RESIDUAL VOID GROUNDWATER MONITORING DESIGN

Ensham Mine

Prepared for:

Ensham Resources Pty Ltd
PO Box 15136
CITY EAST QLD 4002

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BASIS OF REPORT

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30255-R01-v3.0	19 February 2021	Daniel Ashton	Ines Epari	Ines Epari
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620.30255-R01-v1.0	25 January 2021	Daniel Ashton	Ines Epari	Ines Epari

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1 Introduction

1.1 Background

Ensham Mine (Ensham) operates under the Environmental Authority (EA) EPML00732813, dated 3 September 2020. In accordance with condition C54 of the EA, Ensham is required to complete a Residual Voids Groundwater Monitoring Bore Investigation. This report presents the results of this investigation and proposes drilling locations, with suggested methodology, for the installation of bores that address this condition.

This report outlines:

- Evaluation of the groundwater aquifers that could be impacted by mining activities and the rehabilitation activities specified in Appendix 3 of EA EPML00732813;
- Proposed network of groundwater bores to detect changes, impacts and long-term threats on groundwater aquifers potentially affected by the mining activities and the rehabilitation activities specified in Appendix 3 of EA EPML00732813; and
- Assess the suitability of the suggested locations for residual void bores in Table C10 – Quarterly groundwater monitoring requirements and location of EA EPML00732813.

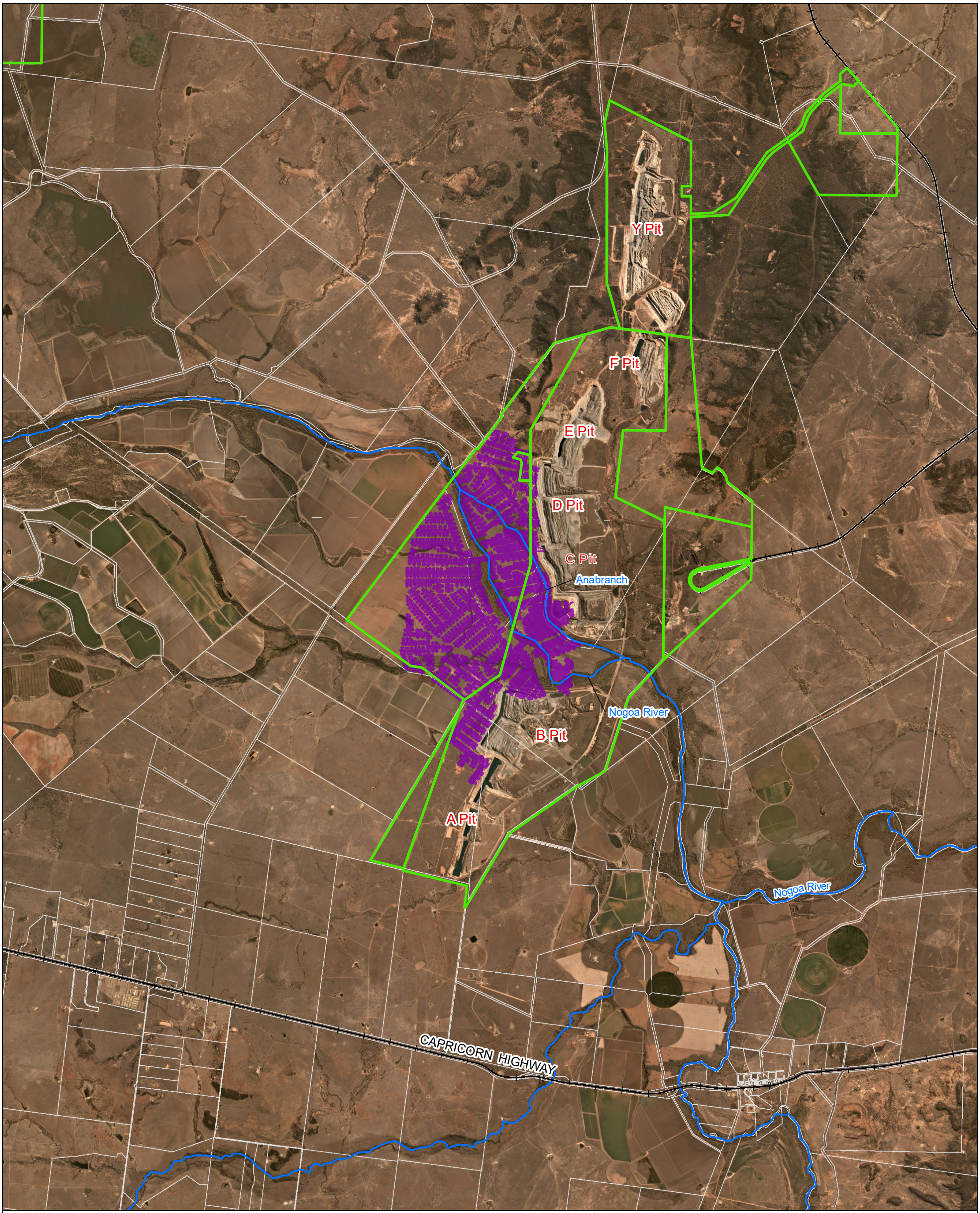
1.2 Site Locality

Ensham Mine is located in Central Queensland, approximately 35 km east of Emerald and 50 km north-west of Blackwater.

The Ensham Mine site covers an along-strike length of over 20 km, from Pit A in the south to Pit Y (Yongala) in the north (Figure 1).

The mining operation at Ensham comprises both open-cut and underground workings, with open-cut operations ramping down due to increasing strip ratios as the coal seams have been followed down-dip to increasing depths. Underground operations commenced in 2011, as a small trial bord and pillar mine, with the main working seam followed through a high-wall portal from Pit C progressing in a south-westerly direction underneath the Nogoa floodplain. The underground operations pictured in Figure 1 is the anticipated extent of mining and does not reflect what has been mined to date.

In this report, “Site” is used to refer to the mining operations and those areas immediately adjacent within the ML boundary. Study area is used to refer to the Site, including the surrounding areas relevant to groundwater processes.



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SLR

Underground Workings
Roads
Rail
Watercourses
Mine Leases
Cadastre

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Locality plan

FIGURE 1

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1.3 Residual Voids

Pits A and B are located south of the Nogoa River, with Pits C, D, E, F and Y all located north of the Nogoa River and its anabranch (Figure 1). Pits A and B have contained significant water volumes since 2009. History of the water level in these voids is displayed in the hydrograph in Figure 2.

Table 1 Summary of residual void and rehabilitation activities within current mine closure plan

Residual Void	Description
Pit A	Pit A is an active water storage location located to the south of the site and is comprised of 2 pits: Pit A South spans approximately 2200 m and Pit A North approximately 1600 m.
Pit B	Pit B is a historic water storage location located to the south of the Site, north of Pit A. This void was dewatered from December 2019 to December 2020. Pit B spans approximately 2000 m.
Pit C	Located in the centre of the site, Pit C spans approximately 1600 m.
Pit D	Located north of Pit C, Pit D spans approximately 2400 m.
Pit F	Located to the north of the site, south of Pit Y, Pit F spans approximately 1900 m.
Pit Y	Located to the north of the site, Pit Y spans approximately 4500 m.

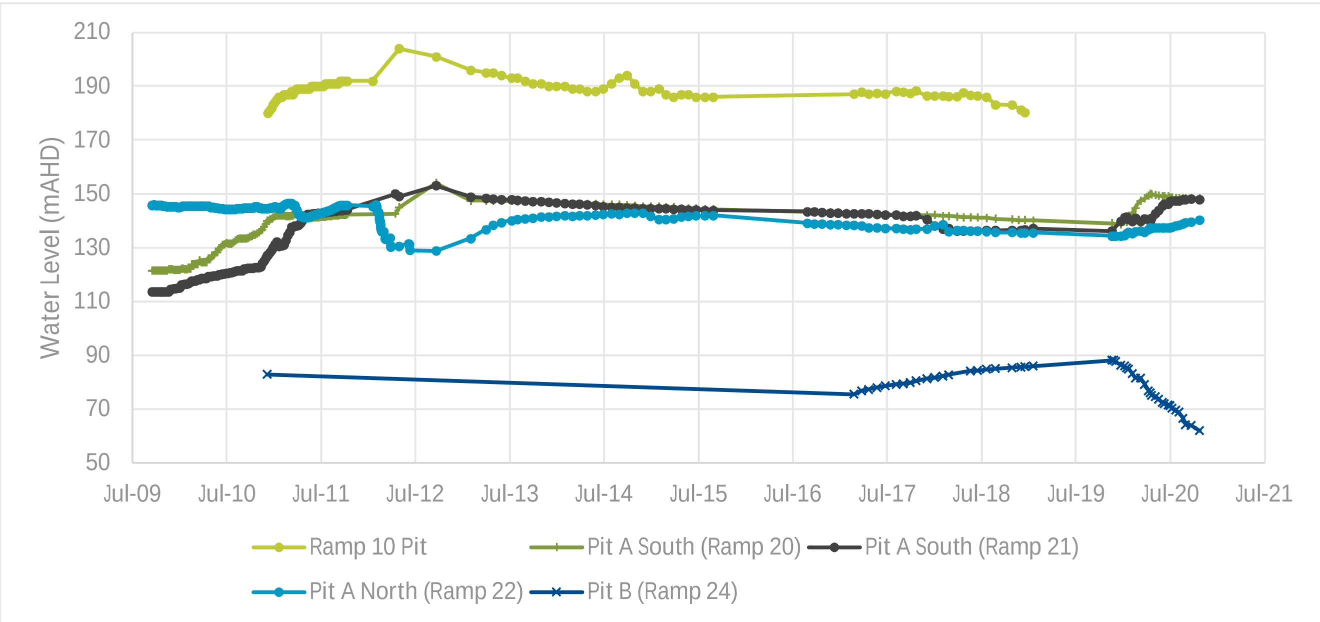


Figure 2 Water level in pit water storage

EA condition C56 related to the design of long-term rehabilitation and closure mandates that these voids must act as groundwater sinks to the receiving environment into perpetuity. Modelling of the long-term groundwater levels in these pits has been used to inform the potential mine design and water management and these technical assessments are used as the foundation for the following conceptualisation of groundwater-surface water interaction (Hydrosimulations, 2020, HEC, 2019).

1.4 Works Design Methodology

Groundwater bores were designed to supply information on one or more of the below design aspects:

- Groundwater occurrence and level;
- Groundwater flow directions and hydraulic properties of hydrogeologic units;
- Gradients in water level or chemistry proximal to key potential source features;
- Gradients in water level or chemistry proximal to key receptors or discharge points; and
- Considerations for future monitoring.

The objective of this method was that each location added substantively to the purpose of the monitoring scope. Additionally, consideration was given to the following aspects of drill design:

- Logistical facets of intrusive works in ensuring the works planned satisfied a “reasonable and practicable” (as defined in the Environmental Protection Act 1994) amount of effort would be applied to accomplish resolving the data gaps present; and
- The nature of each potential source as pertains to the level of risk to receptors. This is a concept that will be developed further in the Groundwater Management and Monitoring Plan (GMMP) and does not significantly change the considerations for additional data collection as part of this package of works.

2 Groundwater Environment

2.1 Local Geology

Ensham Mine is located in the western part of the Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. The Rewan Formation is recognised as the basal aquitard of the GAB (Habermehl, 1980). In the study area, the Rewan Group is present at subcrop. The Clematis Sandstone which forms the basal aquifer of the GAB is not present, the closest intake area being located 50 km south-east of the study area.

Table 2 provides a summary of the stratigraphy across the site. The stratigraphic sequence comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences. The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal deposits mined at Ensham Mine are found within the Rangal Coal Measures, which is the uppermost Permian unit. The surface geology of the study area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north.

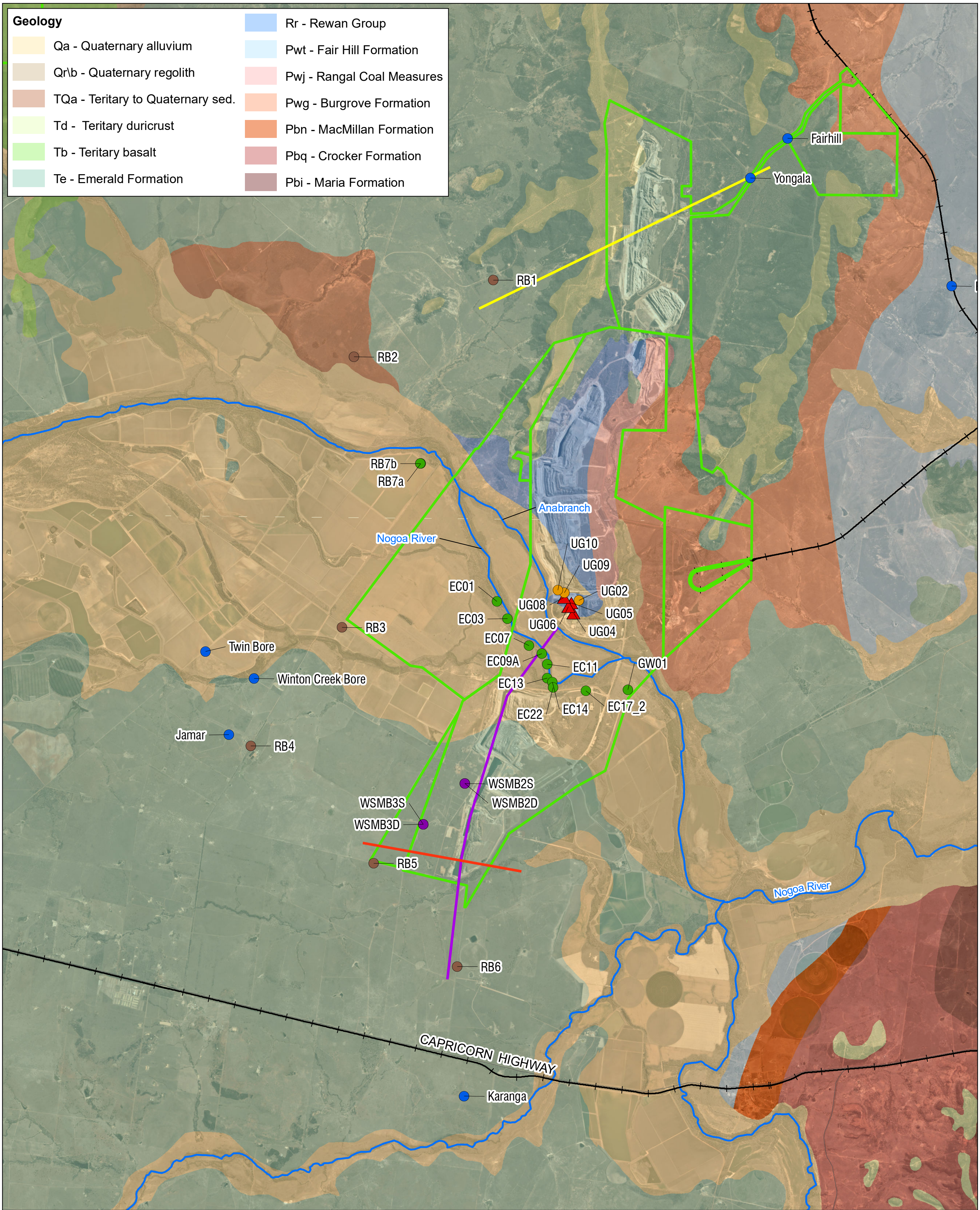
The structural geology of the Bowen Basin includes major north-west to south-east trending faults, including the Jellinbah Fault and Yarrabee Fault located over 40 km east of the Project. However, no regional-scale faults have been mapped within the study area. Where present, faulting is generally normal, trending east to west, to south-east to north-west, with throws of less than 10 m, although occasional low angle thrust faulting has been noted (AGE, 2006).

Table 2 Summary of site stratigraphy

Age	Unit	Maximum thickness[1] (m)	Description
Quaternary	-	25	Alluvium - silt, clay, sand and gravel
Tertiary	-	ND	Duricrusted palaeosols at the top of deep weathering profiles, including ferricrete and silcrete; duricrusted old land surfaces
	Emerald Formation	50	Fluviatile and lacustrine claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, lignite, oil shale, interbedded basalt; all deeply weathered in outcrop
	Basalt	ND	Tertiary volcanics (basalt) mapped as being present over 10 km west of the site
Triassic	Rewan Group	200	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment.
Permian	Rangal Coal Measures	125	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams.
	Burngrove Formation	200	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones - coal seams include the Virgo and Leo seams.
	Fair Hill Formation	150	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate
	Macmillan Formation	100	Lithic and feldspathic sublabile mudstone, siltstone and sandstone

1 Approximate maximum thickness based on available exploration holes and/or relevant literature

ND: not defined, not enough data available



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Groundwater Monitoring Bores

- Alluvial monitoring bore
- Private landholder bore
- Regional monitoring bore
- Underground bore (coal)
- Underground bore (spoil)
- WSMB series

- Pit A Cross Section
- North-South Cross Section
- Pit Y Cross Section
- Roads
- Rail
- Watercourses
- Mine Leases

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Geology and Bore Locations

FIGURE 3

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2.2 Monitoring Network

A table with bore details for data used in this assessment is provided in Appendix A. Figure 3 displays these locations with the monitoring unit for each observation bore.

2.3 Groundwater Units

The following section outlines the main water bearing units relevant to Ensham mine. These are displayed in the conceptual cross sections Figure 4, Figure 5 and Figure 6.

2.3.1 Quaternary Alluvium

Alluvial deposits are associated with Nogoa River and its anabranch. The Quaternary aged alluvium comprises shallow sequences of clay, silty sand and sand, underlain by basal sands and gravel. Hydraulic conductivities are variable and have been shown to range from 1.00E+02 m/day (AGE, 2006) to 9.00E-04 m/day (AGE, 2017) (Table 3).

Some of the groundwater monitoring bores which are screened the alluvium have been periodically dry indicating that the alluvium might not be saturated continuously; but rather form stagnant lenses with unsaturated regions. This has been reported in the quarterly reviews of groundwater monitoring.

2.3.2 Rewan Group

The Rewan Group comprises low permeability siltstones, mudstones and lithic sandstones and is recognised to be a regional scale aquitard. The thickness of this formation is up to 200 m in the study area, providing a barrier to groundwater flow between the overlying alluvium and the underlying coal measures. Hydraulic conductivities are variable and have been shown to regionally range from 1.00E-01 m/day to 1.30E-05 m/day (SLR, 2020) (Table 3). This unit is described throughout this report along with the aquifers present in the study area, as there is a noted groundwater presence within this formation. However, it remains considered to be an aquitard and inhibitor to flow rather than a significant water bearing and transporting feature.

2.3.3 Rangal Coal Measures

The Rangal Coal Measures comprise economic coal seams interbedded with low permeability siltstone, sandstone and shale.

This unit can be subdivided into the following hydrogeological units:

- Very low to low permeability siltstones and sandstones that comprise the majority of the Permian age interburden and overburden; and
- Low to moderately permeable coal seams, of varying degrees of competency and fracturing.

Hydraulic conductivities have been measured to vary significantly within this interburden, ranging from 1.20E-01 m/day (JBT 2016) to 2.00E-05 m/day (Parsons Brinckerhoff, 2011) (Table 3).

The coal seams form aquifers that generally exhibit low transmissivities and are confined by overlying and underlying shales and mudstones. Groundwater storage and movement largely occurs within the coal seams, along cleats and occasionally within minor fault zones that intercept the seams. As shown in Table 3, hydraulic conductivities of the coal seams are variable and have been shown to range from 5.00E+00 m/day (BHP, 2009) to 1.00E-06 m/day (Matrix Plus, 2010).

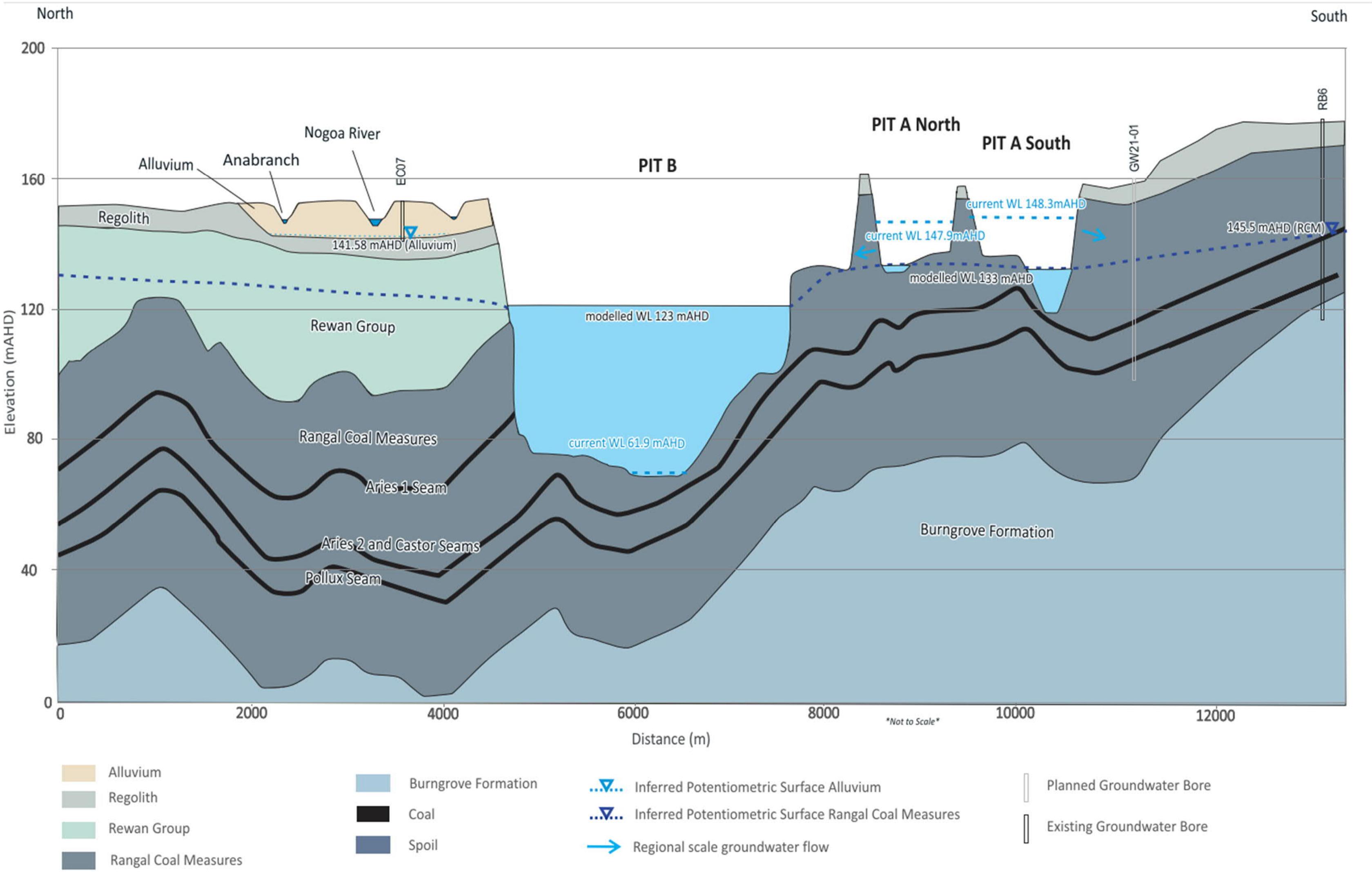


Figure 4 Cross section of Nogoa River and Pits A and B (north to south)

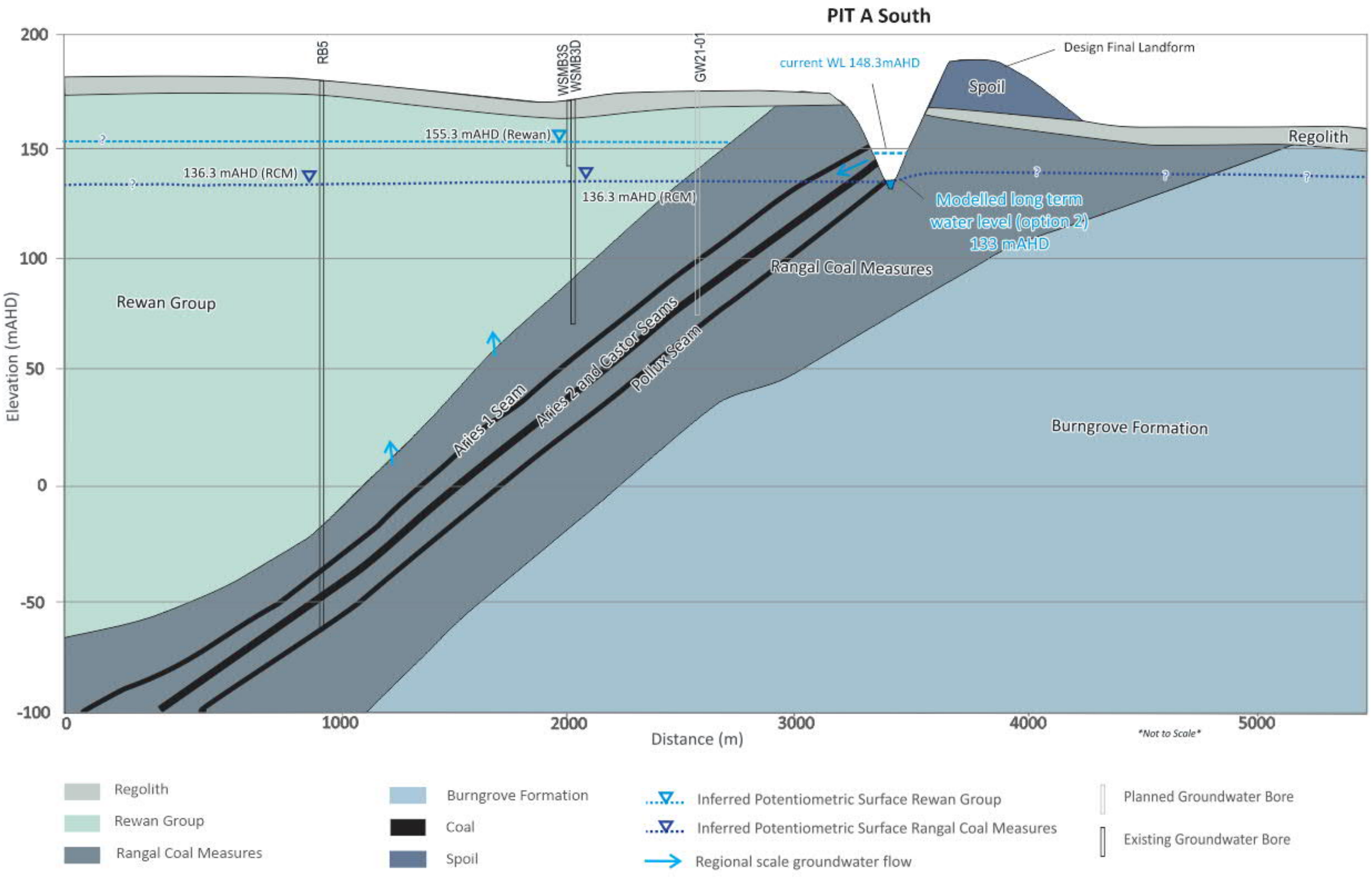


Figure 5 Cross section through Pit A (west to east)

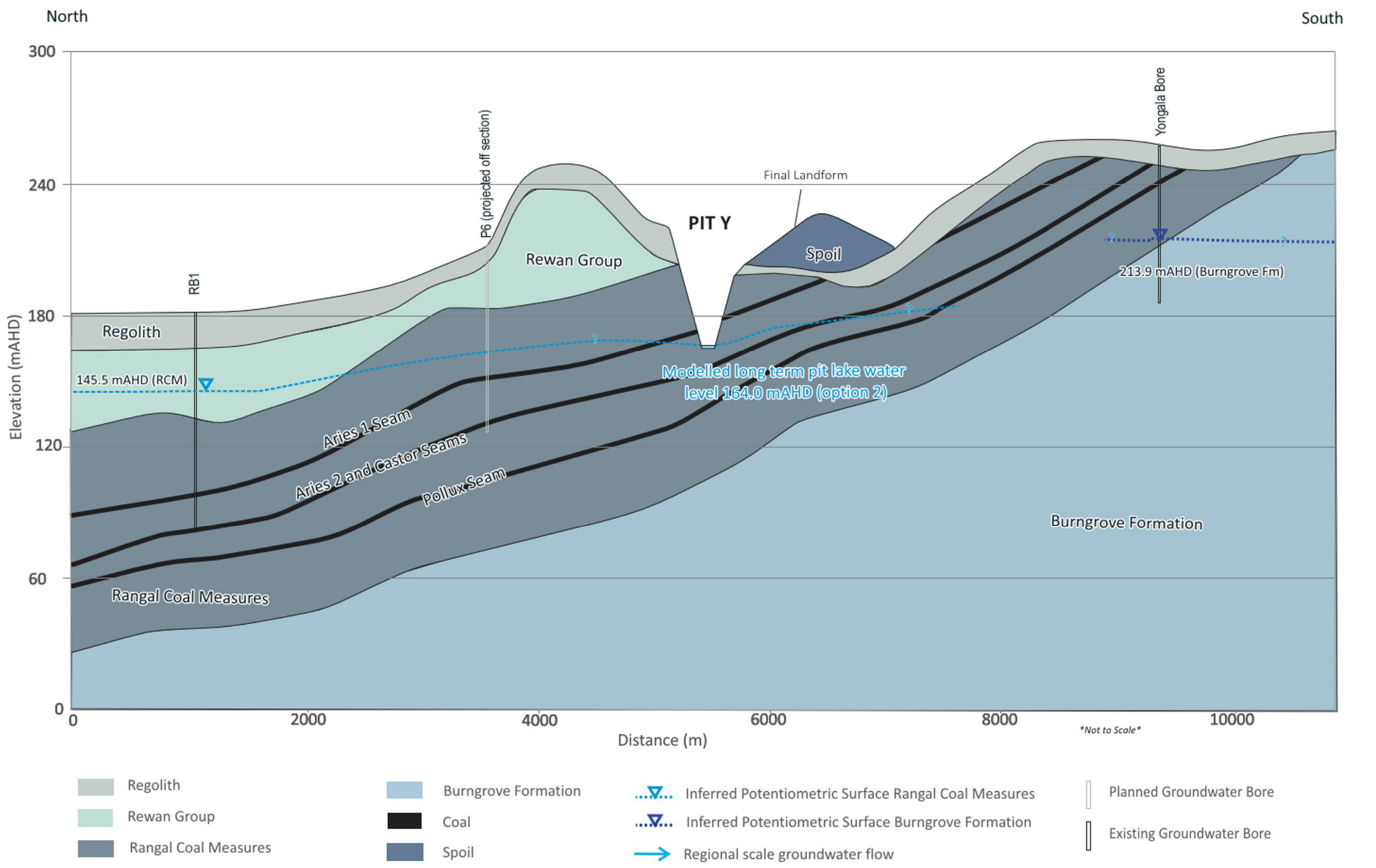


Figure 6 Cross section through Pit Y (west to east)

Table 3 Hydraulic properties

Age	Formation	Kh [m/d]	Kv [m/d]
Quaternary	Alluvium	1.00E+02[1] to 9.00E-04[2]	2.50E+01[8] to 4.00E-03[9]
Triassic	Rewan Group	1.00E-01[3] to 1.30E-05[4]	5.00E-04[6] to 5.80E-09[4]
Permian	Rangal Coal Measures – Coal seams	5.00E+00[3] to 1.00E-06[5]	1.00E+00[1] to 1.00E-06[1]
	Rangal Coal Measures - Interburden	1.20E-01[6] to 2.00E-05[7]	3.00E-02[6] to 7.00E-08[8]

1: AGE (2006); 2: AGE (2017); 3: BHP Billiton Mitsubishi Alliance (2009); 4: OGIA (2016); 5: Matrix Plus (2010); 6: JBT(2016); 7: Parsons Brinckerhoff (2011); 8: Ausenco-Norwest (2012); 9: KCB (2016)

2.4 Groundwater Occurrence and Flow

Groundwater level observations are recorded quarterly for the bores within the Ensham monitoring network. Full record of these water level measurements are presented in Appendix B.

Groundwater elevation contours were developed for each aquifer to illustrate flow directions (Figure 7 and Figure 8). These are considered key to establishing potential groundwater impact for monitoring. Some professional judgement was applied to development of groundwater elevation plots by reconciling observed groundwater levels with hydrogeologically significant features such as mining features (mine dewatering and waste storages) and surface water bodies.

2.4.1 Quaternary Alluvium

There are 11 groundwater monitoring bores screened within the alluvium along the Nogoa River floodplain. Recent groundwater observations from these bores (November 2020) show the water level in the alluvium ranges from 138.34 mAHD (GW01) to 153.54 mAHD (Twin Bore). Based on the inconsistent water occurrence in bores throughout this area (EC17_2 was found dry), the alluvium is interpreted to possess zones where sediment is not fully saturated.

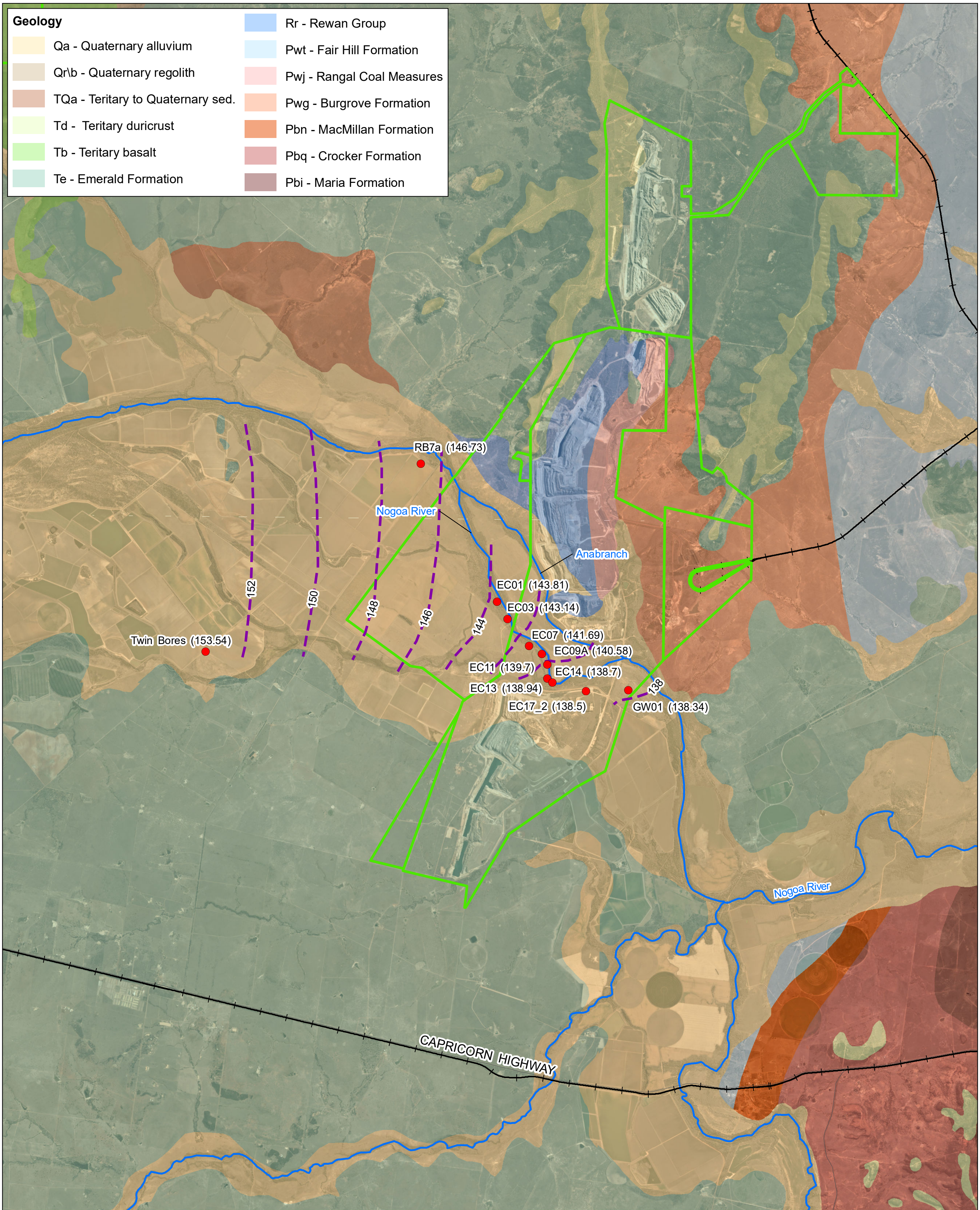
The primary driver of groundwater flow in this aquifer is topographic gradients, following the direction of the Nogoa River from north-west to south-east in the study area. The alluvium is not well connected with the Nogoa River, which can be concluded by the difference in salinity between the more saline alluvial groundwater and the fresher river water. Lithological observations of the base of the creek have identified lenses of aquitard material (clays) dividing the surface water areas from basal gravel layers that comprise the lower areas of this aquifer feature. The shallow silts and clays are anticipated to be partially isolating the Nogoa River, limiting leakage from the river into the basal sands and gravels. It is possible that leakage may occur where these clays are absent or where the basal sands are exposed within the river.

Locally, there is potential interaction between the northern extent of Pit B and the Nogoa Alluvium where it outcrops in the pit wall. Seepage has been observed along this outcropping contact, though this is anecdotal and no robust monitoring data is available to support or reject this hypothesis.

The area south-east and west of the Ensham Mine, on the floodplain and to the south of the floodplain, is dominated by intense agricultural activity and associated irrigation, sourced from the Nogoa River surface water takes and channel water from Fairbairn Dam. The understanding of the effect of irrigation is limited. The only example of a probable irrigation effects are the trends for bores EC01 and EC03, as shown in Appendix B. Both bores record a slight rising trend in groundwater levels from 2015 irrespective of climate and streamflow trends. This trend is not visible in bores further to the east and away from irrigation areas.

2.4.2 Rewan Group

There are four groundwater monitoring bores screened within the Rewan group, Landowner bores Jamar and Winton Creek, and Water Storage Monitoring Bores (WSMB) observation points WSMB2S and WSMB3S. The most recent water level observations (November 2020) show that the ground water level ranges from 115.75 mAHD (Jamar bore) to 155.27 mAHD (WSMB3S), however quarterly evaluations of the hydrographs of these landowner bores have highlighted the significance of abstraction on the water level observed at these bores, and they may not represent reliable assessments of regional groundwater levels. Given the paucity of data in this unit, no contour plots of water level in this aquifer were possible.



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- Alluvium Groundwater Monitoring
- Alluvium Groundwater Contour (mAHD)
- Roads
- Rail
- Watercourses
- Mine Leases

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Alluvium Groundwater Contour (Nov 2020)

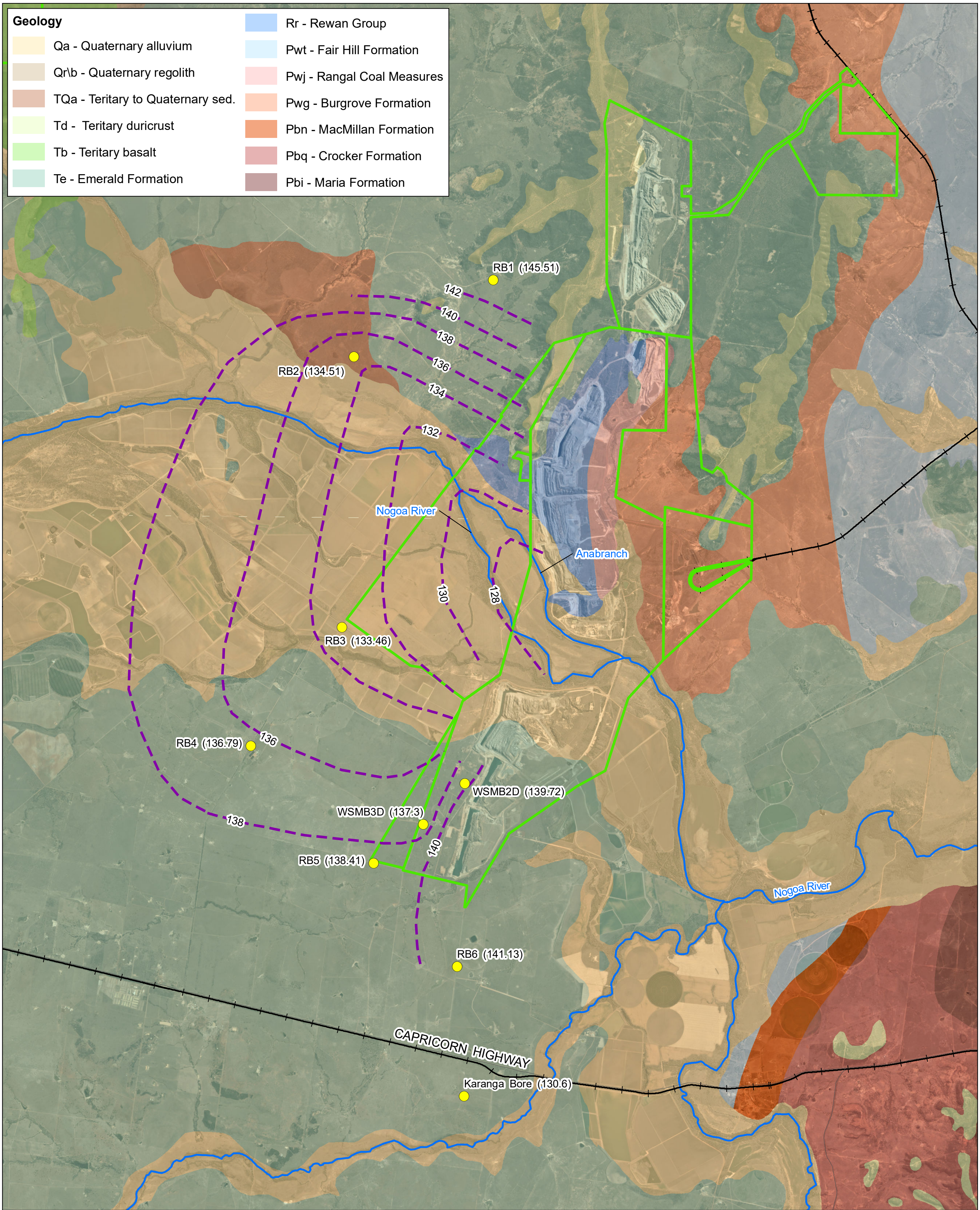
FIGURE 7

2.4.3 Rangal Coal Measures

As the mined unit within the Study Area, this formation is well monitored regionally, with eight bores installed to this feature. The most recent groundwater level observations (November 2020) show that water level ranges from 133.46 mAHD (RB3) to 145.51 mAHD (RB1). Groundwater in the Rangal Coal Measures flows primarily towards the Ensham underground mine area due to the dewatering and depressurisation associated with underground mine development. Potentiometric level contours of November 2020 monitoring shown in Figure 8 illustrate the influence of this depressurisation.

Recharge to the Rangal Coal Measures occurs primarily from rainfall infiltration on exposed outcrop. The coal measures also subcrop in localised zones beneath alluvium associated with the Nogoa River, where the unit may be recharged by downward seepage where there is an absence of clay and silt layers. Limited recharge may also occur via downward leakage from the Triassic age Rewan Group and Tertiary sediments, as well as from areas of site surface water storage (i.e. in-pit water storages from open-cut mining at the Ensham Mine). The coal seams are connected with the open-cut pits (which are the mined-out areas of the outcropping coal seams). If the pit voids fill up with water, this can create flow into the coal seams. This principle is investigated in Section 2.6.1.

Limited hydraulic connection between the A and B Pits and underground is implied by the presence of retained surface water in these pits and local elevated groundwater conditions. Fracture flow and flow through seams is likely. This would have the effect of prolonged drainage of the southern and central pits into the underground void until underground mining is completed and groundwater levels recover towards the levels associated with the final voids.



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SLR

- RCM Groundwater Monitoring
- RCM Groundwater Contour (mAHD)
- Roads
- Rail
- Watercourses
- Mine Leases

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Rangal Coal Measures Groundwater Contour (Nov 2020)

FIGURE 8

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2.5 Groundwater Chemistry

This section outlines the groundwater chemistry for each groundwater unit in the Study Area flow system. This is a necessary step in describing the conceptual model of groundwater environments to determine potential interaction between surface water and groundwater.

2.5.1 Quaternary Alluvium

Figure 9 presents major ion analysis of groundwater chemistry data through the use of a Durov diagram. This figure shows that the majority of bores screened in the alluvium are of sodium-chloride (Na-Cl) water type dominance (Figure 9).

Alluvium bores show a wide range in salinity with recorded values from approximately 1,000 µS/cm to 30,000 µS/cm. Water pH is neutral with a median value of 7.1. As described in Section 2.4.1, most of the alluvium is hydraulically isolated from the Nogoa River, resulting in brackish to highly saline conditions. Slow infiltration recharge and evapotranspiration are likely to be the dominant processes resulting in salinisation of the alluvium.

Linear trends visible in ionic content (cation section) and EC are indicative of the transport of a saline slug down the alluvial system, a feature that was observed following flooding in 2011 (Figure 10). Decreasing trend in EC values over the last two to three years show this slug of high EC water moving through the system.

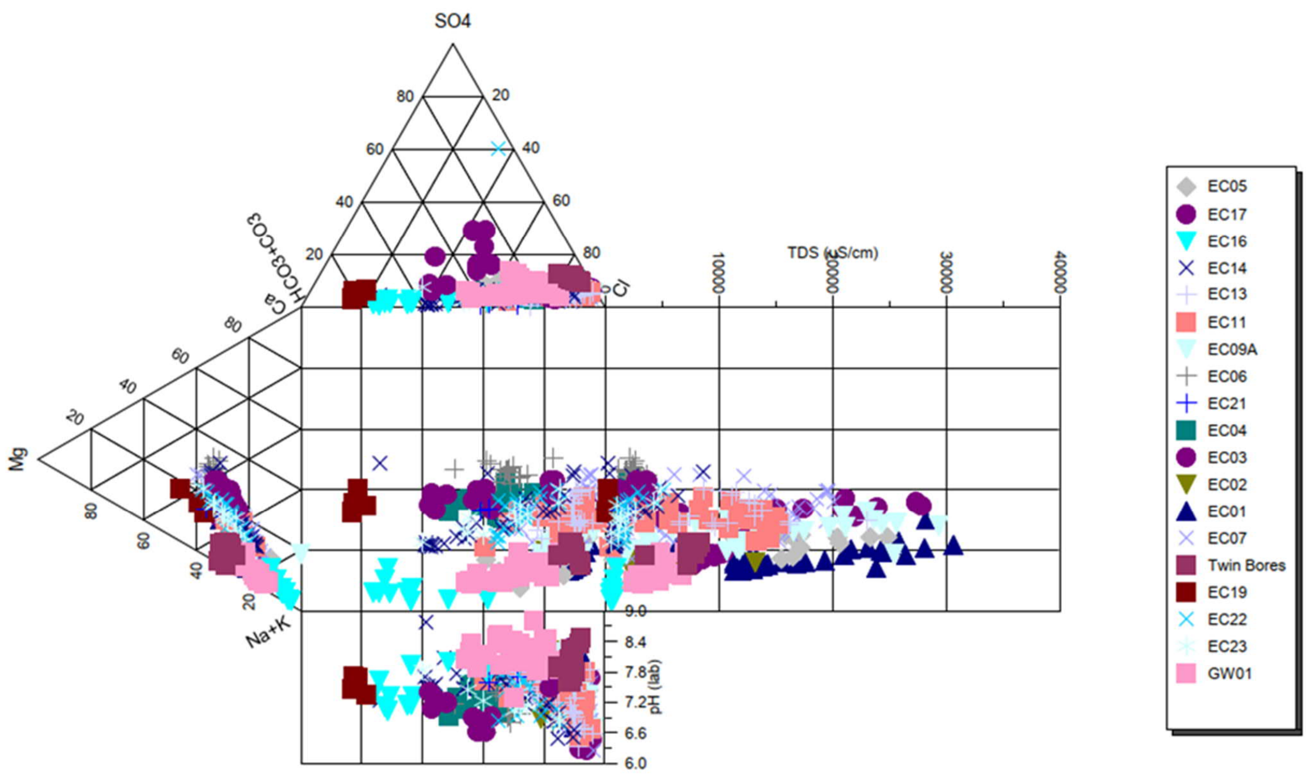


Figure 9 Durov diagram – alluvium

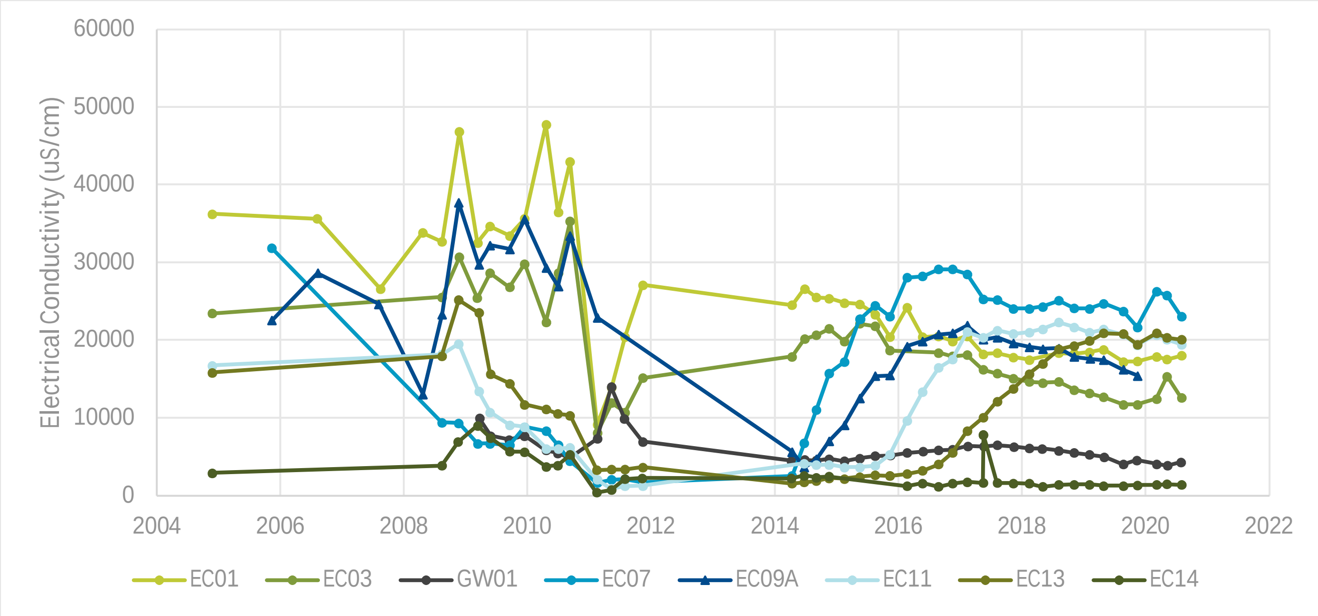


Figure 10 Electrical conductivity over time in alluvial monitoring bores

2.5.2 Rewan Group

Bores screened in the Rewan Group (Winton Creek Bore and Jamar Bore) are all Na-Cl dominant (Figure 11). EC is variable with recorded values ranging from approximately 1300 µS/cm to 8300 µS/cm. Water pH is neutral with a median value of 7.7.

Though sourced from only two locations, this data shows a relatively small range of values, with the majority of samples clustered tightly. Three samples show varied ionic ratios at Jamar bore and these may represent samples significantly affected by abstraction within the sampling period. Overall, little trend in groundwater chemistry change over time illustrates the low degree of groundwater flow within this aquifer as chemistry values are relatively stable.

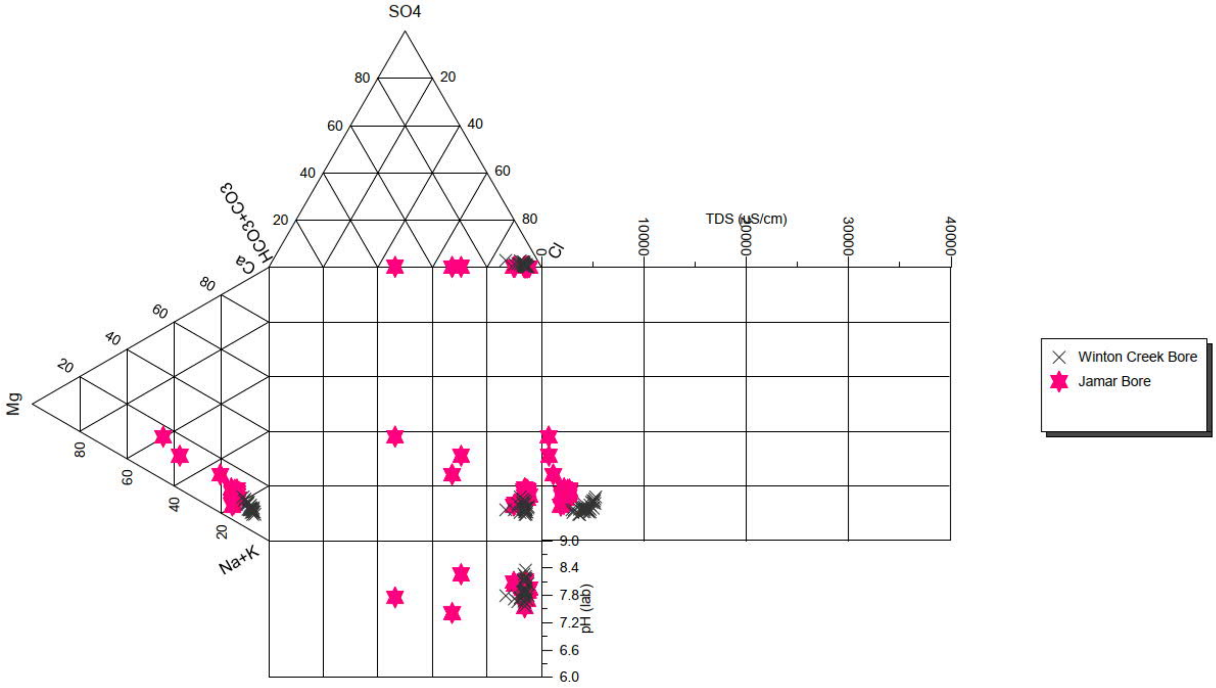


Figure 11 Durov diagram – Rewan group

2.5.3 Rangal Coal Measures

All bores monitoring the Rangal Coal Measures are Na-Cl dominant with the exception of Karanga Bore (private bore to the south of the open-cut pits), which is Mg-Cl dominant (Figure 12). The presence of Mg ions, which are strongly adsorbed compared to K or Na ions may indicate that this bore monitors an area that receives higher recharge and where groundwater is younger. This corresponds with the location of the bore where the coal measures occur at outcrop. Furthermore, this bore presents consistently lower EC values and groundwater level variations which are not matched the other bores. This may indicate the influence of abstraction at this bore.

Electrical conductivity ranges within the Rangal Coal Measures are variable, with values measured from approximately 2000 µS/cm to 4000 µS/cm (Karanga bore and RB1) and approximately 7000 µS/cm to µS/cm 13000 (all other bores). Water pH is neutral with a median value of 7.7.

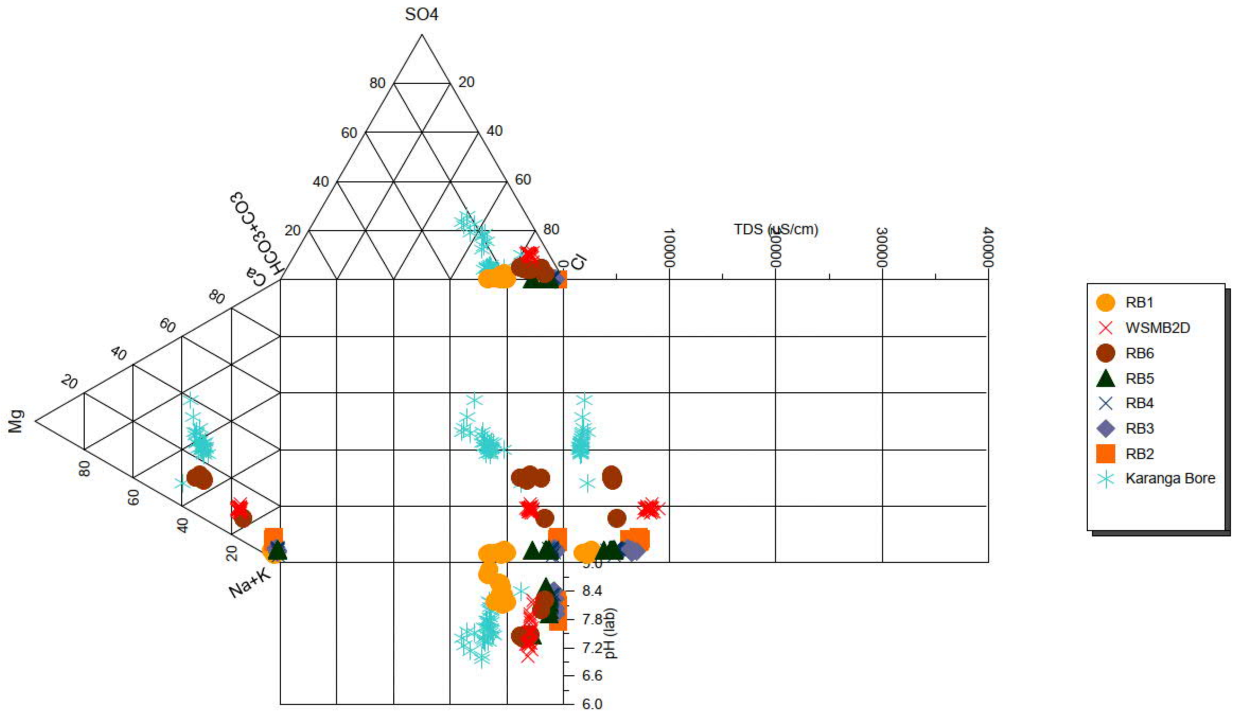


Figure 12 Durov diagram – Rangal Coal Measures

2.6 Groundwater Interaction

Based on the above definition of the aspects of the hydrogeologic system, the following interactions are considered relevant for the long term monitoring of residual voids:

- Groundwater discharge/recharge at pit lakes; and
- Interaction between Nogoa Alluvium and mine void.

2.6.1 Pit Lakes

The key risk with regard to groundwater values are the potential interactions between water contained in in-pit voids and the infiltration that may be presently occurring or potentially occurring in future with storm related water level rise in the pits. Steady state groundwater levels based on the groundwater and surface water modelling carried out by Hydrosimulations (2020) and HEC (2019) respectively are displayed in Table 4. This shows the crossover of each pit, a term that refers to the stage height at which the pit transitions between sink and source, according to long term groundwater level modelling.

Table 4 Modelled steady state groundwater level with the crossover of each void

Parameter	Pit A	Pit B	Pit CD	Pit E
Regional Groundwater Level [mAHD]	144	142	142	150
Upper Crossover [mAHD]	132.5	137.3	140	145
Lower Crossover [mAHD]	110	75	77.3	130^
Average Final Pit Lake Level [mAHD]*	133	123	125.5	140

Notes: * Average Final Pit Lake Level is calculated over the last 50 years of simulation
- Pits B and CD are infilled in Option 3.
^ Pit E in Option 3 has another lower crossover at 116-118 mAHD
NC Not Calculated

Surface water modelling suggests that flow should occur from Pit A to Pit B, due to 10m head difference (using surface water model levels), and from Pit E to Pit D, due to 14m head difference (Table 4). HEC (2020) does predict “groundwater outflow” from Pit A and from Pit E. This “groundwater outflow” is flow from one pit downgradient into the adjacent pit, and not to the regional groundwater system (Table 4 shows that the regional levels are always much higher than the pit lake water levels). The movement downgradient is called “groundwater outflow” because there is a narrow strip of “aquifer” material separating adjacent pits in the groundwater model. The model reports a loss to groundwater, but it is really a short-term transfer of water from one pit lake to another through intervening aquifer material.

Nevertheless, the groundwater levels and managed water level in the pits currently suggests there may be a potential for contribution to groundwater under present conditions. Bore RB5 is located approximately 2.5 km south-west of A Pit and intersects the A21 and Castor Coal Seams. Between May 2018 and March 2020, the bore recorded a slight decline in groundwater levels in response to depressurisation of the coal measures from approved mining. However, groundwater levels at RB5 increased by 0.93 m to 137.68 mAHD between Q2 and Q3 2020 (Figure 13). This rise may relate to increased water storage in A Pit in recent months, due to transfers from B Pit.

Figure 13 shows the water level in ramps 20, 21 and 22 which correspond with Pit A water storages. Available information indicates the maximum pit water fill level in these voids is likely around 150 mAHD, approximately 20 m below the pit crest/natural surface. A similar rise in water levels is visible in the water storage monitoring bores WSMB2D and WSMB3D that intersect coal around 108 m and 102 m depth, respectively (Appendix A). A rise in groundwater levels is also visible for bores WSMB2S and WSMB3S that intersect the shallower overburden (siltstone and sandstone) of the Permian coal measures, to 50 m and 20.8 m depth. Bore WSMB3S has generally been recorded as dry, with a bore total depth of 20.8 m. However, since Q1 2020, groundwater levels have been recorded at around 18 m below surface (156 mAHD). This is above the recorded pit water level of 150 mAHD, but this may relate to the monthly monitoring frequency of pit levels. These trends indicate that A Pit is potentially acting as a groundwater source, recharging the Permian coal measures and buffering the impacts of depressurisation of the coal measures due to mining.

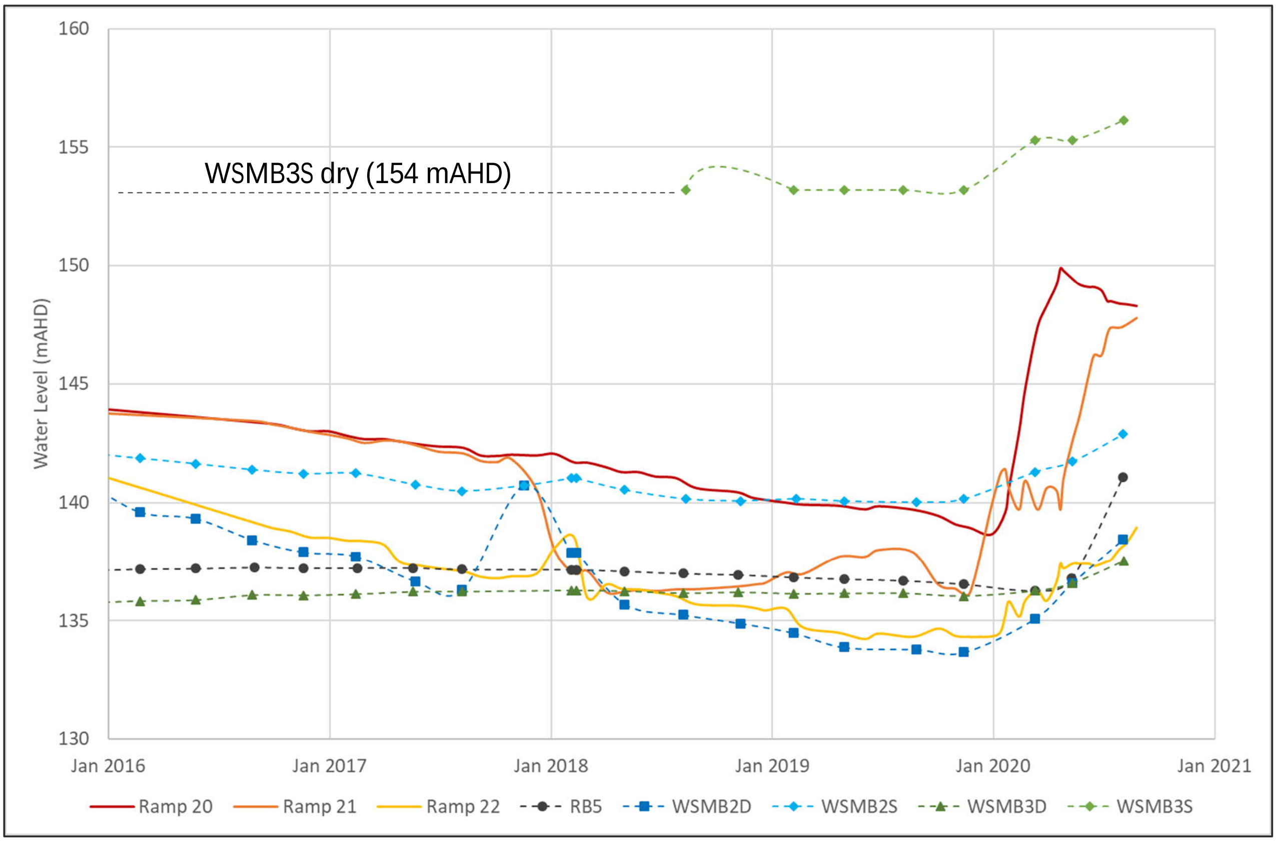


Figure 13 Surface storage and WSMB bore water levels 2016 to 2020

With additional storage of water in A Pit there has been a visible response in groundwater levels in the Permian coal measures at the WSMB bores and RB5, though no chemistry change at these locations is evident at this stage. A summary of the water quality recorded within A Pit and the Permian coal measures is shown in Table 5. As shown in below, pit water quality is generally consistent between the pit water and Permian coal measures, but does show a higher (alkaline) pH, higher sulfate and dissolved metals content is generally lower within the surface water than in the coal measures. Recent data shows that most bores record sulfate concentrations of less than 100 mg/L, with the exception of WSMB2D, WSMB2S and RB6. Groundwater within the Permian coal measures is used for stock water supply when necessary. There are no known adverse effects on stock for concentrations of sulfate below 1,000 mg/L (ANZG, 2018).

Review of the proportion of major ions is presented in the piper diagram in Figure 14. The piper diagram shows similar water quality between the WSMB bores along the A Pit highwall and the pit water quality (ENSR21 and ENR22 = Pit A ramps). However, groundwater to the south at RB6 shows a higher proportion of calcium and magnesium, which may relate to local recharge from irrigation. RB5 to the south-west of A Pit also shows a lower proportion of sulfate, potentially indicating a limited extent of advection and dispersion of sulfate from the pit water to the Permian groundwater to the west.

Based on this data, there is potential the water storage is providing a recharge source to the coal measures that is buffering depressurisation associated with mining. The water within A Pit shows a slight flow gradient from the pit to the Permian coal measures to the west and south, but changes in water quality are more localised. It should be noted that due to the structure of the coal measures there is also a limited potential for seepage to the east other than through the shallow weathered horizon (regolith).

Table 5 Water Quality Summary

Analyte	Unit	LOR	A Pit (Analysis on 12th August 2020)	Permian Coal Measures (RB1, RB2, RB3, RB4 and RB6)
EC (Field)	µS/cm	0.01	10,216 to 10,277	3,790 to 11,080
pH (Field)	pH Units	1	8.1 to 8.45	6.89 to 7.46
Sulfate	mg/L	1	616 to 702	<1 to 142
Dissolved aluminium	mg/L	0.01	0.02	<0.01
Dissolved antimony	mg/L	0.001	<0.001	<0.001
Dissolved arsenic	mg/L	0.001	0.001 to 0.002	<0.001 to 0.005
Dissolved manganese	mg/L	0.001	0.001 to 0.003	0.037 to 0.144
Dissolved molybdenum	mg/L	0.001	0.004 to 0.006	<0.001 to 0.004
Dissolved selenium	mg/L	0.0002	0.0008 to 0.001	0.0003 to 0.0012
Dissolved silver	mg/L	0.001	<0.001	<0.001
Dissolved boron	mg/L	0.05	0.36 to 0.43	0.34 to 0.49
Dissolved iron	mg/L	0.05	<0.05	<0.05 to 0.71

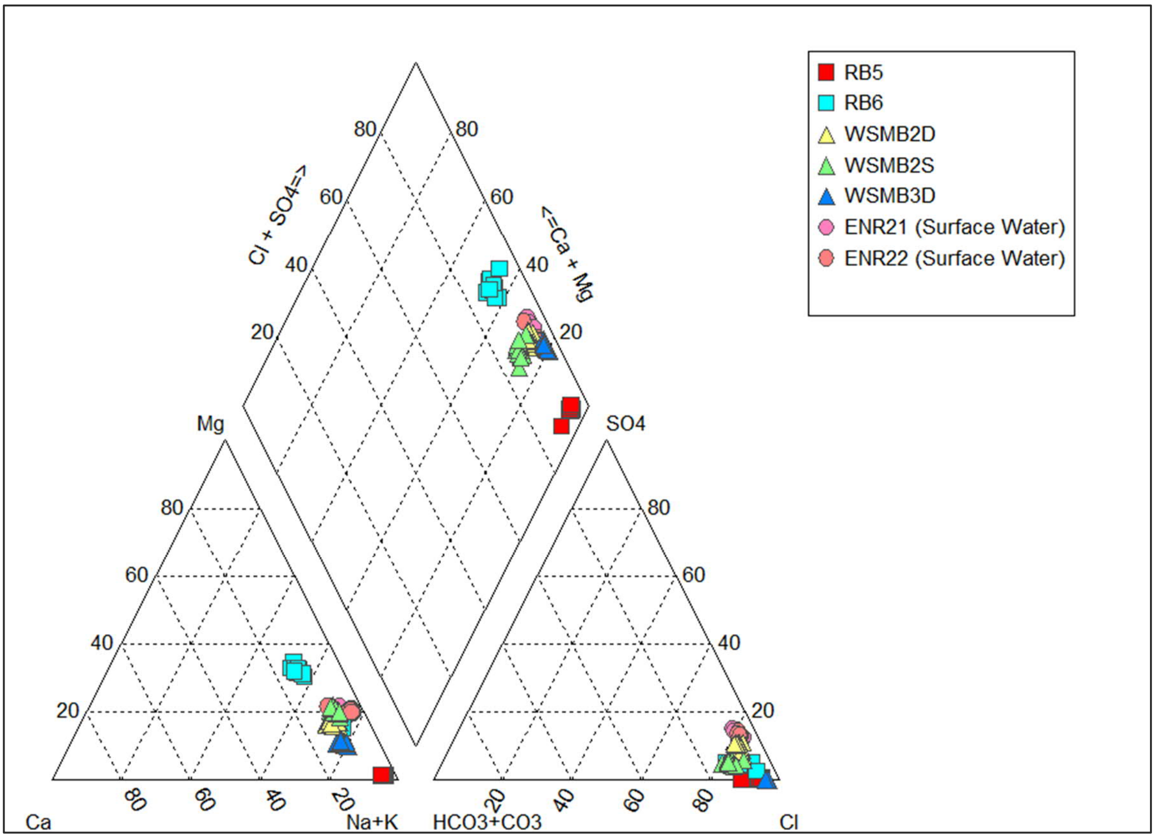


Figure 14 Piper diagram of Pit A water storage and local groundwater monitoring

2.6.2 Nogoa River

Based on the hydrogeologic literature available, the alluvium is understood to lack a significant connection with the Nogoa River. This is based primarily on the difference in dissolved ionic content or salinity between the more saline alluvial groundwater and the fresher river water. Multiple orders of magnitude difference between these areas would not exist without barriers to connection that might allow dispersion or diffusion of the end member chemistries. Furthermore, isolated bores installed in the alluvium are sporadically dry despite consistent flow in the river, indicating that there is no continuous recharge from the Nogoa River within the study area.

Figure 15 shows a conceptual cross section of the alluvium around the Nogoa River (AGE, 2006). The upper part of the alluvium comprises silts and clay that may act as a boundary, limiting recharge. The silts and clays are underlain by a more permeable layer of sands and gravels (referred as basal gravel or basal alluvium). The shallow silts and clays are anticipated to be sealing the Nogoa River, limiting leakage from the river into the basal sands and gravels. It is possible that infiltration may occur where these clays are absent or where the basal sands are exposed within the river. However, there is no data to suggest this occurs on site. This hydraulic separation of the alluvium from the Nogoa River means that whilst the water in the river is fresh, the underlying alluvium can be brackish to highly saline (Section 2.5.1). The updated historical groundwater quality dataset confirms the poor quality of the groundwater in the alluvium, which is generally brackish to highly saline (Figure 10).

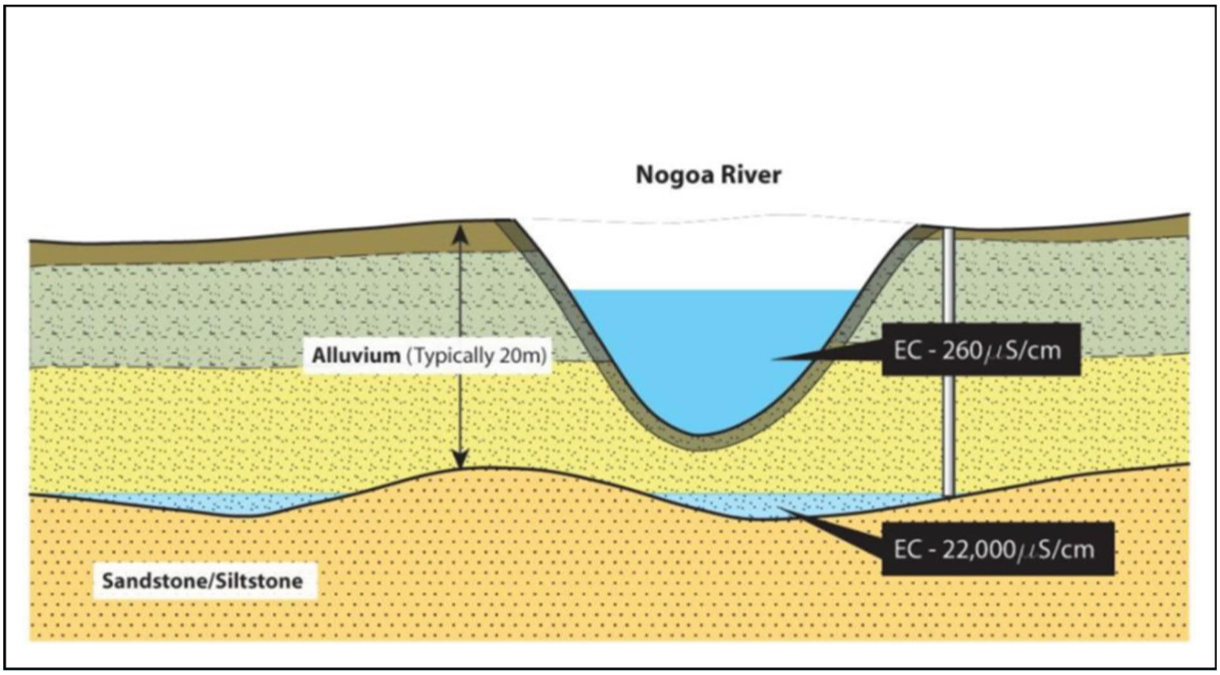


Figure 15 Conceptual diagram of Nogoa River groundwater system (AGE, 2006)

As noted in Section 2.3.1, the alluvial aquifer outcrops in the northern wall of Pit B. Seepage discharge from the alluvium into the pit has been observed at this location and is considered a potential interaction requiring monitoring. Modelled conditions suggest that there is not likely to be a discharge to alluvium under steady state conditions, however a groundwater bore has been proposed in this report to address the data gap of the specific groundwater interaction at this location.

3 Proposed Groundwater Bores

The proposed drilling locations for the establishment of new groundwater bores are discussed in detail below. Description of drilling method, data collection, and other aspects of execution is provided in Section 4 of this report.

A complete catalogue of the drilling locations, construction depths, and design screening data can be found in Table 9. Figure 16 shows the indicative bore locations. A nominal bore design with casing and construction details can be found in Appendix C.

These bores are proposed in addition to the monitoring network outlined in Section 2.2.

3.1 WSMB Bores

The following bores are already in the monitoring network and been proposed to be added to the list of mandated monitoring locations. Listed in Table 6, these WSMB series bores were originally installed to observe groundwater environments nearby Pits A and B used for mine water management. Consisting of two nested bores at each location, these are screened in the Rewan and Rangal Coal Measures (RCM) aquifers and are considered well suited to be included in the EA for residual void monitoring purposes.

Table 6 Existing groundwater bores for residual void monitoring

Bore ID	Monitored Aquifer	Bore Depth (m)	Observed Water Level (mAHD) (Nov 2020)	Downstream of potential source	Groundwater Flow Direction	Groundwater Chemistry Change
WSMB2S	Rewan	50	142.78	✓	✓	✓
WSMB2D	RCM	108	139.72	✓	✓	✓
WSMB3S	Rewan	24	155.27	✓	✓	✓
WSMB3D	RCM	102	137.3	✓	✓	✓

3.2 DES Proposed Bores

Proposed groundwater bores listed in Table 7 were put forward by DES as minimum additional monitoring required around key residual voids. These bores focus on monitoring the alluvium, with the concern being that any potential impact on the alluvial groundwater system may have a receiving environment proximal to the river system.

These bores are considered to be broadly appropriate in all cases, though amendments to the designed locations have been made to accommodate logistical constraints while maintaining the intent of each location. For designed locations P2 and P5, there is existing groundwater monitoring bores within the area that have been deemed appropriate to use in place of installing a new bore. At P2, this proposed replacement location is termed Field Bore 5 and is located approximately 1.3 km east of the designed P2 coordinates. This bore is located within the alluvial system east of Pit B and, though there is not interpreted to be a groundwater flow gradient in this direction, is considered an appropriate location to monitor. Site observations at this location have observed a groundwater level of 10.2 mbgl and bore condition to be broadly acceptable. Confirmation of bore construction through downhole camera survey is recommended in the next package of works to validate the details available in the public bore database.

At P5, existing groundwater monitoring bore 13020177 is proposed to satisfy the requirement for an additional observation bore. It is located 415 m northwest of the designed P5 coordinates and is installed to 16 mbgl within the alluvial gravels that act as main conduits to flow within this aquifer. Groundwater level was observed to be 14.19 mbgl on 28 January 2021, confirming saturation of the alluvium in this area. A downhole camera surface was not possible at this location due to the narrow bore construction.

Table 7 Proposed groundwater bores listed in EA

Bore ID	Target Aquifer	Target Depth (m) (estimate)	Expected Water Level (mAHD)	Downstream of potential source	Groundwater Flow Direction	Groundwater Chemistry Change
Field Bore 5 (P2)	Alluvium	15	139	✓	✓	✓
P3	Alluvium	15	144		✓	✓
P4	Alluvium	15	139	✓	✓	✓
13020177 (P5)	Alluvium	15	142		✓	✓
P6	RCM	60	150	✓	✓	✓

3.3 Additional Proposed Bores

Table 8 lists bores additional to those outlined in the EA which are designed to cover off other potential flow gradients away from mine voids. As outlined in Section 2.6.1, Pit A and Pit B water levels are above the regional groundwater level and therefore may be contributing to the Rewan and Rangal Coal Measures aquifers. Groundwater contours shown in Figure 8 indicate potential for radial flow away to the south and west of Pit A. GW21-01 is designed to observe this and provide a sentry location proximal to the potential contaminant source. This location will pair with RB5 and RB6 to characterise gradients in chemistry and water level through the south of the mining area.

GR21-02 is designed to characterise the groundwater environment immediately north of the area where alluvium outcrops in Pit B. This location provides verification regarding the interaction between alluvium and pit waters. GW21-03 is located immediately west of Pit B. Groundwater gradients in this area are uncertain, with no observation bores in the Rangal Coal Measures in this area. Laying just outside of the planned underground development area, this bore provides data on groundwater to aid mine water management and act as a sentry for potential interaction between the groundwater environment.

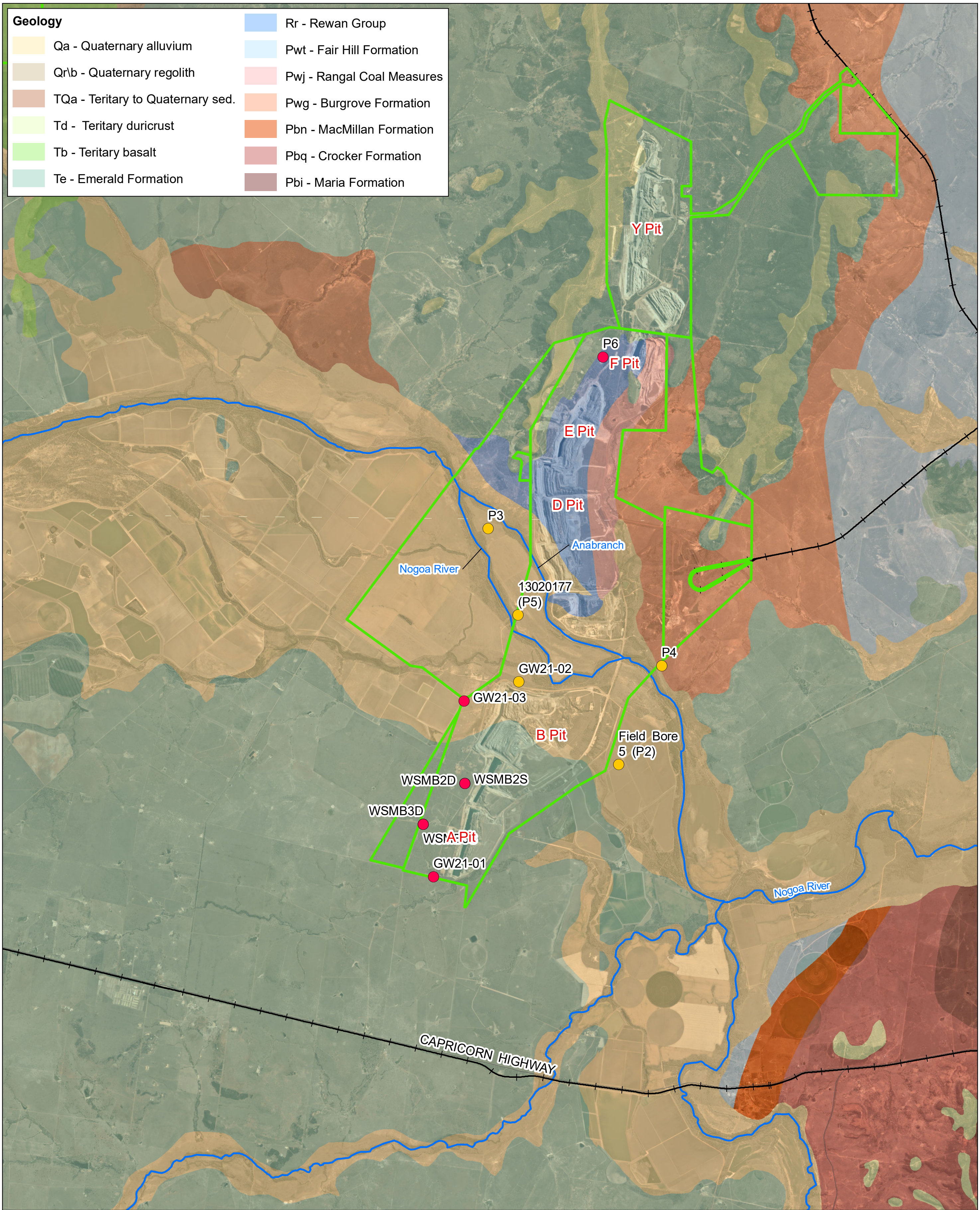
Table 8 Proposed groundwater bores in addition to those listed in EA

Bore ID	Target Aquifer	Target Depth (m) (estimate)	Expected Water Level (mAHD)	Downstream of potential source	Groundwater Flow Direction	Groundwater Chemistry Change
GW21-01	RCM	100	142	✓	✓	✓
GW21-02	Alluvium	15	140	✓	✓	✓
GW21-03	RCM	120	132	✓	✓	✓

Table 9 Groundwater bores proposed to be included in EA monitoring residual void and rehabilitation

Hole_ID	Easting (GDA94 z55)	Northing (GDA94 z55)	Depth (m)	Screen Interval (m)	Designed By	Comment	Target Aquifer	Area
WSMB2S	649062	7397630	50	43 - 49	Ensham	Down gradient of Pit A South	Rewan	Pit A
WSMB2D	649062	7397630	108	97 - 107	Ensham	Down gradient of Pit A South	RCM	Pit A
WSMB3S	647826	7396410	24	6.0-21.0	Ensham	Down gradient of Pit A South	Rewan	Pit A
WSMB3D	647826	7396410	102	60 - 72	Ensham	Down gradient of Pit A South	RCM	Pit A
Field Bore 5 (P2)	653653	7398192	15	TBA	DES	Down gradient of Pit B	Alluvium	Pit B
P3	649753	7405232	15	TBA	DES	Located between Pit D and the Nogoa River	Alluvium	Pit D
P4	654943	7401143	15	TBA	DES	Located between Pit C and the Nogoa River	Alluvium	Pit C
13020177 (P5)	650654	7402654	16	TBA	DES	Located down gradient of Pit C and Pit D, adjacent to Nogoa River. Proximal to EC alluvial monitoring network.	Alluvium	Pits C and D
P6	653181	7410347	60	TBA	DES	Down gradient of Pit Y between Pit and RB2	RCM	Pit Y
GW21-01	648130	7394839	100	TBA	SLR	Monitor GW-Pit water interaction proximal to source. Potential southern flow gradient (wetland).	RCM	Pit A
GW21-02	650676	7400661	15	TBA	SLR	Alluvium outcrop in pit wall, bore to characterise nature of interaction over time	Alluvium	Pit B
GW21-03	649039	7400089	120	TBA	SLR	Monitor Pit B interaction with groundwater at point where flow network is not well defined.	RCM	Pit B

Note: Final location will be subject to survey



N

0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.30255
Date:	10-Feb-2021
Drawn by:	JG

Proposed Monitoring Locations

- Alluvium
- RCM
- Rewan

- Roads
- Rail
- Watercourses
- Mine Leases

ENSHAM RESIDUAL VOID MONITORING REPORT

Proposed Void Management Monitoring Locations

SLR

FIGURE 16

H:\Projects-SLR\620-BNE\620-BNE\620.30255.00000 Ensham Residual Void Monitoring Design\06 SLR Data\01 CADGIS\GIS\62030255_F19 Proposed groundwater Monitoring Locations.mxd

3.4 Residual Risk

The following section aims to provide an assessment of residual risk of the drilling program as evaluated during the design and justification of the proposed drilling works. This is considered necessary for all programs in order to appropriately articulate the balance between a comprehensive program and one that satisfies the goals of the intrusive works. The points captured below act as potential risks that are carried through the project that may only be addressed by the inclusion of additional bores into the program. These additional locations can be designed if required.

- Definition of extent of contamination
    - These bores are aimed to identify potential contamination to the groundwater environment. The program in its current form is not sufficient to determine extent of potential contamination, or the potential risk to groundwater receptors.
    - The source pathway receptor relationship is not considered to be relevant in this situation as the requirement states that the network be sufficient to determine changes to groundwater. These may be considered independent from receptor and no environmental values for groundwater have been established in this area.
- Bores designed based on contouring and flow directions with consideration give for the relatively significant data gaps for some areas (ie. south of the mining area). In some locations, data sourced from landholder bores is incorporated to complete the picture of groundwater environment, though this data may be influenced by local groundwater uses. Professional judgement has been used for the inclusion of this data.
- A risk-based strategy was used to define the key areas for monitoring. The proposed program does not define additional monitoring in the Rewan as the defined low hydraulic conductivity and high hydraulic gradients limit the potential for significant groundwater outflow or impact to receptors.

4 Drilling Methodology Requirements

All groundwater bores are to be drilled and installed by a suitably licensed and qualified Class 2 (confined aquifer) water bore driller as per requirement in Queensland Government legislation (Water Act 2000). Each bore is to be drilled to its required target depth using a suitable drilling methodology. As such, the adopted drilling methodology for these locations must be capable of reaching the proposed target depths as outlined in above sections.

In accordance with EA EPML00732813 condition C48 (c), these bores must be installed with sufficient time to perform 18 months of sampling for incorporation into GMMP updates. A draft schedule for this work feeding into GMMP revision is outlined in Table 10.

4.1 Groundwater Monitoring Bore Installation

4.1.1 Construction requirements

Bores will be drilled to the nominated target aquifer as outlined in Section 3, and the end-of-hole depths adjusted accordingly. Due to this potential variability, the total drill metres of this program may be significantly different to plan. In accordance with Condition C55 (f), the installation of these locations will be carried out in cleared areas away from remnant vegetation and in line with site practices for minimising environmental disturbance.

As a guide, monitoring bores should be pre-collared through any unstable sediments and surface casing (i.e. 150 mm PVC casing) grouted in. The holes should be drilled on air, where possible, with a nominal hole diameter of 100 mm to accommodate a minimum 48 mm of annulus space around the 50 mm PVC casing (i.e. 24 mm on each side of casing) for the gravel pack. The 50 mm casing should be constructed with minimum Class 12 uPVC, with a preference for Class 18 uPVC threaded casing for ease of use for ongoing groundwater sampling (i.e. no screws to catch equipment).

During drilling, samples should be collected at 1 m intervals and details on the lithology logged by a geologist or hydrogeologist. Observations of the groundwater regime should also be logged, including the depth water was first intercepted, groundwater flows (i.e. v notch weir) and water quality (i.e. EC, pH).

A nominal bore design (Appendix C) for the observation bores has been developed in accordance with the Minimum Construction Requirements for Water Bores in Australia (edition 4) (NUDLC, 2020) Final bore construction details should be confirmed by a hydrogeologist prior to construction. Logging of lithology intersected with photographs of material should be recorded during drilling and a bore design and lithological log should be produced following intrusive works. The bores should be constructed with gravel pack across the screen and a minimum of 1 m above the screened interval. A minimum 1 m thick bentonite seal is above the gravel pack, and the hole grouted to surface. The bore should be finished with a lockable steel riser and a 1 m x 1m cement base dug a minimum of 0.2 m into the ground to maintain bore stability.

4.1.2 Bore Development

Following construction, the bores shall be developed (providing yields are sufficient) until the hydrogeologist is satisfied that the bores return clear water, the gravel pack has been sufficiently developed, and drilling fluids have been sufficiently purged from the formation.

Water quality parameters including pH, EC, and temperature should be regularly monitored during development using a water quality meter. These measurements will assist the hydrogeologist decide when the bore has been sufficiently developed and a bore development record can be produced to certify the bore has been installed and commissioned properly.

4.1.3 Groundwater Sampling

Following bore installation, SLR recommends a targeted campaign of groundwater sampling and slug testing to appropriately factor in the new groundwater investigation locations into GMMP revision.

Table 10 Draft schedule for delivery of conditions C48, C52, C53 and C55 (e).

	Q1 2021			Q2 2021			Q3 2021			Q4 2021			Q1 2022			Q2 2022			Q3 2022			Q4 2022			Q1 2023			Q2 2023			Q3 2023			Q4 2023		
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Design of RV Monitoring																																				
Procurement of Drilling Contractor																																				
Bore Installation and Commissioning																																				
Sampling and other data capture																																				
GMMP Update																																				

Completed	
Planned Work	
Deliverable	

5 Summary

Based on an assessment of the potential groundwater impacts from residual voids on site, this report presents evidence for additional groundwater monitoring to be included in the EA for the purposes of monitoring for impact. The mechanisms for potential groundwater influence are outlined in the conceptual model put forth through compiled geological and hydrogeological knowledge. The key elements of this conceptualisation include:

- Long term groundwater levels are modelled to maintain each residual void as a groundwater sink, however present water management conditions have resulted in water levels above the regional groundwater table.
- There is no evidence for groundwater discharge within the study area to any sensitive receptors or aquatic environments such as the Nogoa River. This includes the shallowest groundwater occurrence on site in the Quaternary Alluvial aquifer which has been characterised as highly saline.
- The primary regional aquifer relevant to potential groundwater impacts is the Rangal Coal Measures, with the Rewan Group acting as an aquitard and unlikely to present a contaminant pathway.

In light of these conceptual principles, the additional groundwater monitoring locations proposed in the updated EA were assessed for their suitability. All were considered to be broadly appropriate, however it is considered that moving P5 location to north of Pit B would address a potential data gap and establish the nature of any potential groundwater interaction with the mine void.

Further to these locations, SLR proposes two monitoring bores west of Pits A and B to provide more robust sentry points given that this area is deemed the most likely groundwater-surface water interaction points on site.

6 References

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APPENDIX A

Existing Groundwater Monitoring Network

620.30255-Ensham Residual Void Investigation
Groundwater Monitoring Locations
January 2021

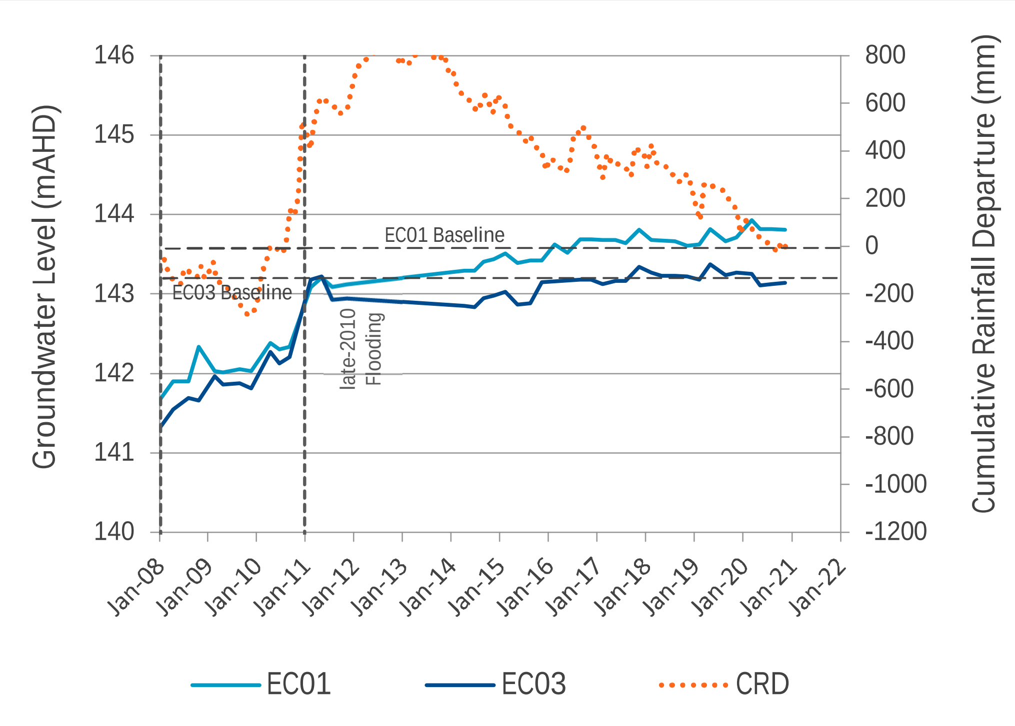
Bore ID	EA	Bore depth (mbGL)	Easting (mE) GDA94 Zone 55	Northing (mN) GDA94 Zone 55	Ground Elevation (mAHD)	TOC elevation (mAHD)	Stick-up (m)	Screened zone (mbGL)	Type	Dia (mm)	Aquifer
EC01	EA	17.2	650018	7403059	153.87	154.3	0.43	14-17	PVC	50	Alluvium
EC03	EA	16.6	650338	7402547	152.71	153.2	0.49	12.3-15.3	PVC	50	Alluvium
EC07	EA	18	650973	7401746	153.39	153.9	0.51	12.6-15.6	PVC	50	Alluvium
EC09A	EA	18	651354	7401504	152.87	153.5	0.63	15.1-18.1	PVC	50	Alluvium
EC11	EA	17.4	651517	7401192	152.24	152.7	0.46	14.3-17.3	PVC	50	Alluvium
EC13	EA	15.2	651517	7400776	151.52	152	0.48	12.2-15.2	PVC	50	Alluvium
EC14	EA	12	651676	7400653	145.75	146.1	0.35	8.7-11.7	PVC	50	Alluvium
EC17_2	-	15	652673	7400395	-	153.5	-	12.0-15.0	PVC	50	Alluvium
GW01	EA	19.79	653934	7400423	-	~153	0.59	-	Steel	~200	Alluvium
WSMB2S	-	50	649062	7397630	172.35	173	0.65	43 - 49	PVC	50	CMO
WSMB2D	-	108	649059	7397630	172.42	173	0.58	97 - 107	PVC	50	CS
WSMB3S	-	24	647826	7396413	173.5	174	0.5	6.0-21.0	PVC	50	CMO
WSMB3D	-	102	647826	7396410	173.43	174	0.57	60 - 72	PVC	50	CMO
UG02	-	12	652465	7403096	106.2	106.2	0	9.0-12.0	PVC	50	Spoil
UG04	-	93	652309	7402713	169.4	169.9	0.5	90 - 93	PVC	50	CS
UG05	-	95.5	652242	7403017	169.8	170.3	0.5	92.5 - 95.5	PVC	50	CS
UG06	-	128.5	652151	7402908	193.3	193.8	0.5	125.5 - 128.5	PVC	50	CS
UG08	-	89.5	652023	7403174	153.5	154	0.5	86.5 - 89.5	PVC	50	CS
UG09	-	29	652030	7403323	95.3	95.8	0.5	26 - 29	PVC	50	Spoil
UG10	-	13	651841	7403395	79.8	80.3	0.5	10.0-13.0	PVC	50	Spoil
RB1	EA	97	649911	7412651	187.16	187.73	0.57	95.5 – 97.0	PVC	50	Coal(A2C)
RB2	EA	149.5	645754	7410363	-	160.6*	0.6	137.5 – 143.5	PVC	50	Coal
RB3	EA	208.3	645395	7402283	155.94	156.49	0.55	205.25 – 208.25	PVC	50	Coal(A2C)
RB4	EA	240.1	642671	7398753	175.03	175.89	0.86	237.1 – 240.1	PVC	50	Coal(A21)
RB5	EA	230.3	646337	7395250	172.89	173.35	0.46	227.3 – 230.3	PVC	50	Coal(A21)
RB6	EA	~60	648836	7392168	-	177.06	-	~54 – 59	PVC	50	Coal(A2C)
RB7a	-	15.2	647740	7407172	-	157.08	-	~ 9 - 15	PVC	61	Alluvium
RB7b	-	154	647737	7407177	-	157.17	-	15	VWP	-	Sand
					0			50			Sandstone
					0			120			Sandstone
					0			146			Coal (A3C)
					0			153			Sandstone
Karanga Bore		~50	649043	7388304	172.97	173.59	0.62	-	PVC	~125	Coal Measures
Winton Creek Bore		60	642771	7400758	157.31	157.59	0.28	-	PVC	~125	Rewan Group
Twin Bores		18.05	641319	7401567	158.39	158.77	0.38	-	Steel	-	Basal alluvium
Jamar Bore		89.7	642025	7399084	183.43	183.84	0.41	-	PVC	~100	Rewan Group
Yongala Bore (RN89383)		74	657586	7415693	266	#VALUE!	-	-	Steel	165	Burngrove Formation
Fairhill Bore (RN89380)		77	658696	7416877	265	#VALUE!	-	-	Steel	150	Burngrove Formation
Railway Bore (RN90140)		61	663591	7412470	181	181.35	0.35	-	PVC	140	Fair Hill Formation

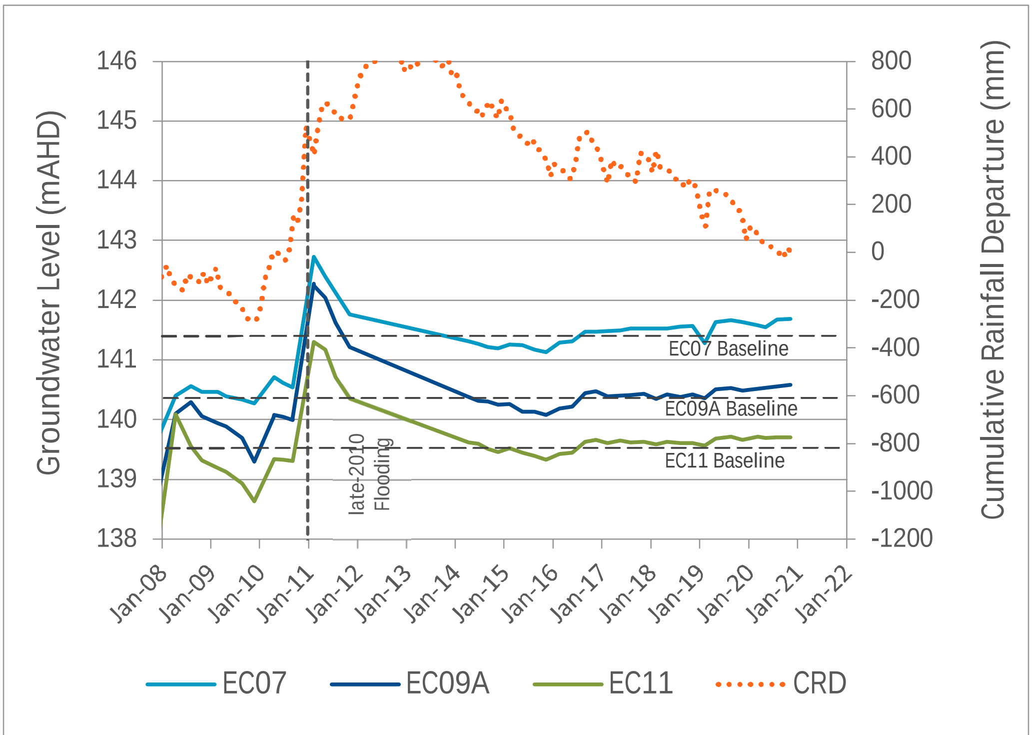
Notes: *- Not available* *CMO = Coal Measure Overburden* *Coordinates are in MGA94 Zone55*

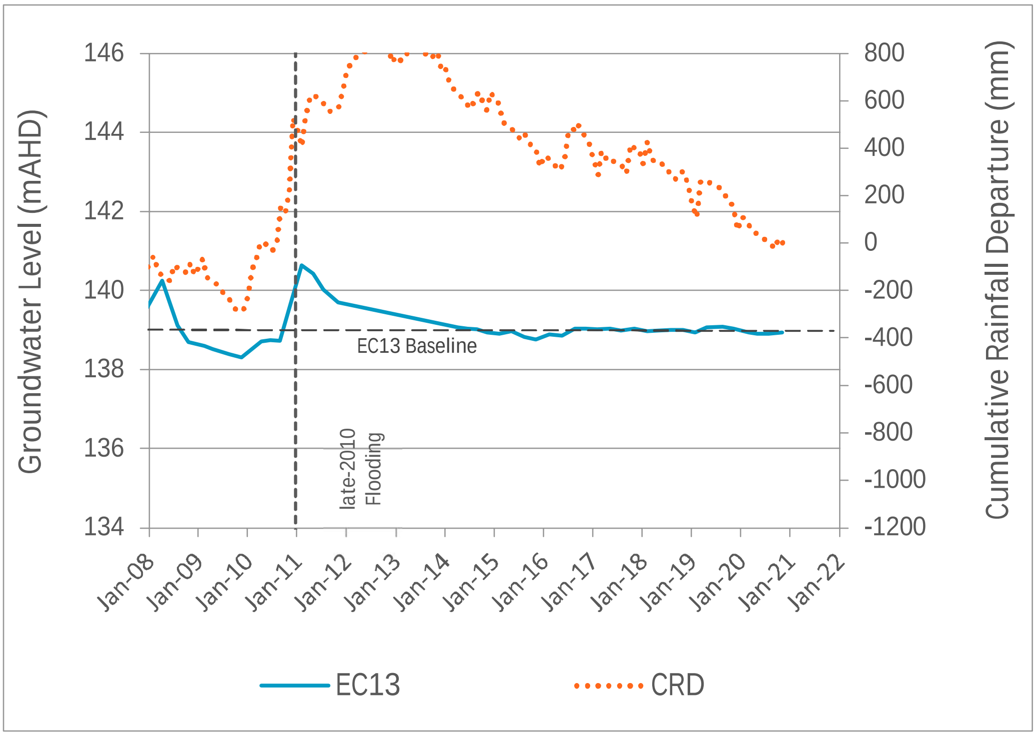
~ approximately *CS = Coal Seam* ** Ground elevation not surveyed, estimated from Geoscience Australia (2011) DEM-*

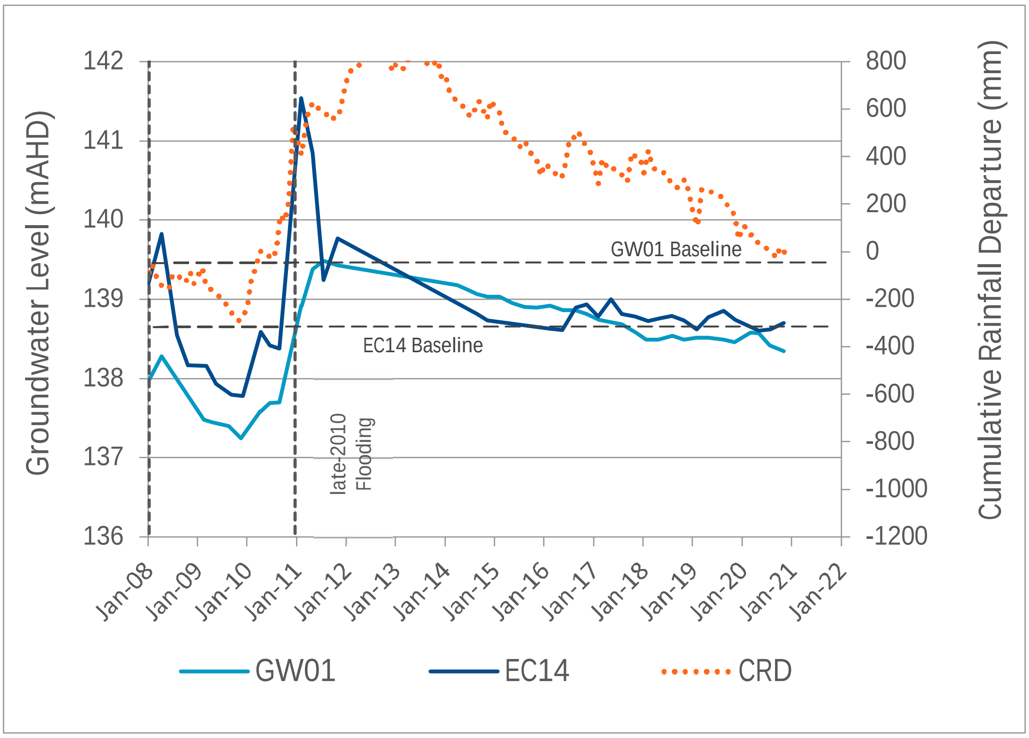
APPENDIX B

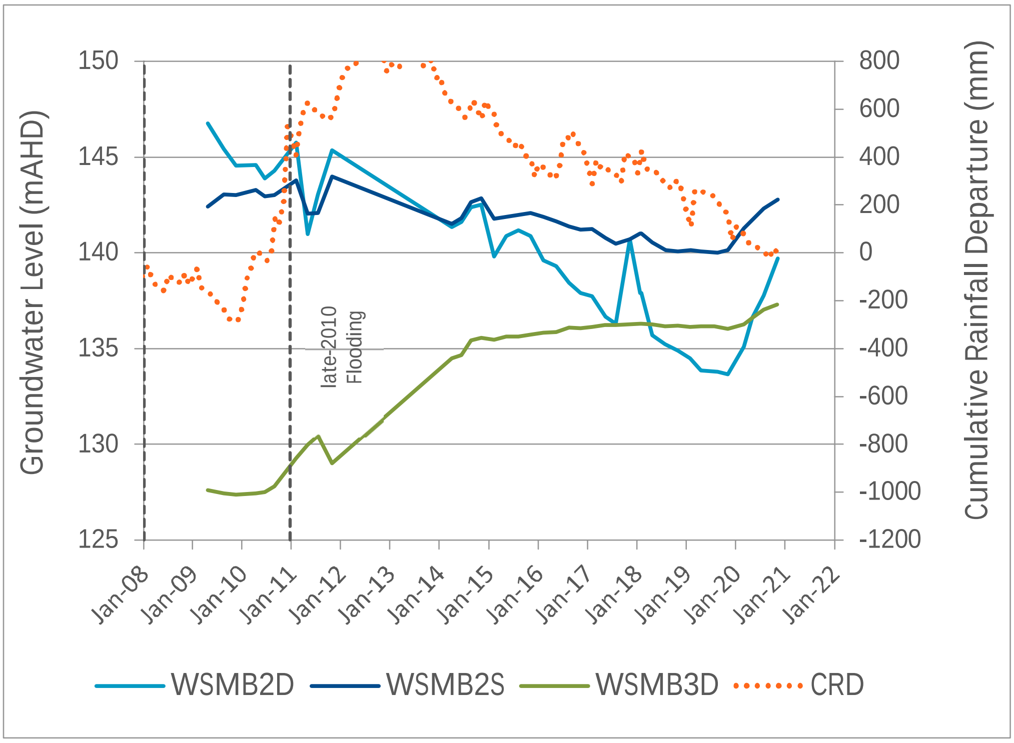
Groundwater Level Monitoring


Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EC01 Baseline
EC03 Baseline
late-2010 Flooding
146
145
144
143
142
141
140
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
EC01
EC03
CRD

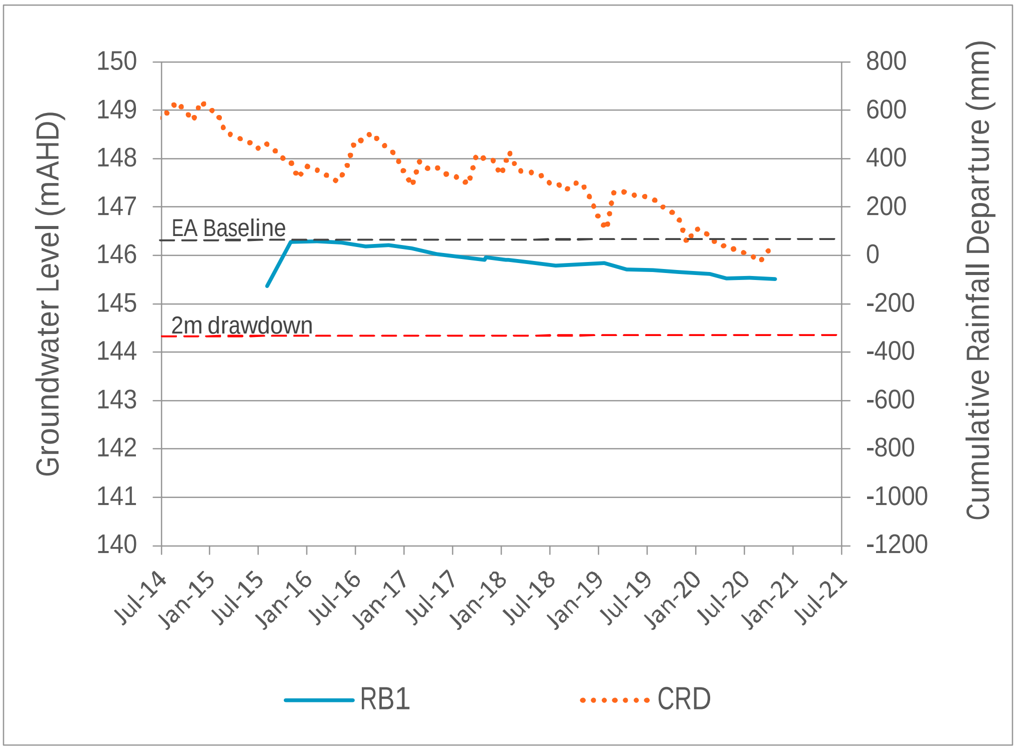

Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EC07 Baseline
EC09A Baseline
EC11 Baseline
late-2010 Flooding
146
145
144
143
142
141
140
139
138
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
EC07
EC09A
EC11
CRD


Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
146
144
142
140
138
136
134
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EC13 Baseline
late-2010
Flooding
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
EC13
CRD

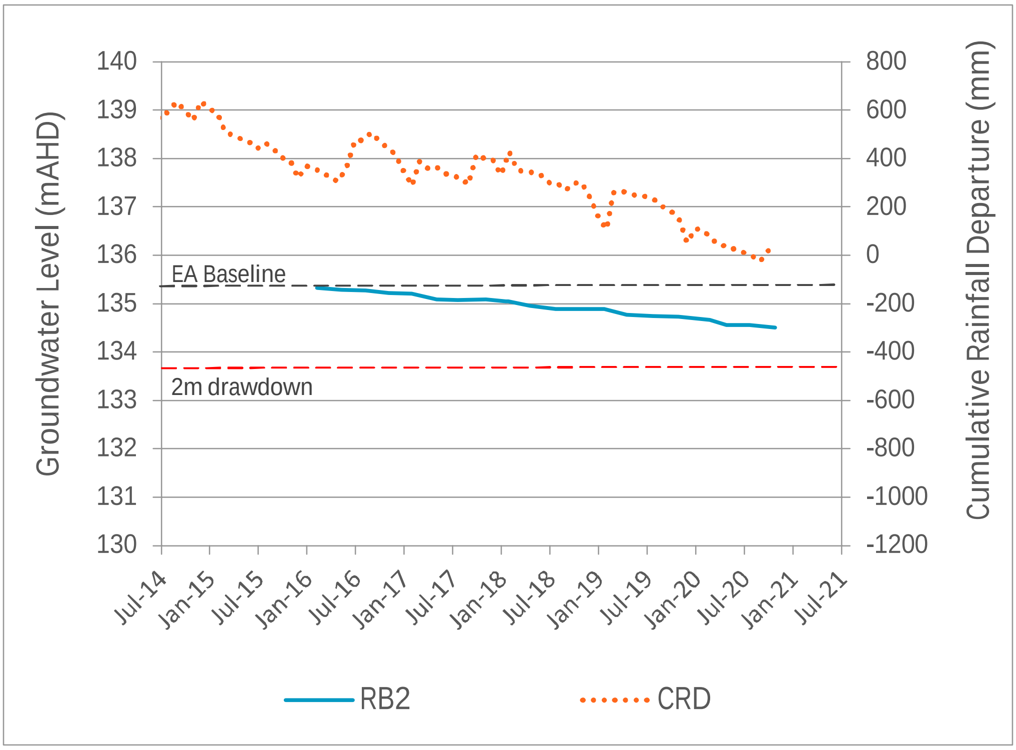

Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
142
141
140
139
138
137
136
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
GW01 Baseline
EC14 Baseline
late-2010
Flooding
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
GW01
EC14
CRD



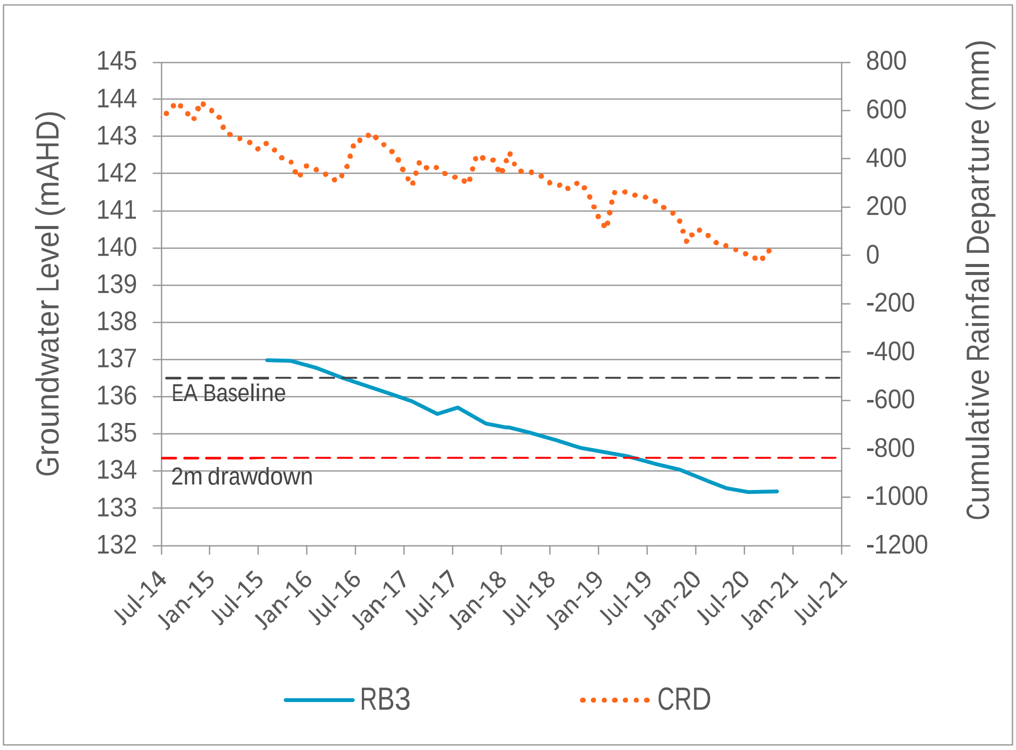
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
late-2010 Flooding
WSMB2D
WSMB2S
WSMB3D
CRD



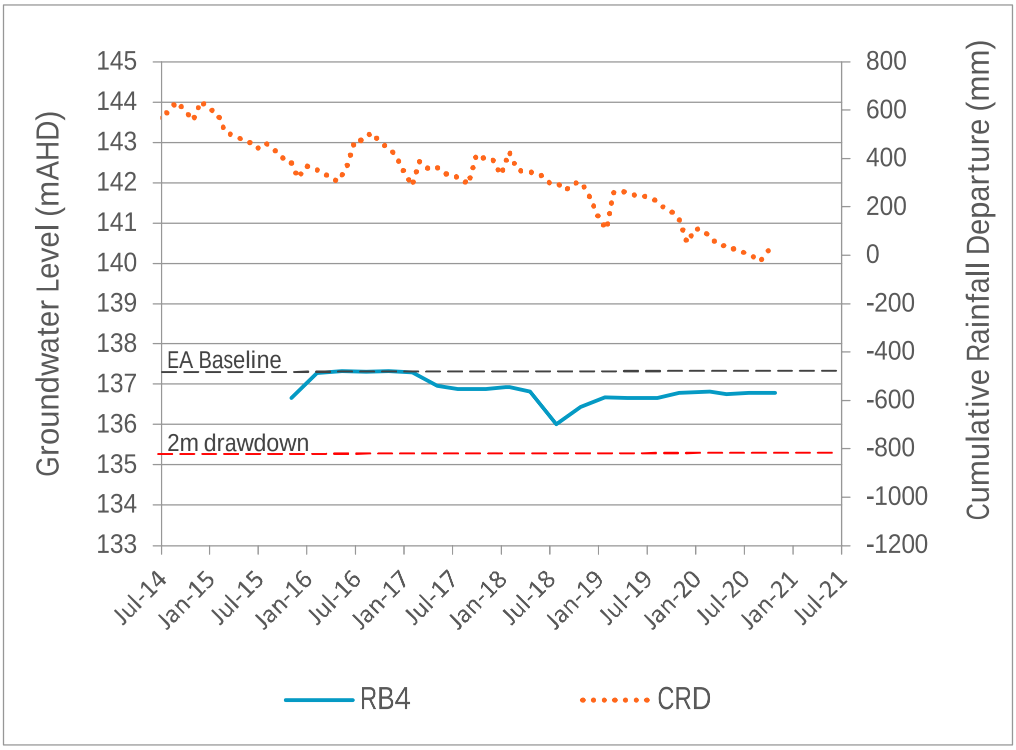
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
RB1
CRD



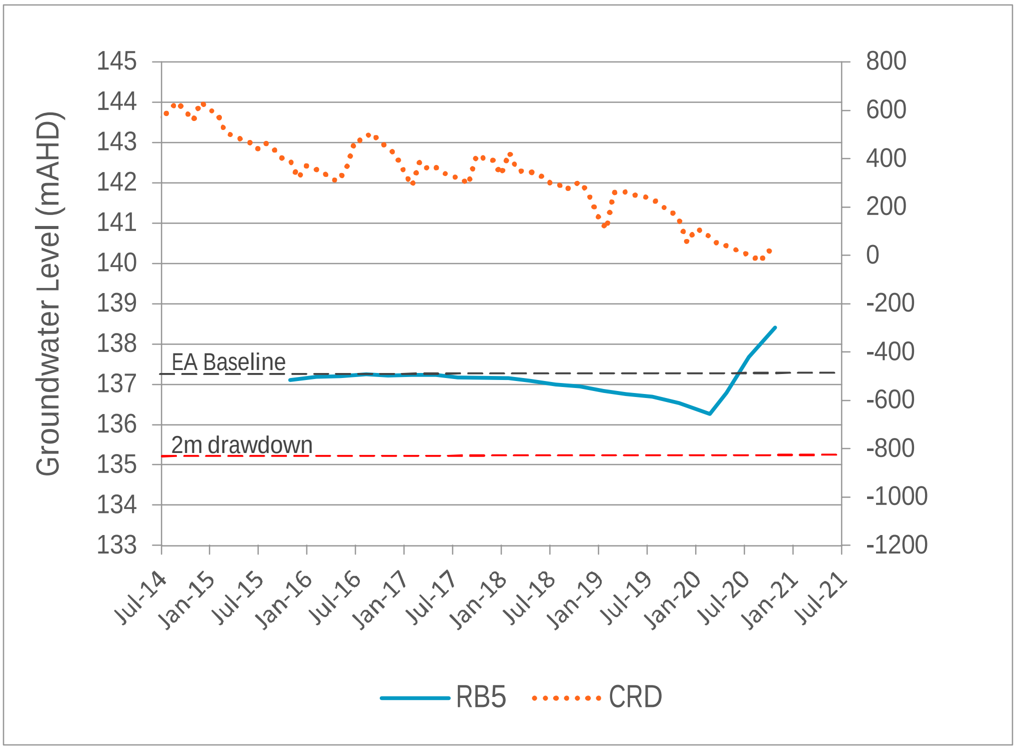
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
RB2
CRD



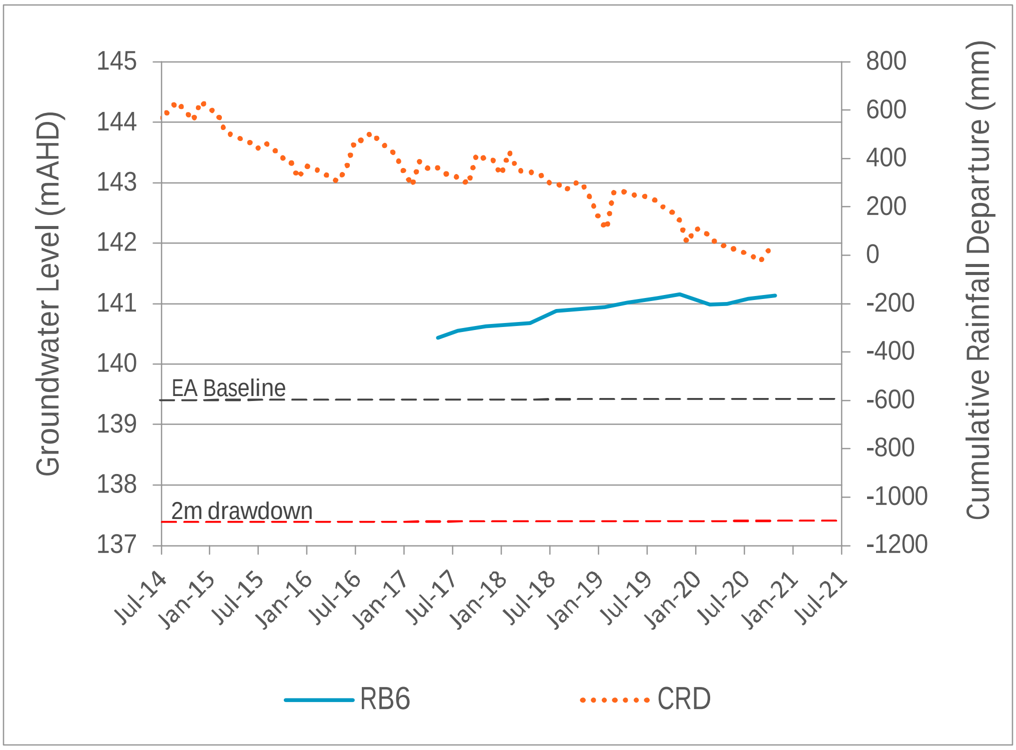
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
RB3
CRD



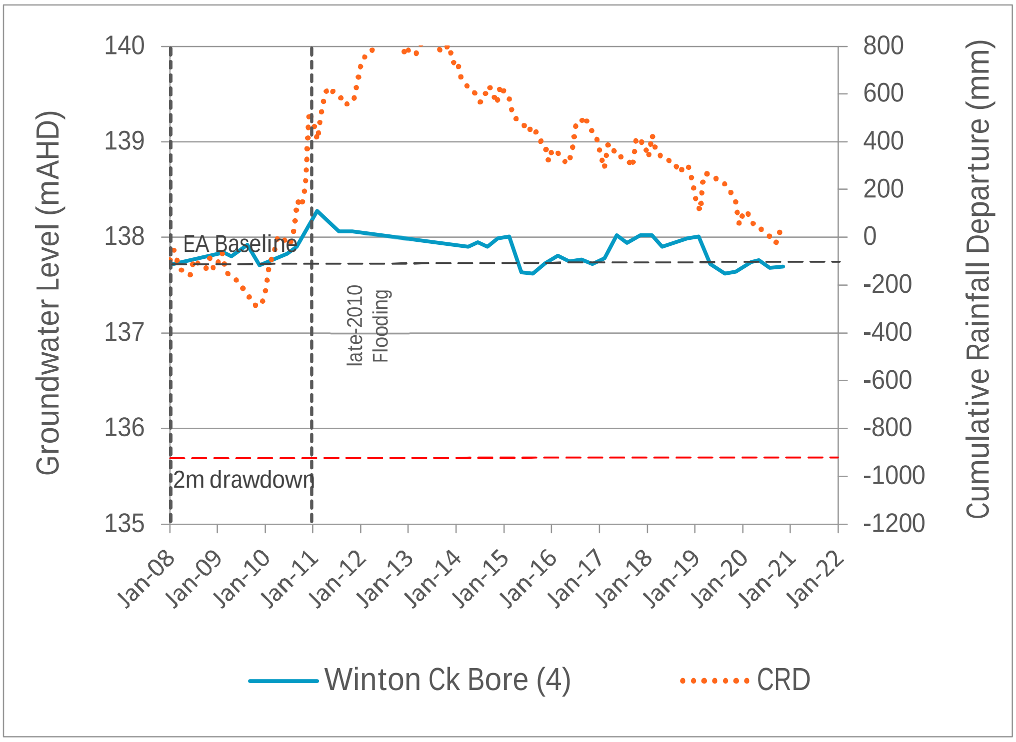
Groundwater Level (mAHD)
145
144
143
142
141
140
139
138
137
136
135
134
133
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Jan-21
Jul-21
RB4
CRD



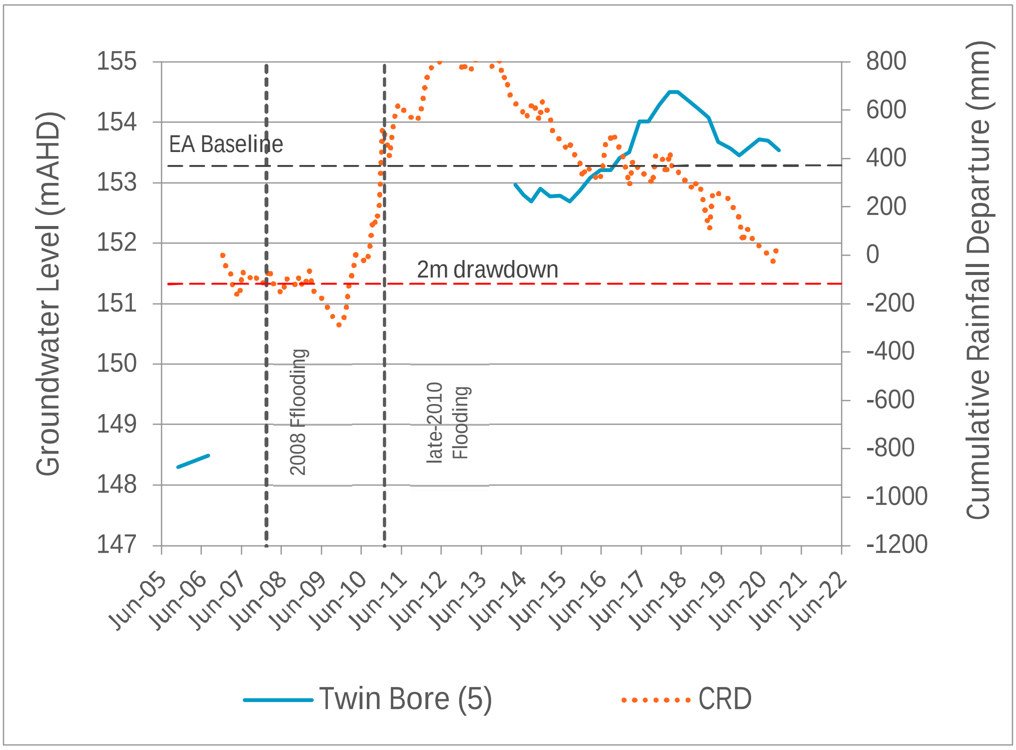
Groundwater Level (mAHD)
145
144
143
142
141
140
139
138
137
136
135
134
133
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Jan-21
Jul-21
RB5
CRD

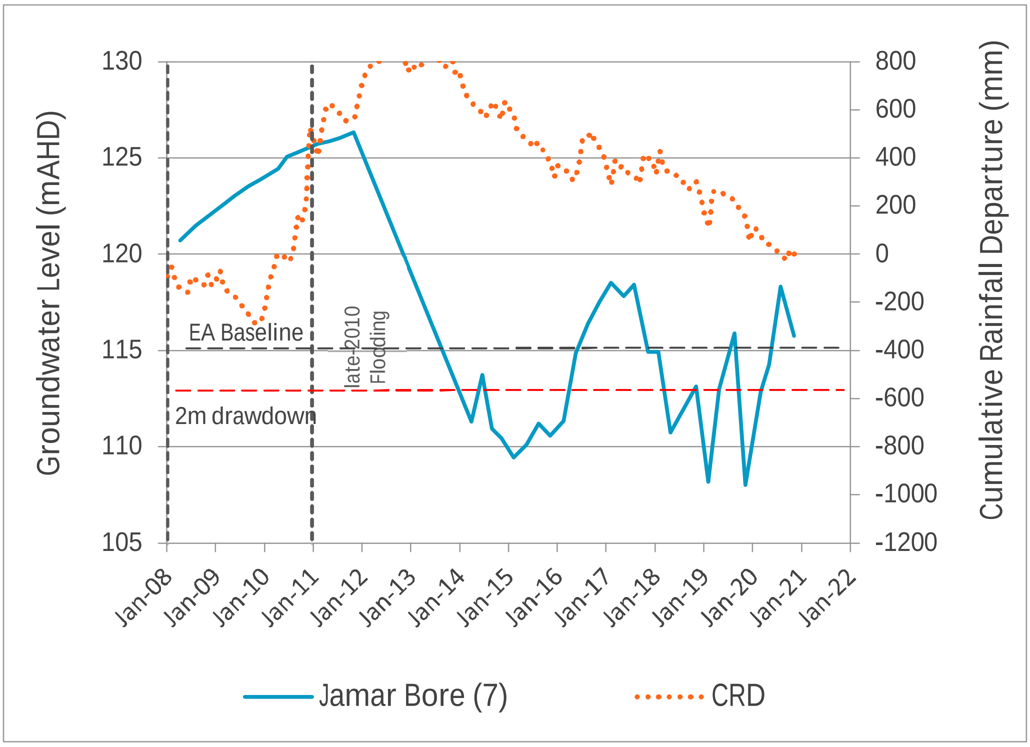


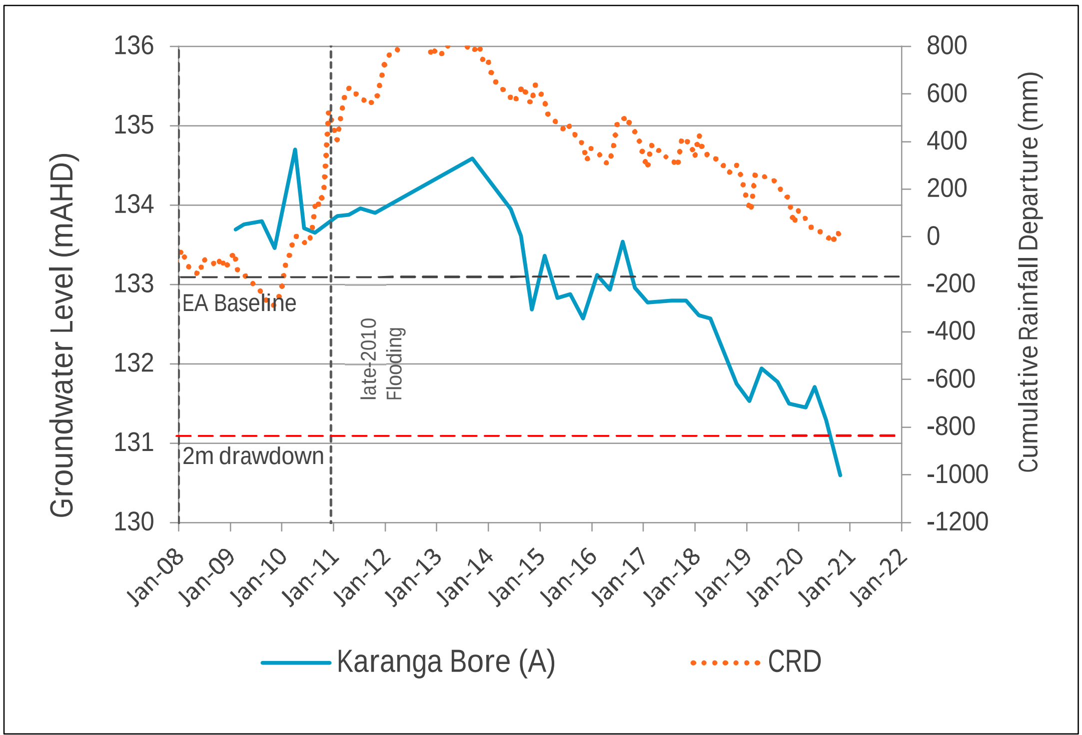
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
145
144
143
142
141
140
139
138
137
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Jan-21
Jul-21
RB6
CRD

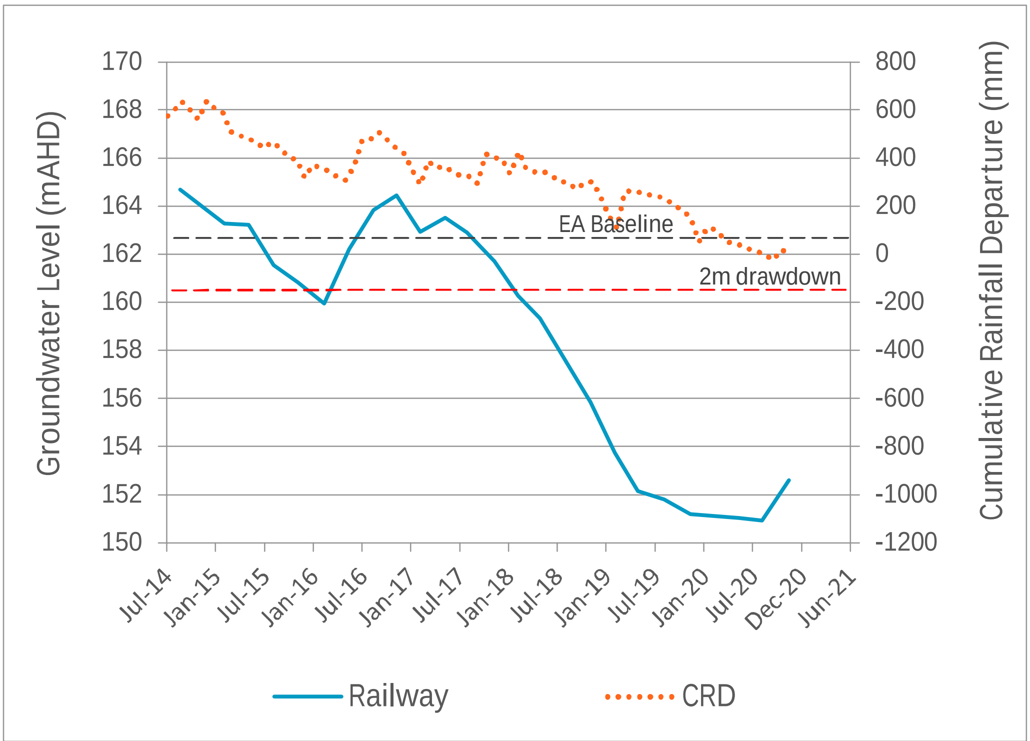


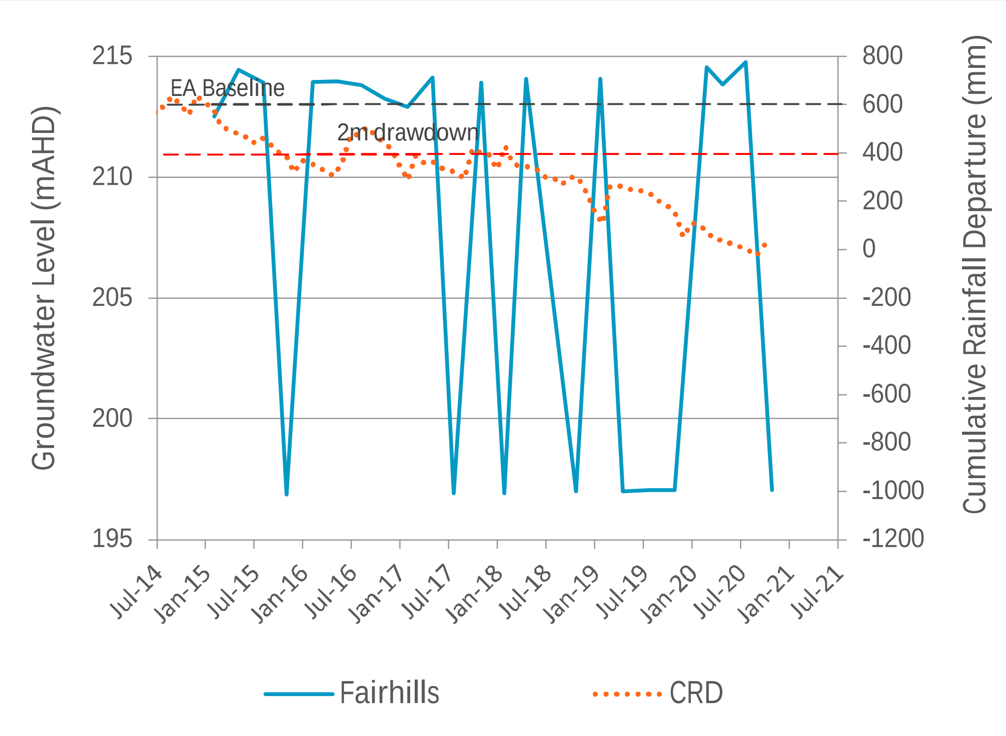
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
140
139
138
137
136
135
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EA Baseline
late-2010 Flooding
2m drawdown
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Winton Ck Bore (4)
CRD


Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
2008 Fflooding
late-2010 Flooding
Jun-05 Jun-06 Jun-07 Jun-08 Jun-09 Jun-10 Jun-11 Jun-12 Jun-13 Jun-14 Jun-15 Jun-16 Jun-17 Jun-18 Jun-19 Jun-20 Jun-21 Jun-22
Twin Bore (5)
CRD

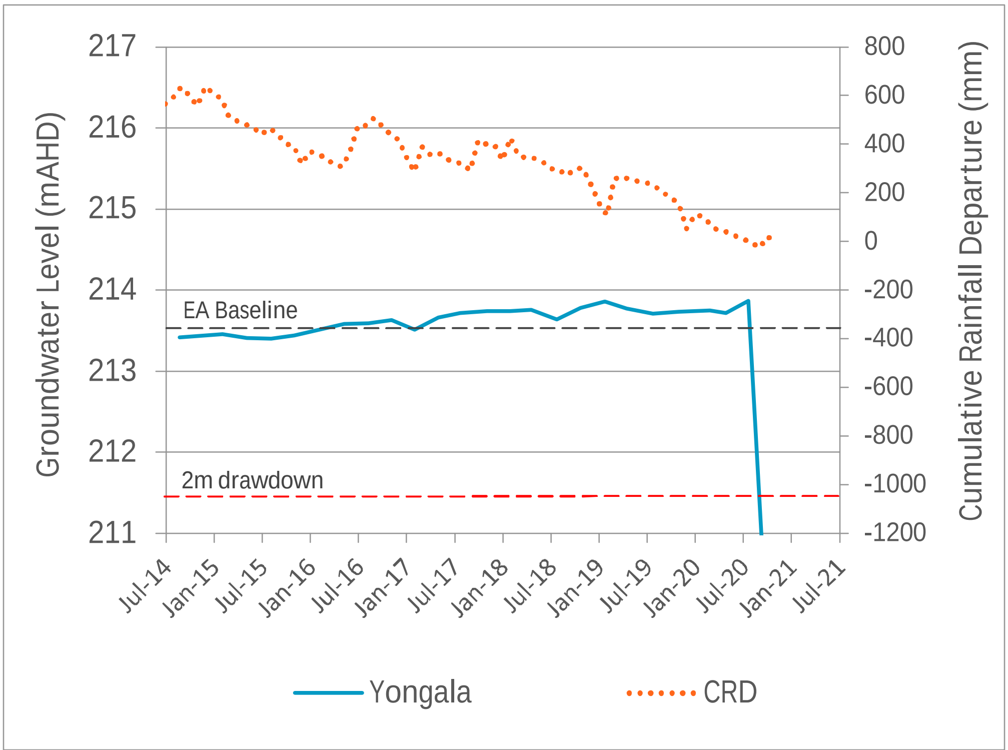

Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
late-2010 Flooding
Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Jan-17 Jan-18 Jan-19 Jan-20 Jan-21 Jan-22
Jamar Bore (7)
CRD


Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
136
135
134
133
132
131
130
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EA Baseline
2m drawdown
late-2010 Flooding
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Karanga Bore (A)
CRD


Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
170
168
166
164
162
160
158
156
154
152
150
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Dec-20
Jun-21
Railway
CRD



215
210
205
200
195
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Jan-21
Jul-21
Fairhills
CRD

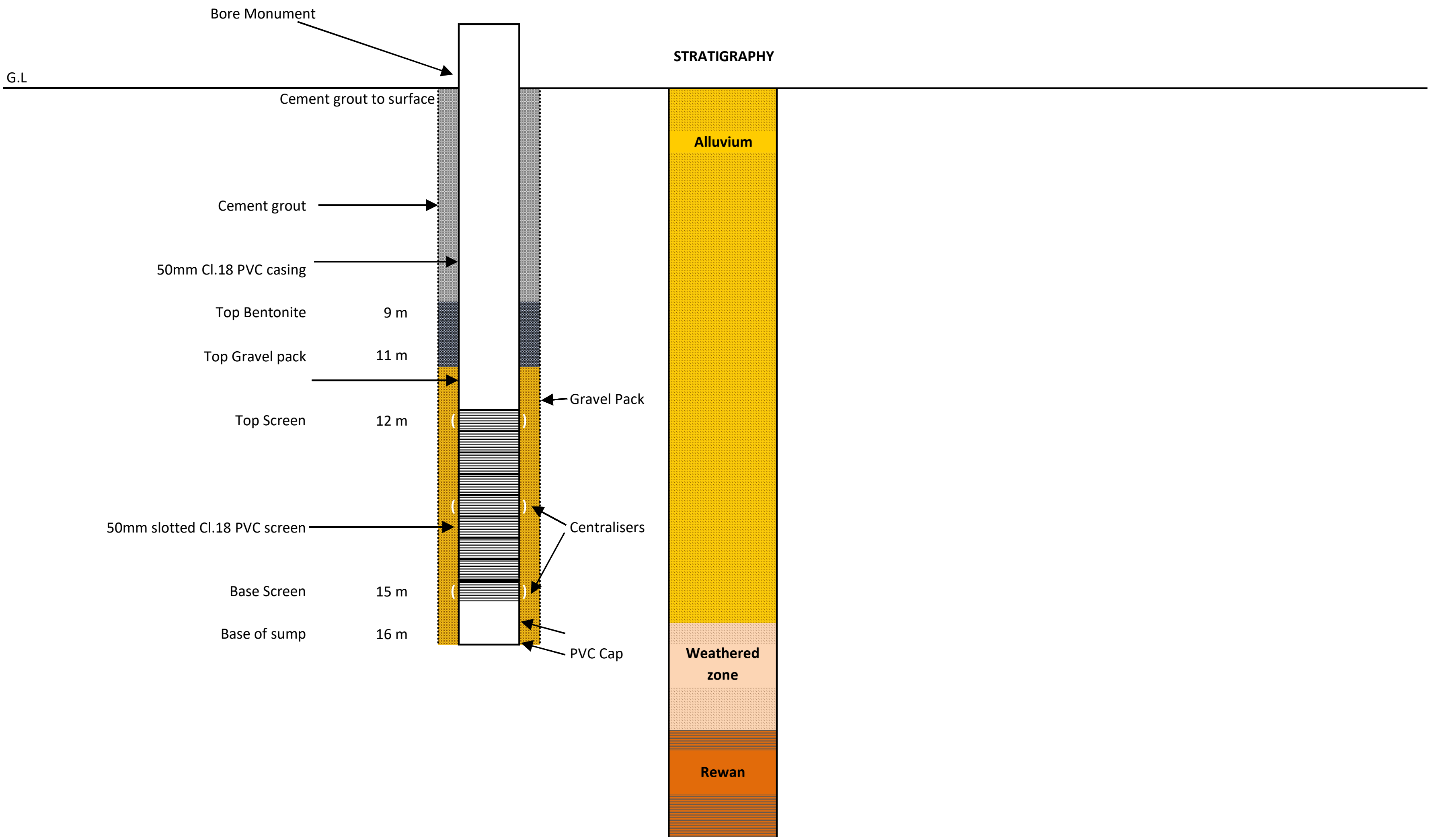


217
216
215
214
213
212
211
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
EA Baseline
2m drawdown
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Jan-19
Jul-19
Jan-20
Jul-20
Jan-21
Jul-21
Yongala
CRD

APPENDIX C

Nominal Bore Design

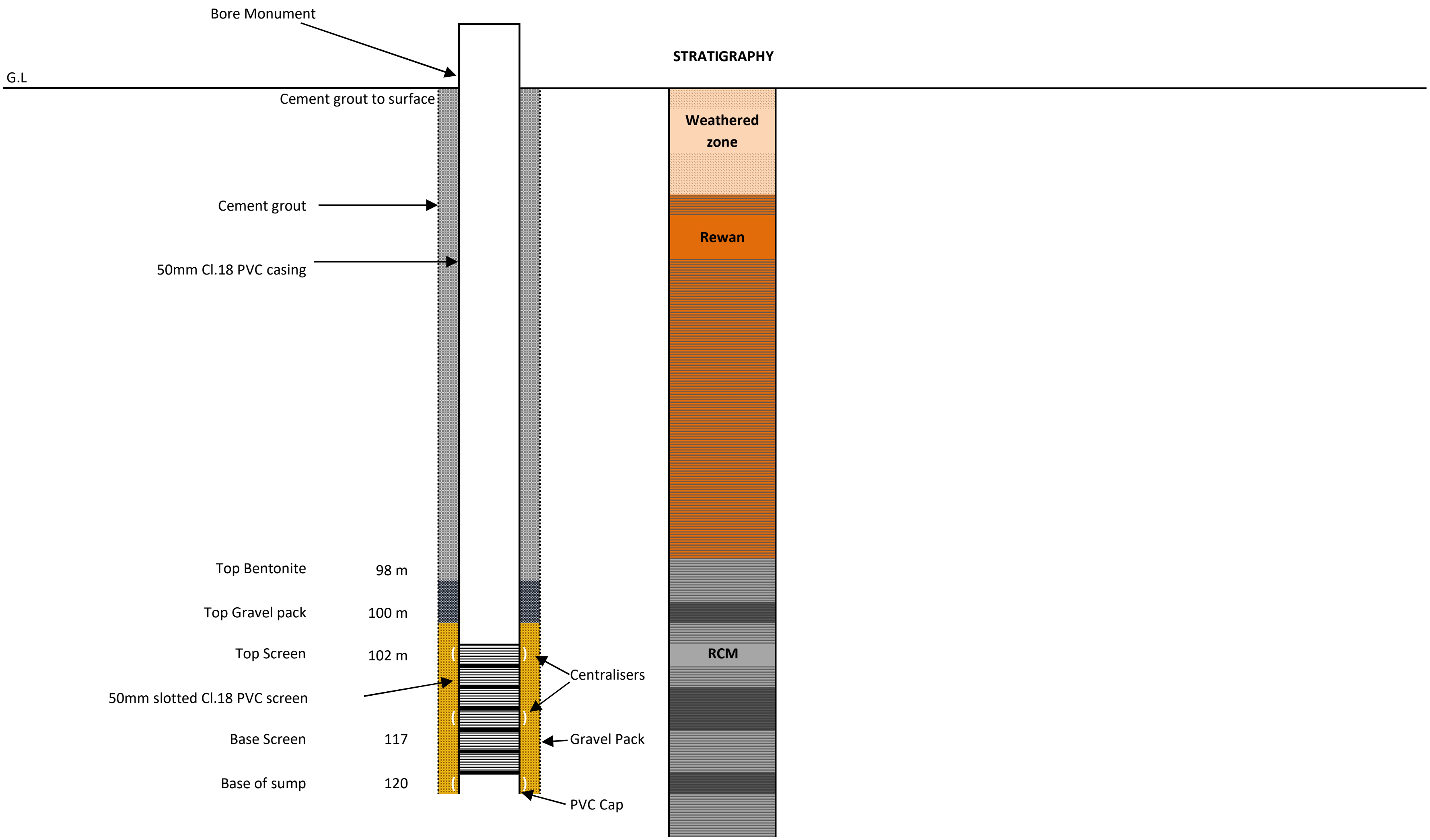
Alluvium Monitoring Bores (nominal design)



Note: all depths are approximate and will be determined during drilling

Not to Scale

Rangal Coal Measures Monitoring Bores (nominal design)



Note: all depths are approximate and will be determined during drilling

Not to Scale

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