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Hydrogeology

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Introduction

The hydrogeological development at Thalanga is closely linked to the geological characteristics of the deposit and surrounds, the mining history of the site, as well as natural rainfall variations. To appreciate changes in groundwater levels over time an understanding of all three components is necessary. Hence, summary findings on all three components from previous progress reports are reiterated below.

1. Geological characteristics

The geological characteristics of the Thalanga site have been described in detail in the September 2018, Thalanga EE progress report (NRC 2018). In Summary, the mined deposit consists of a series of steeply dipping, partially interconnected narrow ore lenses. A typical cross section of such ore lenses is shown in Figure 1.

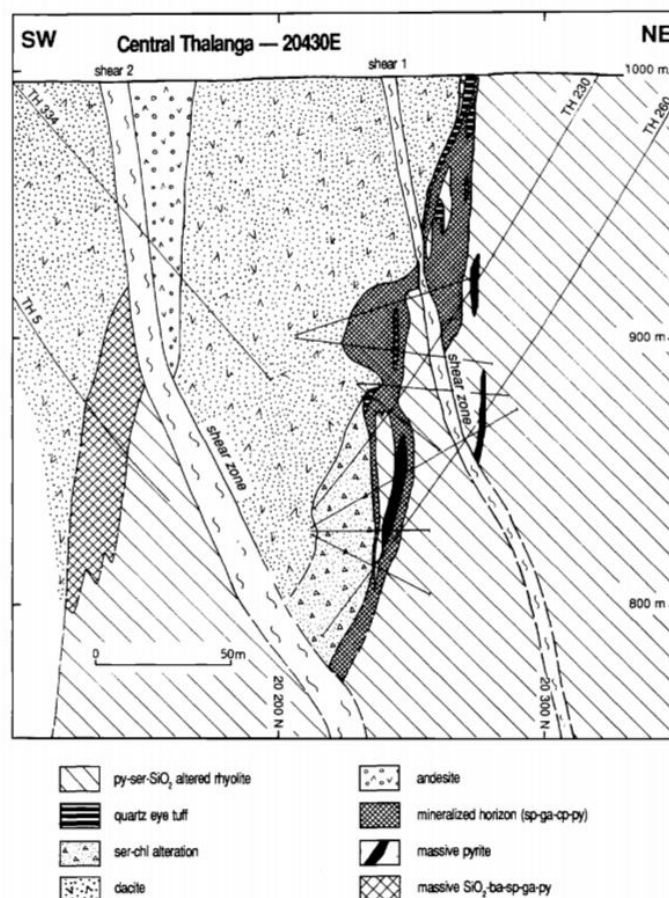


Figure 1 Typical cross section of the Thalanga Bed Rock geology (from Berry et al., 1992)

The characteristics of the deposit have important implications for the groundwater level development. The deposit, due to sulphide mineral void spaces, can be classified as an aquifer that is confined by the surroundings. Less permeable strata envelops the deposit and dewatering of the orebody has generally limited influence on surrounding natural groundwater tables. This limited influence has been demonstrated by groundwater level measurements around the previously mined out Central Pit throughout 1989 and 1990 (Figure 9); groundwater level measurements conducted by Giblin in 1995; the result of pumping tests conducted by Rob Lait & Associates with regards to the West 45 project (Rob Lait & Associates, 2011); and groundwater level monitoring results for West 45 and the subsequent Far West dewatering since 2018.

Lateral connection between different aquifer sections of the deposit may be facilitated by the presence of a veneer of intensely weathered, but often clayey bedrock, which in places was found to be up to 48m deep (Barrett, Askew, Fuller, & Partners, 1982). Overlying the near surface, partially weathered, central Thalanga deposit (the original, now backfilled Central Pit), was a clay gossan, which contained small natural perched aquifers. These small perched aquifers were localised within the ore structure and have subsequently been removed by mining.

Overlying the lower eastern and northern sections of the Thalanga lease is the Campaspe Formation. The Campaspe Formation consists of late tertiary sediments, composed of poorly sorted sandstone, coarse conglomerate, ferruginous clay and silt. The sedimentary sequence, in places up to 200m thick (Henderson and Nind, 2014), is often characterised by pore filling by silt and mud, which would suggest a limited aquifer potential. Nevertheless, Pitt (1988) found that the Campaspe Formation can host groundwater reservoirs. The Thalanga bore field, located within the Campaspe Formation approximately 2000m east, north-east of the mine site is evidence of that aquifer potential. The bore field was commissioned in 1988 and continues to supply the Thalanga site with process water. As such the Campaspe Formation, due to its Regional extent and proven aquifer potential, is the only aquifer of significance at Thalanga.

Recent alluvial is only present along drainage lines. These drainage lines may contain gravels with good aquifer potential. However, the lateral extent and depth of these gravels was found to be very limited (Australian Groundwater Consultants, 1981). Hence, these shallow, potential recent alluvial aquifers are considered ephemeral.

2. Mining History

The mining history of the Thalanga deposit is relevant to the understanding of the groundwater situation at Thalanga. The below has been summarised from the March 2018, Thalanga EE progress report (NRC 2018) and further extended. Operations at the site are now divided into five phases:

- Phase One (1989 - 1998) included the mining of the initial 75m deep Central Pit and subsequent extraction of zinc-lead-copper ore from the East (~420m deep), Vomacka (~150m deep), Central (~175m deep), West (~460m deep) and Far West (~450m deep) underground locations.

- Phase Two (1998 - 2006) comprised the processing of Highway Reward copper-gold ore and the generation of additional tailings.
- Phase Three (2006 - 2008) saw the takeover of the Thalanga operation by Kagara and the processing of copper ore from Kagaras Balcooma operation and additional tailings production.
- Phase Four (2008 - 2012) involved the mining of the 85m deep zinc-lead-copper Vomacka Pit orebody and the creation of additional tailings. Phase Three also saw the initial development of the West 45 deposit, which was halted following the cessation of the Kagara operations
- Phase Five (2012 - 2019) included the recent extended West 45 underground development, the generation of additional tailings and the dewatering activities with regards to the Far West project.

2.1 Phase One

The initial Thalanga mine began production in June 1989. Mining of the volcanic massive sulphide (VMS) deposit by the open pit method was conducted until October 1990 and subsequent underground extraction of ore from the East Underground, Vomacka Underground, Central Underground, West Underground and Far West Underground continued until June 1998. In the nine years of operation, the Thalanga venture extracted 4.753.000t of polymetallic Zn-Pb-Cu ore with an average grade of 8.52% zinc, 2.65% lead and 1.62% copper.

Most of the resulting tailings were stored in a series of tailings ponds approximately 700m north of the Central Pit. However, between 1990 and 1995 and June 1998 and July 2000 approximately 340,000m³ of tailings were used as hydraulic underground backfill (Soto, 2001 cited in Scott & Langton, 2002) URS, 2002.

Waste rock from the Central Pit was stored in two separate waste rock dumps (WRDs). The East WRD with a volume of approximately 700,000m³ was located approximately 200m southeast of the Central Pit and comprised a mixture of oxide, supergene and intermediate wastes produced during pit development operations in 1988/1989 (AGC Woodward-Clyde, 1994).

Waste rock from the lower sulfide rich production area mined during 1989/1990 was stored in the 1,230,000m³ West WRD, in the area now termed the Wet Land area, 100m west of the Central Pit. Following significant acid seepage issues, the West WRD was relocated into the Central Pit during the 1998/1999 wet season, partially (~75%) backfilling the void (URS, 2002) and creating a surface water sink for runoff from mine impacted areas. Apart from this, approximately 407,000m³ of waste rock backfill was placed into the mined underground workings. Prior to relocation, the creation of the West WRD inadvertently resulted in the compaction of the underlying clayey strata and potential aquifer sections within and below that strata.

2.2 Phase Two

Underground tailings deposition continued in the following years using tailings generated by the onsite processing of Copper-Gold Highway Reward ore between 1999 and 2005. It is not clear if the practice of underground tailings deposition was halted, when an alkaline tailings water pond started to fill the remaining shallow Central Pit void in August 2002. Clear is, the water levels within the Central Pit void continued to increase following the initial appearance of the water body. Upon increased contact with the acid generating waste rock in the pit the pH of the water body changed from alkaline to acid.

2.3 Phase Three

Phase Three begins with the takeover of the Thalanga mine site by Kagara in 2006. Prior to this, processing of ore from Highway Reward had ceased, and the new owners progressed to process ore from their Balcooma orebody. Tailings deposition into the underground had ceased and the new owners progressed to pump water from the evaporation pond into the remaining pit void. The process of in pit disposal of surplus water was only halted due to the observation of significantly increased groundwater levels and the renewed dewatering need for the proposed Vomacka Pit.

2.4 Phase Four

Stage Four began with the development of the Zn-Pb-Cu orebody in the approximately 85m deep Vomacka Pit. Waste rock from the Vomacka Pit was used to further fill the remaining initial Central Pit void to subsequently create an elevated land form from which surface water would shed rather than collect in. Tailings from the Vomacka Pit development were stored in a newly created tailings cell adjacent to the historical tailings cells in the north-eastern section of the mining lease. Phase Four also saw the initial development of the West 45 deposit until 2012.

2.5 Phase Five

Following the cessation of the Kagara operations, and a change of ownership to Cromarty Resources, has seen renewed activity at West 45, with mining re-commencing in April 2017 and, as of October 2017, having reached a depth of 155m. In addition, dewatering of the Far West deposit commenced in 2018 via existing early 1990s vent shafts and escape ladder ways.

3. Climatic factors

Of the climatic factors rainfall variability and evaporation have a significant influence on long term groundwater levels.

3.1 Rainfall

At Thalanga long term rainfall records for the Balfes Creek Post Office (Figure 2), located less than 20km north east of the Thalanga site, show that the area goes through multi-year drought cycles. Since the Thalanga operation started in 1988 the Region has seen low rainfall periods between 1991 and 1997, 2003 and 2005 and 2013 and 2018 (Figure 2).

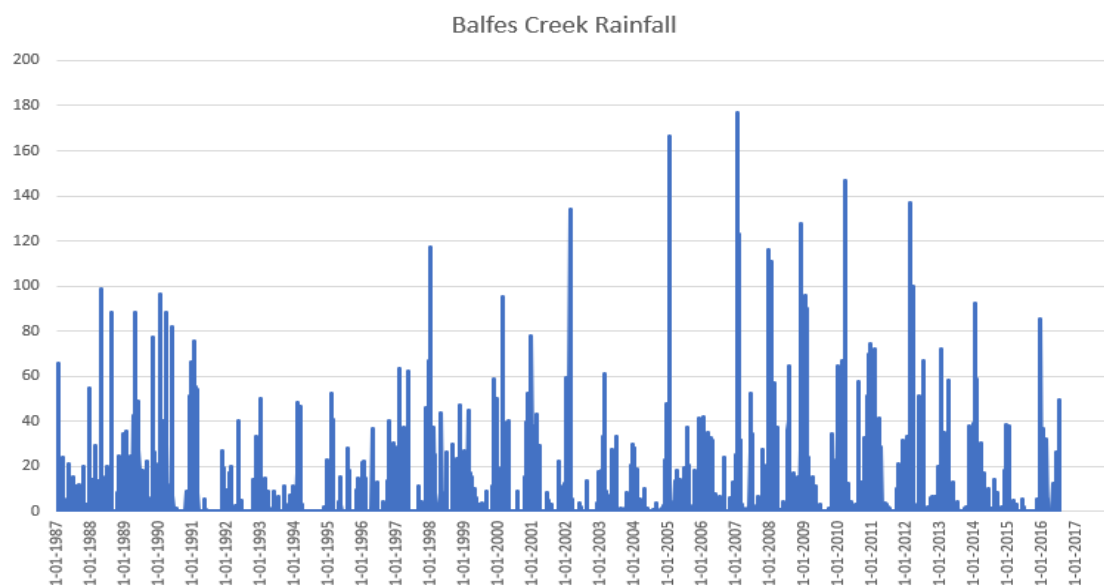


Figure 2 Rainfall recorded for Balfes Creek Post Office (BoM Station 34000)

Rainfall data for the Thalanga site itself exists only for about 10 years between 1993 and 2003; nevertheless, records for these 10 years represent an overall good match with the Balfes Creek Post Office site (Figure 3). The exemption are rainfall intensities, which appear to be greater at Thalanga.

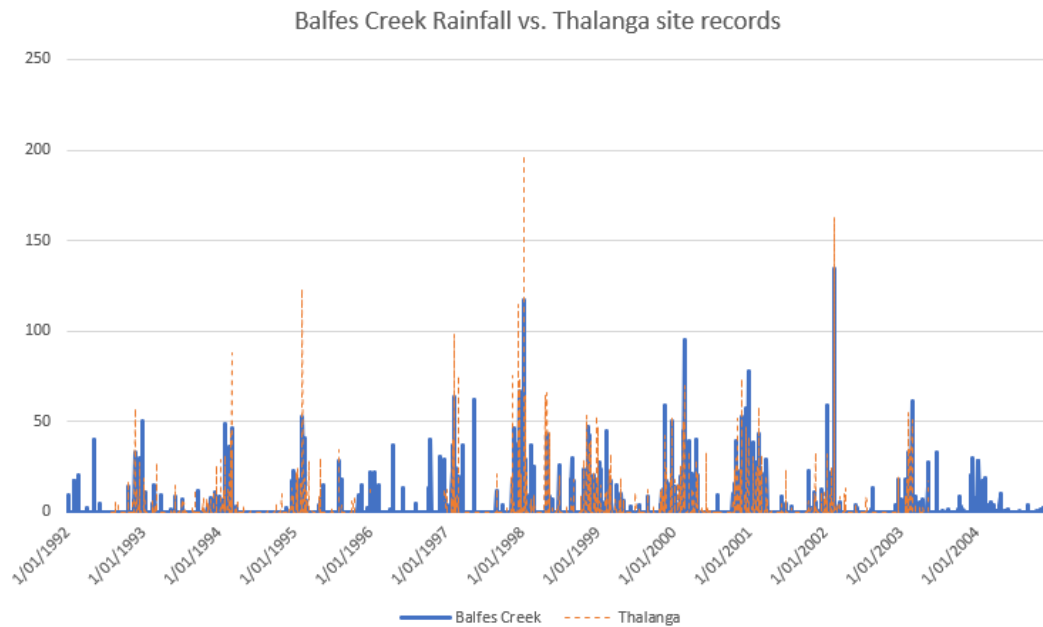


Figure 3 Comparison of rainfall at Balfes Creek Post Office and Thalanga Mine Site between 1992 and 2004.

3.2 Evaporation

The annual pan evaporation rate of approximately 2130 mm exceeds the average annual rainfall of 668 mm (100-year range: 116mm to 1443mm).

Monthly mean evaporation data has been compiled from Australian-wide pan evaporation data available on the BoM website (Figure 4). Average monthly evaporation exceeds average monthly rainfall for all months except January and February. This means natural groundwater recharge occurs mostly during the months of January and February.

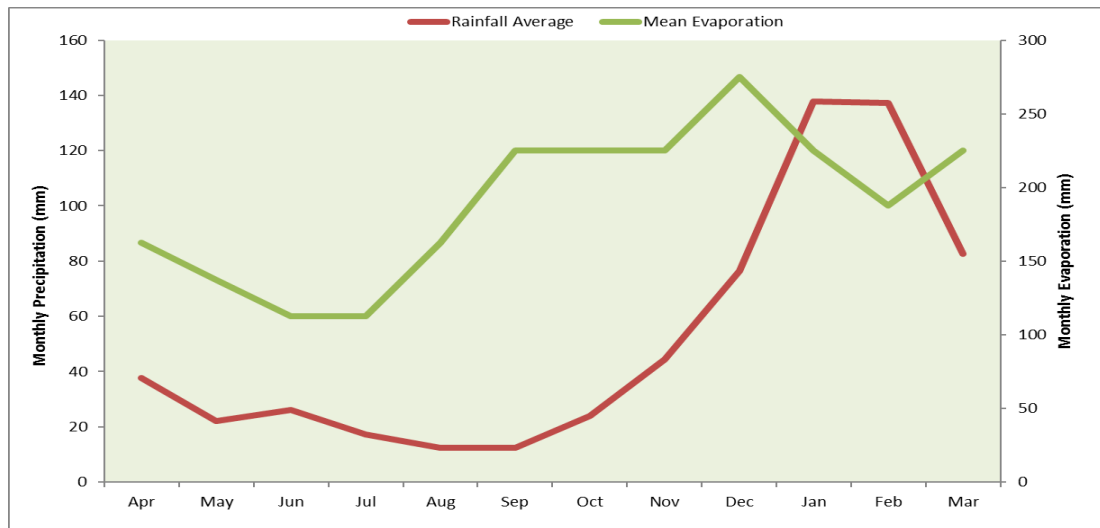


Figure 4 Mean monthly rainfall and mean inferred pan evaporation for Thalanga (inferred from BOM 2005)

Daily evaporation alongside with rainfall measurements at the Thalanga site itself have been recorded between August 1992 and October 1995 (Figure 5). Daily rainfall events can exceed daily evaporation particularly during the rainy season months, hence subsequent pooling of excess rainfall could provide a possibility for recharge.

A sum of the daily evaporation values suggests that total yearly pan evaporation for the Thalanga site is about 2250mm, with actual recorded monthly pan evaporation rates (Figure 6) larger than the previously inferred values (Figure 4).

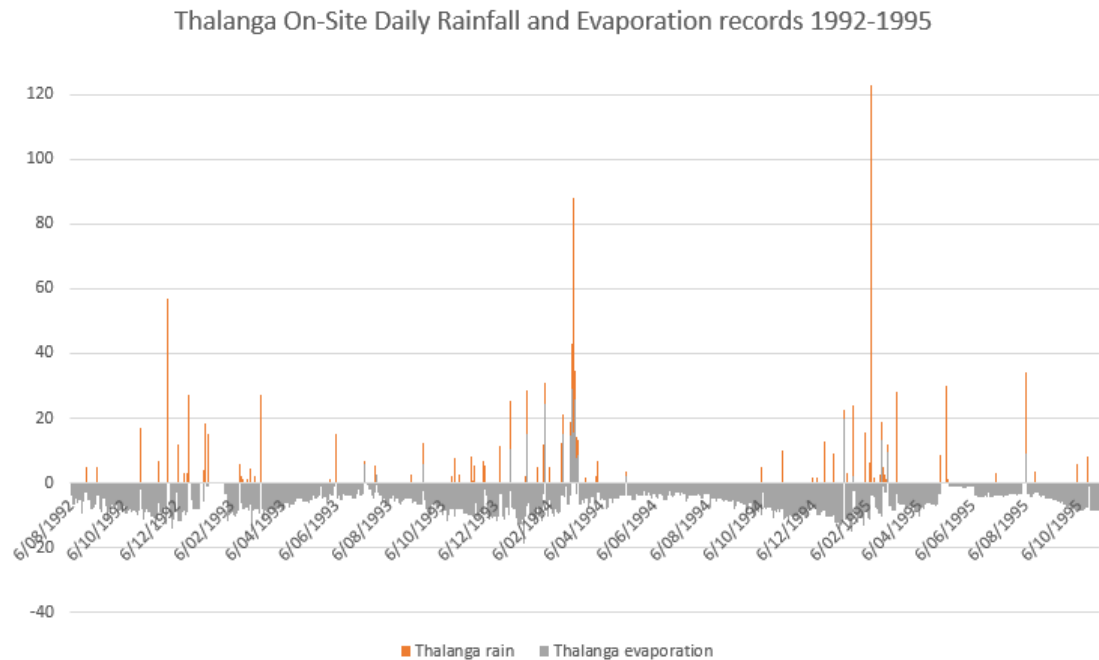


Figure 5 Thalanga on-site rainfall and evaporation records

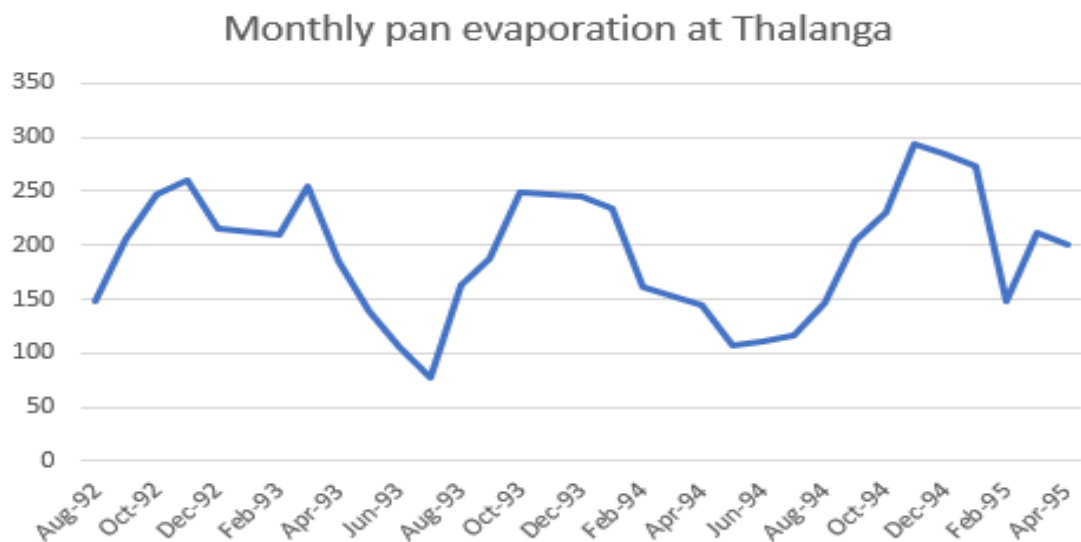


Figure 6 Recorded monthly pan evaporation rates at Thalanga between August 1992 and April 1995

Figures 5 and 6 suggest that recharge may generally occur between October and April with larger rainfall event outside of that time window possibly making a minor contribution to groundwater levels.

Pre-mining Baseline conditions

1. Pre-mining landholder bore inventory

The pre-mining registered landholder bore inventory within 5km of the Thalanga mine site consisted of 6 shallow groundwater bores (Table 1). Information available on these 6 bores is sparse (Available records in Appendix A), generally comprising of depth, bore diameter and installation method. Some limited strata records for available suggesting that most bores have been installed through thin alluvium into the underlying Campaspe Formation. Water quality, standing water levels and yield information varies, possibly as a result of bore installation and the influence of the overlying rainfall fed alluvium.

Table 1 Summary of pre-mining landholder bores within 5km of the Thalanga mine

	RN60286	RN60287	RN60289	RN60633	RN60637	RN60638
Strata	-	Alluvium (Campaspe)	-	Alluvium (Campaspe)	Alluvium (Campaspe)	Alluvium (Campaspe)
Depth	15.2m	18.3m	21.3m	40.8m	43.2m	51.2m
Ø	910mm	1000mm	1500mm	125mm	125mm	125mm
SWL	-2.1m	-	-	-16.2m	-18.3m	-20.4m
EC	-	203µS/cm	2500µS/cm	-	4050µS/cm	3020µS/cm
Yield	0.19L/s	0.38L/s	0.19L/s	1.26L/s	0.88L/s	0.76L/s

2. Pre-mining Thalanga mine water supply bores

In addition to the few landholder bores RGC Thalanga, in need of a water supply for the then proposed Thalanga mine, engaged Australian Groundwater Consultants to test the nearby Campaspe Formation for additional supply bore locations. Between 1983 and 1984 about 45 groundwater exploration holes were drilled into the Campaspe Formation at a distance between 2 and 6.5 km north and east of the future Thalanga processing area. Of these groundwater exploration holes, five were converted into production bores while an unknown number of the remainder was used to measure draw down during a 11 months long pumping test. Subsequent installation of additional monitoring bores confirmed the initial assessment that the Campaspe Formation could supply the anticipated water requirements (2000m³/day) for the Thalanga mine.

3. Pre-mining aquifer information

Prior to the start-up of the Thalanga operation the only available aquifer information was through landholder bores and preliminary drilling of the Campaspe Formation. The suitability of the Campaspe Formation as a water supply was confirmed through the drilling and testing of the Thalanga bore field.

The available records for the registered landholder bores, as shown in Table 1 and Appendix A state that the bores have been installed within alluvium to a depth of 51.2m (RN60638). It must be stressed that this alluvium was unlikely recently deposited material, but rather the sedimentary sequence of the underlying, older sedimentary Campaspe Formation. As such, the available information for yield and EC seem to confirm this assessment as yields from recent uncemented alluvium would a) be considerably higher; and b) since recharged by recent rainfall, EC would be considerably lower. Also, considering the contemporary local morphology and the absence of significant streams or gradients, the accumulation of up to 51m of recent alluvium would be very unlikely. Nevertheless, the targeting of the Campaspe Formation confirms that this aquifer is of significance for small water supplies in the area. However, as Table 1 also shows, water quality, even with regards for livestock use, can be marginal.

Prior to the Thalanga operation only limited groundwater information was available for aquifers within the volcanic bed rock. The earliest sighted study by AGC (1981) was the initial attempt to locate a water supply for the then proposed Thalanga mine. Based on the limited information available, AGC (1981) stated that the volcanic bedrock was not expected to yield significant groundwater except along destressed faults or fracture zones.

Barrett et al. (1982) reported on a few geotechnical issues that are directly relevant to the hydrogeological understanding of the Thalanga site. They characterised the rock quality, which has been described in the geology section, and noted that the depth to slightly weathered material in the central Thalanga section was approximately 20m. Fresh, unweathered rock was generally encountered between 40m and 70m. With direct reference to groundwater, Barrett et al. (1982) reported that surface drilling did not encounter groundwater flows and that the development of the initial Penarroja decline encountered flows up to 0.83L/sec from near the surface, or when continuous joints, faults or shears were encountered. Flows of up to 6.94L/sec were encountered from underground drill holes that intersected water bearing structures. The assessment at the time concluded that inflow into the decline was generated by simple groundwater depletion from above the orebody and that the larger measured flow volumes originated from a number of major structures in the production areas, i.e. the ore body. The latter comment is significant with regards to understanding the hydrogeology of the Thalanga site and will be elaborated on in the current aquifer situation section of this EE progress report.

4. Pre-mining groundwater flow gradients

Based on the limited information available a detailed assessment of pre-mining flow gradients is only tentative. Overall, groundwater flow across the pre-mining Thalanga site would have been along the weathering boundary, following the topographic gradients.

As for the Campaspe Formation, detailed hydrogeological information is available through the drilling and pumping tests of the Thalanga bore field. AGC (1988) provided a potentiometric map showing the groundwater flow directions within the Campaspe Formation, approximately 1km to 2km northeast of the Thalanga mine site (Figure 7). Groundwater levels for a large number of these early bores have been measured throughout the initial mine development and subsequent tailings backfill of the underground workings. The water level records for these bores are presented in Appendix B.



Figure 7 Modified extract from AGC (1988) showing potentiometric map with groundwater flow directions within the Campaspe Formation

Mining induced changes

1. Hydrogeological site history

The operational history of the Thalanga mine had profound influences on the hydrogeological development of the site. Groundwater level changes were determined through monitoring bores installed for various purposes at various sections of the mine site, excavated voids, exploration holes, as well as apparent surface soil saturation. A chronological account of groundwater level changes tied to the mining history in the introduction is given below.

1.1 Phase One (1989-1998)

As stated earlier the Phase One operation at Thalanga commenced in June 1989, consisting of the initial Central Pit and connected underground workings. The Central Pit and underground workings required dewatering, therefore lowering the groundwater table within the deposit. Subsequent ore processing produced tailings and process waters, which were stored in dams, potentially creating elevated recharge areas on the original land surface. Both dewatering and the creation of artificial recharge areas have the potential to modify the hydrogeology of the site.

Central Pit

The initial mining of the Central Pit (1989-1990) resulted in the dewatering of the open pit only. A comparison between the dewatered 75m deep Central Pit and bores along the pit rim (WM1, WM2, WM4, WM5 and WM6) showed that dewatering was successful within the deposit, while dewatering had little influence on groundwater levels of the surrounding rock (Figure 9 and Figure 10).

Dewatering of the initial Central Pit progressed through the use of two pumping holes in the central eastern section of the open pit. Mining commenced in late June 1989 and concluded in October 1990 (Kendall, 1990). Monitoring of the drawdown within the ore zone and the adjacent footwall and hanging wall occurred. From the hand-written records, bores WM1, WM2, WM5 and WM6 are located within the footwall and hanging wall of the deposit and have sufficient data to allow for a visual water level trend assessment. The monitoring bores within the open pit were clustered around the pumping bores within the ore deposit (Figure 9). Water levels of the bores on the pit floor were reported as 2m to 10m below ground level, which would have been near the bottom of the final open pit at the time of measurement. While the reference point and the groundwater level in the open pit is reduced to approximately 70m–75m below ground level, groundwater levels in the surrounding footwall and hanging wall bores remained fairly stable and at least 20m above the pit floor.

Opportunistic measurements during 2000 and 2001 of the pit rim bores WM1, WM2 and WM3 (Thienenkamp; 2004) showed that groundwater levels in 2 of the 3 bores remained at similar levels than measurements recorded 10 years earlier.

The above observations are consistent with the geological conditions of the ore deposit, which suggests that the ore deposit is the main aquifer section within the volcanics at Thalanga. A strong compartmentalisation of the surrounding bedrock aquifer has been stated in every hydrogeological investigation since 1981. The demonstrated minimal interconnection between different aquifer sections in and around the Central Pit is a key observation for such compartmentalisation.

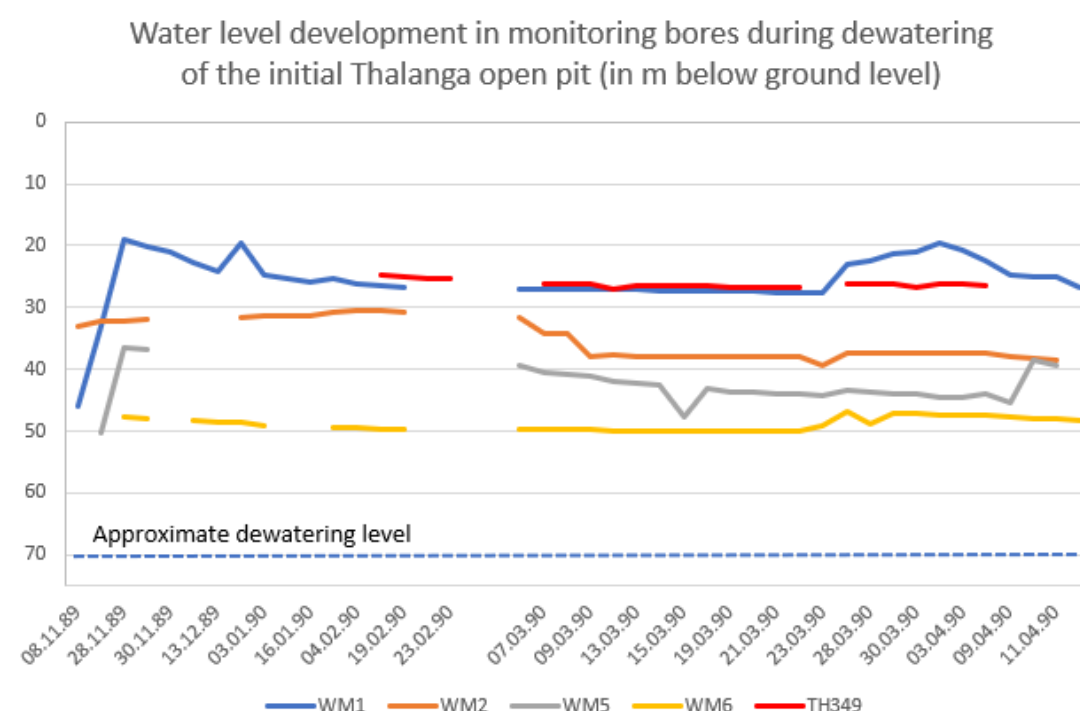


Figure 8: Water level in the initial Thalanga pit compared to dewatering monitoring bores

The early experience of the Central Pit dewatering suggests that there is limited hard rock connection between the deposit and the surrounding country rock.

With continued mining of the various connected Thalanga underground orebodies, the Central Pit remained dry until it was partially backfilled in the 1998/1999 wet season. Importantly, prior to backfilling the Central Pit, the underground workings directly below the Central Pit were driven upwards to excavate as much as possible of the high-grade ore (crown pillar) that commonly forms the bottom of an open pit. As a result of that upwards excavation, the crown pillar collapsed, essentially opening a direct hydraulic connection between the Central Pit and the underground workings below.

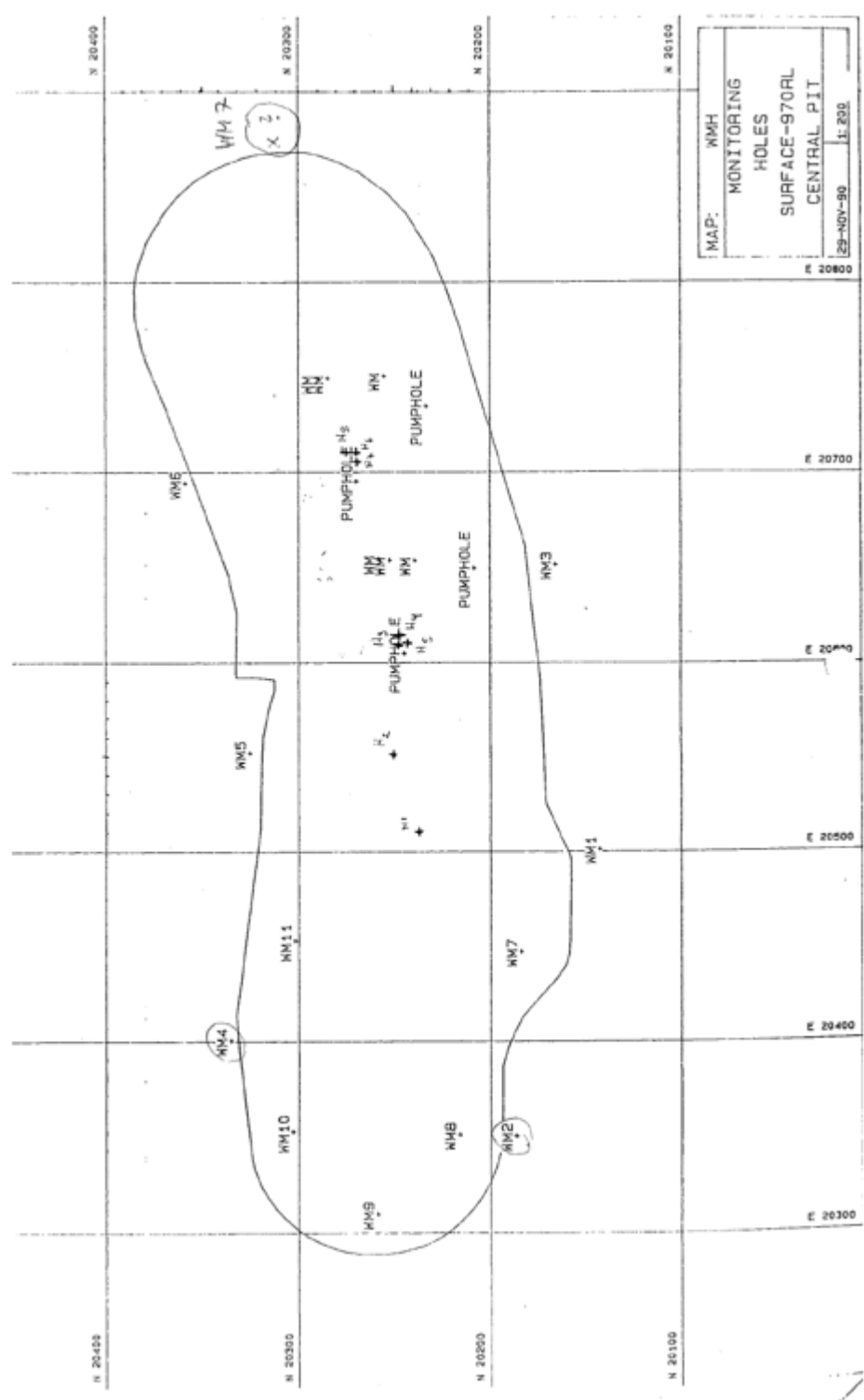


Figure 9 Location of the Central Pit dewatering and monitoring bores

Waste Rock Dumps

The presence of the 700,000m³ East WRD and 1,230,000m³ West WRD most likely had an influence on the hydrogeological characteristics of the underlying strata. The effects of the larger West WRD likely greater than these of the smaller East WRD. While the former was positioned off the strike of the orebody, the hydrogeological effect of the latter was probably reduced by its proximity to the Vomacka underground and associated exploration hole connection.

Underground

Between 1990 and 1998 the underground workings at Thalanga extracted about 4.753.000t of ore from five connected satellite orebodies accessed and radiating away from the initial Central Pit along the strike of the deposit. The Vomacka and Thalanga East deposits were accessed via a decline originating in the upper eastern section of the Central Pit. The Thalanga West, the Far West decline and Central Thalanga deposits were accessed via a decline in the lower south western portion of the Central Pit (Figure 10 and Figure 11). In addition, the collapse of the crown pillar created a direct connection to the Central and West Thalanga underground.

There were no groundwater monitoring bores that could have documented the impact of the 1990-1998 underground dewatering.

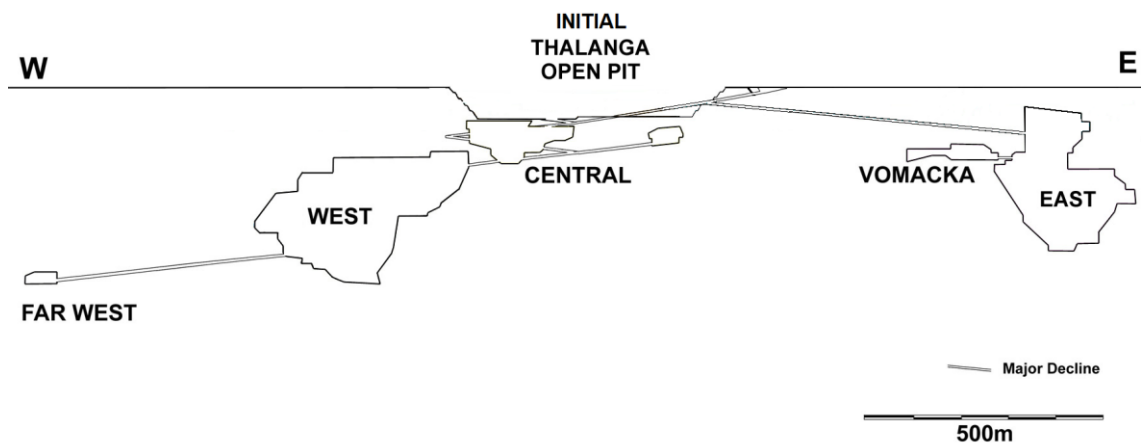


Figure 10 Cross section through the Thalanga underground extent at the end of 1998

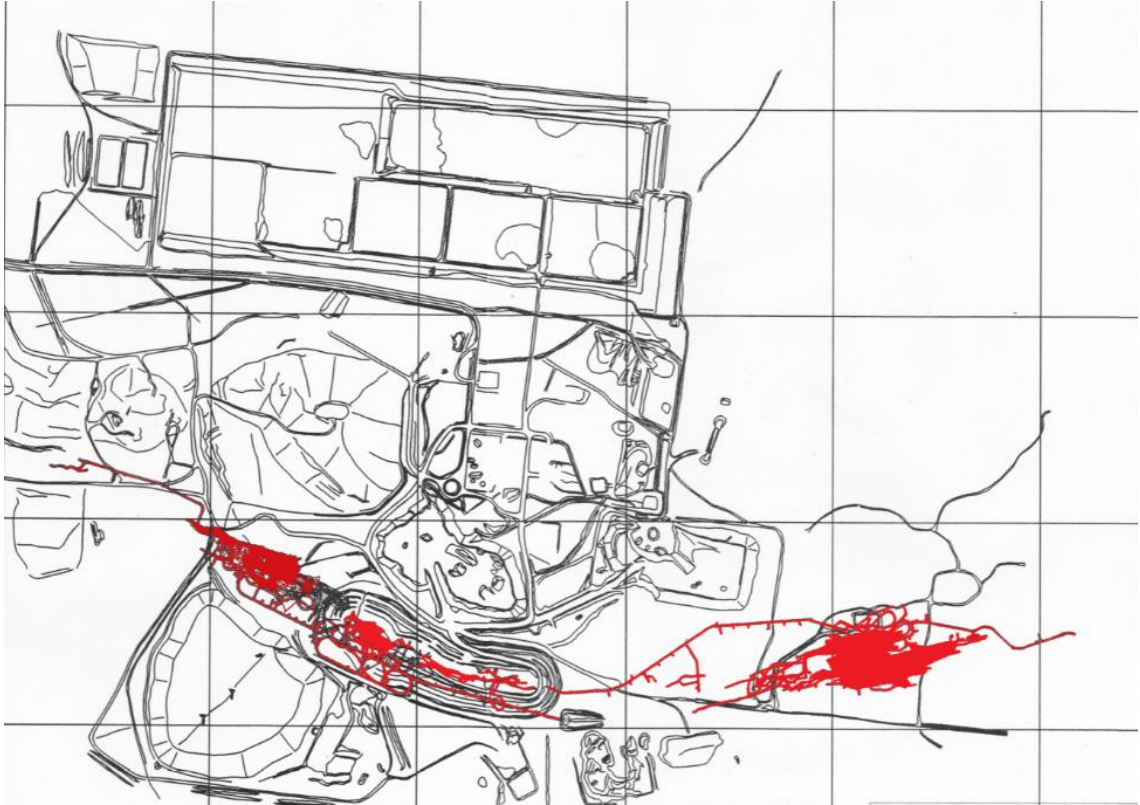


Figure 11 Top down view of the extent of the Thalanga underground workings as of the end of 1998

Tailings dams and water storage

Regular groundwater monitoring at Thalanga commenced in September 1989 with monitoring of the initial tailings dam bores (alternative names in brackets) A1(TD2), A3(TD4), NB(TD5) and H(TD6), followed in 1990 by the monitoring of I(TD1), A2(TD3) and F(TD7) and joined in 1995 by TD10. Due to several changes in ownership, the naming of these monitoring bores has changed over time and the expansion of the tailings dam areas resulted in bores B, C, D, E being destroyed. Bores F, G and H were consumed by the later cell 9 extension and the fate of bores A1 and A2 are unknown. Of the initial tailings monitoring bores only bore A3 remained serviceable in 2019.

Data on groundwater levels for a number of historical tailings dam monitoring bores is available from January 1997 to December 2000. For locations see Figure 12 .

Regardless of their condition, monitoring records for bores A1, A2, A3, H and F exist for the years between 1997 and 2000 (for bore A3 till 2018). The groundwater level records for these bores only start about 7 years after operation began at Thalanga. These measurements are nevertheless useful with regards to interpreting the groundwater level behaviour at Thalanga. Particularly the development at A1, A3 and H offer an insight into groundwater level changes due to the construction and operation of the tailings dams (Figure 13 and Figure 14).

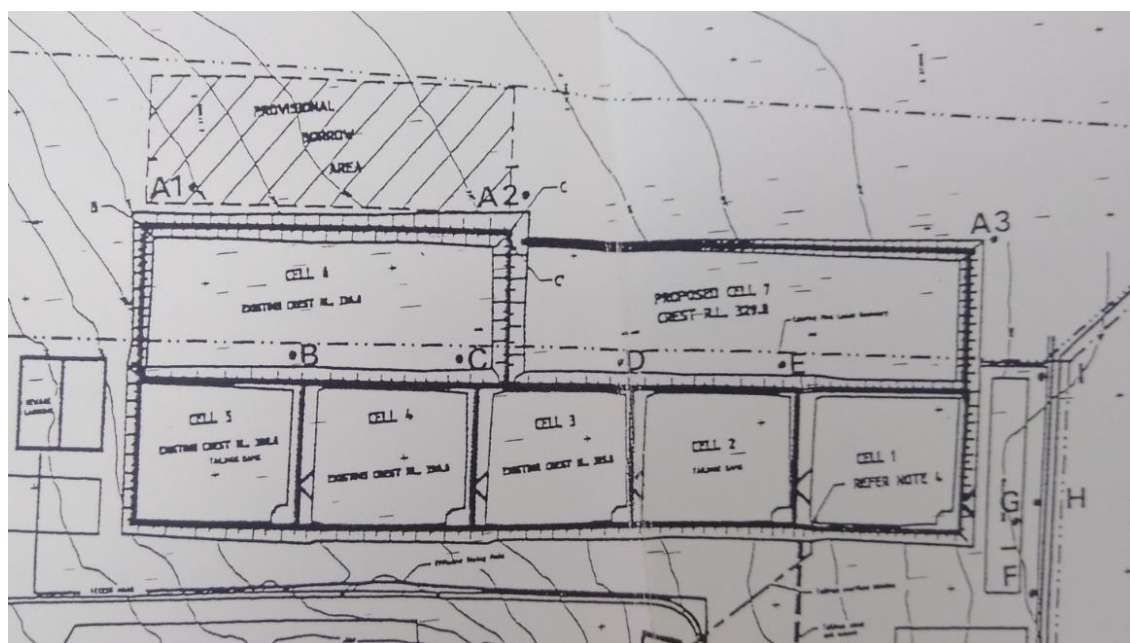


Figure 12 Existing and proposed tailings cells at Thalanga in 1996 (from RGC, 1996)

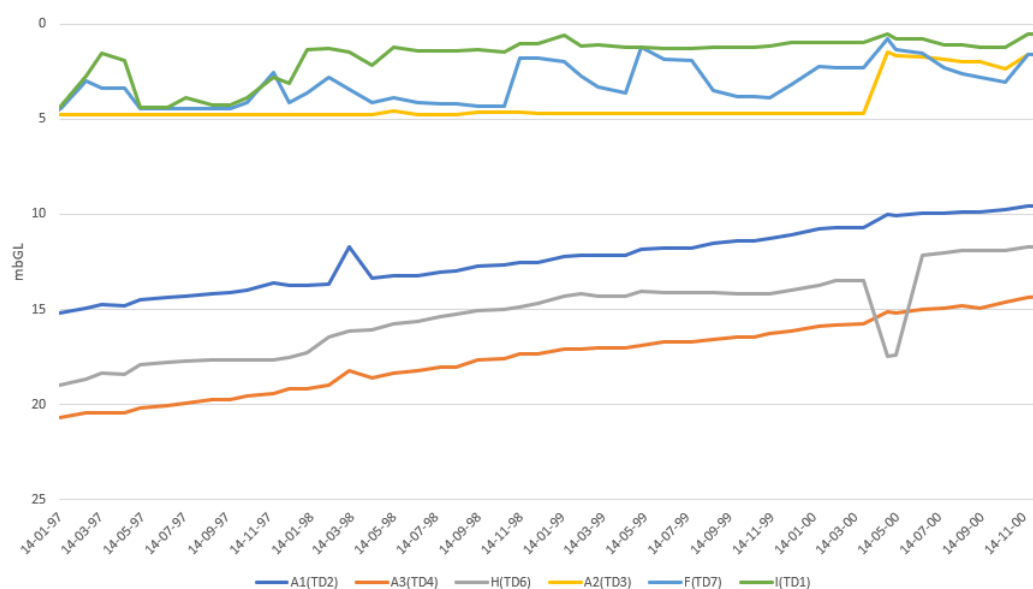


Figure 13 Groundwater level behaviour at tailings dam monitoring bores A1(TD2), A2(TD3), A3(TD4), H(TD6), F(TD7) and I(TD1) between January 1997 and November 2000

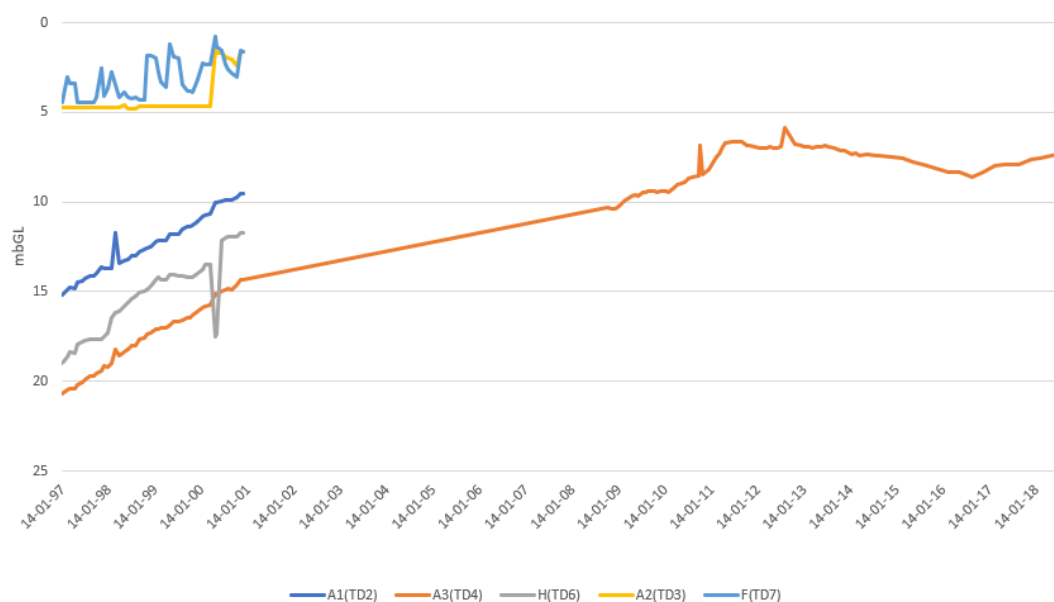


Figure 14 Groundwater level behaviour at tailings dam monitoring bores A1(TD2), A2(TD3), A3(TD4), H(TD6), F(TD7) between January 1997 and August 2018

It is clear from the uniform rise of water levels that tailings deposition in the tailings dams had an influence on groundwater tables in the vicinity. From the groundwater tables alone, it is not clear if groundwater level increases are due to direct seepage or are the result of aquifer compression. Also, records for bores A2(TD3) and F(TD7) suggest that shallow bores are either not impacted since their water level is above the rising trend, or alternatively have been impacted prior to the water levels being recorded.

What also becomes obvious by looking at Figure 13 and Figure 14 is that groundwater levels within the deeper groundwater horizons of bores A1(TD2), A3(TD4) and H(TD6) have been increasing despite water levels in the underground workings 1,000m to 1,400m to the south being at their minimum (reaching -450m below ground level in May 1998).

1.2 Phase Two (1998-2006)

Phase Two at Thalanga started in 1998/99 and lasted till 2006. Phase Two is marked by the backfilling of the Central Pit with the West WRD. The West WRD, consisting of AMD generating massive sulphide waste, became a source of ongoing acid drainage soon after its construction. After several attempts failed to control the acid seepage, the WRD was relocated to partially fill the Central Pit.

Phase Two saw a change of processing technique to treat Cu-Au ore from the Highway Reward deposit approximately 45km east of Thalanga, it is also characterised by the uninhibited deposition of tailings into the underground voids. Prior to that (between 1991 and 1995) minor volumes of thickened tailings had been selectively deposited underground behind constructed

bulkheads (Thalanga Copper Mines, 2002). However, during Phase Two tailings appeared to have been simply pumped down open exploration holes.

Central Pit

The Central Pit, partially (~75%) backfilled with acid generating waste rock, remained uncapped and soon became a site surface water sink. Combined with the underground tailings deposition water levels rose, eventually forming an alkaline surface water body in the lowest section of the pit. Water quality soon changed from alkaline to acid.

The first appearance of alkaline water was aided by the method of waste rock deposition into the Central Pit. The method used was 'end dumping', which results in an accumulation of coarser material at the base of the dump slope, forming a basal zone with high hydraulic conductivity. Combined with the collapse of the crown pillar, tailings decant water from below was now able to rise into the remaining pit void encountering mainly coarse grained, unoxidized rock material. Due to the initially limited contact with acid generating materials, the rising tailings decant water was at first able to maintain its alkaline composition. Upon the later rise of water in the pit, saturation of the fine grained, strongly acid generating waste rock occurred. Consequently, alkaline conditions could not be maintained, and the pit water body became acid.

Underground

Underground operations at Thalanga ceased in 1998 and the only relevant activity consisted of tailings deposition via exploration holes.

It is not clear if the practice of underground tailings deposition halted after the appearance of the pit water body, clear is that water levels continued to increase in the Central Pit.

Besides the created Central Pit water body, the underground tailings deposition concurred also with the development of large surface subsidence areas (about 100x100m) both in the West zone and the East zone of the Thalanga lease.

The appearance of a pond in the Central Pit prompted the installation of 8 deep (V1, V2, V3, V4, V5, V6B, V7B and V8B) and 3 shallow (V6A, V7A and V8A) monitoring bores in 2003. The bores were designed to monitor the impact of tailings backfill (Table 2 and Figure 16), however due to subsidence issues locations V7A/B and V8A/B soon became non-operational.



Figure 15 Location of the 2003 V series bores to monitor the impact of underground tailings deposition

Table 2: Underground tailings backfill monitoring bores

EAST	NORTH	NAME 1	NAME 2	DEPTH	SLOTS	INITIAL SWL *	INITIAL TDS**
371071	7750980	PZ-001	V1	50m	32-50m	-41m	1200ppm
371182	7750489	PZ-002	V2	50m	29-50m	-30.2m	5200ppm
371466	7750645	PZ-003	V3	50m	32-50m	-30m	-
371795	7750113	PZ-004	V4	50m	32-50m	-33m	5340ppm
372450	7749855	PZ-005	V5	40m	28-40m	dry	-
372856	7750258	PZ-006a/b	V6a/b	50m	14-20m 29-41m	-40m	1600ppm
372490	7750530	PZ-007a/b	V7a/b	50m	8-14m 32-50m	dry	-
372976	7750530	PZ-008a/b	V8a/b	61m	25-43m 55-61m	-32m	1620ppm

*SWL = standing water level

**TDS = total dissolved solids

A review of the initial historical development at these bores between 2003 and 2006 (Figure 16) shows that the initial groundwater levels in the short period following bore installation were relatively stable, indicating that either underground tailings backfill had no immediate impact; groundwater tables had already risen; or tailings deposition was not occurring at the time.

Regardless, by 2006 the acid pond within the Central Pit had flooded the decline connecting the Vomacka and East underground workings to the Central Pit (Figure 17).

RGC Thalanga continued to operate till 2004. In 2006 the site was acquired by Kagara starting the third phase of the Thalanga operation.

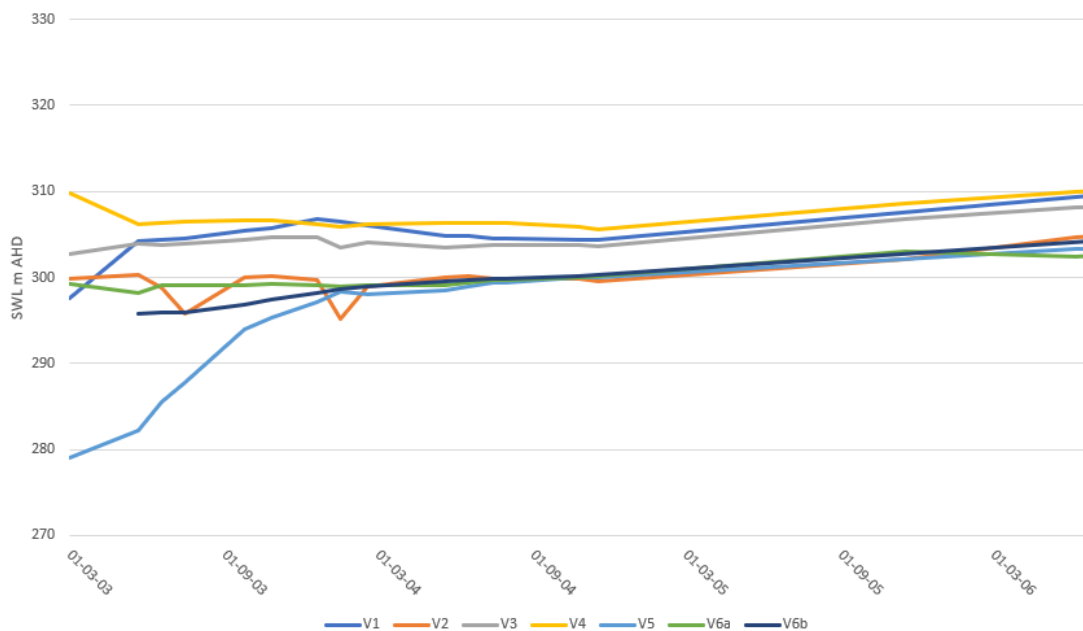


Figure 16 Groundwater level development at V1, V2, V3, V4, V5 and V6A/B between installation in 2003 till mid 2006



Figure 17 Flooded East Thalanga decline within the Central Pit in 2006. Flood level at approximately RL 308m, inferred from a comparison between mine plans and available topographic maps

Tailings dams, water storage and investigation of perched aquifer

During the later stage of Phase Two the surface tailings storage at Thalanga underwent a minor lift and convergence of tailings cells 1 and 7. Groundwater level records for the tailings dam bores are not available for the period between December 2000 and October 2008 (Figure 14).

Kendall (1990) reported the presence of a shallow perched aquifer in the southern portion of the



Figure 18). The removal of the West WRD produced an area of permanently ponding acid water in the footprint of the former WRD. To investigate the presence of perched, near surface aquifer sections in the vicinity of the former West WRD, ten shallow and two deeper bores were installed in 2001 (MW-1, MW-2A/B, MW-3, MW-4A/B, MW-5, MW-6, MW-7, MW-8, MW-9 and MW-10). Only two of the shallow bores recorded water at a level between 1.55m and 1.7m, the rest of the other eight shallow bores remained dry (URS, 2002). The two shallow bores containing water were MB-2A and MB-3, closest to the former West WRD and the East WRD respectively. Both locations can be considered impacted due to hydraulic ground loading effects introduced by the prolonged presence of the former WRDs. Initially described in the study of soil mechanics, it is now widely acknowledged that surface loading can impact on the groundwater environment (see, for example, Rodhe & Bockgard, 2006 and Rasmussena & Moteb, 2007). The deeper bore sections both reported groundwater with water levels between 10.7m and 13.61m below ground level, this was despite the remaining Central Pit still being empty at this stage.

Besides the initial measurements following installation there appear to be no additional measurements from MW-1, MW-2A/B, MW-3, MW-4A/B, MW-5, MW-6, MW-7, MW-8, MW-9 and MW-10.

Table 3: Details of shallow and nested monitoring bores installed in 2001

BORE	EASTING	NORTHING	DEPTH	SLOTS	SWL (MAY 2001)
MW-1	371486	7749806	3	1.6-3	dry

BORE	EASTING	NORTHING	DEPTH	SLOTS	SWL (MAY 2001)
MW-2A	371342	7749784	3	0.5-3	1.55m
MW-2B	371342	7749784	24	20-23	10.7m
MW-3	371770	7749739	2.4	1-2.5	1.7m
MW-4A	371759	7749546	3	1.5-3	dry
MW-4B	371759	7749546	22.5	19.5-23	13.61m
MW-5	372097	7749453	3	1.5-3	dry
MW-6	371202	7749459	3	1.5-3	dry
MW-7	371122	7749408	3	1.6-3	dry
MW-8	371606	7749384	3	1.6-3	dry
MW-9	371937	7749397	3	1.6-3	dry
MW-10	371873	7749591	3	1.6-3	dry



Figure 18 Locations of perched aquifer bores south of the Central Pit

1.3 Phase Three (2006-2008)

Phase Three of the Thalanga operation (2006-2008) started with the processing of Cu ore from Kagara's initial Balcooma operation, utilising the existing Thalanga processing plant.

Groundwater monitoring records for the period appear to be absent and no additional monitoring bores were installed until 2008.

Central and Vomacka Pit and underground

Phase Three saw the direct discharge of water from the evaporation pond into the remaining Central Pit void. This process was only discontinued with the commencement of the Vomacka open pit operation of Phase Four in 2008. Rob Lait and Associates reported that process water deposition into the Central Pit continued till at least February 2008 and only ended with the need for dewatering of the Vomacka pit. It can be assumed that by 2006 the underground voids had no additional capacity. There are no records suggesting that underground tailings deposition was continued following the acquisition by Kagara. Regardless, the deposition of surface water into the remaining Central Pit void would have filled any remaining underground voids.

Rob Lait reported that in pit deposition of process waters to the pit rim had resulted in elevated groundwater tables at the Vomacka location (RLA 2008B). In addition, in early March 2008 Kagara staff reported that water had expressed at the eastern deeps subsidence area. That surface water expression was explained with the impacts of a particularly good 2007/2008 wet season. However, the unexpected surface water expression also evoked fears that artificially raising groundwater tables through process water discharge to the Central Pit could impact on the nearby Campaspe Formation (RLA 2008A). This fear prompting the installation of 2 new monitoring bores C1 and C2 (Figure 19) to the east of the Thalanga mine site.



Figure 19 Location of C1 and C2 (installed in 2008) with regards to the Thalanga mine site

Tailings dams and water storage

Three additional bores (TH1, TH4 and TH5) were placed in the vicinity of the new tailings cell 9 (Figure 20). Process tailings of the Balcooma ore were stored in the previously constructed Cell 8 and new Cell 9, adjacent to the south and east of the existing tailings cell 7.



Figure 20 Location of TH1, TH4 and TH5 (installed in 2008) with regards to tailings cell 9

1.4 Phase Four (2008-2012)

Phase Four started in 2008 with renewed mining operations at Thalanga. The mining target was the Vomacka orebody, which was to be mined by developing an 85m deep pit. During the process of establishing dewatering requirements (RLA 2008B) it became clear that both the underground tailings deposition and subsequent process water discharge to the Central Pit resulted not only in the complete flooding of the underground workings, but also caused shallow groundwater tables and saturated ground conditions in the Vomacka area.

The realisation that disposal of process water and tailings underground and in the remaining Central Pit caused flooding issues for the proposed Vomacka Pit resulted in renewed dewatering efforts at Thalanga. Evidence for the increased flooding and subsequent dewatering can be seen in the continuum of groundwater level records of the V-bores between 2006 and 2008. What can be seen in Figure 21 and particularly Figure 22 is the rise of groundwater tables across the Thalanga mine site to close to surface levels till 2008 and the subsequent influence on groundwater tables due to the Vomacka Pit dewatering from 2008 onwards.

Of likely significance is the development of groundwater levels measured at V5. The strong groundwater level increase during 2003 and early 2004 possibly being the result of water levels within the Central Pit reaching the level of the East Decline and starting to flood the, otherwise not connected, underground workings in the east. V5 being the bore closest to the East Decline possibly seeing the greatest initial change in groundwater levels upon the onset of flooding.

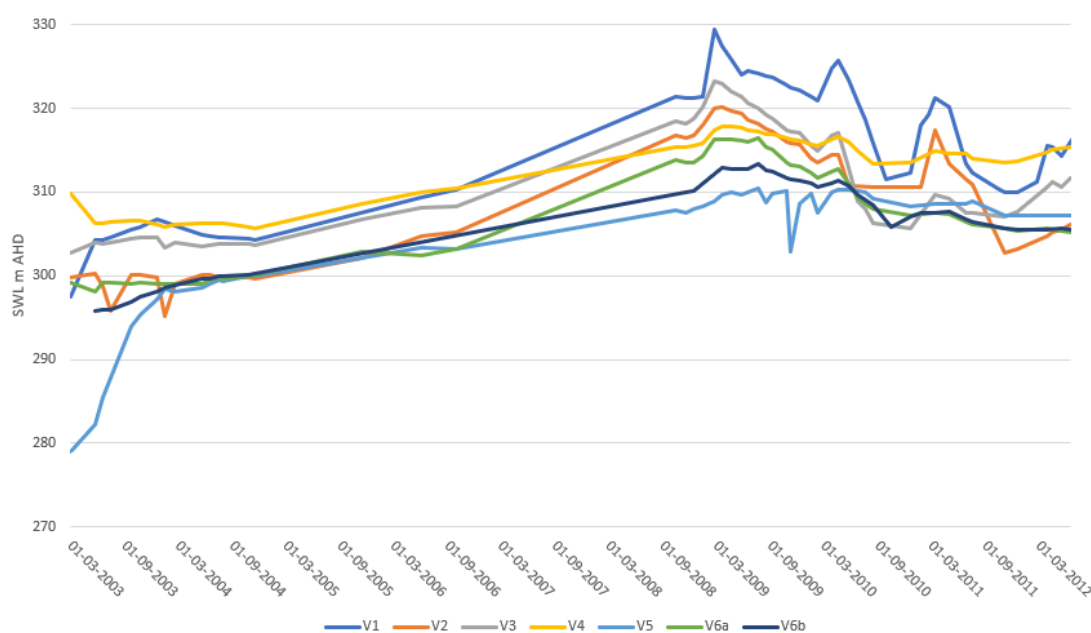


Figure 21 Groundwater level development at V1, V2, V3, V4, V5 and V6A/B between installation in 2003 till mid 2012 in mAHD

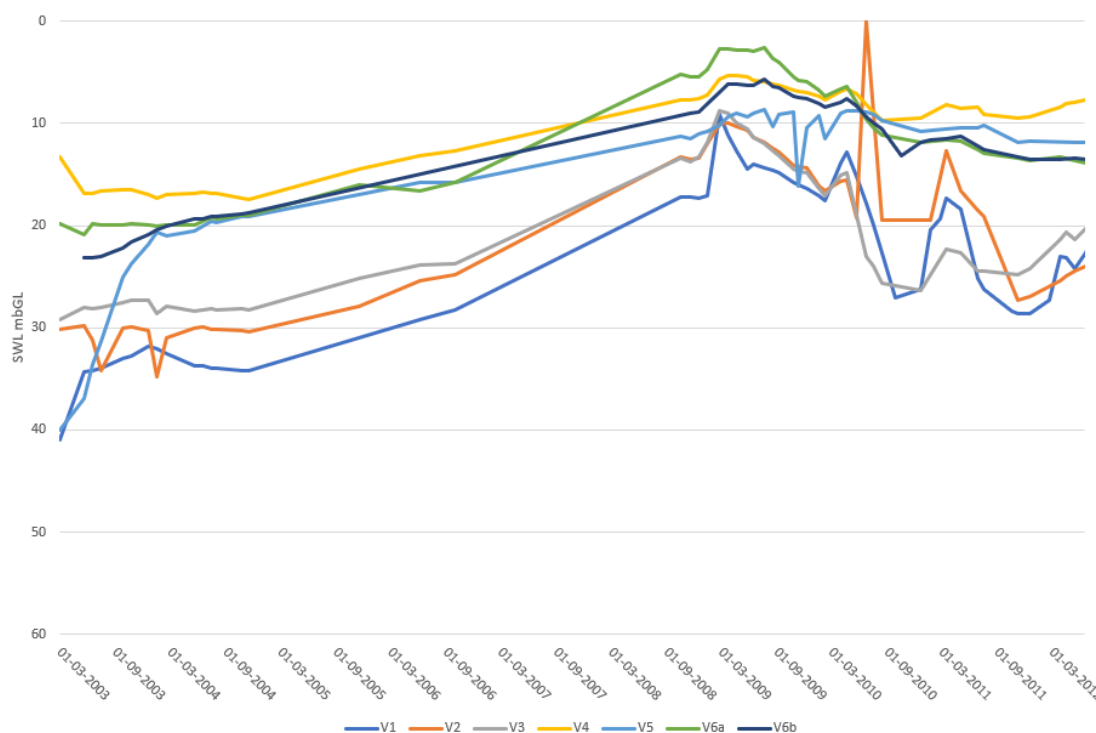


Figure 22 Groundwater level development at V1, V2, V3, V4, V5 and V6A/B between installation in 2003 till mid 2012 in mbGL

Campaspe Formation bores

Groundwater level records for 2008 installed C1 and C2 are presented in Figure 23. What can be seen is that groundwater levels for C2 appear to be steadily increasing between 2008 and 2012, while groundwater levels at C1 seem to experience a sudden increase in 2011.

The reasons for both increases are not clear. The climate data shown in Figure 2 indicates that rainfall between 2008 and 2012 did not increase. Hence, climatic factors are an unlikely reason for groundwater level increases at C2. The relative sudden change at C1 is unlikely to be groundwater related and possibly the result of changing bore configuration, i.e. a reduction in bore collar height. Changes at C2 may be the result of reduced pumping rates from the nearby Campaspe bore field (Figure 24), measurement- or transcript error, or in the worst-case scenario a manifestation of previously increased groundwater tables across the mine site migrating east. The previously delineated bedrock channel (Pitt, 1988) underlying the Campaspe Formation (Figure 25) would represent a pathway for migration.

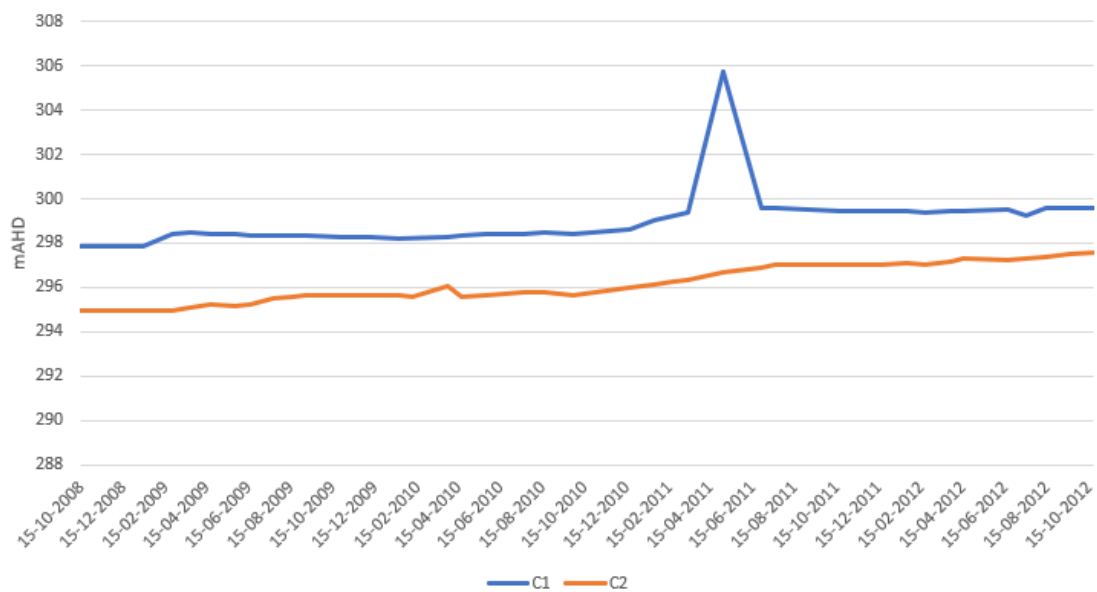


Figure 23 Groundwater level development at C1 and C2 from 2008 to 2012

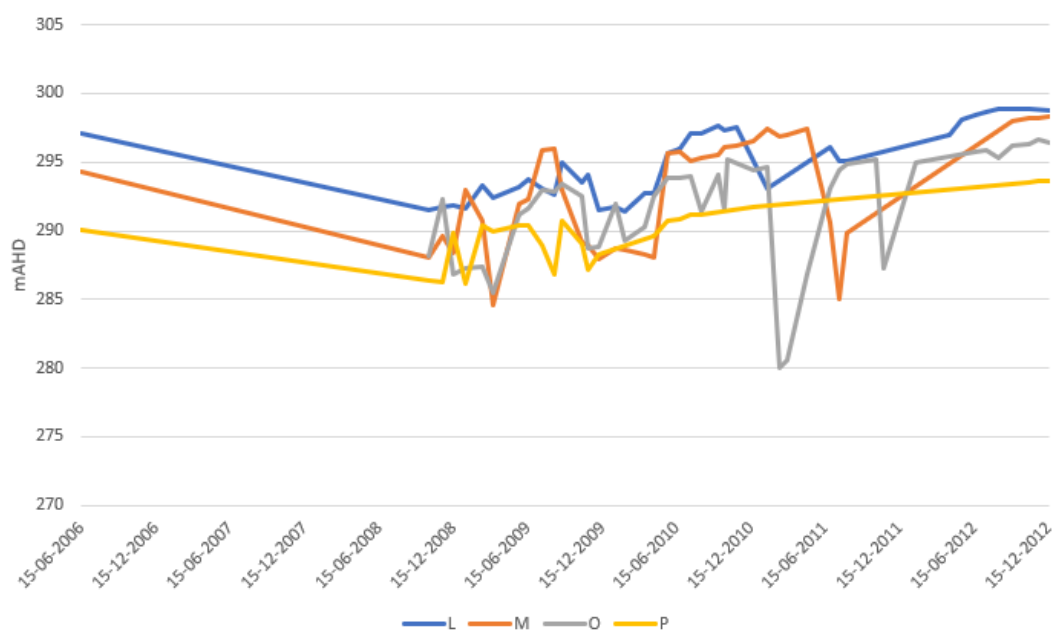


Figure 24 Groundwater level changes in Campaspe Formation bores L, M, O and P between 2006 and 2012

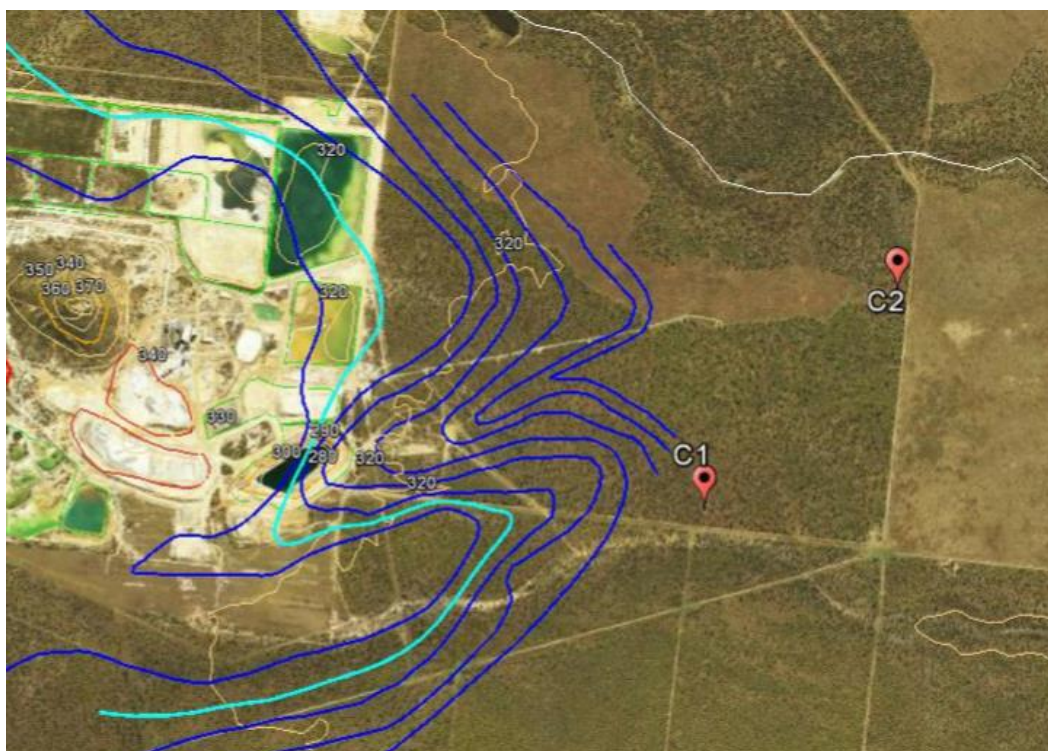


Figure 25 Bedrock channel deepening towards the north east beneath the Campaspe Formation at Thalanga

Central Pit

With the onset of mining at the Vomacka Pit the newly produced surficial benign oxide waste rock was used to create an elevated doughnut structure around the Central Pit. The later produced reactive sulphide waste rock was used to fill the remaining Central Pit void and the doughnut core. The Central Pit would no longer receive surface water and the elevated structure would now shed water.

Vomacka Pit

The newly created Vomacka Pit reached its final depth of 85m by early 2012 (RLA, 2014). Following its excavation, the pit started to fill with water.

Underground

Phase Four also saw renewed underground interests at Thalanga. Activities included the initial dewatering of the West 45 deposit approximately 1500m North West from the Central Pit between 2011 and 2012. Rob Lait & Associates (2010, 2011a) installed four monitoring bores and two pumping bores to assess the hydrogeology and assist the dewatering of the West 45 deposit (Figure 26 and Table 4).



Figure 26 Locations of the four monitored West 45 bores

The bores were installed to a depth of between 79 and 91m with signs of weathering ranging from 3m to 22m below ground level. According to the drill logs (Appendix C), larger groundwater interceptions occurred in the fractured quartz eye rhyolite of the uneconomical part of the orebody (W45B1, ~15L/sec) and the bottom of the foot-wall rhyolite (W45B3, ~10L/sec). The bore solely intersecting the hanging wall dacite (W45B2) yielded only 0.46L/sec. While W45B4 was installed in an alternating sequence of ore deposit type quartz eye rhyolite, footwall rhyolite and hanging wall dacite yielded approximately 5L/sec.

Subsequent dewatering of the West 45 deposit continued until the change into care and maintenance of the Thalanga operation in 2012 (Figure 22 and Figure 27Figure 22).

Table 4: Details of the 2010 West 45 monitoring bore installation (adapted from Rob Lait & Associates, 2010)

HOLE ID	WATER BEARING INTERVALS	AIR LIFT ESTIMATE EACH INTERVAL	PERFORATED INTERVALS	FINAL AIR LIFT DISCHARGE	SWL BELOW GL
	m	L/s	m	L/s	m
W45B1	18.5–21.5	Trace	31–43	15.0	18
	23.5–24.0	1.25	73–79		
	31.0–34.0	6.25			
	39.0–43.0	15.0			
W45B2	17.0–23.0	0.05	33–39	0.46	20
	34.0–38.0	0.5	73–79		
W45B3	21.0–22.0	0.30	55–79	10.0	20
	22.0–27.0	0.75			
	46.0–47.0	1.25			
	64.0–65.0	5.10			
	77.0–78.0	10.0			
W45B4	33.0–34.0	0.04	67–79	5.0	24
	69.0–70.0	5.0			

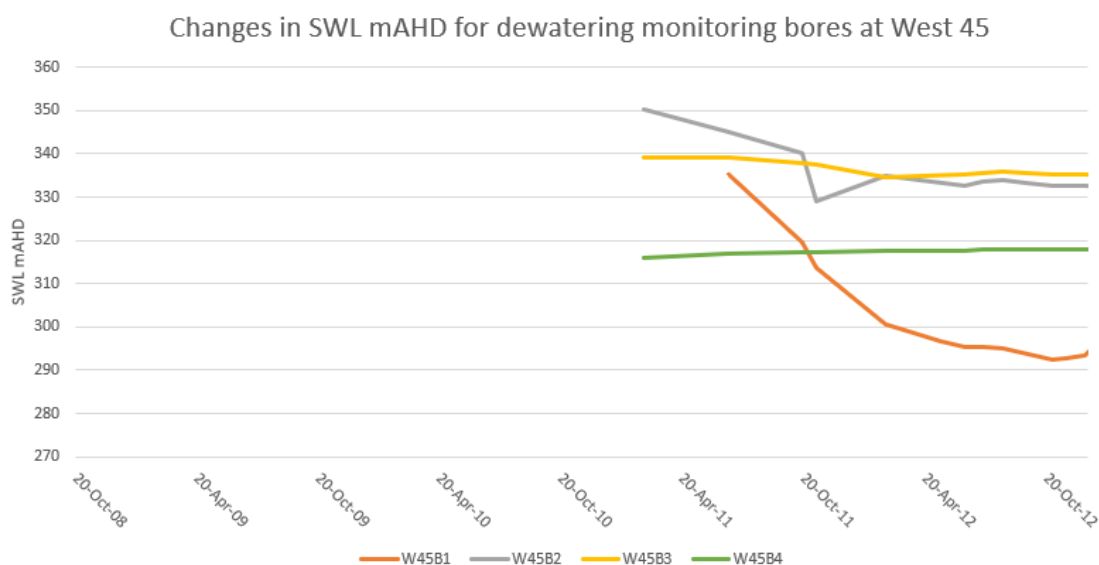


Figure 27 Groundwater development at W45B1, W45B2, W45B3 and W45B4

Tailings dams and water storage

The 2008-2012 period saw the construction of tailings cell 9. Cell 9, constructed in late 2008, initially received tailings from the re-processing of Highway Reward copper-gold tailings from the partial dredging of tailings cell 1/7. Later the ore treatment plant was reconverted back to processing multi-metallic zinc-lead-copper ore from the Vomacka pit at Thalanga. Cell 9 has an area of 18.5ha with the current capacity to store additional tailings. The groundwater levels development for previously installed TH1, TH4 and TH5 are shown in Figure 28.

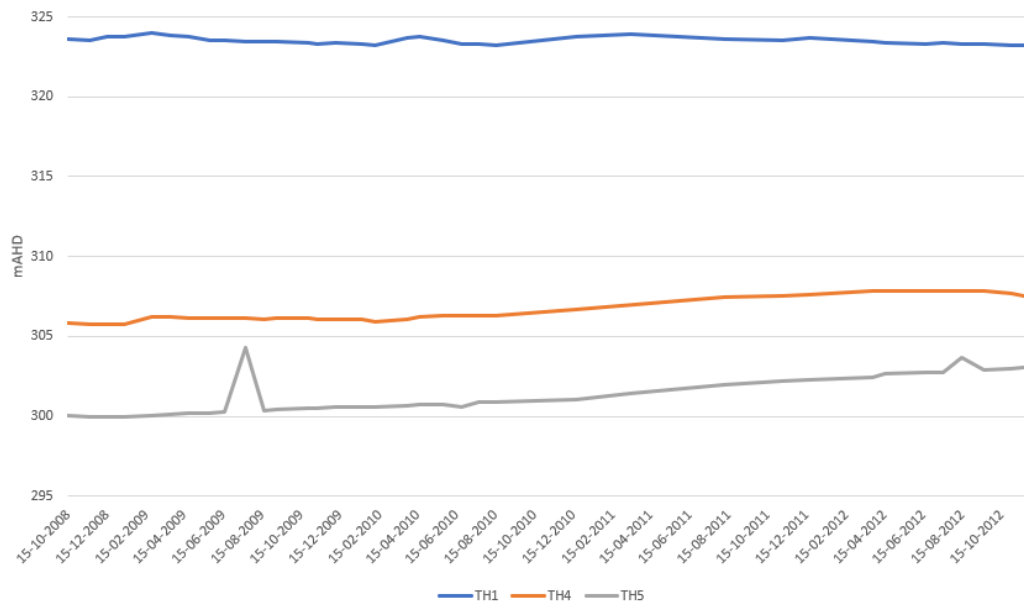


Figure 28 Groundwater level development at TH1, TH4 and TH5 from 2008 to 2012

Bore TH1, installed in the midst of the mine site reported near surface levels (-0.19m) following bore installation in 2008 and recorded a slight water level decrease to -0.9m till 2012. Bore TH4 and TH5 located east of the new cell 9 recorded groundwater level increases between 2m and 3m respectively. The decrease in groundwater level at TH1 is possibly related to the dewatering of the Vomacka area while increases at TH4 and TH5 could be either the result of seepage from the new cell 9 or the result of aquifer compression.

1.5 Phase Five (2012-2019)

Open Pits and Underground

Phase five started with an initial 2-year period of the site being in care and maintenance mode. The Central Pit being completely backfilled, now being a water shedding structure. The Vomacka Pit being left to fill with groundwater and limited surface runoff. The initial underground remaining flooded and the new West 45 underground being left to naturally flood with groundwater.

In 2014, the current operator Cromarty Resources acquired the Thalanga site initially refurbishing infrastructure and completing additional resource studies. Dewatering of the West 45 underground recommenced in 2017 with concentrate and tailings production restarting in September 2017. 2018 and 2019 saw additional dewatering efforts to re-access the previously dewatered (Phase One, 1989-1998) Far West deposit.

To Monitor the impacts of the renewed dewatering of the Far West deposit (the Far West had previously been dewatered between 1995 and 1998 as part of the RGC Thalanga operation) Cromarty Resources installed an additional five monitoring bores to depth between 50 and

100m in the hanging wall dacite and footwall rhyolite surrounding the Far West deposit (Figure 29). Observations made during the drilling of the Far West bores and subsequent testing of the aquifer situation confirmed the very low aquifer potential of the hanging wall dacite and footwall rhyolite (Table 5).

Groundwater occurred only in very few fractures between a depth of 19m to 57m, and airlift flow was at times too small to be measured or dried up soon after being encountered. The drying up of encountered groundwater flows is typical of compartmentalised, small capacity aquifers (bore logs in Appendix D)

The weathered horizon reached depths between 2m and 28m with no groundwater associated. Importantly, none of the Far West bores encountered groundwater below the depth of 57m, essentially confirming the generally lower fracture density of the rock at depth, as suggested by Barrett et al. (1982) and Rob Lait & Associates (2010).



Figure 29 Locations of the Far West monitoring bores

Table 5: Summary of bore details for FWMB1, FWMB2, FWMB3, FWMB4 and FWMB5

	FWMB1	FWMB2	FWMB3	FWMB4	FWMB5
	UTM	UTM	UTM	UTM	UTM
	55K	55K	55K	55K	55K
Easting	370581	371053	370067	370854	370850
Northing	7750587	7751109	7750831	7751735	7750306
Depth	100m	100m	100m	50m	52m
Hole diameter	0–4m 8 inch (precollar) 4–100m 7 inch	0–4m 8 inch (precollar) 4–100m 7 inch	0–4m 8 inch (precollar) 4–100m 7 inch		
Water encountered @	29m Too small to measure EC 2200 $\mu\text{S}/\text{cm}$ 34m 1.5L/s – 2450 $\mu\text{S}/\text{cm}$	30m Too small to measure 53m 0.57L/s – 12700 $\mu\text{S}/\text{cm}$ 57m 1.8L/s – 13047 $\mu\text{S}/\text{cm}$	43m 0.0015 L/s – 1455 $\mu\text{S}/\text{cm}$	19m ~1L/sec 23m 13500 $\mu\text{S}/\text{cm}$ 30m ~0.5L/s 12000 $\mu\text{S}/\text{cm}$	30m 10820 $\mu\text{S}/\text{cm}$ 42m ~0.35L/s 11200 $\mu\text{S}/\text{cm}$ 45m ~0.7L/s 10700 $\mu\text{S}/\text{cm}$
Casing	class 12 100mm 0–94m	class 12 100mm 0–94m	class 12 100mm 0–94m	class 12 50mm 0–18m 21–47m	class 12 50mm 0–30m 33–47m
2mm hand slotting	94–100m	94–100m	94–100m	18–21m 47–50m	30–33m 47–50m
Gravel	32–100m	51.5–100m	40–100m	17–50m	29–52m
Bentonite	29–32m	48.5–51.5m	37–40m	16–17m	28–29m
Cement Grout	0–29m	0–48.5m	0–37m	0–16m	0–28m
Developed	45 minutes	30 minutes	Too small flow. Bore cleaned prior to casing installation		
SWL overnight. Prior to development	27.26m below top of casing. PVC casing 0.65m above ground surface	25.10m below top of casing. PVC casing 0.70m above ground surface	Overnight water recovered to 92m. Not final water level due to very slow inflow	8m	20m

	FWMB1	FWMB2	FWMB3	FWMB4	FWMB5
Permeability	Test 1: 2.566E-7m/s Test 2: 2.566E-7m/s Test 3: 2.566E-7m/s	Test 1: 2.696E-7m/s Test 2: 2.903E-7 – 7.498E-8m/s	Test 1: 2.661E-7 – 3.319E-8m/s		

Impact of renewed underground dewatering

Renewed dewatering of the flooded West 45 underground started in April 2015, from a level approximately 30m below ground (Karl Spaleck, personal communication, 13 November 2017). Figure 30 shows the initial groundwater level development in the West 45 monitoring bores till 2012 followed by the subsequent flooding between 2012 and 2015) and the renewed dewatering of the West 45 deposit since 2015 as well as the impacts of the recent dewatering of the Far West deposit (since 2017).

West 45 bores

What can be seen is that only bore W45B1, which is located in the uneconomic quartz eye rhyolite along the strike of the ore deposit, shows a groundwater level trend that can be associated with the dewatering and flooding of the West 45 orebody. Important to note is that despite the cessation of pumping in 2012, water levels in W45B1 did not recover to pre-mining levels, confirming that groundwater mining, as suggested by Rob Lait & Associates (2011), was in fact occurring. The groundwater level in bore W45B2, only 60m from the orebody, was not impacted by the dewatering and mining the West 45 deposit but appears to be impacted by the more recent dewatering of the Far West deposit. Noteworthy, groundwater levels in W45B3 and W45B4 show, despite the bores having reported air lift flow rates of 10L/sec and 5L/sec respectively, only limited changes in groundwater levels. The latter indicating that there is very limited connection between the deposit and the adjacent hanging wall dacite and footwall rhyolite.

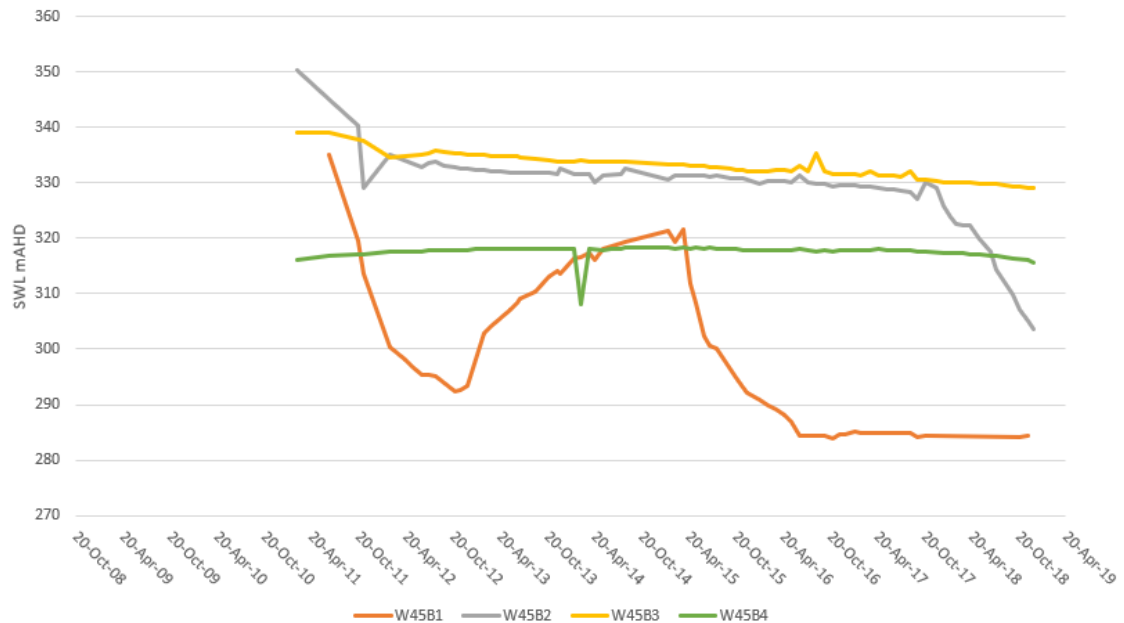


Figure 30: Groundwater level records of W45B1, W45B2, W45B3 and W45B4

V – Series bores

Dewatering of the West 45 bores during 2012 and again in 2015 appears to have had a very limited impact on groundwater levels within the V-Series bores (Figure 31). The previous Vomacka Pit dewatering efforts between 2008 and 2010 halted the previous groundwater level increases and started to reverse the trend towards declining conditions. Groundwater levels in the V-Series bores since have seen an initially stronger decline in bores to the west of the Central Pit and a lower rate of decline east of the Central Pit. Between 2012 and 2018 the groundwater level declines east and west of the Central Pit has been fairly uniform. Renewed dewatering of the Far West deposit since 2018 has seen a significant decrease in groundwater levels in bores west of the Central Pit.

The previously discussed separation of the west and east underground workings is the likely reason behind the different groundwater behaviour of the V-Series bores. Bores V4, V5 and V6A/B are hydraulically disconnected from the western underground section and previous groundwater level increases were only facilitated by the former flooding of the decline in the Central Pit.

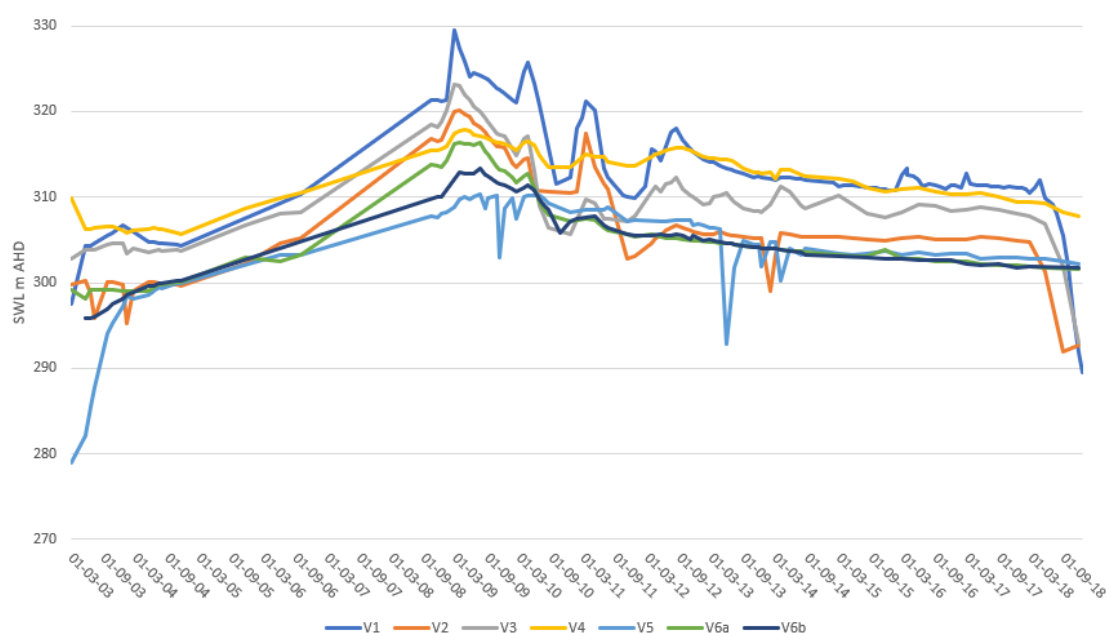


Figure 31 Groundwater level development in bores V1, V2, V3, V4, V5 and V6a/b between 2003 and 2018

Far West bores

The impact of the Far West dewatering on the recent Far West bores so far appears to be limited. The only bore showing a clear declining trend is FWMB2 (Figure 32). The intention for the Far West monitoring bores was for them to be installed outside of the ore zone. However due to space restrictions FWMB2 has been installed in close proximity to V1 making FWMB2 less useful when assessing groundwater level impacts beside the ore zone.

Regardless, bores FWMB1, FWMB3, FWMB4 and FWMB5 are not being impacted by the Far West dewatering.

Combined impact

The combined impact of the West 45 and Far West underground dewatering efforts confirms that main aquifer and hydrogeological feature at Thalanga is the orebody and associated underground workings. Hydrogeological interaction between the deposit and the surrounding rock cannot be established. Out of nine West 45 and Far West monitoring bores that have been drilled, only three appear to be impacted by the dewatering efforts. From their respective location and drill logs it can be concluded that the three impacted bores have been installed within uneconomical sections of the ore deposit and not as intended in the surrounding bed rock.

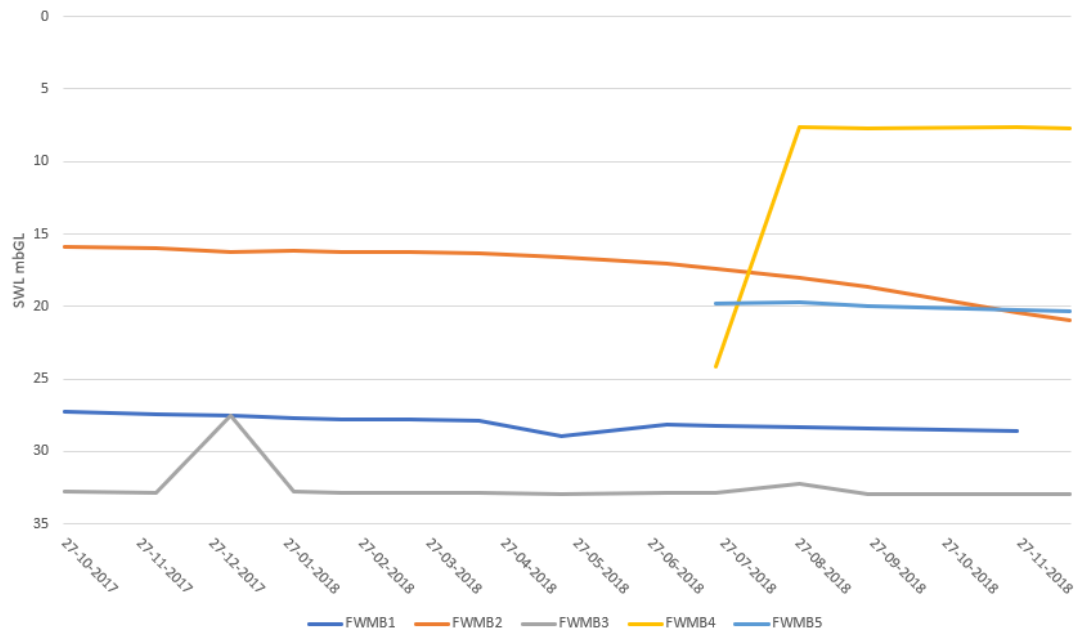


Figure 32 Groundwater level records of FWMB1, FWMB2, FWMB3, FWMB4 and FWMB5

Tailings Dams and water storage

There has been no extension or lift of the existing tailings storage facilities since 2012. In April 2012 a subsurface seepage affected water body was identified within the excavated clay borrow pits directly north of the tailings dams. This was followed by repairs to the Cell 5 and Cell 6 seepage interception trenches and a clean out of the clean water diversion drain (RLA 2014).

The groundwater level development at bores TH1, TH4 and TH5 is shown in Figure 33. What can be seen is that groundwater levels at TH1 further declined till 2015 and subsequently started to increase again from there on. Groundwater levels at TH4 appear to have been decreasing while groundwater levels at TH5 appeared increasing in the absence of tailings deposition between the start of the care and maintenance period in 2012 and the recommencement of tailings deposition in 2017. Groundwater levels at TH4 decreased during that period, while groundwater levels at TH5 showed a temporary levelling out.

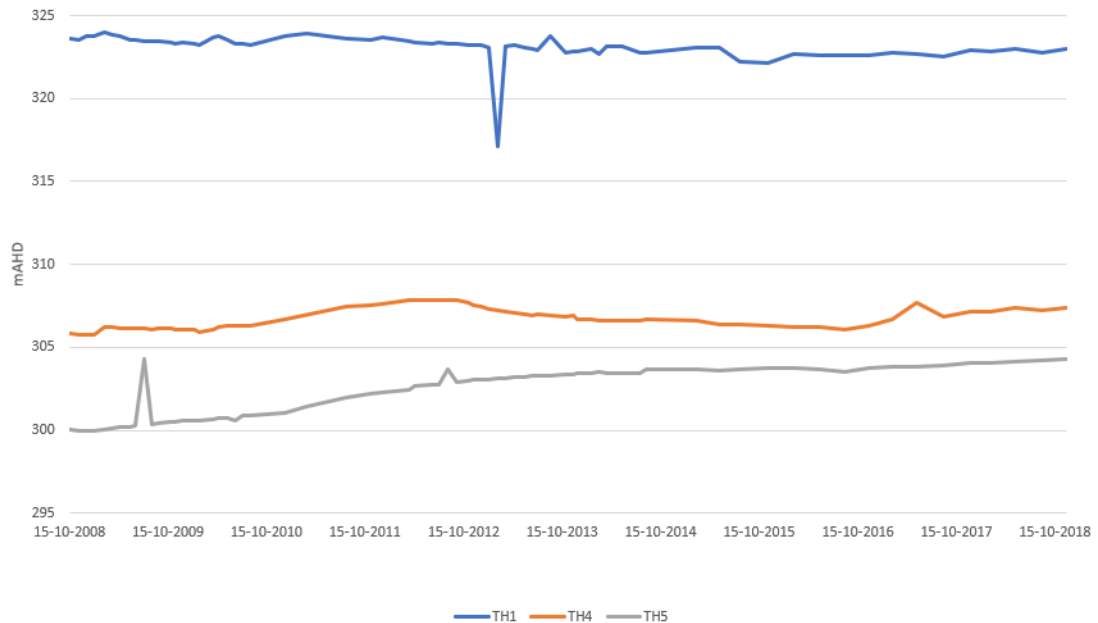


Figure 33 Groundwater level development at TH1, TH4 and TH5 from 2008 to 2018

In late 2018 two additional tailings dam monitoring bores (A1 and A4) were installed approximately 130m to the north of the tailings dam area.

Campaspe Formation bores

The groundwater level development of bores C1 and C2, installed to monitor the impact of the previously artificially increased groundwater level increases on the Campaspe Formation is shown in Figure 34. Groundwater levels in C1 remained almost static during Phase Five, while groundwater levels at C2 continued to slowly increase for another 100cm till early 2018 (Figure 34). During the same period groundwater levels in the Campaspe Formation Production bore M (closest to C2) increased by about 40cm (Figure 35).

Groundwater level data for bore M is only available till September 2017. The reason being bore M being reequipped and used again for groundwater extraction. The recommissioning of bore M for process water use coincides with falling groundwater tables at C2. The latter confirming that groundwater tables at C2 are influenced by groundwater extraction from the Campaspe Formation borefield.

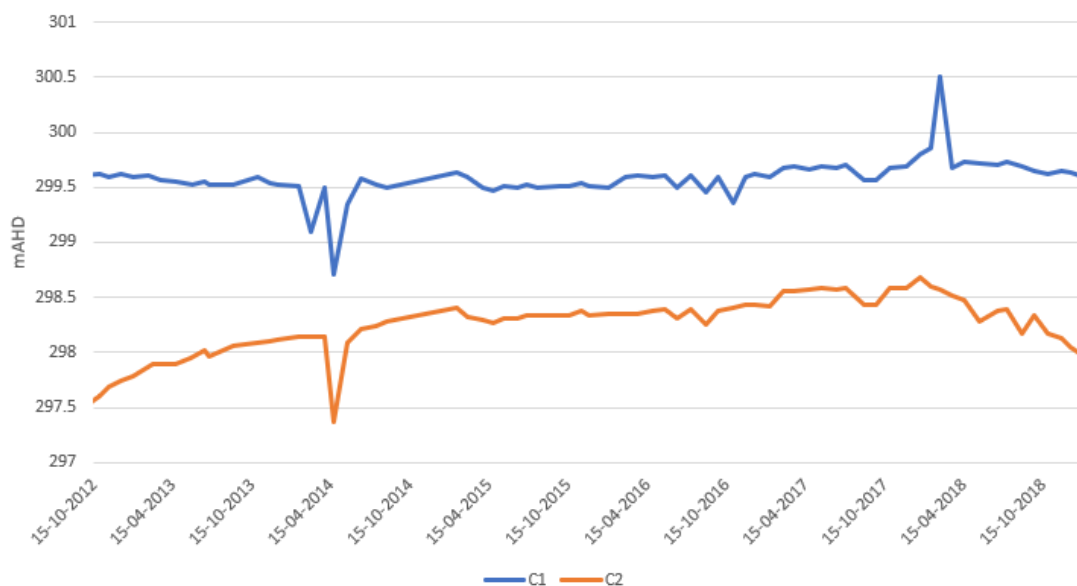


Figure 34 Groundwater level development at C1 and C2 from 2012 to 2018

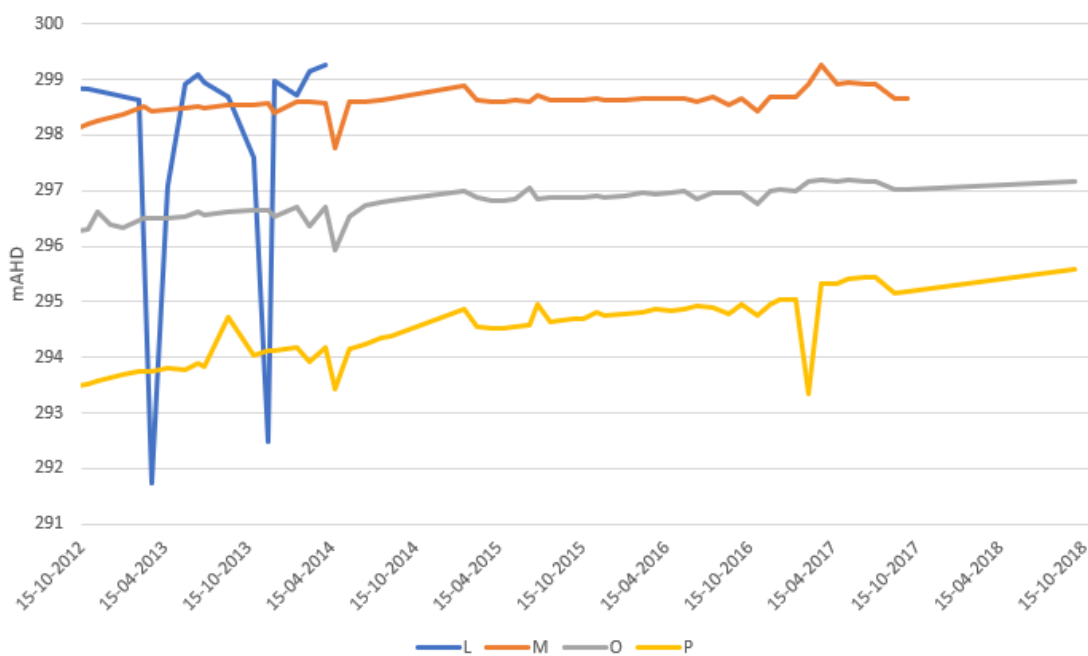


Figure 35 Groundwater level changes in Campaspe Formation bores L, M, O and P between 2012 and 2018

1.6 Summary of the hydrogeological site history

The hydrogeological development of the Thalanga site is the result of operational changes. Initial changes were introduced by the dewatering of the Central Thalanga pit and associated satellite underground orebodies. This dewatering lowered the groundwater tables along the strike of the deposit but had little influence on groundwater tables in the adjacent dipping rock units.

The construction and filling of the initial tailings dams in the north and the construction of the main WRD in the south-west resulted in the creation of perched aquifers in the immediate vicinity of these structures.

Later backfilling of the underground and Central Pit with tailings and process water, resulted in high groundwater tables across wide areas of the mine by 2008. These high groundwater tables were facilitated by the interconnection of underground workings throughout the deposit (Figure 10 and Figure 11) and the presence of hundreds of exploration holes connecting these underground workings to the surface (Figure 36).

Renewed dewatering activities for the Vomacka Pit and subsequent for the West 45 and Far West underground workings have reduced, and currently reduce groundwater tables once more along the strike of the deposit.

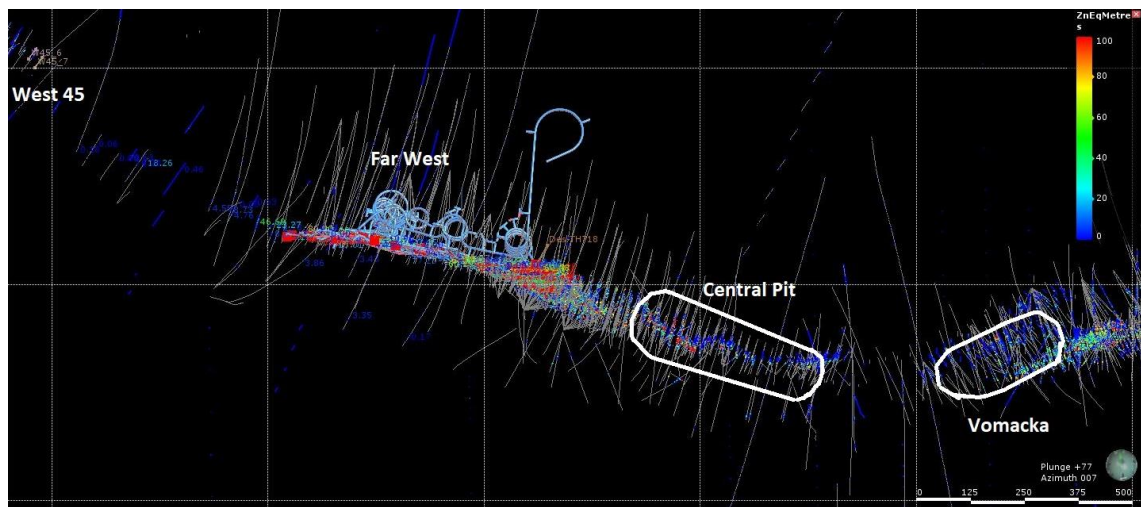


Figure 36 Plan view of locations and directions of more recent Cromarty Resources exploration drill holes with the locations of the West 45, Far West, central- and Vomacka Pit as reference

Hydraulic conductivity values

Two sets of hydraulic conductivity (k) values exist for the Thalanga site. One set of k values exists for three of the recently installed Far West monitoring bores (Table 5). Hydraulic conductivities for the bedrock flanking the deposit ranged from 0.0029m/day to 0.0221m/day.

Another set of k values exists for five locations across the foot print of tailings cell 8 and three monitoring bores installed south and east of cell 8, now partially covered by cell 9.

The five locations across the cell 8 footprint were tested at three different depths (0-1m, 1-2m and 2-6m), results are shown in Figure 37. What can be seen is that k values across the cell 8 footprint decreased with depth. It is believed that the top 2m of higher permeability soil material was excavated prior to tailings deposition. The 4m below reported k values between 0.00014m/day and 0.00039m/day.

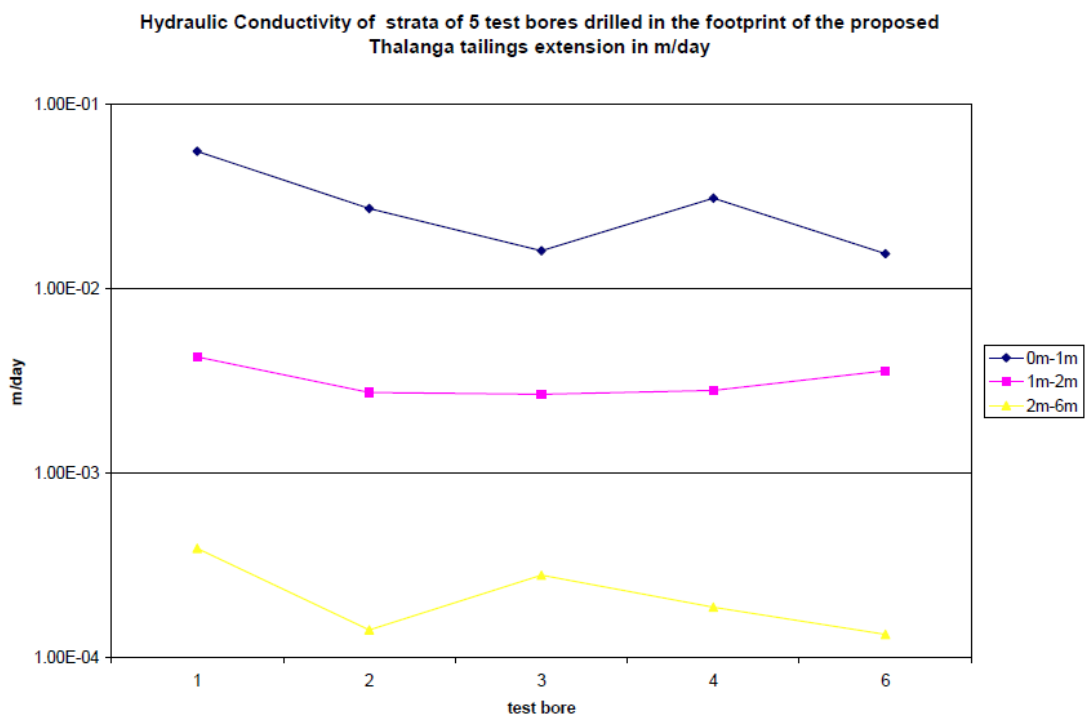


Figure 37 Hydraulic conductivity in m/day of strata in the footprint of cell 8 (from AGE 2006)

The three monitoring bores were all drilled to 30m depth, where they uniformly encountered hard fresh rhyolite. Hydraulic conductivity measurements of the 17-30m bedrock zone recorded k values between 0.000343m/day and 0.122m/day (AGE reported 3.43m/day in error, see evaluation sheets in AGE 2006). The bedrock hydraulic conductivity values were similar to the k values measured for the bulk weathered material above. The higher conductivity value of 0.122m/day was due to a fracture being intersected during drilling, yielding 0.5L/s.

Overall, the results of the hydrogeological testing at Thalanga confirm the low k nature of the unmineralized bedrock and most of the overlying weathered material. The greatest k values were recorded from the top 1m, indicating the presence of a potential pathway for seepage, should water levels rise into that level.

Conceptual hydrogeological model

The main feature of the hydrogeological model for Thalanga is evidently the Thalanga deposit. However, the previous section clearly outlined that the dynamics of the groundwater development changed over time.

Groundwater flow velocities and flow directions depend on hydraulic gradients. With fluctuations in groundwater levels, flow directions at times may be reversed. To demonstrate this with regards to the Thalanga site, hydraulic gradients between V1 and C2 and V6A and C2 have been calculated for three different dates. Date one (14.10.2008) represents the period of highest groundwater tables induced by the process water deposition in the remaining Central Pit. Date two (28.10.2013) is representative of falling groundwater tables following the dewatering and recovery of groundwater tables at the Vomacka Pit and West 45 underground. Date three (26.11.2018) is representative of the current situation characterised by the impacts of the Far West dewatering. Following Darcy's Law for calculating the hydraulic gradient between the groundwater levels at two points (h_1 and h_2) the following equation can be applied:

$$i = \frac{h_1 - h_2}{l}$$

Where i is the hydraulic gradient and l is the distance between the groundwater levels at point h_1 and h_2 . Using the above the following hydraulic gradients can be calculated (Table 6 and Table 7).

Table 6: Change in hydraulic gradient between V1 and C2 between 2008 and 2018

	14.10.2008	28.10.2013	26.11.2018
Distance V1 to C2	3600m	3600m	3600m
SWL AHD at V1	321.39m	312.34m	292.68m
SWL AHD at C2	294.94m	298.09m	297.97m
Hydraulic gradient V1 to C2	0.00734	0.00395	-0.00147

Table 7 Change in hydraulic gradient between V6A and C2 between 2008 and 2018

	14.10.2008	28.10.2013	26.11.2018
Distance V6A to C2	1980m	1980m	1980m
SWL AHD at V6A	313.86m	304.18m	301.54m

	14.10.2008	28.10.2013	26.11.2018
SWL AHD at C2	294.94m	298.09m	297.97m
Hydraulic gradient V1 to C2	0.00955	0.00308	0.00180

What can be seen on Table 6 and Table 7 is that due to the distance between the locations the hydraulic gradients between the individual groundwater locations are extremely low and currently negative between V1 and C2.

The greatest hydraulic gradient between the mine site and the Campaspe Formation existed during 2008 between V6A and C2 (0.00955). Combining this hydraulic gradient with measured hydraulic conductivity values allows for the calculation of Darcy's velocity or flux, using:

$$v = ki$$

Where v is Darcy's velocity and ki is the product of the hydraulic conductivity (k) and the hydraulic gradient (i). Using the highest measured hydraulic conductivity value for bedrock (0.122m/day) in combination with the highest hydraulic gradient (0.00955) results in a calculated Darcy's velocity of 0.001165m/day. Using the highest values available for the site, it becomes apparent that groundwater flow velocities through the natural geology are extremely slow.

The current aquifer situation is marked by rapidly falling groundwater levels across the western section of the mine that is in connection with the underground workings. These major groundwater changes are directly linked to the characteristics of the ore deposit and the mining history.

Besides the major influence of the underground workings, the presence of the tailings dams resulted in increased groundwater levels within the vicinity of these dams. Similarly, the past presence of the Western WRD likely resulted in the compressing of the aquifer producing elevated groundwater tables in its vicinity.

The importance of any original hydrogeological features has been reduced by some orders of magnitude. Perched natural aquifers above the deposit have been mined out, as well as previously confined sections in the deposit have been opened, dewatered and refilled with tailings and impacted water.

What remains valid is that the aquifer of the Thalanga orebody is kept within the confines of the Thalanga deposit. Historic and current groundwater monitoring records confirm that surrounding aquifer zones have no or very limited connection to the orebody. The reported presence of fracture zones and faults within the deposit is of little consequence. Figure 38 shows the locations of these fractures and faults from the previous September 2018 geology progress report (NRC, 2018). Compared with the locations and groundwater level behaviour of monitoring bores, it becomes clear that the impact these faults and fractures have on the groundwater environment surrounding the orebody is very limited.

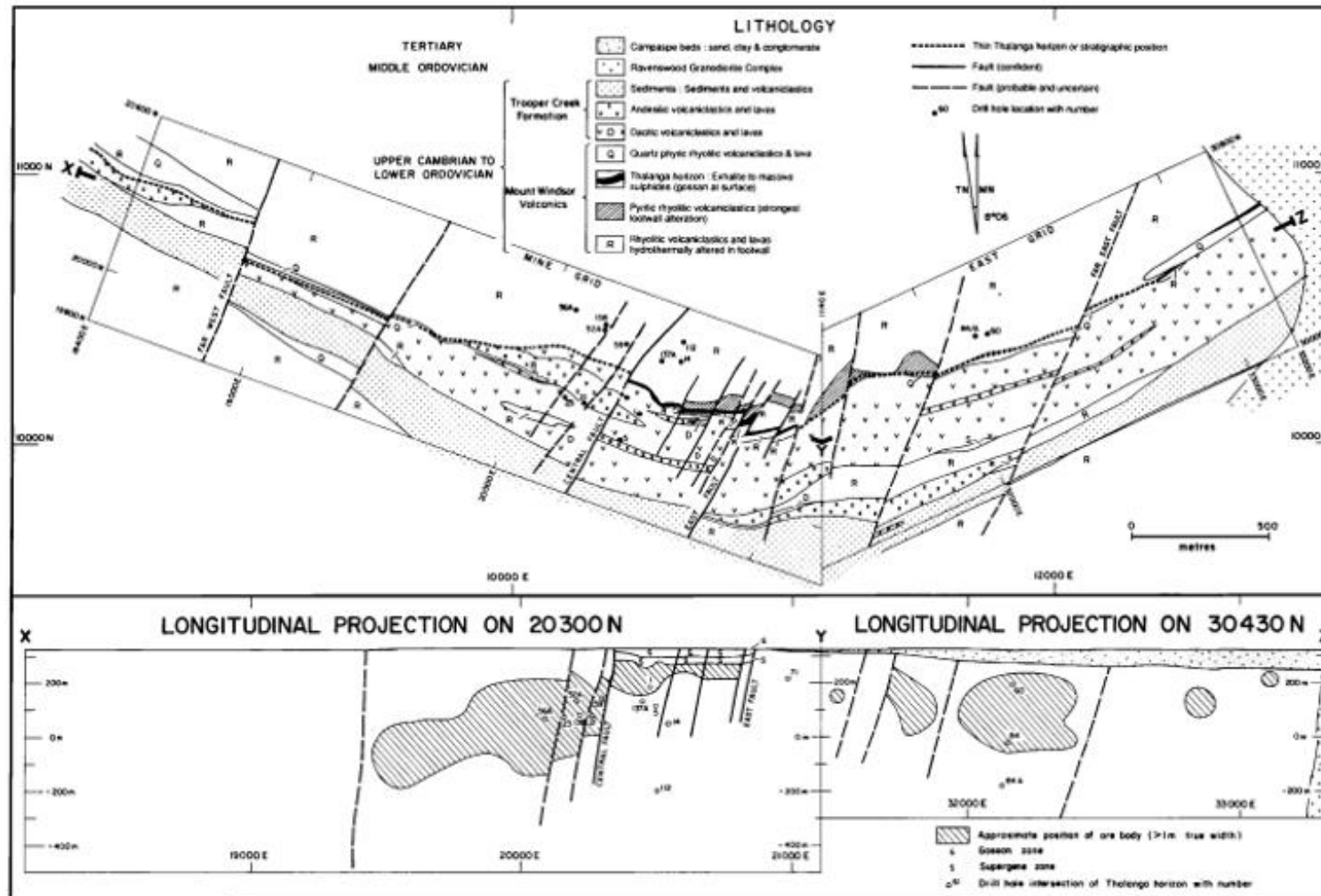


Figure 38 Inferred and confirmed fault locations at Thalanga (from Berry *et al.*, 1992).

1.7 Visualisation of the hydrogeological development

In order to better understand the hydrogeological development at Thalanga a visualisation of the hydrogeological site history is provided in the following sections.

Pre-mining conceptualisation

Initial pre-mining groundwater flow has been discussed in the Pre-mining baseline conditions section. Figure 7 shows the measured groundwater gradients through the Campaspe Formation in the east of the mine lease. Additional interpreted groundwater gradients across the pre-mining Thalanga site have been added to a pre-mining 1978 aerial photograph (State of Queensland, 2014), (Figure 39).

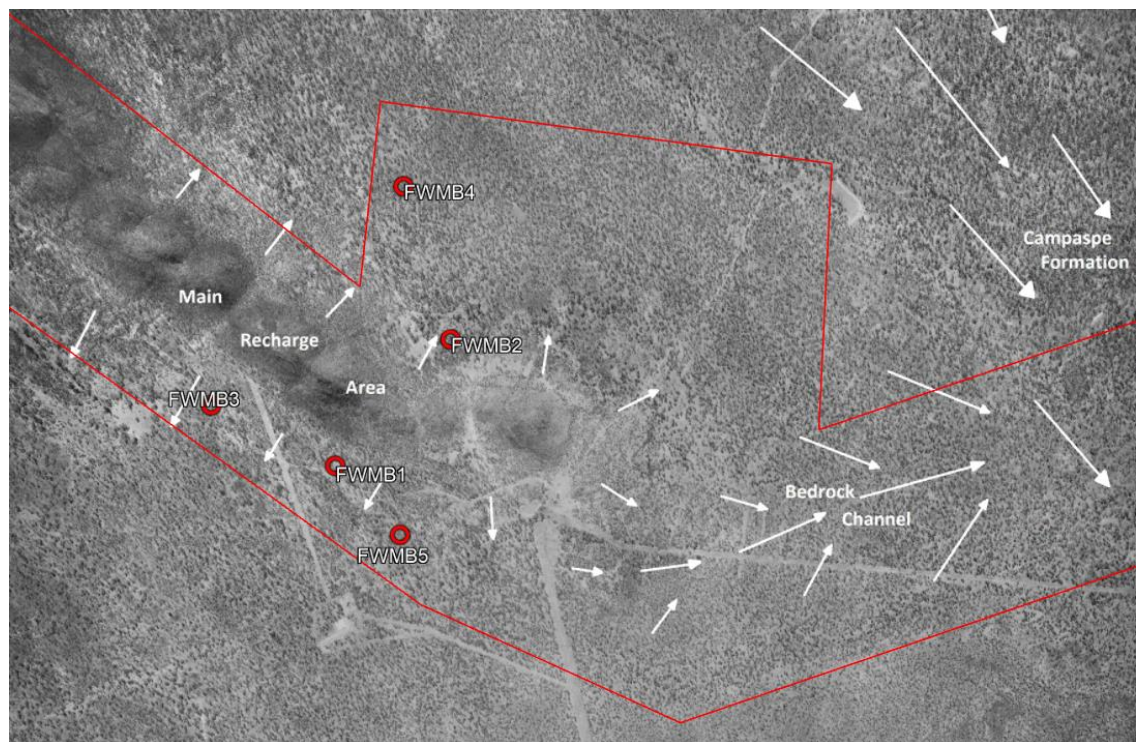


Figure 39 Likely pre-mining groundwater flow directions at Thalanga (modified excerpt from State of Queensland, 2014) Mine lease boundary in red

Following recharge events, groundwater flow would have been mainly along the weathering boundary before reaching the bedrock channel, potentially connecting the Thalanga site with the Campaspe Formation aquifer. Groundwater flow recharge and flow rates would have been low, as indicated by the measured low hydraulic conductivity values and the natural moderately high groundwater EC values. The ore deposit aquifer within the bedrock would have been largely isolated from the above exchange.

Groundwater conceptualisation during Phase One

Figure 40 conceptualises the groundwater situation during Phase One. Due to dewatering, groundwater levels significantly declined within the Thalanga deposit (lower SWL), while groundwater levels around the tailings dams and waste rock dumps increased, likely due to a combination of hydraulic loading and near surface seepage flow. The hills to the west of the site continued to be the main recharge area. The Campaspe Formation in the east remaining the main aquifer being utilised as the process water source for the Thalanga mine site. Potential recharge to the Bedrock Channel would have been reduced due to the underground dewatering activities and draining of potential recharge via exploration holes. Despite that, groundwater levels within the Campaspe Formation were maintained, indicating that any recharge via the bedrock channel is probably low.



Figure 40 Conceptual groundwater situation at Thalanga during Phase One, 1989-1998 (modified exert from State of Queensland, 2012)

Groundwater conceptualisation during Phase Two

Figure 41 conceptualises the groundwater situation during Phase Two. Mining of the Thalanga orebody stopped in 1998 and the underground was backfilled with tailings and process water.

Subsequently groundwater levels within the mined-out deposit rose to levels where recharge to the bedrock channel became a possibility.

Since processing of the Highway Reward ore continued at Thalanga, tailings continued to be generated, resulting in further increasing groundwater levels around the tailings dams.

Removal of the western waste rock dump into the open pit reduced to pressure on the WRD footprint area. Regardless, groundwater levels remained high around the former WRD area



Figure 41 Conceptual groundwater situation at Thalanga during Phase Two, 1998-2006 (2004 background image, modified from Digital Globe, Google Earth accessed February 2019)

Groundwater conceptualisation during Phase Three

Figure 42 conceptualises the groundwater situation during Phase Three. Due to the discharge of process water into the remaining Central Pit void, groundwater levels in the underground and connected exploration drill holes rose close to the surface (Figure 43). Water in the uncased exploration holes saturates the surrounding ground (orange shaded area), possibly allowing for migration towards or along the bedrock channel leading to the Campaspe Formation aquifer in the east.

Deposition of tailings into cell 8 and cell 9 likely increased groundwater tables in the vicinity of these dams. The groundwater tables along the southern side of the former West WRD remain high.

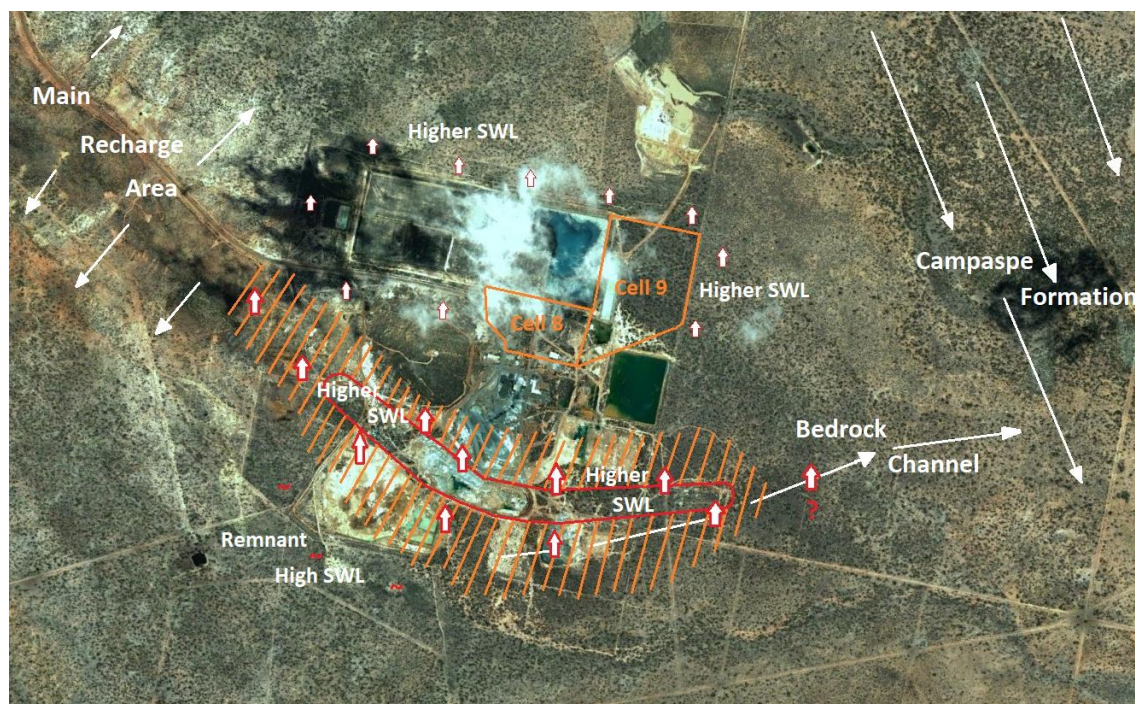


Figure 42 Conceptual groundwater situation at Thalanga during Phase Three, 2006-2008 (2004 background image, modified from Digital Globe, Google Earth accessed February 2019)

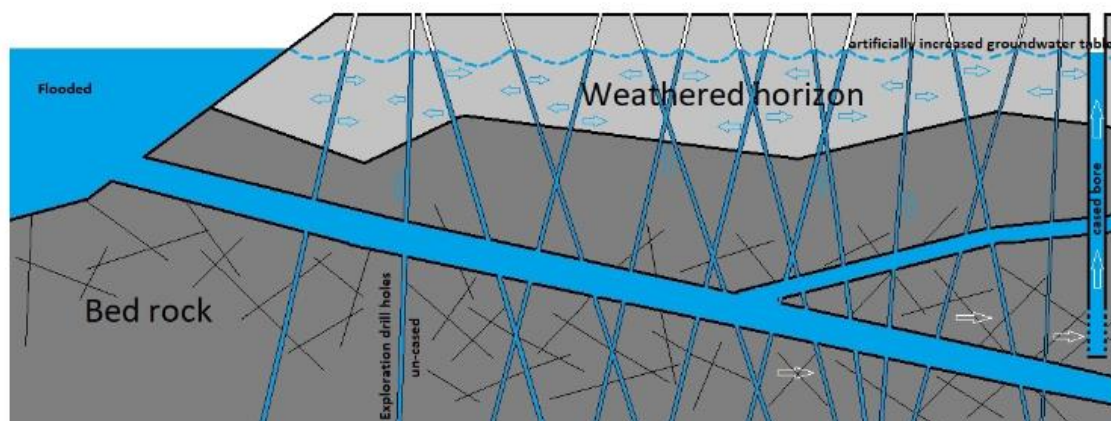


Figure 43 Conceptual cross section of accelerated groundwater level increases through uncased exploration holes in comparison to groundwater level increases in cased bores (on the right).

Groundwater conceptualisation during Phase Four

Phase Four, between 2008 and 2012 (Figure 44), first saw a reduction of groundwater levels due to the dewatering efforts to allow access to the Vomacka Pit. Due to the interconnection

through the underground and exploration holes, groundwater level decreases were broad, including sections directly south of the tailings dams. The area to the east of the new cell 9, nevertheless, saw an increase in groundwater levels as cell 9 became operational.

Bores installed in the Campaspe Formation also saw an increase in groundwater levels, this increase appears to be linked to a reduction in groundwater pumping rates due to the 2012 commencement of the care and maintenance mode.

In the months prior to the care and maintenance mode, the 2012 dewatering of the West 45 deposit appeared to have had a localised impact only. Groundwater level decreases from the West 45 dewatering overlapped with groundwater level decreases from the previous Vomacka dewatering.

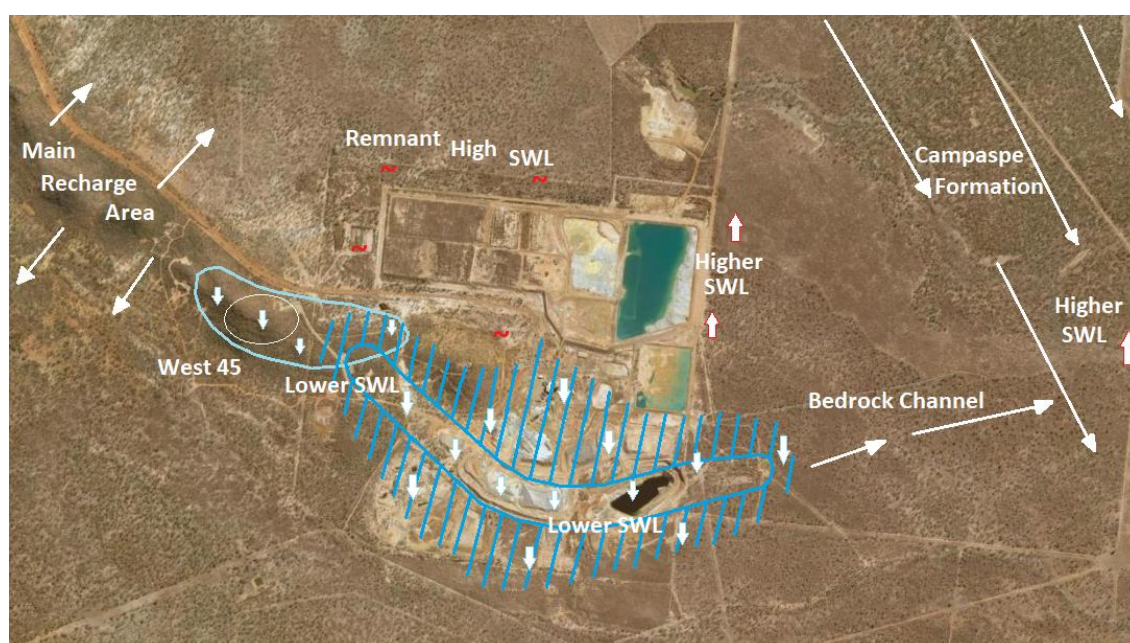


Figure 44 Conceptual groundwater situation at Thalanga during Phase Four, 2008-2012
(Background image from State of Queensland 2016)

Groundwater conceptualisation during Phase Five

Phase Five, from 2012 till 2019, is marked by dewatering activities associated with the West 45 and Far West orebodies and an accelerated decrease in groundwater tables in the western section of the Thalanga deposit (Figure 45). Groundwater tables associated with the Vomacka and eastern side of the mine site experienced minor declines in groundwater tables due to the limited bedrock connection between the deposits. As stated earlier, while connection via underground workings within the individual east and west sections of the Thalanga orebody are extensive, connection between the separate east and west underground workings only exists via a decline in the upper section of the now backfilled Central Pit.

Due to renewed tailings production since 2017, groundwater levels east of cell 9 started to increase again, after remaining unchanged between 2012 and 2017. Related to this production is the renewed need for process water and decreasing groundwater tables near the Campaspe Formation production bores.



Figure 45 Conceptual groundwater situation at Thalanga during Phase Five, 2012-2019
(Background image from State of Queensland 2016)

Likely future development

Due to continued dewatering activities, the future development has the potential to induce a further reduction of groundwater levels within the western section of the Thalanga orebody. Due to the limited connection the eastern section may only see a continued but minor decline in groundwater levels. This decline may in part be facilitated through evaporation from the Vomacka Pit lake surface.

Groundwater levels east of cell 9 may see some further increases. Like the groundwater tables north of the previous tailings dams cells, this increase will likely be contained within the surrounding strata in the vicinity of the TSF. Similarly, groundwater tables around the former West WRD and south of the TSF area will likely remain elevated.

Groundwater levels within the Campaspe Formation will possibly decrease slightly, depending on the process water requirements of the Thalanga Plant.

It is recommended that water tables within the Vomacka Pit should be kept below the level of the Campaspe Formation, which is visible within the southern pit wall. Contact of contaminated groundwater or pit water with the bedrock channel should not occur.

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Appendix summary

Appendix A	Bore logs of registered bores within 5km of the Thalanga lease
Appendix B	Groundwater level development of the Campaspe Formation bores between 1995 and 2003
Appendix C	Bore logs of the West 45 bores installed in 2010
Appendix D	Bore logs of the Far West bores installed in 2017 - 2018

Appendix A

Bore logs of registered bores within 5km of the Thalanga lease

BORE REPORT

REG NUMBER 60286

REGISTRATION DETAILS

OFFICE	Ayr	BASIN	1203	LATITUDE	20-18-14	MAP-SCALE	104
DATE LOG RECD		SUB-AREA	000	LONGITUDE	145-47-14	MAP-SERIES	M
D/O FILE NO.	515/001(3216)	SHIRE	2310-CHARTERS TOWEI	EASTING	374142	MAP-NO	8057
R/O FILE NO.		LOT	829	NORTHING	7753894	MAP NAME	HOMESTEAD
H/O FILE NO.		PLAN	GF808564	ZONE	55	PROG SECTION	
		ORIGINAL DESCRIPTION	THALANGA HOLDING	ACCURACY	INSP	PRES EQUIPMENT	NE
				GPS ACC			
GIS LAT	-20.304016944	PARISH NAME	77-ALLANDALE			ORIGINAL BORE NO	TOMS MILL
GIS LNG	145.78723803	COUNTY	GRIFFITH			BORE LINE	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
						DATA OWNER	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	11/09/1974				
STATUS	Existing	DRILLERS NAME					
ROLES	WS	DRILL COMPANY					
		METHOD OF CONST.	PICK AND SHOVEL				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	11/09/1974	1	Concrete Liner for Wells	1.000	WT	914	0.00	15.20

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
902			11/09/1974 SWL -2.10 M TMP NUL C
903			11/09/1974 DISCH 16.3 M3D

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 60286

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	11/09/1974	-2.10	R		NR

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
------	------	----------------	-----	-----	--------------

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
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WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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**** End of Report. Produced: 25/10/2017 04:37:02 PM ****

BORE REPORT

REG NUMBER 60287

REGISTRATION DETAILS

OFFICE	Ayr	BASIN	1203	LATITUDE	20-19-49	MAP-SCALE	104
DATE LOG RECD		SUB-AREA	000	LONGITUDE	145-43-54	MAP-SERIES	M
D/O FILE NO.	515/001(3216)	SHIRE	2310-CHARTERS TOWEI	EASTING	367567	MAP-NO	8057
R/O FILE NO.		LOT	829	NORTHING	7751439	MAP NAME	HOMESTEAD
H/O FILE NO.		PLAN	GF808564	ZONE	55	PROG SECTION	
		ORIGINAL DESCRIPTION	THALANGA HOLDING	ACCURACY		PRES EQUIPMENT	NE
				GPS ACC			
GIS LAT	-20.33040661	PARISH NAME	77-ALLANDALE			ORIGINAL BORE NO	BEATTIE MILL
GIS LNG	145.731683598	COUNTY	GRIFFITH			BORE LINE	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
						DATA OWNER	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	11/09/1974				
STATUS	Abandoned and Destroyed	DRILLERS NAME					
ROLES	WS	DRILL COMPANY					
		METHOD OF CONST.	PICK AND SHOVEL				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	11/09/1974	1	Concrete Liner for Wells	1.000	WT	1066	0.00	2.40
A	11/09/1974	2	Open Hole			16	2.40	18.30

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
903			11/09/1974 DISCH 32.7 M3D

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 60287

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE E	DATE	RD	ANALYST	QAN	DEPT H (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	11/09/1974	1	GCL	062631	18.00	PU	GB	203	7.2		117.90	103.16	19	24	0.3	2.7	0.10

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	11/09/1974	1	27.0	4.8	2.5	3.0		29.0			44.0	0.00	0.0	7.6				

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	11/09/1974		203								GB

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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BORE REPORT

REG NUMBER 60289

REGISTRATION DETAILS

OFFICE	Ayr	BASIN	1203	LATITUDE	20-22-44	MAP-SCALE	104
DATE LOG RECD		SUB-AREA	000	LONGITUDE	145-45-54	MAP-SERIES	M
D/O FILE NO.	515/001(3216	SHIRE	2310-CHARTERS TOWEI	EASTING	371087	MAP-NO	8057
R/O FILE NO.		LOT	829	NORTHING	7746109	MAP NAME	HOMESTEAD
H/O FILE NO.		PLAN	GF808564	ZONE	55	PROG SECTION	
		ORIGINAL DESCRIPTION	THALANGA HOLDING	ACCURACY		PRES EQUIPMENT	NE
				GPS ACC			
GIS LAT	-20.379016392	PARISH NAME	77-ALLANDALE			ORIGINAL BORE NO	OLD BRACEBROUGH ROAD MILL
GIS LNG	145.765016182	COUNTY	GRIFFITH			BORE LINE	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
						DATA OWNER	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	11/09/1974				
STATUS	Existing	DRILLERS NAME					
ROLES	WS	DRILL COMPANY					
		METHOD OF CONST.	PICK AND SHOVEL				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	11/09/1974	1	Concrete Liner for Wells			1524	0.00	21.30

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
903		11/09/1974	DISCH 16.3 M3D

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 1

BORE REPORT

REG NUMBER 60289

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE E	DATE	RD	ANALYST	QAN	DEPT H (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	11/09/1974	1	GCL	062629	21.00	PU	GB	2500	8.0		1456.40	1255.11	318	330	0.4	8.7	0.23

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	11/09/1974	1	355.0	50.0	50.0	47.0		396.0		3.0	555.0	0.40	0.0	0.0				

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	11/09/1974		2500								GB

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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BORE REPORT

REG NUMBER 60633

REGISTRATION DETAILS

OFFICE	Ayr	BASIN	1203	LATITUDE	20-21-14	MAP-SCALE	104
DATE LOG RECD		SUB-AREA	000	LONGITUDE	145-46-24	MAP-SERIES	M
D/O FILE NO.	515/001(3216	SHIRE	2310-CHARTERS TOWEI	EASTING	371937	MAP-NO	8057
R/O FILE NO.		LOT	829	NORTHING	7748849	MAP NAME	HOMESTEAD
H/O FILE NO.	L52171B	PLAN	GF808564	ZONE	55	PROG SECTION	
		ORIGINAL DESCRIPTION	THALANGA HOLDING	ACCURACY		PRES EQUIPMENT	NE
				GPS ACC			
GIS LAT	-20.354017008	PARISH NAME	77-ALLANDALE			ORIGINAL BORE NO	
GIS LNG	145.773349856	COUNTY	GRIFFITH			BORE LINE	-
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
						DATA OWNER	
FACILITY TYPE	Sub-Artesian Facility	DATE DRILLED	14/04/1983				
STATUS	Existing	DRILLERS NAME					
ROLES	WS	DRILL COMPANY					
		METHOD OF CONST.	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	14/04/1983	1	Plastic Casing	5.900	WT	125	0.00	40.80
A	14/04/1983	2	Perforated or Slotted Casing	5.900	AP	125	34.10	40.80

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.52	SANDY SOIL DR J BROWN ROTARY SWL16.1M
3	1.52	24.38	CEMENTED COUNTRY WITH CLAY
5	24.38	37.49	CLAY WITH SAND AREAS WATER
7	37.49	40.84	BROKEN DIORITE WATER WATER
902			14/04/1983 SWL -16.15 M TMP NUL C
903			14/04/1983 DISCH 16.3 M3D AIR TST
910	24.40	37.50	QUALITY DESCRIPT/CONDUCT: POTABLE

BORE REPORT

REG NUMBER 60633

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
911	37.50	40.80	QUALITY DESCRIP/CONDUCT: POTABLE

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			ALLUV
DNR	2	0.00	40.80	GRANITE

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD CTR (l/s)	CONDIT	FORMATION NAME
1	24.40	37.50	SAND						UC	ALLUV
			SILT							
2	37.50	40.80	GNTG						FR	GRANITE

PUMP TEST DETAILS PART 1

PIPE	DATE	REC RN OF NO. PUMP-BORE	TOP (m)	BOTTOM (m)	DIST METH (m)	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	19/04/1983	1 60633	34.10	40.80								

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	19/04/1983	1		16.20				1.26								

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

BORE REPORT

REG NUMBER 60633

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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BORE REPORT

REG NUMBER 60637

REGISTRATION DETAILS

OFFICE Ayr	BASIN 1203	LATITUDE 20-21-14	MAP-SCALE 104
DATE LOG RECD	SUB-AREA 000	LONGITUDE 145-44-09	MAP-SERIES M
D/O FILE NO. 515/001(3216	SHIRE 2310-CHARTERS TOWEI	EASTING 367832	MAP-NO 8057
R/O FILE NO.	LOT 829	NORTHING 7748999	MAP NAME HOMESTEAD
H/O FILE NO. L52171B	PLAN GF808564	ZONE 55	PROG SECTION
	ORIGINAL DESCRIPTION THALANGA HOLDING	ACCURACY INSP	PRES EQUIPMENT JP
		GPS ACC	
GIS LAT -20.354017503	PARISH NAME 77-ALLANDALE		ORIGINAL BORE NO LOCO BORE
GIS LNG 145.735850383	COUNTY GRIFFITH		BORE LINE -
CHECKED N			
			POLYGON
			RN OF BORE REPLACED
			DATA OWNER
FACILITY TYPE Sub-Artesian Facility	DATE DRILLED 12/04/1983		
STATUS Existing	DRILLERS NAME		
ROLES WS	DRILL COMPANY		
	METHOD OF CONST. ROTARY RIG		

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	12/04/1983	1	Plastic Casing	5.900	WT	125	0.00	43.20
A	12/04/1983	2	Perforated or Slotted Casing	5.900	AP	125	24.30	43.20

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.52	SANDY SOIL DR J BROWN ROTARY SWL18.3
3	1.52	18.28	CEMENTED COUNTRY
5	18.28	28.95	GRAVEL AND CLAY WATER
7	28.95	42.67	DECOMPOSED RED GRANITE
9	42.67	43.28	COARSE RED GRANITE WITH QUARTZ WATER
11	43.28	44.80	HARD GRANITE
902			12/04/1983 SWL -18.28 M TMP NUL C

BORE REPORT

REG NUMBER 60637

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
903			12/04/1983 DISCH 21.8 M3D AIR TST
910	24.40	28.90	QUALITY DESCRIPT/CONDUCT: POTABLE

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			ALLUV
DNR	2	0.00	44.80	GRANITE

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	24.40	28.90	GRAV CLAY							UC	ALLUV
2	42.70	43.30	GNTG							FR	GRANITE

PUMP TEST DETAILS PART 1

PIPE	DATE	REC RN OF NO. PUMP-BORE	TOP (m)	BOTTOM (m)	DIST METH (m)	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	19/04/1983	1 60637	24.30	43.20								

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	19/04/1983	1		18.30				0.88								

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

BORE REPORT

REG NUMBER 60637

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE E	DATE	RD ANALYST	QAN	DEPT H (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	09/07/1996	1 GCL	182165		PU	GB	4050	7.5	83	2773.05	2465.13	561	633	0.4	13.3	1.44

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	09/07/1996	1	723.8	7.5	103.7	73.5	0.01	768.1	0.00	2.1	935.8	0.25	0.0	158.3	0.03	0.00	0.30	0.17

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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BORE REPORT

REG NUMBER 60638

REGISTRATION DETAILS

OFFICE Ayr	BASIN 1203	LATITUDE 20-20-04	MAP-SCALE 104
DATE LOG RECD	SUB-AREA 000	LONGITUDE 145-43-54	MAP-SERIES M
D/O FILE NO. 515/001(3216	SHIRE 2310-CHARTERS TOWEI	EASTING 366692	MAP-NO 8057
R/O FILE NO.	LOT 829	NORTHING 7751174	MAP NAME HOMESTEAD
H/O FILE NO. L52171B	PLAN GF808564	ZONE 55	PROG SECTION
	ORIGINAL DESCRIPTION THALANGA HOLDING	ACCURACY INSP	PRES EQUIPMENT HS
		GPS ACC	
GIS LAT -20.334573316	PARISH NAME 77-ALLANDALE		ORIGINAL BORE NO BEATTIES BORE
GIS LNG 145.731683654	COUNTY GRIFFITH		BORE LINE -
CHECKED N			
			POLYGON
			RN OF BORE REPLACED
			DATA OWNER
FACILITY TYPE Sub-Artesian Facility	DATE DRILLED 10/04/1983		
STATUS Existing	DRILLERS NAME		
ROLES WS	DRILL COMPANY		
	METHOD OF CONST. ROTARY RIG		

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	10/04/1983	1	Plastic Casing	5.900	WT	125	0.00	50.00
A	10/04/1983	2	Perforated or Slotted Casing	1.000	AP	125	30.50	50.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	1.82	SANDY SOIL DR J BROWN ROTARY
3	1.82	41.14	CEMENTED COUNTRY WITH CLAY SWL 20.4M
5	41.14	51.20	CLAY SANDY AND FINE GRAVEL WATER
902			10/04/1983 SWL -20.42 M TMP NUL C
903			10/04/1983 DISCH 65.4 M3D AIR TST
910	41.10	51.20	QUALITY DESCRIPT/CONDUCT: POTABLE

STRATIGRAPHY DETAILS

BORE REPORT

REG NUMBER 60638

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	0.00	51.20	ALLUV

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD CTR (l/s)	CONDIT	FORMATION NAME
1	41.10	51.20	SAND CLAY GRAV						UC	ALLUV

PUMP TEST DETAILS PART 1

PIPE	DATE	REC RN OF NO. PUMP-BORE	TOP (m)	BOTTOM (m)	DIST METH (m)	TEST TYPES	PUMP TYPE	SUCTION SET (m)	Q PRIOR TO TEST (l/s)	DUR OF Q PR (min)	PRES ON ARRIV (m)	Q ON ARRIV (l/s)
A	19/11/1982	1 60638	30.50	50.00								

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	19/11/1982	1		20.40				0.76								

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

PIPE	DATE	RD ANALYST	QAN	DEPT H (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	09/07/1996	1 GCL	182174		PU	GB	3020	8.0	94	2224.82	1907.60	324	673	0.3	14.6	6.97

BORE REPORT

REG NUMBER 60638

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	09/07/1996	1	604.4	6.5	50.7	48.1	0.00	808.4	0.00	6.2	559.1	0.70	16.9	123.8	0.39	0.00	0.30	0.07

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS**** NO RECORDS FOUND ****

BORE REPORT

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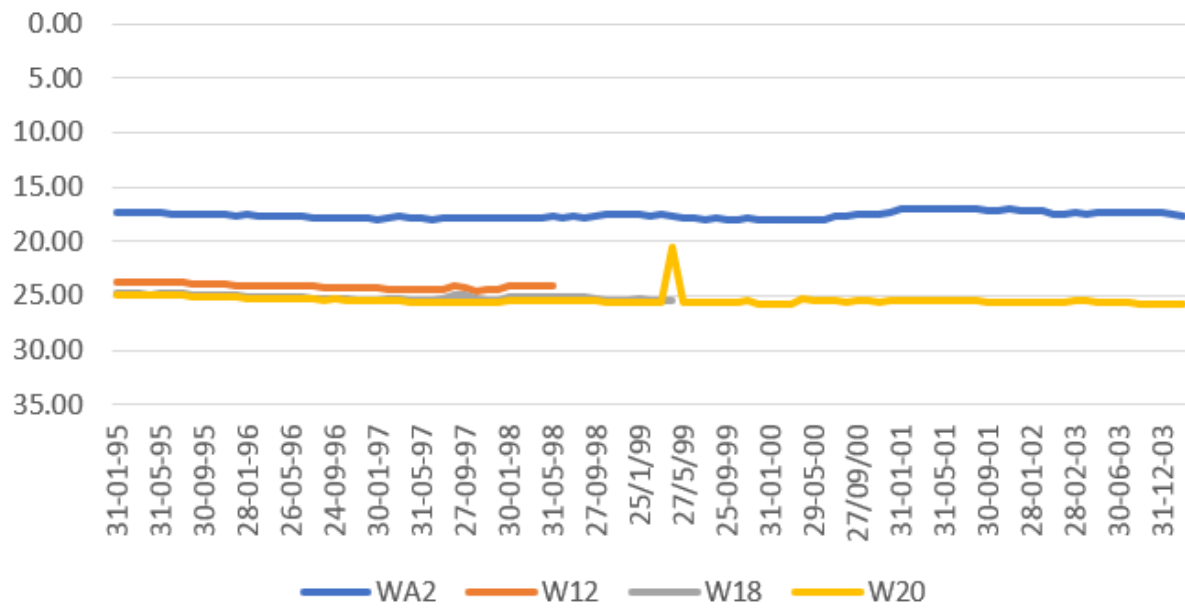
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**** End of Report. Produced: 31/10/2017 10:56:36 AM ****

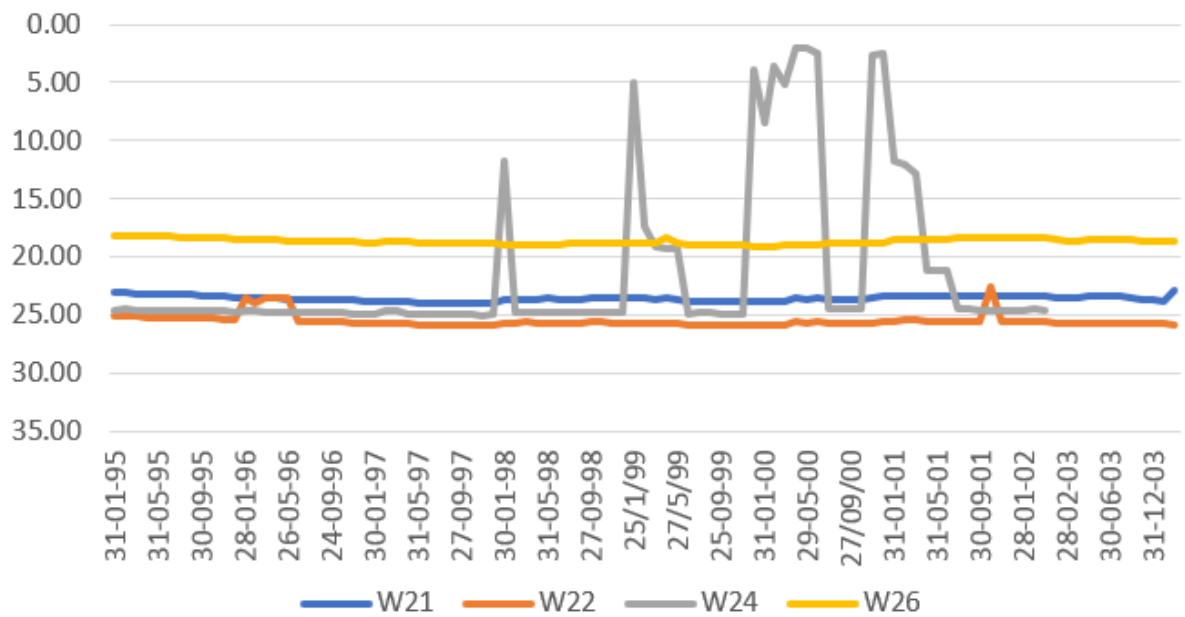
Appendix B

Groundwater level development of the Campaspe Formation bores between 1995 and 2003

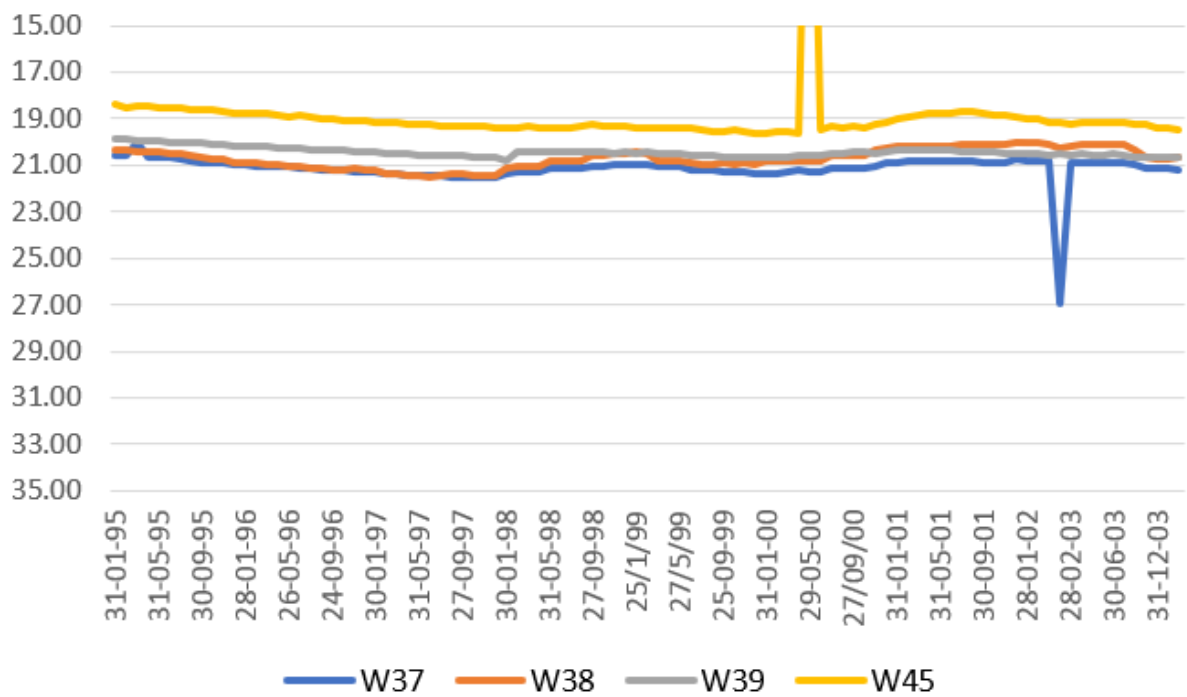
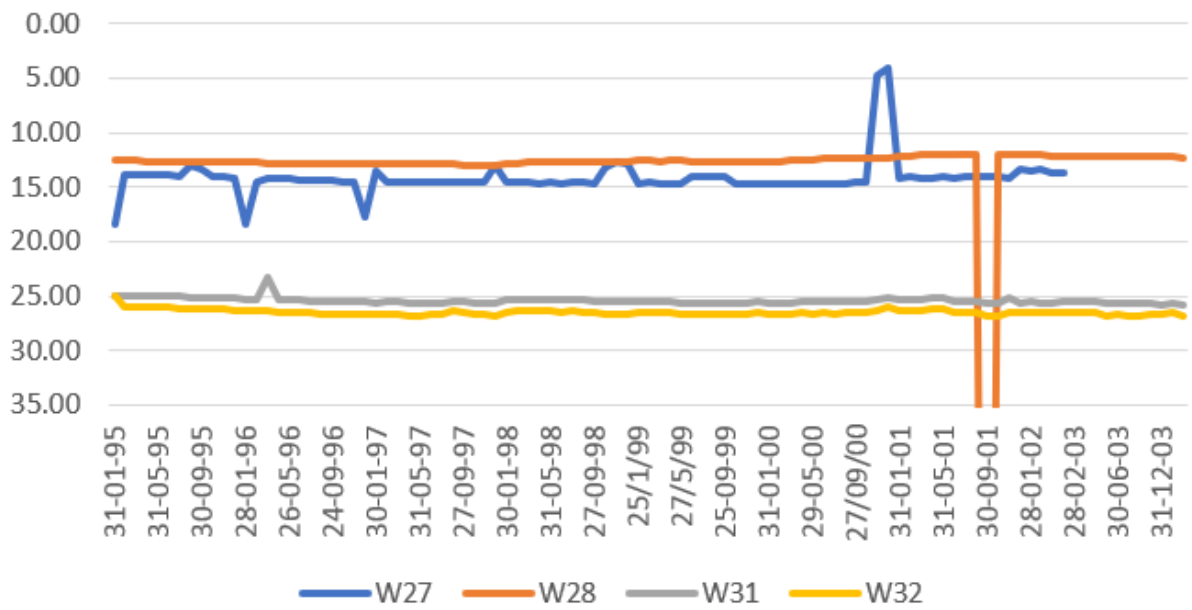
WA2-W12-W18-W20



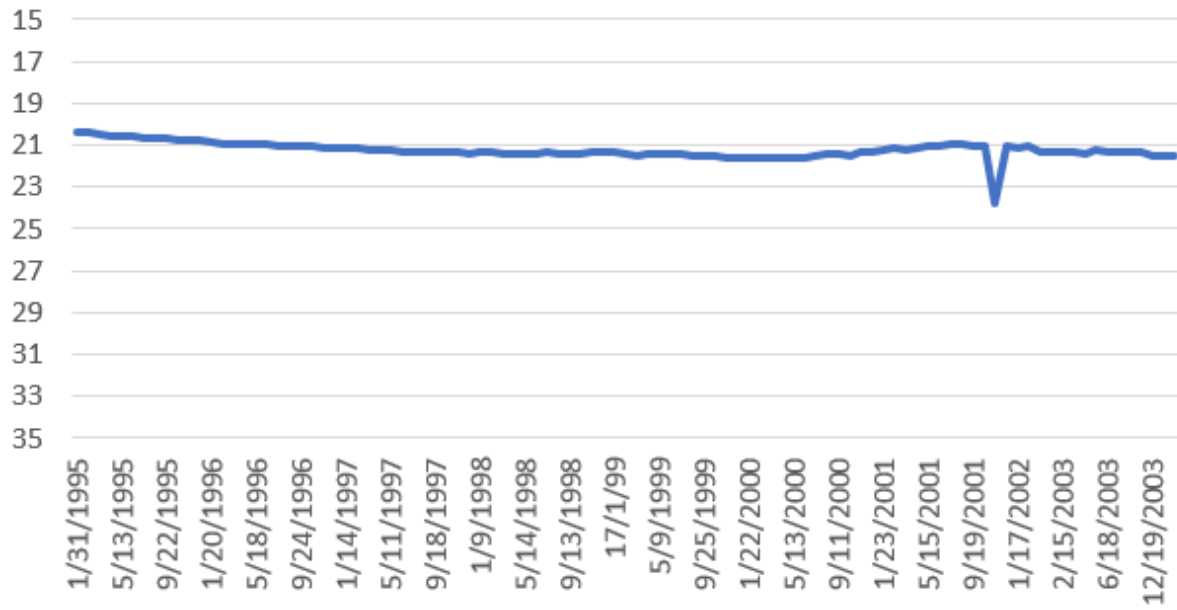
W21-W22-W24W26



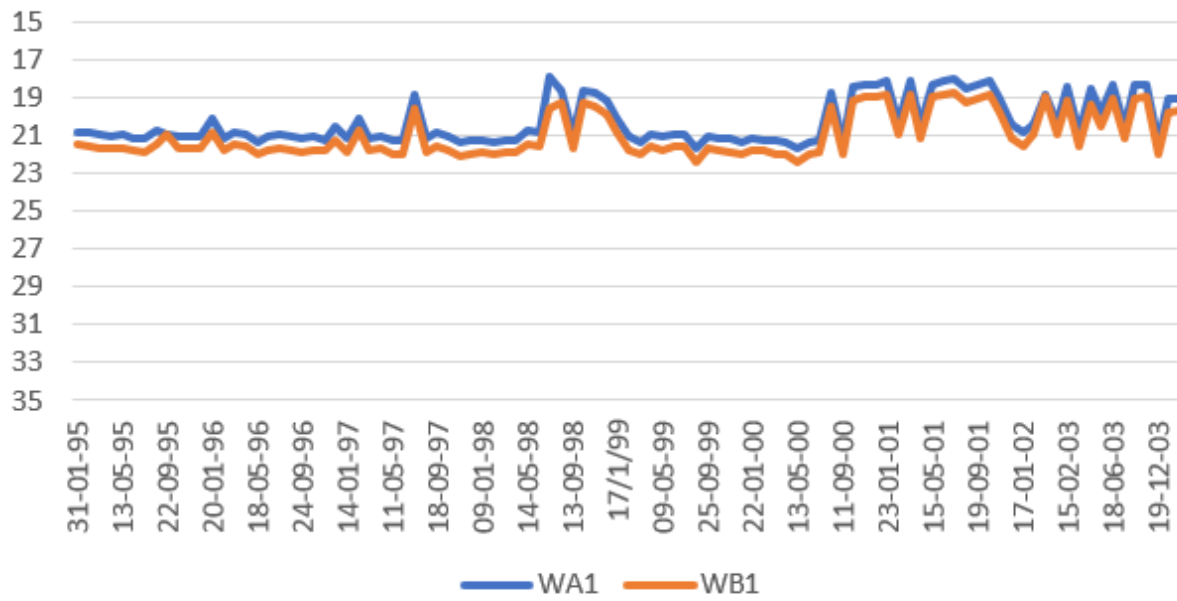
W27-W28-W31W32



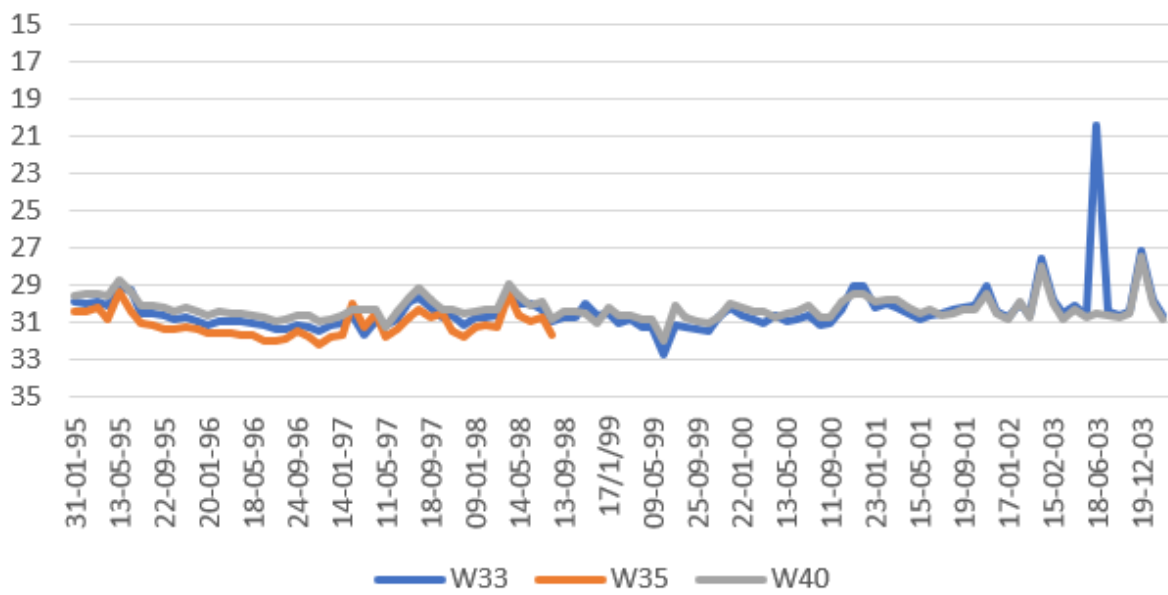
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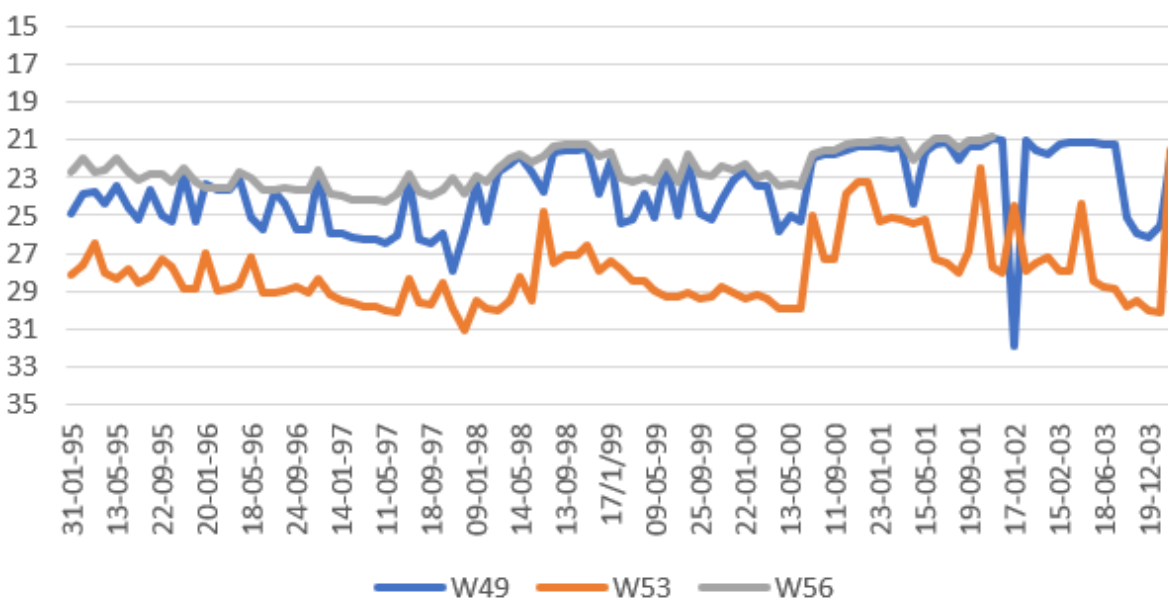
WA1 and WB1



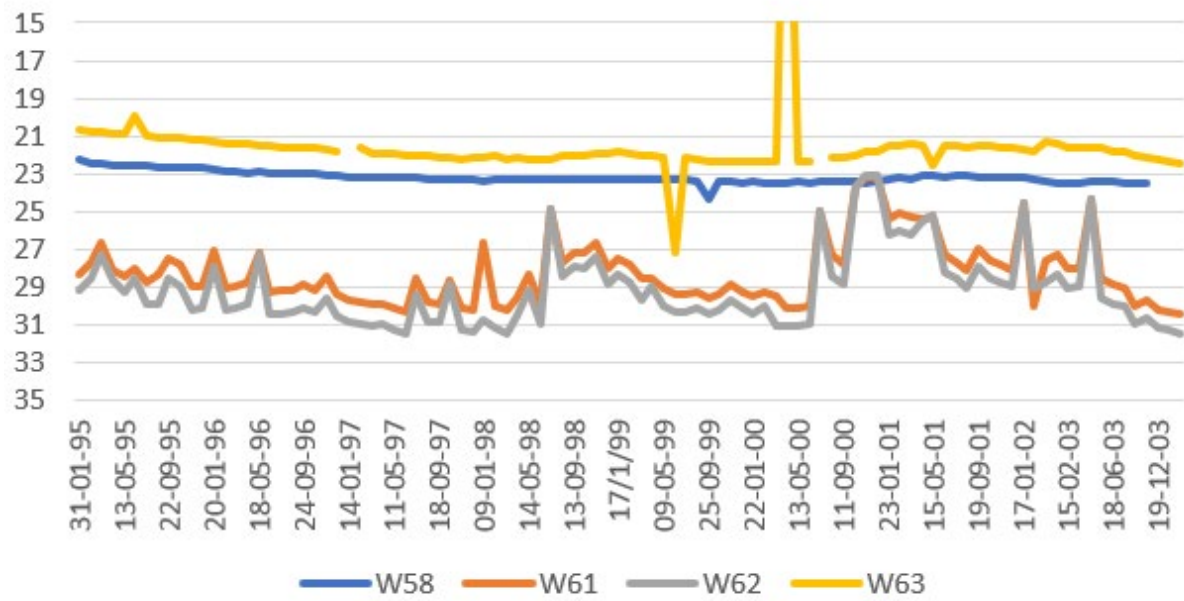
W33-W35-W40



W49-W53-W56

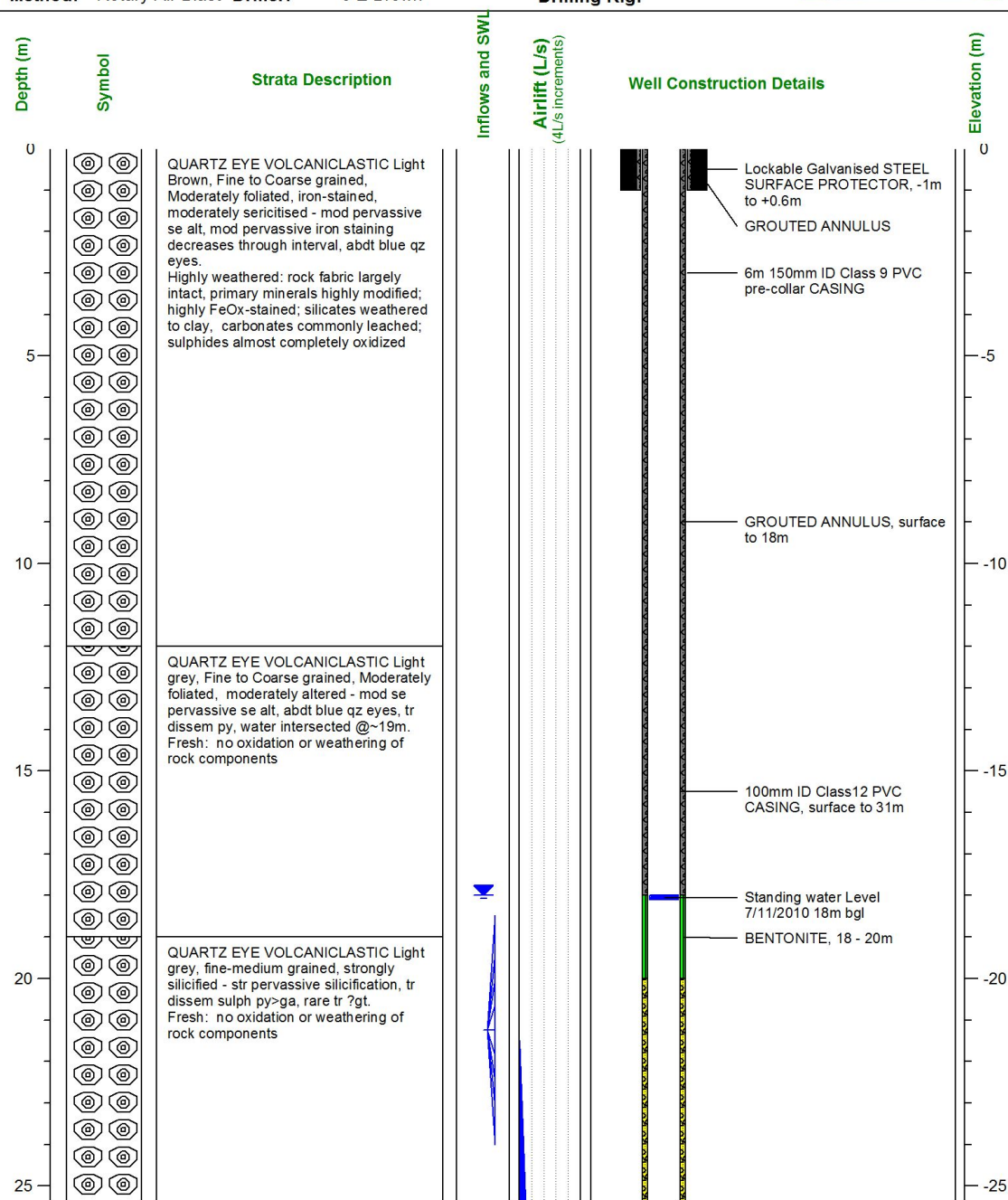


W58-W61-W62-W63



Appendix C

Bore logs of the West 45 bores installed in 2010

Borehole No: WB01**Location:** West 45**Date Drilled:** 7/11/2010**Easting:** 369899**Northing:** 7751452**Method:** Rotary Air Blast**Driller:** J E Brown**Client:** Kagara Copper Ltd**Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 1 of 4

Notes:

Datum: MGA

West 45 WB01

Borehole No: WB01

Location: West 45

Date Drilled: 7/11/2010

Easting: 369899

Northing: 7751452

Method: Rotary Air Blast

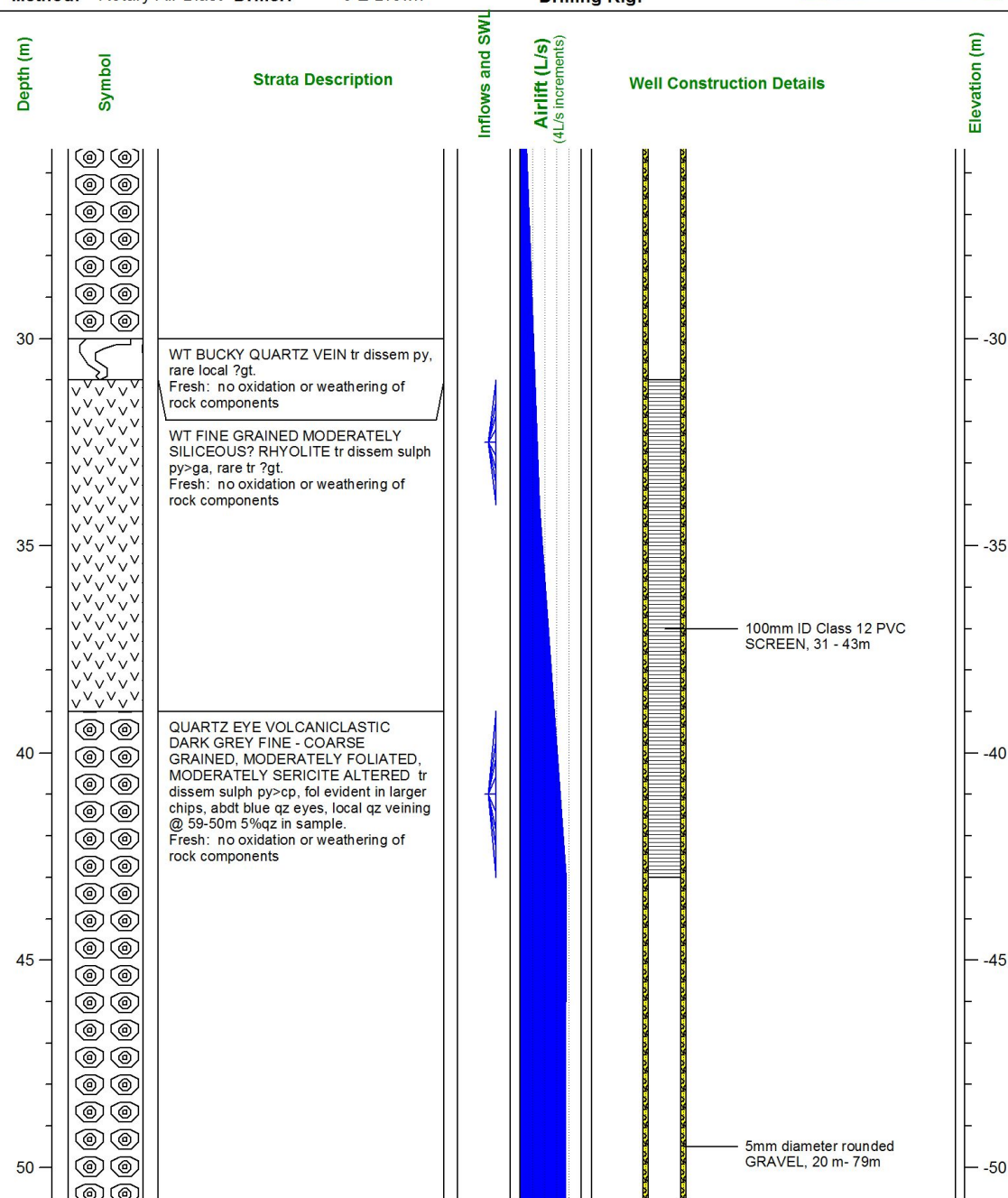
Driller: J E Brown

Client: Kagara Copper Ltd

Project No: NG256

Elevation (m):

Drilling Rig:



Page 2 of 4

Notes:

Datum: MGA

West 45 WB01

Borehole No: **WB01**

Location: West 45

Date Drilled: 7/11/2010

Easting: 369899

Northing: 7751452

Method: Rotary Air Blast

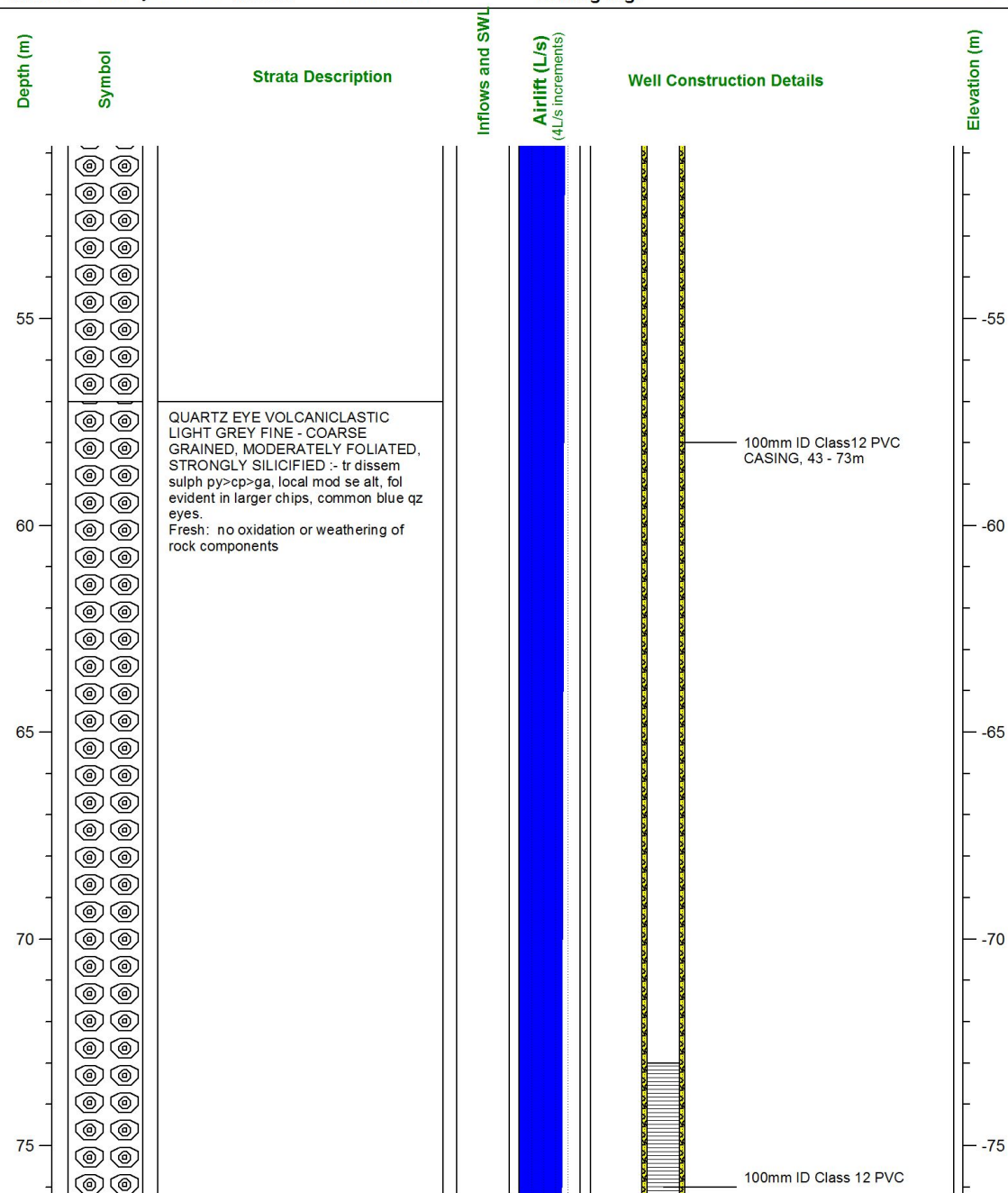
Driller: J E Brown

Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



Page 3 of 4

Notes:

Datum:MGA

West 45 WB01

Borehole No: WB01

Location: West 45

Date Drilled: 7/11/2010

Easting: 369899

Northing: 7751452

Method: Rotary Air Blast

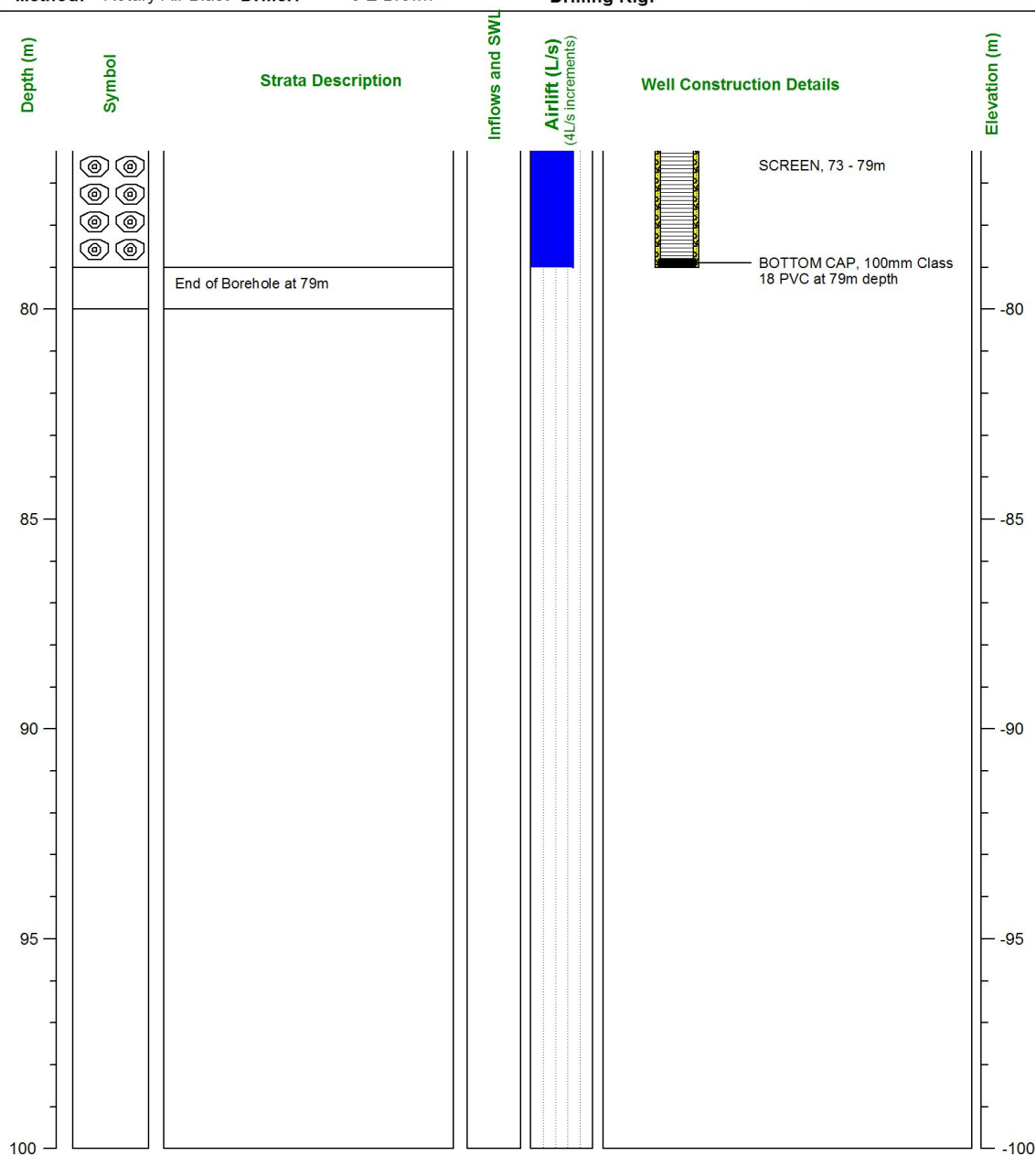
Driller: J E Brown

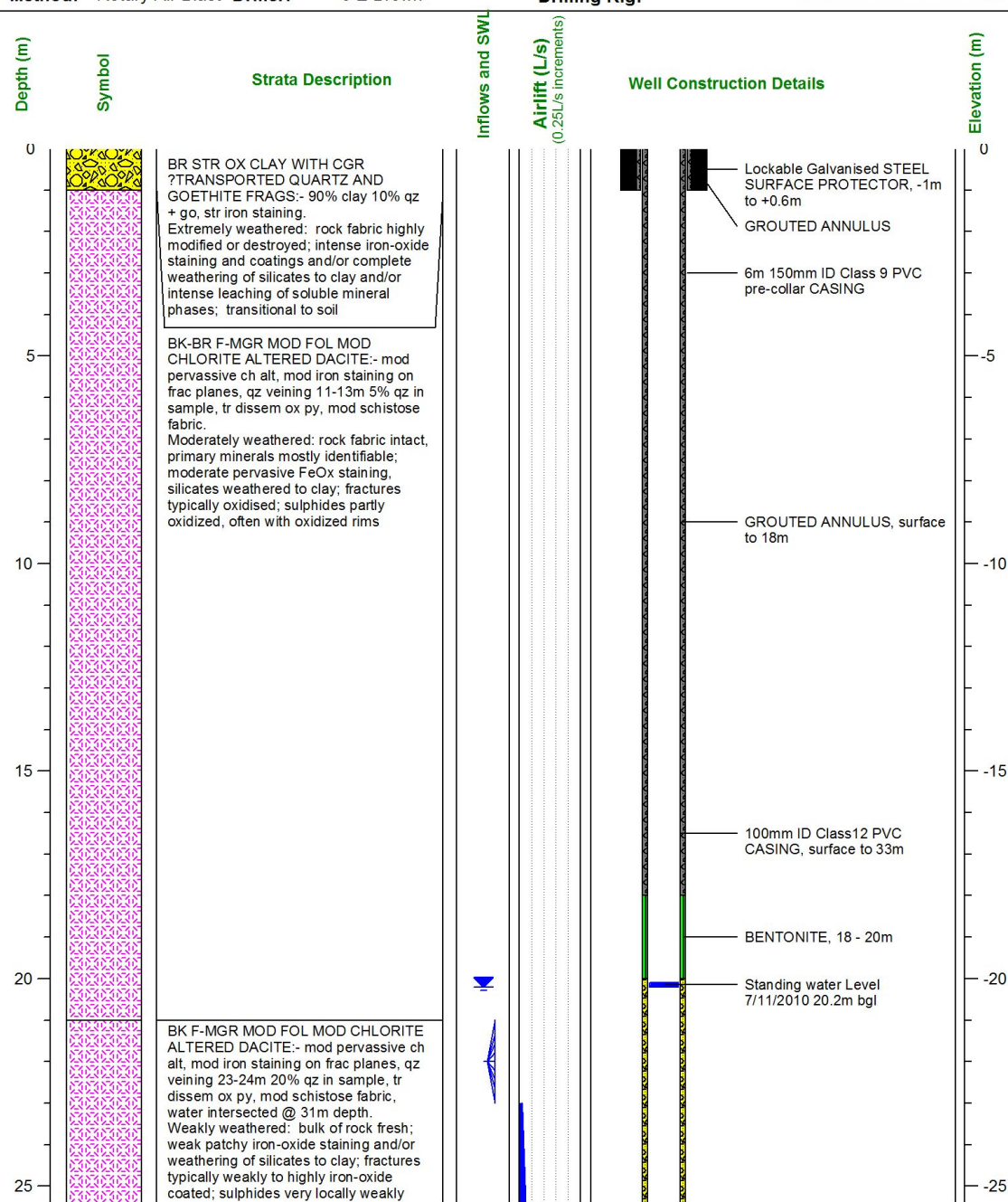
Client: Kagara Copper Ltd

Project No: NG256

Elevation (m):

Drilling Rig:



Borehole No: WB02**Location:** West 45**Date Drilled:** 7/11/2010**Easting:** 369985**Northing:** 7751195**Method:** Rotary Air Blast**Driller:** J E Brown**Client: Kagara Copper Ltd****Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 1 of 4

Notes:

Datum:MGA

West 45 WB02

Borehole No: **WB02**

Location: West 45

Date Drilled: 7/11/2010

Easting: 369985

Northing: 7751195

Method: Rotary Air Blast

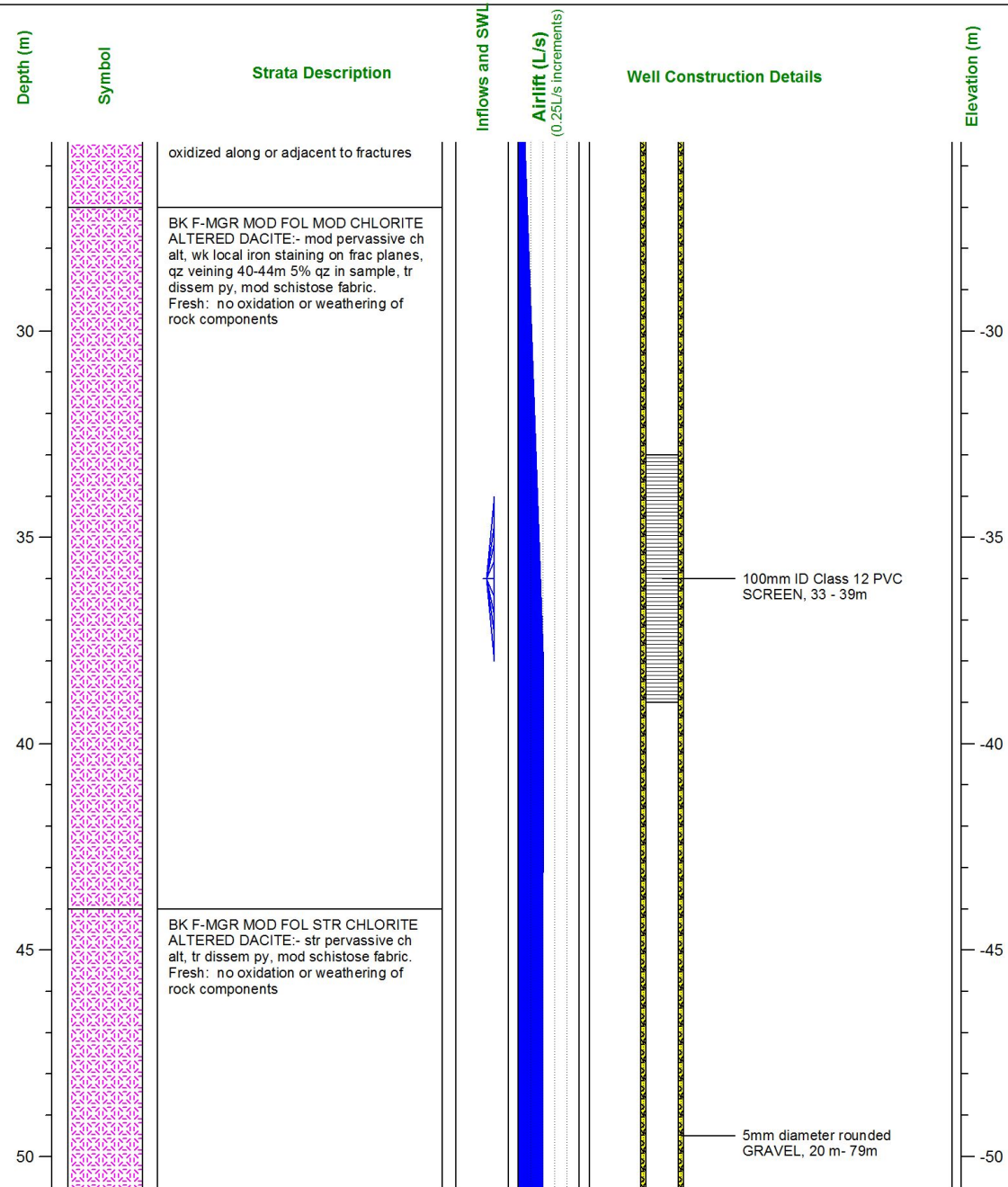
Driller: J E Brown

Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



Page 2 of 4

Notes:

Datum:MGA

West 45 WB02

Borehole No: **WB02**

Location: West 45

Date Drilled: 7/11/2010

Easting: 369985

Northing: 7751195

Method: Rotary Air Blast

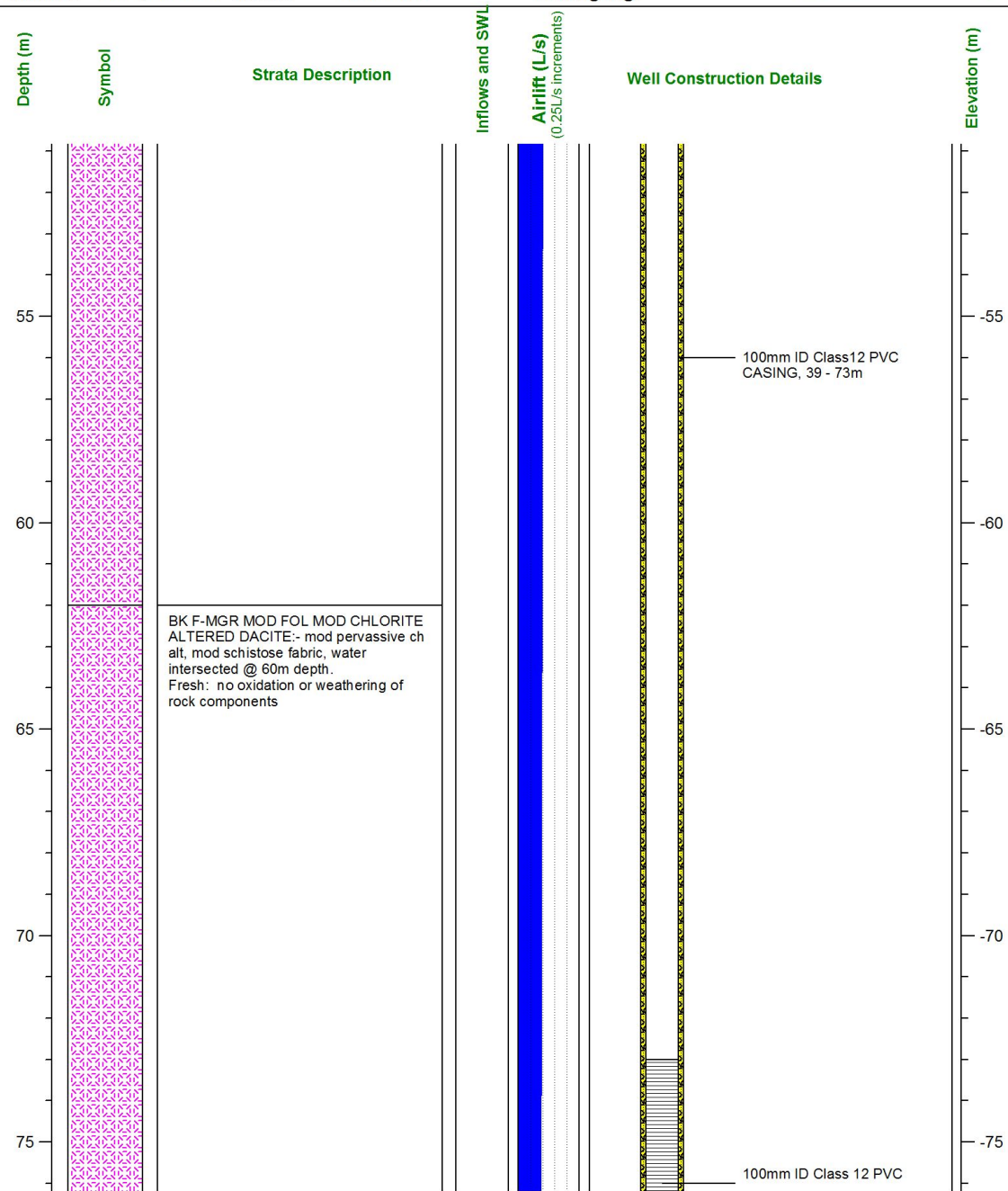
Driller: J E Brown

Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



Page 3 of 4

Notes:

Datum:MGA

West 45 WB02

Borehole No: WB02

Location: West 45

Date Drilled: 7/11/2010

Easting: 369985

Northing: 7751195

Method: Rotary Air Blast

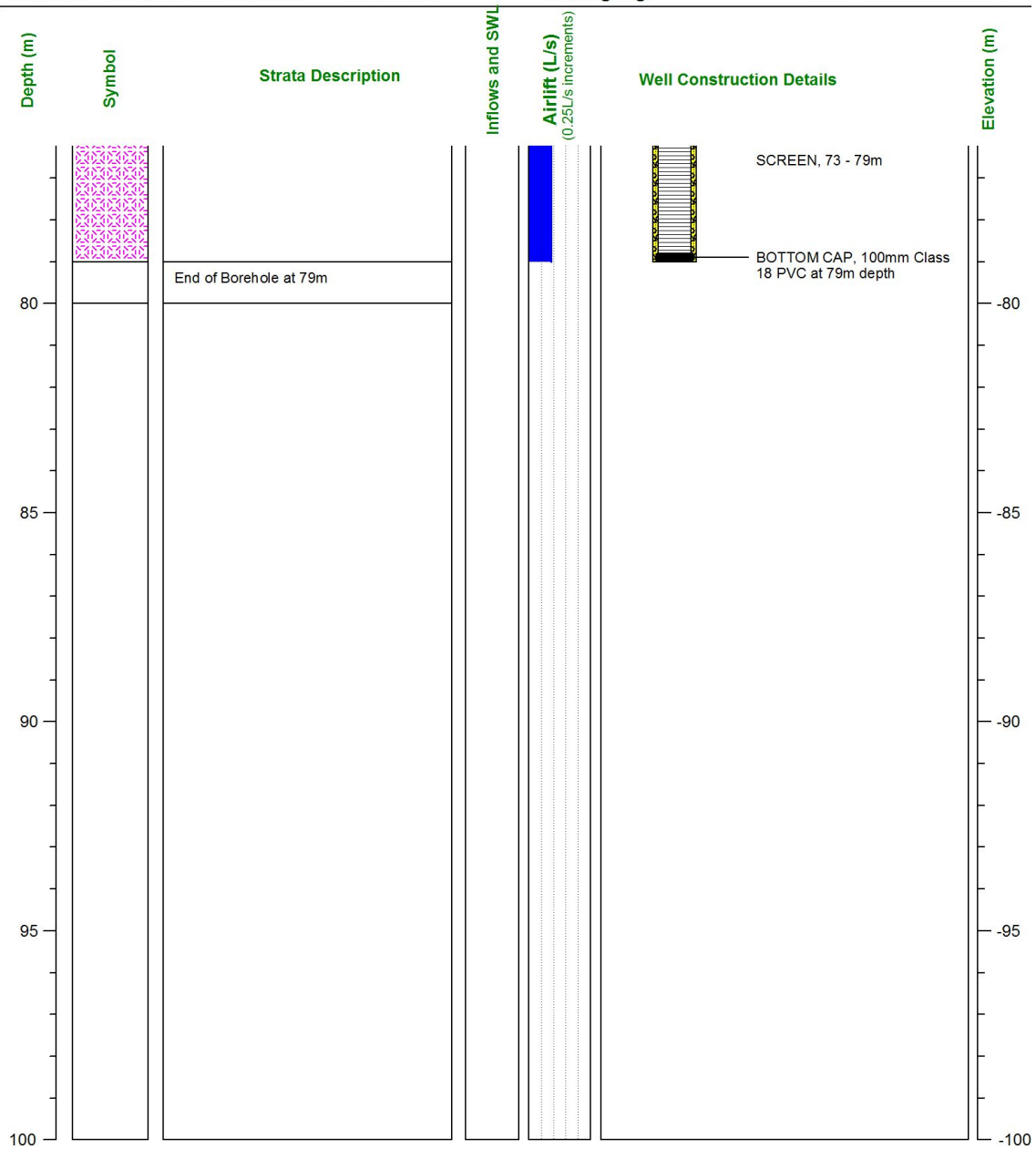
Driller: J E Brown

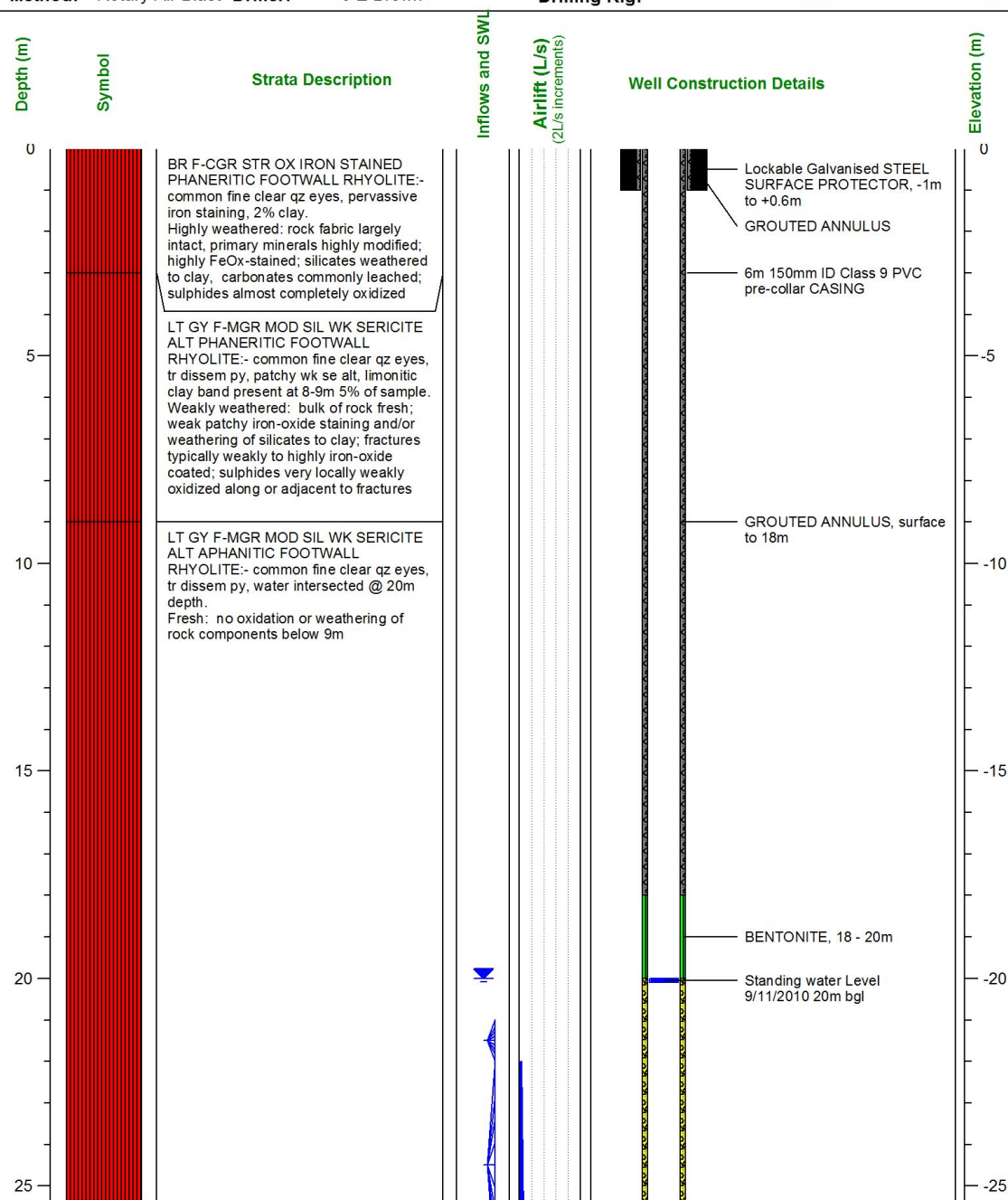
Client: Kagara Copper Ltd

Project No: NG256

Elevation (m):

Drilling Rig:



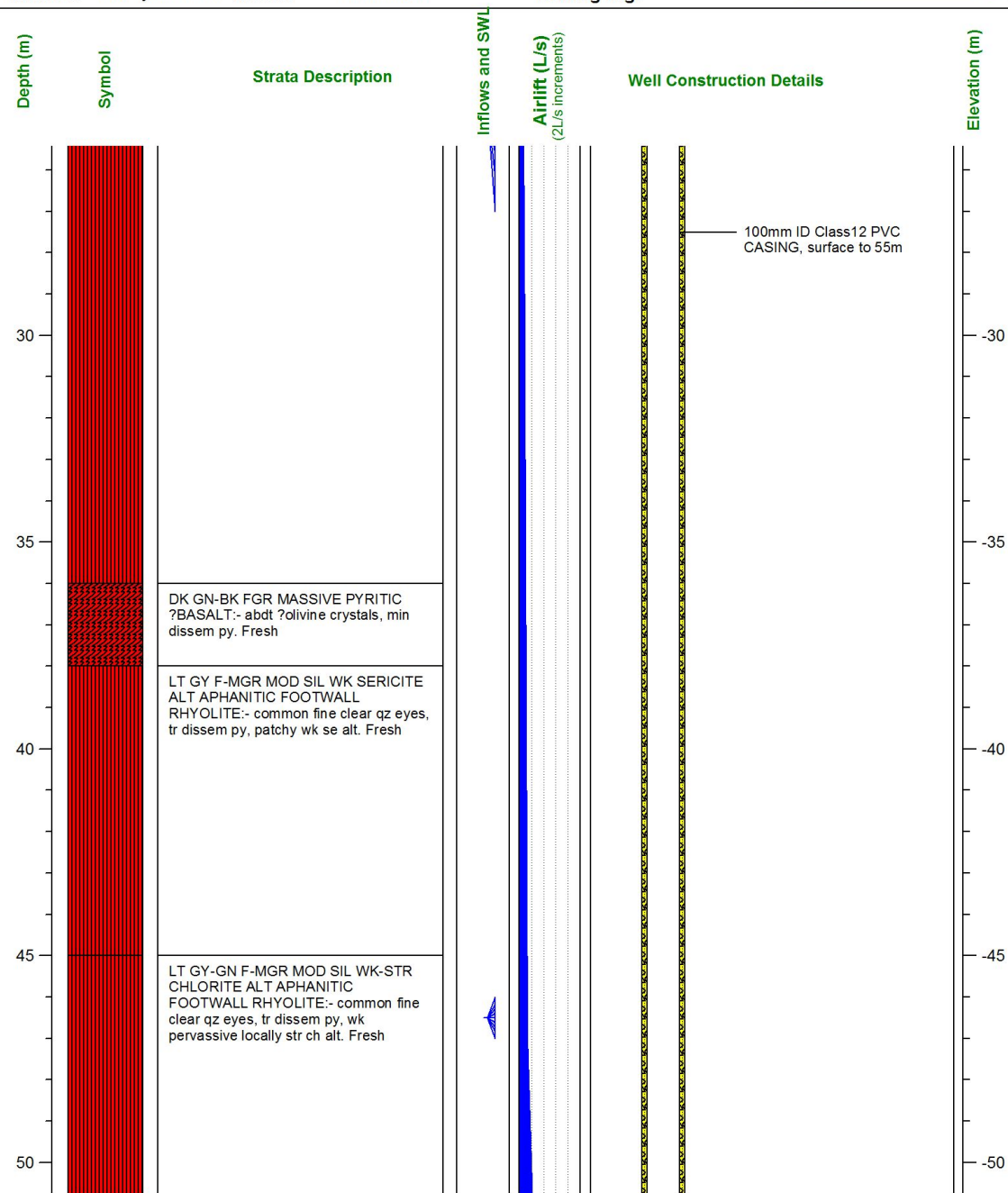
Borehole No: WB03**Location:** West 45**Date Drilled:** 9/11/2010**Easting:** 370437**Northing:** 7751432**Method:** Rotary Air Blast**Driller:** J E Brown**Client: Kagara Copper Ltd****Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 1 of 4

Notes:

Datum:MGA

West 45 WB03

Borehole No: WB03**Location:** West 45**Date Drilled:** 9/11/2010**Easting:** 370437**Northing:** 7751432**Method:** Rotary Air Blast**Driller:** J E Brown**Client:** Kagara Copper Ltd**Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 2 of 4

Notes:

Datum:MGA

West 45 WB03

Borehole No: **WB03**

Location: West 45

Date Drilled: 9/11/2010

Easting: 370437

Northing: 7751432

Method: Rotary Air Blast

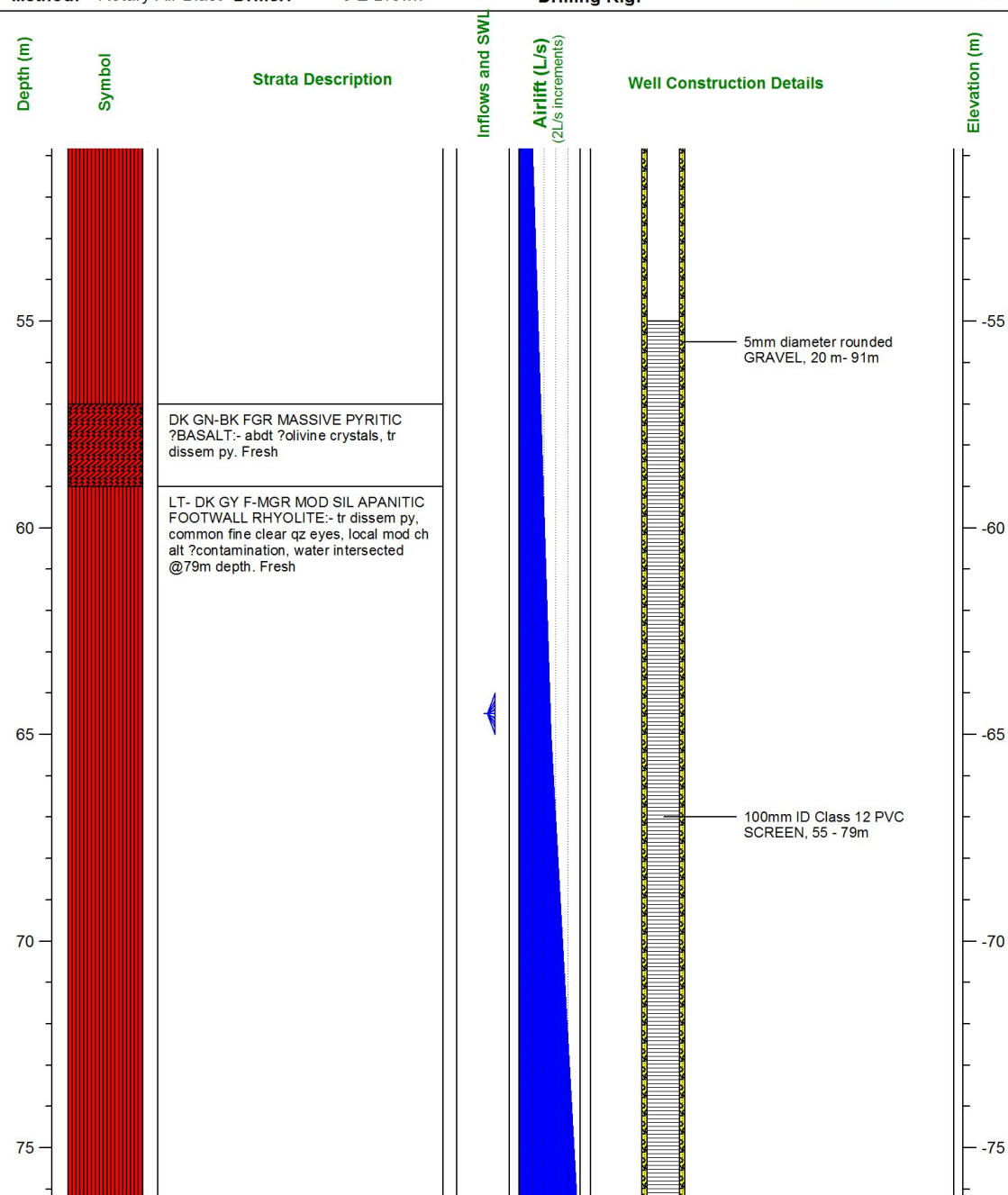
Driller: J E Brown

Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



Page 3 of 4

Notes:

Datum:MGA

West 45 WB03

Borehole No: **WB03**

Location: West 45

Date Drilled: 9/11/2010

Easting: 370437

Northing: 7751432

Method: Rotary Air Blast

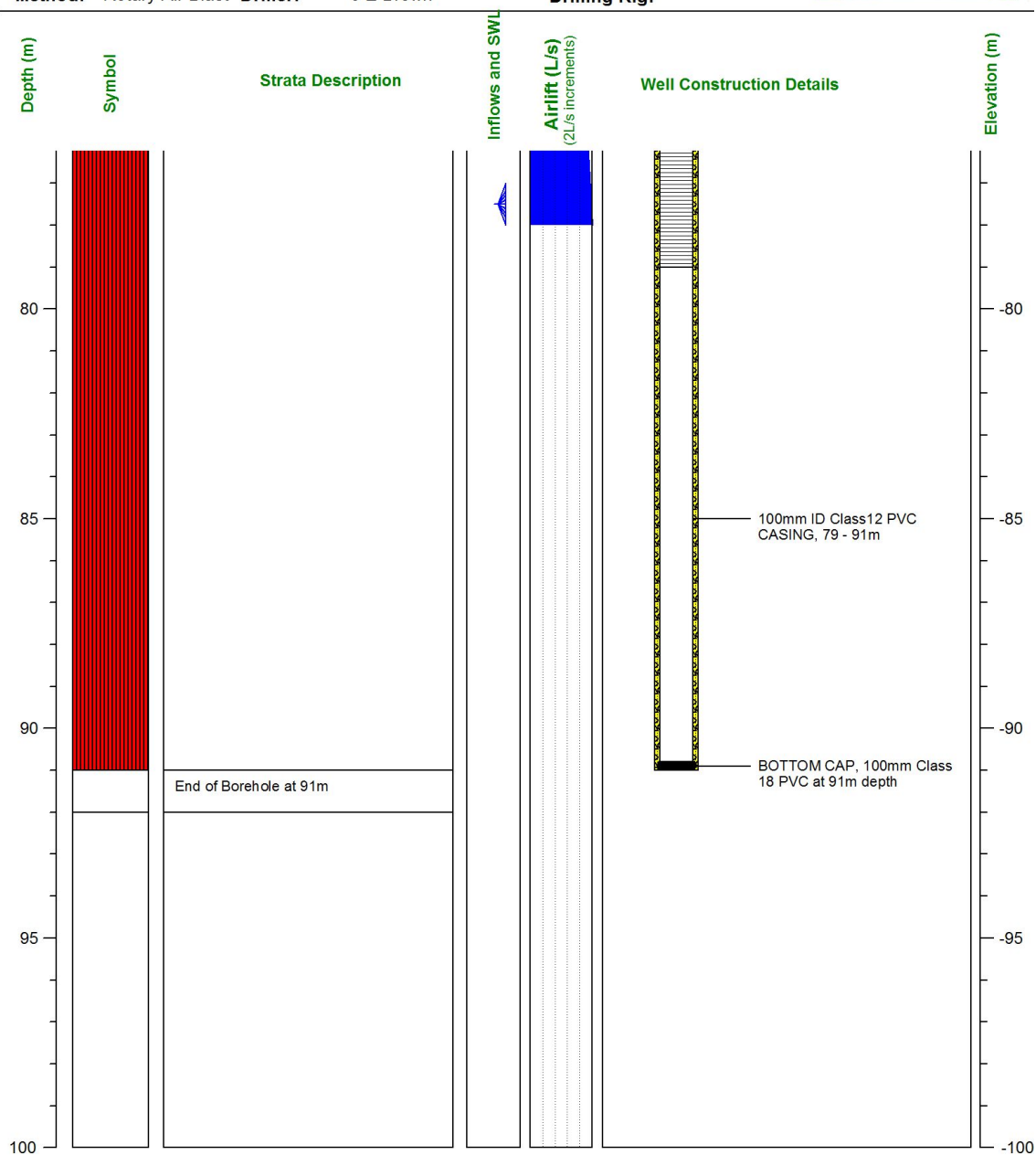
Driller: J E Brown

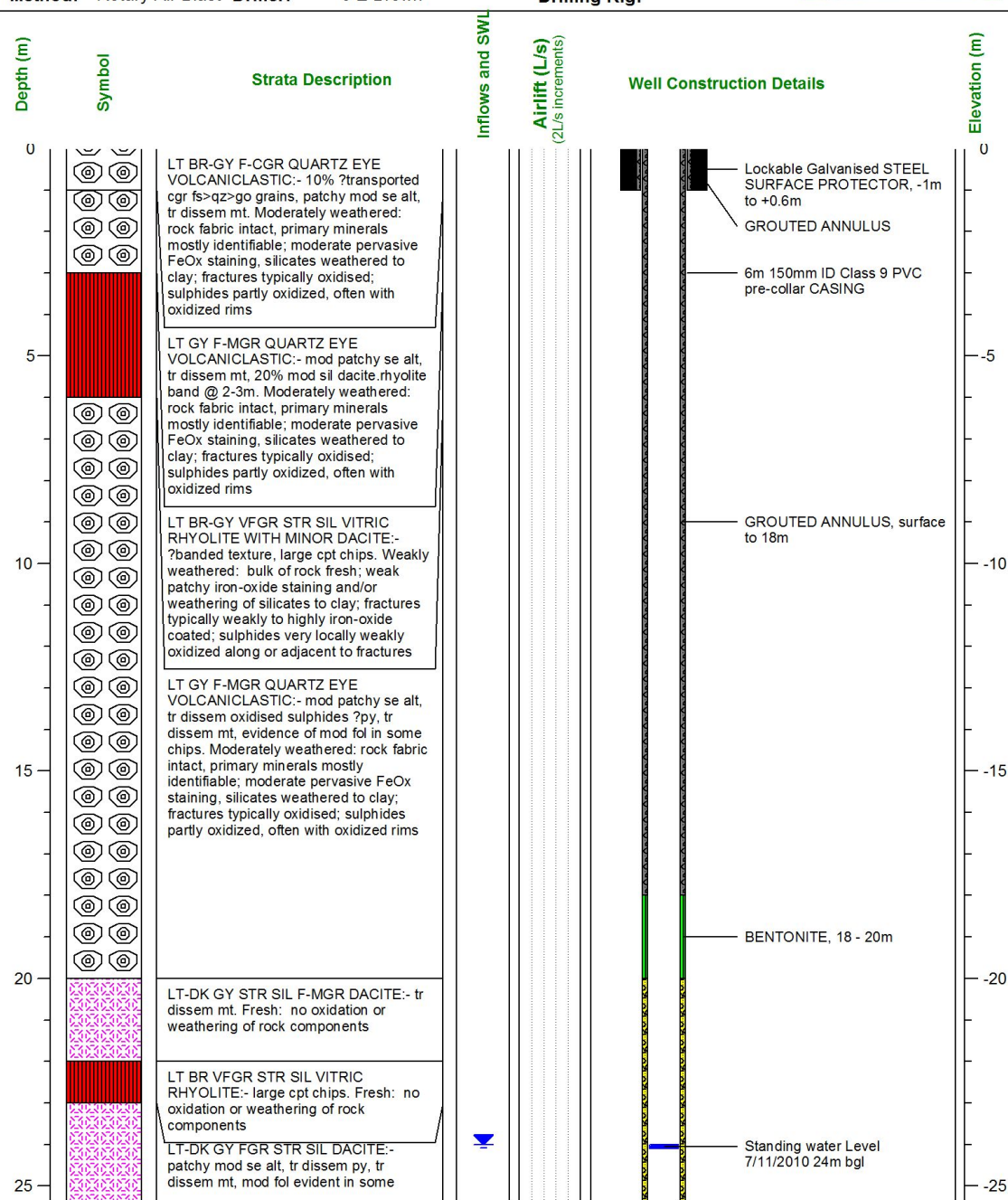
Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



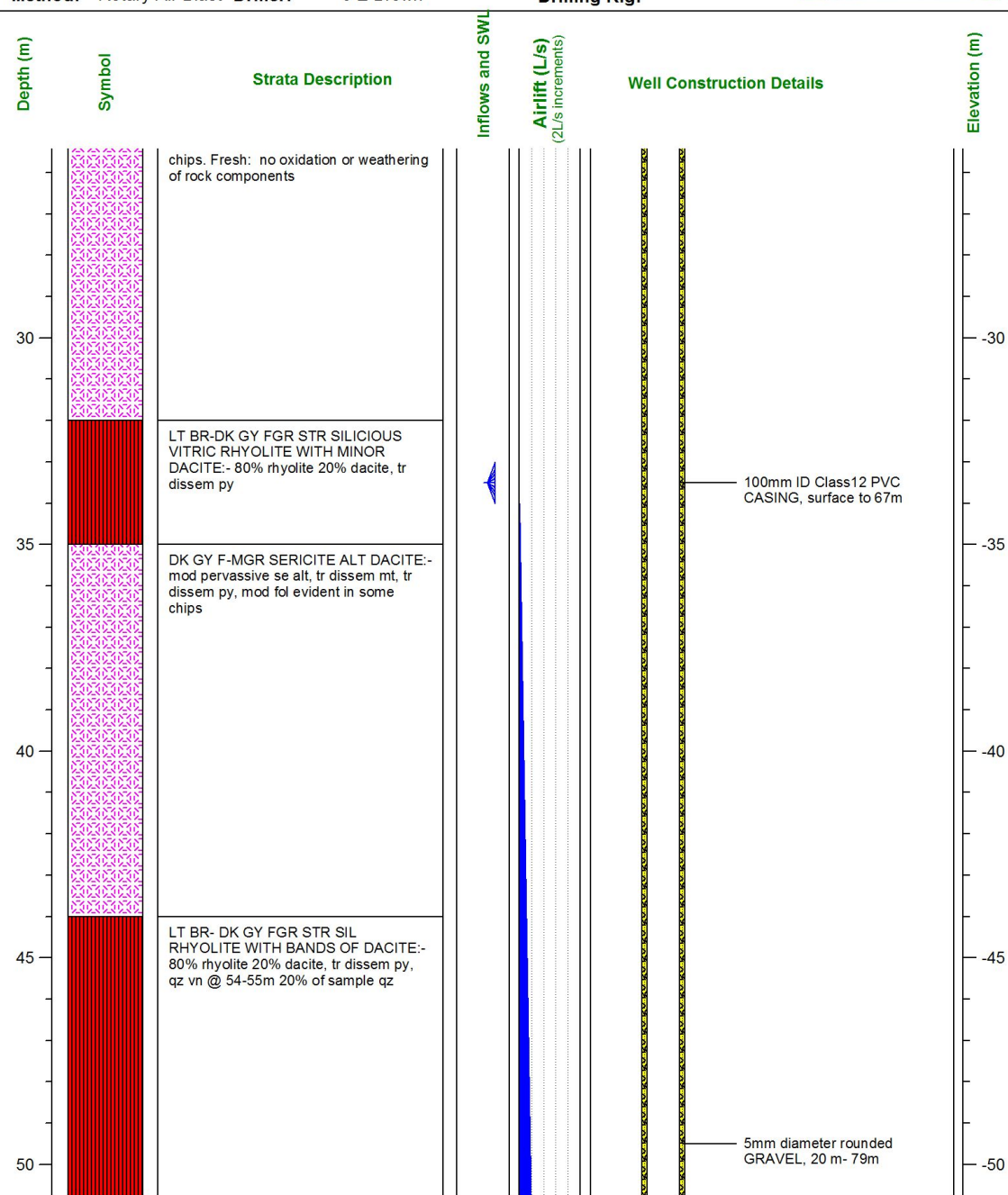
Borehole No: WB04**Location:** West 45**Date Drilled:** 7/11/2010**Easting:** 370703**Northing:** 7750812**Method:** Rotary Air Blast**Driller:** J E Brown**Client:** Kagara Copper Ltd**Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 1 of 4

Notes:

Datum:MGA

West 45 WB04

Borehole No: WB04**Location:** West 45**Date Drilled:** 7/11/2010**Easting:** 370703**Northing:** 7750812**Method:** Rotary Air Blast**Driller:** J E Brown**Client: Kagara Copper Ltd****Project No:** NG256**Elevation (m):****Drilling Rig:**

Page 2 of 4

Notes:

Datum:MGA

West 45 WB04

Borehole No: **WB04**

Location: West 45

Date Drilled: 7/11/2010

Easting: 370703

Northing: 7750812

Method: Rotary Air Blast

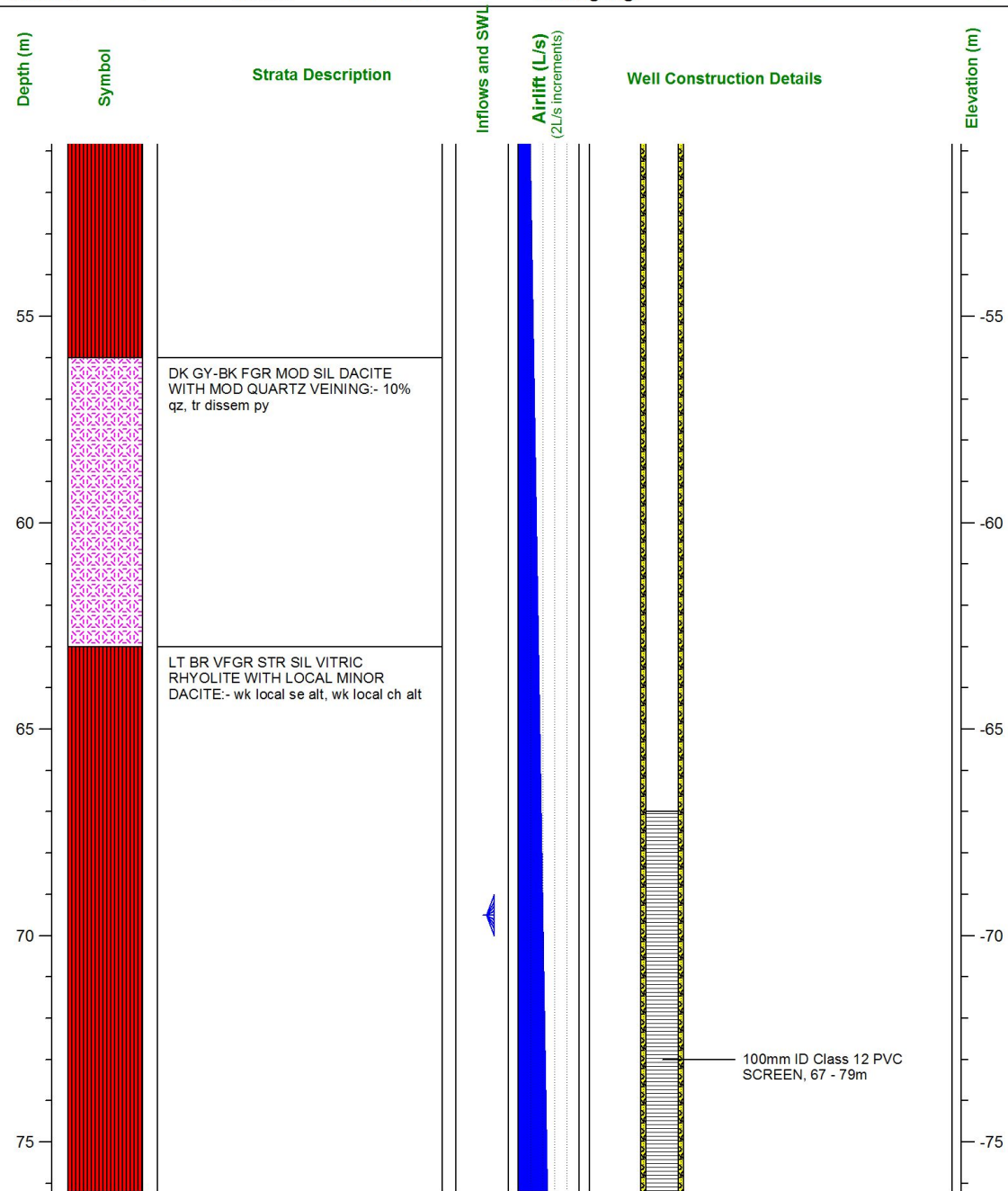
Driller: J E Brown

Client: **Kagara Copper Ltd**

Project No: NG256

Elevation (m):

Drilling Rig:



Page 3 of 4

Notes:

Datum: MGA

West 45 WB04

Borehole No: WB04

Location: West 45

Date Drilled: 7/11/2010

Easting: 370703

Northing: 7750812

Method: Rotary Air Blast

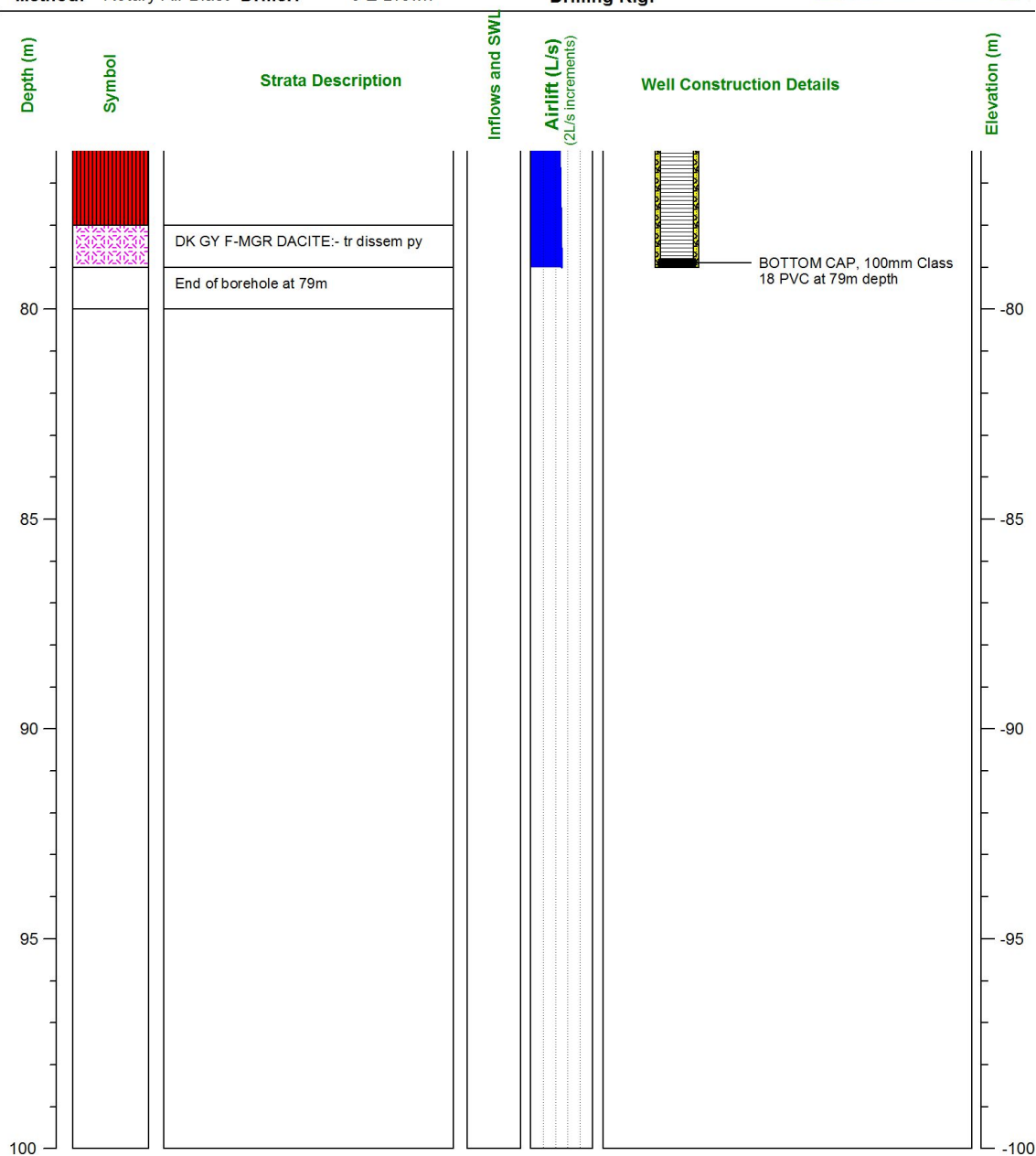
Driller: J E Brown

Client: Kagara Copper Ltd

Project No: NG256

Elevation (m):

Drilling Rig:



Appendix D

Bore logs of the Far West bores installed in 2017 - 2018

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB1

 LOCATION:
Far West Project

 DATE STARTED:
6/15/2017

 DATE COMPLETED:
6/16/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7750587 mS

 EASTING:
370581 mE

 DATUM:
GDA94 ZONE 55K

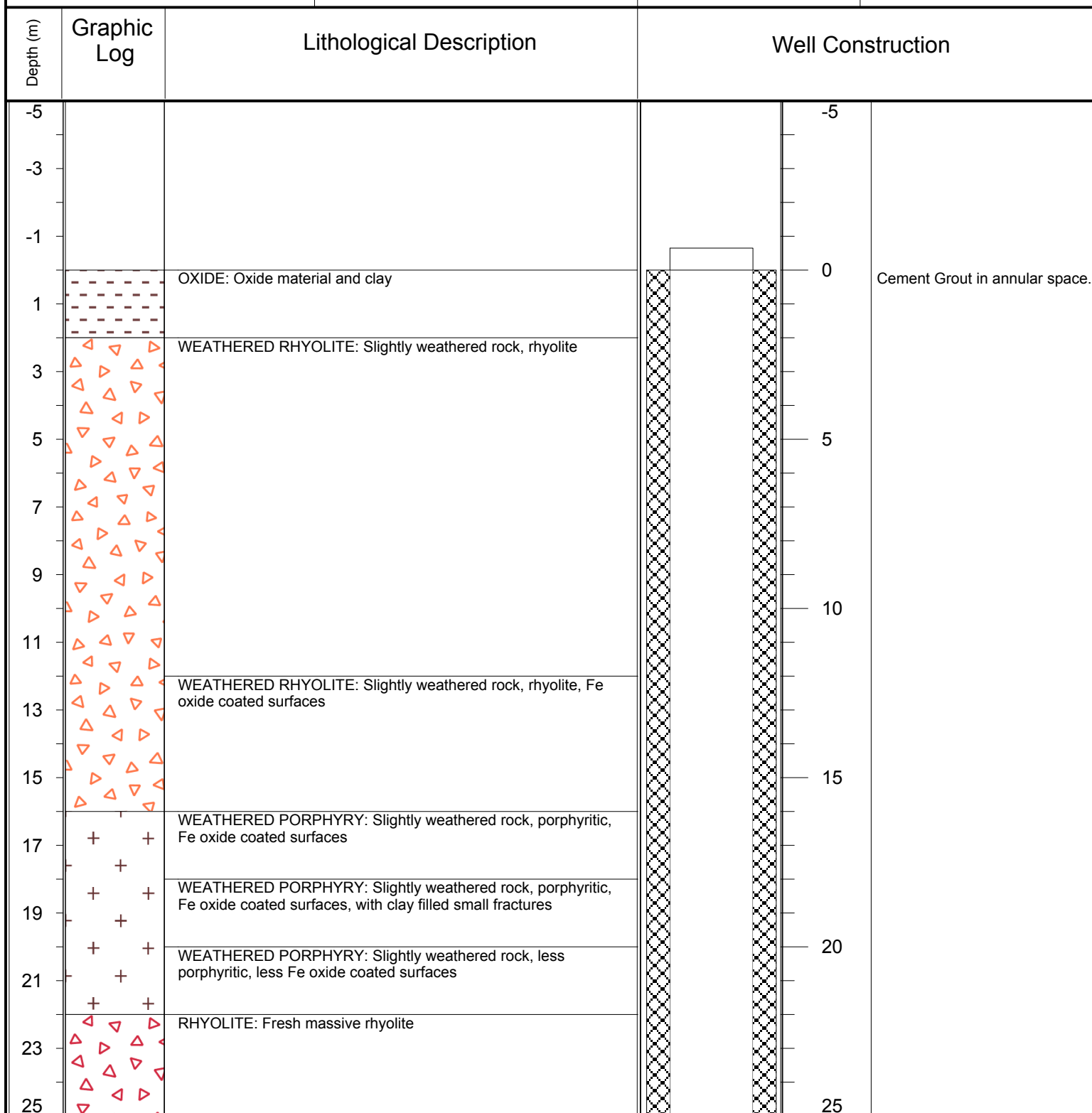
 GROUND SURFACE ELEV.:
TBC mAHD

 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

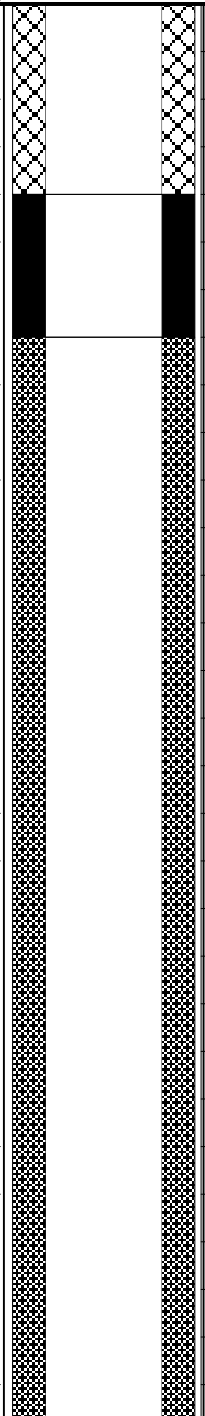
 DRILLING METHOD:
DTH Rotary Air

 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
27.26 m


NOTES: Bore developed for 1 hour with a supply of 0.685L/s and EC of 2,270µS/cm @ 26.3°C.

PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB1	
LOCATION: Far West Project	DATE STARTED: 6/15/2017	DATE COMPLETED: 6/16/2017
DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7750587 mS	EASTING: 370581 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH	DRILLING METHOD: DTH Rotary Air	TOTAL DEPTH: 100 m
		DEPTH TO WATER: 27.26 m

Depth (m)	Graphic Log	Lithological Description	Well Construction	
25		FRACTURED RHYOLITE: Fractured rhyolite, Fe oxide surfaces		25
27		FRACTURED RHYOLITE: More fractured		27
29		FRACTURED RHYOLITE: Fractured rhyolite Fe oxide surfaces		29
31		RHYOLITE: Less fractured fresh rhyolite		30
33				33
35		RHYOLITE: Massive rhyolite, dark grey, no Qtz, no Fe oxide surfaces		35
37				37
39				39
41				41
43		RHYOLITE: Rhyolite with Qtz veins		43
45		RHYOLITE: Massive Rhyolite		45
47				47
49		RHYOLITE: Rhyolite with Qtz >50%		49
51		RHYOLITE: Massive rhyolite		51
53				53
55		RHYOLITE: Massive rhyolite with chlorite alteration		55

Water encountered @ 29m:
Flow too small to measure, EC
(2,200µS/cm).
Bentonite Seal.

Water encountered @ 34.35m:
Supply (1.5L/s), EC
(2,450µS/cm).

Airlifted @ 48m: Supply
(1.35L/s), EC (2,550µS/cm).

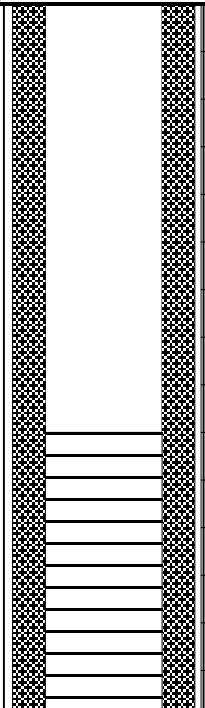
NOTES: Bore developed for 1 hour with a supply of 0.685L/s and EC of 2,270µS/cm @ 26.3°C.

PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB1	
LOCATION: Far West Project	DATE STARTED: 6/15/2017	DATE COMPLETED: 6/16/2017
DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7750587 mS	EASTING: 370581 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH	DRILLING METHOD: DTH Rotary Air	TOTAL DEPTH: 100 m
		DEPTH TO WATER: 27.26 m

Depth (m)	Graphic Log	Lithological Description	Well Construction	
55	+ +	PORPHYRY: Green, dark grey speckled porphyry, minor pyrite	55	
57	+ +	PORPHYRY: Green, dark grey speckled porphyry in dark grey rhyolite		
59	+ +		60	
61	+ +	RHYOLITE: Massive dark grey rhyolite, minor barite		
63	+ +		65	
65	+ +	RHYOLITE: Massive rhyolite		
67	+ +		70	Airlifted @ 68m: Supply (0.53L/s), EC (2,530µS/cm).
69	+ +	FRACTURED RHYOLITE: Fractured rhyolite, drill dropping fast		
71	+ +		75	Airlifted @ 75m: Supply (0.47L/s), EC (2,510µS/cm).
73	+ +	SILICEOUS BANDED RHYOLITE: Banded rhyolite, dark and light grey siliceous rhyolite		
75	+ +		80	
77	+ +	SILICEOUS BANDED RHYOLITE: Banded rhyolite, dark and light grey, very siliceous rhyolite		
79	+ +		85	
81	+ +			
83	+ +			
85	+ +			

NOTES: Bore developed for 1 hour with a supply of 0.685L/s and EC of 2,270µS/cm @ 26.3°C.

PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB1	
LOCATION: Far West Project	DATE STARTED: 6/15/2017	DATE COMPLETED: 6/16/2017
DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7750587 mS	EASTING: 370581 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH	DRILLING METHOD: DTH Rotary Air	TOTAL DEPTH: 100 m
		DEPTH TO WATER: 27.26 m

Depth (m)	Graphic Log	Lithological Description	Well Construction
85			 85 90 95 100 Slotted PVC class 12 pipe screen, 2mm wide slots. Gravel Pack, 3-6mm washed gravel. Developed for 1hour. Supply (0.685L/s), EC (2,270µS/cm @ 26.3°C). Airlifted @ 100m: Supply (0.72L/s), EC (2,480µS/cm).

NOTES: Bore developed for 1 hour with a supply of 0.685L/s and EC of 2,270µS/cm @ 26.3°C.

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB2

 LOCATION:
Far West Project

 DATE STARTED:
6/14/2017

 DATE COMPLETED:
6/15/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7751109 mS

 EASTING:
371053 mE

 DATUM:
GDA94 ZONE 56

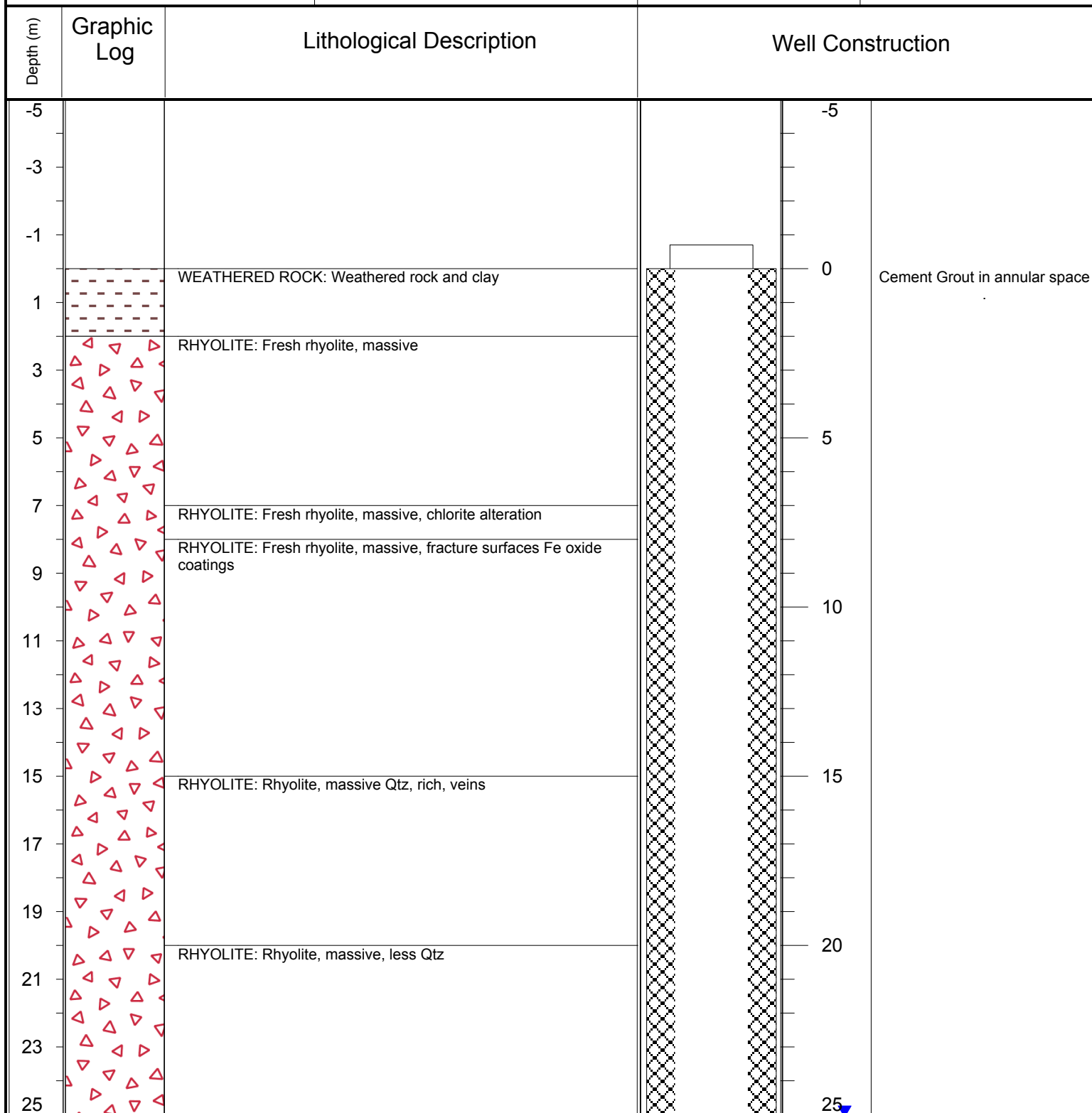
 GROUND SURFACE ELEV.:
TBC mAHD

 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

 DRILLING METHOD:
DTH Rotary Percussion Air Hammer

 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
25.1 m


NOTES:

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB2

 LOCATION:
Far West Project

 DATE STARTED:
6/14/2017

 DATE COMPLETED:
6/15/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7751109 mS

 EASTING:
371053 mE

 DATUM:
GDA94 ZONE 56

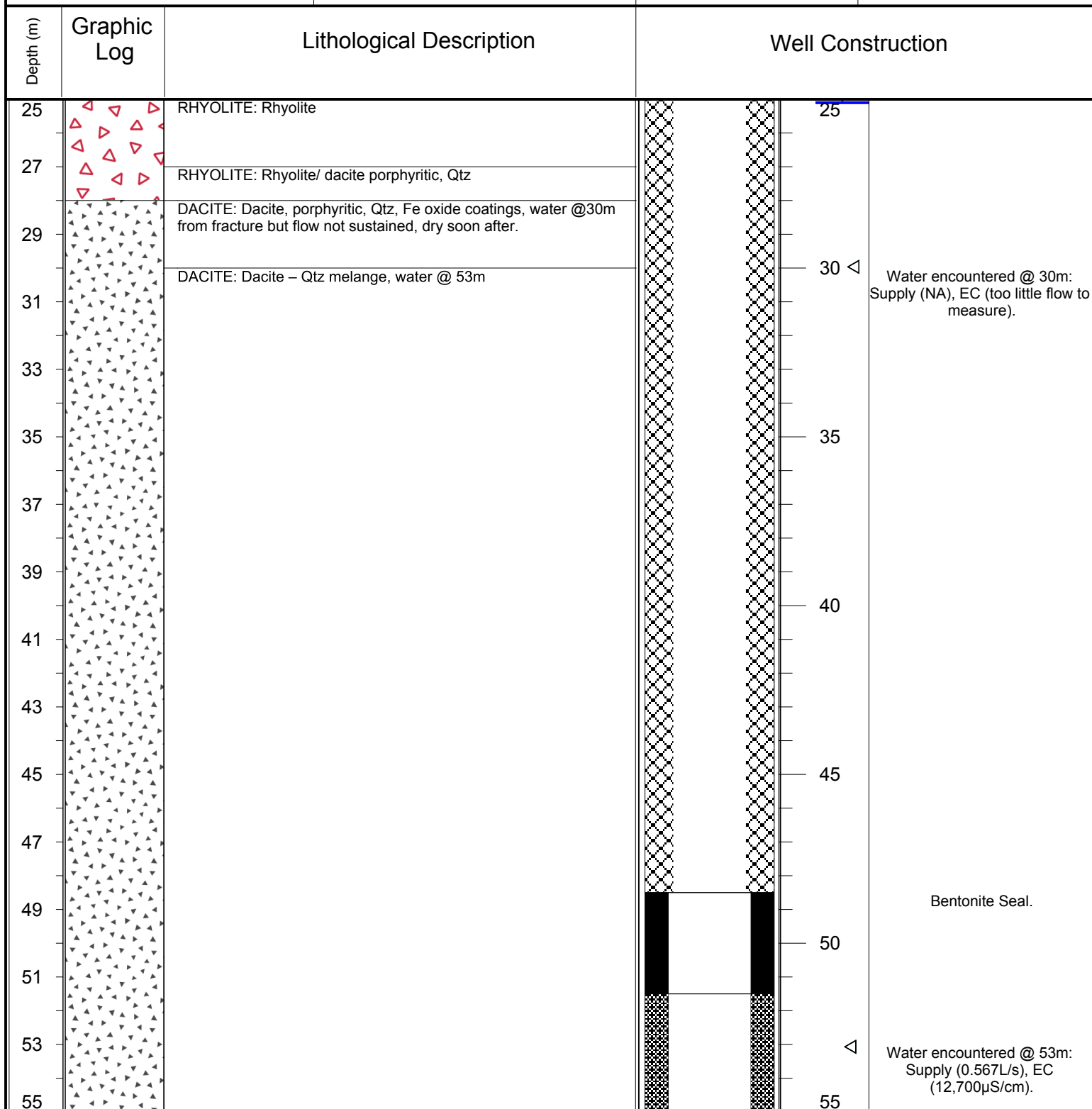
 GROUND SURFACE ELEV.:
TBC mAHD

 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

 DRILLING METHOD:
DTH Rotary Percussion Air Hammer

 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
25.1 m


NOTES:

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB2

 LOCATION:
Far West Project

 DATE STARTED:
6/14/2017

 DATE COMPLETED:
6/15/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7751109 mS

 EASTING:
371053 mE

 DATUM:
GDA94 ZONE 56

 GROUND SURFACE ELEV.:
TBC mAHD

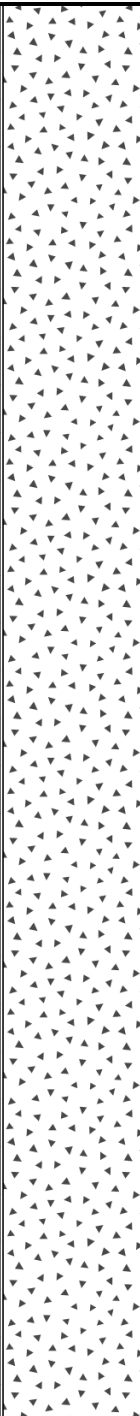
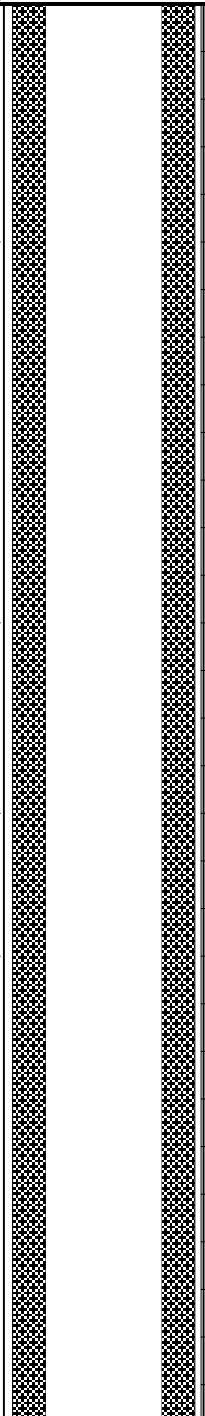
 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

 DRILLING METHOD:
DTH Rotary Percussion Air Hammer

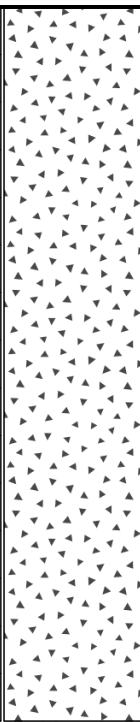
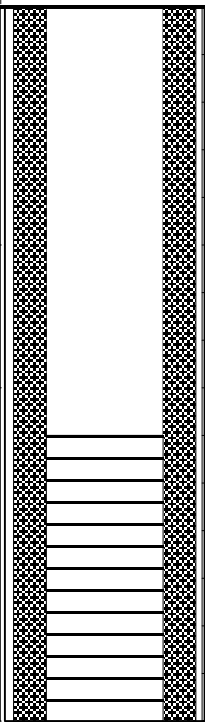
 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
25.1 m

Depth (m)	Graphic Log	Lithological Description	Well Construction
55		DACITE: Dacite, some minor barite	
57			Water encountered @ 57m: Supply (1.8L/s), EC (13,047µS/cm).
59			
61		DACITE: Dacite	
63			
65			
67			Airlifted @ 67m: Supply (1.5L/s).
69		DACITE: Dacite with 50% Qtz	
71			
73		DACITE: Dacite with less Qtz	
75		DACITE: Dacite with Qtz	
77			
79			
81			
83			
85			

NOTES:

	PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB2	
	LOCATION: Far West Project	DATE STARTED: 6/14/2017	DATE COMPLETED: 6/15/2017
	DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7751109 mS	EASTING: 371053 mE
	DATUM: GDA94 ZONE 56	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH		DRILLING METHOD: DTH Rotary Percussion Air Hammer	TOTAL DEPTH: 100 m
			DEPTH TO WATER: 25.1 m

Depth (m)	Graphic Log	Lithological Description	Well Construction				
85				85	Airlifted @ 85m: Supply (0.837L/s).		
87							
89							
91		DACITE: Dacite with more Qtz		90			
93		DACITE: Dacite with less Qtz					
95				95	Slotted PVC class 12 pipe screen, 2mm wide slots. Gravel Pack, 3-6mm washed gravel.		
97							
99						Airlifted @ 100m: Supply (1.02L/s), EC (13,000µS/cm).	
						100	

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB3

 LOCATION:
Far West Project

 DATE STARTED:
6/17/2017

 DATE COMPLETED:
6/18/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7750831 mS

 EASTING:
370067 mE

 DATUM:
GDA94 ZONE 55K

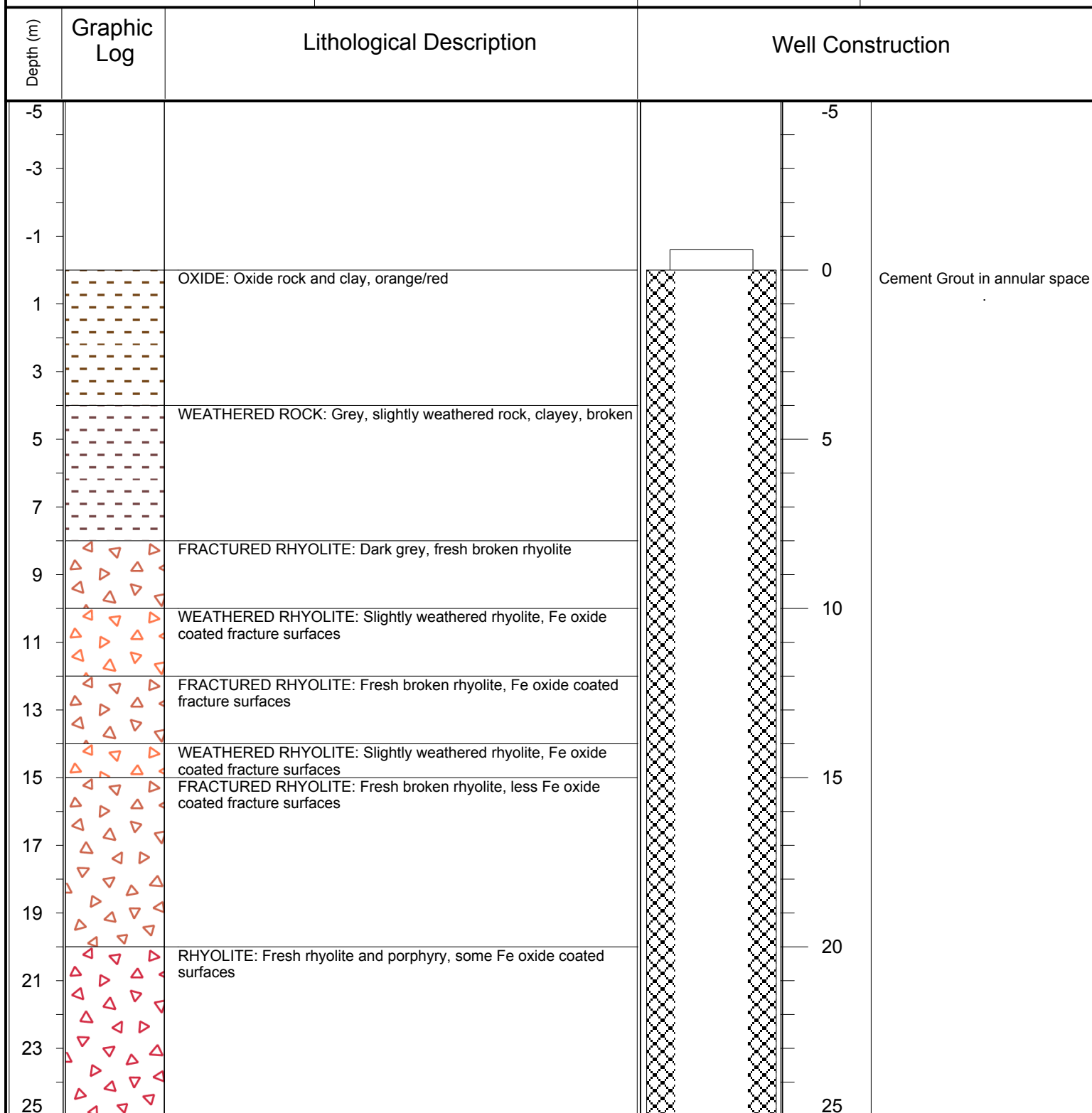
 GROUND SURFACE ELEV.:
TBC mAHD

 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

 DRILLING METHOD:
DTH Rotary Percussion Air Hammer

 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
33.36 m


NOTES:

PROJECT:
RVR_FAR WEST/16_167/2017

 WELL ID:
FWMB3

 LOCATION:
Far West Project

 DATE STARTED:
6/17/2017

 DATE COMPLETED:
6/18/2017

 DRILLING CONTRACTOR:
Brown Drilling

 NORTHING:
7750831 mS

 EASTING:
370067 mE

 DATUM:
GDA94 ZONE 55K

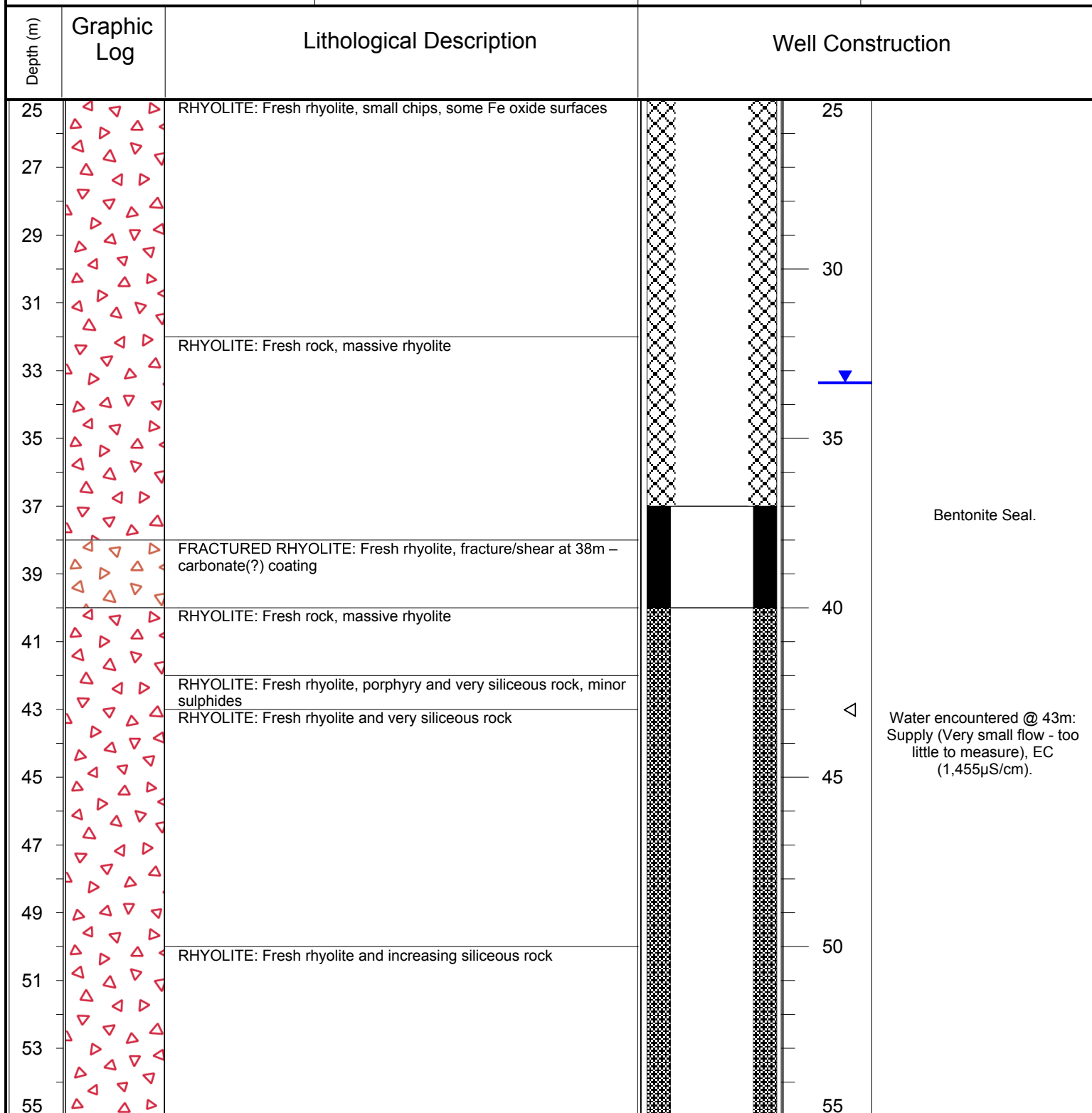
 GROUND SURFACE ELEV.:
TBC mAHD

 TOC ELEVATION:
TBC mAHD

 LOGGED BY:
MTH

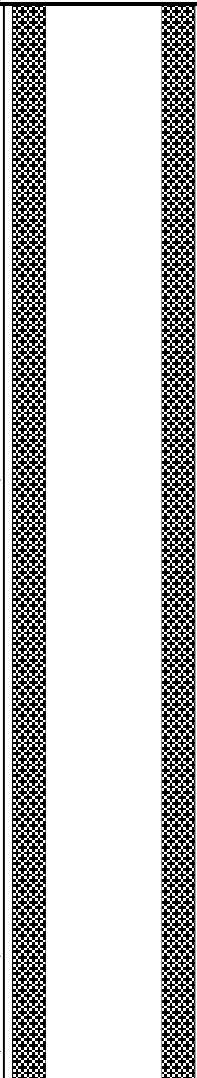
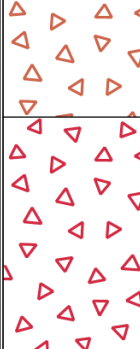
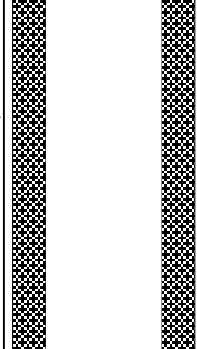
 DRILLING METHOD:
DTH Rotary Percussion Air Hammer

 TOTAL DEPTH:
100 m

 DEPTH TO WATER:
33.36 m


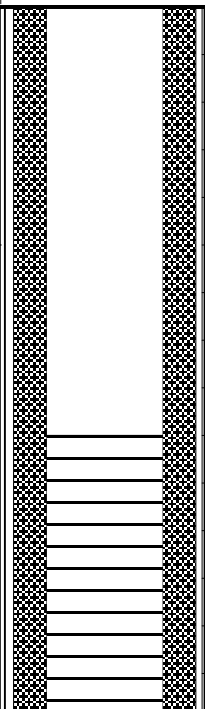
NOTES:

PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB3	
LOCATION: Far West Project	DATE STARTED: 6/17/2017	DATE COMPLETED: 6/18/2017
DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7750831 mS	EASTING: 370067 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH	DRILLING METHOD: DTH Rotary Percussion Air Hammer	TOTAL DEPTH: 100 m
		DEPTH TO WATER: 33.36 m

Depth (m)	Graphic Log	Lithological Description	Well Construction	
55		RHYOLITE: Fresh rhyolite and minor porphyry		55
57				
59				
61				
63				
65				
67				
69				
71				
73				
75		RHYOLITE: Fresh massive rhyolite		65
77		RHYOLITE: Fresh rhyolite and very siliceous, light grey rock		75
79		FRACTURED RHYOLITE: Fresh rhyolite, fracture/shear at 77m – carbonate(?) coating		
81		RHYOLITE: Fresh massive rhyolite		80
83				
85				
				85

NOTES:

PROJECT: RVR_FAR WEST/16_167/2017	WELL ID: FWMB3	
LOCATION: Far West Project	DATE STARTED: 6/17/2017	DATE COMPLETED: 6/18/2017
DRILLING CONTRACTOR: Brown Drilling	NORTHING: 7750831 mS	EASTING: 370067 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: TBC mAHD	TOC ELEVATION: TBC mAHD
LOGGED BY: MTH	DRILLING METHOD: DTH Rotary Percussion Air Hammer	TOTAL DEPTH: 100 m
		DEPTH TO WATER: 33.36 m

Depth (m)	Graphic Log	Lithological Description	Well Construction	
85		RHYOLITE: Fresh massive rhyolite, minor sulphides		85
87				
89				
91			90	
93				
95			95	
97				
99				
			Slotted PVC class 12 pipe screen, 2mm wide slots. Gravel Pack, 3-6mm washed gravel. Airlifted @ 100m: Supply (0.0015L/s), EC (1,470µS/cm).	

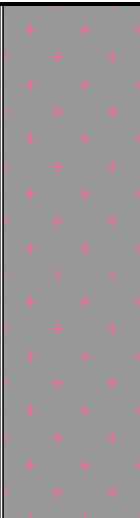
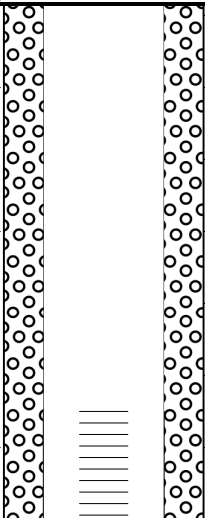
NOTES:

PROJECT: Thalanga	WELL ID: FWMB4	
LOCATION: Thalanga, QLD	DATE STARTED: 29/06/2018	DATE COMPLETED: 29/06/2018
DRILLING CONTRACTOR: Brown Drillers	NORTHING: 7751735 mS	EASTING: 370854 mE
DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: 336 mAHD	TOC ELEVATION: TBD mAHD
LOGGED BY: MT	DRILLING METHOD: Rotary Air	TOTAL DEPTH: 50 m
		DEPTH TO WATER: 20 m

Depth (m)	Graphic Log	Lithological Description	Well Construction
-4			
-3			
-2			
-1			
0		TOPSOIL: Very pizolithic, silty clay	
1		CLAY: Very pizolithic, quartz at 3m	
2			
3		CLAY: Very pizolithic clay	
4			
5		CLAY: Very pizolithic silty clay	
6			
7		ROCK: Brown, very weathered rock, with a silcrete layer	
8		ROCK: Brown, very weathered rock, with a silcrete layer. Occuring with rounded sand in clayey silt	
9		SAND: Coarse, rounded sand in clayey silt	
10		SAND: Coarse, rounded sand in silt	
11		SAND: Coarse, rounded sand into weathered rock	
12		RHYOLITE: Fresh	
13		RHYOLITE: Fresh with FeOX coating	
14			
15			
16			
17		RHYOLITE: Brown, fresh rhyolite/dacite, moist	
18			
19		RHYOLITE: Fractured, fresh, water encountered at ~1L/s	
20		RHYOLITE: Banded, fresh and broken; enough water to clean samples	
21			
22		RHYOLITE: Banded, fresh and broken; enough water to clean samples, minor pyrite (water EC: 13500µS/cm)	
23			
24		RHYOLITE: Massive, slightly pyritic, Fe on surfaces. (No pyrite occurrence at 29-30m)	
25			
26			
27			
28			
29			
30		RHYOLITE: Massive, unfractured (Water EC: 12,000µS/cm @ ~0.5L/s)	
31			
32			
33			
34			
35			

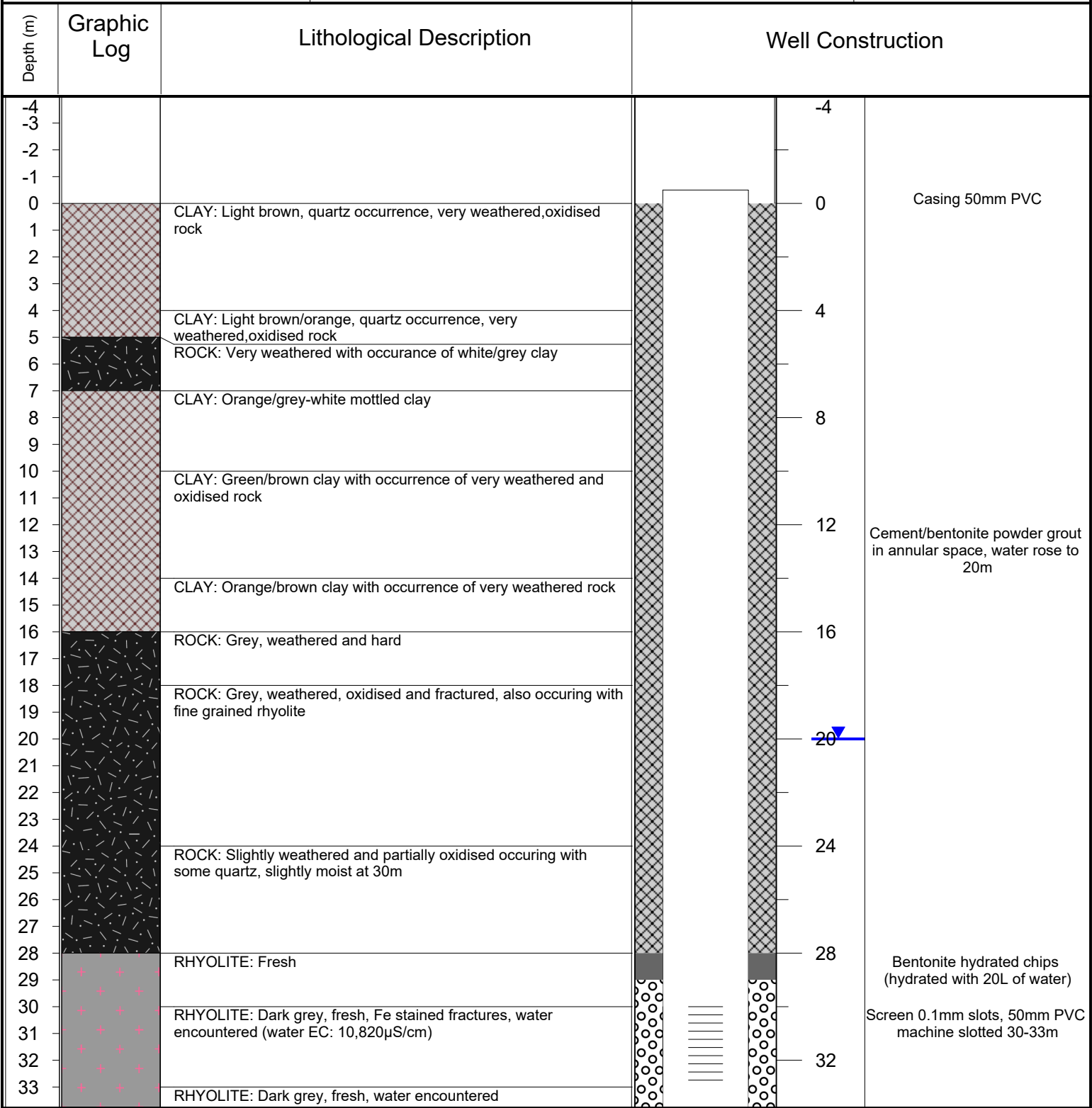
NOTES:

	PROJECT: Thalanga	WELL ID: FWMB4	
	LOCATION: Thalanga, QLD	DATE STARTED: 29/06/2018	DATE COMPLETED: 29/06/2018
	DRILLING CONTRACTOR: Brown Drillers	NORTHING: 7751735 mS	EASTING: 370854 mE
	DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: 336 mAHD	TOC ELEVATION: TBD mAHD
LOGGED BY: MT	DRILLING METHOD: Rotary Air	TOTAL DEPTH: 50 m	DEPTH TO WATER: 20 m

Depth (m)	Graphic Log	Lithological Description	Well Construction	
36				36
37				
38		RHYOLITE: Dark grey, massive and unfractured, little pryite		
39				
40				40
41				
42		RHYOLITE: Massive and unfractured		
43				
44				44
45				
46				
47				
48		RHYOLITE: Massive and unfractured with minor pyrite occurrence		48
49				
50				
51				
52				52

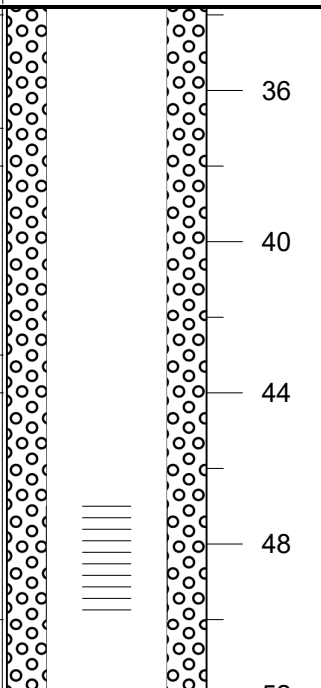
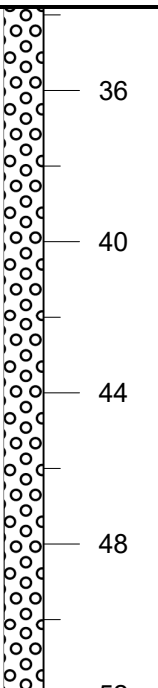
Screen 0.1mm slots, 50mm PVC machine slotted 47-50m

	PROJECT: Thalanga	WELL ID: FWMB5	
	LOCATION: Thalanga, QLD	DATE STARTED: 27/06/2018	DATE COMPLETED: 27/06/2018
	DRILLING CONTRACTOR: Brown Drillers	NORTHING: 7750306 mS	EASTING: 370850 mE
	DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: 335 mAHD	TOC ELEVATION: TBD mAHD
LOGGED BY: MJ	DRILLING METHOD: Rotary Air	TOTAL DEPTH: 52 m	DEPTH TO WATER: 31 m



NOTES:

	PROJECT: Thalanga	WELL ID: FWMB5	
	LOCATION: Thalanga, QLD	DATE STARTED: 27/06/2018	DATE COMPLETED: 27/06/2018
	DRILLING CONTRACTOR: Brown Drillers	NORTHING: 7750306 mS	EASTING: 370850 mE
	DATUM: GDA94 ZONE 55K	GROUND SURFACE ELEV.: 335 mAHD	TOC ELEVATION: TBD mAHD
LOGGED BY: MJ	DRILLING METHOD: Rotary Air	TOTAL DEPTH: 52 m	DEPTH TO WATER: 31 m

Depth (m)	Graphic Log	Lithological Description	Well Construction		
34		RHYOLITE: Fresh, very little fracturing, water encountered			Gravel 3-5mm rounded to sub rounded (washed quartz) Screen 0.1mm slots, 50mm PVC machine slotted 47-50m
35					
36					
37		RHYOLITE: Fresh with little disseminated pyrite			
38		RHYOLITE: Fresh with no pyrite (water @42m EC: 11,200µS/cm @ ~0.35L/s)			
39					
40					
41					
42					
43		RHYOLITE: Fresh with little disseminated pyrite			
44		RHYOLITE: Dark, massive (water EC: 10,700µS/cm @ ~0.70L/s)			
45					
46					
47					
48					
49					
50		RHYOLITE: Dark, massive			
51					
52					