**Appendix B Table B-1**) and hardsetting. When the average MOR was considered for each soil resource group the soils from the Drainage flat, Samphire clay and Woodland clay areas indicate a potential for hardsetting, which could result in issues with root penetration and vegetation establishment.

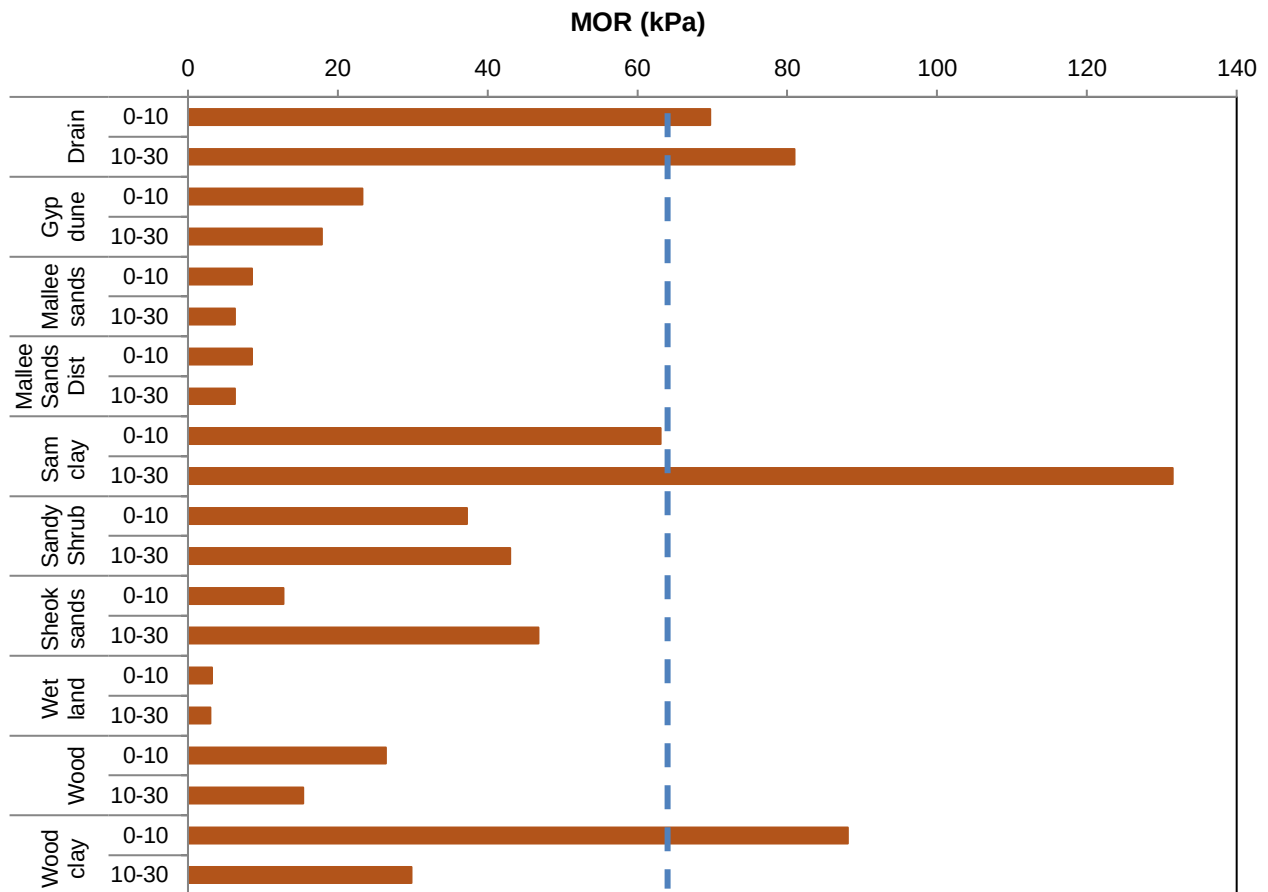


Figure 4-4: Mean soil strength (Modulus of Rupture; MOR) values for soil resource groups within the Study Area

4.2.4 Saturated Hydraulic Conductivity

Twenty representative samples from the Study Area were assessed for saturated hydraulic conductivity (K_{sat}). Sample K_{sat} values ranged between 0.05 mm/hr to 91.9 mm/hr; and were classed as having extremely slow to moderately rapid drainage (**Table 4-2**). The two samples that were classified as moderately rapid drainage were the topsoil and subsoil from the Wetland sample (S10). Drainage was variable for all the other areas, however, was generally slow. Samples from both depths at location S05 (Samphire Clay), and at location S01 (Sandy Shrubland) reported very slow to extremely slow drainage rates. Slow drainage classifications suggest that water infiltration into the soil material will be slow, increasing the likelihood of surface runoff and erosion if placed on sloped surfaces. This should be considered when determining applications for re-use of the material.

Table 4-2: Drainage classes and saturated conductivity (K_{sat}) rates for representative soil samples within the Study Area

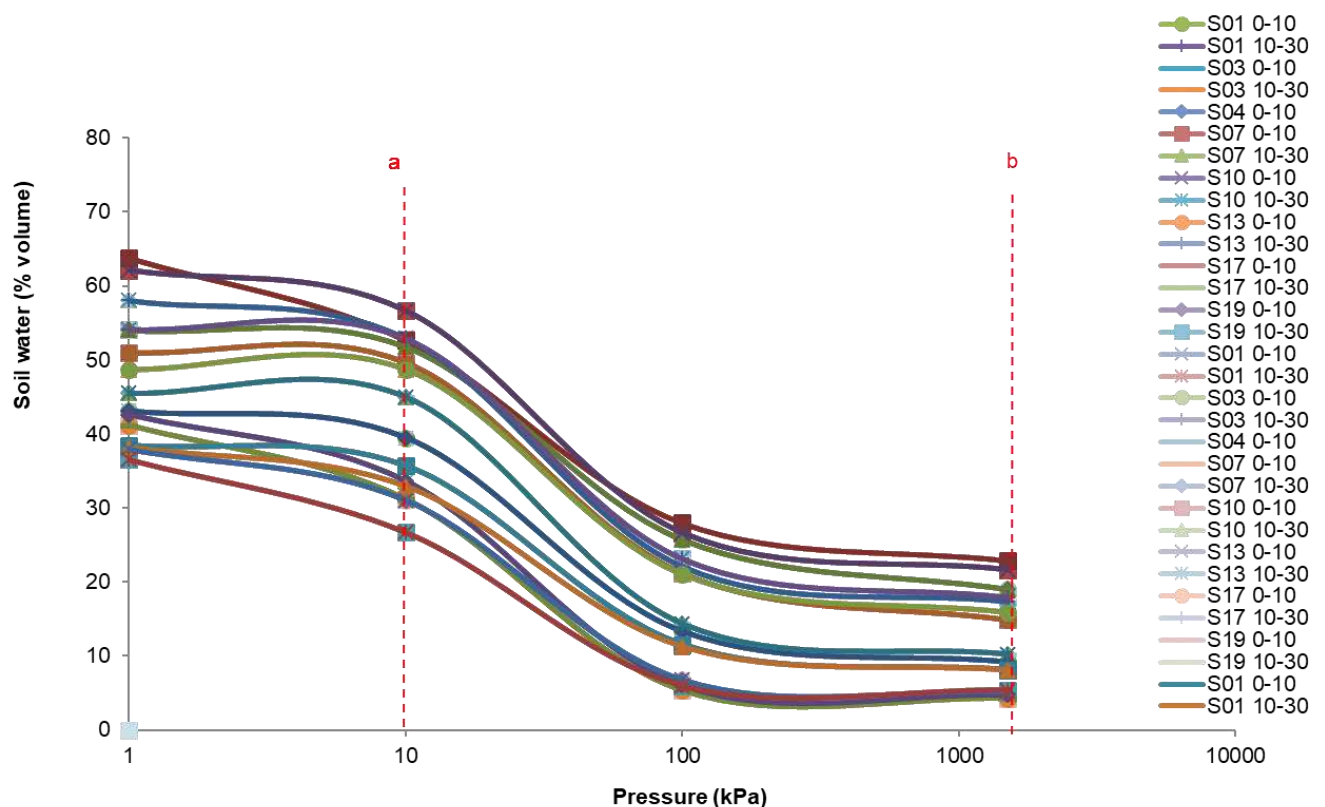
Soil Resource Group	Sample ID	Depth (cm)	K_{sat} (mm/hr)	Drainage class
Drainage	S18	0 to 10	2.3	Slow
		10 to 30	3.8	Slow
Gypsum Dune	S04	0 to 10	12.4	Moderately slow
		10 to 30	12.4	Moderately slow
Samphire Clay	S05	0 to 10	0.4	Very Slow
		10 to 30	0.2	Extremely slow
Sandy Shrubland	S01	0 to 10	0.1	Extremely slow
		10 to 30	1.0	Very slow
	S17	0 to 10	29.1	Moderate
		10 to 30	31.7	Moderate
Sheoak Sands	S13	0 to 10	5.5	Moderately slow
		10 to 30	0.8	Very slow
Wetland, Disturbed	S10	0 to 10	91.9	Moderately rapid
		10 to 30	74.6	Moderately rapid
Woodland	S03	0 to 10	10.0	Moderately slow
		10 to 30	16.3	Moderately slow
	S07	0 to 10	12.3	Moderately slow
		10 to 30	12.9	Moderately slow
Woodland Clay	S19	0 to 10	3.8	Slow
		10 to 30	15.4	Moderately slow

Note: Samples were selected to represent the soils across the Study Area

4.2.5 Water Retention

The soil-sized fraction (<2 mm) of the 14 samples chosen to represent soil resource groups within the Study Area, were analysed. Both the topsoil and subsurface soil samples showed very similar trends in water retention characteristics for most locations (**Figure 4-5**). Soil moisture upper storage limit (USL) reported a range of 7% to 45%, this dropped to 4% to 39% when coarse material content was accounted for (**Appendix C, Table C-1**).

The plant-available water (PAW) (<2 mm) is calculated as the difference between the USL and lower storage limit (LSL) and was low (4%) in S01 subsoil, (Sandy Shrubland) and high for the remaining samples (range 21 to 45 %) (**Appendix C, Table C-1**). When the coarse material content was accounted for, the effective PAW (ePAW) declined to 14 to 39%, which is still considered to be moderate to high.



Note: (a) represents soil water volume (%) at USL (b) represent soil water volume (%) at LSL. The difference between a and b is the PAW (%)

Figure 4-5: Water retention curves (%volume) for representative samples from the Study Area

4.3 Chemical Characteristics

4.3.1 Soil pH and Salinity

The soil pH_w reported for samples from the Study Area varied between neutral to strongly alkaline (range 7.9 to 8.8 **Table 4-3**) and for pH_{Ca} ranged from neutral to strongly alkaline in samples from all locations except one (S17, Sandy Shrubland) which was slightly acidic (**Appendix C, Table C-2**). When averaged for the soil resource groups the pH_{Ca} ranged from 5.5 to 7.8 and was classed as neutral to moderately alkaline (**Table 4-3**).

The mean electrical conductivity (EC) ranged between 0.01 to 4.58 dS/m and was classed as non-saline to extremely saline. Soils from both depths within the resource groups Mallee Sands, Mallee Sands-disturbed and Sheoak Sands were all non-saline (**Table 4-3**). The samples from both depths of the Gypsum dune, and Samphire clay were extremely saline while samples from Woodlands Clay were very saline to highly saline. (**Appendix C, Table C-2**). In general, high salinity is likely to restrict plant growth; however, local salt tolerant species such as samphire's are adapted to such conditions and are present on the more saline soils within the Study Area (e.g. Samphire Clay).

Table 4-3: Mean soil pH and EC values for soil resource groups within the Study Area

Soil Resource Group	Depth(cm)	pH _w (pH units)	pH _{Ca} (pH units)	EC (dS/m)
Drainage	0 to 10	8.5	6.3	0.52
	10 to 30	8.5	7.1	1.61
Gypsum Dune	0 to 10	8.1	7.6	2.34
	10 to 30	8.0	7.6	3.00
Mallee Sand	0 to 10	8.6	6.1	0.01
	10 to 30	8.4	6.3	0.02
Mallee Sand Disturbed	0 to 10	8.6	6.1	0.01
	10 to 30	8.4	6.3	0.02
Samphire Clay	0 to 10	8.0	7.4	1.98
	10 to 30	8.4	7.8	4.58
Sandy Shrubland	0 to 10	8.0	5.5	0.07
	10 to 30	8.5	5.9	0.58
Sheoak sands	0 to 10	7.9	6.1	0.04
	10 to 30	8.4	6.6	0.09
Wetland	0 to 10	8.4	6.4	0.02
	10 to 30	8.7	6.4	0.04
Woodland	0 to 10	8.7	7.5	0.09
	10 to 30	8.7	7.6	0.43
Woodland clay	0 to 10	8.4	7.5	0.94
	10 to 30	8.8	7.7	1.14

4.3.2 Exchangeable Cations and Exchangeable Sodium Percentage

The concentration of all exchangeable cations was highly variable between the samples with exchangeable calcium reported as particularly high in the Gypsum dune samples (**Appendix C, Table C-2**). The calculated cation exchange capacity (CEC) was also highly variable and ranged from low to high (1.2 to 32.1 meq/100g) in most samples and very high (48 to 178 meq/100g) in the Gypsum Dune samples (S04), (**Appendix C, Table C-2**).

The exchangeable sodium percentage (ESP) was calculated to give an indication of soil sodicity. Results indicate that soil material from both depths at the Drainage flat (S18), Samphire clay (S05) and Sandy Shrubland (S17 and S01) were sodic (ESP 6 to 15%) or highly sodic (ESP >15%) (**Appendix C, Table C-2**).

4.3.3 Soil Organic Carbon and Plant-Available Nutrients

Soil organic carbon (OC) was low in all samples, ranging from below detection limit (<0.5%) to 0.9% (**Appendix C, Table C-2**). The low OC is typical of arid areas in Australia and not considered to be problematic with respect to vegetation establishment and growth.

Plant-available nutrients varied slightly between sample locations and soil resource groups but was generally low (**Appendix C, Table C-2**). Ammonium-N was low in all groups and ranged from below detection <0.1 mg/kg to 2.1 mg/kg, and plant-available nitrate-N was also very low to low (range from <0.1 to 18.0 mg/kg) in all samples except S12 10 to 30 cm which reported nitrate-N of 157 mg/kg.

Plant-available phosphorus was low (<5 to 13 mg/kg), and potassium low to moderate (<200 to 301 mg/kg). Sulphur levels were extremely variable, ranging from below detection (<0.5 mg/kg) in most samples to very high (>5,800 mg/kg) in samples from the Gypsum Dune, location S04 (**Appendix C, Table C-2**).

These low and variable nutrient values are naturally occurring and not considered to be problematic with respect to endemic vegetation establishment.

4.3.4 Elements of Potential Environmental Concern

The soils of the Study Area are naturally high in chromium and nickel. Most, but not all, of the samples exceeded the Interim Sediment Quality Guidelines (ISQG) trigger values in these elements (**Table 4-4**), however, no samples exceeded local environmental investigation level (EIL's) thus the levels recorded are not considered problematic for the local environment.

Table 4-4: Number of samples that exceeded trigger values for total element concentrations for samples from the Study Area

Element	Number of Samples Analysed	Trigger Value Exceedances		
		Local EIL	ISQG-low	ISQG-high
Arsenic	40	0	0	0
Cadmium		0	0	0
Chromium		0	37	0
Copper		0	0	0
Lead		0	0	0
Mercury		0	0	0
Nickel		0	20	2
Zinc		0	0	0

Note: Only elements with at least one defined trigger value are included in the table

The Geochemical Abundance Index (GAI) analysis of the topsoil and subsoil of each soil resource group was conducted. GAI is a screening tool which compares elemental concentration to known crustal abundances and can flag potential issues that warrant additional investigation (see **Appendix E** for methods). No samples recorded GAI > 3 (**Appendix C, Table C-5**) suggesting there are not likely to be elemental toxicity issues with the 15 elements assessed (from the 40 samples), provided these soils are kept within the local area.

Table 4-5: Number of samples that exceeded trigger values for soluble element concentrations for samples from the Study Area

Element	Number of Samples Analysed	Trigger Value Exceedances	
		GIL Marine Water	ANZECC Marine Water
Aluminium	40	-	-
Arsenic		-	-
Boron		-	-
Cadmium		0	0
Chromium		21	2
Cobalt		33	0
Copper		40	25
Lead		15	0
Mercury		0	0
Nickel		32	0
Selenium		0	0
Vanadium		0	0
Zinc		32	18

Note: - is recorded where trigger values are not defined. Only elements with at least one defined trigger value are included in the table

The concentrations of some of the elements of potential environmental concern collected in DI water leachates from soil samples within the Study Area were below detection limits (**Appendix C, Table C-5**). However, the majority of samples did report water soluble concentrations of chromium, cobalt, copper, nickel, and zinc above the defined trigger values (**Table 4-5**). These levels present baseline values naturally occurring within the area and are not expected to pose issues within the Study Area.

5. Discussion, Summary and Management Recommendations

5.1 Creation of Soil Management Units (SMU)

Based on the characteristics of the ten soil resource groups (**Section 4**), several of the groups were merged to create seven soil management units (SMUs) (**Table 5-1, Figure 5-1**) with consideration of the soil analytical properties, and comparison to the aerial imagery and available maps (Stantec 2019b). This was done to simplify management of soils within the Study Area.

The disturbed areas of the Mallee Sands soil resource group reported similar characteristics to the undisturbed Mallee Sands. The Wetlands sample (S10) and Shrubland sample (S17) also reported similar properties and would not be practical to manage separately from the Mallee Sands due to the variable distribution in the field, hence these four soil resource groups have been combined to be treated as one SMU (Mallee Sands) for stripping and management purposes.

Sample location S01 was originally grouped as Sandy Shrubland, however, analysis of results indicate soil properties are more consistent with those at location S18, a drainage area that goes through a shrubland area, hence it is proposed that these groups be managed as one SMU, Shrubland Drain.

Table 5-1: Soil resource group and soil management unit (SMU) allocation for each sample location within the Study Area

Sample Location ID	Soil Resource group	Soil Management Unit
S01	Sandy Shrubland	Shrubland Drain
S02	Mallee Sand	Mallee Sand
S03	Woodland Clay	Woodland Clay
S04	Gypsum Dune	Gypsum Dune
S05	Samphire Clay	Samphire Clay
S06	Woodland	Woodland
S07	Woodland	Woodland
S08	Woodland	Woodland
S09	Mallee Sand Disturbed	Mallee Sand
S10	Wetland Disturbed	Mallee Sand
S11	Mallee Sand Disturbed	Mallee Sand
S12	Woodland	Woodland
S13	Sheoak Sands	Sheoak Sands
S14	Sheoak Sands	Sheoak Sands
S15	Woodland	Woodland
S16	Mallee Sand	Mallee Sand
S17	Sandy Shrubland	Mallee Sand
S18	Drainage Line	Shrubland Drain
S19	Woodland Clay	Woodland Clay
S20	Woodland Clay	Woodland Clay
Total	10	7

The boundary of each SMU is indicated in **Figure 5-1**; these boundaries should be considered indicative only.

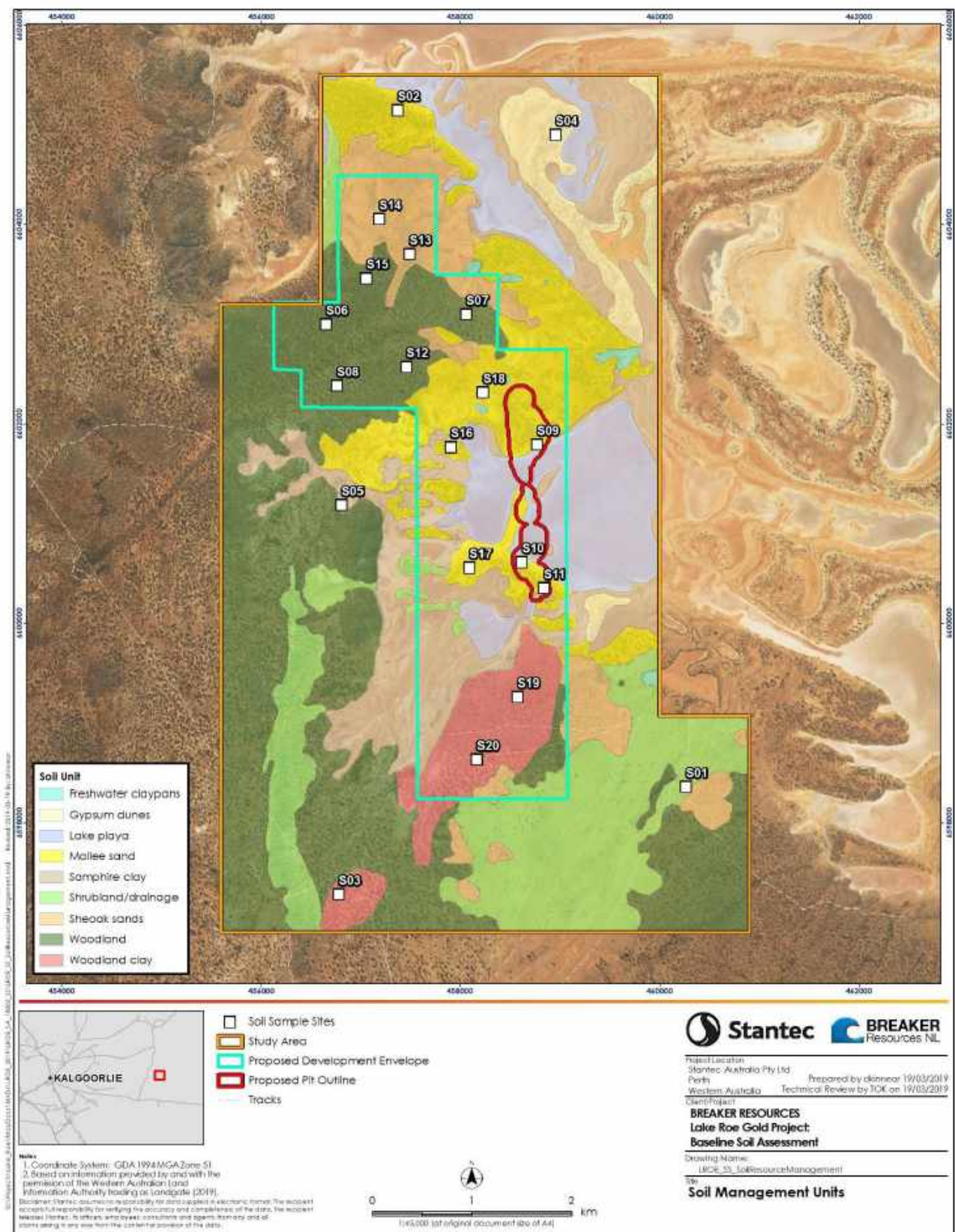


Figure 5-1: Soil management units (SMU) for the Study Area

5.2 Summary of SMU Characteristics and Implications for Management

The main objective of this baseline soil assessment was to assess and characterise the soils within the Study Area, to provide information that can be used to assist in soil management for future mining operations.

There were substantial differences in physical characteristics (texture, stability, soil strength and water retention) between soils of the Study Area, and in chemical characteristics particularly salinity and sodicity. As in other areas of the Goldfields region of Western Australia, local vegetation has adapted to soil conditions including those that are naturally highly saline and / or sodic as evidenced by the range of flora naturally present within the Study Area (Stantec 2019c). However, once disturbed and moved some of these soil characteristics may represent a constraint for subsequent rehabilitation.

Much of the Study Area is characterised by soils that are unstable and contain one or more chemical characteristics that are likely to restrict plant growth (e.g. high sodicity, salinity). However, local flora species have adapted to these specific conditions and while these soils are un-disturbed, they pose no environmental risk or concern. Specific properties make each of these soils more or less favourable for use in future rehabilitation and therefore care should be taken to segregate those soils that have more favourable properties.

Of specific importance is the non-saline topsoils within the Mallee Sand, Sheoak Sand and Woodland SMU, that account for approximately 202 ha, 117 ha and 237 ha respectively within the Development Envelope. These soils are the most suitable for use in rehabilitation (**Table 5-2**) and care should be taken not to contaminate these soils with highly saline soil material or leachates. The tendency for instability of some soils is also a concern for their eventual use in rehabilitation, particularly on sloping landforms. Ideally surface soil (0 to 10 cm) and subsoil (10 to 30 cm) should be stripped and stockpiled separately if being re-used.

A preliminary impact assessment is presented in **Table 5-3**. The chemical and physical properties of the SMU's are summarised in **Table 5-4**.

It is recognised that soils in the Study Area has naturally elevated levels of a number of elements, including soluble metals that can be of potential environmental concern. All the SMUs within the Study Area reported high concentrations of metals in water leachates from the samples, with concentrations of one or more elements above environmental trigger values. However, it is recognised that this is relatively consistent across the Study Area and is considered likely to be also reflected in adjacent lake sediments. A related Aquatic Ecology Baseline Study of that will include assessment of lake surface waters and sediments is planned for 2019.

Until baseline chemical characteristics, including total and soluble element concentrations in the lake system are established, it is recommended that soil material is stripped and stored in a manner which limits potential for sediment or leachate entering Lake Roe or peripheral wetlands. As part of that, the material should be stockpiled and re-used in areas of similar chemical properties.

All soil suitable for re-use is recommended to be stored in stockpiles less than two metres high, and paddock dumped to maximise vegetation re-establishment and conservation of the biological integrity of the soil. A conservative approach is recommended in which stockpiles are located upslope and away from potentially sensitive environmental areas, including the lake and peripheral wetlands. Locations may be re-assessed after investigation of the lake system and its natural background chemical characteristics.

Table 5-2: Relative rankings of Soil Management Units (SMU) in terms of suitability for use in rehabilitation

Soil Management Unit	Depth	Estimated area within Study Area	Estimated area within proposed Development Envelope
Most suitable for use in rehabilitation ¹			
Woodland	Surface	1125 ha	237 ha
Less suitable for use in rehabilitation ^{1, 2}			
Sheoak Sand	Surface	292 ha	117 ha
Mallee Sand	Surface	471 ha	202 ha
Mallee sand	Subsurface	471 ha	202 ha
Woodland	Subsurface	1125 ha	237 ha
Woodland Clay	Subsurface	185 ha	133 ha
Least suitable for use in rehabilitation			
Gypsum Dune	Surface and subsurface	142 ha	0 ha
Samphire Clay ⁴	Surface and subsurface	551 ha	156 ha
Shrubland Drain	Surface and subsurface	561 ha	30 ha
Sheoak Sand	Subsurface	292 ha	117 ha
Woodland Clay	Surface	185 ha	134 ha

Notes: ¹All soils have potential stability concerns hence none are optimal for placement on slopes. ² Soils have chemical restriction on re-use applications (sodicity/ salinity). ³ Requires additional testing to confirm stability prior to stockpiling. ⁴ Additional testing recommended to characterise this material, no samples were collected within the Development Envelope.

Table 5-3: Preliminary impact assessment of soils

		Preliminary Impact Assessment		
Key Aspects	Findings	Direct Impacts	Indirect Impacts	Risk
Terrestrial Environmental Quality (Soils). The Study Area includes part of Lake Roe, a saline playa with numerous peripheral wetlands The soils within the Study Area show high variability in chemical and physical properties.	- ten soil resource groups with seven soil management units (SMUs); - four SMUs are least preferred for use in rehabilitation (unstable, saline and / or sodic, and high soluble element concentrations) - Three SMUs are preferred for use in rehabilitation	- properties of some soils, such as high salinity, may constrain rehabilitation outcomes; - physical instability of some soils will create erosion risk if placed on sloping areas.	- presence of soluble metals in soils from across the Study Area may be concern for the lake system - potential for erosion may lead to sediment transport to the lake playa	Potential - inappropriate soil management may constrain rehabilitation outcomes or lead to localised impacts on the lake system.

Table 5-4: Summary of soil properties within each Soil Management Unit within the Study Area

Soil Management Unit	Depth (cm)	Physical Properties						Chemical Properties						
													Elements of Potential Concern	
		Coarse Material Content ² (>2 mm)	Soil texture ¹	Stability ³	Hardsetting	Drainage	Water Retention ⁴ (PAW %)	pH _{Ca}	Salinity Class	Exchangeable Sodium Percentage (%)	Organic Carbon (%)	Nutrient Status	Total Elements ⁵	Soluble Elements ⁵
Shrubland Drain (n=2) Locations: S18, S01	0-10	34	Sand/Clay Loam, Clay loam	Unstable, completely dispersive (Class 1)	Hardsetting (65.5 kPa)	Extremely slow to Slow (0.1 to 1.1 mm/hr)	High (27.3%)	Neutral to Moderately alkaline (6.1)	Moderately saline (0.32 dS/m)	Sodic (32.5%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	10-30	61	Heavy Clay, Medium Heavy Clay	Variable: Unstable, and dispersive and Partially stable and dispersive (Class 1 and 3a)	Hardsetting (77.7 kPa)	Slow (1.0 to 2.3 mm/hr)	Low (3.9%)	Moderately alkaline (6.8)	Very saline (1.37 dS/m)	Sodic (38.2%)	Low (<0.5%)	Low, (moderate K)	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Ni, Zn
Gypsum Dune (n=1) Location: S04	0-10	10.9	Sandy Clay Loam	Partially stable, non-dispersive (Class 4)	Non-hardsetting (23.3 kPa)	Moderately slow (12.4 mm/hr)	High (27.8%)	Moderately alkaline (7.6)	Extremely saline (2.34 dS/m)	Non-sodic (<0.1%)	Low (<0.5%)	Low, (high S)	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cu
	10-30	8.5	Light Clay	Stable (Class 7)	Non-hardsetting (17.9 kPa)	Moderately slow (12.5 mm/hr)	NA	Moderately alkaline (7.6)	Extremely saline (3.00 dS/m)	Non-sodic (0.2%)	Low (<0.5%)	Low, (high S)	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cu
Mallee Sands (n= 6) Mallee Sands (n=3) Locations: S02, S16, S17 Mallee Sands, Disturbed (n=3) Locations: S09, S10, S11	0-10	52	Sandy Loam, Clayey Sand	Partially stable, non-dispersive (Class 3b and Class 5)	Non-hardsetting (9.6 kPa)	29.1	High (24.3%)	Neutral (5.6)	Non-saline (0.01 dS/m)	Slightly sodic (7.1%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	10-30	47	Clay Loam, Clayey Sand	Partially stable, non-dispersive (Class 3b)	Non-hardsetting (10.9 kPa)	31.7	High (20.9%)	Neutral (5.8)	Non-saline (0.02 dS/m)	Slightly sodic (7.1%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	0-10	32	Sandy Loam	Variable: Partially stable, non-dispersive (Class 3a, 3b and 6)	Non-hardsetting (6.8 kPa)	91.9	26.3	Neutral (6.2)	Non-saline (0.01 dS/m)	Non-sodic (5.9%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	10-30	20	Sandy Loam	Variable: Partially stable, non-dispersive (Class 3b and 6)	Non-hardsetting (5.2 kPa)	74.6	28.9	Neutral (6.3)	Non-saline (0.03 dS/m)	Slightly Sodic (8.3%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
Sapphire Clay (n=1) Location: S05	0-10	71.4	Light Clay	Unstable, dispersive (Class 2)	Hardsetting (63.1 kPa)	Extremely slow (0.4 mm/hr)	NA	Moderately alkaline (7.4)	Moderately saline (1.98 dS/m)	Highly Sodic (38.31%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	10-30	31.8	Medium Clay	Unstable, dispersive (Class 2)	Hardsetting (131.5 kPa)	Extremely slow (0.2 mm/hr)	NA	Moderately alkaline (7.8)	Extremely saline (4.58 dS/m)	Highly Sodic (43.7%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cu, Pb, Ni, Zn
Sheep Sands (n=2) Locations: S13, S14	0-10	10.3	Sandy Loam, Clay Loam	Variable: Unstable and dispersive or Partially stable (Class 2 and 3a)	Non-hardsetting (12.7 kPa)	Slow (5.5 mm/hr)	39.4	Neutral (6.1)	Non-saline (0.04 dS/m)	Non-sodic (2.4%)	Low (<0.5%)	Low	Naturally high in Cr	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn

Soil Management Unit	Depth (cm)	Physical Properties						Chemical Properties						
													Elements of Potential Concern	
		Coarse Material Content ² (>2 mm)	Soil texture ¹	Stability ³	Hardsetting	Drainage	Water Retention ⁴ (PAW %)	pH _{Ca}	Salinity Class	Exchangeable Sodium Percentage (%)	Organic Carbon (%)	Nutrient Status	Total Elements ⁵	Soluble Elements ⁵
	10-30	29.3	Sandy Clay Loam, Light Clay	Variable: Unstable and dispersive or Partially stable (Class 2 and 4)	Non-hardsetting (46.8 kPa)	Extremely slow (0.8 mm/hr)	19.4	Neutral (6.6)	Non-saline (0.09 dS/m)	Highly Sodic (18.09%)	Low (<0.5%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
Woodland (n=6) Locations: S06, S07, S08, S12, S15	0-10	24.3	Light Clay, Clay Loam	Partially stable, non-dispersive (Class 3a and 3b)	Non-hardsetting (23.2 kPa)	Moderately slow (11.1 mm/hr)	25.6	Moderately alkaline (7.5)	Non-saline (0.09 dS/m)	Non-sodic (0.3%)	Low (0.9%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
	10-30	40.8	Light Clay, Medium Clay, Medium Heavy Clay	Partially stable, non-dispersive (Class 3b and 4)	Non-hardsetting (16.0 kPa)	Moderately slow (14.6 mm/hr)	18.2	Moderately alkaline (7.6)	Slightly saline (0.50 dS/m)	Non-sodic (0.7%)	Low (0.9%)	Low	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Pb, Ni, Zn
Woodland Clay (n=2) Locations: S03, S19, S20	0-10	38.6	Light Clay	Unstable, dispersive (Class 2)	Hardsetting (73.0 kPa)	Slow (6.9 mm/hr)	17.8	Moderately alkaline (7.4)	Moderately saline (0.65 dS/m)	Non-sodic (0.5%)	Low (<0.5%)	Low, moderate S	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Cr, Co, Cu, Ni, Zn
	10-30	41.4	Light Clay, Medium Clay	Partially stable, non-dispersive (Class 4)	Non-hardsetting (24.0 kPa)	Moderately slow (15.8 mm/hr)	16.0	Moderately alkaline (7.7)	Moderately saline (0.80 dS/m)	Non-sodic (0.3%)	Low (<0.5%)	Low, moderate S	Naturally high in Cr and Ni	Naturally high, exceeded trigger values in: Co, Cu, Ni, Zn

Notes:

- Field texture based on the <2 mm size fraction.
- Determined for all coarse fragments >2 mm in size.
- Class categories are described in **Appendix E**.
- Effective plant-available water (PAW, % vol) based on average amounts per soil management unit group and takes into account coarse material content.
- Elevated elements with respect to environmental screening criteria (Refer to **Appendix E**). Elements that recorded exceedances are noted.

Soil management unit (SMU) average values are presented where applicable, n= number of sample locations. Results are given broad qualitative ratings of good, moderate and poor for each physical and chemical parameter relative to suitability for endemic plant growth and/or overall material stability. NA = not available

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A close-up, low-angle shot of a person's hand reaching out towards a bright sun in a field of tall grass. The hand is silhouetted against the bright light of the sun, which is positioned in the lower right quadrant of the frame. The grass is tall and swaying, creating a sense of movement. The overall color palette is warm, dominated by golden yellows and oranges from the sunlight, with deep shadows in the grass and the hand.

Appendices

Appendix A Sample Register

Table A-1
Sample Register
Lake Roe Gold Project

Sample ID	Date Sampled	Depth (cm)		Matrix	Material Description	Site Description	Landform / Location	Land System	Soil Resource Group	Sample Location		Stantec							ALS Environmental					
		From	To							Easting	Northing	Field Texture	Gravel Content	Modulus of Rupture	Emerson Aggregate Test	Saturated Hydraulic Conductivity	Water Retention	pH, EC (1:5) and pH (CaCl)	Soil Suite			Particle Size	Metals	
																			Nutrients, Organic Carbon	ExCATs with prewash	Total elements (15 NEPM)		Leachable elements (15 NEPM)	
S01 0-10	11/06/2018	0	10	Soil	Sandy Clay	Sandy clay flat with chenopod shrubland - undisturbed analogue	Analogue / Flat micro relief	MX43	Sandy shrubland	460269	6598355	x	x	x	x	x	x	x	x	x	x	x	x	
S01 10-30		10	30	x								x	x	x	x	x	x	x	x	x				
S02 0-10		0	10	Soil								Sandy	Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Analogue / sand dune / plain	Carnegie	Mallee Sand	457375	6605143	x	x	x	x		
S02 10-30	10	30	x	x	x	x			x	x										x	x			
S03 0-10	0	10	Soil	Clay	Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	Analogue / flat micro relief	MX43	Woodland Clay	456786	6597273	x								x	x	x	x	x	x
S03 10-30	10	30	x								x	x	x	x	x	x	x	x	x	x	x			
S04 0-10	0	10	Soil								Sandy loam / some grazing by rabbits	Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Gypsum dune / elevated soil around shrubs	Carnegie	Gypsum dune	458961	6604902	x	x	x	x	x	x	x
S04 10-30	10	30	x	x	x	x	x	x	x	x								x	x	x	x			
S05 0-10	0	10	Soil	Clay (heavy)	Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	Analogue / Slope (flat)	MX43	Samphire/ clay	456811	6601185								x	x	x	x	x	x	x
S05 10-30	10	30	x								x	x	x			x	x			x	x			
S06 0-10	0	10	Soil								Sandy loam	Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	Analogue / Flat micro relief	MX43	Woodland	456654	6602993	x	x	x	x			x
S06 10-30	10	30	x	x	x	x			x	x										x	x			
S07 0-10	0	10	Soil	Fine silt / clay	Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed shrubland	Analogue / No micro relief	MX43	Woodland	458063	6603096								x	x	x	x	x	x	x
S07 10-20	10	30	x								x	x	x	x	x	x	x	x	x	x	x			
S08 0-10	0	10	Soil								Sandy loam	Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	Analogue / flat micro relief	MX43	Woodland	456767	6602381	x	x	x	x			x
S08 10-30	10	30	x	x	x	x			x	x										x	x			
S09 0-10	0	10	Soil	Sand	Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Heavily degraded (drilling) Euc / Flat micro relief	Carnegie	Mallee Sands HD	458775	6601788								x	x	x	x			x
S09 10-30	10	30	x								x	x	x			x	x			x	x			
S10 0-10	0	10	Soil								Sandy	Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Heavily/completely degraded / Flat micro relief	Carnegie	Wetland HD	458620	6600606	x	x	x	x	x	x	x
S10 10-30	10	30	x	x	x	x	x	x	x	x								x	x	x	x			
S11 0-10	0	10	Soil	Sandy	Sandy flat with Eucalyptus malle over spinifex - heavily disturbed	Heavily degraded / Flat micro-relief	Carnegie	Mallee Sands HD	458842	6600353								x	x	x	x			x
S11 10-30	10	30	x								x	x	x			x	x			x	x			
S12 0-10	0	10	Soil								Sandy clay	Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	Analogue / Plain / Flat - No micro relief	MX43	Woodland	457460	6602572	x	x	x	x	x	x	x
S12 10-30	10	30	x	x	x	x			x	x										x	x			
S13 0-10	0	10	Soil	Sandy Loam	Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	Analogue plain / Slight slope	MX43	Sheoak sands	457493	6603703								x	x	x	x	x	x	x
S13 10-30	10	30	x								x	x	x			x	x			x	x			
S14 0-10	0	10	Soil								Sandy clay	Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	Analogue plain / No micro relief	MX43	Sheoak sands	457186	6604051	x	x	x	x	x	x	x
S14 10-30	10	30	x	x	x	x	x	x	x	x								x	x	x	x			
S15 0-10	0	10	Soil	Sandy loam	Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	Analogue plain	MX43	Woodland	457057	6603458								x	x	x	x			x
S15 10-30	10	30	x								x	x	x			x	x			x	x			
S16 0-10	0	10	Soil								Sandy	Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Analogue / Flat micro-relief	Carnegie	Mallee Sand	457911	6601762	x	x	x	x			x
S16 10-30	10	30	x	x	x	x			x	x										x	x			
S17 0-10	0	10	Soil	Sand	Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Pilolus and tussock grassland - undisturbed analogue	Analogue / Flat micro-relief	Carnegie	Sandy shrubland	458095	6600552								x	x	x	x	x	x	x
S17 10-30	10	30	x								x	x	x	x	x	x	x	x	x	x	x			
S18 0-10	0	10	Soil								Sandy w/clay (clay w/depth)	Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	Analogue / Drainage / Flat micro-relief	MX43	Drainage line	458229	6602313	x	x	x	x	x	x	x
S18 10-30	10	30	x	x	x	x	x	x	x	x								x	x	x	x			
S19 0-10	0	10	Soil	Clay loam	Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	Analogue / Flat micro-relief	MX43	Woodland Clay	458577	6599260								x	x	x	x	x	x	x
S19 10-30	10	30	x								x	x	x	x	x	x	x	x	x	x	x			
S20 0-10	0	10	Soil								Clay	Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	Analogue / Flat micro-relief	MX43	Woodland Clay	458170	6598629	x	x	x	x	x	x	x
S20 10-30	10	30	x	x	x	x			x	x										x	x			

Appendix B Sample Location Site Descriptions



Stantec Australia
41 Bishop Street, Jolimont, WA
6014 www.stantec.com

TEL: +61 (08) 9388 8799
FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S01

Client: Breaker Resources NL
Date: 6/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy clay flat with *chenopod* shrubland
Soil Assessment Group: Sandy Shrubland
Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 460269 mE **Northing:** 6598355 mN
Land System: MX43
Soil Management Unit: Shrubland Drain



Plate A-1: Soil surface at Site S01

Surface description:

Moderate strength surface crusting present, ~0.8 cm thick.



Plate A-2: Soil profile at Site S01

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S01_0-10	Sandy clay. Abundance of aggregates ranging from 1 to 4 cm in size
10-30 cm	Subsoil	S01_10-30	Few roots present occurring at more than 10 cm in depth.



Plate A-3: Vegetation at Site S01

Surface description:

Moderate strength surface crusting present, ~0.8 cm thick. Course fragments (quartz and unknown) covering approximately 80 to 90% of the soil surface, ranging between 0.1 to 1 cm. Sparse woody debris and leaf litter present. A low percentage (~30%) of cryptogams were present. Flat micro-relief.

Vegetation description:

Sparse Sheoak over *Chenopod* shrubland.

Additional information:

Fauna habitat zone: Shrubland



Stantec Australia

41 Bishop Street, Jolimont, WA
6014 www.stantec.com

TEL: +61 (08) 9388 8799
FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S02

Client: Breaker Resources NL

Date: 4/11/2018

Location: Lake Roe – undisturbed analogue

Site Description: Sandy plain/sand dune with *Eucalyptus* over spinifex

Soil Assessment Group: Mallee Sand

Datum: UTM, GDA 94, Zone 51J

Coordinates:

Easting: 457375 mE

Northing: 6605143 mN

Land System: Carnegie

Soil Management Unit: Mallee Sand



Plate B-1: Soil surface at Site S02

Surface description:

Weak strength surface crusting present ~1 cm thick



Plate B-2: Soil profile at Site S02

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S02_0-10	Uniform. Sandy. No aggregates present.
10-30 cm	Subsoil	S02_10-30	Moderate roots present occurring at 10 cm in depth.



Plate B-3: Vegetation at Site S02

Surface description:

Moderate strength surface crusting present, ~0.8 cm thick. Course fragments (quartz and unknown) covering approximately 80 to 90% of the soil surface, ranging between 0.1 to 1 cm. Sparse woody debris and leaf litter present. A low percentage (~30%) of cryptogams were present. Flat micro-relief.

Vegetation description:

Eucalyptus woodland over Spinifex.

Additional information:

Habitat zone: Mallee over spinifex

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ABN: 17 007 820 322

Site ID:**S03****Client:** Breaker Resources NL**Date:** 7/11/2018**Location:** Lake Roe – undisturbed analogue**Site Description:** Clay flat with *Eucalyptus* woodland over *chenopod* shrubland**Soil Assessment Group:** Woodland Clay**Datum:**

UTM, GDA 94, Zone 51J

Coordinates:**Easting:** 456786 mE **Northing:** 6597273 mN**Land System:** MX43**Soil Management Unit:** Woodland Clay**Plate C-1: Soil surface at Site S03****Surface description:**

Moderate strength surface crusting present, ~1 cm thick

**Plate C-2: Soil profile at Site S03****Profile description:**

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S03_0-10	Orange/brown clay. Moderate presence of aggregates. Moderate strength surface crusting present, ~1 cm thick. Very few to few roots present occurring at a depth of 0 to 30 cm. Moderate abundance of coarse fragments present (Quartz) ranging from 1 to 3 cm in size.
10-30 cm	Subsoil	S03_10-30	

**Plate C-3: Vegetation at Site S03****Surface description:**

Moderate strength surface crusting present, ~1 cm thick. High abundance of coarse fragments (quartz and unknown grey) covering the soil surface, ranging between 2 to 6 cm (with some up to 10 cm). High abundance of surface woody debris and leaf litter. A high percentage (>90%) of cryptogams present. Flat micro-relief.

Vegetation description:*Eucalyptus* woodland over *Chenopods* (*Meriana atriplex*).**Additional information:**

Fauna habitat zone: Eucalypt woodland



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Site ID: S04

Client: Breaker Resources NL **Datum:** UTM, GDA 94, Zone 51J
Date: 5/11/18 **Coordinates:** **Easting:** 458961 mE **Northing:** 6604902 mN
Location: Lake Roe – undisturbed analogue **Land System:** Carnegie
Site Description: Sandy loam gypsum dunes with pine over chenopod
Soil Assessment Group: Gypsum Dune **Soil Management Unit:** Gypsum Dune



Plate D-1: Soil surface at Site S04

Surface description:

Moderate strength surface crusting present, ~0.8 cm thick.



Plate D-2: Soil profile at Site S04

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S04_0-10	Sandy clay. Abundance of aggregates ranging from 1 to 4 cm in size
10-30 cm	Subsoil	S04_10-30	Few roots present occurring at more than 10 cm in depth.



Plate D-3: Vegetation at Site S04

Surface description:

Moderate strength surface crusting present, ~0.8 cm thick. Course fragments (quartz and unknown) covering approximately 80 to 90% of the soil surface, ranging between 0.1 to 1 cm. Sparse woody debris and leaf litter present. A low percentage (~30%) of cryptogams were present. Flat micro-relief.

Vegetation description:

Sparse Sheoak over Chenopod shrubland.

Additional information:

Fauna habitat zone: Gypsum dunes



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FAX: +61 (08) 93888633
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Site ID: S05

Client: Breaker Resources NL **Datum:** UTM, GDA 94, Zone 51J
Date: 7/11/2018 **Coordinates:** **Easting:** 456811 mE **Northing:** 6601185 mN
Location: Lake Roe – undisturbed analogue **Land System:** MX43
Site Description: Heavy clay slope with *Tecticornia* shrubland / low *chenopod* shrubs
Soil Assessment Group: Samphire Clay **Soil Management Unit:** Samphire Clay



Plate E-1: Soil surface at Site S05

Surface description:

Moderate strength surface crusting present, ~5 mm thick



Plate E-2: Soil profile at Site S05

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S05_0-10	Orange/brown heavy clay. No mottles present. Moderate strength surface crusting present, ~5 mm thick. Moderate strength aggregates (1 to 5 cm in size). Very few to few roots present occurring at 0-10 cm in depth.
10-30 cm	Subsoil	S05_10-30	



Plate E-3: Vegetation at Site S05

Surface description:

High presence (80-90%) of coarse fragments (quartz) covering the soil surface, 1 to 10 cm in size. Sparse woody debris with no leaf litter present. A low percentage (~10-20%) of cryptogams were present. Predominantly flat to gently sloping micro-relief.

Vegetation description:

Tecticornia shrubland / low Chenopod shrubs including Atriplex.

Additional information:

Fauna habitat zone: Eucalypt woodland/samphire



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 FAX: +61 (08) 9388 8633
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Site ID: S06

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods
Soil Assessment Group: Woodland

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 456654 mE **Northing:** 6602993 mN
Land System: MX43
Soil Management Unit: Woodland



Plate F-1: Soil surface at Site S06

Surface description:

Moderate strength surface crusting, approximately 1 cm thick



Plate F-2: Soil profile at Site S06

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S06_0-10	Brown sandy loam. Moderate strength surface crusting, approximately 1 cm thick. Moderate, rounded aggregates present, approximately 2 cm in size. Coarse fragments common (calcretes and quartz), ~ 2 cm in size
10-30 cm	Subsoil	S06_10-30	Moderate roots present at 10+ cm in depth.



Plate F-3: Vegetation at Site S06

Surface description:

Moderate strength surface crusting, approximately 1 cm thick. Rounded coarse fragments (common) (calcretes and quartz) ranging from 0.5 to 2 cm in size. Presence of ~ 20% of cryptogams. Surface debris common, ~30%. Flat micro-relief.

Vegetation description:

Eucalyptus woodland over Melaleuca shrubland over Chenopods.

Additional information:

Fauna habitat zone: Eucalypt woodland



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FAX: +61 (08) 9388 8633
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Site ID: S07

Client: Breaker Resources NL
Date: 4/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Fine silt/clay flat with Eucalyptus over chenopod shrubland
Soil Assessment Group: Woodland

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458063 mE **Northing:** 6603096 mN
Land System: MX43
Soil Management Unit: Woodland



Plate G-1: Soil surface at Site S07

Surface description:

Moderate strength surface crusting present, ~1 cm thick.



Plate G-2: Soil profile at Site S07

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S07_0-10	Brown, fine silt/clay. No aggregates present, soil breaks readily into fine powder. Rounded coarse fragments (calcretes – hard) present, ~5 to 10% in abundance and 2 cm in size.
10-30 cm	Subsoil	S07_10-30	Medium roots present (common) occurring at 10+ cm in depth.



Plate G-3: Vegetation at Site S07

Surface description:

Moderate strength surface crusting present, ~1 cm thick. Rounded coarse fragments (calcretes) present, ~5 to 10% in abundance and 2 cm in size. Sparse leaf litter present (~5%). A high percentage (80%) of cryptogams were present. No micro-relief.

Vegetation description:

Eucalyptus (good condition) over Atriplex.

Additional information:

Fauna habitat zone: Eucalypt woodland



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TEL: +61 (08) 9388 8799
FAX: +61 (08) 9388 633
ABN: 17 007 820 322

Site ID: S08

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods
Soil Assessment Group: Woodland

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 456767 mE **Northing:** 6602381 mN
Land System: MX43
Soil Management Unit: Woodland



Plate H-1: Soil surface at Site S08

Surface description:

Moderate strength surface crusting, approximately 1 cm thick.



Plate H-2: Soil profile at Site S08

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S08_0-10	Orange/brown sandy loam. No mottles present. No aggregates present. Rounded coarse fragments common, ~1 to 2 cm in size.
10-30 cm	Subsoil	S08_10-30	Fine / medium roots present at 10 to 20 cm in depth.



Plate H-3: Vegetation at Site S08

Surface description:

Moderate strength surface crusting, approximately 1 cm thick. 50 to 70% of coarse fragments present, approximately less than 2 cm in size. Presence of 50 to 70 % of cryptogams (within bare soil). Leaf litter and woody debris present. Flat micro-relief.

Vegetation description:

Eucalyptus over Melaleuca over Chenopod.

Additional information:

Fauna habitat zone: Eucalypt woodland



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FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S09

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – heavily disturbed (drilling)
Site Description: Sandy flat with Eucalyptus over sparse spinifex
Soil Assessment Group: Mallee Sand – Disturbed

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458775 mE **Northing:** 6601788 mN
Land System: MX43
Soil Management Unit: Mallee Sand



Plate I-1: Soil surface at Site S09

Surface description:

Weak strength surface crusting present, ~1 cm thick.



Plate I-2: Soil profile at Site S09

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S09_0-10	Orange/brown sand. No mottles present. Weak aggregates present, ~2 to 6 cm in size. No coarse fragments present.
10-30 cm	Subsoil	S09_10-30	Moderate abundance of fine to coarse roots present occurring at 10+ cm in depth.



Plate I-3: Vegetation at Site S09

Surface description:

Moderate strength surface crusting present, ~1 cm thick. No coarse fragments present. Woody debris and leaf litter present (common). Cryptogams (moderate) present, most areas heavily degraded. Flat micro-relief.

Vegetation description:

Eucalyptus trees (6 to 9 m) over Spinifex (sparse), no mid storey present. Area heavily degraded (drilling).

Additional information:

Fauna habitat zone: Mallee over spinifex



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Site ID: S10

Client: Breaker Resources NL
Date: 6/11/2018
Location: Lake Roe – heavily disturbed (drilling)
Site Description: Sandy flat with Eucalyptus over spinifex
Soil Assessment Group: Wetland -Disturbed

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458620 mE **Northing:** 6600606 mN
Land System: Carnegie
Soil Management Unit: Mallee Sand



Plate J-1: Soil surface at Site S10

Surface description:

No coarse fragments present. No cryptogams present.



Plate J-2: Soil profile at Site S10

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S10_0-10	Orange/brown sand. No mottles present. No aggregates present. No coarse fragments present. Sparse abundance of very fine / fine roots occurring at 0 to 5 cm in depth.
10-30 cm	Subsoil	S10_10-30	



Plate J-3: Vegetation at Site S10

Surface description:

No coarse fragments present. No cryptogams present. Leaf litter and woody debris present (common) in good condition – area of sample had none of either. Flat micro-relief.

Vegetation description:

Eucalyptus over Spinifex – area completely degraded by exploration drilling.

Additional information:

Fauna habitat zone: Freshwater wetland



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ABN: 17 007 820 322

Site ID: S11

Client: Breaker Resources NL
Date: 6/11/2018
Location: Lake Roe – heavily disturbed
Site Description: Sandy flat with Eucalyptus Mallee over spinifex
Soil Assessment Group: Mallee Sands- Disturbed

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:**458842 mE **Northing:**6600353 mN
Land System: MX43

Soil Management Unit: Mallee Sand



Plate K-1: Soil surface at Site S11

Surface description:

Weak strength surface crusting present, ~0.5 cm thick.



Plate K-2: Soil profile at Site S11

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S11_0-10	Sand. No mottles present. No aggregates present. No coarse fragments present.
10-30 cm	Subsoil	S11_10-30	Fine to coarse roots present (common) occurring at 10+ cm in depth.



Plate K-3: Vegetation at Site S11

Surface description:

Weak strength surface crusting present, ~0.5 cm thick. No coarse fragments present. Woody debris and leaf litter present (common). Cryptogams (rare, less than 10%) present. Flat micro-relief.

Vegetation description:

Eucalyptus (Mallee) over Spinifex. Area heavily degraded (exploration drilling).

Additional information:

Fauna habitat zone: Mallee over spinifex



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FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S12

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods
Soil Assessment Group: Woodland

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:**457460 mE **Northing:**6602572 mN
Land System: MX43
Soil Management Unit: Woodland



Plate L-1: Soil surface at Site S12

Surface description:

Medium strength aggregates present, ~2 to 5 cm in size.



Plate L-2: Soil profile at Site S12

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S12_0-10	Red, sandy clay. No coarse fragments present.
10-30 cm	Subsoil	S12_10-30	Medium abundance of fine / medium roots occurring at 10 to 30 cm in depth.



Plate L-3: Vegetation at Site S12

Surface description:

Medium strength surface crusting, ~1 cm thick. No active erosion. No coarse fragments present. Cryptogams present (40% cover). Leaf litter and woody debris present (20% cover, 100% under Eucalyptus). Flat micro-relief.

Vegetation description:

Eucalyptus over *Eremophila* sp. over Chenopods.

Additional information:

Fauna habitat zone: Eucalypt Woodland



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Site ID: S13

Client: Breaker Resources NL **Datum:** UTM, GDA 94, Zone 51J
Date: 4/11/2018 **Coordinates:** **Easting:** 457493 mE **Northing:** 6603703 mN
Location: Lake Roe – undisturbed analogue **Land System:** MX43
Site Description: Sandy loam plain/low slope with Sheoak over *Eremophila* and chenopods
Soil Assessment Group: Sheoak Sand **Soil Management Unit:** Sheoak Sand



Plate M-1: Soil surface at Site S13

Surface description:

Medium strength aggregates present, ~2 cm in size.



Plate M-2: Soil profile at Site S13

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S13_0-10	Brown sandy loam. No coarse fragments present.
10-30 cm	Subsoil	S13_10-30	Very fine to fine roots present.



Plate M-3: Vegetation at Site S13

Surface description:

No coarse fragments present. Surface debris (10%) present. Cryptograms (common, 70 to 90%) present. Slight sloping micro-relief.

Vegetation description:

Sparse. *Allocasuarina*, *Eremophila*, *Senna*, *Ptilotus*

Additional information:

Fauna habitat zone: Sheoak over chenopod



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FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S14

Client: Breaker Resources NL
Date: 4/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy clay plain with *Allocasuarina* over chenopods
Soil Assessment Group: Sheoak Sand

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 457186 mE **Northing:** 6604051 mN
Land System: MX43
Soil Management Unit: Sheoak Sand



Plate N-1: Soil surface at Site S14

Surface description:

Weak strength surface crusting, ~0.5 cm thick.



Plate N-2: Soil profile at Site S14

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S14_0-10	Brown, sandy clay. Medium strength aggregates present, ~2 cm in size. No coarse fragments present.
10-30 cm	Subsoil	S14_10-30	Fine roots (common) occurring at 0 to 30 cm in depth.



Plate N-3: Vegetation at Site S14

Surface description:

Weak strength surface crusting, ~0.5 cm thick. No active erosion presents. No coarse fragments present. Cryptogams (common) present, 70 to 90% cover. Surface debris present, 5%. No micro-relief present.

Vegetation description:

Allocasuarina over *Chenopods* (*Atriplex* and *Cratystylus*)

Additional information:

Fauna habitat zone: Sheoak over chenopod



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FAX: +61 (08) 9388 8633
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Site ID: S15

Client: Breaker Resources NL
Date: 4/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy loam plain with Eucalyptus over Eremophila and chenopods
Soil Assessment Group: Woodland

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 457057 mE **Northing:** 6603458 mN
Land System: MX43
Soil Management Unit: Woodland



Plate O-1: Soil surface at Site S15

Surface description:

Weak strength surface crusting, ~0.5 cm.



Plate O-2: Soil profile at Site S15

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S15_0-10	Brown sandy loam. Weak strength aggregates present, ~2 cm in size. Angular shaped, calcrete coarse fragments (5% abundance) present, ~2 cm in size.
10-30 cm	Subsoil	S15_10-30	Fine to coarse roots present (very common) occurring at 0 to 30 cm in depth.



Plate O-3: Vegetation at Site S15

Surface description:

Weak strength surface crusting, ~0.5 cm thick. No active erosion present. Angular shaped, calcrete coarse fragments (5% abundance) present, ~0.5 to 4 cm in size. Cryptogams (common, 70 to 90%) present. Surface debris present (10% cover). No micro-relief present.

Vegetation description:

Eucalyptus over Eremophila and Chenopods.

Additional information:

Fauna habitat zone: Eucalypt woodland



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Site ID: S16

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy flat with scattered Eucalyptus over spinifex with Mallee mid-upper storey
Soil Assessment Group: Mallee Sand

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 457911 mE **Northing:** 6601762 mN
Land System: Carnegie
Soil Management Unit: Mallee Sand



Plate P-1: Soil surface at Site S16

Surface description:

Weak strength surface crusting, ~0.5 cm thick.



Plate P-2: Soil profile at Site S16

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S16_0-10	Orange/ brown, sand. No mottles present. No aggregates present. No coarse fragments present.
10-30 cm	Subsoil	S16_10-30	Fine to medium roots (moderate abundance) occurring at 10 cm in depth.



Plate P-3: Vegetation at Site S16

Surface description:

Weak strength surface crusting, ~0.5 cm thick. No coarse fragments present. Cryptogams (moderate) present, 20 to 50% cover. Leaf litter and woody debris (common) present. Flat micro-relief present.

Vegetation description:

Sparse Sheoak over Chenopod shrubland.

Additional information:

Fauna habitat zone: Mallee over spinifex



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Site ID: S17

Client: Breaker Resources NL **Datum:** UTM, GDA 94, Zone 51J
Date: 6/11/2018 **Coordinates:** **Easting:** 458095 mE **Northing:** 6600552 mN
Location: Lake Roe – undisturbed analogue **Land System:** Carnegie
Site Description: Sandy flat with open mulga (*Acacia*) over shrubland with *Dodonaea*, *Eremophila*, *Solanum* and *Ptilotus* and tussock grassland
Soil Assessment Group: Sandy Shrubland **Soil Management Unit:** Mallee Sand



Plate Q-1: Soil surface at Site S17

Surface description:

Sand. Medium strength surface crusting, ~0.3 cm.



Plate Q-2: Soil profile at Site S17

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S17_0-10	Sand. No mottles present. Medium strength aggregates present, ~2 to 4 cm in size. No coarse fragments present.
10-30 cm	Subsoil	S17_10-30	Fine to medium roots present (rare) occurring at 10 to 30 cm in depth.



Plate Q-3: Vegetation at Site S17

Surface description:

Weak strength surface crusting, ~0.3 cm thick. No coarse fragments present. Cryptograms (common, 50 to 60%) present. Woody debris (common) and leaf litter (moderate cover) present. Flat micro-relief.

Vegetation description:

Mulga and *Dodonaea* over *Eremophila* over *Solanum* and *Ptilotus* and tussock grassland (open vegetation).

Additional information:

Fauna habitat zone: Shrubland



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TEL: +61 (08) 9388 8799
 FAX: +61 (08) 9388 8633
 ABN: 17 007 820 322

Site ID: S18

Client: Breaker Resources NL
Date: 5/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia & Allocasuarina
Soil Assessment Group: Drainage Line

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458229 mE **Northing:** 6602313 mN
Land System: MX43
Soil Management Unit: Shrubland Drain



Plate R-1: Soil surface at Site S18

Surface description:

Weak strength surface crusting, ~0.1 cm thick.



Plate R-2: Soil profile at Site S18

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S18_0-10	Sandy. No mottles present. Medium strength aggregates present, 1 to 5 cm in size. Coarse fragments (iron, very common) present, 3 to 5 cm in size – some very large.
10-30 cm	Subsoil	S18_10-30	Increased clay content. Fine roots (moderate abundance) occurring at 10+ cm in depth.



Plate R-3: Vegetation at Site S18

Surface description:

Weak strength surface crusting, ~0.1 cm thick. Coarse fragments present (quartz and iron), common in abundance at 1 to 5 cm in size. Cryptogams (rare) present. Woody debris (moderate) and leaf litter (rare) present. Flat micro-relief present.

Vegetation description:

Tecticornia, *Melaleuca* and *Allocasuarina*.

Additional information:

Fauna habitat zone: Freshwater wetland, low shrubland



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TEL: +61 (08) 9388 8799
FAX: +61 (08) 9388 8633
ABN: 17 007 820 322

Site ID: S19

Client: Breaker Resources NL
Date: 6/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Clay loam flat with Eucalyptus woodland over open shrubland and chenopods
Soil Assessment Group: Woodland Clay
Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458577 mE **Northing:** 6599260 mN
Land System: MX43
Soil Management Unit: Woodland Clay



Plate S-1: Soil surface at Site S19

Surface description:

Weak strength surface crusting, ~1 cm. Coarse fragments (e.g. quartz) present at surface, 2 to 5 cm in size.



Plate S-2: Soil profile at Site S19

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S19_0-10	Orange/brown clay loam. No mottles present. Medium strength aggregates present, ~2 to 5 cm in size. Coarse fragments present. Fine to medium roots present.
10-30 cm	Subsoil	S19_10-30	Fine to medium roots (moderate abundance) occurring at 10 cm in depth. Coarse fragments common. Fine to medium roots present.



Plate S-3: Vegetation at Site S19

Surface description:

Weak strength surface crusting, ~1 cm thick. Coarse fragments (e.g. quartz) present, very common abundance at ~80% and 0.5 to 5 cm in size. Cryptogams (moderate to low, 10 to 25%) present. Woody debris (very common) and leaf litter present. Flat micro-relief.

Vegetation description:

Eucalyptus over open shrubland mid storey and Chenopod, lower storey.

Additional information:

Fauna habitat zone: Eucalypt woodland



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Site ID: S20

Client: Breaker Resources NL
Date: 6/11/2018
Location: Lake Roe – undisturbed analogue
Site Description: Clay flat with Eucalyptus woodland over chenopod shrubland
Soil Assessment Group: Woodland Clay

Datum: UTM, GDA 94, Zone 51J
Coordinates: **Easting:** 458170 mE **Northing:** 6598629 mN
Land System: MX43
Soil Management Unit: Woodland Clay



Plate T-1: Soil surface at Site S20

Surface description:

Weak strength surface crusting, ~0.5 cm thick.



Plate T-2: Soil profile at Site S20

Profile description:

Depth	Material	Sample ID	Description
0-10 cm	Topsoil	S20_0-10	Orange/ brown, sand. No mottles present. No aggregates present. No coarse fragments present.
10-30 cm	Subsoil	S20_10-30	Fine to medium roots (moderate abundance) occurring at 10 cm in depth.



Plate T-3: Vegetation at Site S20

Surface description:

Weak strength surface crusting, ~0.5 cm thick. No coarse fragments present. Cryptogams (moderate) present, 20 to 50% cover. Leaf litter and woody debris (common) present. Flat micro-relief present.

Vegetation description:

Sparse Sheoak over Chenopod shrubland.

Additional information:

Fauna habitat zone: Mallee over spinifex

Appendix C Results Tables

Table C-1
Soil Physical Test Results
Lake Roe Gold Project

					Analyte Grouping	Coarse Material Content ¹	Particle Size Distribution				Soil Texture		Soil Stability ³	Soil Strength	Saturated Hydraulic Conductivity	
					Analyte	Coarse Material Content (>2 mm)	Gravel ² (>2 mm)	Sand (0.06 - 2.00 mm)	Silt (2 - 60 µm)	Clay (<2 µm)	Field Texture	Texture (determined from PSD)	Emerson Class (20 hr)	MOR	K _{SAT}	Drainage Class ⁴
					LOR	0.1	1	1	1	1	-	-	NA	0.1	0.001	NA
					Units	%	%	%	%	%	-	-	Class	kPa	mm/hr	Class
					Screening Level	-	-	-	-	-	-	-	<2	60	-	-
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	Sample ID	-	-	-	-	-	-	-	-	-	-	-
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shubland Drain	Sandy shrubland	6/11/2018	S01 0-10	31.3	5	9	4	82	Clay Loam	Loamy Sand	1	61	0.1	Extremely slow
					S01 10-30	43.9	4	16	9	71	Medium Heavy Clay	Loamy Sand	3a	74	1.0	Very slow
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	S02 0-10	7.9	-	-	-	-	Sandy Loam	Loamy Sand	3b	-	-	-
					S02 10-30	9.6	-	-	-	-	Clay Loam	Loamy Sand	3b	12	-	-
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S03 0-10	31.9	13	19	8	60	Light Clay	-	2	43	10.0	Moderately slow
					S03 10-30	26.5	14	18	8	60	Medium Clay	-	4	12	16.3	Moderately slow
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum dune	Gypsum dune	5/11/2018	S04 0-10	10.9	1	12	11	76	Sandy Clay Loam	Loam/Loamy Sand	4	23	12.4	Moderately slow
					S04 10-30	8.5	1	25	4	70	Light Clay	Loam/Loamy Sand	7	18	12.5	Moderately slow
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire clay	Samphire clay	7/11/2019	S05 0-10	71.4	15	16	9	60	Light Clay	Sandy Loam	2	63	0.4	Very slow
					S05 10-30	31.8	4	26	10	60	Medium Clay	Silty Loam	2	131	0.2	Extremely slow
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S06 0-10	29.9	-	-	-	-	Light Clay	-	3b	32	-	-
					S06 10-30	45.5	-	-	-	-	Light Clay	Silty Loam	4	16	-	-
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed shrubland	MX43	Woodland	Woodland	4/11/2018	S07 0-10	26.1	3	13	6	78	Light Clay	-	3b	25	12.3	Moderately slow
					S07 10-20	25.0	7	14	7	72	Light Clay	-	4	11	12.9	Moderately slow
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S08 0-10	25.8	-	-	-	-	Light Clay	Loamy Sand	3b	26	-	-
					S08 10-30	37.3	-	-	-	-	Light Clay	Loamy Sand	4	25	-	-
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee Sand Disturbed	5/11/2018	S09 0-10	3.8	-	-	-	-	Sandy Loam	-	3b	-	-	-
					S09 10-30	3.4	-	-	-	-	Sandy Loam	-	3b	-	-	-
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland Disturbed	6/11/2018	S10 0-10	2.1	<1	4	<1	96	Sandy Loam	-	6	3	91.9	Moderately rapid
					S10 10-30	0.0	<1	4	<1	96	Sandy Loam	-	6	3	74.6	Moderately rapid
Sandy flat with Eucalyptus malle over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee Sand Disturbed	6/11/2018	S11 0-10	3.7	-	-	-	-	Sandy Loam	Sand	3a	10	-	-
					S11 10-30	2.6	-	-	-	-	Sandy Loam	Sand	3b	7	-	-
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S12 0-10	23.4	-	-	-	-	Light Clay	-	3a	23	-	-
					S12 10-30	21.5	-	-	-	-	Medium Heavy clay	-	3b	12	-	-
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheok Sands	Sheoak Sands	4/11/2018	S13 0-10	13.0	1	8	4	87	Sandy Loam	-	3b	14	5.5	Moderately slow
					S13 10-30	21.8	2	9	4	85	Sandy Clay Loam	-	2	90	0.8	Very slow
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheok Sands	Sheoak Sands	4/11/2018	S14 0-10	7.6	-	-	-	-	Clay Loam	Loamy Sand	2	11	-	-
					S14 10-30	36.9	-	-	-	-	Light Clay	Loamy Sand	4	4	-	-
Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S15 0-10	16.1	-	-	-	-	Clay Loam	-	4	10	-	-
					S15 10-30	74.8	-	-	-	-	Light Clay	-	4	16	-	-
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	1.6	-	-	-	-	Clayey Sand	-	5	-	-	-
					S16 10-30	2.9	-	-	-	-	Clayey Sand	-	3b	9	-	-
Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilotus and tussock grassland - undisturbed	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 0-10	6.1	1	2	7	90	Sandy Loam	-	5	-	29.1	Moderate
					S17 10-30	1.7	<1	2	7	91	Clay Loam	-	3b	-	31.7	Moderate
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	S18 0-10	36.9	19	4	11	66	Sandy Clay Loam	Sand	1	70	1.1	Very slow
					S18 10-30	77.1	9	6	36	49	Heavy Clay	Sand	1	-	2.3	Slow
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S19 0-10	45.3	19	10	13	58	Light Clay	Sandy Clay Loam	2	73	3.8	Slow
					S19 10-30	55.9	40	11	9	40	Light Clay	Sandy Clay	4	35	15.4	Moderately slow
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 0-10	38.7	-	-	-	-	Light Clay	Clay Loam	2	103	-	-
					S20 10-30	41.8	-	-	-	-	Light Clay	Silty Loam	4	25	-	-

Notes:
- Not analysed / not calculated
1. Coarse material content determined via dry sieving method.
2. Gravel content determined via hydrometer method.
3. Soil stability classes derived from Moore, 1998
4. Drainage classes derived from Hunt & Gilkes, 1992

Table C-1
Soil Physical Test Results
Lake Roe Gold Project

					Analyte Grouping	Water Retention - Soil Sized Fraction			Water Retention - Including Coarse Material	
					Analyte	USL (10 kPa)	LSL (1500 kPa)	PAW	USL (10 kPa)	PAW
					LOR	0.1	0.1	0.1	0.1	0.1
					Units	%	%	%	%	%
					Screening Level	-	-	-	-	-
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	Sample ID	-	-	-	-	-
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shubland Drain	Sandy shrubland	6/11/2018	S01 0-10	237	197	39.8	163	27.3
					S01 10-30	189	182	7	106	4
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	S02 0-10	-	-	-	-	-
					S02 10-30	-	-	-	-	-
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S03 0-10	201	176	24	137	16
					S03 10-30	199	174	25	146	18
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum dune	Gypsum dune	5/11/2018	S04 0-10	223	192	31	198	28
					S04 10-30	206	167	38.7	189	35.5
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire clay	Samphire clay	7/11/2019	S05 0-10	-	-	-	-	-
					S05 10-30	-	-	-	-	-
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S06 0-10	-	-	-	-	-
					S06 10-30	-	-	-	-	-
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed shrubland	MX43	Woodland	Woodland	4/11/2018	S07 0-10	224	189	35	166	26
					S07 10-20	212	188	24	159	18
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S08 0-10	-	-	-	-	-
					S08 10-30	-	-	-	-	-
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee Sand Disturbed	5/11/2018	S09 0-10	-	-	-	-	-
					S09 10-30	-	-	-	-	-
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland Disturbed	6/11/2018	S10 0-10	221	194	27	216	26
					S10 10-30	217	189	29	217	29
Sandy flat with Eucalyptus malle over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee Sand Disturbed	6/11/2018	S11 0-10	-	-	-	-	-
					S11 10-30	-	-	-	-	-
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S12 0-10	-	-	-	-	-
					S12 10-30	-	-	-	-	-
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheok Sands	Sheoak Sands	4/11/2018	S13 0-10	258	212	45	224	39
					S13 10-30	237	212	25	185	19
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheok Sands	Sheoak Sands	4/11/2018	S14 0-10	-	-	-	-	-
					S14 10-30	-	-	-	-	-
Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S15 0-10	-	-	-	-	-
					S15 10-30	-	-	-	-	-
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	-	-	-	-	-
					S16 10-30	-	-	-	-	-
Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilotus and tussock grassland - undisturbed	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 0-10	249	223	26	234	24
					S17 10-30	220	199	21	216	21
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	S18 0-10	-	-	-	-	-
					S18 10-30	-	-	-	-	-
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S19 0-10	237	203	35	130	19
					S19 10-30	212	181	31	94	14
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 0-10	-	-	-	-	-
					S20 10-30	-	-	-	-	-

Notes:
- Not analysed / not calculated
1. Coarse material content determined via dry sieving method.
2. Gravel content determined via hydrometer method.
3. Soil stability classes derived from Moore, 1998
4. Drainage classes derived from Hunt & Gilkes, 1992

Table C-2
Soil Chemical Test Results
Lake Roe Gold Project

					Analyte Grouping	Chemical Parameters			Organic Matter	Exchangeable Cations							
					Analyte	pH (H ₂ O)	pH (CaCl ₂)	EC	Organic Carbon	Exchangeable Calcium	Exchangeable Potassium	Exchangeable Magnesium	Exchangeable Sodium	Cation exchange capacity	Effective Cation Exchange Capacity ¹	Exchangeable Sodium Percentage ²	Ammonium Nitrogen
					LOR	0.1	0.1	0.001	0.5	0.01	0.01	0.01	0.1	5.00	1	1	0.1
					Units	pH units	pH units	dS/m	%	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	mg/kg
					Screening Level	-	-	-	<1.0	-	-	-	-	-	-	6	-
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	Sample ID	-	-	-	-	-	-	-	-	-	-	-	-
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shubland Drain	Sandy Shrubland	6/11/2018	S01 0-10	7.6	5.9	123.0	<0.5	1.5	0.3	1.3	0.8	4	3.9	20.5	0.2
					S01 10-30	8.8	6.5	1120.0	<0.5	5.5	1.1	5.4	6.3	18.3	18.3	34.4	0.2
					S02 0-10	8.4	5.8	5.0	<0.5	-	-	-	-	-	-	-	-
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	S02 10-30	8.3	6.1	10.0	<0.5	-	-	-	-	-	-	-	-
					S03 0-10	8.7	7.3	88.0	<0.5	28.7	1.0	3.4	<0.1	33.2	33.1	0.3	0.3
					S03 10-30	8.8	7.6	107.0	0.8	27.4	0.7	4.6	<0.1	32.8	33.0	0.3	<0.1
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S04 0-10	8.1	7.6	2340.0	<0.5	46.9	0.3	0.4	<0.1	47.6	47.6	0.2	0.7
					S04 10-30	8.0	7.6	3000.0	<0.5	177.0	0.5	1	0.2	178	178.7	0.1	1.4
					S05 0-10	8.0	7.4	1980.0	<0.5	1.5	0.7	2.8	3.1	8.2	8.1	38.3	2.1
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum Dune	Gypsum Dune	5/11/2018	S05 10-30	8.4	7.8	4580.0	<0.5	1.9	1.4	8.2	9	20.5	20.5	43.9	0.1
					S06 0-10	8.9	8.0	77.0	0.9	-	-	-	-	-	-	-	<0.1
					S06 10-30	9.1	7.8	115.0	0.6	-	-	-	-	-	-	-	<0.1
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire Clay	Samphire Clay	7/11/2019	S07 0-10	9.0	7.8	81.0	0.5	26.7	0.8	1.8	<0.1	29.4	29.3	0.3	0.2
					S07 10-20	9.4	7.9	152.0	<0.5	24.6	1.0	3.3	0.3	29.2	29.2	1.0	<0.1
					S08 0-10	9.1	7.9	176.0	0.8	-	-	-	-	-	-	-	<0.1
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S08 10-30	9.0	8.1	996.0	0.8	-	-	-	-	-	-	-	<0.1
					S09 0-10	8.8	6.1	6.0	<0.5	-	-	-	-	-	-	-	1.4
					S09 10-30	8.6	6.2	12.0	<0.5	-	-	-	-	-	-	-	<0.1
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee Sands Disturbed	5/11/2018	S10 0-10	8.4	6.4	18.0	<0.5	1.2	0.1	0.4	<0.1	1.7	1.7	5.9	<0.1
					S10 10-30	8.7	6.4	36.0	<0.5	0.5	0.2	0.4	0.1	1.3	1.2	8.3	<0.1
					S11 0-10	8.3	6.0	10.0	<0.5	-	-	-	-	-	-	-	<0.1
Sandy flat with Eucalyptus mallee over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee Sands Disturbed	6/11/2018	S11 10-30	8.2	6.3	36.0	<0.5	-	-	-	-	-	-	-	0.1
					S12 0-10	7.5	6.3	27.0	<0.5	-	-	-	-	-	-	-	0.3
					S12 10-30	6.6	6.3	781.0	<0.5	-	-	-	-	-	-	-	0.7
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S13 0-10	7.8	5.5	6.0	<0.5	2.1	0.5	1.6	<0.1	4.3	4	2.4	0.5
					S13 10-30	7.9	5.8	24.0	<0.5	2.0	0.5	1.6	0.9	5	5	18.0	0.2
					S14 0-10	8.0	6.7	66.0	<0.5	-	-	-	-	-	-	-	0.6
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak Sand	Sheoak Sands	4/11/2018	S14 10-30	8.9	7.3	147.0	<0.5	-	-	-	-	-	-	-	<0.1
					S15 0-10	8.8	7.6	108.0	1.2	-	-	-	-	-	-	-	0.7
					S15 10-30	9.4	7.9	434.0	<0.5	-	-	-	-	-	-	-	<0.1
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	8.5	5.8	3.0	<0.5	-	-	-	-	-	-	-	<0.1
					S16 10-30	8.1	6.0	21.0	<0.5	-	-	-	-	-	-	-	<0.1
					S17 0-10	8.4	5.1	7.0	<0.5	0.6	0.3	0.5	<0.1	1.4	1.4	7.1	0.4
Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilotus and tussock grassland - undisturbed	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 10-30	8.1	5.2	36.0	<0.5	0.6	0.2	0.6	<0.1	1.6	1.4	7.1	0.3
					S18 0-10	8.5	6.3	521.0	<0.5	0.4	0.4	1.7	2	4.5	4.5	44.4	<0.1
					S18 10-30	8.5	7.1	1610.0	<0.5	1.2	1.0	5.8	5.8	13.8	13.8	42.0	0.2
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	S19 0-10	8.0	7.0	65.0	<0.5	10.5	0.8	2.7	<0.1	14	14	0.7	1.2
					S19 10-30	8.8	7.3	89.0	<0.5	27.9	1.0	3.2	<0.1	32.3	32.1	0.3	0.3
					S20 0-10	8.8	8.0	1810.0	<0.5	-	-	-	-	-	-	-	1
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 10-30	8.8	8.1	2200.0	<0.5	-	-	-	-	-	-	-	<0.1

Notes:
- Not analysed / not calculated
1. eCEC is calculated from the sum of basic cations (Ca, K, Mg, Na)
2. ESP is calculated from exchangeable sodium and eCEC

Table C-2
Soil Chemical Test Results
Lake Roe Gold Project

					Plant Available Nutrients			
					Nitrate Nitrogen	Phosphorus	Potassium	Sulfur
					0.1	5	200	10
					mg/kg	mg/kg	mg/kg	mg/kg
					-	-	-	-
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	-	-	-	-
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shubland Drain	Sandy Shrubland	6/11/2018	6.2	<5	<200	<10
					5.9	<5	389	51
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	-	6	<200	<10
					-	<5	<200	<10
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	9.7	8	364	<10
					4.2	<5	230	<10
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum Dune	Gypsum Dune	5/11/2018	2.5	<5	<200	5820
					<0.1	<5	264	6740
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire Clay	Samphire Clay	7/11/2019	0.3	<5	263	273
					3	<5	452	471
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	3.3	12	333	<10
					4	<5	386	<10
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed shrubland	MX43	Woodland	Woodland	4/11/2018	8.6	<5	264	<10
					4.8	<5	421	<10
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	12	6	213	<10
					3.6	<5	<200	28
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	allee Sands Disturbed	5/11/2018	3.3	12	<200	<10
					1.2	<5	<200	<10
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland Disturbed	6/11/2018	4.5	<5	<200	<10
					0.4	<5	<200	<10
Sandy flat with Eucalyptus malle over spinifex - heavily disturbed	Carnegie	Mallee Sand	allee Sands Disturbed	6/11/2018	4.1	<5	220	<10
					14	<5	281	<10
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	7.7	<5	264	<10
					157	8	<200	<10
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak Sand	Sheoak Sands	4/11/2018	0.2	<5	216	<10
					2.3	<5	241	<10
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheoak Sand	Sheoak Sands	4/11/2018	1.3	5	<200	<10
					4.8	<5	310	<10
Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	1.9	<5	313	<10
					18	<5	330	29
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	1.4	5	<200	<10
					<0.1	<5	<200	<10
Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilotus and tussock grassland - undisturbed	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	0.7	<5	<200	<10
					0.9	<5	<200	<10
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	2	<5	<200	17
					0.8	<5	342	94
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	2.5	11	315	<10
					2.9	<5	286	<10
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	5.9	13	474	194
					2.3	8	301	300

Notes:
- Not analysed / not calculated
1. eCEC is calculated from the sum of basic cations (Ca, K, Mg, Na)
2. ESP is calculated from exchangeable sodium and eCEC

Table C-3
Multi-element Solids Analytical Results
Lake Roe Gold Project

ABC Results - Analytical Results Lake Roe Gold Project					Analyte Grouping	Elements (Total)													
	Analyte	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium					
	LOD	5	10	1	50	1	2	2	5	5	5	0	2	5					
	Topsoil ABC	5.0	61.5	<1	<50	<1	122.7	8.2	16.9	6.1	317.4	<0.1	23.9	<5					
	Subsoil ABC	7.0	65.0	<1	110.0	<1	115.1	9.2	22.5	6.0	311.9	<0.1	23.0	<5					
	Lake Roe Topsoil EL	45	-	-	-	-	250	-	85	480	-	-	65	-					
	Lake Roe Subsoil EL	45	45	-	-	-	250	-	90	480	-	-	90	-					
	ISOE - Low	20	-	-	-	2	80	-	65	50	-	0	21	-					
	ISOE - High	70	-	-	-	10	370	-	270	220	-	1	52	-					
	Sample ID	-	-	-	-	-	-	-	-	-	-	-	-	-					
	Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shrubland Drain	Sandy Shrubland	6/11/2018	901 0-10	<5	20	<1	<50	<1	146	7	14	6	261	<0.1	22	<5
						901 10-30	<5	30	<1	<50	<1	131	11	31	6	396	<0.1	38	<5
	Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	302 0-10	<5	30	<1	<50	<1	85	5	9	146	<0.1	13	<5	
						302 10-30	<5	30	<1	<50	<1	89	6	10	87	<0.1	15	<5	
	Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	303 0-10	<5	80	<1	<50	<1	144	27	43	<5	806	<0.1	71	<5
						303 10-30	<5	80	<1	<50	<1	144	29	47	<5	817	<0.1	77	<5
	Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum dune	Gypsum dune	5/11/2018	304 0-10	<5	30	<1	<50	<1	57	4	9	116	<0.1	11	<5	
						304 10-30	<5	30	<1	<50	<1	52	4	6	125	<0.1	16	<5	
	Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire clay	Samphire clay	7/11/2018	305 0-10	5	20	<1	<50	<1	156	12	17	47	631	<0.1	33	<5
						305 10-30	27	7	<1	110	<1	166	17	41	618	<0.1	51	<5	
	Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	306 0-10	<5	80	<1	<50	<1	116	8	27	5	254	<0.1	27	<5
						306 10-30	<5	80	<1	<50	<1	116	8	27	<5	268	<0.1	26	<5
	Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	307 0-10	<5	80	<1	<50	<1	99	10	19	<5	219	<0.1	24	<5
						307 10-30	<5	80	<1	<50	<1	92	7	26	<5	179	<0.1	23	<5
	Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	308 0-10	<5	60	<1	<50	<1	128	11	28	6	516	<0.1	34	<5
						308 10-30	<5	60	<1	<50	<1	113	12	34	<5	482	<0.1	36	<5
	Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee sands HD	5/11/2018	309 0-10	<5	60	<1	<50	<1	151	5	8	156	<0.1	13	<5	
						309 10-30	<5	60	<1	<50	<1	137	4	5	117	<0.1	11	<5	
	Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland HD	6/11/2018	310 0-10	<5	120	<1	<50	<1	78	3	9	<5	98	<0.1	8	<5
						310 10-30	<5	160	<1	<50	<1	86	4	8	<5	109	<0.1	10	<5
	Sandy flat with Eucalyptus malle over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee sands HD	6/11/2018	311 0-10	<5	90	<1	<50	<1	90	6	11	<5	369	<0.1	16	<5
						311 10-30	<5	90	<1	<50	<1	95	6	11	<5	373	<0.1	16	<5
	Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	312 0-10	<5	60	<1	<50	<1	127	10	19	7	376	<0.1	19	<5
						312 10-30	<5	60	<1	<50	<1	120	9	20	<5	320	<0.1	31	<5
	Sandy loam plain/low slope with Sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	313 0-10	<5	20	<1	<50	<1	135	6	12	6	268	<0.1	18	<5
						313 10-30	<5	20	<1	<50	<1	119	8	12	6	388	<0.1	16	<5
	Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	314 0-10	<5	40	<1	<50	<1	101	6	13	<5	251	<0.1	20	<5
						314 10-30	<5	40	<1	<50	<1	90	7	20	<5	269	<0.1	23	<5
	Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	315 0-10	<5	60	<1	<50	<1	107	8	18	<5	219	<0.1	23	<5
						315 10-30	5	5	<1	110	<1	101	8	21	<5	182	<0.1	28	<5
	Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	316 0-10	<5	60	<1	<50	<1	115	7	5	243	<0.1	11	<5	
						316 10-30	<5	90	<1	<50	<1	86	5	9	<5	290	<0.1	13	<5
	Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilopus and tussock grassland - undisturbed analogue	Carnegie	Mallee Sand	Sandy Shrubland	6/11/2018	317 0-10	<5	70	<1	<50	<1	75	5	10	<5	242	<0.1	11	<5
						317 10-30	<5	90	<1	<50	<1	75	5	10	<5	230	<0.1	11	<5
	Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	318 0-10	<5	40	<1	<50	<1	155	5	10	6	257	<0.1	15	<5
						318 10-30	<5	50	<1	<50	<1	171	7	19	<5	290	<0.1	24	<5
	Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	319 0-10	<5	80	<1	<50	<1	184	10	26	8	336	<0.1	32	<5
						319 10-30	<5	90	<1	<50	<1	184	10	28	6	386	<0.1	32	<5
	Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	320 0-10	<5	120	<1	<50	<1	184	14	33	6	593	<0.1	46	<5
						320 10-30	<5	110	<1	<50	<1	136	17	58	<5	452	<0.1	57	<5
Notes: ABC values calculated from mean concentrations of baseline soil data Exceeds the NEM (2013) EL for protection of areas of ecological significance Exceeds the ANZECC ISOE Low (Trigger Value) Exceeds the ANZECC ISOE-High (Trigger Value)																			

Table C-3
Multi-element Solids Analytical Results
Lake Roe Gold Project

Lake Roe Gold Project					Analyte Grouping		
					Elements (Total)		
					Analyte	Vanadium	Zinc
					LOD	5	5
					Units	mg/kg	mg/kg
					Topsoil ABC	102.8	19.7
					Subsoil ABC	98.1	19.2
					Lake Roe Topsoil EL	-	<50
					Lake Roe Subsoil EL	-	210
					ISQG - Low	200	200
					ISQG - High	410	410
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	Sample ID	-	-
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shrubland Drain	Sandy shrubland	6/11/2018	S01 0-10	123	18
					S01 10-30	110	23
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	S02 0-10	80	9
					S02 10-30	81	9
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S03 0-10	104	52
					S03 10-30	101	46
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum dune	Gypsum dune	5/11/2018	S04 0-10	48	9
					S04 10-30	42	9
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Sapphire clay	Sapphire clay	7/11/2019	S05 0-10	87	25
					S05 10-30	81	36
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S06 0-10	123	27
					S06 10-30	127	25
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S07 0-10	72	20
					S07 10-30	71	17
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S08 0-10	107	44
					S08 10-30	94	41
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee sands HD	6/11/2018	S09 0-10	117	7
					S09 10-30	110	5
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland HD	6/11/2018	S10 0-10	77	9
					S10 10-30	85	9
Sandy flat with Eucalyptus mallee over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee sands HD	6/11/2018	S11 0-10	86	11
					S11 10-30	82	10
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S12 0-10	80	18
					S12 10-30	83	13
Sandy loam plain/slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S13 0-10	88	14
					S13 10-30	83	10
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S14 0-10	74	17
					S14 10-30	68	17
Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S15 0-10	149	20
					S15 10-30	129	19
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	99	9
					S16 10-30	120	8
Sandy flat with open mulga (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Ptilopus and tussock grassland - undisturbed analogue	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 0-10	75	14
					S17 10-30	70	10
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	S18 0-10	125	10
					S18 10-30	121	15
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S19 0-10	181	24
					S19 10-30	170	18
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 0-10	161	36
					S20 10-30	134	43
Notes:							
ABC values calculated from mean concentrations of baseline soil data							
Exceeds the NEMP (2013) EL for protection of areas of ecological significance							
Exceeds the ANZECC ISQG-Low (Trigger Value)							
Exceeds the ANZECC ISQG-High (Trigger Value)							
- Not analysed / not calculated							
1. EL trigger value is adopted based on average clay content (calculated from results in Table C-1)							
2. EL trigger value is adopted based on average CEC and pH _C (calculated from results in Table C-2)							
3. EL trigger value is adopted based on average CEC (calculated from results in Table C-2)							
4. EL trigger value is adopted based on average pH _C (calculated from results in Table C-2)							

Table C-4
Multi-element Solution Analytical Results
Lake Roe Gold Project

Multi-element Solution Analytical Results Lake Roe Gold Project					Analyte Grouping	Elements (Dissolved)													
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled	Sample ID	Aluminum	Asenic ¹	Barium	Beryllium	Boron	Cadmium	Chromium ²	Cobalt	Copper	Iron	Lead	Manganese	Mercury	
						LOG	0.01	0.001	0.001	0.001	0.05	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.001
						Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
						ND/CC	-	-	-	-	-	0.0007	0.0027	0.0013	-	0.0044	-	-	0.0001
					ND/CC	0.0006	0.0006	0.15	0.009										
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shrubland Drain	Sandy shrubland	6/11/2018	S01 0-10	30.40	0.002	0.215	<0.001	0.09	<0.0001	0.071	0.014	0.028	19.40	0.007	0.540	<0.0001	
					S01 10-30	56.90	0.025	0.479	0.001	0.27	<0.0001	0.125	0.011	0.059	40.10	0.008	0.290	<0.0001	
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	4/11/2018	S02 0-10	15.60	0.002	0.167	<0.001	<0.05	<0.0001	0.042	0.01	0.011	14.10	0.005	0.286	<0.0001	
					S02 10-30	11.60	0.015	0.266	<0.001	<0.05	<0.0001	0.009	0.006	0.003	9.74	0.003	0.157	<0.0001	
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S03 0-10	5.27	0.006	0.226	<0.001	0.09	<0.0001	0.018	0.003	0.006	3.38	<0.001	0.100	<0.0001	
					S03 10-30	7.01	0.002	0.206	<0.001	0.08	<0.0001	0.027	0.005	0.008	4.83	<0.001	0.108	<0.0001	
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Carnegie	Gypsum dune	Gypsum dune	5/1/2018	S04 0-10	0.04	0.004	0.017	<0.001	0.04	<0.0001	0.003	<0.001	0.003	0.001	<0.001	0.003	<0.0001	
					S04 10-30	0.04	0.007	0.004	<0.001	0.11	<0.0001	<0.001	<0.001	0.002	<0.005	<0.001	<0.001	<0.0001	
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire clay	Samphire clay	7/11/2018	S05 0-10	15.30	0.002	0.192	<0.001	0.60	<0.0001	0.499	0.007	0.010	10.50	0.004	0.328	<0.0001	
					S05 10-30	3.97	0.035	0.240	<0.001	1.76	<0.0001	0.014	<0.001	0.006	2.94	<0.001	0.022	<0.0001	
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/1/2018	S06 0-10	0.61	0.002	0.001	<0.001	8.01	<0.0001	0.016	0.005	0.007	5.61	0.005	0.152	<0.0001	
					S06 10-30	15.80	0.038	0.281	<0.001	0.09	<0.0001	0.033	0.006	0.013	11.00	0.002	0.176	<0.0001	
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S07 0-10	1.06	<0.001	0.201	<0.001	<0.05	<0.0001	0.001	0.001	0.003	0.26	<0.001	0.041	<0.0001	
					S07 10-20	16.90	0.002	0.213	<0.001	0.05	<0.0001	0.033	0.005	0.018	8.61	0.002	0.112	<0.0001	
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/1/2018	S08 0-10	1.64	0.001	0.280	<0.001	<0.05	<0.0001	0.002	0.002	0.003	0.33	0.003	0.182	<0.0001	
					S08 10-30	2.70	0.002	0.257	<0.001	0.09	<0.0001	0.005	0.002	0.004	1.52	<0.001	0.049	<0.0001	
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Mallee Sands HD	5/11/2018	S09 0-10	10.80	0.002	0.176	<0.001	<0.05	<0.0001	0.036	0.010	0.008	13.00	0.006	0.384	<0.0001	
					S09 10-30	10.30	0.002	0.169	<0.001	<0.05	<0.0001	0.034	0.011	0.008	11.50	0.005	0.343	<0.0001	
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Carnegie	Mallee Sand	Wetland HD	6/11/2018	S10 0-10	7.94	0.002	0.151	<0.001	0.05	<0.0001	0.022	0.004	0.006	6.61	0.005	0.277	<0.0001	
					S10 10-30	16.00	<0.001	0.115	<0.001	0.05	<0.0001	0.018	0.006	0.005	5.67	0.002	0.258	<0.0001	
Sandy flat with Eucalyptus mallee over spinifex - heavily disturbed	Carnegie	Mallee Sand	Mallee Sands HD	6/11/2018	S11 0-10	5.05	0.002	0.269	<0.001	0.05	<0.0001	0.042	0.016	0.015	15.10	0.007	1.040	<0.0001	
					S11 10-30	20.80	0.002	0.342	<0.001	0.07	<0.0001	0.052	0.022	0.019	18.20	0.008	1.230	<0.0001	
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S12 0-10	14.40	0.002	0.232	<0.001	<0.05	<0.0001	0.041	0.007	0.015	12.60	0.005	0.276	<0.0001	
					S12 10-30	2.47	<0.001	0.133	<0.001	<0.05	<0.0001	0.005	<0.001	0.002	1.30	<0.001	0.017	<0.0001	
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S13 0-10	12.20	0.002	0.152	<0.001	0.05	<0.0001	0.033	0.009	0.012	10.80	0.006	0.419	<0.0001	
					S13 10-30	17.30	0.002	0.176	<0.001	0.06	<0.0001	0.047	0.014	0.018	15.10	0.008	0.564	<0.0001	
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S14 0-10	15.30	0.002	0.279	<0.001	<0.05	<0.0001	0.035	0.007	0.011	9.84	0.004	0.313	<0.0001	
					S14 10-30	8.84	0.001	0.189	<0.001	<0.05	<0.0001	0.018	0.003	0.008	4.72	0.002	0.133	<0.0001	
Sandy loam plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S15 0-10	12.90	0.003	0.170	<0.001	0.06	<0.0001	0.023	0.006	0.010	7.83	0.002	0.125	<0.0001	
					S15 10-30	7.66	0.003	0.135	<0.001	0.05	<0.0001	0.013	0.003	0.003	4.10	0.001	0.103	<0.0001	
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Carnegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	11.30	0.001	0.221	<0.001	<0.05	<0.0001	0.031	0.012	0.009	11.60	0.01	1.190	<0.0001	
					S16 10-30	17.70	0.002	0.273	<0.001	0.05	<0.0001	0.056	0.021	0.012	19.40	0.007	0.782	<0.0001	
Sandy flat with open midge (Acacia) over shrubland with Dodonaea, Eremophila, Solanum and Phoraea and tussock grassland - undisturbed analogue	Carnegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 0-10	28.30	0.003	0.210	<0.001	0.09	<0.0001	0.054	0.016	0.016	14.90	0.006	0.510	<0.0001	
					S17 10-30	11.90	0.001	0.213	<0.001	0.05	<0.0001	0.034	0.016	0.019	12.20	0.005	0.753	<0.0001	
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	MX43	Shrubland Drain	Drainage line	5/11/2018	S18 0-10	1.11	0.001	0.139	<0.001	0.06	<0.0001	0.002	0.001	0.002	0.45	<0.001	0.067	<0.0001	
					S18 10-30	40.70	0.004	0.378	0.001	0.22	0.0002	0.057	0.009	0.047	38.30	0.01	0.514	<0.0001	
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S19 0-10	14.90	0.002	0.188	<0.001	0.08	<0.0001	0.044	0.012	0.014	13.80	0.007	0.268	<0.0001	
					S19 10-30	10.20	0.003	0.165	<0.001	<0.05	<0.0001	0.026	0.004	0.011	7.82	0.002	0.124	<0.0001	
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 0-10	0.47	<0.001	0.07	<0.001	0.07	<0.0001	<0.001	<0.001	0.002	0.26	<0.001	0.004	<0.0001	
					S20 10-30	0.53	0.002	0.097	<0.001	0.24	<0.0001	<0.001	<0.001	0.002	0.24	<0.001	0.003	<0.0001	
Notes:																			
Exceeds the NEPM (2013) GL for protection of slightly to moderately disturbed fresh water ecosystems																			
Exceeds the NEPM (2013) GL for protection of slightly to moderately disturbed marine water ecosystems																			
Exceeds the ANZG-CC (2000) criteria for protection of highly disturbed fresh water ecosystems (80% protection of species)																			
Exceeds the ANZG-CC (2000) criteria for protection of highly disturbed marine water ecosystems (80% protection of species)																			
Exceeds the ANZG-CC (2000) criteria for protection of highly disturbed estuarine water ecosystems (80% protection of species)																			

Table C-4
Multi-element Solution Analytical Results
Lake Rye Gold Project

Multi-element Solution Analytical Results Lake Roe Gold Project					Analyte Grouping					Elements (Dissolved)				
					Analyte	Nickel	Selenium	Vanadium	Zinc					
					LOR	0.001	0.01	0.01	0.005					
					Units	mg/L	mg/L	mg/L	mg/L <th colspan="5"></th>					
						0.007	ND	0.1	0.015 <th colspan="5"></th>					
					ANZECC Marine Water	0.56	ND	0.28	0.043 <th colspan="5"></th>					
					Sample ID									
Location Description	Land System	Soil Management Unit	Soil Resource Group	Date Sampled										
Sandy clay flat with chenopod shrubland - undisturbed analogue	MX43	Shrubland Drain	Sandy shrubland	6/11/2018	S01 0-10	0.04	<0.01	0.04	0.085					
Sandy plain/sand dune with Eucalyptus over spinifex - undisturbed analogue	Camegie	Mallee Sand	Mallee Sand	4/11/2018	S01 10-30	0.074	<0.01	0.06	0.118					
					S02 0-10	0.024	<0.01	0.03	0.060					
					S02 10-30	0.02	<0.01	0.03	0.037					
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	7/11/2018	S03 0-10	0.012	<0.01	0.02	0.036					
Sandy loam gypsum dunes with pine over chenopod - undisturbed analogue	Camegie	Gypsum dune	Gypsum dune	5/11/2018	S03 10-30	0.017	<0.01	0.03	0.036					
					S04 0-10	<0.001	<0.01	<0.01	<0.005					
					S04 10-30	<0.001	<0.01	<0.01	<0.005					
Heavy clay slope with Tecticornia shrubland / low chenopod shrubs - undisturbed analogue	MX43	Samphire clay	Samphire clay	7/11/2018	S05 0-10	0.022	<0.01	0.02	0.076					
Sandy loam flat with Eucalyptus woodland over Melaleuca and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S06 0-10	0.007	<0.01	0.02	0.026					
					S06 10-30	0.021	<0.01	0.02	0.027					
					S07 0-10	0.002	<0.01	0.01	0.046					
Fine silt/clay flat with Eucalyptus over chenopod shrubland - undisturbed analogue	MX43	Woodland	Woodland	4/11/2018	S07 10-20	0.022	<0.01	0.04	0.028					
					S08 0-10	0.005	<0.01	0.01	0.008					
					S08 10-30	0.004	<0.01	0.02	0.033					
Sandy flat with Eucalyptus over sparse spinifex - heavily disturbed (drilling)	Camegie	Mallee Sand	Mallee Sands HD	5/11/2018	S09 0-10	0.018	<0.01	0.03	0.048					
Sandy flat with Eucalyptus over spinifex - heavily disturbed (drilling)	Camegie	Mallee Sand	Wetland HD	6/11/2018	S09 10-30	0.018	<0.01	0.03	0.04					
					S10 0-10	0.011	<0.01	0.01	0.034					
					S10 10-30	0.009	<0.01	0.01	0.029					
Sandy flat with Eucalyptus mallee over spinifex - heavily disturbed	Camegie	Mallee Sand	Mallee Sands HD	6/11/2018	S11 0-10	0.036	<0.01	0.03	0.066					
					S11 10-30	0.044	<0.01	0.04	0.061					
					S12 0-10	0.027	<0.01	0.02	0.065					
Sandy clay flat/plain with Eucalyptus over Eremophila and chenopods - undisturbed analogue	MX43	Woodland	Woodland	5/11/2018	S12 10-30	0.004	<0.01	0.02	0.028					
Sandy loam plain/low slope with sheoak over Eremophila and chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S13 0-10	0.017	<0.01	0.02	0.063					
					S13 10-30	0.024	<0.01	0.03	0.065					
					S14 0-10	0.023	<0.01	0.02	0.043					
Sandy clay plain with Allocasuarina over chenopods - undisturbed analogue	MX43	Sheoak sands	Sheoak sands	4/11/2018	S14 10-30	0.014	<0.01	0.02	0.016					
					S15 0-10	0.016	<0.01	0.03	0.033					
					S15 10-30	0.013	<0.01	0.04	0.025					
Sandy flat with scattered Eucalyptus over spinifex with mallee mid-upper storey - undisturbed analogue	Camegie	Mallee Sand	Mallee Sand	5/11/2018	S16 0-10	0.024	<0.01	0.02	0.051					
					S16 10-30	0.031	<0.01	0.04	0.063					
					S17 0-10	0.033	<0.01	0.04	0.095					
Sandy drainage (flat) with clay at depth, with Melaleuca, Tecticornia and Allocasuarina - undisturbed analogue	Camegie	Mallee Sand	Sandy shrubland	6/11/2018	S17 10-30	0.021	<0.01	0.02	0.050					
					S18 0-10	0.002	<0.01	<0.01	<0.005					
					S18 10-30	0.055	<0.01	0.07	0.065					
Clay loam flat with Eucalyptus woodland over open shrubland and chenopods - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S19 0-10	0.02	<0.01	0.03	0.054					
					S19 10-30	0.017	<0.01	0.04	0.011					
					S20 0-10	<0.001	<0.01	<0.01	<0.005					
Clay flat with Eucalyptus woodland over chenopod shrubland - undisturbed analogue	MX43	Woodland Clay	Woodland Clay	6/11/2018	S20 10-30	<0.001	<0.01	0.02	<0.005					
Notes														
Exceeds the NEMF (2013) GL for protection of slightly to moderately disturbed fresh water ecosystems														
Exceeds the NEMF (2013) GL for protection of slightly to moderately disturbed marine water ecosystems														
Exceeds the ANZECC (2000) criteria for protection of highly disturbed fresh water ecosystems (80% protection of species)														
Exceeds the ANZECC (2000) criteria for protection of highly disturbed marine water ecosystems (80% protection of species)														
- Not analysed / not calculated														
1. GL assumed all arsenic is as As(V)														
2. GL assumed all chromium is as Cr(III)														
Where trigger value is less than the detection limit, <LOR values are not highlighted														

Table C-5
Geochemical Abundance Index Results
Lake Roe Gold Project

	Analyte	Average Total Element Concentration ¹																				Soil Management Unit										Average Crustal Abundance ² (mg/kg or %)
	Soil Resource Group	Soil Resource Group																Soil Management Unit														
		Drainage line	Drainage line	Gypsum dune *	Gypsum dune*	Mallee sands	Mallee sands	Mallee sands Disturbed	Mallee sands Disturbed	Samphire clay*	Samphire clay*	Sandy shrubland	Sandy shrubland	Sheok sands	Sheok sands	Wetland - Disturbed	Wetland - Disturbed	Woodland	Woodland	Woodland clay	Woodland clay	Shrubland drain SMU	Shrubland drain SMU	Mallee sands SMU	Mallee sand SMU	Woodland SMU	Woodland SMU	Woodland clay SMU	Woodland clay SMU			
	Depth	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm			
Element	LOR (mg/kg)	n=1	n=1	n=1	n=1	n=2	n=2	n=2	n=2	n=1	n=1	n=2	n=2	n=2	n=2	n=1	n=1	n=6	n=6	n=2	n=2	n=2	n=2	n=3	n=3	n=5	n=5	n=3	n=3			
Arsenic	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5.0	7.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	6.0			
Barium	10	40.0	50.0	80.0	80.0	60.0	60.0	60.0	60.0	80.0	80.0	100.0	100.0	45.0	55.0	30.0	30.0	41.7	43.3	100.0	115.0	30.0	35.0	81.0	73.3	68.0	68.0	93.3	93.3	500.0		
Beryllium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6.0			
Boron	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	ND			
Cadmium	1	<1	<2	<3	<4	<5	<6	<7	<8	<9	<10	<11	<12	<13	<14	<15	<16	<17	<18	<19	<20	<1	<1	<1	<1	<1	<1	<1	0.4			
Chromium	2	155.0	171.0	118.0	116.0	117.0	120.5	117.0	120.5	144.0	144.0	189.0	160.0	86.5	99.0	85.0	87.0	130.3	123.0	79.0	80.5	150.5	151.0	106.0	98.5	115.8	112.4	174.0	154.7	70.0		
Cobalt	2	5.0	7.0	9.0	8.0	9.0	8.5	9.0	8.5	27.0	29.0	12.0	13.5	3.5	5.5	5.0	6.0	7.0	8.8	4.0	4.5	6.0	9.0	5.0	4.5	9.0	8.8	17.0	18.7	8.0		
Copper	5	10.0	19.0	24.0	27.0	18.5	20.5	18.5	20.5	43.0	47.0	29.0	43.0	8.0	10.0	9.0	10.0	12.5	20.3	9.5	9.0	12.0	25.0	9.1	9.0	21.6	25.4	33.7	44.3	30.0		
Lead	5	6.0	<5	5.0	<5	7.0	7.0	7.0	7.0	<5	<5	7.0	6.0	5.0	6.0	<5	<5	5.5	5.3	<5	<5	6.0	6.0	6.0	5.0	6.0	7.0	7.0	6.0	35.0		
Manganese	5	257.0	290.0	294.0	288.0	297.0	251.0	806.0	717.0	444.5	369.0	179.5	207.5	146.0	146.0	322.7	360.2	170.0	169.5	259.0	343.0	217.0	202.5	322.8	286.2	565.0	465.0	1000.0	0.06 ³			
Mercury	0.1	<0.18	<0.17	<0.16	<0.15	<0.14	<0.13	<0.12	<0.11	<0.10	<0.9	<0.8	<0.7	<0.6	<0.5	<0.4	<0.3	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<1	0.06 ³			
Nickel	2	15.0	24.0	27.0	26.0	26.5	27.0	26.5	27.0	71.0	77.0	39.0	44.5	11.0	14.5	13.0	15.0	20.3	27.5	9.5	10.5	18.5	31.0	12.6	12.0	27.6	27.8	49.7	55.3	50.0		
Selenium	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0.4 ³			
Vanadium	5	125.0	121.0	123.0	127.0	114.5	106.0	114.5	106.0	104.0	101.0	171.0	152.0	73.5	81.0	80.0	81.0	95.8	89.0	76.0	77.5	124	115.5	92.3	88	106.2	100.8	148.7	135.0	90.0		
Zinc	5	10.0	15.0	27.0	25.0	19.0	16.0	19.0	16.0	52.0	46.0	30.0	30.5	9.0	8.5	9.0	9.0	15.3	16.8	11.5	9.5	14	19	8.8	9.5	25.8	23.0	37.3	35.7	90.0		

Notes
1. Total element content values are mean concentrations (calculated from Table 3)
2. Average crustal abundance in soils derived from Environmental Chemistry of the Elements (Bowen, 1979) as provided in GARD Guide (GNAP, 2009)
3. LOR is greater than average crustal abundance. GAI is assessed using LOR as a whole number and result indicated with a '<'
<LOR - element below analytical limit of reporting, effective GAI is less than calculated GAI
ND data not published n denotes number of samples used to determine mean concentration
* indicates same locations used for soil resource group and soil management group hence GAI the same
Soil Management Unit data only included for groupings which are different to original Soil Resource Groups
Shaded cells indicate a GAI value of 3 or greater

Table C-5
Geochemical Abundance Index Results
Lake Roe Gold Project

		Analyte	Geochemical Abundance Index																											
Soil Resource Group		Soil Resource Group																				Soil Management Unit								
		Drainage line	Drainage line	Gypsum Dune *	Gypsum Dune *	Mallee Sands	Mallee Sands	Mallee Sands Disturbed	Mallee Sands Disturbed	Samphire Clay *	Samphire Clay *	Sandy Shrubland	Sandy Shrubland	Sheok Sands	Sheok Sands	Wetland Disturbed	Wetland Disturbed	Woodland	Woodland	Woodland Clay	Woodland Clay	Shrubland Drain SMU	Shrubland Drain SMU	Mallee Sand SMU	Mallee Sand SMU	Woodland SMU	Woodland SMU	Woodland Clay SMU	Woodland Clay SMU	
		Depth	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm	0 to 10 cm	10 to 30 cm
Element	LOR (mg/kg)	n=1	n=1	n=1	n=1	n=2	n=2	n=2	n=2	n=1	n=1	n=2	n=2	n=2	n=2	n=1	n=1	n=6	n=6	n=2	n=2	n=2	n=2	n=3	n=3	n=5	n=5	n=3	n=3	
Arsenic	5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<0	0.0	<LOR	<LOR	<LOR	<LOR	<LOR	<0	0.0	<LOR	<LOR		
Barium	10	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	0.0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	
Beryllium	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	
Boron	50																													
Cadmium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Chromium	2	1	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0.0	0.0	0.0	0.0	0.0	0.0	
Cobalt	2	<0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	<0	0.0	<0	<0	<0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Copper	5	<0	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<0	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	
Lead	5	<0	<LOR	<0	<LOR	<0	<0	<0	<0	<LOR	<LOR	<0	<0	<0	<0	<0	<LOR	<LOR	<0	<0	<LOR	<LOR	<0	<LOR	<0	<0	<LOR	<LOR	<LOR	
Manganese	5	<1	<0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<1	<0	1	0	<0	<0	<0	<0	
Mercury	0.1			<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	
Nickel	2	<0	<0	<0	<0	<0	<0	<0	<0	0.0	0.0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	
Selenium	5	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	
Vanadium	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	<0	<0	<0	0	0	0	0	0	0	0	0	
Zinc	5	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	

Notes
1. Total element content values are mean conce
2. Average crustal abundance in soils derived fr
3. LOR is greater than average crustal abundanc
<LOR - element below analytical limit of reportin
ND data not published
* indicates same locations used for soil resource
Soil Management Unit data only included for grouping
Shaded cells indicate a GAI value of 3 or greater

Appendix D Primary Laboratory Reports

CHAIN OF CUSTODY

At E Laboratories, please tick ☐

☐ADELAIDE 21 Burma Road Pooraka SA 5095
 Ph: 08 8359 0890 E: adelaid@alsglobal.com
 ☐BRISBANE 32 Shand Street Stafford QLD 4053
 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
 ☐GLADSTONE 46 Callermoundah Drive Cinnah QLD 4680
 Ph: 07 7471 5600 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@atsglobal.com
 MELBOURNE 2-4 Westall Road Melbourne VIC 3004 Ph: 02 4668 9433 E: samples.melbourne@atsglobal.com
 MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee@mail@atsglobal.com
 NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4668 9433 E: samples.newcastle@atsglobal.com
 PERTH 4430 Global Commerce Way, Wangara WA 6005 Ph: 08 9406 1301 E: samples.perth@atsglobal.com

□SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
 Ph: 02 8784 8555 E: samples.sydney@aisglobal.com
 □TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
 Ph: 07 4796 0600 E: townesville.environmental@aisglobal.com
 □WOLLONGONG 99 Kenny Street Wollongong NSW 250
 Ph: 02 4225 3125 E: wollongong@aisglobal.com

[illegible]

CERTIFICATE OF ANALYSIS

Work Order : **EP1814230**
Client : **STANTEC AUSTRALIA PTY LTD**
Contact : **[REDACTED]**
Address : **[REDACTED]**
Telephone : **[REDACTED]**
Project : **LROE-SA-18002 SS**
Order number : **S0433**
C-O-C number : **----**
Sampler : **SAM LOSTROM**
Site : **----**
Quote number : **EP/619/18**
No. of samples received : **40**
No. of samples analysed : **40**

Page : 1 of 26

Date Samples Received : 04-Dec-2018 15:40
Date Analysis Commenced : 10-Dec-2018
Issue Date : 19-Dec-2018 13:50



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

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

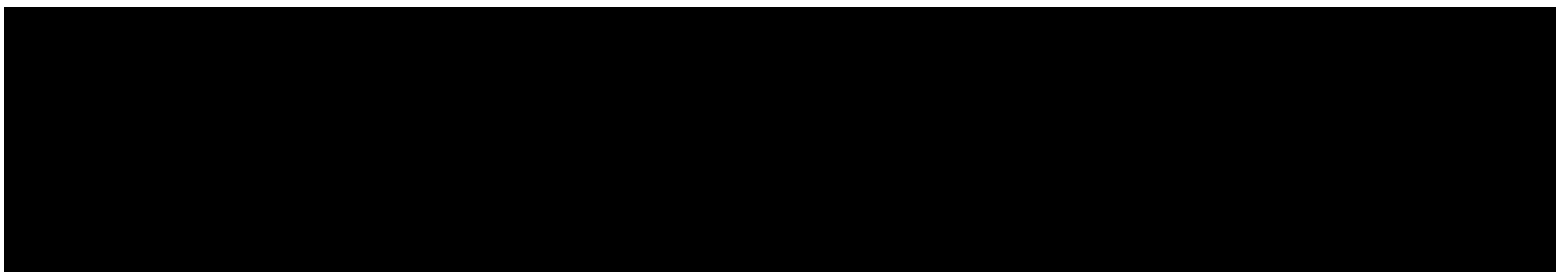
This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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





General Comments

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

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

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

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

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

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

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

LOR = Limit of reporting

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

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Colwell P and K, and KCL Extractable Sulfur analysis conducted by ALS Brisbane, NATA Site No. 818.
- PSD analysis conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- ED021 (Bicarbonate Extractable K - Colwell): Limit of reporting raised for some samples due to matrix interference.
- EG005T (Total Metals) : Poor matrix spike recovery for selenium due to possible matrix interference. Confirmed by re-extraction and re-analysis.
- 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^+ + Al^{3+}).



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S01 0-10	S01 10-30	S02 0-10	S02 10-30	S03 0-10
Client sampling date / time				06-Nov-2018 00:00	06-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-001	EP1814230-002	EP1814230-003	EP1814230-004	EP1814230-005
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	30.4	56.9	15.6	11.6	5.27
Arsenic	7440-38-2	0.001	mg/L	0.002	0.025	0.002	0.015	0.006
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	0.215	0.479	0.167	0.256	0.226
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	0.071	0.125	0.042	0.029	0.018
Cobalt	7440-48-4	0.001	mg/L	0.014	0.011	0.010	0.006	0.003
Copper	7440-50-8	0.001	mg/L	0.028	0.059	0.011	0.010	0.006
Lead	7439-92-1	0.001	mg/L	0.007	0.008	0.005	0.003	<0.001
Manganese	7439-96-5	0.001	mg/L	0.540	0.290	0.286	0.157	0.100
Nickel	7440-02-0	0.001	mg/L	0.040	0.074	0.024	0.020	0.012
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.04	0.08	0.03	0.03	0.02
Zinc	7440-66-6	0.005	mg/L	0.085	0.118	0.060	0.037	0.036
Boron	7440-42-8	0.05	mg/L	0.09	0.27	<0.05	<0.05	0.09
Iron	7439-89-6	0.05	mg/L	19.4	40.1	14.1	9.74	3.38
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S03 10-30	S04 0-10	S04 10-30	S05 0-10	S05 10-30
Client sampling date / time				07-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-006	EP1814230-007	EP1814230-008	EP1814230-009	EP1814230-010
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	7.81	0.04	0.05	15.3	3.97
Arsenic	7440-38-2	0.001	mg/L	0.002	0.017	0.007	0.002	0.035
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	0.206	0.020	0.004	0.192	0.240
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	0.027	<0.001	<0.001	0.049	0.014
Cobalt	7440-48-4	0.001	mg/L	0.005	<0.001	<0.001	0.007	<0.001
Copper	7440-50-8	0.001	mg/L	0.008	0.001	0.002	0.010	0.006
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	0.004	<0.001
Manganese	7439-96-5	0.001	mg/L	0.108	<0.001	<0.001	0.328	0.022
Nickel	7440-02-0	0.001	mg/L	0.017	<0.001	<0.001	0.022	0.007
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.03	<0.01	<0.01	0.02	0.02
Zinc	7440-66-6	0.005	mg/L	0.036	<0.005	<0.005	0.075	0.026
Boron	7440-42-8	0.05	mg/L	0.08	<0.05	0.11	0.60	1.76
Iron	7439-89-6	0.05	mg/L	4.83	<0.05	<0.05	10.5	2.94
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S06 0-10	S06 10-30	S07 0-10	S07 10-20	S08 0-10
Client sampling date / time				05-Nov-2018 00:00	05-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-011	EP1814230-012	EP1814230-013	EP1814230-014	EP1814230-015
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	8.61	15.8	1.06	16.8	1.64
Arsenic	7440-38-2	0.001	mg/L	0.002	0.038	<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	0.238	0.281	0.201	0.213	0.280
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	0.016	0.033	0.001	0.033	0.002
Cobalt	7440-48-4	0.001	mg/L	0.005	0.006	0.001	0.005	0.004
Copper	7440-50-8	0.001	mg/L	0.007	0.013	0.003	0.018	0.003
Lead	7439-92-1	0.001	mg/L	0.001	0.002	<0.001	0.002	<0.001
Manganese	7439-96-5	0.001	mg/L	0.152	0.176	0.041	0.112	0.182
Nickel	7440-02-0	0.001	mg/L	0.012	0.021	0.002	0.022	0.005
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.02	0.04	0.01	0.04	0.01
Zinc	7440-66-6	0.005	mg/L	0.027	0.046	0.010	0.028	0.008
Boron	7440-42-8	0.05	mg/L	0.09	0.09	<0.05	0.05	<0.05
Iron	7439-89-6	0.05	mg/L	5.40	11.0	0.26	8.81	0.33
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S08 10-30	S09 0-10	S09 10-30	S10 0-10	S10 10-30
Client sampling date / time				05-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-016	EP1814230-017	EP1814230-018	EP1814230-019	EP1814230-020
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	2.70	10.8	10.3	7.94	5.05
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.002	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	0.257	0.176	0.168	0.151	0.115
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	0.005	0.036	0.034	0.022	0.018
Cobalt	7440-48-4	0.001	mg/L	0.002	0.010	0.011	0.004	0.006
Copper	7440-50-8	0.001	mg/L	0.004	0.008	0.008	0.006	0.005
Lead	7439-92-1	0.001	mg/L	<0.001	0.006	0.005	0.002	0.002
Manganese	7439-96-5	0.001	mg/L	0.049	0.384	0.343	0.277	0.258
Nickel	7440-02-0	0.001	mg/L	0.004	0.018	0.018	0.011	0.009
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.02	0.03	0.03	0.01	0.01
Zinc	7440-66-6	0.005	mg/L	0.033	0.048	0.040	0.034	0.029
Boron	7440-42-8	0.05	mg/L	0.09	<0.05	<0.05	<0.05	0.05
Iron	7439-89-6	0.05	mg/L	1.52	13.0	11.5	6.61	5.67
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S11 0-10	S11 10-30	S12 0-10	S12 10-30	S13 0-10
Client sampling date / time				06-Nov-2018 00:00	06-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-021	EP1814230-022	EP1814230-023	EP1814230-024	EP1814230-025
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	16.0	20.8	14.4	2.47	12.2
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.002	<0.001	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	0.269	0.342	0.232	0.133	0.152
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	0.042	0.052	0.041	0.005	0.033
Cobalt	7440-48-4	0.001	mg/L	0.016	0.019	0.007	<0.001	0.009
Copper	7440-50-8	0.001	mg/L	0.015	0.022	0.015	0.002	0.012
Lead	7439-92-1	0.001	mg/L	0.007	0.008	0.005	<0.001	0.006
Manganese	7439-96-5	0.001	mg/L	1.04	1.23	0.276	0.017	0.419
Nickel	7440-02-0	0.001	mg/L	0.036	0.044	0.027	0.004	0.017
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.03	0.04	0.02	<0.01	0.02
Zinc	7440-66-6	0.005	mg/L	0.066	0.061	0.065	0.028	0.063
Boron	7440-42-8	0.05	mg/L	0.05	0.07	<0.05	<0.05	0.05
Iron	7439-89-6	0.05	mg/L	15.1	18.2	12.6	1.30	10.8
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S13 10-30	S14 0-10	S14 10-30	S15 0-10	S15 10-30
Client sampling date / time				30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-026	EP1814230-027	EP1814230-028	EP1814230-029	EP1814230-030
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	17.3	15.3	8.64	12.8	7.66
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.001	0.003	0.003
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	0.176	0.279	0.189	0.170	0.260
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	0.047	0.035	0.018	0.023	0.013
Cobalt	7440-48-4	0.001	mg/L	0.014	0.007	0.003	0.006	0.005
Copper	7440-50-8	0.001	mg/L	0.018	0.011	0.008	0.010	0.010
Lead	7439-92-1	0.001	mg/L	0.008	0.004	0.002	0.002	<0.001
Manganese	7439-96-5	0.001	mg/L	0.564	0.313	0.133	0.125	0.103
Nickel	7440-02-0	0.001	mg/L	0.024	0.023	0.014	0.016	0.013
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.03	0.02	0.02	0.03	0.04
Zinc	7440-66-6	0.005	mg/L	0.065	0.043	0.016	0.033	0.025
Boron	7440-42-8	0.05	mg/L	0.06	<0.05	<0.05	0.06	0.15
Iron	7439-89-6	0.05	mg/L	15.1	9.84	4.72	7.83	4.10
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S16 0-10	S16 10-30	S17 0-10	S17 10-30	S18 0-10
Client sampling date / time				05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-031	EP1814230-032	EP1814230-033	EP1814230-034	EP1814230-035
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	11.3	17.7	28.3	11.5	1.11
Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.003	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	0.221	0.273	0.210	0.213	0.139
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	0.031	0.056	0.054	0.034	0.002
Cobalt	7440-48-4	0.001	mg/L	0.012	0.012	0.011	0.016	0.001
Copper	7440-50-8	0.001	mg/L	0.009	0.012	0.016	0.019	0.002
Lead	7439-92-1	0.001	mg/L	0.010	0.007	0.006	0.006	<0.001
Manganese	7439-96-5	0.001	mg/L	1.19	0.782	0.610	0.753	0.067
Nickel	7440-02-0	0.001	mg/L	0.024	0.031	0.033	0.021	0.002
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.02	0.04	0.04	0.02	<0.01
Zinc	7440-66-6	0.005	mg/L	0.051	0.063	0.095	0.063	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	0.05	0.05	0.05	0.06
Iron	7439-89-6	0.05	mg/L	11.6	19.4	16.4	12.2	0.45
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: DI WATER LEACHATE
 (Matrix: WATER)

Client sample ID

				S18 10-30	S19 0-10	S19 10-30	S20 0-10	S20 10-30
Client sampling date / time				05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit	EP1814230-036	EP1814230-037	EP1814230-038	EP1814230-039	EP1814230-040
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	44.7	14.9	10.2	0.47	0.53
Arsenic	7440-38-2	0.001	mg/L	0.004	0.002	0.003	<0.001	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	0.378	0.289	0.165	0.077	0.097
Cadmium	7440-43-9	0.0001	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.157	0.044	0.026	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	0.009	0.007	0.004	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.047	0.012	0.011	0.002	0.002
Lead	7439-92-1	0.001	mg/L	0.010	0.004	0.002	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.314	0.268	0.124	0.004	0.003
Nickel	7440-02-0	0.001	mg/L	0.055	0.020	0.017	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	0.07	0.03	0.04	<0.01	0.02
Zinc	7440-66-6	0.005	mg/L	0.065	0.054	0.011	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	0.22	0.06	<0.05	0.07	0.24
Iron	7439-89-6	0.05	mg/L	38.3	13.5	7.82	0.26	0.24
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S01 0-10	S01 10-30	S02 0-10	S02 10-30	S03 0-10
Client sampling date / time					06-Nov-2018 00:00	06-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-001	EP1814230-002	EP1814230-003	EP1814230-004	EP1814230-005
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		5.9	6.5	5.8	6.1	7.3
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.6	8.8	8.4	8.3	8.7
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		123	1120	5	10	88
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		2.7	9.4	<1.0	1.9	4.0
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		4	9	----	----	8
Silt (2-20 µm)	----	1	%		9	16	----	----	19
Fine Sand (0.02-0.2 mm)	----	1	%		19	30	----	----	40
Coarse Sand (0.2-2.0 mm)	----	1	%		63	41	----	----	20
Gravel (>2mm)	----	1	%		5	4	----	----	13
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		2.72	2.56	----	----	2.53
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		1.5	5.5	----	----	28.7
Exchangeable Magnesium	----	0.1	meq/100g		1.3	5.4	----	----	3.4
Exchangeable Potassium	----	0.1	meq/100g		0.3	1.1	----	----	1.0
Exchangeable Sodium	----	0.1	meq/100g		0.8	6.3	----	----	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		4.0	18.3	----	----	33.2
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		<200	389	<200	<200	364
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	51	<10	<10	<10
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		20	20	30	30	80
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		146	131	85	87	144
Cobalt	7440-48-4	2	mg/kg		7	11	5	6	27
Copper	7440-50-8	5	mg/kg		14	31	9	10	43



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S01 0-10	S01 10-30	S02 0-10	S02 10-30	S03 0-10
Client sampling date / time					06-Nov-2018 00:00	06-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-001	EP1814230-002	EP1814230-003	EP1814230-004	EP1814230-005
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		6	6	<5	<5	<5
Manganese	7439-96-5	5	mg/kg		261	396	146	146	806
Nickel	7440-02-0	2	mg/kg		22	38	13	15	71
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		123	110	80	81	104
Zinc	7440-66-6	5	mg/kg		18	23	9	9	52
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	6	<5	8
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		7.6	9.1	6.8	7.1	9.0
EP004: Organic Matter									
Organic Matter	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S03 10-30	S04 0-10	S04 10-30	S05 0-10	S05 10-30
Client sampling date / time					07-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-006	EP1814230-007	EP1814230-008	EP1814230-009	EP1814230-010
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		7.6	7.6	7.6	7.4	7.8
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.8	8.1	8.0	8.0	8.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		107	2340	3000	1980	4580
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		5.9	4.4	9.4	4.0	15.0
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		8	11	4	9	10
Silt (2-20 µm)	----	1	%		18	12	25	16	26
Fine Sand (0.02-0.2 mm)	----	1	%		37	6	18	44	42
Coarse Sand (0.2-2.0 mm)	----	1	%		23	70	52	16	18
Gravel (>2mm)	----	1	%		14	1	1	15	4
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		2.55	2.73	2.76	2.58	2.60
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		27.4	46.9	177	1.5	1.9
Exchangeable Magnesium	----	0.1	meq/100g		4.6	0.4	1.0	2.8	8.2
Exchangeable Potassium	----	0.1	meq/100g		0.7	0.3	0.5	0.7	1.4
Exchangeable Sodium	----	0.1	meq/100g		<0.1	<0.1	0.2	3.1	9.0
Cation Exchange Capacity	----	0.1	meq/100g		32.8	47.6	178	8.2	20.5
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		230	<200	264	263	452
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	5820	6740	273	471
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	5	7
Barium	7440-39-3	10	mg/kg		80	30	20	20	20
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	110
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		144	57	53	156	166
Cobalt	7440-48-4	2	mg/kg		29	4	6	12	17
Copper	7440-50-8	5	mg/kg		47	9	11	17	41



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S03 10-30	S04 0-10	S04 10-30	S05 0-10	S05 10-30
Client sampling date / time					07-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	07-Nov-2018 00:00	07-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-006	EP1814230-007	EP1814230-008	EP1814230-009	EP1814230-010
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Manganese	7439-96-5	5	mg/kg		717	116	125	631	618
Nickel	7440-02-0	2	mg/kg		77	11	16	33	61
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		101	48	42	87	81
Zinc	7440-66-6	5	mg/kg		46	9	9	25	36
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	<5	<5
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		8.7	7.2	7.0	7.1	8.8
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.4	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%		0.8	<0.5	<0.5	<0.5	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S06 0-10	S06 10-30	S07 0-10	S07 10-20	S08 0-10
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-011	EP1814230-012	EP1814230-013	EP1814230-014	EP1814230-015
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		8.0	7.8	7.8	7.9	7.9
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.9	9.1	9.0	9.4	9.1
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		77	115	81	152	176
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		3.4	3.8	4.2	5.3	4.8
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		----	----	6	7	----
Silt (2-20 µm)	----	1	%		----	----	13	14	----
Fine Sand (0.02-0.2 mm)	----	1	%		----	----	35	38	----
Coarse Sand (0.2-2.0 mm)	----	1	%		----	----	43	34	----
Gravel (>2mm)	----	1	%		----	----	3	7	----
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		----	----	2.59	2.57	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		----	----	26.7	24.6	----
Exchangeable Magnesium	----	0.1	meq/100g		----	----	1.8	3.3	----
Exchangeable Potassium	----	0.1	meq/100g		----	----	0.8	1.0	----
Exchangeable Sodium	----	0.1	meq/100g		----	----	<0.1	0.3	----
Cation Exchange Capacity	----	0.1	meq/100g		----	----	29.4	29.2	----
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		333	386	264	421	213
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		80	80	80	80	60
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		118	116	99	92	128
Cobalt	7440-48-4	2	mg/kg		9	8	7	7	11
Copper	7440-50-8	5	mg/kg		24	27	19	25	28



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S06 0-10	S06 10-30	S07 0-10	S07 10-20	S08 0-10
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-011	EP1814230-012	EP1814230-013	EP1814230-014	EP1814230-015
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		5	<5	<5	<5	6
Manganese	7439-96-5	5	mg/kg		294	268	210	179	516
Nickel	7440-02-0	2	mg/kg		27	26	24	23	34
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		123	127	72	71	107
Zinc	7440-66-6	5	mg/kg		27	25	20	17	44
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		12	<5	<5	<5	6
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		8.8	9.2	8.5	9.3	8.7
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.5	1.1	0.9	0.5	1.4
Total Organic Carbon	----	0.5	%		0.9	0.6	0.5	<0.5	0.8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S08 10-30	S09 0-10	S09 10-30	S10 0-10	S10 10-30
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-016	EP1814230-017	EP1814230-018	EP1814230-019	EP1814230-020
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		8.1	6.1	6.2	6.4	6.4
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.0	8.8	8.6	8.4	8.7
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		996	6	12	18	36
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		5.1	<1.0	<1.0	1.6	4.1
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		----	----	----	<1	<1
Silt (2-20 µm)	----	1	%		----	----	----	4	4
Fine Sand (0.02-0.2 mm)	----	1	%		----	----	----	9	11
Coarse Sand (0.2-2.0 mm)	----	1	%		----	----	----	87	85
Gravel (>2mm)	----	1	%		----	----	----	<1	<1
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		----	----	----	2.69	2.70
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		----	----	----	1.2	0.5
Exchangeable Magnesium	----	0.1	meq/100g		----	----	----	0.4	0.4
Exchangeable Potassium	----	0.1	meq/100g		----	----	----	0.1	0.2
Exchangeable Sodium	----	0.1	meq/100g		----	----	----	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g		----	----	----	1.7	1.3
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		<200	<200	<200	<200	<200
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		28	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		60	60	60	120	160
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		113	151	137	78	86
Cobalt	7440-48-4	2	mg/kg		12	5	4	3	4
Copper	7440-50-8	5	mg/kg		34	8	7	9	8



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S08 10-30	S09 0-10	S09 10-30	S10 0-10	S10 10-30
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-016	EP1814230-017	EP1814230-018	EP1814230-019	EP1814230-020
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		<5	6	5	<5	<5
Manganese	7439-96-5	5	mg/kg		482	156	117	98	109
Nickel	7440-02-0	2	mg/kg		36	13	11	8	10
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		94	117	110	77	85
Zinc	7440-66-6	5	mg/kg		41	7	5	9	9
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	12	<5	<5	<5
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		9.2	8.6	7.4	7.4	7.2
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.4	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%		0.8	<0.5	<0.5	<0.5	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S11 0-10	S11 10-30	S12 0-10	S12 10-30	S13 0-10
Client sampling date / time					06-Nov-2018 00:00	06-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-021	EP1814230-022	EP1814230-023	EP1814230-024	EP1814230-025
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		6.0	6.3	6.3	6.3	5.5
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.3	8.2	7.5	6.6	7.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		10	36	27	781	6
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		1.2	1.4	2.4	3.3	<1.0
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		----	----	----	----	4
Silt (2-20 µm)	----	1	%		----	----	----	----	8
Fine Sand (0.02-0.2 mm)	----	1	%		----	----	----	----	16
Coarse Sand (0.2-2.0 mm)	----	1	%		----	----	----	----	71
Gravel (>2mm)	----	1	%		----	----	----	----	1
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		----	----	----	----	2.71
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		----	----	----	----	2.1
Exchangeable Magnesium	----	0.1	meq/100g		----	----	----	----	1.6
Exchangeable Potassium	----	0.1	meq/100g		----	----	----	----	0.5
Exchangeable Sodium	----	0.1	meq/100g		----	----	----	----	<0.1
Cation Exchange Capacity	----	0.1	meq/100g		----	----	----	----	4.3
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		220	281	264	<200	216
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		90	80	60	60	20
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		93	95	127	140	135
Cobalt	7440-48-4	2	mg/kg		6	6	10	9	6
Copper	7440-50-8	5	mg/kg		11	11	19	20	12



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S11 0-10	S11 10-30	S12 0-10	S12 10-30	S13 0-10
Client sampling date / time					06-Nov-2018 00:00	06-Nov-2018 00:00	04-Nov-2018 00:00	04-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-021	EP1814230-022	EP1814230-023	EP1814230-024	EP1814230-025
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		<5	<5	7	7	6
Manganese	7439-96-5	5	mg/kg		369	373	375	320	268
Nickel	7440-02-0	2	mg/kg		16	16	30	31	18
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		86	82	80	83	88
Zinc	7440-66-6	5	mg/kg		11	10	18	13	14
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	8	<5
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		6.9	7.2	7.0	6.6	6.5
EP004: Organic Matter									
Organic Matter	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S13 10-30	S14 0-10	S14 10-30	S15 0-10	S15 10-30
Client sampling date / time					30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-026	EP1814230-027	EP1814230-028	EP1814230-029	EP1814230-030
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		5.8	6.7	7.3	7.6	7.9
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.9	8.0	8.9	8.8	9.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		24	66	147	108	434
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		2.1	1.4	4.7	2.7	5.4
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		4	----	----	----	----
Silt (2-20 µm)	----	1	%		9	----	----	----	----
Fine Sand (0.02-0.2 mm)	----	1	%		16	----	----	----	----
Coarse Sand (0.2-2.0 mm)	----	1	%		69	----	----	----	----
Gravel (>2mm)	----	1	%		2	----	----	----	----
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		2.71	----	----	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		2.0	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g		1.6	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g		0.5	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g		0.9	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g		5.0	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		241	<200	310	313	330
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	<10	<10	<10	29
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	5
Barium	7440-39-3	10	mg/kg		20	40	60	60	60
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		119	101	90	107	101
Cobalt	7440-48-4	2	mg/kg		8	6	7	8	8
Copper	7440-50-8	5	mg/kg		12	13	20	18	21



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S13 10-30	S14 0-10	S14 10-30	S15 0-10	S15 10-30
Client sampling date / time					30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00	30-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-026	EP1814230-027	EP1814230-028	EP1814230-029	EP1814230-030
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		6	<5	<5	<5	<5
Manganese	7439-96-5	5	mg/kg		388	251	269	219	182
Nickel	7440-02-0	2	mg/kg		16	20	23	23	23
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		83	74	68	149	129
Zinc	7440-66-6	5	mg/kg		10	17	17	20	19
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	5	<5	<5	<5
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		7.0	7.4	8.9	8.7	9.2
EP004: Organic Matter									
Organic Matter	----	0.5	%		<0.5	<0.5	<0.5	2.1	0.8
Total Organic Carbon	----	0.5	%		<0.5	<0.5	<0.5	1.2	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S16 0-10	S16 10-30	S17 0-10	S17 10-30	S18 0-10
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-031	EP1814230-032	EP1814230-033	EP1814230-034	EP1814230-035
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		5.8	6.0	5.1	5.2	6.3
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.5	8.1	8.4	8.1	8.5
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		3	21	7	36	521
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		1.5	2.7	<1.0	1.3	4.8
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		----	----	7	7	11
Silt (2-20 µm)	----	1	%		----	----	2	2	4
Fine Sand (0.02-0.2 mm)	----	1	%		----	----	10	11	11
Coarse Sand (0.2-2.0 mm)	----	1	%		----	----	80	80	55
Gravel (>2mm)	----	1	%		----	----	1	<1	19
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		----	----	2.70	2.71	2.79
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		----	----	0.6	0.6	0.4
Exchangeable Magnesium	----	0.1	meq/100g		----	----	0.5	0.6	1.7
Exchangeable Potassium	----	0.1	meq/100g		----	----	0.3	0.2	0.4
Exchangeable Sodium	----	0.1	meq/100g		----	----	<0.1	<0.1	2.0
Cation Exchange Capacity	----	0.1	meq/100g		----	----	1.4	1.6	4.5
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		<200	<200	<200	<200	<200
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		<10	<10	<10	<10	17
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		60	90	80	70	40
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		116	145	80	75	155
Cobalt	7440-48-4	2	mg/kg		3	5	5	5	5
Copper	7440-50-8	5	mg/kg		7	9	10	10	10



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S16 0-10	S16 10-30	S17 0-10	S17 10-30	S18 0-10
Client sampling date / time					05-Nov-2018 00:00	05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	05-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-031	EP1814230-032	EP1814230-033	EP1814230-034	EP1814230-035
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		5	6	<5	<5	6
Manganese	7439-96-5	5	mg/kg		243	290	242	230	257
Nickel	7440-02-0	2	mg/kg		11	13	11	11	15
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		99	120	75	70	125
Zinc	7440-66-6	5	mg/kg		9	8	14	10	10
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		5	<5	<5	<5	<5
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		6.9	6.8	7.1	6.7	9.3
EP004: Organic Matter									
Organic Matter	----	0.5	%		0.8	<0.5	0.6	<0.5	<0.5
Total Organic Carbon	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S18 10-30	S19 0-10	S19 10-30	S20 0-10	S20 10-30
Client sampling date / time					05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-036	EP1814230-037	EP1814230-038	EP1814230-039	EP1814230-040
					Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit		7.1	7.0	7.3	8.0	8.1
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.5	8.0	8.8	8.8	8.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		1610	65	89	1810	2200
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		11.6	2.5	3.8	3.3	10.4
EA150: Soil Classification - National Committee on Soil and Terrain (2009)									
Clay (<2 µm)	----	1	%		36	13	9	----	----
Silt (2-20 µm)	----	1	%		6	10	11	----	----
Fine Sand (0.02-0.2 mm)	----	1	%		8	27	18	----	----
Coarse Sand (0.2-2.0 mm)	----	1	%		41	31	22	----	----
Gravel (>2mm)	----	1	%		9	19	40	----	----
EA152: Soil Particle Density									
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3		2.72	2.77	2.68	----	----
ED008: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		1.2	10.5	27.9	----	----
Exchangeable Magnesium	----	0.1	meq/100g		5.8	2.7	3.2	----	----
Exchangeable Potassium	----	0.1	meq/100g		1.0	0.8	1.0	----	----
Exchangeable Sodium	----	0.1	meq/100g		5.8	<0.1	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g		13.8	14.0	32.3	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	10	mg/kg		342	315	286	474	301
ED047: Potassium Chloride Extractable Sulfur (KCI-40)									
ø KCI-40 Extractable Sulfur	----	10	mg/kg		94	<10	<10	194	300
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		50	80	90	120	110
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		171	194	184	184	136
Cobalt	7440-48-4	2	mg/kg		7	10	10	14	17
Copper	7440-50-8	5	mg/kg		19	25	28	33	58



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S18 10-30	S19 0-10	S19 10-30	S20 0-10	S20 10-30
Client sampling date / time					05-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00	06-Nov-2018 00:00
Compound	CAS Number	LOR	Unit		EP1814230-036	EP1814230-037	EP1814230-038	EP1814230-039	EP1814230-040
					Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES - Continued									
Lead	7439-92-1	5	mg/kg		<5	8	6	6	<5
Manganese	7439-96-5	5	mg/kg		290	336	286	553	452
Nickel	7440-02-0	2	mg/kg		24	32	32	46	57
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		121	181	170	161	134
Zinc	7440-66-6	5	mg/kg		15	24	18	36	43
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	11	<5	13	8
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		9.1	8.6	8.9	8.9	9.3
EP004: Organic Matter									
Organic Matter	----	0.5	%		<0.5	<0.5	<0.5	<0.5	0.8
Total Organic Carbon	----	0.5	%		<0.5	<0.5	<0.5	<0.5	<0.5



Environmental

QUALITY CONTROL REPORT

Work Order : EP1814230

Page : 1 of 16

Client : STANTEC AUSTRALIA PTY LTD

Project : LROE-SA-18002 SS
Order number : S0433
C-O-C number : ----
Sampler : SAM LOSTROM
Site : ----
Quote number : EP/619/18
No. of samples received : 40
No. of samples analysed : 40

Date Samples Received : 04-Dec-2018
Date Analysis Commenced : 10-Dec-2018
Issue Date : 19-Dec-2018



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

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

21 CFR Part 11.



General Comments

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

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

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

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA001: pH in soil using 0.01M CaCl extract (QC Lot: 2093059)									
EP1814230-001	S01 0-10	EA001: pH (CaCl ₂)	----	0.1	pH Unit	5.9	5.9	0.00	0% - 20%
EP1814230-011	S06 0-10	EA001: pH (CaCl ₂)	----	0.1	pH Unit	8.0	7.8	1.26	0% - 20%
EA001: pH in soil using 0.01M CaCl extract (QC Lot: 2093060)									
EP1814230-021	S11 0-10	EA001: pH (CaCl ₂)	----	0.1	pH Unit	6.0	6.0	0.00	0% - 20%
EP1814230-031	S16 0-10	EA001: pH (CaCl ₂)	----	0.1	pH Unit	5.8	5.6	4.39	0% - 20%
EA002: pH 1:5 (Soils) (QC Lot: 2089291)									
EP1814230-001	S01 0-10	EA002: pH Value	----	0.1	pH Unit	7.6	7.4	3.86	0% - 20%
EP1814230-010	S05 10-30	EA002: pH Value	----	0.1	pH Unit	8.4	8.4	0.00	0% - 20%
EA002: pH 1:5 (Soils) (QC Lot: 2089294)									
EP1814230-021	S11 0-10	EA002: pH Value	----	0.1	pH Unit	8.3	8.0	3.44	0% - 20%
EP1814230-030	S15 10-30	EA002: pH Value	----	0.1	pH Unit	9.4	9.4	0.00	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2089292)									
EP1814230-001	S01 0-10	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	123	131	6.51	0% - 20%
EP1814230-010	S05 10-30	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	4580	4720	2.89	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2089293)									
EP1814230-021	S11 0-10	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	10	10	0.00	0% - 50%
EP1814230-030	S15 10-30	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	434	388	11.3	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2088060)									
EP1814230-001	S01 0-10	EA055: Moisture Content	----	0.1	%	2.7	2.3	14.8	No Limit
EP1814230-010	S05 10-30	EA055: Moisture Content	----	0.1	%	15.0	15.7	4.41	0% - 50%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2088061)									
EP1814230-021	S11 0-10	EA055: Moisture Content	----	0.1	%	1.2	1.2	0.00	No Limit
EP1814230-036	S18 10-30	EA055: Moisture Content	----	0.1	%	11.6	9.6	18.7	0% - 50%



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2088070)									
EP1814219-001	Anonymous	EA055: Moisture Content	----	0.1	%	72.4	73.7	1.79	0% - 20%
EP1814248-004	Anonymous	EA055: Moisture Content	----	0.1	%	3.9	3.9	0.00	No Limit
ED008: Exchangeable Cations (QC Lot: 2089307)									
EP1814230-001	S01 0-10	ED008: Exchangeable Calcium	----	0.1	meq/100g	1.5	1.4	0.00	0% - 50%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.3	0.00	0% - 50%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.3	0.3	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	0.8	0.8	0.00	No Limit
		ED008: Cation Exchange Capacity	----	0.1	meq/100g	4.0	3.8	3.13	0% - 20%
EP1814230-014	S07 10-20	ED008: Exchangeable Calcium	----	0.1	meq/100g	24.6	23.7	3.55	0% - 20%
		ED008: Exchangeable Magnesium	----	0.1	meq/100g	3.3	3.2	4.13	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	1.0	1.0	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	0.3	0.3	0.00	No Limit
		ED008: Cation Exchange Capacity	----	0.1	meq/100g	29.2	28.2	3.51	0% - 20%
ED021: Bicarbonate Extractable Potassium (Colwell) (QC Lot: 2083856)									
EP1814230-001	S01 0-10	ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	<200	225	11.6	No Limit
EP1814230-009	S05 0-10	ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	263	267	1.68	No Limit
ED021: Bicarbonate Extractable Potassium (Colwell) (QC Lot: 2083858)									
EP1814230-021	S11 0-10	ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	220	<200	9.42	No Limit
EP1814230-029	S15 0-10	ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	313	265	16.6	No Limit
ED047: Potassium Chloride Extractable Sulfur (KCI-40) (QC Lot: 2083845)									
EP1814230-001	S01 0-10	ED047: KCI-40 Extractable Sulfur	----	10	mg/kg	<10	<10	0.00	No Limit
EP1814230-011	S06 0-10	ED047: KCI-40 Extractable Sulfur	----	10	mg/kg	<10	<10	0.00	No Limit
ED047: Potassium Chloride Extractable Sulfur (KCI-40) (QC Lot: 2083847)									
EP1814230-021	S11 0-10	ED047: KCI-40 Extractable Sulfur	----	10	mg/kg	<10	<10	0.00	No Limit
EP1814230-031	S16 0-10	ED047: KCI-40 Extractable Sulfur	----	10	mg/kg	<10	<10	0.00	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 2089599)									
EP1814230-001	S01 0-10	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	20	20	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	146	135	7.50	0% - 20%
		EG005T: Cobalt	7440-48-4	2	mg/kg	7	7	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	22	20	9.25	0% - 50%
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	14	14	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	6	6	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	261	276	5.69	0% - 20%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	123	119	3.87	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	18	16	12.4	No Limit



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 2089599) - continued									
EP1814230-001	S01 0-10	EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EP1814230-011	S06 0-10	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	80	80	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	118	130	9.26	0% - 20%
		EG005T: Cobalt	7440-48-4	2	mg/kg	9	9	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	27	28	0.00	0% - 50%
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	24	24	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	5	5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	294	284	3.32	0% - 20%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	123	137	10.3	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	27	29	6.93	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 2089602)									
EP1814230-021	S11 0-10	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	90	80	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	93	108	15.4	0% - 20%
		EG005T: Cobalt	7440-48-4	2	mg/kg	6	6	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	16	15	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	11	10	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	369	368	0.00	0% - 20%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	86	84	1.40	0% - 50%
		EG005T: Zinc	7440-66-6	5	mg/kg	11	11	0.00	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EP1814230-031	S16 0-10	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	60	60	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	116	122	4.66	0% - 20%
		EG005T: Cobalt	7440-48-4	2	mg/kg	3	3	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	11	11	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	7	6	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	5	<5	0.00	No Limit
EG005T: Manganese	7439-96-5	5	mg/kg	243	247	1.73	0% - 20%		

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 Project : LROE-SA-18002 SS



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 2089602) - continued									
EP1814230-031	S16 0-10	EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	99	98	1.75	0% - 50%
		EG005T: Zinc	7440-66-6	5	mg/kg	9	8	0.00	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 2089606)									
EP1814511-001	Anonymous	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	30	20	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	10	9	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	5	5	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	7	6	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	17	15	11.3	No Limit
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	7	6	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	22	18	17.2	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EP1814511-003	Anonymous	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	200	190	0.00	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	25	25	0.00	0% - 50%
		EG005T: Cobalt	7440-48-4	2	mg/kg	9	8	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	32	31	0.00	0% - 50%
		EG005T: Arsenic	7440-38-2	5	mg/kg	20	21	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	26	25	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	10	10	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	54	54	0.00	0% - 50%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	23	23	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	61	60	1.70	0% - 50%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2089600)									
EP1814230-001	S01 0-10	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EP1814230-011	S06 0-10	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2089601)									
EP1814230-021	S11 0-10	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EP1814230-031	S16 0-10	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

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Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2089605)									
EP1814511-001	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EP1814511-003	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 2083881)									
EP1814230-001	S01 0-10	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	0.00	No Limit
EP1814230-011	S06 0-10	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	12	10	18.3	No Limit
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 2083882)									
EP1814230-021	S11 0-10	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	0.00	No Limit
EP1814230-031	S16 0-10	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	5	<5	0.00	No Limit
EP004: Organic Matter (QC Lot: 2089310)									
EP1814230-001	S01 0-10	EP004: Organic Matter	----	0.5	%	<0.5	<0.5	0.00	No Limit
		EP004: Total Organic Carbon	----	0.5	%	<0.5	<0.5	0.00	No Limit
EP1814230-011	S06 0-10	EP004: Organic Matter	----	0.5	%	1.5	1.4	0.00	No Limit
		EP004: Total Organic Carbon	----	0.5	%	0.9	0.8	0.00	No Limit
EP004: Organic Matter (QC Lot: 2089311)									
EP1814230-021	S11 0-10	EP004: Organic Matter	----	0.5	%	<0.5	<0.5	0.00	No Limit
		EP004: Total Organic Carbon	----	0.5	%	<0.5	<0.5	0.00	No Limit
EP1814230-031	S16 0-10	EP004: Organic Matter	----	0.5	%	0.8	0.6	27.8	No Limit
		EP004: Total Organic Carbon	----	0.5	%	<0.5	<0.5	0.00	No Limit
Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2096355)									
EP1814230-001	S01 0-10	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.215	0.216	0.766	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.071	0.069	2.22	0% - 20%
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	0.014	0.015	0.00	0% - 50%
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.028	0.029	0.00	0% - 20%
		EG020A-W: Lead	7439-92-1	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.540	0.526	2.48	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.040	0.040	0.00	0% - 20%
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.085	0.088	3.34	0% - 50%
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	30.4	29.8	2.17	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	0.04	0.04	0.00	No Limit
		EG020A-W: Boron	7440-42-8	0.05	mg/L	0.09	0.08	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	19.4	19.3	0.536	0% - 20%
EP1814230-011	S06 0-10	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit

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Sub-Matrix: **WATER**

Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2096355) - continued									
EP1814230-011	S06 0-10	EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.238	0.237	0.449	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.016	0.015	0.00	0% - 50%
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-W: Lead	7439-92-1	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.152	0.146	3.85	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.012	0.011	0.00	0% - 50%
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.027	0.025	10.8	No Limit
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	8.61	8.02	7.03	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	0.02	0.02	0.00	No Limit
		EG020A-W: Boron	7440-42-8	0.05	mg/L	0.09	0.07	31.1	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	5.40	5.10	5.77	0% - 20%
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2098195)									
EP1814230-013	S07 0-10	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.201	0.198	1.64	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.041	0.039	5.23	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.010	0.007	27.3	No Limit
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	1.06	1.06	0.00	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	0.01	0.01	0.00	No Limit
		EG020A-W: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	0.26	0.28	8.78	No Limit
EP1814230-023	S12 0-10	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.232	0.227	2.39	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.041	0.044	7.99	0% - 20%
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.015	0.016	7.17	0% - 50%
		EG020A-W: Lead	7439-92-1	0.001	mg/L	0.005	0.006	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.276	0.286	3.47	0% - 20%

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 Work Order : EP1814230
 Client : STANTEC AUSTRALIA PTY LTD
 Project : LROE-SA-18002 SS



Sub-Matrix: **WATER**

Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2098195) - continued									
EP1814230-023	S12 0-10	EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.027	0.029	6.17	0% - 20%
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.065	0.059	9.32	0% - 50%
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	14.4	16.0	10.9	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	0.02	0.02	0.00	No Limit
		EG020A-W: Boron	7440-42-8	0.05	mg/L	<0.05	0.05	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	12.6	13.7	8.16	0% - 20%
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 2098196)									
EP1814230-033	S17 0-10	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Barium	7440-39-3	0.001	mg/L	0.210	0.217	3.25	0% - 20%
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.054	0.054	0.00	0% - 20%
		EG020A-W: Cobalt	7440-48-4	0.001	mg/L	0.011	0.011	0.00	0% - 50%
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.016	0.016	0.00	0% - 50%
		EG020A-W: Lead	7439-92-1	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-W: Manganese	7439-96-5	0.001	mg/L	0.610	0.619	1.45	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.033	0.031	6.10	0% - 20%
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.095	0.088	7.70	0% - 50%
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	28.3	27.1	4.27	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Vanadium	7440-62-2	0.01	mg/L	0.04	0.04	0.00	No Limit
		EG020A-W: Boron	7440-42-8	0.05	mg/L	0.05	0.06	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	16.4	15.9	2.97	0% - 20%
EG035W: Water Leachable Mercury by FIMS (QC Lot: 2096397)									
EP1814230-001	S01 0-10	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1814230-011	S06 0-10	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035W: Water Leachable Mercury by FIMS (QC Lot: 2098209)									
EP1814230-013	S07 0-10	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1814230-023	S12 0-10	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035W: Water Leachable Mercury by FIMS (QC Lot: 2098210)									
EP1814230-033	S17 0-10	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result		LCS	Low	High
EA001: pH in soil using 0.01M CaCl extract (QCLot: 2093059)								
EA001: pH (CaCl2)	----	----	pH Unit	----	4 pH Unit	100	99	101
				----	7 pH Unit	100	99	101
EA001: pH in soil using 0.01M CaCl extract (QCLot: 2093060)								
EA001: pH (CaCl2)	----	----	pH Unit	----	4 pH Unit	101	99	101
				----	7 pH Unit	100	99	101
EA002: pH 1:5 (Soils) (QCLot: 2089291)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	70	130
				----	7 pH Unit	100	70	130
EA002: pH 1:5 (Soils) (QCLot: 2089294)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	102	70	130
				----	7 pH Unit	100	70	130
EA010: Conductivity (1:5) (QCLot: 2089292)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	99.3	94	106
EA010: Conductivity (1:5) (QCLot: 2089293)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	98.9	94	106
ED008: Exchangeable Cations (QCLot: 2089307)								
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	22.13 meq/100g	95.8	84	112
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	1.558 meq/100g	97.6	84	114
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.913 meq/100g	108	92	112
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.377 meq/100g	106	80	120
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	24.98 meq/100g	96.5	85	111
ED021: Bicarbonate Extractable Potassium (Colwell) (QCLot: 2083856)								
ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	<200	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell) (QCLot: 2083858)								
ED021: Bicarbonate Extractable K (Colwell)	----	100	mg/kg	<200	----	----	----	----
ED047: Potassium Chloride Extractable Sulfur (KCl-40) (QCLot: 2083845)								
ED047: KCl-40 Extractable Sulfur	----	10	mg/kg	<10	34 mg/kg	103	70	130
ED047: Potassium Chloride Extractable Sulfur (KCl-40) (QCLot: 2083847)								
ED047: KCl-40 Extractable Sulfur	----	10	mg/kg	<10	34 mg/kg	104	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2089599)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	22 mg/kg	98.4	70	130
EG005T: Barium	7440-39-3	10	mg/kg	<10	155 mg/kg	93.2	70	130
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	----	----	----	----



Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result			Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2089599) - continued								
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	5 mg/kg	90.0	70	130
EG005T: Chromium	7440-47-3	2	mg/kg	<2	34 mg/kg	115	70	130
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005T: Copper	7440-50-8	5	mg/kg	<5	34 mg/kg	94.7	70	130
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	92.4	70	130
EG005T: Manganese	7439-96-5	5	mg/kg	<5	----	----	----	----
EG005T: Nickel	7440-02-0	2	mg/kg	<2	51 mg/kg	106	70	130
EG005T: Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	----	----	----	----
EG005T: Zinc	7440-66-6	5	mg/kg	<5	62 mg/kg	100	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2089602)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	22 mg/kg	99.8	70	130
EG005T: Barium	7440-39-3	10	mg/kg	<10	155 mg/kg	94.4	70	130
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	----	----	----	----
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	5 mg/kg	90.0	70	130
EG005T: Chromium	7440-47-3	2	mg/kg	<2	34 mg/kg	120	70	130
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005T: Copper	7440-50-8	5	mg/kg	<5	34 mg/kg	97.2	70	130
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	97.1	70	130
EG005T: Manganese	7439-96-5	5	mg/kg	<5	----	----	----	----
EG005T: Nickel	7440-02-0	2	mg/kg	<2	51 mg/kg	108	70	130
EG005T: Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	----	----	----	----
EG005T: Zinc	7440-66-6	5	mg/kg	<5	62 mg/kg	103	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2089606)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	22 mg/kg	99.1	70	130
EG005T: Barium	7440-39-3	10	mg/kg	<10	155 mg/kg	89.6	70	130
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	----	----	----	----
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	5 mg/kg	90.0	70	130
EG005T: Chromium	7440-47-3	2	mg/kg	<2	42.22 mg/kg	98.3	70	130
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005T: Copper	7440-50-8	5	mg/kg	<5	34 mg/kg	96.2	70	130
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	93.6	70	130
EG005T: Manganese	7439-96-5	5	mg/kg	<5	----	----	----	----
EG005T: Nickel	7440-02-0	2	mg/kg	<2	51 mg/kg	109	70	130
EG005T: Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----



Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: Compound	CAS Number	LOR	Unit	Result				
EG005T: Total Metals by ICP-AES (QCLot: 2089606) - continued								
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	----	----	----	----
EG005T: Zinc	7440-66-6	5	mg/kg	<5	62 mg/kg	98.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089600)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.154 mg/kg	87.9	81	115
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089601)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.154 mg/kg	90.7	81	115
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089605)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.154 mg/kg	90.1	81	115
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 2083881)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	100 mg/kg	98.1	70	130
				<5	44.9 mg/kg	102	87	113
				<5	58.07 mg/kg	95.7	80	120
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 2083882)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	100 mg/kg	98.1	70	130
				<5	44.9 mg/kg	102	87	113
				<5	58.07 mg/kg	95.7	80	120
EP004: Organic Matter (QCLot: 2089310)								
EP004: Organic Matter	----	0.5	%	<0.5	2.3 %	86.5	70	130
				<0.5	85 %	80.7	70	130
EP004: Total Organic Carbon	----	0.5	%	<0.5	----	----	----	----
EP004: Organic Matter (QCLot: 2089311)								
EP004: Organic Matter	----	0.5	%	<0.5	2.3 %	98.3	70	130
				<0.5	85 %	79.4	70	130
EP004: Total Organic Carbon	----	0.5	%	<0.5	----	----	----	----

Sub-Matrix: WATER				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: Compound	CAS Number	LOR	Unit	Result				
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2096355)								
EG020A-W: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	85	120
EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.6	81	120
EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	112	80	120
EG020A-W: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	103	83	120
EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	83	120
EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.2	81	120
EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	94.8	83	120
EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	91.4	82	120
EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	101	82	120
EG020A-W: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.6	83	120



Sub-Matrix: **WATER**

Sub-Matrix: WATER				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
Method: Compound	CAS Number	LOR	Unit	Result				
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2096355) - continued								
EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.2	83	120
EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	102	79	120
EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	94.8	80	120
EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	103	77	120
EG020A-W: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	108	72	120
EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	81	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2098195)								
EG020A-W: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	85	120
EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.0	81	120
EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	113	80	120
EG020A-W: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	106	83	120
EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	83	120
EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	95.8	81	120
EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	97.4	83	120
EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	93.8	82	120
EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	101	82	120
EG020A-W: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.7	83	120
EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.1	83	120
EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	102	79	120
EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	94.1	80	120
EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	77	120
EG020A-W: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	107	72	120
EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	99.7	81	120
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2098196)								
EG020A-W: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	102	85	120
EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.0	81	120
EG020A-W: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	104	80	120
EG020A-W: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	100	83	120
EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.9	83	120
EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	94.5	81	120
EG020A-W: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	94.2	83	120
EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	92.2	82	120
EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.4	82	120
EG020A-W: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.6	83	120
EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	95.1	83	120
EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	98.8	79	120
EG020A-W: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	92.4	80	120
EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	103	77	120
EG020A-W: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	100	72	120



Sub-Matrix: **WATER**

Method: Compound				Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
CAS Number	LOR	Unit						
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2098196) - continued								
EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	99.0	81	120
EG035W: Water Leachable Mercury by FIMS (QCLot: 2096397)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	93	115
EG035W: Water Leachable Mercury by FIMS (QCLot: 2098209)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	104	93	115
EG035W: Water Leachable Mercury by FIMS (QCLot: 2098210)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	93	115

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2089599)							
EP1814230-001	S01 0-10	EG005T: Arsenic	7440-38-2	50 mg/kg	79.6	70	130
		EG005T: Barium	7440-39-3	50 mg/kg	114	70	130
		EG005T: Beryllium	7440-41-7	10 mg/kg	115	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	100	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	129	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	107	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	104	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	102	70	130
		EG005T: Selenium	7782-49-2	10 mg/kg	# 55.1	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	110	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	101	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2089602)							
EP1814230-021	S11 0-10	EG005T: Arsenic	7440-38-2	50 mg/kg	89.0	70	130
		EG005T: Barium	7440-39-3	50 mg/kg	71.9	70	130
		EG005T: Beryllium	7440-41-7	10 mg/kg	110	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	101	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	75.8	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	102	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	100	70	130

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 Work Order : EP1814230
 Client : STANTEC AUSTRALIA PTY LTD
 Project : LROE-SA-18002 SS



Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2089602) - continued							
EP1814230-021	S11 0-10	EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	98.7	70	130
		EG005T: Selenium	7782-49-2	10 mg/kg	74.7	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	70.6	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	98.6	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2089606)							
EP1814511-001	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	99.6	70	130
		EG005T: Barium	7440-39-3	50 mg/kg	97.6	70	130
		EG005T: Beryllium	7440-41-7	10 mg/kg	110	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	98.1	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	96.2	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	104	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	99.8	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	96.1	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	98.0	70	130
		EG005T: Selenium	7782-49-2	10 mg/kg	108	70	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	92.5	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	89.7	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089600)							
EP1814230-001	S01 0-10	EG035T: Mercury	7439-97-6	10 mg/kg	89.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089601)							
EP1814230-021	S11 0-10	EG035T: Mercury	7439-97-6	10 mg/kg	91.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2089605)							
EP1814511-001	Anonymous	EG035T: Mercury	7439-97-6	10 mg/kg	92.2	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 2083881)							
EP1814230-002	S01 10-30	EK080: Bicarbonate Ext. P (Colwell)	----	40 mg/kg	94.0	70	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 2083882)							
EP1814230-022	S11 10-30	EK080: Bicarbonate Ext. P (Colwell)	----	40 mg/kg	94.0	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020W: Water Leachable Metals by ICP-MS (QCLot: 2096355)							
EP1814230-002	S01 10-30	EG020A-W: Arsenic	7440-38-2	1 mg/L	104	70	130
		EG020A-W: Beryllium	7440-41-7	1 mg/L	105	70	130
		EG020A-W: Barium	7440-39-3	1 mg/L	115	70	130



Sub-Matrix: WATER

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035W: Water Leachable Mercury by FIMS (QCLot: 2098209) - continued							
EP1814230-014	S07 10-20	EG035W: Mercury	7439-97-6	0.01 mg/L	94.7	70	130
EG035W: Water Leachable Mercury by FIMS (QCLot: 2098210)							
EP1814230-034	S17 10-30	EG035W: Mercury	7439-97-6	0.01 mg/L	96.2	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order : EP1814230

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Client : STANTEC AUSTRALIA PTY LTD

Project : LROE-SA-18002 SS

Site : ----

Sampler : SAM LOSTROM

Order number : S0433

Date Samples Received : 04-Dec-2018

Issue Date : 19-Dec-2018

No. of samples received : 40

No. of samples analysed : 40

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO** Method Blank value outliers occur.
- **NO** Duplicate outliers occur.
- **NO** Laboratory Control outliers occur.
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- **NO** Quality Control Sample Frequency Outliers exist.

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 Client : STANTEC AUSTRALIA PTY LTD
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Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG005T: Total Metals by ICP-AES	EP1814230--001	S01 0-10	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EP1814230--021	S11 0-10	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EP1814230--001	S01 0-10	Selenium	7782-49-2	55.1 %	70-130%	Recovery less than lower data quality objective

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA001: pH in soil using 0.01M CaCl extract							
Amber Glass Bottle - Unpreserved							
S07 0-10,	S07 10-20,	17-Dec-2018	11-Nov-2018	36	----	----	----
S12 0-10,	S12 10-30						
Amber Glass Bottle - Unpreserved							
S04 0-10,	S04 10-30,	17-Dec-2018	12-Nov-2018	35	----	----	----
S06 0-10,	S06 10-30,						
S08 0-10,	S08 10-30,						
S09 0-10,	S09 10-30,						
S16 0-10,	S16 10-30,						
S18 0-10,	S18 10-30						
Amber Glass Bottle - Unpreserved							
S01 0-10,	S01 10-30,	17-Dec-2018	13-Nov-2018	34	----	----	----
S10 0-10,	S10 10-30,						
S11 0-10,	S11 10-30,						
S17 0-10,	S17 10-30,						
S19 0-10,	S19 10-30,						
S20 0-10,	S20 10-30						
Amber Glass Bottle - Unpreserved							
S02 0-10,	S02 10-30,	17-Dec-2018	14-Nov-2018	33	----	----	----
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30						
Amber Glass Bottle - Unpreserved							
S13 0-10,	S13 10-30,	17-Dec-2018	07-Dec-2018	10	----	----	----
S14 0-10,	S14 10-30,						
S15 0-10,	S15 10-30						



Matrix: **SOIL**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002: pH 1:5 (Soils)							
Amber Glass Bottle - Unpreserved							
S07 0-10,	S07 10-20,	12-Dec-2018	11-Nov-2018	31	----	----	----
S12 0-10,	S12 10-30						
Amber Glass Bottle - Unpreserved							
S04 0-10,	S04 10-30,	12-Dec-2018	12-Nov-2018	30	----	----	----
S06 0-10,	S06 10-30,						
S08 0-10,	S08 10-30,						
S09 0-10,	S09 10-30,						
S16 0-10,	S16 10-30,						
S18 0-10,	S18 10-30						
Amber Glass Bottle - Unpreserved							
S01 0-10,	S01 10-30,	12-Dec-2018	13-Nov-2018	29	----	----	----
S10 0-10,	S10 10-30,						
S11 0-10,	S11 10-30,						
S17 0-10,	S17 10-30,						
S19 0-10,	S19 10-30,						
S20 0-10,	S20 10-30						
Amber Glass Bottle - Unpreserved							
S02 0-10,	S02 10-30,	12-Dec-2018	14-Nov-2018	28	----	----	----
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30						
Amber Glass Bottle - Unpreserved							
S13 0-10,	S13 10-30,	12-Dec-2018	07-Dec-2018	5	----	----	----
S14 0-10,	S14 10-30,						
S15 0-10,	S15 10-30						
EA010: Conductivity (1:5)							
Amber Glass Bottle - Unpreserved							
S07 0-10,	S07 10-20,	12-Dec-2018	11-Nov-2018	31	----	----	----
S12 0-10,	S12 10-30						
Amber Glass Bottle - Unpreserved							
S04 0-10,	S04 10-30,	12-Dec-2018	12-Nov-2018	30	----	----	----
S06 0-10,	S06 10-30,						
S08 0-10,	S08 10-30,						
S09 0-10,	S09 10-30,						
S16 0-10,	S16 10-30,						
S18 0-10,	S18 10-30						



Matrix: **SOIL**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA010: Conductivity (1:5) - Analysis Holding Time Compliance							
Amber Glass Bottle - Unpreserved		12-Dec-2018	13-Nov-2018	29	----	----	----
S01 0-10,	S01 10-30,						
S10 0-10,	S10 10-30,						
S11 0-10,	S11 10-30,						
S17 0-10,	S17 10-30,						
S19 0-10,	S19 10-30,						
S20 0-10,	S20 10-30,						
Amber Glass Bottle - Unpreserved		12-Dec-2018	14-Nov-2018	28	----	----	----
S02 0-10,	S02 10-30,						
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30,						
Amber Glass Bottle - Unpreserved		12-Dec-2018	07-Dec-2018	5	----	----	----
S13 0-10,	S13 10-30,						
S14 0-10,	S14 10-30,						
S15 0-10,	S15 10-30,						
EA055: Moisture Content (Dried @ 105-110°C)							
Amber Glass Bottle - Unpreserved		----	----	----	11-Dec-2018	18-Nov-2018	23
S07 0-10,	S07 10-20,						
S12 0-10,	S12 10-30,						
Amber Glass Bottle - Unpreserved		----	----	----	11-Dec-2018	19-Nov-2018	22
S04 0-10,	S04 10-30,						
S06 0-10,	S06 10-30,						
S08 0-10,	S08 10-30,						
S09 0-10,	S09 10-30,						
S16 0-10,	S16 10-30,						
S18 0-10,	S18 10-30,						
Amber Glass Bottle - Unpreserved							
S01 0-10,	S01 10-30,						
S10 0-10,	S10 10-30,						
S11 0-10,	S11 10-30,						
S17 0-10,	S17 10-30,						
S19 0-10,	S19 10-30,						
S20 0-10,	S20 10-30,						
Amber Glass Bottle - Unpreserved		----	----	----	11-Dec-2018	21-Nov-2018	20
S02 0-10,	S02 10-30,						
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30,						
ED008: Exchangeable Cations							
Amber Glass Bottle - Unpreserved		17-Dec-2018	02-Dec-2018	15	17-Dec-2018	02-Dec-2018	15
S07 0-10,	S07 10-20						



Matrix: **SOIL**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
ED008: Exchangeable Cations - Analysis Holding Time Compliance							
Amber Glass Bottle - Unpreserved							
S04 0-10, S18 0-10,	S04 10-30, S18 10-30	17-Dec-2018	03-Dec-2018	14	17-Dec-2018	03-Dec-2018	14
Amber Glass Bottle - Unpreserved							
S01 0-10, S10 0-10, S17 0-10, S19 0-10,	S01 10-30, S10 10-30, S17 10-30, S19 10-30	17-Dec-2018	04-Dec-2018	13	17-Dec-2018	04-Dec-2018	13
Amber Glass Bottle - Unpreserved							
S03 0-10, S05 0-10,	S03 10-30, S05 10-30	17-Dec-2018	05-Dec-2018	12	17-Dec-2018	05-Dec-2018	12
ED047: Potassium Chloride Extractable Sulfur (KCl-40)							
Amber Glass Bottle - Unpreserved							
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	14-Dec-2018	02-Dec-2018	12	17-Dec-2018	02-Dec-2018	15
Amber Glass Bottle - Unpreserved							
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	14-Dec-2018	03-Dec-2018	11	17-Dec-2018	03-Dec-2018	14
Amber Glass Bottle - Unpreserved							
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	14-Dec-2018	04-Dec-2018	10	17-Dec-2018	04-Dec-2018	13
Amber Glass Bottle - Unpreserved							
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	14-Dec-2018	05-Dec-2018	9	17-Dec-2018	05-Dec-2018	12
EG035T: Total Recoverable Mercury by FIMS							
Amber Glass Bottle - Unpreserved							
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	13-Dec-2018	02-Dec-2018	11	13-Dec-2018	02-Dec-2018	11

Method	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue	
EG035T: Total Recoverable Mercury by FIMS - Analysis Holding Time Compliance							
Amber Glass Bottle - Unpreserved							
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	13-Dec-2018	03-Dec-2018	10	13-Dec-2018	03-Dec-2018	10
Amber Glass Bottle - Unpreserved							
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	13-Dec-2018	04-Dec-2018	9	13-Dec-2018	04-Dec-2018	9
Amber Glass Bottle - Unpreserved							
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	13-Dec-2018	05-Dec-2018	8	13-Dec-2018	05-Dec-2018	8
EN60: Bottle Leaching Procedure							
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	13-Dec-2018	02-Dec-2018	11	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S04 0-10, S06 0-10,	S04 10-30, S06 10-30	12-Dec-2018	03-Dec-2018	9	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S08 10-30, S09 10-30, S16 10-30, S18 10-30	13-Dec-2018	03-Dec-2018	10	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S01 0-10,	S01 10-30	12-Dec-2018	04-Dec-2018	8	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	13-Dec-2018	04-Dec-2018	9	----	----	----



Matrix: **SOIL**

Method		Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EN60: Bottle Leaching Procedure - Analysis Holding Time Compliance							
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI)							
S02 0-10,	S02 10-30,	12-Dec-2018	05-Dec-2018	7	----	----	----
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30						
EP004: Organic Matter							
Amber Glass Bottle - Unpreserved							
S07 0-10,	S07 10-20,	15-Dec-2018	11-Nov-2018	34	----	----	----
S12 0-10,	S12 10-30						
Amber Glass Bottle - Unpreserved							
S04 0-10,	S04 10-30	15-Dec-2018	12-Nov-2018	33	----	----	----
Amber Glass Bottle - Unpreserved							
S06 0-10,	S06 10-30,	15-Dec-2018	12-Nov-2018	33	----	----	----
S08 0-10,	S08 10-30,						
S09 0-10,	S09 10-30,						
S16 0-10,	S16 10-30,						
S18 0-10,	S18 10-30						
Amber Glass Bottle - Unpreserved							
S01 0-10,	S01 10-30	15-Dec-2018	13-Nov-2018	32	----	----	----
Amber Glass Bottle - Unpreserved							
S10 0-10,	S10 10-30,	15-Dec-2018	13-Nov-2018	32	----	----	----
S11 0-10,	S11 10-30,						
S17 0-10,	S17 10-30,						
S19 0-10,	S19 10-30,						
S20 0-10,	S20 10-30						
Amber Glass Bottle - Unpreserved							
S02 0-10,	S02 10-30,	15-Dec-2018	14-Nov-2018	31	----	----	----
S03 0-10,	S03 10-30,						
S05 0-10,	S05 10-30						
Amber Glass Bottle - Unpreserved							
S13 0-10,	S13 10-30,	15-Dec-2018	07-Dec-2018	8	----	----	----
S14 0-10,	S14 10-30,						
S15 0-10,	S15 10-30						

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for **VOC in soils** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA001: pH in soil using 0.01M CaCl extract								
Amber Glass Bottle - Unpreserved (EA001) S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	17-Dec-2018	11-Nov-2018	✖	17-Dec-2018	17-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA001) S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	17-Dec-2018	12-Nov-2018	✖	17-Dec-2018	17-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA001) S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	17-Dec-2018	13-Nov-2018	✖	17-Dec-2018	17-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA001) S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	17-Dec-2018	14-Nov-2018	✖	17-Dec-2018	17-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA001) S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	17-Dec-2018	07-Dec-2018	✖	17-Dec-2018	17-Dec-2018	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)								
Amber Glass Bottle - Unpreserved (EA002)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	12-Dec-2018	11-Nov-2018	✖	12-Dec-2018	12-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA002)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	12-Dec-2018	12-Nov-2018	✖	12-Dec-2018	12-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA002)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	12-Dec-2018	13-Nov-2018	✖	12-Dec-2018	12-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA002)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	12-Dec-2018	14-Nov-2018	✖	12-Dec-2018	12-Dec-2018	✓
Amber Glass Bottle - Unpreserved (EA002)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	12-Dec-2018	07-Dec-2018	✖	12-Dec-2018	12-Dec-2018	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010: Conductivity (1:5)								
Amber Glass Bottle - Unpreserved (EA010) S07 0-10, S12 0-10,		04-Nov-2018	12-Dec-2018	11-Nov-2018	✖	12-Dec-2018	09-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EA010) S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,		05-Nov-2018	12-Dec-2018	12-Nov-2018	✖	12-Dec-2018	09-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EA010) S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,		06-Nov-2018	12-Dec-2018	13-Nov-2018	✖	12-Dec-2018	09-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EA010) S02 0-10, S03 0-10, S05 0-10,		07-Nov-2018	12-Dec-2018	14-Nov-2018	✖	12-Dec-2018	09-Jan-2019	✓
Amber Glass Bottle - Unpreserved (EA010) S13 0-10, S14 0-10, S15 0-10,		30-Nov-2018	12-Dec-2018	07-Dec-2018	✖	12-Dec-2018	09-Jan-2019	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA055: Moisture Content (Dried @ 105-110°C)								
Amber Glass Bottle - Unpreserved (EA055) S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	----	----	----	11-Dec-2018	18-Nov-2018	✘
Amber Glass Bottle - Unpreserved (EA055) S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	----	----	----	11-Dec-2018	19-Nov-2018	✘
Amber Glass Bottle - Unpreserved (EA055) S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	----	----	----	11-Dec-2018	20-Nov-2018	✘
Amber Glass Bottle - Unpreserved (EA055) S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	----	----	----	11-Dec-2018	21-Nov-2018	✘
Amber Glass Bottle - Unpreserved (EA055) S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	----	----	----	11-Dec-2018	14-Dec-2018	✔
EA150: Soil Classification - National Committee on Soil and Terrain (2009)								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H) S07 0-10,	S07 10-20	04-Nov-2018	----	----	----	17-Dec-2018	03-May-2019	✔
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H) S04 0-10, S18 0-10,	S04 10-30, S18 10-30	05-Nov-2018	----	----	----	17-Dec-2018	04-May-2019	✔
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H) S01 0-10, S10 0-10, S17 0-10, S19 0-10,	S01 10-30, S10 10-30, S17 10-30, S19 10-30	06-Nov-2018	----	----	----	17-Dec-2018	05-May-2019	✔
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H) S03 0-10, S05 0-10,	S03 10-30, S05 10-30	07-Nov-2018	----	----	----	17-Dec-2018	06-May-2019	✔
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H) S13 0-10,	S13 10-30	30-Nov-2018	----	----	----	17-Dec-2018	29-May-2019	✔



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA152: Soil Particle Density								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152) S07 0-10,	S07 10-20	04-Nov-2018	----	----	----	17-Dec-2018	03-May-2019	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152) S04 0-10, S18 0-10,	S04 10-30, S18 10-30	05-Nov-2018	----	----	----	17-Dec-2018	04-May-2019	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152) S01 0-10, S10 0-10, S17 0-10, S19 0-10,	S01 10-30, S10 10-30, S17 10-30, S19 10-30	06-Nov-2018	----	----	----	17-Dec-2018	05-May-2019	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152) S03 0-10, S05 0-10,	S03 10-30, S05 10-30	07-Nov-2018	----	----	----	17-Dec-2018	06-May-2019	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152) S13 0-10,	S13 10-30	30-Nov-2018	----	----	----	17-Dec-2018	29-May-2019	✓
ED008: Exchangeable Cations								
Amber Glass Bottle - Unpreserved (ED008) S07 0-10,	S07 10-20	04-Nov-2018	17-Dec-2018	02-Dec-2018	✗	17-Dec-2018	02-Dec-2018	✗
Amber Glass Bottle - Unpreserved (ED008) S04 0-10, S18 0-10,	S04 10-30, S18 10-30	05-Nov-2018	17-Dec-2018	03-Dec-2018	✗	17-Dec-2018	03-Dec-2018	✗
Amber Glass Bottle - Unpreserved (ED008) S01 0-10, S10 0-10, S17 0-10, S19 0-10,	S01 10-30, S10 10-30, S17 10-30, S19 10-30	06-Nov-2018	17-Dec-2018	04-Dec-2018	✗	17-Dec-2018	04-Dec-2018	✗
Amber Glass Bottle - Unpreserved (ED008) S03 0-10, S05 0-10,	S03 10-30, S05 10-30	07-Nov-2018	17-Dec-2018	05-Dec-2018	✗	17-Dec-2018	05-Dec-2018	✗
Amber Glass Bottle - Unpreserved (ED008) S13 0-10,	S13 10-30	30-Nov-2018	17-Dec-2018	28-Dec-2018	✓	17-Dec-2018	28-Dec-2018	✓

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Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED021: Bicarbonate Extractable Potassium (Colwell)								
Amber Glass Bottle - Unpreserved (ED021)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	14-Dec-2018	03-May-2019	✓	14-Dec-2018	03-May-2019	✓
Amber Glass Bottle - Unpreserved (ED021)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	14-Dec-2018	04-May-2019	✓	14-Dec-2018	04-May-2019	✓
Amber Glass Bottle - Unpreserved (ED021)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	14-Dec-2018	05-May-2019	✓	14-Dec-2018	05-May-2019	✓
Amber Glass Bottle - Unpreserved (ED021)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	14-Dec-2018	06-May-2019	✓	14-Dec-2018	06-May-2019	✓
Amber Glass Bottle - Unpreserved (ED021)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	14-Dec-2018	29-May-2019	✓	14-Dec-2018	29-May-2019	✓

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Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED047: Potassium Chloride Extractable Sulfur (KCl-40)								
Amber Glass Bottle - Unpreserved (ED047)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	14-Dec-2018	02-Dec-2018	✖	17-Dec-2018	02-Dec-2018	✖
Amber Glass Bottle - Unpreserved (ED047)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	14-Dec-2018	03-Dec-2018	✖	17-Dec-2018	03-Dec-2018	✖
Amber Glass Bottle - Unpreserved (ED047)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	14-Dec-2018	04-Dec-2018	✖	17-Dec-2018	04-Dec-2018	✖
Amber Glass Bottle - Unpreserved (ED047)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	14-Dec-2018	05-Dec-2018	✖	17-Dec-2018	05-Dec-2018	✖
Amber Glass Bottle - Unpreserved (ED047)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	14-Dec-2018	28-Dec-2018	✔	17-Dec-2018	28-Dec-2018	✔

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Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005T: Total Metals by ICP-AES								
Amber Glass Bottle - Unpreserved (EG005T)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	13-Dec-2018	03-May-2019	✓	13-Dec-2018	03-May-2019	✓
Amber Glass Bottle - Unpreserved (EG005T)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	13-Dec-2018	04-May-2019	✓	13-Dec-2018	04-May-2019	✓
Amber Glass Bottle - Unpreserved (EG005T)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	13-Dec-2018	05-May-2019	✓	13-Dec-2018	05-May-2019	✓
Amber Glass Bottle - Unpreserved (EG005T)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	13-Dec-2018	06-May-2019	✓	13-Dec-2018	06-May-2019	✓
Amber Glass Bottle - Unpreserved (EG005T)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	13-Dec-2018	29-May-2019	✓	13-Dec-2018	29-May-2019	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS								
Amber Glass Bottle - Unpreserved (EG035T)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	13-Dec-2018	02-Dec-2018	✖	13-Dec-2018	02-Dec-2018	✖
Amber Glass Bottle - Unpreserved (EG035T)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	13-Dec-2018	03-Dec-2018	✖	13-Dec-2018	03-Dec-2018	✖
Amber Glass Bottle - Unpreserved (EG035T)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	13-Dec-2018	04-Dec-2018	✖	13-Dec-2018	04-Dec-2018	✖
Amber Glass Bottle - Unpreserved (EG035T)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	13-Dec-2018	05-Dec-2018	✖	13-Dec-2018	05-Dec-2018	✖
Amber Glass Bottle - Unpreserved (EG035T)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	13-Dec-2018	28-Dec-2018	✔	13-Dec-2018	28-Dec-2018	✔

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Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Amber Glass Bottle - Unpreserved (EK080)								
S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	----	----	----	10-Dec-2018	03-May-2019	✓
Amber Glass Bottle - Unpreserved (EK080)								
S04 0-10, S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S04 10-30, S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	----	----	----	10-Dec-2018	04-May-2019	✓
Amber Glass Bottle - Unpreserved (EK080)								
S01 0-10, S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S01 10-30, S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	----	----	----	10-Dec-2018	05-May-2019	✓
Amber Glass Bottle - Unpreserved (EK080)								
S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	----	----	----	10-Dec-2018	06-May-2019	✓
Amber Glass Bottle - Unpreserved (EK080)								
S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	----	----	----	10-Dec-2018	29-May-2019	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EN60: Bottle Leaching Procedure								
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	13-Dec-2018	02-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S04 0-10, S06 0-10,	S04 10-30, S06 10-30	05-Nov-2018	12-Dec-2018	03-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	13-Dec-2018	03-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S01 0-10,	S01 10-30	06-Nov-2018	12-Dec-2018	04-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	13-Dec-2018	04-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	12-Dec-2018	05-Dec-2018	✖	----	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-D1a) S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	13-Dec-2018	28-Dec-2018	✔	----	----	----



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP004: Organic Matter								
Amber Glass Bottle - Unpreserved (EP004) S07 0-10, S12 0-10,	S07 10-20, S12 10-30	04-Nov-2018	15-Dec-2018	11-Nov-2018	✖	17-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S04 0-10,	S04 10-30	05-Nov-2018	15-Dec-2018	12-Nov-2018	✖	15-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S06 0-10, S08 0-10, S09 0-10, S16 0-10, S18 0-10,	S06 10-30, S08 10-30, S09 10-30, S16 10-30, S18 10-30	05-Nov-2018	15-Dec-2018	12-Nov-2018	✖	17-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S01 0-10,	S01 10-30	06-Nov-2018	15-Dec-2018	13-Nov-2018	✖	15-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S10 0-10, S11 0-10, S17 0-10, S19 0-10, S20 0-10,	S10 10-30, S11 10-30, S17 10-30, S19 10-30, S20 10-30	06-Nov-2018	15-Dec-2018	13-Nov-2018	✖	17-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S02 0-10, S03 0-10, S05 0-10,	S02 10-30, S03 10-30, S05 10-30	07-Nov-2018	15-Dec-2018	14-Nov-2018	✖	15-Dec-2018	12-Jan-2019	✔
Amber Glass Bottle - Unpreserved (EP004) S13 0-10, S14 0-10, S15 0-10,	S13 10-30, S14 10-30, S15 10-30	30-Nov-2018	15-Dec-2018	07-Dec-2018	✖	17-Dec-2018	12-Jan-2019	✔

Matrix: **WATER**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Evaluation	Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation		Date analysed	Due for analysis	Evaluation
EG020W: Water Leachable Metals by ICP-MS									
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-W)		12-Dec-2018	17-Dec-2018	10-Jun-2019	✓	17-Dec-2018	10-Jun-2019	✓	
S01 0-10,	S01 10-30,								
S02 0-10,	S02 10-30,								
S03 0-10,	S03 10-30,								
S04 0-10,	S04 10-30,								
S05 0-10,	S05 10-30,								
S06 0-10,	S06 10-30,								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-W)		13-Dec-2018	17-Dec-2018	11-Jun-2019	✓	17-Dec-2018	11-Jun-2019	✓	
S07 0-10,	S07 10-20,								
S08 0-10,	S08 10-30,								
S09 0-10,	S09 10-30,								
S10 0-10,	S10 10-30,								
S11 0-10,	S11 10-30,								
S12 0-10,	S12 10-30,								
S13 0-10,	S13 10-30,								
S14 0-10,	S14 10-30,								
S15 0-10,	S15 10-30,								
S16 0-10,	S16 10-30,								
S17 0-10,	S17 10-30,								
S18 0-10,	S18 10-30,								
S19 0-10,	S19 10-30,								
S20 0-10,	S20 10-30,								



Matrix: **WATER**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EG035W: Water Leachable Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035W)	12-Dec-2018	----	----	----	14-Dec-2018	09-Jan-2019	✔	
S01 0-10, S02 0-10, S03 0-10, S04 0-10, S05 0-10, S06 0-10,	S01 10-30, S02 10-30, S03 10-30, S04 10-30, S05 10-30, S06 10-30							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035W)	13-Dec-2018	----	----	----	17-Dec-2018	10-Jan-2019	✔	
S07 0-10, S08 0-10, S09 0-10, S10 0-10, S11 0-10, S12 0-10, S13 0-10, S14 0-10, S15 0-10, S16 0-10, S17 0-10, S18 0-10, S19 0-10, S20 0-10,	S07 10-20, S08 10-30, S09 10-30, S10 10-30, S11 10-30, S12 10-30, S13 10-30, S14 10-30, S15 10-30, S16 10-30, S17 10-30, S18 10-30, S19 10-30, S20 10-30							



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Bicarbonate Extractable K (Colwell)	ED021	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Bicarbonate Extractable P (Colwell)	EK080	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	6	52	11.54	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Organic Matter	EP004	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH in soil using a 0.01M CaCl2 extract	EA001	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Potassium Chloride Extractable Sulfur (KCl-40)	ED047	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	6	53	11.32	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	6	54	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Bicarbonate Extractable P (Colwell)	EK080	6	40	15.00	15.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organic Matter	EP004	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH in soil using a 0.01M CaCl2 extract	EA001	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Potassium Chloride Extractable Sulfur (KCl-40)	ED047	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	53	5.66	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	54	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Bicarbonate Extractable K (Colwell)	ED021	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Bicarbonate Extractable P (Colwell)	EK080	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organic Matter	EP004	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Potassium Chloride Extractable Sulfur (KCl-40)	ED047	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	53	5.66	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	54	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Bicarbonate Extractable P (Colwell)	EK080	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	53	5.66	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	54	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.



Matrix: **WATER**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Water Leachable Mercury by FIMS	EG035W	5	40	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	5	40	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Water Leachable Mercury by FIMS	EG035W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Water Leachable Mercury by FIMS	EG035W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Water Leachable Mercury by FIMS	EG035W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	3	40	7.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH in soil using a 0.01M CaCl ₂ extract	EA001	SOIL	In house: Referenced to Rayment and Lyons (2011) 4B3 (mod.) or 4B4 (mod.) 10 g of soil is mixed with 50 mL of 0.01M CaCl ₂ and tumbled end over end for 1 hour. pH is measured from the continuous suspension. This method is compliant with NEPM (2013) Schedule B(3)
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3 - 2003
Soil Particle Density	* EA152	SOIL	Soil Particle Density by AS 1289.3.5.1-2006 : Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Exchangeable Cations with pre-treatment	ED008	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 15A2. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Bicarbonate Extractable K (Colwell)	ED021	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 18A1 Potassium is extracted from the soil using 0.5M NaHCO ₃ at a 1:100 soil:solution ratio and determined by ICP.
Potassium Chloride Extractable Sulfur (KCl-40)	* ED047	SOIL	In house: Referenced to Rayment and Lyons (2011), method 10D1. ALS is not NATA accredited for this testing procedure.
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, AS 4439.3, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)



Analytical Methods	Method	Matrix	Method Descriptions
Water Leachable Mercury by FIMS	EG035W	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the TCLP solution. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Bicarbonate Extractable P (Colwell)	EK080	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 9B1 Phosphorus is extracted from the soil using 0.5M NaHCO ₃ at a 1:100 soil:solution ratio and determined by FIA.
Organic Matter	EP004	SOIL	In house: Referenced to AS1289.4.1.1 - 1997. Dichromate oxidation method after Walkley and Black. This method is compliant with NEPM (2013) Schedule B(3).
Preparation Methods	Method	Matrix	Method Descriptions
pH in soil using a 0.01M CaCl ₂ extract	EA001-PR	SOIL	In house: Referenced to Rayment and Higginson 4B1, 10 g of soil is mixed with 50 mL of 0.01M CaCl ₂ and tumbled end over end for 1 hour. pH is measured from the continuous suspension. This method is compliant with NEPM (2013) Schedule B(3) (Method 103)
Exchangeable Cations Preparation Method	ED007PR	SOIL	In house: Referenced to Rayment & Higginson (1992) method 15A1. A 1M NH ₄ Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
Bicarbonate Extractable K (Colwell)	ED021PR	SOIL	In house: Referenced to Rayment & Higginson (1992) Method 18A1 Potassium is extracted from the soil using 0.5M NaHCO ₃ at a 1:100 soil:solution ratio and determined by ICP.
KCl-40 Extractable Sulfur Preparation	ED047-PR	SOIL	KCl-40 Extractable Sulfur Preparation
Digestion for Total Recoverable Metals in DI Water Leachate	EN25W	SOIL	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Deionised Water Leach	EN60-Dia	SOIL	In house QWI-EN/60 referenced to AS4439.3 Preparation of Leachates
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)
Organic Matter	EP004-PR	SOIL	In house: Referenced to AS1289.4.1.1 - 1997. Dichromate oxidation method after Walkley and Black. This method is compliant with NEPM (2013) Schedule B(3) (Method 105)

**SAMPLE RECEIPT NOTIFICATION (SRN)****Work Order : EP1814230****Client : STANTEC AUSTRALIA PTY LTD**

Project : LROE-SA-18002 SS
Order number : S0433
C-O-C number : ----
Site : ----
Sampler : SAM LOSTROM

Page : 1 of 22
Quote number : EP2018MWH AUS0007 (EP/619/18)
QC Level : NEPM 2013 B3 & ALS QC Standard

Dates

Date Samples Received : 04-Dec-2018 15:40
Client Requested Due : 17-Dec-2018
Date

Issue Date : 06-Dec-2018
Scheduled Reporting Date : **17-Dec-2018**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 2
Receipt Detail :

Security Seal : Intact.
Temperature : 15.8 - Ice Bricks present
No. of samples received / analysed : 40 / 40

General Comments

- This report contains the following information:
 - Sample Container(s)/Preservation Non-Compliances
 - Summary of Sample(s) and Requested Analysis
 - Proactive Holding Time Report
 - Requested Deliverables
- Please see scanned COC for sample discrepancies: extra samples , samples not received etc.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (SamplesPerth@alsenviro.com)
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **Colwell P and K, and KCL Extractable Sulfur analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818.**
- **PSD analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911.**
- **pH analysis should be conducted within 6 hours of sampling.**



Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Bicarbonate Extractable K (Colwell) : ED021		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Bicarbonate Extractable K (Colwell) : ED021		
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Bicarbonate Extractable P (Colwell) : EK080		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Bicarbonate Extractable P (Colwell) : EK080		
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Electrical Conductivity (1:5) : EA010		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Electrical Conductivity (1:5) : EA010		
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Exchangeable Cations with pre-treatment : ED008		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Moisture Content : EA055		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Moisture Content : EA055		
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Organic Matter : EP004		



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Organic Matter : EP004		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Organic Matter : EP004		
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
pH (1:5) : EA002		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
pH (1:5) : EA002		
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
pH in soil using a 0.01M CaCl2 extract : EA001		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
pH in soil using a 0.01M CaCl₂ extract : EA001		
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Potassium Chloride Extractable Sulfur (KCl-40) : ED047		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Potassium Chloride Extractable Sulfur (KCI-40) : ED047		
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Potassium Chloride Extractable Sulfur (KCI-40) : ED047		
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Total Mercury by FIMS : EG035T		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Total Mercury by FIMS : EG035T		
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
Total Metals by ICP-AES : EG005T		
S01 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S01 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S02 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S03 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S04 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S05 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S06 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved



Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Total Metals by ICP-AES : EG005T		
S07 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S07 10-20	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S08 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S09 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S10 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S11 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S12 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S13 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S14 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S15 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S16 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S17 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S18 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S19 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 0-10	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved
S20 10-30	- Amber Glass Bottle - Unpreserved	- Soil Glass Jar - Unpreserved

Summary of Sample(s) and Requested Analysis



Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA001 pH (CaCl)	SOIL - EA055-103 Moisture Content	SOIL - ED008 Def Exchangeable Cations with pre-treatment -	SOIL - EP004 (Carbon) Organic Matter & Total Organic Carbon (Calc.)	SOIL - IN-4S pH plus EC (1:5)	SOIL - MIS-SOL Miscellaneous Subcontracted Analysis (Solid)	SOIL - S-03 15 Metals (NEPM 2013 Suite - incl. Digestion)
EP1814230-001	06-Nov-2018 00:00	S01 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-002	06-Nov-2018 00:00	S01 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-003	07-Nov-2018 00:00	S02 0-10	✓	✓		✓	✓	✓	✓
EP1814230-004	07-Nov-2018 00:00	S02 10-30	✓	✓		✓	✓	✓	✓
EP1814230-005	07-Nov-2018 00:00	S03 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-006	07-Nov-2018 00:00	S03 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-007	05-Nov-2018 00:00	S04 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-008	05-Nov-2018 00:00	S04 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-009	07-Nov-2018 00:00	S05 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-010	07-Nov-2018 00:00	S05 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-011	05-Nov-2018 00:00	S06 0-10	✓	✓		✓	✓	✓	✓
EP1814230-012	05-Nov-2018 00:00	S06 10-30	✓	✓		✓	✓	✓	✓
EP1814230-013	04-Nov-2018 00:00	S07 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-014	04-Nov-2018 00:00	S07 10-20	✓	✓	✓	✓	✓	✓	✓
EP1814230-015	05-Nov-2018 00:00	S08 0-10	✓	✓		✓	✓	✓	✓
EP1814230-016	05-Nov-2018 00:00	S08 10-30	✓	✓		✓	✓	✓	✓
EP1814230-017	05-Nov-2018 00:00	S09 0-10	✓	✓		✓	✓	✓	✓
EP1814230-018	05-Nov-2018 00:00	S09 10-30	✓	✓		✓	✓	✓	✓
EP1814230-019	06-Nov-2018 00:00	S10 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-020	06-Nov-2018 00:00	S10 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-021	06-Nov-2018 00:00	S11 0-10	✓	✓		✓	✓	✓	✓
EP1814230-022	06-Nov-2018 00:00	S11 10-30	✓	✓		✓	✓	✓	✓
EP1814230-023	04-Nov-2018 00:00	S12 0-10	✓	✓		✓	✓	✓	✓
EP1814230-024	04-Nov-2018 00:00	S12 10-30	✓	✓		✓	✓	✓	✓
EP1814230-025	30-Nov-2018 00:00	S13 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-026	30-Nov-2018 00:00	S13 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-027	30-Nov-2018 00:00	S14 0-10	✓	✓		✓	✓	✓	✓
EP1814230-028	30-Nov-2018 00:00	S14 10-30	✓	✓		✓	✓	✓	✓
EP1814230-029	30-Nov-2018 00:00	S15 0-10	✓	✓		✓	✓	✓	✓
EP1814230-030	30-Nov-2018 00:00	S15 10-30	✓	✓		✓	✓	✓	✓
EP1814230-031	05-Nov-2018 00:00	S16 0-10	✓	✓		✓	✓	✓	✓
EP1814230-032	05-Nov-2018 00:00	S16 10-30	✓	✓		✓	✓	✓	✓
EP1814230-033	06-Nov-2018 00:00	S17 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-034	06-Nov-2018 00:00	S17 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-035	05-Nov-2018 00:00	S18 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-036	05-Nov-2018 00:00	S18 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-037	06-Nov-2018 00:00	S19 0-10	✓	✓	✓	✓	✓	✓	✓
EP1814230-038	06-Nov-2018 00:00	S19 10-30	✓	✓	✓	✓	✓	✓	✓
EP1814230-039	06-Nov-2018 00:00	S20 0-10	✓	✓		✓	✓	✓	✓
EP1814230-040	06-Nov-2018 00:00	S20 10-30	✓	✓		✓	✓	✓	✓



Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA150H-Y Particle Size Analysis by Hydrometer: Yellow	SOIL - ED047 Potassium Chloride Extractable Sulfur (KCL-40)	SOIL - EG020W Water Leachable Metals by ICPMS	SOIL - EN60-D1a Deionised Water Leach	SOIL - IN-6S Colwell P and K	SOIL - W-02W (ICPMS) 8 Metals (Water Leachable) ICPMS & FIMS
EP1814230-001	06-Nov-2018 00:00	S01 0-10	✓	✓	✓	✓	✓	✓
EP1814230-002	06-Nov-2018 00:00	S01 10-30	✓	✓	✓	✓	✓	✓
EP1814230-003	07-Nov-2018 00:00	S02 0-10		✓	✓	✓	✓	✓
EP1814230-004	07-Nov-2018 00:00	S02 10-30		✓	✓	✓	✓	✓
EP1814230-005	07-Nov-2018 00:00	S03 0-10	✓	✓	✓	✓	✓	✓
EP1814230-006	07-Nov-2018 00:00	S03 10-30	✓	✓	✓	✓	✓	✓
EP1814230-007	05-Nov-2018 00:00	S04 0-10	✓	✓	✓	✓	✓	✓
EP1814230-008	05-Nov-2018 00:00	S04 10-30	✓	✓	✓	✓	✓	✓
EP1814230-009	07-Nov-2018 00:00	S05 0-10	✓	✓	✓	✓	✓	✓
EP1814230-010	07-Nov-2018 00:00	S05 10-30	✓	✓	✓	✓	✓	✓
EP1814230-011	05-Nov-2018 00:00	S06 0-10		✓	✓	✓	✓	✓
EP1814230-012	05-Nov-2018 00:00	S06 10-30		✓	✓	✓	✓	✓
EP1814230-013	04-Nov-2018 00:00	S07 0-10	✓	✓	✓	✓	✓	✓
EP1814230-014	04-Nov-2018 00:00	S07 10-20	✓	✓	✓	✓	✓	✓
EP1814230-015	05-Nov-2018 00:00	S08 0-10		✓	✓	✓	✓	✓
EP1814230-016	05-Nov-2018 00:00	S08 10-30		✓	✓	✓	✓	✓
EP1814230-017	05-Nov-2018 00:00	S09 0-10		✓	✓	✓	✓	✓
EP1814230-018	05-Nov-2018 00:00	S09 10-30		✓	✓	✓	✓	✓
EP1814230-019	06-Nov-2018 00:00	S10 0-10	✓	✓	✓	✓	✓	✓
EP1814230-020	06-Nov-2018 00:00	S10 10-30	✓	✓	✓	✓	✓	✓
EP1814230-021	06-Nov-2018 00:00	S11 0-10		✓	✓	✓	✓	✓
EP1814230-022	06-Nov-2018 00:00	S11 10-30		✓	✓	✓	✓	✓
EP1814230-023	04-Nov-2018 00:00	S12 0-10		✓	✓	✓	✓	✓
EP1814230-024	04-Nov-2018 00:00	S12 10-30		✓	✓	✓	✓	✓
EP1814230-025	30-Nov-2018 00:00	S13 0-10	✓	✓	✓	✓	✓	✓
EP1814230-026	30-Nov-2018 00:00	S13 10-30	✓	✓	✓	✓	✓	✓
EP1814230-027	30-Nov-2018 00:00	S14 0-10		✓	✓	✓	✓	✓
EP1814230-028	30-Nov-2018 00:00	S14 10-30		✓	✓	✓	✓	✓
EP1814230-029	30-Nov-2018 00:00	S15 0-10		✓	✓	✓	✓	✓
EP1814230-030	30-Nov-2018 00:00	S15 10-30		✓	✓	✓	✓	✓
EP1814230-031	05-Nov-2018 00:00	S16 0-10		✓	✓	✓	✓	✓
EP1814230-032	05-Nov-2018 00:00	S16 10-30		✓	✓	✓	✓	✓
EP1814230-033	06-Nov-2018 00:00	S17 0-10	✓	✓	✓	✓	✓	✓
EP1814230-034	06-Nov-2018 00:00	S17 10-30	✓	✓	✓	✓	✓	✓
EP1814230-035	05-Nov-2018 00:00	S18 0-10	✓	✓	✓	✓	✓	✓
EP1814230-036	05-Nov-2018 00:00	S18 10-30	✓	✓	✓	✓	✓	✓
EP1814230-037	06-Nov-2018 00:00	S19 0-10	✓	✓	✓	✓	✓	✓
EP1814230-038	06-Nov-2018 00:00	S19 10-30	✓	✓	✓	✓	✓	✓
EP1814230-039	06-Nov-2018 00:00	S20 0-10		✓	✓	✓	✓	✓
EP1814230-040	06-Nov-2018 00:00	S20 10-30		✓	✓	✓	✓	✓



Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received		Instructions Received	
				Date	Evaluation	Date	Evaluation
EA001: pH in soil using a 0.01M CaCl2 extract							
S01 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S01 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S02 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S02 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S03 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S03 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S04 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S04 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S05 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S05 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S06 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S06 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S07 0-10	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S07 10-20	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S08 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S08 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S09 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S09 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S10 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S10 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S11 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S11 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S12 0-10	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S12 10-30	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S16 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S16 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S17 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S17 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S18 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S18 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S19 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S19 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S20 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S20 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
EA002: pH (1:5)							
S01 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S01 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S02 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S02 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S03 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S03 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S04 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S04 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S05 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S05 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	14-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S06 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S06 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S07 0-10	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S07 10-20	Amber Glass Bottle - Unpreserv	11-Nov-2018	11-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S08 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S08 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S09 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S09 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	12-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S10 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S10 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S11 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖
S11 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	13-Nov-2018	04-Dec-2018	✖	06-Dec-2018	✖

[illegible]

[illegible]

[illegible]



S17 0-10	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
S17 10-30	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
S18 0-10	Non-Volatile Leach: 28 day HT(€	03-Dec-2018	----	04-Dec-2018	✗	06-Dec-2018	✗
S18 10-30	Non-Volatile Leach: 28 day HT(€	03-Dec-2018	----	04-Dec-2018	✗	06-Dec-2018	✗
S19 0-10	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
S19 10-30	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
S20 0-10	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
S20 10-30	Non-Volatile Leach: 28 day HT(€	04-Dec-2018	----	04-Dec-2018	✓	06-Dec-2018	✗
EP004: Organic Matter							
S01 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S01 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S02 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S02 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S03 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S03 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S04 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S04 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S05 0-10	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S05 10-30	Amber Glass Bottle - Unpreserv	14-Nov-2018	12-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S06 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S06 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S07 0-10	Amber Glass Bottle - Unpreserv	11-Nov-2018	09-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S07 10-20	Amber Glass Bottle - Unpreserv	11-Nov-2018	09-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S08 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S08 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S09 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S09 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S10 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S10 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S11 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S11 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S12 0-10	Amber Glass Bottle - Unpreserv	11-Nov-2018	09-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S12 10-30	Amber Glass Bottle - Unpreserv	11-Nov-2018	09-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S16 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S16 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S17 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S17 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S18 0-10	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S18 10-30	Amber Glass Bottle - Unpreserv	12-Nov-2018	10-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S19 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S19 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S20 0-10	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗
S20 10-30	Amber Glass Bottle - Unpreserv	13-Nov-2018	11-Dec-2018	04-Dec-2018	✗	06-Dec-2018	✗

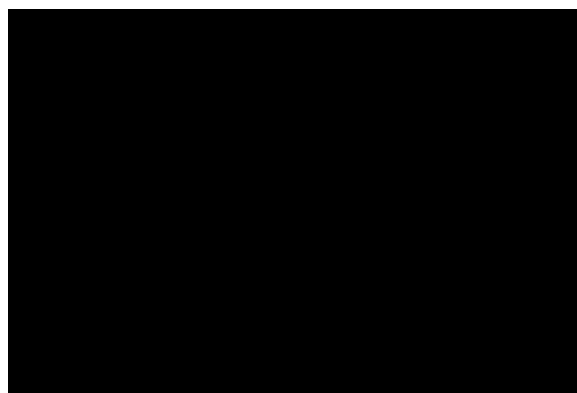
Requested Deliverables

ACCOUNTS ADDRESS

- A4 - AU Tax Invoice (INV)

Bronwyn Smedley

- *AU Certificate of Analysis - NATA (COA)
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)
- Attachment - Report (SUBCO)
- Chain of Custody (CoC) (COC)
- EDI Format - ENMRG (ENMRG)
- EDI Format - ESDAT (ESDAT)
- EDI Format - XTab (XTAB)



CERTIFICATE OF ANALYSIS

Batch: EP1814230

CLIENT: Stantec Australia PTY LTD

LABORATORY: ALSE Perth
DATE RECEIVED: 04/12/2018

DATE COMPLETED: 17/12/2018
SAMPLE TYPE: Soil
No. of SAMPLES: 40

COMMENTS

1. Samples extracted using 2M KCl fluid at ratio 1:10 for 1 hour.
2. Nitrate as Nitrate and Ammonium as Ammonium results in this report is not covered by NATA accreditation.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number.
Results apply to sample(s) as submitted. All pages to this report have been checked and approved for release.

ISSUING LABORATORY: ALS Perth

Sample ID	EP1814230-001	EP1814230-001	% RPD
Sample Name	S01 0-10	Duplicate	
Sample Date	6/11/2018 0:00	6/11/2018 0:00	
NO3_NO3 mg/kg	6.2	5.9	5
NH4_NH4 mg/kg	0.2	0.2	14

Sample ID	EP1814230-002	EP1814230-002	% Recovery	EP1814230-003	EP1814230-004
Sample Name	S01 10-30	Matrix Spike		S02 0-10	S02 10-30
Sample Date	6/11/2018 0:00	6/11/2018 0:00		7/11/2018 0:00	7/11/2018 0:00
NO3_NO3 mg/kg	2.1	20	81	0.4	0.5
NH4_NH4 mg/kg	0.1	12	93	0.4	<0.1

Sample ID	EP1814230-005	EP1814230-006	EP1814230-007	EP1814230-008	EP1814230-009
Sample Name	S03 0-10	S03 10-30	S04 0-10	S04 10-30	S05 0-10
Sample Date	7/11/2018 0:00	7/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00	7/11/2018 0:00
NO3_NO3 mg/kg	9.7	4.2	2.5	<0.1	0.3
NH4_NH4 mg/kg	0.3	<0.1	0.7	1.4	2.1



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Sample ID	EP1814230-010	EP1814230-011	EP1814230-011	% RPD	EP1814230-012
Sample Name	S05 10-30	S06 0-10	Duplicate		S06 10-30
Sample Date	7/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00		5/11/2018 0:00
NO3_NO3 mg/kg	3.0	3.3	3.4	5	4.0
NH4_NH4 mg/kg	0.1	<0.1	<0.1	0	<0.1

Sample ID	EP1814230-013	EP1814230-014	EP1814230-015	EP1814230-016	EP1814230-017
Sample Name	S07 0-10	S07 10-20	S08 0-10	S08 10-30	S09 0-10
Sample Date	4/11/2018 0:00	4/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00
NO3_NO3 mg/kg	8.6	4.8	12	3.6	3.3
NH4_NH4mg/kg	0.2	<0.1	<0.1	<0.1	1.4

Sample ID	EP1814230-018	EP1814230-019	EP1814230-020
Sample Name	S09 10-30	S10 0-10	S10 10-30
Sample Date	5/11/2018 0:00	6/11/2018 0:00	6/11/2018 0:00
NO3_NO3 mg/kg	1.2	4.5	0.4
NH4_NH4 mg/kg	<0.1	<0.1	<0.1

Sample ID	EP1814230-021	EP1814230-021	% RPD
Sample Name	S11 0-10	Duplicate	
Sample Date	6/11/2018 0:00	6/11/2018 0:00	
NO3_NO3 mg/kg	4.1	4.2	1
NH4_NH4 mg/kg	<0.1	<0.1	0

Sample ID	EP1814230-022	EP1814230-022	% Recovery	EP1814230-023	EP1814230-024
Sample Name	S11 10-30	Matrix Spike		S12 0-10	S12 10-30
Sample Date	6/11/2018 0:00	6/11/2018 0:00		4/11/2018 0:00	4/11/2018 0:00
NO3_NO3 mg/kg	14	33	83	7.7	157
NH4_NH4 mg/kg	0.1	12	94	0.3	0.7

Sample ID	EP1814230-025	EP1814230-026	EP1814230-027	EP1814230-028	EP1814230-029
Sample Name	S13 0-10	S13 10-30	S14 0-10	S14 10-30	S15 0-10
Sample Date	30/11/2018 0:00	30/11/2018 0:00	30/11/2018 0:00	30/11/2018 0:00	30/11/2018 0:00
NO3_NO3 mg/kg	0.2	2.3	1.3	4.8	1.9
NH4_NH4 mg/kg	0.5	0.2	0.6	<0.1	0.7

Sample ID	EP1814230-030	EP1814230-031	EP1814230-031	% RPD	EP1814230-032
Sample Name	S15 10-30	S16 0-10	Duplicate		S16 10-30
Sample Date	30/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00		5/11/2018 0:00
NO3_NO3 mg/kg	18	1.4	1.6	12	<0.1
NH4_NH4 mg/kg	<0.1	<0.1	0.1	0	<0.1

Sample ID	EP1814230-033	EP1814230-034	EP1814230-035	EP1814230-036	EP1814230-037
Sample Name	S17 0-10	S17 10-30	S18 0-10	S18 10-30	S19 0-10
Sample Date	6/11/2018 0:00	6/11/2018 0:00	5/11/2018 0:00	5/11/2018 0:00	6/11/2018 0:00
NO3_NO3 mg/kg	0.7	0.9	2.0	0.8	2.5
NH4_NH4 mg/kg	0.4	0.3	<0.1	0.2	1.2

Sample ID	EP1814230-038	EP1814230-039	EP1814230-040
Sample Name	S19 10-30	S20 0-10	S20 10-30
Sample Date	6/11/2018 0:00	6/11/2018 0:00	6/11/2018 0:00
NO3_NO3 mg/kg	2.9	5.9	2.3
NH4_NH4 mg/kg	0.3	1.0	<0.1



Sample ID	MB	LCS	Recovery
NO3_NO3 mg/kg	<1	18	80%
NH4_NH4 mg/kg	<0.1	12.0	93%

Sample ID	MB	LCS	Recovery
NO3_NO3 mg/kg	<1	17	78%
NH4_NH4 mg/kg	<0.1	11.8	92%



Appendix E Laboratory and Analytical Method Descriptions

E.1 Soil Physical Characteristics

The soil physical properties were determined using a combination of testwork procedures including:

- soil texture and particle size distribution;
- soil structure and structural stability;
- soil strength;
- hydraulic conductivity; and
- water retention.

Soil texture was determined through a combination of particle size distribution and field texture measurements. Particle size distribution is a measurement of the proportions of sand (0.02 to 2.00 mm), silt (0.002 to 0.02 mm) and clay (<0.002 mm) particles in a sample. The measured proportions are compared to the Australian texture triangle (McDonald *et al.* 1998). Field texture is determined by working the soil size fraction (<2 mm) of the material by hand using the method described in McDonald *et al.* (1998). The soil coarse material fraction (particles greater than 2 mm) was determined gravimetrically. The soil texture class influences most physical and many chemical and biological processes. Soil structure, water holding capacity, hydraulic conductivity, soil strength, fertility, erodibility and susceptibility to compaction are some of the factors closely linked to soil texture. The percentage of coarse material can provide information on the ability of the material to withstand mechanical breakdown and erosion.

Soil structure describes the arrangement of solid particles and void space in a soil. The structure of a soil influences the ability of soil to support plant growth, store and transmit water and resist erosional processes. Soil structure is described through physical examination of the soil. It can be influenced by the particle size distribution, chemical composition and organic matter content, and is often affected by root growth, vehicle compaction, and with respect to reconstructed soil profiles, the methods of soil handling and deposition. A well-structured soil is one with a range of different sized aggregates; with component particles bound together to give a range of pore sizes facilitating root growth and the transfer of air and water. When a soil material is disturbed, the breakdown of aggregates into primary particles can lead to structural decline (Needham *et al.* 1998). This can result in hardsetting and crusting at the soil surface and a 'massive' soil structure at depth, which potentially reduces the ability of seeds to germinate, roots to penetrate the soil matrix, and water to infiltrate to the root zone.

The structural stability of a soil and its susceptibility to structural decline can be complex and the tendency for a soil to remain stable, or to become structurally unstable depends on the net effect of a number of properties, including the amount and type of clay present, organic matter content, soil chemistry and the nature of disturbance. Soil aggregates that are unstable and will readily slake and disperse indicate a weak soil structure that is easily degraded. These soils are regarded as potentially problematic from an erosion perspective and unsuitable for use in the reconstruction of soil profiles for rehabilitation, particularly if left exposed at the surface. Structural stability of a soil is measured using the Emerson Aggregate Test which identifies the potential slaking and dispersive properties of soil aggregates under a worst-case scenario. Severe stress is applied to the soil material through wetting and saturation. The soils are rated into classes using the method described Soil Guide: A Handbook for understanding and managing agricultural soils (Moore 1998). Generally, samples allocated into Emerson Classes 1 and 2 are those most likely to exhibit dispersive properties and therefore be the most problematic with respect of soil erosion.

Soil strength is determined using the modulus of rupture (MOR) test which identifies the tendency for the soil fraction (<2 mm) of material to hardset as a direct result of soil slaking and dispersion. An average MOR of >60 kPa has been described as the critical value for distinguishing potentially problematic soils in agricultural scenarios (Cochrane and Aylmore 1997). If placed in near surface soil profiles, materials with high MOR may restrict root penetration and impact germination and emergence of some vegetation. As the MOR test is conducted on reconstructed soil blocks composed of the <2 mm soil fraction, it does not take into account the effect of coarse material content or soil structure on soil strength, nor any degree of compaction that may naturally occur under field conditions. It does, however, provide insight into the potential for soil layers to hardset and compact with repeated wetting and drying cycles, and the ability of roots to fracture the soil and penetrate crack faces.

The saturated hydraulic conductivity (K_{sat}) refers to the permeability of soil, or the ability of water to infiltrate and drain through the soil matrix and is dependent on soil properties such as texture and structure (Hunt and Gilkes 1992; Hazelton and Murphy 2007; Moore 1998). Freely draining soils with high K_{sat} values (62.5 to >250.0 mm/hr) promote infiltration and are generally less susceptible to surface runoff and erosion. Slow draining soils with low K_{sat} values (0 to 5.0 mm/hr), are more likely to experience waterlogging, increased surface runoff and erosion. To determine saturated hydraulic conductivity, selected samples were collected in bulk in the field, and re-packed to approximate field bulk density. Drainage classes were determined for each sample according to their K_{sat} (Hunt and Gilkes 1992).

The water retention properties of soil materials are important for determining the amount of water available for plant growth when soil materials are intended for use in rehabilitation. It can also give an indication of the potential for soil to hold water and release it through evaporation. In low-nutrient environments, common to most of arid zone Australia, the amount of water available to plants is often the most limiting factor to vegetation establishment and growth. The water retention or water holding capacity of a soil is influenced by a number of factors, with the particle size (and pore space) distribution, soil structure and organic matter content being the most influential. Soil water retention is measured through pressurising samples. As the pressure increases the amount of water that is held within the pores of the soil is reduced. The soil water (% volume) at 10 kPa is considered to represent water holding potential at field capacity, or the soil upper storage limit [USL] and the soil water at 1500 kPa is considered to represent water holding potential at wilting point (lower storage limit [LSL]) of the soil. Field capacity is representative of the percentage of water remaining in a soil two or three days after it has been saturated and free drainage has practically ceased. Wilting point is the percentage of water in the soil at which plants wilt and fail to recover. The difference between the USL and LSL is referred to as the plant-available water (PAW) and is measured as percent of soil volume.

E.2 Soil Chemical Characteristics

The soil chemical properties were determined using a combination of testwork procedures including:

- soil pH in water and calcium chloride;
- soil salinity;
- exchangeable cations;
- exchangeable sodium percentage (ESP); and
- plant-available nutrients.

The soil pH provides a measure of the activity of hydrogen ions in a soil solution made from a 1:5 soil to liquid suspension. Ratings are assigned from very strongly acidic to strongly alkaline based on the recorded pH measured in deionised water (pH_w) and other solutions (Van Gool, Tille, and Moore 2005). Soil pH is often measured in 0.01 M calcium chloride (pH_{Ca}), which is considered to be a more accurate measurement of hydrogen ion concentration present in a natural soil solution under similar conditions to soil solution taken up by plants (Hunt and Gilkes 1992). The soil pH measured in $CaCl_2$ is usually lower than pH measured in water; and both measurements are taken for a complete assessment. The ideal pH range for plant growth of most agricultural species is considered to be between 5.0 and 7.5 (Moore 1998). Outside this range, the plant-availability of some nutrients can be affected, while various metal toxicities (e.g. aluminium and manganese) can become limiting to plant growth at low pH. For native species, which are known to be tolerant of wider ranges in soil pH, preferred pH ranges are best inferred from the natural, undisturbed soil in which they are observed to occur.

Soil salinity, or electrical conductivity (EC) is a measure of the amount of readily soluble salts in soil and soil pore water (Moore 1998). The salinity is measured from a soil solution made from a 1:5 soil to deionised water suspension. Soil salinity classes are rated from non-saline to extremely saline based on the measured EC (recorded in dS/m) and the soil texture. The classes used for rating are equivalent to those commonly used by the United States Department of Agriculture (USDA) and Commonwealth Scientific and Industrial Research Organisation (CSIRO). Soil salinity can limit plant growth and impact soil structural stability. The measured salinity of a soil is influenced by natural processes of landscape evolution, hydrological processes and rainfall (Hunt and Gilkes 1992) and may also be affected by anthropogenic processes such as water application for dust suppression, leaching and seepage from water bodies and infrastructure.

Exchangeable cations held on clay particle surfaces and within organic matter are an important source of soil fertility and can influence the physical properties of soil. Generally, if cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}) and potassium (K^+) are the dominant ions on the exchange surfaces, the soil will typically display increased physical structure and stability, which aids aeration, drainage and root growth

(Moore 1998). If sodium cations (Na^+) are dominant on exchange surfaces and the exchangeable sodium percentage (ESP) exceeds more than 6% of the total exchangeable cations, then the soil is considered to be sodic, which can lead to poor physical properties such as increased dispersion upon wetting, hardsetting at the soil surface and increased erosion in soils, particularly when placed on sloped surfaces of constructed landforms. If ESP exceeds 15%, then the soil is considered to be highly sodic (Moore 1998). The effective cation exchange capacity (eCEC), or the sum of total cations that can be held for exchange on the soil surfaces is used to determine the exchange capacity of the soil (which is typically related to clay and organic matter content).

Soil nutrients are important for plant growth and health. The most important macronutrients are nitrogen (N), phosphorus (P), potassium (K) and sulfur (S). Nitrogen is an integral component of essential plant compounds, and is important for root growth and development, and enhancing the uptake of other nutrients (Brady and Weil 2002). A significant proportion of soil nitrogen is held in organic matter and is not readily available to for plant uptake (Hazelton and Murphy 2007). Phosphorus is essential for the growth of plants and animals as it plays a key role in the formulation of energy producing organic compounds. Adequate phosphorus nutrition enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed production), and maturation (Brady and Weil 2002). Potassium plays a critical role in a number of plant physiological processes. Adequate amounts of potassium have been linked to improved drought tolerance, improved winter hardiness, better resistance to certain fungal diseases, and greater tolerance to insect pests. Potassium can also improve the structural stability of plants (Brady and Weil 2002). Sulfur is a constituent of many protein enzymes that regulate activities such as photosynthesis and nitrogen fixation (Brady and Weil 2002). A large proportion of soil sulfur is held in organic matter and must be converted to inorganic sulfate sulfur to become available for plant-uptake. The conversion of organic to inorganic sulfur is usually catalysed by micro-organisms.

To measure the nutrient content of soil, the macronutrients are extracted using methods that approximate root-zone extraction from the soil. The resulting measurement is representative of plant-available nutrient content. Plant-available nitrogen is generally measured in the separate nitrate and ammonium forms. Both ammonium and nitrate are available forms of nitrogen for plant uptake. Potassium and phosphorus are typically measured using the Colwell method, and sulfur is extracted and measured as plant-available sulfate sulfur (Rayment and Lyons 2011).

Australian soils are typically nutrient-poor. The majority of Australian native plant species have a number of physiological adaptations that enable them to be productive in areas where the supply of macronutrients is limited. There is limited information available which details the specific nutritional requirements for native plant species in the semi-arid zones of Australia.

E.3 Multi Elemental Composition

E.3.1 Multi-elements in solids

The availability of metals (micronutrients) in soils play a significant role in many biological functions. The majority of metals occur in inert forms in soils and rocks, and only become available to plants and animals if they are chemically altered during oxidation reactions, or if severe weathering events occur (Hazelton and Murphy 2007). Although some metals are essential to support plant growth, high concentrations can be toxic to flora and fauna. The exact sensitivity of different plant types and animal species in the semi-arid region of Australia has not been studied extensively. Assessment of potential toxicology is made through comparison of metal concentrations to site-specific soil and rock elemental concentrations (where available), as well as published guideline criteria. It is noted that this represents a conservative estimate as local soil and groundwater in mineralised areas is likely to contain more naturally elevated concentrations of metals and salts compared to guideline criteria.

To assess the potential for elemental enrichment, materials are generally tested for total elemental concentrations. For the purposes of this assessment, total elemental concentrations were determined via acid-digest.

Total elemental concentrations of materials can be compared to standard median soil and rock abundance values (Bowen, 1979) to evaluate the extent of elemental enrichment (in accordance with the GARD Guide). The result is reported as a geochemical abundance index (GAI). In general, a GAI of 3 or greater is considered as indicative of enrichment that may require additional examination to assess the environmental significance of the element.

As a conservative approach, all samples were assessed as 'soil' material, which may enter the ecosystem via dust or bulk movement of material, and as sediment material which may enter the ecosystem via water-driven erosion and transport. The latter is considered to represent the more bioavailable form of the metal. Where available, site-specific screening criteria have been developed for assessment of potential impacts using the National Environment Protection Measure (NEPM) (NEPM 2013) Environmental Investigation Levels (EIL) for aged contaminants that apply to 99% protection of areas of ecological significance. It is noted that this represents a conservative approach to screening. Criteria for assessment of potential impacts as sediment in surface waters has been developed using Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) (ANZECC 2000) interim sediment quality guidelines (ISQG) low and highly probable effects values. It is noted that for the purposes of this study, background soil samples that exceed a trigger value under the guideline does not necessarily indicate a concentration of environment significance, but rather an indication that the natural surface soils are enriched with respect to that element.

The EIL values are determined by the sum of the ambient background concentration (ABC) and added contaminant limits (ACL) for each element. For this study the ABC values (**Table E-5-1**) for specific elements was derived from mean concentrations of topsoil and subsoil samples (**Appendix C Table C-5**). A summary of assessment criteria for total elements in solids assessed as part of this study is provided in **Table E-5-1**.

Table E-5-1: Assessment criteria for multi-elements in solids

Total Element (mg/kg)	Topsoil ABC	Subsoil ABC	Lake Roe Topsoil EIL ¹	Lake Roe Subsoil EIL ¹	ISQG Low ²	ISQG High ³
Aluminium	-	-	-	-	ND	ND
Arsenic	5.0	7.0	45	45	20	70
Barium	61.5	65.0	-	-	ND	ND
Beryllium	<1	<1	-	-	ND	ND
Boron	<50	110.0	-	-	ND	ND
Cadmium	<1	<1	-	-	1.5	10
Chromium ⁴	122.7	119.1	250	250	80	370
Cobalt	8.2	9.3	-	-	ND	ND
Copper ⁵	16.9	22.5	85	90	65	270
Iron	-	-	-	-	ND	ND
Lead	6.1	6.0	480	480	50	220
Manganese	317.4	311.9	-	-	ND	ND
Mercury	<0.1	<0.1	-	-	0.15	1
Nickel ⁶	23.9	28.0	65	90	21	52
Selenium	<5	<5	-	-	ND	ND
Vanadium	102.8	98.1	-	-	ND	ND
Zinc ⁷	19.7	19.2	<50	210	200	410

Notes: ND = No trigger value data is published

¹ Lake Roe site specific EIL for 99% protection of areas of ecological significance NEPM (2013)

² Assumed all Chromium is present as Cr III (conservative approach based on mineralogy). EIL value adopted based on average clay content for each material type

³ EIL value adopted based on average CEC and pH_{Ca} for each material type

⁴ EIL value adopted based on average CEC for each material type

⁵ EIL value adopted based on average CEC and pH_{Ca} for each material type

E.3.2 Multi-elements in Solution

For the assessment of multi-elements in solution (deionised water leachate), the laboratory results were compared to published guideline criteria for the protection of aquatic ecosystems (surface water and groundwater), based on the methodology set out in NEPM and ANZECC guidelines.

In the absence of site-specific data, the adopted trigger values for potential impact to surface water receptors from runoff have been determined conservatively based on previous knowledge related to the local hydrology of the Study Area (**Section 2.4**) and assumes 80% protection of species due to the nature of land clearing and mining operation in the surrounding area.

For assessment of impact to groundwater receptors from seepage and infiltration, results have been compared to NEPM groundwater investigation levels (GIL) trigger values for moderately to slightly disturbed fresh and marine water ecosystems based on the salinity of regional groundwater (i.e. fresh to hyper-saline). This approach for assessment of potential impact is considered to be a conservative assessment of elevated levels of elements in seepage and runoff. A summary of assessment criteria for the elements assessed as part of this study is provided in **Table E-5-2**.

Table E-5-2: Assessment criteria for multi-elements in solution

Soluble Elements (mg/L)	Groundwater	Surface Water
	GIL Marine Water ¹	ANZECC Marine Water ²
Arsenic ³	ND	ND
Barium	ND	ND
Beryllium	ND	ND
Boron	ND	ND
Cadmium	0.0055	0.036
Chromium ⁴	0.0274	0.085
Cobalt	0.001	0.15
Copper	0.001	0.008
Lead	0.0044	0.012
Manganese	ND	ND
Mercury	0.0004	0.0014
Nickel	0.07	0.56
Selenium	ND	ND
Vanadium	0.1	0.28
Zinc	0.015	0.043

Notes: ND = no trigger value data is published.

¹ Exceeds the NEPM (2013) GIL for protection of slightly to moderately disturbed marine water ecosystems

² Exceeds the ANZECC (2000) criteria for protection of highly disturbed marine water ecosystems (80% protection of species)

³ GIL screening criteria assumes all arsenic as As (V)

⁴ GIL screening criteria assumes all chromium as Cr (III)

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