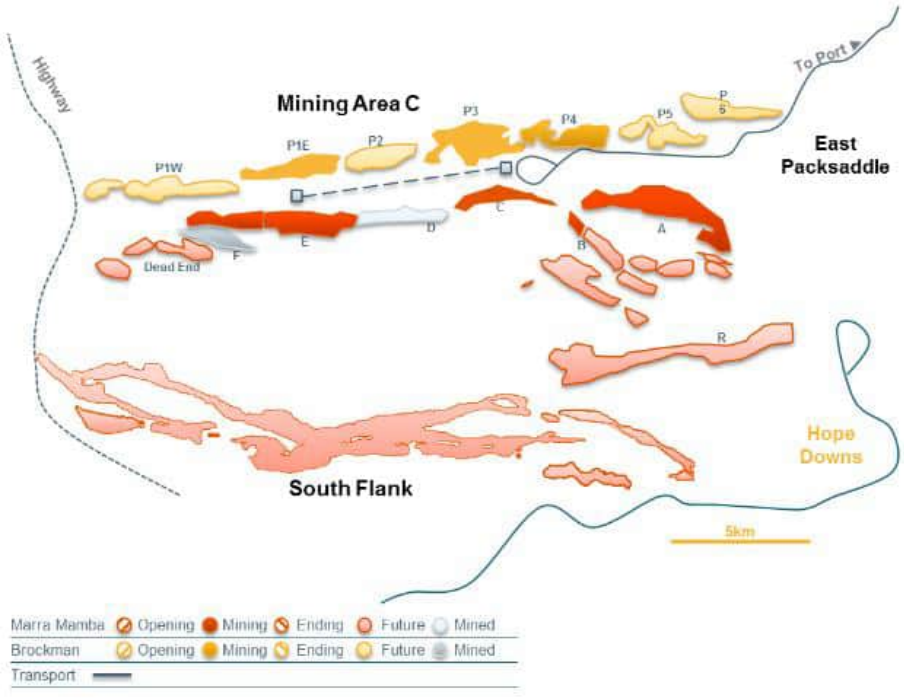
BHP

Central Pilbara Hydrogeological Assessment

23 January 2025



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1 Introduction

1.1 Overview

This hydrogeological assessment has been carried out to inform and support BHP's Central Pilbara Hub (CPH) increase to mine dewatering required for continued below water table mining at CPH.

CPH is located approximately 100 km northwest of Newman in the Pilbara region of Western Australia (Figure 1.1). CPH comprise Mining Area C (MAC) and South Flank mines, with the South Flank orebody positioned approximately 9 km south of MAC (Figure 1.2). The mines are located within mineral lease ML70/281 and the East Pilbara-Hamersley-Fractured rock aquifer (DoW, 2013) and are shown on Figure 1.3:

- MAC
    - North Flank (A, B, C, E, F, R, Dead End Deposits),
    - Packsaddle Deposits.
- South Flank (Vista Oriental, Grand Central and Highway Deposits).

Mining is currently undertaken using conventional open pit iron ore mining activities which include both inpit and expit dewatering infrastructure facilitating dry mining conditions. Once mined the ore is transported via an overland conveyor to ore handling facilities at the MAC mine and then transported by rail to Port Hedland for export. Water generated from mine dewatering is utilized onsite for mining purposes (dust suppression and onsite processing/blending of ore) with excess reinjected (managed aquifer recharge (MAR) and infiltration ponds) or discharged to nearby creeks.

This assessment builds on the existing data and modelling that was used to support previous CPH approvals (Section 1.2) and makes use of additional investigations and modelling to assess the hydrologic change of the additional dewatering rate. The assessment also recognizes the temporal and spatial variance in water balance outcomes, and cumulative effects from other mining activities, and predicts changes to hydrologic conditions which could eventuate owing to the planned mining sequence and mine closure strategies.

The assessment was completed in context of the broader key water dependent receptors at Coondewanna Flats, Weeli Wolli Springs, and Ben's Oasis, and considers impact in relation to outcome-based thresholds which have been already adopted for the key assets.

This assessment is for a dewatering limit increase to up to 65.7 GL/yr (180 ML/d) and is reported in accordance with the H3 level of assessment of the DWER Operational Policy No 5.12 Hydrogeological reporting associated with a groundwater well license.

1.2 Licences and Approvals

EP Act Part IV Ministerial Statement 1072 last amended in Jan 2020 for mining multiple CPH iron ore deposits, onsite processing and blending, associated infrastructure incorporates:

- mine dewatering up to 37.3 GL/yr; and
- surplus water management up to 34.8 GL/yr via MAR, infiltration ponds and discharge from sedimentation basins and discharge to a drainage line that leads to Pebble Mouse Creek.

BHP (2023) Central Pilbara Water Resource Management Plan has been implemented to meet the requirements of MS1072 Condition 6, Water Management Environment Management Plan.

EP Act Part V L7851/2002/6 last amended Nov 2022 for multiple CPH iron ore deposits incorporates Category 6 (Mine Dewatering):

- up to 34.84 GL/yr
- discharge in aggregate with production capacity consisting of up to:
    - 10,950,000 tonnes per Annual Period (discharged to the Western Sediment Basin);
    - 8,760,000 tonnes per Annual Period (discharged to the Central Sediment Basin);
    - 16,425,000 tonnes per Annual Period in aggregate for the Packsaddle Infiltration Trial consisting of up to:
        - 10,950,000 tonnes per Annual Period (discharged to the Packsaddle Infiltration Ponds); and
        - 16,425,000 tonnes per Annual Period to discharge Points A (L4) and B (L5);
    - 12,775,000 tonnes per Annual Period (reinjection – Juna Downs);
    - 12,760,000 tonnes per Annual Period to South Flank MAR reinjection bores; and
    - 12,760,000 tonnes per Annual Period surface water discharge to Pebble Mouse Creek

DWER Rights in Water and Irrigations Act 1914 (*RIWI* Act) regulates CPH groundwater abstraction related to mine dewatering via the following Section 5C Licence to take groundwater:

- GWL110044(13) for up to 36.5 GL/yr for CPH mine dewatering and associated mining purposes within ML70/281.
- GWL166389(10) for up to 21.9 GL/yr for CPH mine dewatering and associated mining purposes (particularly the South Flank borefield commissioned in 2018) within ML70/249, ML70/281, E47/13, E47/1540, P47/1611 and is conjunctional with GWL11044(13) such that the combined abstraction is up to 36.5 GL/yr.

Groundwater abstraction for each of these licences complies with the monitoring commitment of the associated operating strategy – BHP (2022) GWL Operating Strategy for Mining Area C and South Flank.

Nearby potable water supply borefields are licenced separately as:

- GWL178477(5) for up to 0.75 GL/yr from the Juna Downs borefield for earthwork and campsite purposes withing ML70/281.

In addition to the existing approved schemes outlined above additional surplus schemes are proposed as part of the Part IV CPH Stage 1 as follows:

- North-West Scheme.
    - Northern Runaway Valley (RAV) Infiltration Ponds
    - Upper Marillana Creek
- North-East Scheme:
    - Lower Marillana Creek

The proposed schemes and existing schemes are shown on Figure 1.4.

2 Climate and Rainfall

The Pilbara region is characterized by very hot summers, mild winters and low and variable rainfall. During summer and autumn (December to March), average daily temperatures exceed 30°C across the region, with average daily maxima exceeding 35°C from October to March (WAAA 2016). Annual climate data and rainfall for the proposal and Newman area is shown on Table 1 and Figure 2.1.

Rainfall is episodic and inconsistent falling mostly in summer and autumn (influenced by tropical and monsoonal drivers) and lesser during winter and spring. Rainfall varies widely across catchments in the Pilbara. Local rainfall data has been collected locally by BHP since 2004 and is available nearby from the Bureau of Meteorology (BoM) station at Newman (Station No. 00716) located approximately 90 km southeast of the proposal area since 1998. Monthly rainfall and average monthly rainfall are presented below and show back to 2004 the annual average rainfall is 420 mm and nearby at BoM Newman station is 327 mm.

Average annual evaporation is approximately 3,200 mm/yr (BoM station at Wittenoom (Station No. 05026)) and exceeds rainfall in each month highlighting the importance of high rainfall events to recharge of groundwater.

Table 1 Proposal Area and Newman (BoM) Rainfall (mm) Statistics Summary

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
BHP Mining Area C Weather Station (WPSA001)													
2004	25	153	61	41	5	0	21	0	1	5	0	29	342
2005	7	16	31	0	0	4	108	16	0	0	0	15	198
2006	81	246	179	81	1	3	0	0	0	0	24	43	658
2007	16	17	18	44	0	0	9	44	0	1	0	8	157
2008	54	81	51	3	0	0	0	13	1	1	46	112	362
2009	72	86	113	3	1	10	3	0	0	0	92	6	384
2010	31	1	5	18	3	1	4	13	0	0	0	0	76
2011	114	158	29	15	13	16	29	0	0	1	56	14	446
2012	295	78	117	9	0	5	0	0	0	51	38	110	703
2013	72	145	35	1	20	83	1	0	0	13	22	203	596
2014	266	13	20	4	40	3	10	0	0	4	92	17	469
2015	50	8	208	38	101	0	22	0	0	15	20	3	465
2016	150	34	30	3	26	90	21	2	40	0	21	39	458
2017	181	172	92	43	4	0	2	2	43	2	2	24	567
2018	192	127	22	1	3	79	1	5	0	2	46	10	487
2019	32	32	52	17	2	20	2	5	41	11	2	9	226
2020	274	118	3	11	18	0	2	5	0	1	20	61	513
2021	55	231	44	66	18	16	2	0	0	0	26	4	461
2022	78	104	55	25	101	1	0	1	78				-
Avg (2004-2022)	108	96	61	22	19	18	13	5	11	6	28	39	420
Bureau of Meteorology Newman Weather Station (Station No. 007176)													
Avg (2004-2022)	83	63	45	28	14	17	16	3	7	8	18	83	327

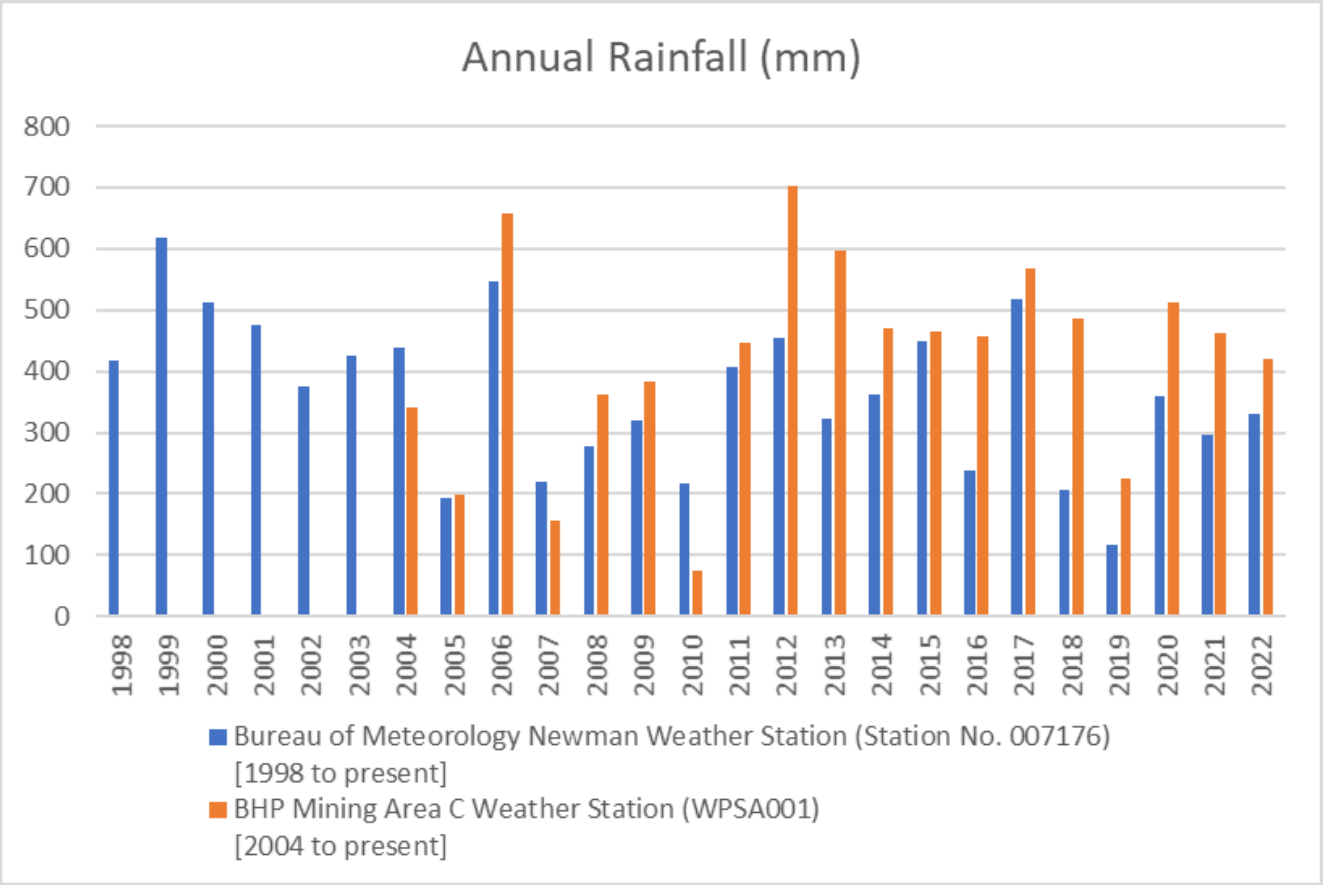


Figure 2.1 Annual Rainfall for the proposal area and Newman.

2.1 Future Climate

Australia's climate has warmed on average by 1.44 +/- 0.24ºC since national records began in 1910, leading to an increase in the frequency of extreme heat events. Rainfall and streamflow have increased across parts of northern Australia since the 1970s. There has been a decrease in the number of tropical cyclones observed in the Australian region since 1982. In the coming decades northern Western Australia can expect to experience:

- continued warming, with more extremely hot days and fewer extremely cool days,
- more intense short-duration heavy rainfall events; and
- fewer tropical cyclones but a greater proportion projected to be of high intensity, with ongoing large variations from year to year; (BoM and CSIRO, 2020).

In terms of mine dewatering climate variability is unlikely to affect the predictions of either dewatering or drawdown during the operational phase of mining (i.e. up to 2050) as the dewatering rates are expected to be many times more that recharge from rainfall and runoff, and consequently, variation in rainfall is unlikely to affect drawdown rates. The results from a number of Global Climate Models (CSIRO 2015) show that the largest median predicted change in rainfall by 2050 is a 5% reduction in the wet season.

3 Hydrogeology

3.1 Conceptual Model Boundary

The CPH mine areas generally sit within a single groundwater catchment. At some of the extremities, the relationships with adjoining catchments are not well defined, but groundwater flows between them are assumed to be minor compared to the flows within the catchment itself, and at well-defined catchment boundaries (i.e. Weeli Wolli Spring).

The extent of this conceptual model is therefore roughly coincident with the Central Pilbara groundwater catchment (Figure 3.1). It is also coincident with the BHP tenements, where geological and groundwater information is available.

The following active mining areas fall within this catchment (BHP unless otherwise stated):

- MAC:
    - North Flank (A, B, C, E, F, R, Dead End Deposits),
    - Packsaddle Deposits.
- South Flank (Vista Oriental, Grand Central and Highway Deposits).
- Hope Downs North and South (Rio Tinto Iron Ore (RTIO)).

The main conceptual model components are shown in Figure 3.2 and described below. The MAC and Hope Downs areas contain a greater level of detail than South Flank, due to the maturity of below water table (BWT) mining resulting in more available hydrogeological data in those areas.

The Hope Downs 1 mine comprises two major iron ore deposits; the Hope North and Hope South orebodies. Both orebodies consist of mineralised Marra Mamba Formation. The Hope North orebody is over 6 km long and is located directly east of MAC, with a significant proportion of the orebody beneath the natural groundwater level.

3.2 Level of Understanding

The conceptual model covers a very large area, approximately 80 km x 30 km. The first groundwater level observations (held by BHP) are from the early 1980's, primarily around MAC's A and E Deposits where the first pumping for water supply occurred. Monitoring frequency and spatial coverage was otherwise limited until the late 1990's when interest in mining the area started to grow and has increased significantly since 2007 when mining BWT commenced at Hope Downs (RTIO) and then in 2010 with the first BWT mining at MAC.

There is a significant amount of time variant groundwater data available in the catchment that clearly defines the response to the major groundwater stresses associated with mining activity at Hope Downs and MAC. However, there are also large areas within the conceptual model domain that have much more limited data and have not been subjected to any major anthropogenic stresses. In some of these areas (Camp Hill and South Flank) small scale test pumping investigations provide some information but in others the data is limited to conceptual geological mapping and ad hoc groundwater monitoring.

There have been many desktop studies that have attempted to synthesize the data to support local dewatering activities, approvals and licencing. The main studies are listed in Section 14.

The spatial extent of hydrogeological certainty is summarised in Table 3.1.

Table 3.1. Conceptual model confidence

Area	Conceptual confidence
MAC – E Central, E East, A, C, F, R deposits	High
Hope Downs aquifer system	High/Moderate
MAC – R and B Deposits	Moderate
Coondewanna Flats / Juna Downs	Moderate
MAC Packsaddle Deposits	Moderate
Weeli Wolli creek / Spring aquifer system	Moderate
South Flank	Moderate / Low
MAC – E West Deposit	Moderate / Low
Jinidi	Moderate / Low
Tandanya / Camp Hill	Low
MAC East Packsaddle Deposit	Low
Mudlark Well	Low
Bens Oasis	Low

3.3 Geology

3.3.1 Introduction

The current extent of geological drilling in CPH is shown in Figures 3.3 and 3.4. Thousands of holes have been drilled in the CPH catchment; however, the distribution is biased to the orebodies. Geological confidence is therefore very high in these areas but much more variable in the areas of the regional aquifers. The main stratigraphy within the conceptual model domain is described below and summarised in Table 3.3. A geological outcrop map is shown in Figure 3.5.

The formations of the Hamersley Group comprise a series of siliceous and carbonate-rich moderate-to deep-water sediments (i.e. chert and shale) that have been chemically altered and iron-enriched to form Banded Iron Formation (BIF) and dolomite**.** Subsequent additional iron-enrichment of the BIF has formed orebodies. The Brockman and the Marra Mamba have notable occurrences of iron-enrichment and these two formations host most orebodies. There is a marked increase in both porosity and permeability associated with the mineralisation process, as such the orebodies form important aquifers.

The geology of the Regional, North Flank and South Flank aquifer systems is explored in more detail below.

Table 3.3. Central Pilbara stratigraphic log

Age	Group	Formation	Member / description	Code
Young	Alluvium			
	Tertiary Detritals	TD3		TD3
		TD2	Inc. calcrete	TD2
		TD1		TD1
	Hamersley	Boolgeeda Iron		HO
		Woongarra Rhyolite		HW
		Weeli Wolli		HJ / WW
		Brockman Iron	Yandicoogina	Y
			Joffre	J1 – J6
			Whaleback Shale	W
			Dales Gorge	D1 – D4
		Mount McRae Shale		R
		Mount Sylvia		S
		Wittenoom	Bee Gorge	OC/OD
			Paraburdoo	OB
			West Angela	WA
		Marra Mamba Iron	Mount Newman	N1 – N3
			McLeod	MM
			Nammuldi	MU
	Fortescue	Jeerinah		JN
Old		Granatoid Complex		

3.3.2 Regional system

Basement

A key occurrence of dolomite is the Paraburdoo Member of the Wittenoom Formation, which forms part of the regional aquifer where it is weathered and karstic.

In the Wanna Munna area to the south of the CPH, the Hamersley Group is absent exposing members of the Jeerinah Formation of the Fortescue Group that underlies the Hamersley Group. The lithology comprises basalt, dolerite sills and mudstone.

Tertiary

The Wittenoom Formation is less resistant to weathering than the surrounding formations and has been eroded to form the subcrop in most of the low-lying areas, such as valley floors and alluvial plains. Bedrock relief has been reduced since the Tertiary by infilling with erosional detritus from the surrounding outcrop (such that the subcropping Wittenoom Formation rarely occurs in outcrop). On the margins of hills, there are colluvial deposits (scree) that fine into alluvial deposits (sand and silt) further into the valley. In places, secondary cementation and chemical alteration of these sediments has occurred forming calcrete, silcrete and pisolite. These Tertiary detrital sediments (collectively referred to as Tertiary Detritals) can be in excess of 100 m thick in some places.

Weathering is often present at the contact between the Tertiary Detritals and underlying basement, possibly representing a paleo-lateritic horizon and marked by a vuggy hardcap zone with interspersed pisolite or manganese deposits. This zone can be permeable and often forms part of a regional aquifer in combination with permeable units in the overlying sediments and underlying karstic Paraburdoo Member dolomite (where present).

Quaternary to recent

Active creek channels and floodplains are infilled with recent alluvium. This ranges from silt and clay to coarse gravel and is often poorly sorted - a characteristic of the ephemeral flow regime.

In places where groundwater levels are shallow and calcrete occurs as extensive outcrops, it is possible that calcrete is still actively forming (based on the morphology of groundwater calcrete in Australia (Horwitz and Mann 1979)). In such settings, calcrete formation occurs just below the groundwater table and occurs typically over a wide area where groundwater is at shallow depth. Active calcrete formation at the water table pushes the overlying calcrete upwards. Ultimately, a plateau or dome of calcrete emerges, with the youngest units at its base (around the water table). As the plateau emerges, it is dissected by streams flowing across it - as is the case with the extensive calcrete outcrop upstream of Weeli Wolli Spring. In such environments, there will be a saturated zone (of approximately 5 m to 10 m) of high permeability calcrete at the water table.

3.3.3 North Flank and Packsaddle system

Introduction

Geological outcrop maps and cross sections through North Flank and Packsaddle are shown in Figures 3.6 and 3.7 and the features shown are described below.

Basement

Two major orogenies affected the Hamersley Basin (the Ophthalmian Orogeny and the Ashburton Orogeny) both of which contributed to the predominant east–west striking regional synclines and anticlines. MAC is on the northern flank of one such anticline (the Weeli Wolli Anticline) and the local geology strikes east west and dips (and youngs) to the north off the flank of the anticline.

A series of more intense tight folds to over-folds are superimposed on the northern flank of the Weeli Wolli anticline and this has overturned the bedding in places, resulting in areas of steep/vertical dips in the Marra Mamba which otherwise dips more moderately to the north (Solid Geology 2013). Vertical faults along the axes of these folds are inconsistently incorporated in the geological model of E Deposit (but none of the other deposits). Whether as a result of overturned bedding alone or overturned bedding in combination with vertical faults, the fold axes appear to have controlled mineralisation and resulted in enhanced permeability along the strike of the mineralised zone.

Lateral thrust faulting has also occurred, caused by strain associated with the over-folds. In particular, thrusting occurred along the contact between the Marra Mamba Formation and the overlying Wittenoom Formation in an "older over younger" (south over north) pattern (e.g. Kepert 2001). This pattern of over-folds and thrusting is commonly associated with both steepened dips and mineralisation in the Marra Mamba Formation. Displacement along the thrust planes is in the order of 200m, overlaying “slices” of Marra Mamba onto Wittenoom Formation. The Wittenoom Formation is the regional aquifer and thrusting and can bring Marra Mamba orebodies in close proximity to or even into direct hydraulic connection with the regional groundwater system. Thrust faults have been confirmed at E Deposit, C Deposit and Hope Downs. Their presence in the geological structure in intervening deposits (i.e. A Deposit) seems likely although a thrust fault is not identified in the current geological model for A Deposit (as of May 2014). The thrust-fault zones are believed to be zones of increased permeability and have an important influence on mine dewatering.

Tertiary

The Wittenoom Formation is less weathering resistant than the surrounding geology and has been eroded to form the North Flank Valley flanked by ridges of Marra Mamba to the south and Brockman Iron Formation to the north. Erosion has resulted in karst development in the Wittenoom Formation, particularly in dolomite of the Paraburdoo Member. The valley has been infilled with sediments that comprise erosional detritus from the surrounding outcrop. Three broad units can be defined in the Tertiary. From oldest to youngest: Tertiary Detritals (TD1, TD2 and TD3). TD1 and TD3 comprise scree and colluvial deposits close to the hills that become finer grained away from the ridges to be matrix-dominant gravelly-silts. The middle of the Tertiary sequence (TD2) is marked by sediments comprising clay and iron-precipitates indicating a period of low-energy deposition. The Tertiary sediments have been altered in places through:

- The precipitation of manganese, often at the basement contact, to form a vuggy hardcap
- The precipitation of iron-cement of both goethite and hematite to form cemented scree at the valley margins and vitreous goethite in the more distal environment which forms localised zones of pisolitic channel iron deposit
- The precipitation of calcrete within the TD2 sequence. It is believed the calcrete is actually micritic limestone rather than a groundwater calcrete (pers. com. Mal Kneeshaw) and represents deposition in a mid-Tertiary lacustrine environment.

3.3.4 South Flank system

South Flank surface geology is shown in Figure 3.8, and geological cross sections in Figure 3.9.

The geology within the South Flank tenement area is dominated by the upper Hamersley group lithologies, intersected by dolerite dykes, and overlain by a thin layer of Tertiary Detritals, with detrital thicknesses increasing towards the longitudinal axis of the valley. The dykes are interpreted to be on the order of kilometres deep and also readily weather into low permeability clays which create barriers to groundwater flow. The southern extent of the tenement area is inferred to be dominated by karstic / massive dolomite extending laterally to the south and pinching out towards the north.

Semi continuous mineralisation within the Marra Mamba Formation is split into northern and southern orebodies (Figure 3.9). The northern orebodies are mostly contained within a secondary synclinal trough and the southern orebodies occur further down the limb at or near the southern portion of the outcropping Marra Mamba and where the Marra Mamba dips below Tertiary Detritals. The northern and southern orebodies are very close to each other in the central part of the South Flank deposit and at the western margins of the mining area. Generally, the northern orebodies are at a higher elevation and have a lower proportion of below water table ore.

Structurally the South Flank mining area is located on the southern limb of the Weeli Wolli Anticline, which has resulted in a rounded, east–west trending ridgeline of outcropping Marra Mamba. The area comprises three (3) local E-W faults, one (1) larger NE-SW regional fault and large-scale anticlines and synclines, with much of the mineralisation constrained to the upper Mount Newman Formation along the fold limbs and within the synclines.
A palaeochannel underlies a major portion of the South Flank valley floor (i.e. to the south of the southern orebodies). Its extent, as defined by drilling in the area, is shown in Figure 3.10. In some locations the channel extends to depths of up to 140 mbgl.

During the Cretaceous Period the majority of the Pilbara was subjected to high rainfall, resulting in significant runoff and the associated erosional features incised into the Proterozoic bedrock.

The palaeo Pebble Mouse Creek has eroded back to the west through the shales and dolomites of the West Angela shale and Wittenoom Formation dolomite. In a number of places, significant features such as faults and dolerite dykes have influenced or reduced the rate of erosion, resulting in waterfall like features or sudden changes in the drainage direction.

The far western section of the palaeochannel appears to be near the head or terminus of the palaeo-drainage system, with the impact of the Bruce Almighty dyke and/or Palladium Fault potential resulting in a waterfall feature. At the onset of drier climate following the wet Cretaceous period, erosion and incision reduced, and deposition and backfilling of the palaeochannel commenced.

At the same time the backfilling of the valley was occurring, surface water ponding, particularly over the underlying dolomitic sequence, resulted in dissolution of carbonates and the development of karstic features. This ultimately resulted in a relatively thin zone of high permeability at or below the palaeochannel floor, occasionally extending to greater depths when associated with faulting or shear zones.

The relatively thick sequence of the Vuggy Breccia unit (VB2) within the backfilled palaeochannel may represent the accumulation of detrital matter from the adjacent Brockman and Marra Mamba Formation hills, being consolidated by the additional clayey material occupying the interstitial space between the fragments. The role of an interpreted dolerite dyke to the east of the South Flank valley cutting across the Pebble Mouse Creek may have influenced the nature of the Vuggy Breccia.

Overlying the Vuggy Breccia is a flat lying, wide spread, 10 to 20 m thick calcrete horizon that appears to represent a period of elevated water table precipitation of carbonates, perhaps during wetter periods in more recent times.

The palaeochannel is bound to the north by the South Flank orebodies and to the south by Mt Robinson and outcropping/subcropping bedrock to the east of Mt. Robinson.

3.3.5 Hope Downs system

The Hope Downs Public Environmental Report/Review document (HDMS, 2000) provides information on the regional and site geology. The Hope Downs orebodies are part of the same geological regime as the BHP North Flank and South Flank deposits and as such is formed from the weathering and infilling of the Weeli Wolli Anticline.

The bulk of the mineralisation at Hope North and South is confined to the Mount Newman Member and the base of the West Angela Member. The Nammuldi Member is only enriched at Hope South. The MacLeod Member is partially mineralised at both deposits.

Figures 3.11 and 3.12 provide some further context. The Hope North Deposit is adjacent to a significant subcrop of Wittenoom Dolomite whereas the Hope South Deposit is not. They also show that thrust faulting has had an impact on the local geology.

3.3.6 Coondewanna Flats system

Coondewanna Flats is bounded by hills of Marra Mamba and Brockman. Preferential weathering of the Wittenoom Formation between these outcrops resulted in a low-lying area which has subsequently been infilled with Tertiary deposits of alluvium and colluvium. The geological sequence comprises an upper Tertiary sequence (TD3) of variable sand, silt and gravel overlying a middle Tertiary sequence (TD2) of variable calcrete and silty gravel overlying shale and dolomite of the Paraburdoo Member (Figure 3.13). The calcrete lies close to the water-table and the extent to which it is saturated varies with recharge state (up to a 5 m change in groundwater levels has been observed following inundation of the Flats).

The Wittenoom Dolomite constitutes an upper shaley Bee Gorge Member, Paraburdoo Dolomite Member and underlying low-permeability West Angela Member. Regionally, erosion has resulted in karst development in the Wittenoom Formation, particularly in dolomite of the Paraburdoo Member, and significantly elevated permeability has been intersected (e.g. holes HNPIAC0001 to HNPIAC0004 in Packsaddle West). Final airlift yields in production bores HNPIAC0001 and HNPIAC0002 were up to 30 L/s. Weathered / fractured sections of the Paraburdoo dolomite are typically succeeded by competent crystalline dolomite of lower permeability. Following

performance reviews of the Juna Downs MAR scheme, estimates of the transmissivity of the dolomite range from 1200 to 1530 m^2/d (BHP 2019a, BHP 2020a).

3.4 Hydrostratigraphy and Relationships

The main aquifers in the Central Pilbara area are:

- Orebody aquifers, which are made up of mineralised and submineralised material of the:
    - Marra Mamba Formation which hosts the North Flank Deposits (A, B, C, E, F, R and Dead End); the South Flank Deposits (Highway, Grand Central and Vista Oriental) and the Rio Tinto Iron Ore (RTIO) Hope Downs 1 deposits.
    - Brockman Iron Formation, which forms east/west striking aquifers in the north, hosted in the Packsaddle orebodies.
- Regional aquifers, which are located through the valley between North Flank and Packsaddle, the South Flank paleochannel, west near Coondewanna Flats and east near Weeli Wolli Spring, and are made up of:
    - Weathered Paraburdoo (and Bee Gorge) Members of the Wittenoom Formation. The Paraburdoo dolomite in particular, can be karstic and highly permeable.
    - Sand, gravel, and calcrete occurrences in the Tertiary Detritals. The Tertiary Detritals are very thick in places, reaching >100 m in some regional aquifers (e.g. South Flank Valley paleochannel).

The orebody and regional bedrock aquifers are separated by the various shale members of the Mt McRae / Mt Sylvia Formations and Wittenoom Formation. The Mt McRae and Mt Sylvia shales are present to the south of the Brockman orebodies and the West Angela Shale is found to the north of the Marra Mamba orebodies. In some areas, the regional aquifers are in direct contact with the orebody aquifers (e.g. A and C deposit) whereas in others they are hydraulically disconnected by the shale formations (e.g. most of the Packsaddle orebodies).

The hydrostratigraphy within the conceptual model boundaries also demonstrates the following properties:

- The Wittenoom Formation is less resistant to weathering than the surrounding geology and has been eroded to form the North Flank Valley flanked by ridges of Marra Mamba Formation to the south and Brockman Iron Formation to the north. Preferential erosion has resulted in karst development in the Wittenoom Formation, particularly in the dolomite of the Paraburdoo Member. The valley has been infilled with sediments that comprise erosional detritus from the surrounding outcrop (Tertiary Detritals).
- The Packsaddle (Brockman Formation) orebodies to the north range from unsaturated to saturated.
- The Marra Mamba Formation orebodies present significant saturated thicknesses and are in variable connection to the regional aquifers.
    - At North Flank, the greatest connection, where orebody and dolomite aquifers are in direct contact is believed to be at A Deposit. The least connection is believed to be at the eastern end of C Deposit, where the West Angela Shale forms an effective, if leaky, barrier between it and the regional aquifers.
    - At South Flank the northern orebodies are separated from the southern orebodies in the west and east but do come together in the central area (and in the far western margin). Generally, the northern orebodies are at a higher elevation and have a lower proportion of BWT ore. The southern orebodies are likely well connected to the regional aquifers at least along some of their strike length.
- Weeli Wolli Spring occurs where Weeli Wolli Creek passes through a gorge eroded through the Wildflower Range. Groundwater flows are concentrated into the spring by low permeability basement rocks. A shallow groundwater system occurs up-gradient form the spring and is associated with an extensive calcrete zone up to 40 m thick.
- Beneath Juna Downs and Coondewanna Flats the regional aquifer is extensive and comprised of karstic Pararburdoo dolomite overlain by a thick sequence of Tertiary Detritals. Depth to bedrock (dolomite) beneath

the Juna Downs MAR borefield is generally >50 m, while depth to bedrock beneath Coondewanna Flats varies from 30 – 50 m and is inferred to be more competent (i.e. less permeable). Estimates of the transmissivity of the dolomite range from 1200 to 1530 m^2/d (BHP 2019a, BHP 2020a).

The Hope Downs 1 mine comprises two major iron ore deposits (HDMS, 2000): the Hope North and Hope South orebodies. Both orebodies consist of mineralised Marra Mamba Formation. The Hope North orebody is over 6 km long and is located directly east of MAC, with a significant proportion of the orebody beneath the natural groundwater level. Up to 100 m of Tertiary Detritals, underlain by the weathered dolomite of the Wittenoom Formation, is present directly to the north, east and west of the Hope Downs North orebody.

Hydraulic parameter values characteristic of the various hydrostratigraphic units in the CPH aquifer systems are summarised in Table 3.2. The values are derived from the FY21 calibrated numerical model.

Table 3.2. Numerical model hydraulic parameters

Parameter / area	Hydraulic conductivity (K)	Specific yield (Sy)
Dolomite	50 to 60 m/d (North Flank Valley) 5 to 7 m/d (South Flank Valley) 10 to 60 m/d (Coondewanna Flats) 12 to 24 m/d (Hope Downs aquifer)	0.1 to 0.5% (North Flank Valley) 2% (South Flank Valley) 0.5% (Coondewanna Flats) 1% (Hope Downs aquifer)
Tertiary Detrital	1.5 to 5 m/d (North Flank Valley) 5 to 80 m/d (South Flank Valley) 5 to 29 m/d (Hope Downs aquifer)	5 to 11% (North Flank Valley) 0.5 to 10% (South Flank Valley) 5% (Hope Downs aquifer)
Orebodies	3 m/d (North Flank) 5 m/d (South Flank) 8 m/d (Hope Downs)	2 to 21% (North Flank) 2% (South Flank) 5% (Hope Downs)
Unmineralised Marra Mamba	1x 10^{-3} to 1x10^{-4} m/d	0.1%
West Angela Shale	0.1 to 0.001 m/d	0.1%
Mount McRae / Sylvia	1x10^{-3} m/d	0.1%
Calcrete	25 m/d	6%

3.5 Structures and Flow Barriers

Regional and local structures play a significant role in the Central Pilbara groundwater system and generally behave as partial, if not almost complete, barriers to flow. The following features play a key role in controlling regional groundwater flow (Figure 3.14):

- Dolerite dykes – generally NE-SW or NW-SE orientation. From west to east:
    - #1 – crosses through the east of MAC E deposit and South Flank Highway deposit (Bruce Almighty Dyke).
    - #2 – crosses between MAC E and C deposits, cuts through the west of R Deposit, to the east of South Flank (and just south of Hope Downs South) and just to the northeast of Ben's Oasis.
- Rock mass flow barriers (or undefined dykes). From west to east:
    - #3 – a feature (likely low permeability rock mass and/or structure called Neale's Fault) separating West Packsaddle and Juna Downs.
    - #4 – a feature cutting through the western end of E Deposit (between E West and E East deposits).
    - #5 – a feature between the eastern end of A Deposit and the Hope Downs aquifer system.
    - #6 – one, or a combination of features, at the eastern end of South Flank Vista Oriental deposits.
    - #7 – several features in and around the Jinidi deposits.

There may be other structures that are hydraulically significant through the South Flank area (and other Central Pilbara catchment areas) but these are only likely to become apparent following monitoring the response to significant dewatering of the South Flank orebodies or MAR injection in the South Flank Valley.

3.6 Regional Flows and Heads

Pre-development groundwater levels are summarised in Figure 3.14 and groundwater level cross sections through the regional aquifers running both to the north and south from Coondewanna Flats to Weeli Wolli Spring are shown in Figures 3.15 and 3.16. The figures show that:

- Water levels are highest in the area of Coondewanna Flats (~660 mRL) and lowest at Weeli Wolli Spring (~562 mRL).
- Groundwater flows from the west through both the southern and northern flank valleys towards Weeli Wolli Spring.

The steps in pre-development water levels across structures, and the flat water levels in the areas between them can be used to delineate several distinct aquifer systems or 'compartments'. The steps are likely indicative of groundwater barriers or partial-barriers, and the flat water levels are likely areas of high hydraulic conductivity. The compartments are listed below and shown in Figure 3.17:

1. The Coondewanna Flats/Juna Downs area between the dykes to the southeast and the northeast (including the western part of E Deposit).
2. The area of Packsaddle west of P2
3. The area of Packsaddle east of P2 (including East Packsaddle deposits)
4. The central part of E Deposit (E Central)
5. The eastern part of E Deposit (E East 3)
6. All of C Deposit and the majority of A Deposit
7. The Hope Downs and Weeli Wolli Spring aquifer systems (including B Deposit, R Deposit, Jinidi and the southern tip of A Deposit, and south to the dyke that crosses the eastern part of the South Flank Valley)
8. The area in the north of South Flank
9. The area in the south of South Flank Valley
10. Camp Hill
11. Tandanya

While the structures appear to coincide with the boundaries of these compartments, pre-development heads also show that groundwater flows from west to east (i.e. flow across these boundaries). The conceptualisation of the dyke flow barrier mechanism is shown in Figure 3.18, demonstrating an example near E Deposit. The pre-development heads suggest that they produce the steps in groundwater by severely constraining the along strike transmissivity of the regional (dolomite) aquifers. The Tertiary Detritals have some degree of saturation all through the North Flank Valley and are generally underlain by fully saturated and high permeability weathered dolomite. However, as the dykes are present in the dolomite (and adjacent bedrock to the south and north of the dolomite), they effectively reduce the cross-sectional flow area but do not stop flow altogether.

Dykes clearly play a significant role in the equilibration of pre-development water levels in the catchment. However, two compartment boundaries do not correspond to the location of a known dyke. These are:

- The area between A Deposit and Hope Downs where the water level changes rapidly from 583 mRL to 573 mRL.
- The transitional area in the east of the South Flank Valley where water levels fall gradually from 628 mRL to 595 mRL at the eastern dyke.

Highly pertinent to this study, the conceptualisation of the area between A Deposit and Hope Downs aquifer system (the "transition zone") is shown in Figure 3.19. A low permeability rock mass flow barrier is formed by a combination of a mass of unmineralised Mt Newman Member that splits the A Deposit orebody into two at its southern end and

an extensive unweathered dolomite adjacent to it. A limited thickness of Tertiary Detritals (maximum 20 to 30 m) overlies these lithologies and allows flow from west to east but pinches out to the northeast. In this way, as per the effect of the dykes to the west, the effective transmissivity of the regional aquifers is constrained significantly at this location.

3.7 Recharge and discharge mechanisms

3.7.1 Introduction

Groundwater discharges as a result of the hydraulic gradient to Weeli Wolli Spring (discharging as throughflow, springflow and evapotranspiration).

Groundwater also discharges through abstraction for both mine dewatering and water supply (Figures 3.20 and 3.21).

Groundwater recharges via rainfall (which most significantly collects and infiltrates at Coondewanna Flats and Weeli Wolli Spring).

Groundwater is also recharged by spring flow supplementation (RTIO at Weeli Wolli Spring) and injection of surplus mine dewatering water at A Deposit MAR (ceased FY19), Juna Downs MAR (commenced FY19) and South Flank (commenced FY22).

3.7.2 Groundwater stresses (natural)

Rainfall recharge

Depth to groundwater is significant being greater than 20 m over most of the catchment (Figure 3.22). Approximate ranges of pre-development depth to groundwater in the various areas are:

- North Flank Valley: 80 to 60 m
- Packsaddle Deposits: 170 to 80 m
- South Flank Valley: 60 to 40 m
- South Flank Deposits: 170 to 50 m
- Coondewanna Flats: 30 to 20 m
- Hope Downs Valley: 40 to 20 m
- Weeli Wolli Spring aquifer system: 15 to 0 m

The depth to groundwater combined with the rainfall pattern and evaporation rates suggests that rainfall recharge is generally small in comparison with the aquifer storage over most of the conceptual model domain. However, time variant groundwater levels in both the Coondewanna Flats and Weeli Wolli Spring aquifers increase following major rainfall events, suggesting that rainfall recharge in these locations may be significant, although infrequent in the case of Coondewanna Flats. For example, at Coondewanna Flats, groundwater level observations show only two responses to rainfall over the 13 years between 2005 and 2017 (Figure 3.30). The first in the 2005/2006 wet season (approximately 1.0 m) and the second in the 2011/2012 wet season (approximately 0.4 m). By contrast, groundwater levels in the Weeli Wolli Spring aquifer system responded to rainfall in most wet seasons, suggesting that recharge here is much more frequent and occurs at a lower rainfall threshold than at Coondewanna Flats. Close to the Spring, water levels are relatively constant, but upstream, between 1998 and 2007 (10 years), GWB0018M recorded water level increases of between 1 and 2 m over four wet seasons (Figure 3.31), and more minor responses in the remaining years.

Discharge

Due to the depth to groundwater being greater than 20 m over the majority of the catchment, the only location for natural discharge via evaporation or transpiration is at the Weeli Wolli Creek and Weeli Wolli Spring.

Weeli Wolli Spring marks the surface and groundwater outflow from the Weeli Wolli Spring catchment (approximately 1,450 km^2) and is approximately coincident with the conceptual model domain - in effect measuring surface water

outflow from the entire model area. The Spring occurs where Weeli Wolli Creek passes through a gorge eroded through the Wildflower Range. Groundwater flows are concentrated into the spring by low permeability basement rocks. A shallow groundwater system occurs up-gradient from the spring and is associated with an extensive zone of calcrete. Downstream of the gorge, the creek flows through a narrow channel past the confluence with Marillana Creek and ultimately into the Fortescue River Valley.

The various hydraulic mechanisms at the Spring are conceptualised as follows:

- Surface flow at Weeli Wolli Spring is a combination of spring baseflow supported by groundwater and seasonal surface water floods.
- On average, there are two surface water flow events each year. There is local infiltration from these surface water flows resulting in recharge to the shallow groundwater system.
- The groundwater system comprises an unconfined aquifer sequence which is made up of high permeability calcrete, moderate permeability Tertiary Detritals and a moderate permeability transition zone underlain by low to high permeability basement.
- Groundwater levels range between 0 and 20 mbgl with water table depths becoming shallower towards the spring. The aquifer thins and narrows towards Weeli Wolli Spring, concentrating groundwater flow, causing gradients to steepen and groundwater to report to the surface as baseflow.
- An analytical water balance of the Spring was developed in by RPS (RPS, 2014). This has provided a guide to the likely magnitude of rates of water movement in and out of this system:
    - Recharge to the spring area occurs as direct infiltration from streamflow events on an almost annual basis; recharge is 2,500 kL/d (when averaged over the year). Throughflow from the catchment upstream is estimated to be approximately 11,000 kL/d.
    - Discharge occurs as spring baseflow (approximately 7,000 kL/d), evapotranspiration (approximately 2,600 kL/d) and groundwater throughflow in the shallow aquifer (approximately 4,000 kL/d).
- There is no evidence for outflow in a deep (fault controlled) aquifer through the gorge through Wildflower Range. There may be a zone of slightly enhanced permeability in the transition zone at the top of the otherwise low permeability basement at the spring. This transition zone, however, is in hydraulic connection and effectively acts as a single aquifer system with the overlying alluvium.
- Aquifer parameters (hydraulic conductivity and specific yield) are within the range of regional estimates and the system is driven by the high permeability in the calcrete and alluvium and low permeability in the basement in proximity to the spring.

3.7.3 Groundwater stresses (anthropogenic)

The CPH borefields and discharge features are shown in Figure 3.20 and the historical usage is shown in Figure 3.21.

Abstraction

- Groundwater abstraction for water supply for mine operation purposes has occurred at MAC since 2001 and reached a maximum of about 8 ML/d from 2007 to 2009. Most of this abstraction occurred from the “Rail Loop Bores” situated just to the north of C Deposit, in the regional dolomite aquifer.
- Dewatering of MAC E and C deposits commenced in 2010 with the average abstraction in 2020 of 13 ML/d and 16 ML/d respectively.
- Dewatering in A deposit commenced in 2019 with an average abstraction in 2020 of 22 ML/d.
- Groundwater abstraction for water supply commenced at South Flank in 2018, with an average abstraction in 2020 of up to 4 ML/d.

Discharge

The mine operation has transitioned from having a water deficit, to a water surplus, as it has progressed from above water table mining to below water table mining. Surplus water has been managed using a number of methods:

- C West pit lake – used during 2011 and 2012 at an average discharge rate of 10 ML/d.
- Central Sediment Basin – previously known as the C Deposit sediment pond which was used since 2011 at an average discharge rate of 6 ML/d and a peak of up to 17 ML/d. As at FY21 it was rebuilt and is now back in operation when required.
- A Deposit MAR – used between 2012 and 2019 at an average discharge rate of 5 ML/d and a peak of up to 16 ML/d.
- Packsaddle Infiltration Ponds – a series of 3 infiltration ponds near Packsaddle used since 2018 at an average discharge rate of 5 ML/d and a peak of up to 22 ML/d.
- Western Sediment Basin – infiltration basin near F deposit, used since 2018 at an average discharge rate of 2 ML/d and a peak of up to 10 ML/d.
- Juna Downs MAR – in use since 2019, at an average discharge rate of 18 ML/d and a peak of up to 26 ML/d.
- South Flank Valley MAR – in use since 2022

Dewatering of the RTIO Hope Downs mine commenced in 2007 (at a rate of approximately 70 ML/d and reaching a maximum of approximately 100 ML/d). Management of the surplus water and impacts to Weeli Wolli Spring at Hope Downs has taken the form of discharge to Weeli Wolli Creek at a rate of approximately 20 ML/d since 2007 (RPS, 2015)

After the closure of the Hope Downs mine, RTIO have committed to artificially support Weeli Wolli Spring until the natural flow returns to within 10% of pre-mining flow rates, potentially up to 20 years after decommissioning (HDMS 2000). The proposed Hope Downs groundwater abstraction and water management strategy includes the following as detailed in the Environmental Protection Authority Report and Recommendations (2001) for the Hope Downs Project:

- Dewatering at Hope Downs over the period YEJ2014 to the end of 2025.
- Infilling of the final Hope Downs mine void and engineering and rehabilitation of the final landform surface such that there is no additional rainfall recharge or recharge from Pebble Mouse Creek.
- Irrigation to support Weeli Wolli Spring at a rate of 20 ML/d during operation of Hope Downs (until 2026) and for a period of 20 years after mine closure (until 2046).
- Recharge to the Hope Downs infilled mine void at a rate of 20 ML/d once mining and infilling at Hope Downs are complete (from 2026 to 2046).

Relevant impact assessment of the proposed surplus schemes have been prepared to support EPA Act Part IV Environmental Impact Assessment where applicable and are not discussed within this report. Existing operational surplus schemes have been included in this numerical model were significant. The management of impacts to environmental from the surplus schemes will be managed through the Central Pilbara Water Resource Management Plan (2023) and Part V operational license.

3.8 Change in Groundwater Levels

The greatest understanding of the groundwater system comes from the extensive time variant monitoring that has occurred since 2000/2001. It is these data that provide the main basis for the conceptual model. These observations are shown in Figures 3.23 to 3.27 and divided based on aquifer compartment. In most cases the hydrographs display clear responses to the various anthropogenic stresses in the system.

The change in groundwater levels as described by the difference between pre-development and 2018 and 2020 head observations, is shown in Figures 3.28 and 3.29, respectively. Note, there is no available "pre-development" (2000/2001) head data within the Coondewanna Flats area to compare head differences in the figures.

Change is most obvious in the Hope Downs and North Flank aquifer systems where most of the groundwater stresses have been concentrated.

Monitoring of the groundwater response to these stresses has shown that:

- The dolomite north of C and A Deposits is very well connected along strike. Drawdown from the rail loop bores (north of C Deposit and operating since 2001) spreads very quickly to the east of A Deposit.
- The C Deposit orebody aquifer shows some disconnection along strike (most likely from unmineralised basement highs) and some disconnection from regional dolomite (due to the presence of West Angelas Shale).
- The A Deposit orebody aquifer shows very good connection to the regional aquifer (through direct contact in the eastern part of the orebody).
- The A and C Deposit orebodies are not connected along strike as they are separated by unmineralised bedrock highs.
- Some flow does occur across the dyke that passes between C and E Deposits. Heads in the eastern part of E Deposit respond to the rail loop abstraction.
- Flow between the A Deposit and Hope Downs aquifer system is limited. As at 2018 (Figure 3.28) regional aquifer heads on western side responded to abstraction and discharge at C Deposit and injection at A Deposit, whereas heads on the eastern side showed an almost linear drawdown in response to Hope Downs dewatering (40 to 50 m at 2018). This difference is not as obvious in 2020 (Figure 3.29) after commencement of abstraction at A deposit, which has resulted in similar groundwater levels in both in the A Deposit and the Hope Downs compartments.
- The Hope Downs compartment displays very high transmissivity, with significant drawdown occurring to the west at R Deposit, to the east towards Jinidi and to the south toward the South Flank Valley and Ben's Oasis.
- Piezometric heads around Weeli Wolli Creek, particularly approaching the Spring, have shown a subdued response to Hope Downs dewatering. This is most likely due to a combination of the presence of a basement high in this area and the effect of the Hope Downs surplus water discharge into the creek. However, although heads at GWB0018M (just upstream of the spring) vary by up to a metre seasonally, since about 2009 they appear to have fallen by nearly 2 m, a change that is most likely due to drawdown migrating from Hope Downs.
- Up to 2021, drawdown has not crossed the structure separating South Flank and the Hope Downs aquifer system.

3.9 Receptors

The Central Pilbara Water Resource Management Plan (CPWRMP) (BHP, 2021) accepted by DWER identified key ecohydrological receptors in the catchment having potential to be affected by groundwater change. These are summarised below, shown on Figure 3.1, and described in more detail in Section 4.

Coondewanna Flats

- Coondewanna Flats (the Flats) is an internally draining alluvial plain and wetland feature which is the terminus for surface water flow from the west of the catchment. The Flats support a Priority Ecological Community (PEC) of woodland and forest. The significant depth to water (>20 m) at the Flats makes it unlikely that this is a groundwater dependent receptor and vegetation communities are more likely to be dependent on the surface water regime in the area. Observed groundwater levels are shown in Figure 3.30. These show that:
    - Groundwater monitoring started in 2004, after the 1999/2000 rainfall event.
    - Prior to MAR, levels were about 4 m higher in the southwest than the northeast. The response to mounding confirms that there is a leaky flow barrier separating these two areas.

- In the northeast, mounding of about 4 m has occurred since MAR commenced in 2019.

Weeli Wolli Spring

- Weeli Wolli Spring is located where Weeli Wolli Creek flows through a narrow gap or gorge in the Wildflower Range. The area supports an unusual combination of riparian vegetation and fauna. RTIO currently (and with plans to continue into the future) discharge surplus mine dewatering water into Weeli Wolli Creek into several locations just upstream of the Spring and one location downstream of the Spring. Observed groundwater levels are shown in Figure 3.31. These show that:
  - Prior to dewatering at Hope Downs, the groundwater gradient was from the south to the north, with a 20 m difference between water levels at GWB0015M and GWB0032M.
  - Post dewatering at Hope Downs, a groundwater divide has developed about half way between Hope Downs and the Spring (between GWB0015M and GWB0016M).
  - The water level close to the Spring (GWB0017M and GWB0032M) has remained relatively stable.

Ben's Oasis

- Ben's Oasis is a series of pools along the channel of Weeli Wolli Creek where there is a shallow basement rock bar. These pools support riparian woodland and forest communities. Four monitoring bores were drilled in the area in 2016 (Figures 3.32 and 3.33). These show that:
  - When monitoring commenced in 2017, there was a 20 to 25 m head difference between the water level in HDD0001M (southwest of the dyke) and the bores northeast of the dyke.
  - The water level in HDD0001M is roughly at the same elevation as the creek bed just to the north.
  - The water levels in all the bores respond to rainfall.
  - The water level at HDD0001M (southwest of the dyke, Ben's Oasis side) was observed (one manual dip) at the end of 2016 significantly lower than all subsequent observations. Due to a break in the observations during 2017, it is not possible to conclude whether this initial manual dip was erroneous, or the subsequent observations are higher due to a major recharge event during 2017.
  - If the 2016 observations at HDD0001M are discounted, and the seasonal minima taken as the baseline, the water level at this location has declined 0.4 m since 2018 (Figure 3.33). As per the point above, it is impossible to tell whether this is due to climate and/or anthropogenic causes.
  - The water level northeast of the dyke (within the Hope Downs aquifer compartment) is between 30 and 40 m below ground surface. Groundwater levels here have been declining since recordings began in 2017, falling between 9 and 13 m in that time (up to 2024).
  - HDD0002M became dry in 2018.

3.10 Groundwater / Surface Water Interaction

Pre-development groundwater heads is shown in Figure 3.11**.** The opportunity for direct interaction between the groundwater and surface water systems in CPH is limited by the depth to groundwater over the entire area. As mentioned above, the only permanent opportunity for groundwater / surface water interaction is in the area of Weeli Wolli Spring. Additional monitoring is required to determine a direct groundwater / surface water interaction at Ben's Oasis.

At Coondewanna Flats, given the 20 – 30 m depth to groundwater, permanent groundwater / surface water interaction is not supported. A periodic lake known as Lake Robinson may be formed following episodes of heavy rainfall where surface water infiltration saturates the vadose zone. However, following these rainfall events, groundwater levels do not appear to rise beyond ~5 m, suggesting the groundwater system at Coondewanna Flats is still disconnected even in peak rainfall.

3.11 Acid and Metalliferous Drainage

As per the *Mining Area C Mine Closure Plan* (BHP 2020b), the Northern Flank as a whole is a low sulphur system and is not likely to generate elevated acidity. When R Deposit, Packsaddle 2, 5, 6 and the Packsaddle Brockman Detrital are developed, potentially acid forming (PAF) volumes may increase from weathered exposures of Acid and metalliferous drainage (AMD) Class 2 and 3. South Flank is also classed as a low sulphur system, with minor amounts of weathered and detrital material designated as AMD class 2 and 3 mainly in detritals and from Grand Central Pushbacks 1 and 2 and Highway Pushback 6.

3.12 Uncertainties

The hydrogeological conceptualisation is based on the observed groundwater levels, water chemistry (see Appendix C), rainfall and geology from numerous boreholes. However, the data, and therefore the conceptualisation is influenced by the following uncertainties.

- Eastern MAC (A and C Deposits):
    - The nature of the connection / disconnection of the orebody aquifers within C Deposit (i.e. along strike) and between C Deposit and the regional aquifers is still uncertain due to the complexity of the hydrogeological system, even with the long history of dewatering and monitoring in this area.
- Western MAC (E Deposits):
    - The hydraulic parameters in the area of E West Deposit remain relatively uncertain. Some insight is given by the response to rainfall events, but this data does not provide a clear understanding of the characteristics of the regional dolomite (hydraulic parameters or geometry) in this area.
    - The central and eastern parts of E Deposit are well defined, as is the role of the flow barriers that separate E East 3 deposit from the rest of E Deposit. To the west however, the situation is less clear as data is more ambiguous and the nature of the flow barrier that cuts through E West and E Central less well defined.
    - Limited information is available on the characteristics of the orebody and regional aquifer west of the E West / E Central flow barrier and consequently it is understood at a conceptual level only.
- Coondewanna Flats and Juna Downs:
    - Hydraulic parameters of the regional aquifer in the immediate vicinity of Juna Downs and Coondewanna Flats are now better understood following the commencement of Juna Downs MAR. However, the parameters, geometry and structural control of the aquifer at depth is less understood, particularly further west of this compartment.
    - The potential for mounding in response to Juna Downs MAR to extend west towards the Karijini National Park boundary (though this is some 12 km away) is uncertain.
    - The extent of disconnection (i.e. the potential flow barrier) across the Coondewanna Flats aquifer is uncertain, as are the potential implications on injection and dewatering. This will become clearer as Juna Downs MAR continues and when dewatering of the Highway Deposits commences.
- Packsaddle:
    - In the west of Packsaddle, there is uncertainty as to the long-term recession trends seen in time series data. This could be a natural long-term recession trend and/or due to influence from abstraction in MAC (e.g. at E Central deposit). There is, however, no time series data pre-MAC abstraction to confirm this.

  - The extent of connection between Packsaddle and the southern regional aquifer is unknown. While pre-development heads show similarities and potential connection (particularly at the P1E deposit), this is not confirmed by time series data.
  - While consistent pre-development heads within West Packsaddle and a portion of P1W potentially indicate hydraulic connection along-strike, this may also have occurred due to water levels 'settling out' over long periods of time, uninfluenced by anthropogenic stressors.
  - Connection between Packsaddle East and the regional system to the south is uncertain. Pre-development heads show up to ~50 m difference. However, while bores in the regional system to the south of Packsaddle East are impacted by Hope Downs dewatering, the extent of hydraulic disconnection (through the low permeability McRae/Sylvia shales south of East Packsaddle) from the East Packsaddle deposits has not been quantified.

- South Flank:
  - There is significant uncertainty at South Flank due to the size of the area and the lack of high rate and duration of abstraction to date.
  - The hydraulic parameters and geometry of the regional aquifer (the dolomite and Tertiary Detritals) through the South Flank Valley are not well understood.
  - There is high confidence that the Highway 1 and 5 Deposits are hydraulically connected to the regional aquifer near Coondewanna Flats. However, the hydraulic connection (particularly with depth) between the other South Flank deposits and the regional aquifers is unknown.
  - The potential flow under increasing water level gradients across the key regional structures is unknown, in particular at the Bruce Almighty Dyke (to the west), and the dyke and potentially lower transmissivity area to the east.
- Jinidi:
  - The southern-most Jinidi orebodies seem to be part of a separate groundwater compartment from the Hope Downs system. The data confirm this (see Appendix C), although there is significant uncertainty in the exact nature of the mechanism behind the separation and the orebody characteristics. This is unlikely to have a major bearing on the dewatering rates or impacts from the other mines in the catchment.
- Weeli Wolli aquifer system:
  - Data pertaining to RTIOs Hope Downs water management (both abstraction and surplus water discharge) is sourced from publicly available information. The lack of specific data (i.e., actual abstraction rates assigned to actual bores) adds uncertainty to the conceptualisation of the Weeli Wolli Spring and Hope Downs aquifer systems.
  - Geology is relatively well known along the creek, however further from this area, in the main zone of calcrete there is very little data. The understanding is therefore extrapolated from the creek.
  - The various discharge and recharge components are hard to measure and probably present non-unique solutions in numerical modelling.
- Bens Oasis:
  - The groundwater level dataset in the area of Ben's Oasis is relatively new (monitoring bores installed in 2016) and leaves the reason for the observed decline in water levels between 2018 and 2024 upgradient of the dyke (i.e. on the Ben's Oasis side) open to interpretation.
  - The hydrogeological characteristics of the Ben's Oasis groundwater catchment are not well defined.

4 Existing Groundwater Use

4.1 Environmental Receptors

4.1.1 Coondewanna Flats

Coondewanna Flats (the Flats) vegetation community Priority Ecological Community (PEC) is a system of broad flats and closed depressions located on the southwest perimeter of CPH (Figure 1.2). Coondewanna Flats comprise an inter-montane alluvial plain bound by hills of Mt Robinson (1,185 mAHD) and The Governor (1,020 mAHD) to the east and south respectively, Packsaddle Hill (851 mAHD) and Mt Meharry (1,249 mAHD) to the north and west respectively, and Newman 18 (786 mAHD) to the southwest.

Surface inflows episodically inundate the Flats and infiltrate into the soil profile, replenishing vadose zone storage. The larger flooding events are associated with groundwater recharge. Surface water flows towards the flats from the north, west and south. Surface water runoff accumulates on the flats before being lost to evaporation or infiltrating into the Tertiary detrital, where it replenishes soil water in the unsaturated zone and contributes to groundwater recharge. Lake Robinson occurs within a topographic low at the north-eastern extent of the flats and is one of the terminus areas for catchment runoff, forming an ephemeral shallow lake within the Flats during the wet season.

Coondewanna Flats is bounded by hills of Marra Mamba and Brockman. Preferential weathering of the Wittenoom Formation between these outcrops resulted in a low-lying area which has subsequently been infilled with Tertiary deposits of alluvium and colluvium. The geological sequence comprises an upper Tertiary sequence of variable sand, silt and gravel overlying a middle Tertiary sequence of variable calcrete and silty gravel overlying shale and dolomite of the Paraburdoo Member. The calcrete lies close to the water-table and the extent to which it is saturated varies with recharge state (up to a 5 m change in groundwater levels has been observed following inundation of the Flats).

Ongoing investigations into the requirements for Coondewanna Flats priority communities have been undertaken with relevant campaigns including:

- AQ2 (2016) Coondewanna Flats Ecohydrological Conceptualisation
- AQ2 (2015) Coondewanna Flats Eco-Hydrology Review and Conceptual Model
- Astron (2014) Coondewanna Flats Ecohydrological Study Ecological Water Requirements of Vegetation Report

Coondewanna Flats support two unusual woodland vegetation communities, which are listed as Priority Ecological Communities (PECs) by the Department of Biodiversity, Conservation and Attractions. (DBCA 2021). The PEC is described as:

- Coolibah-lignum flats: *Eucalyptus victrix* over Muehlenbeckia community Woodland or forest of Eucalyptus victrix (coolibah) over thicket of Duma florulenta (lignum) on red clays in run-on zones. Associated species include Eriachne benthamii, Themeda triandra, Aristida latifolia, Eulalia aurea and Acacia aneura. A series of subtypes have been identified: ·
    - Priority 3 - Coolibah and mulga (Acacia aneura) woodland over lignum and tussock grasses on clay plains (Coondewanna Flats and Wunna Munna Flats).
    - Priority 1 - Coolibah woodlands over lignum (Duma florulenta) over swamp wandiree (Lake Robinson is the only known occurrence).

Studies show *Eucalyptus victrix* obtain water from both the upper-soil horizon immediately following recharge and more generally from the zones between 6 and 18mbgl, thereby avoiding the degree of drought stress experienced by shallower rooted species. The following supports that the soil moisture reservoir beneath the flats, fed by surface water runoff rather that groundwater, is likely to be the sustaining water source for the vegetations community:

- depth to groundwater is between 20 to 30 mbgl;
- basal area per hectare is indicative of water limited community;

- symptoms of drought stress during dry season observed in leaf water potential measurements;
- matric potential indicating water access above 18 m; and
- pre-dawn leaf water potentials as low as -4,600 kPa have been measured during the dry season; these are not consistent with groundwater use.

While none of these indicators are conclusive in isolation, taken together, and in the absence of any contraindicative data, they show a very low likelihood that groundwater drawdown will impact this community.

4.1.2 Weeli Wolli Spring and Ben's Oasis

Weeli Wolli Spring is located approximately 14 km east of North Flank and comprises an area where surface water and groundwater flows discharge from the Upper Weeli Wolli Creek catchment. The spring occurs where groundwater flow is constrained through a gorge in Wildflower Range, supporting permanent pools and riparian woodlands.

A shallow groundwater system with extensive areas of calcrete is present up-gradient of the spring. Downstream of the Weeli Wolli gorge, the creek flows via a narrow channel past the confluence with Marillana Creek and ultimately into the Fortescue River Valley.

The spring's natural function is currently being impacted from Rio Tinto Iron Ore (RTIO) Hope Downs operations and is maintained through artificial discharge through a series of spigots.

The Priority 1 Weeli Wolli Spring PEC supports a permanent series of pools, which are fed by the Weeli Wolli Spring. It is dominated by fringing forest or tall woodlands of Melaleuca argentea and Eucalyptus camaldulensis, over trees of Eucalyptus victrix and a dense shrub layer dominated by various wattle species, in particular Acacia citrinoviridis. The presence of water provides habitat for many sedges and herbs (van Leeuwen, 2009).

Weeli Wolli PEC is described by DBCA 2021 as:

- Priority 1 Weeli Wolli Spring's riparian woodland and forest associations are unusual as a consequence of composition of the understorey. The sedge and herbfield communities that fringe many of the pools and associated water bodies along the main channels of Weeli Wolli Creek have not been recorded from any other wetland site in the Pilbara. The spring and creekline are also noted for their relatively high diversity of stygofauna and this is probably attributed to the large-scale calcrete and alluvial aquifer system associated with the creek. The valley of Weeli Wolli Spring also supports a very rich microbat assemblage including a threatened species (Macroderma gigas).

An unusual and diverse aquatic fauna assemblage occurs in a series of permanent pools up gradient of the spring associated with the shallow groundwater system. The permanent discharge from Weeli Wolli Spring is an uncommon habitat for the Pilbara and may function as a refuge for mesic-adapted fauna. A relatively high diversity of stygofauna is associated with the calcrete and alluvial aquifer system.

The creek valley at Weeli Wolli Spring supports a diverse bird assemblage (over 60 species) and very rich microbat assemblage including the Ghost bat (Macroderma gigas), a State listed species. The permanent pools provide a water source and foraging habitat for microbats.

In 2014, the Weeli Wolli Spring PEC was updated by the DBCA to also include Ben's Oasis, which is located 12 km south and upstream of Weeli Wolli Spring. At this location, the vegetation is concentrated along a relatively narrow creek channel adjacent to some surface water pools. There is very little documented information about the geology, hydrology, and ecology of Ben's Oasis.

4.2 Third Party Groundwater Users

Rio Tinto operates the Hope Downs water supply borefield located ~10 km downstream to the east of A Deposit. These bores provide water for potable supply, construction, dust suppression and for the processing facilities.

There are no other third part groundwater users in the area.

5 Groundwater Investigations

The long history of groundwater abstraction at MAC has been supported by many targeted hydrogeological Investigations. These have come in the form of desktop studies, drilling campaigns, test pumping and hydrodynamic trials. By far the greatest amount of information however has come from the monitoring of the groundwater response to dewatering across the orebody since 2010.The original conceptual hydrogeological model for MAC was developed by Woodward Clyde in 1997 during the Environmental Impact Assessment (EIA) for C Deposit; this model supported the original Weeli Wolli Numerical Groundwater Model. Detailed dewatering investigations for C and E Deposits started in 2004 and the numerical model was extended to include detail around E Deposit (Aquaterra 2005). Test production bores were subsequently drilled in 2005, 2008 and 2010 (Aquaterra 2007 and 2009).

Numerous small-scale investigations to support local dewatering efforts have been undertaken since 2010 accompanied by operational monitoring programs and data collection. These investigations have subsequently been incorporated into conceptual model updates. A review of the overall conceptual model for MAC was undertaken by Parsons Brinckerhoff in 2012 with an additional review of the influence of geological structure on the hydrogeology of C and E Deposits was undertaken by Solid Geology in 2013. In 2014 a synthesis of all previous work and monitoring data was undertaken by RPS (2015) and RPS (2014). This synthesis was undertaken at two scales: a regional assessment (CPH Ecohydrology Study) which included the entire Weeli Wolli catchment (RPS 2015); and a detailed review of the mine-hydrogeology of A, C and E Deposits (RPS 2014).

Surplus studies commenced in 2016/2017 to assess options for the management of surplus water from MAC and South Flank dewatering activities. In-line with DWER Strategic policy 2.09: Use of mine dewatering surplus (2013), surplus water management operations at Juna Downs and South Flank MAR were developed to enable and sustainably manage water at Central Pilbara Hub.

The combined data from all these activities, but particularly the dewatering response, has been used to build the conceptualisation presented in Section 3, which is described in more detail in Appendix C.

6 Drilling

The first production bores in the MAC area were drilled in 1997 and were used for water supply. A series of regional monitoring holes were also drilled across the Central Pilbara in 1997, data from which has underpinned the conceptual understanding of the broader aquifer system (the GWB/BH series). In 2001 additional regional monitoring points were installed along with additional supply bores.

Since then, over 100 production boreholes have been drilled in the area along with 700 observation bores that have been used over time to observe the groundwater system. The locations of current MAC and South Flank production bores are shown in Figure 3.4 and the borehole logs are provided in Appendix D.

Hydrogeological information has also been gathered from the thousands of resource geology holes that have been drilled across the site. The resulting geological models have also informed the hydrogeological conceptual models described in Section 5.

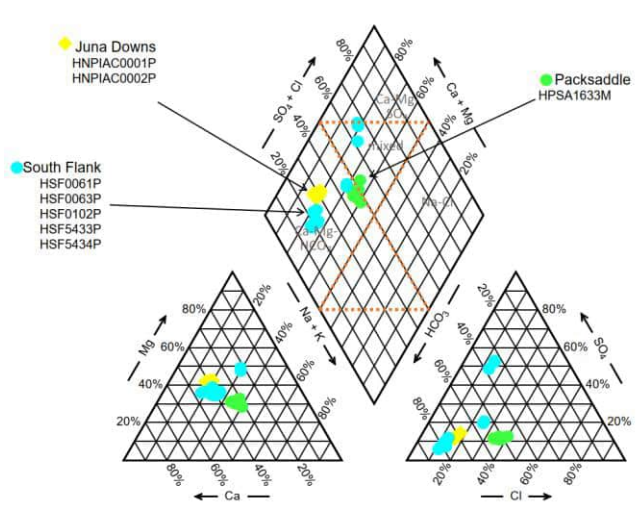
7 Test Pumping

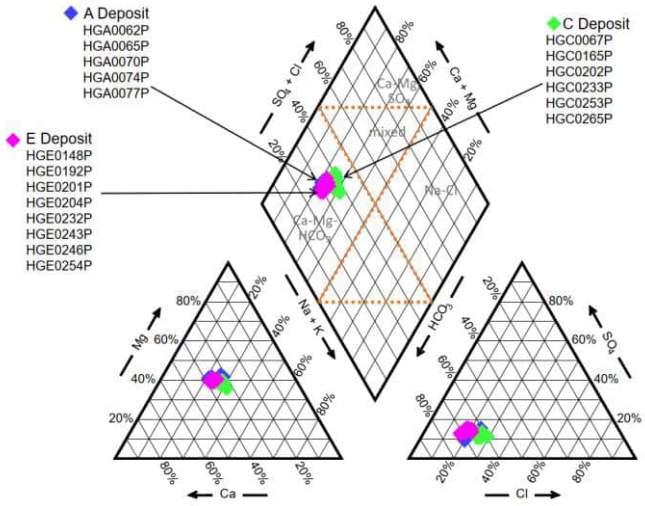
Historical test pumping has been completed at production bores for well efficiency and aquifer parameter determination, however, given the length of dewatering operation, operational water data and long-term monitoring summarised in Section 3 is of greater value in estimating aquifer parameters and response.

8 Groundwater Chemistry

Groundwater quality at CPH is near neutral (pH generally in the range 6-8) and fresh with total dissolved solids (TDS) typically less than 600 mg/L. The small range of TDS suggests that groundwater evolution may be relatively limited.

Piper plot diagrams, completed in the 2022 Triennial Aquifer Review are shown below and show groundwaters are generally dominated by bicarbonate with no dominant cation concentration, which is normally associated with recharge influenced by the weathering of carbonates. The relative clustering of the water samples suggests that the groundwater in the Marra Mamba and Wittenoom Dolomite aquifers are connected.





Groundwater chemistry analysis completed in accordance with groundwater licence conditions has included testing groundwater for a broad range of chemicals (including pH, TDS, major anions and cations, hydrocarbons, metals, and nutrients). There has not been detected any significant or persistent hydrocarbons or metals. There has been some minor nitrate exceedances, particularly persistent near packsaddle bore HPSA1633M possibly influenced by agriculture or nearby infiltration/water treatment facilities. The continued near neutral pH results support acid metalliferous drainage (AMD) is not widespread or impacting groundwater. As per the Mining Area C Mine Closure Plan (BHP 2020b), the Northern Flank as a whole is a low sulphur system and is not likely to generate elevated acidity. When R Deposit, Packsaddle 2, 5, 6 and the Packsaddle Brockman Detrital are developed, potentially acid forming (PAF) volumes may increase from weathered exposures of AMD Class 2 and 3. South Flank is also classed as a low sulphur system, with minor amounts of weathered and detrital material designated as AMD class 2 and 3 mainly in detritals and from Grand Central Pushbacks 1 and 2 and Highway Pushback 6.

Groundwater chemistry data is presented and summarised within the conceptual model report in Appendix C.

9 Groundwater Modelling

9.1 Previous Model Setup

The most recent modelling completed at CPH was to support a 5C licence increase at MAC ((BHP, 2019b). Modelling was completed prior to this to support the South Flank mine approvals in 2017 (BHP, 2016). These two updates are important in this context because they were focussed on different areas of the CPH, which combined, form the scope for this study.

The precursor to these two models (and several others predating 2017) was the Weeli Wolli groundwater model (1997). Updates and improvements have been made at each iteration, reflecting the procurement of additional hydrogeological data with time. The main changes in these two models were:

- 2016: South Flank Approvals (BHP, 2016), compared to the MAC EMP Rev 6 model (BHP, 2015):
    - Modflow USG (Panday et al. 2013)
    - Increased cell size to uniform 200 x 200 m
    - Two additional layers (increased to 6 layers)
    - Increased historic stress period length to 6 monthly
    - South Flank and R Deposit orebody geology updated
    - Linear and non-linear uncertainty analysis on South Flank dewatering and drawdown
- 2018: MAC 5C licence (BHP, 2019b), compared to the South Flank Approvals model:
    - C Deposit West Angela Shale extended along strike
    - Transition zone between A Deposit / Hope Downs implemented as per the updated conceptual model and the existing flow barrier removed
    - Low permeability structure inserted east of South Flank (i.e., representing the dyke in that location)
    - Recharge reduced into Coondewanna Flats
    - Updated pre-development groundwater levels used in steady state calibration

Using the most recent version of the model (BHP, 2019b) as a template, this model has been updated for the purposes of this study. There were no major changes necessary (i.e., to domain, layering etc) but it did require several minor changes, which are described in more detail in following sections. These included:

- Updates to orebody aquifer geometries (generally deepening or extending horizontally)
- Changes to hydraulic properties
- Updates to structures and added a flow barrier through Coondewanna Flats
- Updates to South Flank geology
- Elevation of top of basement increased to the southwest of Weeli Wolli Spring.

9.2 Current Model Set-up

9.2.1 Grid, layers, and boundaries

A brief summary of the main model features is provided below (and in Figures 9.1 to 9.6), with additional details for the main inflows and outflows provided in subsequent sections:

- The model domain covers 88 km east-west and 29 km north-south. It is divided into equal size rows (145) and columns (442) and 6 variable thickness layers.

- There are 384,540 total model cells (cell size is a uniform 200 m by 200 m).
- Of the total number of cells 208,142 are active and 176,398 are no-flow.
- The hydrostratigraphy is based on detailed geological modelling around the MAC and South Flank orebodies. Away from these areas it is based on more sparse regional drilling and publicly available information.
- Several dykes are explicitly represented in the model. These are simulated using the Horizontal Flow Barrier boundary condition.
- Specified head boundaries are assigned to certain model boundaries to allow groundwater to flow in or out of the catchment. The head values are based on observed values in the vicinity of these locations.
- A general head boundary is used in layers 2 to 4 beneath Weeli Wolli Spring to simulate throughflow out of the model at this location.
- The streamflow-routing package is used to simulate Weeli Wolli Creek surface water flows and groundwater interaction. The baseflow component is calibrated to the assumption that minimum flows at the spring have not been less than 3.6 ML/d in the recorded history.
- Rainfall recharge is applied to Coodewanna Flats, the local Weeli Wolli Spring catchment, Packsaddle, the western part of the Hope Downs aquifer system, Jinidi and South Flank areas.
- Evapotranspiration is simulated in the area of Weeli Wolli Spring, with a maximum potential rate of 300 mm/yr (BoM 2022, Climate Data Online - average evapotranspiration based on standard 30-year climatology (1961-1990)). Maximum discharge is set between 0 and 5 m of the ground surface, with an extinction depth at 20 m below surface.
- Variable stress period lengths were used with adaptive time stepping.
- Historical BHP dewatering and discharge to groundwater is simulated using well boundary conditions (with negative values for abstraction and positive for injection/discharge). Future Dewatering from BHP mining areas is simulated using drain cells. The drain elevation changes with time based on the target water level. The efficiency of the drain cells are not limited by the conductance term which is set at a high value.
- Future BHP surplus water management is simulated into the Juna Downs and South Flank MAR schemes.
- Historical and future dewatering (and MAR) of Hope Downs is simulated using well boundary conditions, with specified abstractions based on publicly available information and extrapolations into the future (RPS, 2015).
- Discharge to the creek from Hope Downs is added to the streamflow-routing package at seven locations along the creek channel (positions based on RPS, 2015).
- The Modflow USG SMS (Sparse Matrix Solver) solver is used.

9.2.2 Weeli Wolli Creek, Spring and deep throughflow

Throughflow

A head-dependent flow boundary type is specified in layers 2 to 4 under Weeli Wolli Spring to simulate deep groundwater throughflow from the catchment, using the Modflow General Head Boundary (GHB) Package (Figure 9.1). The model calculates the flux (outflow only in this case) based on the hydraulic gradient across the boundary, factored by a hydraulic conductance term. The model is sensitive to the hydraulic conductance term which was determined during the 2014 model calibration and has not been changed since.

The specified head at the GHB is assigned an elevation of 550.5 mAHD, with conductance values of 333, 0.25 and 6.25 m^2/d assigned to the boundary in layers 2, 3, and 4 respectively. The conductance values were estimated using the relevant saturated thickness, cell dimensions and hydraulic conductivity of each layer.

Weeli Wolli Spring and Creek

In relation to the potential hydrogeological changes from mining activities, Weeli Wolli Spring is a groundwater dependent system that is sensitive to groundwater level changes. Although daily spring flow recordings range between 3.6 ML/d and 3,333 ML/d, the low flow (baseflow) average ranges between 3.6 ML/d and 10 ML/d. The peak flows (which are not accurately measured by the low-flow gauging station at Weeli Wolli Spring) result from surface run-off after heavy rainfall events. These isolated high rainfall events and their associated peak surface flows and

recessions are not simulated by the model. The model only predicts the groundwater-dependent components of the hydrogeological system (including the Spring when it is supported by groundwater, but not run-off). As a result, the simulated baseflow at Weeli Wolli Spring during the transient calibration will only be consistent with the measured baseflow data. It should also be noted that the range of recorded baseflows changed to between 5 ML/d to 6 ML/d when the spring gauging station was moved downstream in 2001.

The surface and groundwater interactions at Weeli Wolli Spring and Weeli Wolli Creek immediately upstream were represented with the Modflow Streamflow-Routing Package (STR) (Figure 9.1 and 9.4). This is a surface-groundwater interaction package that simulates leakage to or from the specified stream cells and allows for the specification of surface flows along the creek and subsequent leakage to groundwater. This feature is also used to simulate surface water augmentation of Weeli Wolli Creek as currently undertaken at Hope Downs.

Weeli Wolli Creek bed elevations are based on the Digital Elevation Model (DEM) data. The Manning's equation and other parameters used to represent Weeli Wolli Spring and Weeli Wolli Creek immediately upstream include:

- A stream bed conductance parameter of 260 m^2/d to represent the thickness and hydraulic conductivity of creek bed material.
- A specified stream width of 20 m.
- Channel slope of 0.005 m/m.
- Manning's "n" of 0.03.

9.2.3 Ben's Oasis

Ben's Oasis is located outside of the main Central Pilbara (in the context of this report) groundwater flow systems. It lies on the upstream (south-western) side of a major NW-SE trending regional dyke that behaves as a flow barrier, and, as of 2024, there is an almost 30 m difference in groundwater levels across it.

There is little to no information as to the hydraulic characteristics of the Ben's Oasis aquifer compartment, other than from the one monitoring bore drilled close to the spring. Groundwater levels on the Hope Downs side of the dyke have fallen between 9 and 13 m since 2017, most likely in response to Hope Downs dewatering. Groundwater levels on the Ben's Oasis side however, over the same period, have varied little.

As the spring is fed from an upstream groundwater compartment, in which there is no active groundwater dewatering and very little hydrogeological knowledge (i.e. very high uncertainty), there is no justification for including it in the model domain. The Hope Downs aquifer compartment is included in the model however and the future drawdown and recovery in this system will be assessed. This can then be compared with drawdown that has already occurred so that inferences about potential impacts at Ben's Oasis can be made. As well as bore HDD0004M (which has data from 2017), bore GWB0020M has been used for this exercise. Located about 10 km southeast of Hope Downs and 5 km north of Ben's Oasis, this bore has data from 1998 to 2013, thus augmenting the data at HDD0004M.

9.2.4 Evapotranspiration

In the Weeli Wolli Spring area, the vegetation types present will result in an evaporative discharge from the area. There will be evaporation from paperbarks at the Spring which rely on a depth to water of less than 3 m. Red Gums and Coolibahs, with greater rooting depths (of up to 20 m) are facultative phreatophytes and vadophytes and will contribute to an evaporative loss from the water table, both directly where roots penetrate the water table and indirectly where the water table is below the roots but matric suction induced by the roots causes a capillary rises of groundwater into the unsaturated zone. This evapotranspiration is represented in the model through a head dependent flux feature (using the depth-dependent Evapotranspiration (ET) package of Modflow).

The areas of specified ET within the model domain are shown in Figure 9.4 and the rate is specified at a maximum potential 300 mm per year, with no seasonality. This rate of ET is consistent with measurements at Weeli Wolli Spring during the EIA for Hope Downs and also with wider research on Eucalypt water use in arid Australia, that suggests that ET rates are constant throughout the year. The rate is also in line with BoM (2022).

The ET surface (the depth at which ET rates start to decline) is set 5 m below the topographic surface to represent tree water use at maximum rates when predicted water levels are within 5 m of ground surface. This represents direct water use by shallow rooting vegetation.

An ET extinction depth of 15 m below the ET surface (i.e. 20 m total depth) is specified to represent declining ET rates with depth such that the ET rate decreases to zero once predicted water levels are 20 m below the topographic surface. This represents progressively declining tree-water use as the depth to water increases and fewer trees have the rooting depth and matric potential to result in evapotranspiration.

9.2.5 Recharge

Direct rainfall recharge is applied to Coondewanna Flats, Weeli Wolli Spring, the Packsaddle Ridge, the area between R Deposit and Hope Downs and areas of outcropping orebody in the Jinidi areas. The majority of recharge to the catchment is applied to the Coondewanna Flats and Weeli Wolli Spring areas with much lower recharge rates applied to the Packsaddle and Jinidi areas (Figure 9.5). The recharge was required in the Packsaddle and Jinidi areas to simulate localised elevated groundwater levels in these areas.

Recharge is not applied to broad valley floors (e.g. between Hope Downs and Weeli Wolli Spring). Recharge is directed to lower layers whenever the upper layer cells become dry through a simulation (e.g. due to dewatering).

The original 2014 application of recharge to the model was based on the relationships described below. This was modified to account for the yearly stress periods used in this model (i.e. averaged).

2014 application of rainfall recharge (reproduced from RPS, 2015)

Groundwater recharge in the Packsaddle, Jinidi and Weeli Wolli areas within the model domain is applied seasonally. The wet season is approximated as the four-month period from January to April each year, with the dry season represented by the eight months between May and December. Recharge is applied during the wet season only. For the modelled wet season, recharge is applied according to the following zones at the following rates:

- 0.12% of total wet season rainfall is applied to the Packsaddle Hills, north of the Northern Flank Valley, to maintain elevated water levels across deposits P1 to P6.
- 0.06% of total wet season rainfall is applied to the areas of outcropping orebodies in the Jinidi area.
- No recharge is applied to the low hydraulic conductivity basement outcrop.

Recharge is also assigned to represent wet season recharge resulting from infiltration of surface water run-off which collects and flows down creek channels following heavy rainfall events. Recharge along Weeli Wolli Creek is applied at the following rates:

- For annual rainfall in excess of 100 mm per year but less than 350 mm per year, recharge is applied to Weeli Wolli Creek at a rate of 2% of excess rainfall above 100 mm per year (i.e. 250 mm rainfall results in (250 - 100) *0.02 = 3 mm per year recharge to the Weeli Wolli Creek recharge zone).
- For annual rainfall in excess of 350 mm per year, recharge is applied to Weeli Wolli Creek at a rate of 6% of excess rainfall above 100 mm per year (i.e. 400 mm rainfall gives (400 -100)*0.06 = 18 mm per year recharge to the Weeli Wolli Creek recharge zone).

For the Coondewanna Flats area, to simulate the episodic nature of recharge the following approach is used:

- Recharge is applied to the Coondewanna Flats area when recorded monthly rainfall exceeded a threshold value of 180 mm. This value was estimated from comparison of groundwater level monitoring in the Coondewanna Flats area and measured rainfall data.
- In addition to the monthly threshold, if there was rainfall in the preceding month, the threshold for the current month was reduced to 100 mm.
- Recharge to the Coondewanna Flats area is then calculated by multiplying rainfall above the threshold by a recharge factor (adjusted during calibration to 8% of rainfall) over the Coondewanna Flats catchment area. This recharge was then assumed to occur over a three-month period over the modelled Coondewanna Flats recharge zone.

9.2.6 Groundwater abstraction

BHP

Historical water supply abstraction from the MAC Rail Loop bores and dewatering from bores at A, C and E Deposits were modelled using the Modflow Well (WEL) Package (Figure 9.3).

Future abstraction from MAC and South Flank dewatering bores (Figure 9.6) was modelled using the Drain Package (DRN) with drain elevations set consistent with the target water levels over the life of the deposit (Figure 9.7 and Appendix A) and conductance values set very high to unconstrained inflows. The target water levels were based on the 2022 mine plan.

An updated (2024) “extended” target water level plan was also used and is shown in Figure 9.8 and Table 9.1. This assumes that several pits are dewatered for longer and deeper than the 2022 mine plan.

Table 9.1. Base case and extended base case target water level comparison

	Maximum depth		End date (end of year)	
	2022 mine plan	2024 (extended) mine plan	2022 mine plan	2024 (extended) mine plan
R Deposit	468	410	2040	2041
Highway 5	591	510	2040	2045
Vista Oriental 4A	600	546	2026	2036
Vista Oriental 5	612	546	2026	2036
Grand Central 2	612	534	2026	2036
Grand Central 4	585	570	2040	2043
E W Deposit	566	566	2036	2050

RTIO

Historical dewatering from RTIO’s Hope Downs was modelled using the Modflow Well (WEL) Package (Figure 9.3).

Future pumping from Hope Downs was simulated with the Well package. Abstraction rates were reduced slightly from the peak of 100 ML/d assumed between 2012 and 2017 (RPS, 2015). Between 2021 and the middle of 2024 they were set at 80 ML/d and then for the last half of 2024 at 72 ML/d. This was because as the dewatering progresses at Hope Downs the saturated thickness decreases significantly, and the model cannot sustain 100 ML/d for the full mine life.

9.2.7 BHP surplus dewatering management

Four existing BHP surplus water discharges within the groundwater catchment were included in the model (Figure 9.3):

- C West Pit Lake
- Sediment Pond
- A Deposit MAR
- Juna Downs MAR

Observations suggest that the infiltration from both the pit lake and sediment pond is very high, with little water lost to evaporation. Therefore, 100% of discharged water is simulated as direct recharge to the groundwater system. All were simulated using the Modflow Well Package.

The Juna Downs and South Flank MAR schemes were included in the predictive model, using the same methodology described above. The locations are shown in Figure 9.6 and the assigned rates were:

- 20 ML/d at Juna Downs for 20 years (from 2019). Actual rates were used in 2019 and 2020.
- 30 ML/d at South Flank for 20 years (from Oct 2021).

9.2.8 RTIO surplus management and mitigation

RTIO surplus water management and Weeli Wolli Spring mitigation is made up of (RPS, 2015):

- Discharge to Weeli Wolli Creek at 7 locations along the creek channel of 20 ML/d. This commenced in 2006 and is anticipated to continue for 20 years post mine closure (to 2045). This is simulated using the Modflow streamflow-routing package.
- Discharge of the remaining surplus water at a location roughly coincident (slightly downstream) with the Spring. This may be in excess of 50 ML/d but is not simulated in the model as it falls outside the model domain and plays no part in the hydrogeological system sustaining the Spring.
- Following Hope Downs closure, some of the production bores are to be repurposed as injection bores. This MAR scheme is anticipated to inject 20 ML/d and run for 20 years (until 2045). This is simulated using the Modflow Well Package.

9.2.9 Flow barriers

The model includes several low permeability features simulated by the Modflow Horizontal Flow Barrier (HFB) Package and their locations are shown in Figure 9.2. From west to east across the model domain these features are described below:

- The structure trending northwest to southeast through the centre of Coondewanna Flats is assigned a thickness (perpendicular to groundwater flow) of 1 m and a K of $1x10^{-4}$ m/d.
- At the western end of E Deposit there is a low K feature that extends northwest to southeast. The feature is assigned a thickness of 1 m and a K of $1x10^{-4}$ m/d.
- At the eastern end of E Deposit, a low K feature (known as Bruce Almighty) that extends northeast to southwest and to the south of the Coondewanna Flats area (and divides the South Flank Highway deposit in two. The feature is assigned a thickness of 1 m and a K' of $1x10^{-4}$ m/d close to E Deposit and $1x10^{-6}$ m/d south of E Deposit towards Coondewanna Flats.
- Between E and C Deposits there is a low K feature that extends northwest to southeast and to the south to R Deposit. The feature is assigned a thickness of 1 m and a variable K: $1x10^{-4}$ m/d close to E Deposit and $1x10^{-7}$ m/d south of E Deposit.
- At the eastern end of the South Flank Valley two low K features orientated from northwest to southeast. These features are assigned a thickness of 1 m and a K of $1x10^{-4}$ m/d.

9.2.10 Model layering

Although there are some local variations, the six-layer model is configured to use Layers 1 to 4 to represent the alluvium while Layers 5 and 6 represent the basement. Available geological mapping and exploration drilling information (Figure 3.3 and Figure 3.4) was used to establish the extent of the various units and the thickness of the alluvium. Where additional information is available from exploration drilling (e.g. around the BHP orebodies), Layers 4 and 5 are used to provide more detailed representation of the orebodies and West Angela Shale units.

9.2.11 Temporal discretisation

Four model versions are required for the history matching and predictive dewatering scenarios:

- A steady state model (no time component)
- A history matching model:

  - From 1st January 1998 to the 31st December 2020
  - 26 stress periods (yearly up to and including 2019 then quarterly for 2020)
- A predictive dewatering model:
  - From 1st January 2020 to the 31st December 2060
  - 88 stress periods (quarterly up to and including 2036, then yearly)
- A closure model:
  - Steady state to determine equilibrium levels
  - Time variant to determine rough time to reach equilibrium levels

The predictive dewatering model includes 20 years post BHP dewatering to allow consideration of mitigation and the recovery of Weeli Wolli Spring.

9.2.12 Pit voids (closure)

In the steady state closure model, evaporation from pit voids was simulated using drain cells with conductance values set at 10 m^2/d. This simplification was justified because:

- The model is too coarse to incorporate the various pit geometries accurately
- The simplification will give an indication of how important the voids might be in controlling regional groundwater levels at equilibrium

As more information becomes available, these simplifications can be modified.

9.3 History Matching

9.3.1 Introduction

Simulated groundwater levels were compared against two observation datasets (Figure 9.9):

- Predevelopment heads over the whole model extent derived from a mix of observed (monitoring bore) and extrapolated (from exploration drilling water strike observations).
- Time variant observations at 35 key monitoring bores from 1998 to the end of 2020.

Model parameters, boundary conditions and other settings were manually varied with the aim of reducing the difference between observed and simulated groundwater levels to a minimum. In addition to this, simulated base flow at Weeli Wolli Spring was compared to observed baseflow.

The model version that produced the best match to observed data is known as the base case.

During the history matching process, the following changes were made to the 2018 version of the model (BHP, 2019b):

- Updates to orebody aquifer geometries
  - Dead End orebody extended into layer 6 and connected to the Dolomite (layer 5 and 6)
  - Vista Oriental 2 extended into layer 6 and extended laterally to contact Submineralised Newman
  - Grand Central 2 layer 5 (orebody) deepened to 540 mRL from 555 mRL
  - Highway 1 extended to the north to incorporate bore SF2440RM
  - C Central orebody extended into layer 6
- Changes to parameter values / geometries / boundaries:
  - Hydraulic conductivity of unmineralised Marra Mamba increased from 0.0001 to 0.01 m/d

- Size of dolomite south of Highway 5 increased
- Specific yield of dolomite north of Coondewanna Flats increased from 1% to 10%
- Specific yield of dolomite in area of R, B and Hope Downs increased from 0.2% to 1.0%
- A portion of West Angela Shale swapped for dolomite in the C Central pit (north wall)
- Constant head boundary southwest of Coondewanna Flats reduced from 665 mRL to 660 mRL
- Constant head boundary directly north of Hope Downs removed
- West Angela Shale introduced to north of E East 3 orebody
- Continuous (thickness of a single model cell) orebody added to layer 6 beneath Packsaddle Deposits

- Changes to flow barriers (structures)
  - Structure added through Coondewanna Flats (layer 1 to 6)
  - Structure added through eastern end of South Flank between VO1 and VO4
  - Bruce Almighty structure (through Highway Deposit) extended to the northwest
  - Reduced hydraulic conductivity of structure to east of South Flank
- South Flank Valley area repaired. The hydrostratigraphy in two regions in South Flank (south of VO2 and south of GC6) were updated using exploration and hydrogeology drillholes, resulting in deepening of the Tertiary Detritals and dolomite within these valleys.
- Changes to Weeli Wolli Spring area:
  - Basement zone (99) extended from layers 5 and 6 to include layers 2 to 4
  - Bottom of layer 1 set at uniform 562 mRL (from 540 to 545 mRL previously)

Evapotranspiration around Weeli Wolli Spring reduced from 0.00082 m/d to 0.00052 m/d.

9.3.2 Base case parameter values

The base case hydraulic values are shown in Table 9.2 and Figures 9.10 to 9.15.

Table 9.2. Base case parameter values

Parameter / area	Hydraulic conductivity (K)	Specific yield (Sy)
Dolomite	50 to 60 m/d (North Flank Valley) 5 to 7 m/d (South Flank Valley) 10 to 60 m/d (Coondewanna Flats) 12 to 24 m/d (Hope Downs aquifer)	0.1 to 0.5% (North Flank Valley) 2% (South Flank Valley) 0.5% (Coondewanna Flats) 1% (Hope Downs aquifer)
Tertiary Detrital	1.5 to 5 m/d (North Flank Valley) 5 to 80 m/d (South Flank Valley) 5 to 29 m/d (Hope Downs aquifer)	5 to 11% (North Flank Valley) 0.5 to 10% (South Flank Valley) 5% (Hope Downs aquifer)
Orebodies	3 m/d (North Flank) 5 m/d (South Flank) 8 m/d (Hope Downs)	2 to 21% (North Flank) 2% (South Flank) 5% (Hope Downs)
Unmineralised Marra Mamba	1x 10^{-3} to 1x10^{-4} m/d	0.1%
West Angela Shale	0.1 to 0.001 m/d	0.1%
Mount McRae / Sylvia	1x10^{-3} m/d	0.1%
Calcrete	25 m/d	6%

Recharge values, which provide a significant control on the steady state heads, were also varied. The final calibrated values are shown in Table 9.3.

Table 9.3. Steady state recharge rates

Zone	Recharge (mm/d)	Proportion of long-term annual average (318 mm/yr)
Weeli Wolli Creek	31.1	9.8%
West Hope Downs	18.3	5.7%
Coondewanna Flats	14.6	4.6%
Packsaddle orebodies	0.4	0.1%
South Flank orebodies	0.4	0.1%
Jinidi orebodies	0.04	0.0%

9.3.3 Steady State (pre-development) results

The model provides a very good approximation of the pre-development heads. Given the size of the model domain, the uncertainty in some of the observed pre-development heads, the dynamic nature of the natural groundwater system and compared to the head change over the entire system (about 100 m), the errors are not considered significant.

A scatter plot of observed and simulated heads is shown in Figure 9.16. The simulated steady state head distribution is shown in Figure 9.17 and with residuals (i.e. the difference between observed and simulated) in Figure 9.18 and the simulated water balance is shown in Figure 9.19 and Table 9.4.

The calibration statistics for the base case model are:

- Scaled Root Mean Square (SRMS): 4.3%
- Range of head observations: 557.5 to 694.0 mAHD (136.5 m)
- Range of head residual (model error): -11.3 m to 19.2 m
- Average head residual: -1.8 m
- Root mean square head residual: 5.9 m

Table 9.4. Steady state water balance

Component	In (ML/d)	Out (ML/d)
Coondewanna recharge	2.3	-
Coondewanna area boundary inflows	3.2	-
Coondewanna area boundary outflows	-	0.9
Weeli Wolli Creek / Hope Downs aquifer systems recharge	2.1	-
Weeli Wolli Creek seepage	2.4	-
Ben's Oasis inflow	0.4	-
Weeli Wolli Creek baseflow	-	5.2
Weeli Wolli Spring deep throughflow	-	2.0
Evapotranspiration	-	2.4
Total flows	10.4	10.5
Water balance error	0.02%	
North Flank Valley throughflow	3.1 (67%)	
South Flank Valley throughflow	1.5 (33%)	

The water balance is consistent with the previous model version.

The result of these changes and recalibration is an improvement of the match between observed and simulated heads throughout the system. The largest consistent head residuals are found around A, C, B and R Deposits, where predicted heads are between 7 and 10 m too high. These errors will not adversely affect the predictive capability of the model in terms of the study objectives (i.e. long term dewatering rates and impacts). They may however present themselves as a spike in dewatering at the start of the predictive dewatering model as the model adjusts (as the predicted water levels will be roughly this amount higher than the target water levels at the start of that model (2021)).

9.3.4 Transient results (January 1998 to December 2020)

The predicted groundwater levels and water level change in December 2020 are shown in Figures 9.20 and 9.21. Hydrographs at all calibration locations are shown in Figures 9.22 to 9.25. Drawdown in the Weeli Wolli aquifer system is shown in Figure 9.26.

The Figures show that:

- By 2020 the bulk of the drawdown is confined to the north-eastern and eastern parts of the catchment (i.e., in North Flank and the Hope Downs aquifer compartment).
- That within aquifer compartments impacted by dewatering, drawdown is widespread.
- That drawdown is occurring within the Weeli Wolli Spring area.
- That the flow barrier between E West and E Central deposits reduces the migration of drawdown significantly into the Coondewanna Flats aquifer compartment.
- The large area of impact from Hope Downs dewatering.
- The effect of the flow barriers (i.e. the step changes in head across them) is replicated.

The hydrographs show that:

- Throughout North Flank (Figure 9.22) the observed hydrographs are replicated well. In more detail:
    - The steady state heads are a little high in A and C Deposits, but accurate in all other areas.
    - Drawdown gradients are replicated well in most areas and especially at A Deposit.
    - The worst match between observed and simulated response is at E Central Deposit. The observed drawdown in the regional dolomite north of E Central Deposit is underpredicted and the gradient in the E Central orebody is not replicated well.
- In the eastern side of the Coondewanna Flats aquifer compartment (Figure 9.23) the observed heads are replicated well. The response to Juna Downs MAR is best replicated in the bores south of Juna Downs (GWB0039M). To the north the model tends to underpredict mounding (HPSA0010M).
- In the area between A Deposit and Hope Downs (Figure 9.24) both initial conditions and the response to dewatering is replicated very well by the model. Only at HEPX0003M (in the north towards Packsaddle) do the simulated and observed heads diverge significantly. This is unlikely to be important in terms of the model objectives.
- In the area of Hope Downs and Weeli Wolli Spring and south towards Ben's Oasis (Figure 9.25) the water levels and responses are replicated very well by the model. This area includes a large variation in observed drawdown, from a maximum next to Hope Downs of almost 100 m to a minimum next to the spring of about 2.5 m. The model reproduces these ranges accurately.

Drawdown in the Weeli Wolli Spring aquifer system is simulated very accurately by the model (Figure 9.26). This is true from GWB0015M at the southwestern part of Weeli Wolli area (on Figure 9.26), close to Hope Downs to just downstream of the Spring itself (GWB0018M).

9.3.5 History match summary

The history match key indicators show that the model is closely aligned to the observed system in almost all areas within the model domain. This includes both the initial conditions (the steady state model) and the transient conditions.

The model therefore replicates the main aspects of the CPH groundwater system, which includes:

- High levels of drawdown (up to 100 m) close to dewatering activities
- Draw-up associated with Juna Downs and A Deposit MAR and groundwater discharge to other locations
- Step changes in head (of tens of metres) across numerous flow barriers
- Discharge of groundwater to Weeli Wolli Creek

- A head change of 138 m, from a high of 695 mRL in the west to 557 mRL by Weeli Wolli Spring.

In terms of the key impact predictions:

- In the area around Weeli Wolli Spring, the model replicates the observed system very well. This is very positive given the mix of stresses in this location (dewatering and creek discharge) and the high range of observed drawdown.
- In the area of Coondewanna Flats, the long-term drawdown trends (emanating from North Flank dewatering) are replicated very well. The replication of the response to Juna Downs MAR is inconsistent however, with the draw-up under predicted in several places. As MAR continues into the future, this will be an area where work to improve the history matching can focus.
- Ben's Oasis is not included in the model, but the area between Ben's Oasis and South Flank and Hope Downs is. The water level response within this area is replicated accurately. This includes the step change in head across the dyke to the east of South Flank (and the lack of drawdown on the South Flank side) and the drawdown migrating from Hope Downs to the south.

9.4 Sensitivity / Uncertainty

9.4.1 Sensitivity analysis

A sensitivity analysis was undertaken on hydraulic parameters and settings that are likely to be significant in terms of determining the dewatering rates and the migration of drawdown from the mining areas into the regional aquifers. These were:

- Regional aquifer (dolomite and Tertiary Detritals) hydraulic conductivity
- Regional aquifer (dolomite and Tertiary Detritals) specific yield
- Orebody specific yield
- The hydraulic conductivity of some of the shales between the orebodies and regional aquifers
- The hydraulic conductivity of the hydraulic flow barriers

In the case of hydraulic conductivity, both horizontal and vertical values were varied.

A total of 243 models were run to achieve this. In each, a single model parameter was varied to test its influence on the simulated groundwater levels. For example, the hydraulic conductivity of the dolomite to the north of B and R Deposits was tested for the following values:

- Base case: Kh = 24 m/d, Kv = 7 m/d
- Sensitivity 1: Kh = 5 m/d, Kv = 1 m/d
- Sensitivity 2: Kh = 10 m/d, Kv = 3 m/d
- Sensitivity 3: Kh = 15 m/d, Kv = 5 m/d
- Sensitivity 4: Kh = 30 m/d, Kv = 9 m/d
- Sensitivity 5: Kh = 40 m/d, Kv = 12 m/d
- Sensitivity 6: Kh = 50 m/d, Kv = 15 m/d

A list of all the changes is provided in Appendix B.

The predicted water levels were then compared against observed at the key history matching bores to judge the outcomes. The analysis was focussed on finding insensitive parameters that could be used to determine the uncertainty of predictions of impacts and dewatering rates. If the match between observed and simulated

groundwater levels was sensitive to the change (in other words significantly reducing the “goodness of fit”) then the parameter value was considered unrealistic and not used to test predictive uncertainty. If the change had little effect on the match, then it was used in the predictive uncertainty analysis. Other reasons for not including in the predictive uncertainty analysis were instability (i.e., the model not running to the end) and a significant increase in the water balance error (Table 9.5).

Table 9.5. Sensitivity runs

Parameter type	Total runs	Unstable	Poor calibration	Significant water balance error	Insensitive
Regional aquifer hydraulic conductivity	97	19	3	4	71
Regional aquifer specific yield	84	13	0	3	68
Orebody specific yield	26	7	0	3	16
The hydraulic conductivity of some of non-aquifer material between the orebodies and regional aquifers	13	1	0	0	12
The hydraulic conductivity of the hydraulic barriers	23	3	0	0	20
Total	243	43	3	10	187

Of the 243 runs, 56 were discarded and 187 were found to be suitable for use in the predictive uncertainty analysis.

The results of the 187 suitable runs at the key receptor monitoring bores GWB0018M (Weeli Wolli Spring) and GWB0039M (Coondewanna Flats) are shown in Figure 9.27. The results show that the “insensitive” runs show little variation around the base case at the key receptor bores. In fact, at GWB0018M, only 5 of the 187 runs fall obviously outside of the main group.

9.4.2 Predictive uncertainty analysis

The predictive uncertainty analysis makes use of the sensitivity analysis described above, and the uncertainty in mine plans (and therefore target water levels). The mine plan was updated after the sensitivity analysis had been conducted. However, the sensitivity analysis demonstrated which parameter combinations result in the greatest dewatering / drawdown (i.e. the “worst case”). The 2024 extended target water levels were therefore run with the base case (i.e. the best estimate) and the worst case parameter values. Therefore the worst case bookend of outcomes, as well as the best estimate, were captured with the 2024 extended mine plan.

Dewatering predictions from the 187 sensitivity models, based on the 2022 mine plan, are shown in Figure 9.28. The base case and worst case models with the 2024 extended mine plan are shown in Figure 9.29.

The results show that:

- With the base case (best estimate) hydraulic parameters, the maximum dewatering rate peaks at 180 ML/d, regardless of which mine plan is used.
- With the worst case hydraulic parameters, the maximum dewatering rate peaks at 208 ML/d with the 2022 mine plan and 215 ML/d with the 2024 extended mine plan.
- The range in maximum dewatering rate, based on all model runs, is between 142 ML/d and 215 ML/d.
- The 2024 extended mine plan does not materially change the maximum dewatering rate, but it does result in significantly greater total volume abstracted, particularly from 2037 onwards.

The base case predicted drawdown in the Weeli Wolli Spring area is shown in Figure 9.30. The uncertainty in drawdown upstream from the Spring at GWB0018M is shown in Figure 9.31. These figures show that, at GWB0018M:

- From 2024 to 2045 (i.e. whilst RTIO are mitigating their impacts), drawdown maximums range from 2.4 to 5.6 m. However, most uncertainty runs predicted maximums during this period of between 3.2 and 3.4 m.

- Once RTIO mitigation finishes (i.e. in 2045) drawdown at GWB0018M is predicted to increase rapidly to between 11.4 and 13.4 m.
- The variation between the two mine plans has little impact on the predicted drawdown at Weeli Wolli Spring.

The predicted drawdown in the Coondewanna Flats area (GWB0039M) is shown in Figure 9.32. This shows that:

- Drawup in response to Juna Downs MAR is predicted to dominate until 2028 when water levels first fall below pre-development values.
- Uncertainty in predicted drawdown is very high. This uncertainty is associated with both hydraulic parameters and the mine plan. At GWB0039M, with the:
    - 2022 mine plan, the maximum drawdown ranges between 23 and 52 m and occurs between 2040 and 2043 depending on the model. The base case model results in a maximum of 33 m drawdown.
    - 2024 mine plan, the maximum drawdown reaches 64 m in the base case model and occurs between 2048 and 2050. In the worst case model, the maximum drawdown reaches 98 m.

The predicted drawdown north-east of the Ben's Oasis area (HDD0004M) is shown in Figure 9.33. This shows that:

- There is a wide range of predicted maximum drawdown at HDD0004M (13 to 21 m) and the year in which it happens (2045 to 2060)
- The 2022 and 2024 extended mine plans result in the same drawdown at HDD0004M (e.g. both predict a maximum of 16 m in 2060).

The following contour plots are provided, all from models with the 2024 extended mine plan:

- Base case groundwater level contours in 2050 (Figure 9.34)
- Base case and worst case water level change contours in 2050 (Figures 9.35 and 9.36)
- Base case and worst case 1 m water level change contour in 2050 (Figure 9.37)
- Base case and worst case water level change contours in 2050 in the Weeli Wolli Spring area (Figures 9.38 and 9.39)
- Base case and worst case water level change contours in 2050 in the Coondewanna Flats area (Figures 9.40 and 9.41)

These show that in 2050:

- Drawdown is extensive throughout the model domain.
- There is very little difference in the extent of the 1 m drawdown contour between the base case and worst case scenarios.
- The difference between the base case and worst case scenarios is almost exclusively in the Coondewanna Flats aquifer compartment.
- Drawdown is highest around the dewatering operations, particularly those that are active in the 2040's.
- The groundwater level in the Weeli Wolli Spring area is higher at this time than the levels to the south in the main Hope Downs aquifer system.
- Drawdown beneath Coondewanna Flats is not uniform. In both the base and worst cases, the greatest drawdown is in the southeast corner, adjacent to the South Flank Highway 5 deposit.

9.4.3 Third party impacts

The groundwater level change predictions referred to in the preceding section are cumulative, arising from dewatering at both BHP and RTIO mines.

In order to separate the proportion of drawdown attributable to each operator, the base case model (2022 mine plan) was run with no BHP dewatering or MAR. However, RTIOs Hope Downs dewatering, creek discharge and MAR was included. The difference in drawdown between this run and the run that includes BHP dewatering and MAR indicates the relative proportion of impacts from each operator. The results are shown in (Figure 9.42) and suggest that:

- 100% of the impacts at Coondewanna Flats are from BHP activities
- Almost all the impacts at Weeli Wolli Spring are from RTIO dewatering until 2045. From then on, the proportion of impacts from BHP increases. By 2060, of the 12.7 m of drawdown predicted in the base case, 9.2 m (72%) is associated with RTIO and 3.5 m (28%) with BHP activities. This is after the RTIO closure mitigation has been applied
- At HDD0004M, just east of the dyke separating Ben's Oasis from the Hope Downs groundwater compartment, by 2060, of the 16.3 m of drawdown predicted in the base case, 13.2 m (81%) is associated with RTIO and 3.1 m (19%) with BHP activities.

9.4.4 Conclusions

The uncertainty analysis shows that to achieve the base case target water levels, dewatering of up to 215 ML/d may be required. Almost all of this uncertainty is associated with the South Flank orebodies and the MAC EW and Dead End deposits. The base case (i.e. best estimate) model peaks at 180 ML/d with both the 2022 and 2024 extended mine plans.

BHP will request a license limit increase to 180 ML/d rather than the predicted maximum of 215 ML/d. However, in terms of the uncertainty associated with predicted drawdown around Weeli Wolli Spring, Ben's Oasis and Coondewanna Flats, the full suite of outcomes should be assessed (even though many produce dewatering maximums above the requested 180 ML/d). In other words, with dewatering capped at 180 ML/d it is possible that the following impacts occur:

- Drawdown between 11.4 and 13.4 m just upstream of Weeli Wolli Spring. This is a cumulative impact from a partially mitigated RTIO contribution (Hope Downs 1) and an unmitigated BHP contribution.
- Up to 100 m drawdown in the northern part of Coondewanna Flats and between 110 and 120 m in the southeast (adjacent to South Flank Highway 5 deposit). The uncertainty at Coondewanna Flats is much greater than the other areas, due both to hydraulic parameter and mine plan uncertainties.
- Drawdown of between 13 to 21 m adjacent to Ben's Oasis but on the downstream (Hope Downs aquifer compartment) side of the dyke.

9.5 Closure

9.5.1 Weeli Wolli Spring mitigation

The model described above assumed the following in terms of the prediction of post closure water management to alleviate impacts on Weeli Wolli Spring for both BHP and RTIO:

- no direct mitigation from BHP and

- direct mitigation by RTIO following their publicly available strategy: 20 ML/d MAR adjacent to the Hope Downs orebody and 20 ML/d continued creek discharge, both for 20 years post closure (i.e. from 2025 until 2045).

These assumptions do not result in the Spring returning to pre-development conditions within a suitable timeframe (i.e. it will take centuries) so additional modelling was undertaken to investigate what might be required to achieve this. In this case, "return to pre-development conditions" means both predicted Spring baseflow and groundwater levels in the Weeli Wolli Spring aquifer compartment (GWB0018M) and the Hope Downs aquifer compartment (GWB0015M) returning to the predicted level when the model assumes no anthropogenic water management activities in the catchment (i.e. a no development, predictive scenario).

Other pertinent aspects of the modelling include:

- Numerous iterations were required of both RTIO and BHP activities to reach the desired outcomes
- Several distinct model runs were required to differentiate then mitigate RTIO and BHP impacts at the Spring. They were:
    - A no development scenario (no anthropogenic water management activities in the catchment at all)
    - A RTIO only scenario, with mitigation as per the publicly available strategy
    - A RTIO only scenario, with mitigation modified to achieve return to pre-development conditions at the Spring ("the fully mitigated RTIO case")
    - The fully mitigated RTIO case, with BHP dewatering without mitigation. This defines the BHP component of the impacts at Weeli Wolli Spring
    - The fully mitigated RTIO case, with BHP dewatering and mitigation. This defines the BHP mitigation requirements.
- As numerous iterations were required, this investigation was undertaken only with the base case model. As all sensitivity / uncertainty runs would require slightly different configurations of mitigation to achieve the desired outcomes.
- BHP mitigation took the form of MAR into the B and R Deposit aquifers. There are several other options available however, but this scenario provides a worst case in terms of required volumes.
- The scenario assumes that Hope Downs closes in 2025 and that mitigation occurs during a 20-year time frame from that moment.

The results are provided in Figures 9.43 and 9.44. These show that, for the base case model, the following is required:

- To fully mitigate the Hope Downs impacts at Weeli Wolli Spring:
    - Increase the rate of Creek Discharge from 20 to 28 ML/d (an increase of 8 ML/d) for the full 20 years (from the previous assumption of 20 ML/d). This equates to a total volume of 204 GL (and does not include the discharge undertaken up to the year 2021).
    - Increase the rate of MAR from 20 to 55 ML/d (an increase of 35 ML/d) for the full 20 years (from the previous assumption of 20 ML/d). This equates to a total volume of 401 GL.
- To fully mitigate the BHP impacts at Weeli Wolli Spring:
    - Inject 40 ML/d into B Deposit and 40 ML/d into R Deposit (i.e. 80 ML/d in total) from 2041 (when dewatering ceases) to 2045. This equates to a total volume of 146 GL.
    - Then, inject 12 ML/d into B Deposit and 12 ML/d into R Deposit from 2046 to 2051 (i.e. a total of 24 ML/d). This equates to a total volume of 53 GL.

These strategies are predicted to return both the Hope Downs and Weeli Wolli Spring aquifer compartments to pre-development levels and therefore return the function of the Spring to pre-development conditions too. Pre-

development conditions at both the Hope Downs and Weeli Wolli Spring are predicted to occur about 20 years after dewatering at R and B Deposits finish.

The change to RTIO's mitigation strategy has a knock-on effect on the dewatering requirements at R and B Deposits, which both increase due to the effects of recirculation of RTIO's MAR water. This is shown in Figure 9.45 and summarised below:

- The peak dewatering at R Deposit increases from about 18 ML/d to almost 30 ML/d.
- The peak dewatering at B Deposit increases from about 6 ML/d to 10 ML/d.

Returning the Hope Downs aquifer compartment groundwater levels to pre-development levels should also have the effect of mitigating any potential impacts in the area of Ben's Oasis. As the Hope Downs aquifer compartment is thought to extend all the way to the dyke behind which (to the south) Ben's Oasis is situated, the MAR at Hope Downs and at R and B Deposits results in water levels in this area returning to pre-development conditions by 2060.

9.5.2 Backfill options

The long-term implications of backfill options for the CPH pit voids was investigated using the base case model. Two scenarios were considered:

- All pits backfilled above pre-development water table elevation
- All pits backfilled as above apart from those in Vista Oriental and Grand Central which receive no backfill.

The steady state model was used for this purpose. Evaporation from the pit voids was simulated using drain cells set at the base elevation of each pit and with a low conductance value of 10 m^2/d. This represents a significant simplification of the processes that will occur once water levels start to recover (i.e., the interplay between inflow, evaporation rate and evaporation surface) but given the major uncertainties with all aspects of simulating the groundwater system post closure (i.e., associated with these inputs over the period of centuries) this is considered appropriate at this stage.

Also, as the E East 3/E Central dyke has been mined out, the models were run with this feature removed.

The results are shown in Figures 9.46 and 9.47. These show that:

- Backfilling all pit voids (along with mitigation) should result in water levels returning to a non-disturbed state in the area of Weeli Wolli Spring. In the areas of North Flank, South Flank and Coondewanna Flats, the removal of the dyke may have some impacts. In more detail:
    - Increasing the heads by:
        - Roughly 4 m in the E East 3 compartment
        - Between 1.0 m and 2.5 m in the C/A Department
        - Between 0.1 m and 0.0 m in the Weeli Wolli Spring area. However, this is likely beyond the level of accuracy the model (numerical and conceptual) is capable of.
    - Decreasing the heads by:
        - Between 5 m and 8 m in the E Central compartment
        - Between 3 m and 4 m in the area of Coondewanna Flats
        - By about 4 m in the South Flank compartment.
- Leaving pit voids at the Grand Central and Vista Oriental pits is predicted to cause a permanent reduction in heads throughout the catchment, driven in this scenario mostly by the depths of the GC2, VO1, VO4a and VO6 pit voids. In more detail, the modelling suggests that water levels are permanently drawn down:
    - in the South Flank Valley aquifers by between 40 and 50 m

- in the Coondewanna Flats compartment by 5 and 10 m
- in the North Flank Valley aquifers:
  - between 5 and 10 m in E West and E Central
  - less than 1 m in C and A Deposits
- in the Hope Downs aquifers between 1 and 2.5 m
- in the Weeli Wolli Spring area by less than 0.25 m

Simulations with the backfilled pit scenario using the time variant model suggest that full recovery of the system (whatever the backfill scenario) will take several hundreds of years. Given the high uncertainty in many factors underpinning this prediction over this time scale (climate most importantly) any more detail in these predictions at this time would be misleading.

Time for full recovery will depend on the mitigation strategy and on climatic conditions (rainfall and evaporation). With the BHP and RTIO MAR and creek discharge simulated with the mitigation model, recovery will be rapid in the area of Weeli Wolli Spring and the Hope Downs aquifer compartment (i.e. full recovery by 2060). In the other areas of the CPH catchment however, with the assumption that no mitigation will occur in here, recovery will be much slower. The uncertainties are too great to define this to any degree of accuracy at this stage, but it is clear that the recovery in the Coondewanna Flats, North Flank and South Flank compartments will be measured in centuries.

10 Assessment of Potential Impacts

10.1 Introduction

Numerical groundwater modelling has been used to estimate the dewatering volumes required to enable the CPH mine plan and the extent of associated drawdown. The model provides a reasonable reproduction of historical groundwater levels within the catchment. Where uncertainty remains, the model was intended to provide a conservative approach to estimating dewatering rates and groundwater level change.

Similar to the previously approved models, Coondewanna Flats and Weeli Wolli Spring are within the model domain and groundwater level change predictions are therefore generated at these locations. Ben's Oasis however is situated outside the model boundary. As the Ben's Oasis spring is fed from an upstream groundwater compartment, in which there is no active groundwater dewatering and very little hydrogeological knowledge (i.e. very high uncertainty), there is no justification for including it in the model domain.

The transient history match at key locations (shown in Figures 9.20 to 9.25) confirms that the model provides an appropriate approximation of the pre-development heads (steady state) and the transient groundwater levels. Any divergences are not considered significant to the model objectives. The model therefore replicates the main aspects of the CPH groundwater system, which includes:

- High levels of drawdown (up to 100 m) close to dewatering activities
- Draw-up associated with Juna Downs and A Deposit MAR and groundwater discharge to other locations
- Step changes in head (of tens of metres) across numerous flow barriers
- Discharge of groundwater to Weeli Wolli Creek
- A natural groundwater level gradient of 138 m, from a high of 695 mRL in the west (Coondewanna Flats) to 557 mRL in the east (Weeli Wolli Spring).

In terms of the key receptor impact predictions:

- In the area around Weeli Wolli Spring, the model replicates the observed system accurately. This is very positive given the mix of stresses in this location (dewatering and creek discharge) and the high range of observed drawdown.
- In the area of Coondewanna Flats, the long-term drawdown trends (emanating from North Flank dewatering) are replicated accurately. The replication of the response to Juna Downs MAR is inconsistent however, with the draw-up under predicted in several places. As MAR continues, this will be an area where work to improve the history matching can focus.
- Ben's Oasis is not included in the model, but the area between Ben's Oasis and South Flank and Hope Downs is. The water level response within this area is replicated accurately. This includes the step change in head across the dyke to the east of South Flank (and the lack of drawdown on the South Flank side) and the drawdown migrating from Hope Downs to the south and adjacent to the Ben's Oasis dyke.

A predictive uncertainty analysis was undertaken on the key hydraulic parameters and settings influencing the dewatering rates and the drawdown extent from the mining areas into the regional aquifers.

In addition to this, an alternative ("extended") target dewatering scenario was tested, which included greater depths and length of dewatering at various pits. The results from all these models have been considered when assessing the potential impacts of dewatering.

A steady state closure model considering evaporation from pit voids was simulated using drain cells with conductance values set at 10 m^2/d to provide an estimate of the importance voids would play in controlling regional groundwater levels post closure.

The below section further develops the anticipated groundwater change in respect to key environmental receptors in the catchment, based on the predictions described in Section 9.

It should be noted that the predicted cumulative drawdown resulting from CPH and RTIO (Hope Downs) is reliant on publicly available RTIO data (RPS, 2015) and that this may not represent the most up to date RTIO plans.

10.2 Environmental Receptors

10.2.1 Weeli Wolli Spring

The predicted drawdown at Weeli Wolli Spring resulting from CPH and RTIO (Hope Downs) mine dewatering operations is shown in Figure 9.30 and the uncertainty in Figure 9.31. These show that (at GWB0018M):

- The range in maximum predicted drawdown during active RTIO mitigation and BHP dewatering (i.e. up to 2045) is between 2.4 and 5.6 m.
- The range in maximum predicted drawdown post 2045 is between 11.4 and 13.4 m.

Based on the current understanding of the ecology of the system, the predicted level of post 2045 drawdown will have an impact on the groundwater dependent ecosystem at Weeli Wolli Spring and may cause a reduction in the extent of the PEC.

Drawdown mitigation measures to prevent the post 2045 impacts at Weeli Wolli Spring are discussed in Section 9.5.1 and presented in Figures 9.43 and 9.44. These predictions show that the following may be required:

- To fully mitigate the Hope Downs impacts at Weeli Wolli Spring:
    - Increase the rate of Weeli Wolli Creek discharge from 20 to 28 ML/d (increase by 8 ML/d) for the full 20 years post mine closure (to 2045). This equates to a total volume of 204 GL (and does not include the discharge undertaken up to the year 2021.
    - Following Hope Downs closure (2025), some of the production bores are to be repurposed for MAR, the rate of MAR is required to increase from 20 to 55 ML/d (increase by 35 ML/d) for the full 20 years (until 2045). This equates to a total volume of 401 GL.
    - As this is a RTIO operation, this estimate should be informed by more recent RTIO data, updated conceptualisation and closure planning; BHP would not supplement this operation.
- To fully mitigate the BHP impacts at Weeli Wolli Spring:
    - Inject 40 ML/d into B Deposit and 40 ML/d into R Deposit (i.e. 80 ML/d in total) from 2041 (when dewatering ceases) to 2045. This equates to a total volume of 146 GL.
    - Then, inject 12 ML/d into B Deposit and 12 ML/d into R Deposit from 2046 to 2051 (i.e. a total of 24 ML/d). This equates to a total volume of 53 GL.

These strategies are predicted to return both the Hope Downs and Weeli Wolli Spring aquifer compartments to pre-development levels and therefore also return the function of the spring to pre-development conditions. With these strategies, this is achieved about 20 years after dewatering at R and B Deposits finish. Returning the Hope Downs aquifer compartment groundwater levels to pre-development conditions should also have the effect of mitigating any potential impacts in the area of Ben's Oasis as the Hope Downs aquifer compartment is thought to extend all the way to the dyke behind which (to the southwest) Ben's Oasis is situated. The MAR at Hope Downs and at R and B Deposits results in water levels in this area returning to pre-development conditions by 2060.

In addition to aquifer recharge, discharge at the spring is likely to be required to maintain water availability at surface until spring function returns. The timing, location and management of the mitigation strategy is yet to be determined.

Predictive modelling shows that BHP and RTIO MAR and creek discharge is an effective mitigation strategy, with recovery to pre-development conditions in the area of Weeli Wolli Spring and Hope Downs aquifer by 2060.

It is worth nothing that, due to uncertainties with the CPH mine plan over the life of the asset and the publicly available RTIO data combined with a potential extension of the RTIO Hope Downs mine life, the timing, location and method of mitigation discussed in Section 9.5.1 are uncertain and will be the subject of further studies.

10.2.2 Coondewanna Flats

The extent of drawdown resulting from the dewatering activities at MAC and South Flank toward Coondewanna Flats is shown in Figures 9.32, 9.40 and 9.41. The Model shows that a draw up of up to 5 m in response to Juna Downs MAR is predicted to occur until 2028. Drawdown predictions in the area of the flats are uncertain due to both hydraulic parameter and mine plan uncertainty. In all the scenarios tested, the maximum drawdown in the northern part of the Flats ranged from approximately 23 m to 98 m. In the southeastern part of the Flats, maximum drawdown was between 110 and 120 m.

The depth to water beneath Coondewanna Flats is typically between 20 to 30 mbgl. It is an internally draining alluvial plain and wetland feature which is the terminus for surface water flow from the west of the catchment. The Flats support a Priority Ecological Community (PEC) of woodland and forest. The significant depth to water (>20 m) at the Flats makes it unlikely that this is a groundwater dependent receptor and vegetation communities are more likely to be dependent on the surface water regime in the area (AQ2 2016).

10.2.3 Ben's Oasis

As discussed in Section 9.2.3, the regional dyke is believed to act as a flow barrier and there is currently no unequivocal evidence that drawdown has occurred at Ben's Oasis in response to Hope Downs dewatering. However, this is based on relatively short-term monitoring and the situation may change as drawdown continues to increase on the Hope Downs side of the dyke and more data is collected. Continued monitoring of groundwater levels at the monitoring bores in the area will help reduce this uncertainty with time.

The modelling has shown that the drawdown just to the northeast of Ben's Oasis, in the Hope Downs aquifer compartment, is likely to reach a maximum of between 13 and 21 m (Figure 9.33).

10.3 Third party groundwater users

The Rio Tinto Hope Downs water supply borefield is the only third party borefield in the drawdown footprint.

The impact of BHP dewatering on these bores is uncertain, given that:

- the groundwater level at these bores would have already been, and will continue to be, significantly reduced due to dewatering of Hope Downs, and
- mitigation (MAR) at Hope Downs may be active when BHP are dewatering R and B Deposits, thereby resulting in a gradient between the MAR and dewatering locations. The exact nature of this gradient will not be known until the MAR details are known.

BHP dewatering is not expected to have a significant additional impact on top of the current and future Hope Downs drawdown.

11 Groundwater Monitoring

The *Central Pilbara Water Resource Management Plan (CPWRMP)* (2021) has been developed by BHP and accepted by DWER and includes nominated groundwater monitoring to meet Condition 6 of MS1072. The *CPWRMP* objective is to protect the environmental receptors identified in Section 3.3 (Coondewanna Flats, Weeli Wolli Springs, and Ben's Oasis). The plan details key environmental receptors, monitoring, triggers, thresholds, and response actions for hydrological changes that may occur at these receptors. This document will be revised considering the additional increase of mine dewatering to 65.7 GL/yr (180 ML/d) and impacts from dewatering at R Deposit, however the groundwater monitoring program is likely to be sufficient and is not expected to significantly change.

The *Groundwater Operating Strategy* (GWOS) (BHP, 2022) has been developed by BHP and accepted by DWER for the management of groundwater at MAC and South Flank to meet 5C licence GWL110044(13) and GWL166389(10) licence conditions. The GWOS describes the conditions for managing groundwater abstraction and management of potential groundwater related impacts. The monitoring program in the GWOS uses a source-pathway-receptor approach to capture appropriate water data within the mining operations, along potential impact pathways and at receptors. The GWOS will be revised considering the additional increase of mine dewatering to 65.7 GL/yr (180 ML/d).

12 Management Approach

BHP operates under the Pilbara Water Resource Management Strategy (BHP, 2021) which is a regional water management strategy that considers the hydrogeological changes resulting from BHP mining in the Pilbara, the receiving receptors (water resources, environment, social and third-party operations), the potential impacts and the required risk-based adaptive management to mitigate potential impacts to an acceptable level. The objective is to enable sustainable water resource management for below water table mining operations and operations which intercept surface water and groundwater flows by setting outcome-based conditions and adaptive management techniques to mitigate and offset operational effects on water levels and quality through 1) preferentially returning surplus dewater to the aquifer and 2) maintaining baseline hydrological conditions at the key environmental receptors.

The Pilbara Water Resource Management Strategy is underpinned by regional water plans. Specifically, for the management of the potential impacts and changes to hydrological conditions resulting from BHP activities in the CPH region the following have been developed by BHP and approved by DWER to manage potential impacts and legal obligations:

- *CPWRMP* (BHP, 2021) – to be updated by BHP and approved by DWER; and
- *MAC and South Flank GWOS* (BHP, 2023) – to be updated by BHP and approved by DWER.

Predictive modelling shows BHP and RTIO MAR and creek discharge is a feasible and effective mitigation strategy. A modelled mitigation scenario was able to achieve recovery to pre-development conditions in the area of Weeli Wolli Spring and the Hope Downs aquifer by 2060. The mitigation measures applied were used to demonstrate an effective mitigation approach and to provide an indication of the volume of water required. Local irrigation and discharge have been demonstrated to be effective management approaches at Weeli Wolli Spring to maintain groundwater levels and ecosystem health (EPA, 2018). Additional requirements for BHP to supplement water to sustain ecosystem health at Weeli Wolli Spring will be determined in the future. However, it is considered unlikely that supplementation will be required whilst mine dewatering continues at Hope Downs and supplementation by RTIO is occurring at Weeli Wooli Spring.

The mitigation approach implemented could be undertaken through number of different methods such as by injection of dewatering surplus or enhanced recharge using dedicated basins, small dams or open pits to capture, impound and infiltrate surface water.

Potential impacts to the groundwater resource and identified key groundwater dependent receptors will be managed through the *CPWRMP*. The management plan forms an adaptive, risk-based management approach designed to proactively counteract, mitigate, and manage the potential impacts (both predicted and actual) to an acceptable ecohydrological level. The *CPWRMP* has been reviewed and updated in parallel with the preparation of this report and includes the management of the potential impacts from the increase in the dewatering limit and dewatering at R Deposit.

BHP will continue to collect and review data in accordance with the monitoring plans (Section 11) and assess whether the data measured with continued dewatering operations is in line with the groundwater model predictions. BHP will work with DWER and/or RTIO to review groundwater modelling outcomes in line with data made available by RTIO.

BHP will work towards the development of an adaptive management strategy that aims to avoid or mitigate the cumulative and detrimental impacts to the groundwater regime at Weeli Wolli Spring and the catchment area. At this stage modelling and conceptualisation indicate that only mitigation at Weeli Wolli Springs is required, however BHP will continue to monitor water levels at Ben's Oasis and Coondewanna Flats and update the management approach should the data differ from these predictions and indicate a need to do so.

13 Conclusions

This document has provided information about the existing environment and assessment of the potential impacts on the aquifer, environment and surrounding users resulting from the increase in mine dewatering to 65.7 GL/yr (180 ML/d) required for continued below water table mining at CPH.

A H3 hydrogeological assessment has been carried out in accordance with the DWER (2019) Operational Policy No 5.12 Hydrogeological reporting associated with a groundwater well licence to inform approvals under EP Act Part IV (MS1072), EP Act Part V (LV851/2002/6) and RIWI Act (5C Licences). The assessment builds on previous regulatory approved hydrogeological assessments and modelling completed in the CPH (BHP, 2019 [MAC] and BHP, 2016 [South Flank]) and consists of an updated description of the conceptual hydrogeological model which informed the basis of the numerical groundwater model development.

Numerical groundwater modelling has been used to estimate the dewatering volumes required to enable the mine plan and the extent of associated drawdown. The model provides a reasonable reproduction of historical groundwater levels within the catchment. Where uncertainty remains, the model was intended to provide a conservative approach to estimating dewatering rates and groundwater level change.

The model generally matches the pre-development (steady state) and transient groundwater levels. The model therefore replicates the main aspects of the CPH groundwater system.

It should be noted that the cumulative predicted drawdown resulting from CPH and RTIO (Hope Downs) are reliant on publicly available RTIO data (RPS, 2015) and that this may not represent the most up to date RTIO plans.

Predicted impacts to receptors are:

- **Weeli Wolli Spring**
    - The range in maximum predicted drawdown during active RTIO mitigation and BHP dewatering (i.e. up to 2045) is between 2.4 and 5.6 m (at bore GWB0018M, just downstream from the Spring). The range in maximum predicted drawdown post 2045 increases to between 11.4 and 13.4 m.
    - Based on current understanding of the ecology of the system, this level of drawdown post 2045 may have an impact on the groundwater dependent ecosystem at Weeli Wolli Spring and may cause a reduction in the extent of the PEC. The model shows that the cumulative impacts from Hope Downs and BHP at Weeli Wolli Spring can be mitigated with MAR and creek discharge. The approach is further discussed in Section 9.5.1.
- **Coondewanna Flats:**
    - Once dewatering at EW and Dead End deposits in North Flank, and Highway 1 and 5 deposits in South Flank get underway, drawdown is likely to reach a maximum of between 23 and 98 m in the northern area and up to 120 m in the southeastern area (adjacent to South Flank Highway 5 deposit).
    - The depth to water at Coondewanna Flats is typically between 20 m - 30 mbgl. It is an internally draining alluvial plain and wetland feature which is the terminus for surface water flow from the west of the catchment. The Flats support a Priority Ecological Community (PEC) of woodland and forest. The significant depth to water (>20 m) at the Flats makes it unlikely that this is a groundwater dependent receptor, and vegetation communities are more likely to be dependent on the surface water regime in the area (section 4.1.1).
- **Ben's Oasis**
    - There is currently no unequivocal evidence that drawdown has occurred at Ben's Oasis in response to Hope Downs dewatering. However, this is based on relatively short-term monitoring and the situation and/or understanding may change as drawdown continues to increase on the Hope Downs side of the dyke and more data is collected. Continued monitoring of groundwater levels at the bores in the area will help reduce this uncertainty with time.
    - The model shows that dewatering from CPH (particularly B and R deposit), and Hope Downs may result in a drawdown peak of between 13 and 21 m just to the northeast of the dyke (at HDD0004M).

- **Rio Tinto – Hope Downs water supply**
    - BHP dewatering is not expected to have a significant additional impact on top of the current and future Hope Downs drawdown.

Based on the assessment it is concluded that the impacts resulting from the increase in mine dewatering to 65.7 GL/yr (180 ML/d) can be adequately managed through the implementation of the mitigation and monitoring measures such that the predicted environmental outcomes will be achieved.

BHP will continue to collect and review data in accordance with the monitoring plans (see Section 11) to assess whether the groundwater system response is in line with the groundwater model predictions.

The following documents are the BHP mechanism to manage potential hydrogeological impacts from mining activities within the CPH region:

- CPWRMP (BHP, 2021)
- MAC and South Flank GWOS (BHP, 2023)

These documents will be reviewed upon approval of the proposed dewatering volume increase.

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Figures

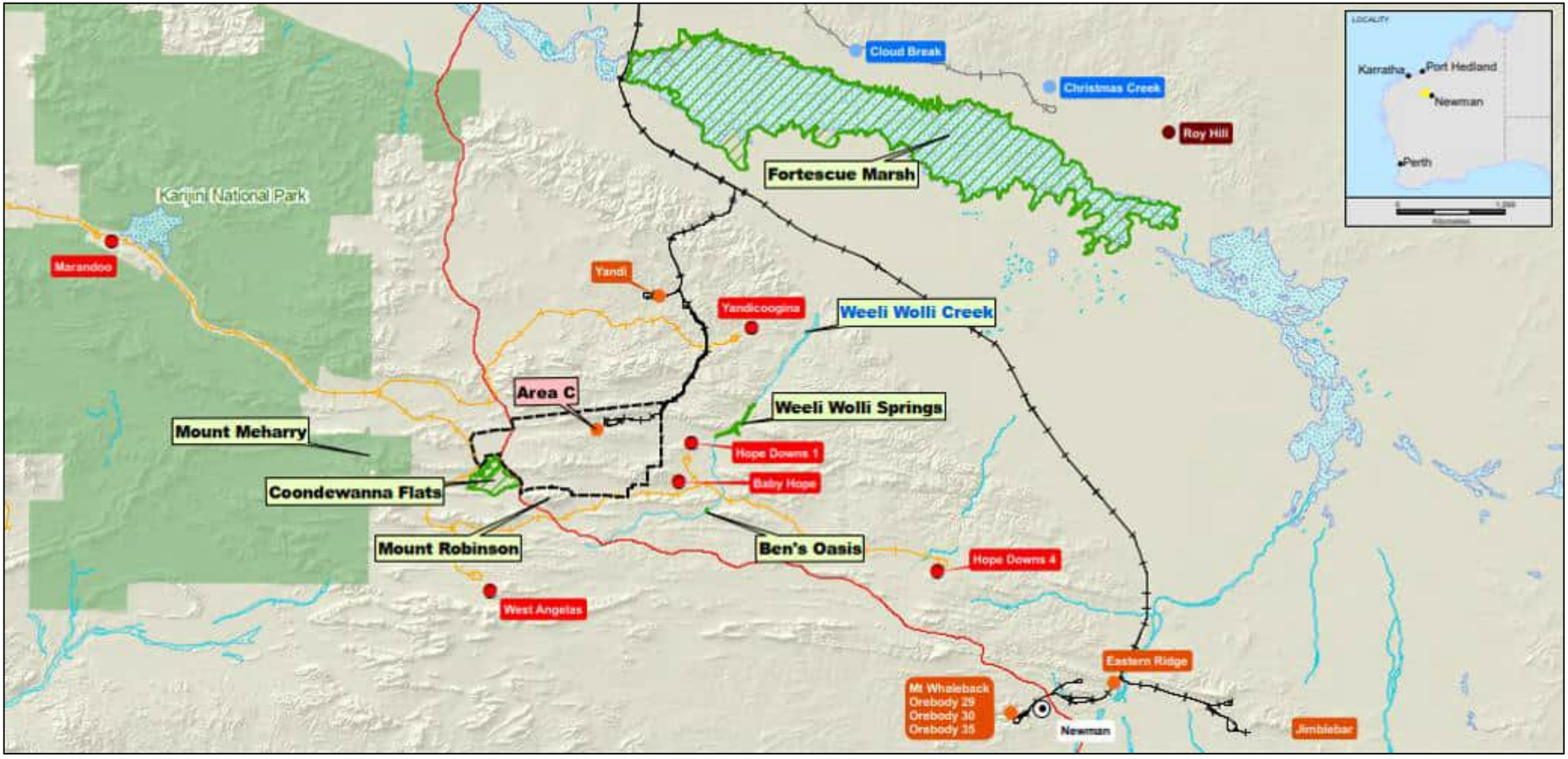


Figure 1.1
CPH Regional Map

BHP

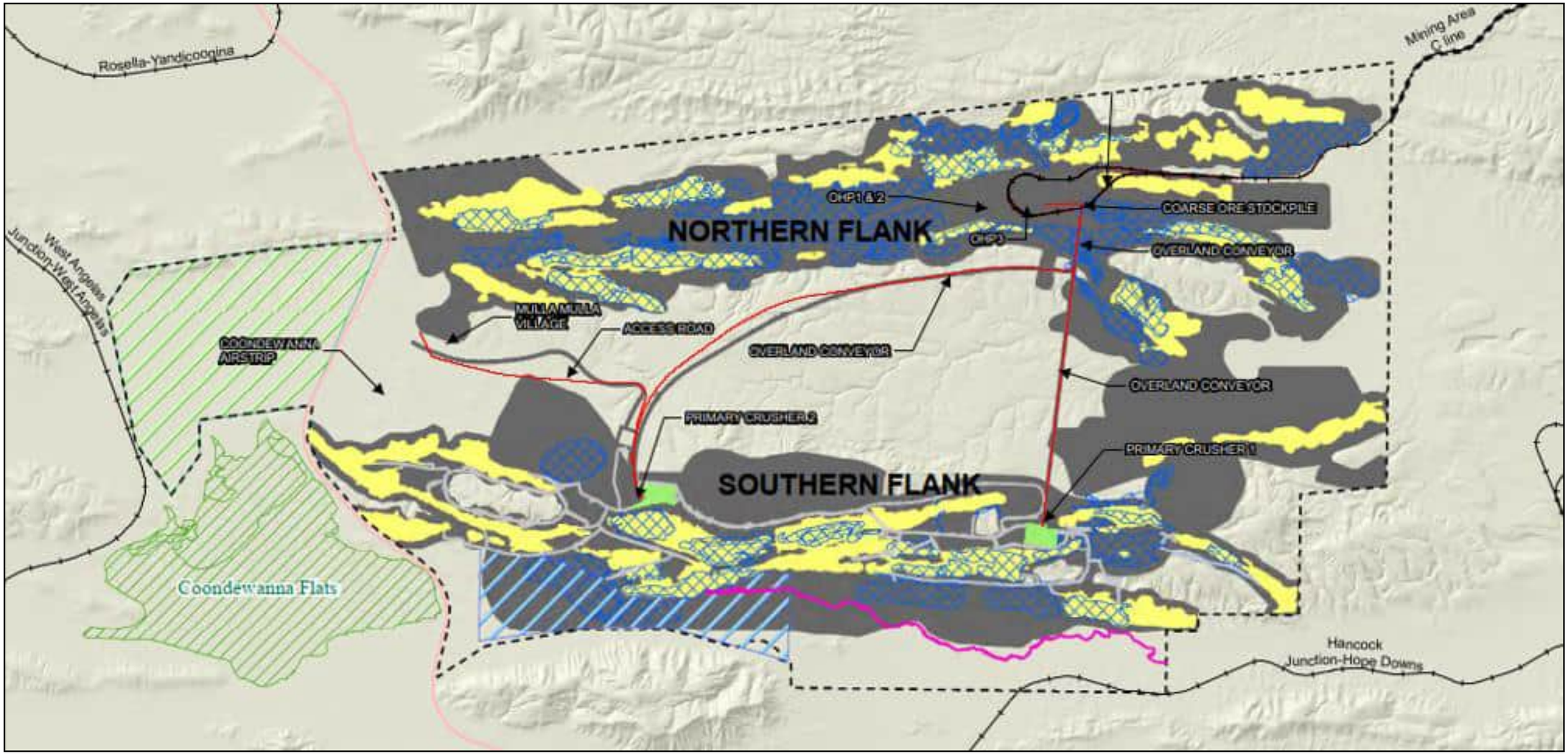


Figure 1.2
CPH Layout

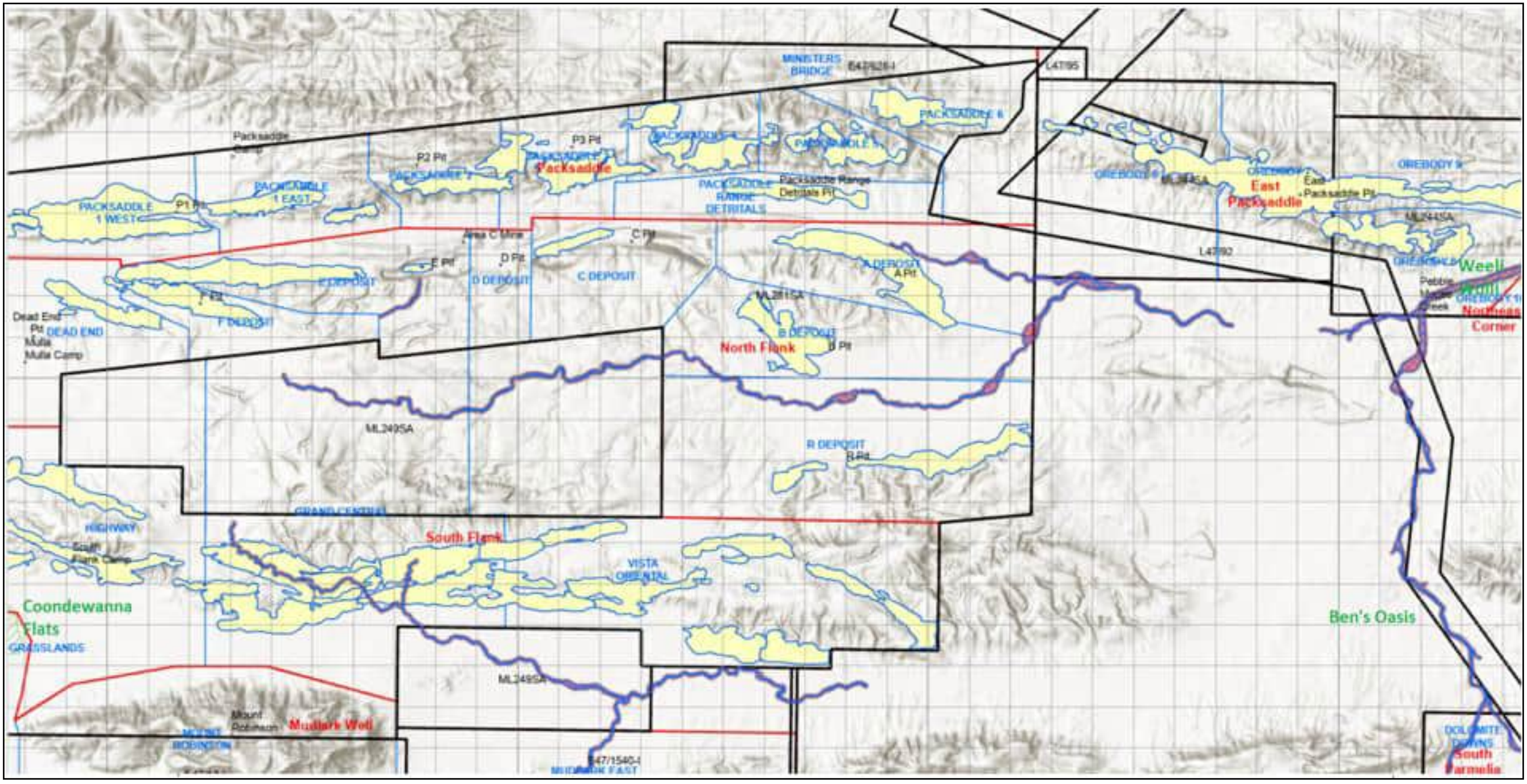


Figure 1.3
CPH Mine and Lease Layout

BHP

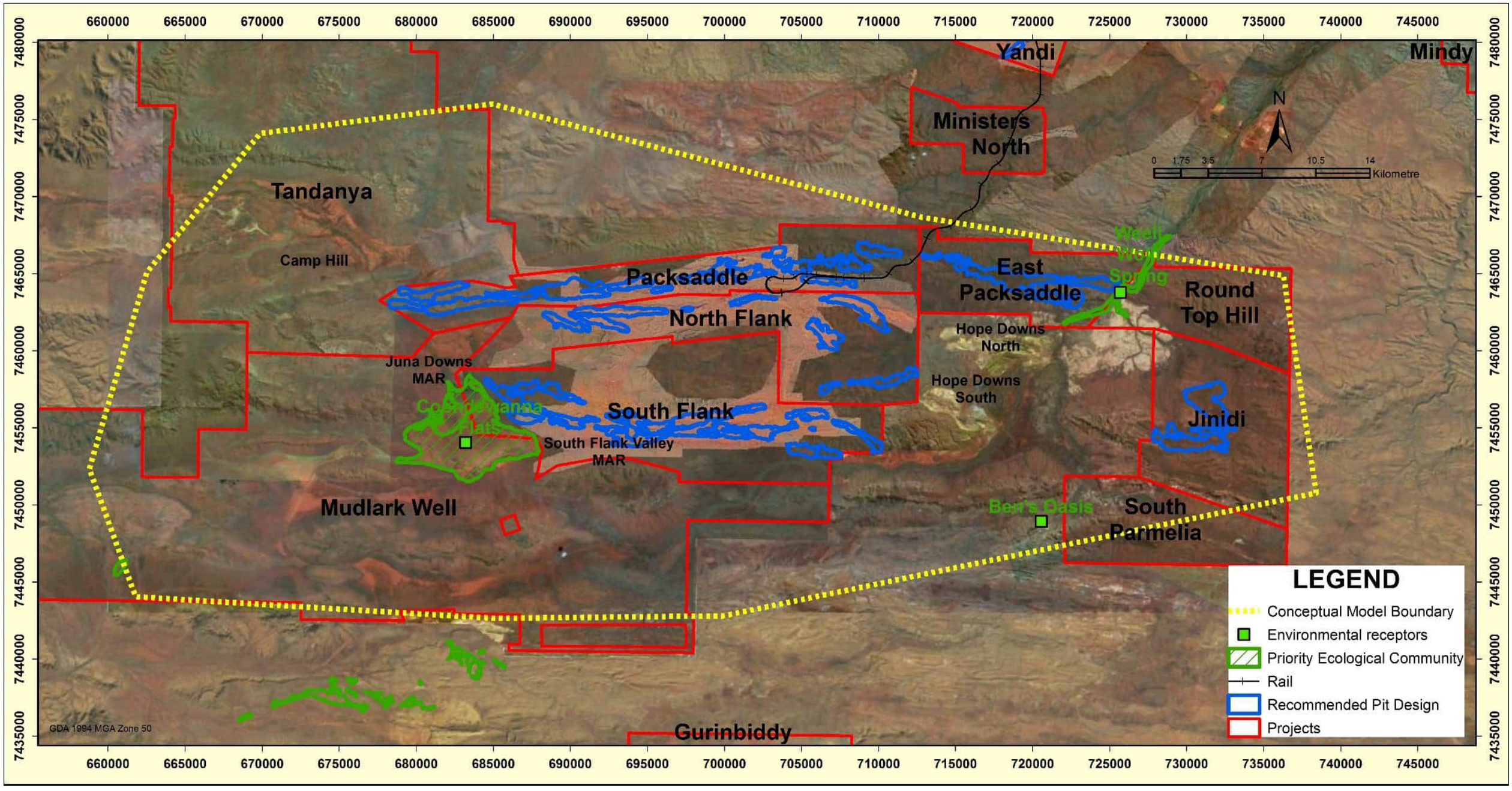
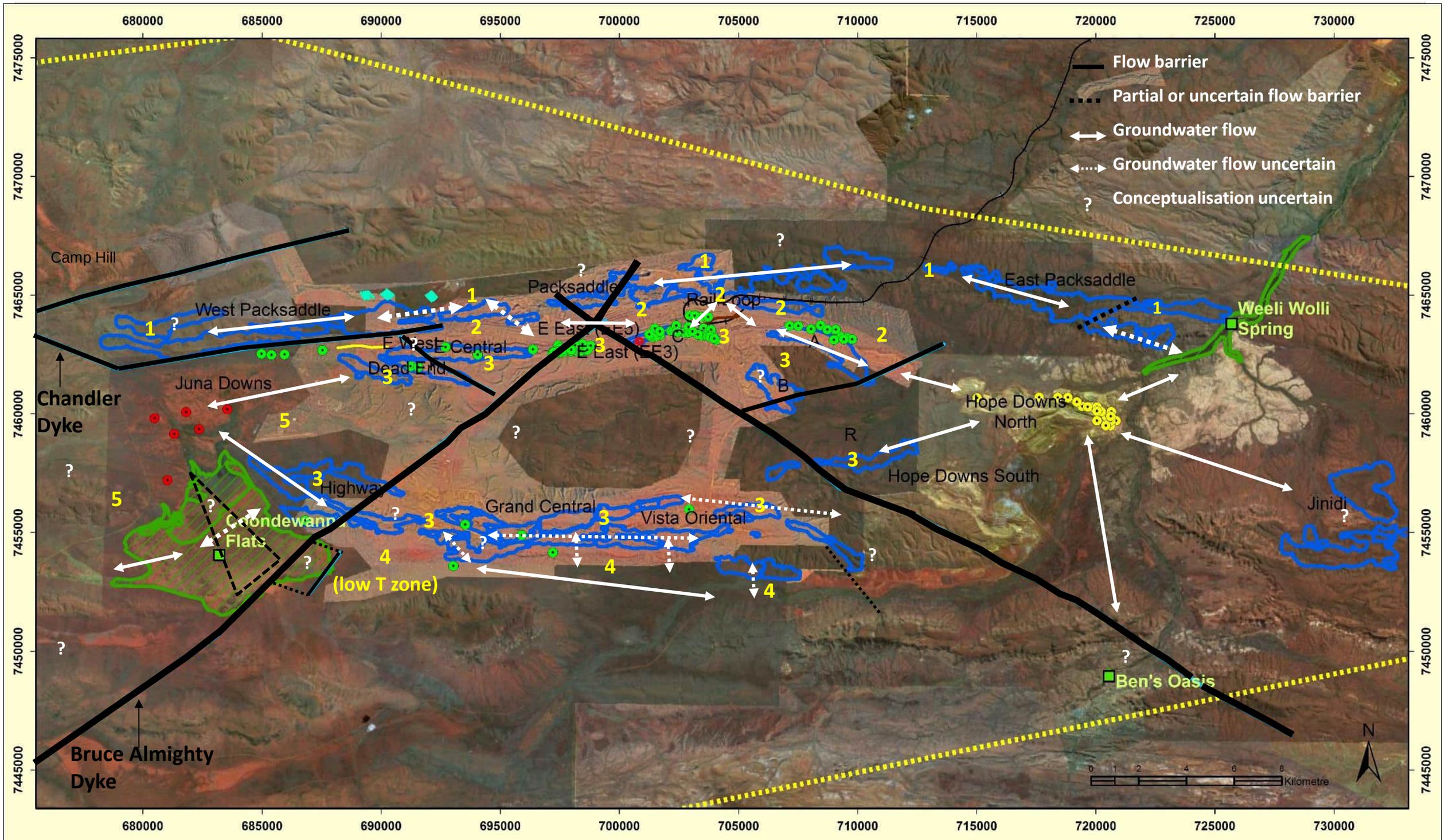


Figure 3.1
Regional Setting and Conceptual Model Boundary

BHP



LEGEND

- BHP Abstraction
- BHP Injection
- Runaway Valley Infiltration Ponds
- C West Pit Lake
- Central Sediment Basin
- Western Sediment Basin
- RTIO (Hope Downs)
- Conceptual Model boundary
- Priority Ecological Community
- Rail
- Recommended Pit Design
- Environmental receptors

#1. Brockman orebodies (Packsaddle)
#2. North Flank Valley Regional Aquifer
#3. Marra Mamba orebodies (North and South Flank)
#4. South Flank Valley Regional Aquifer
#5. Coondewanna Flats/Juna Downs Regional Aquifer

BHP

Central Pilbara Conceptual Model
CPH Conceptualisation

Scale: 1:210,365	Plotted: 26/08/2021	FIGURE 3.2
Coordinate System: GDA 1994 MGA Zone 50	Revised: 26/08/2021	
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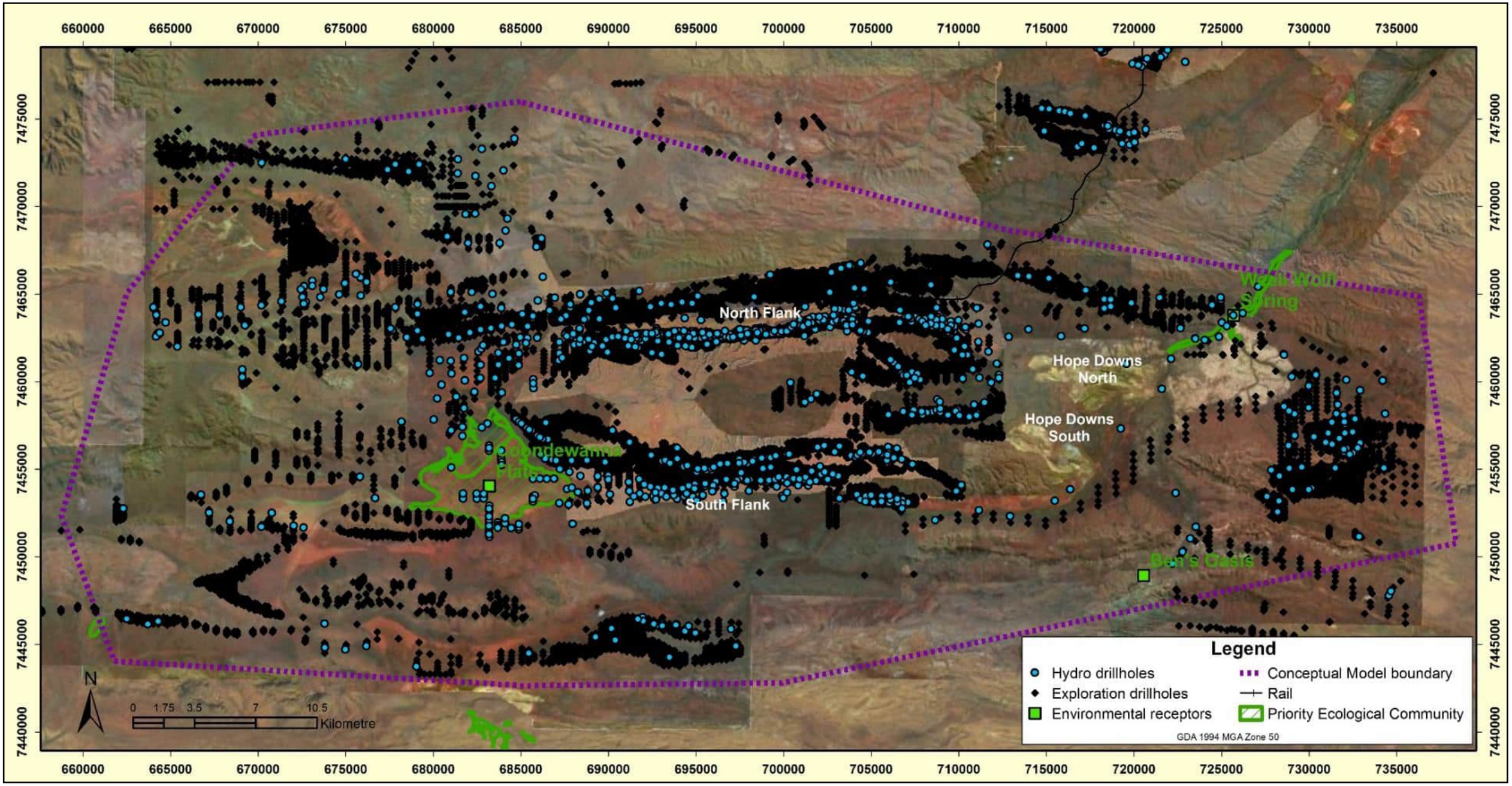


Figure 3.3
Exploration drilling coverage in CPH (2021)

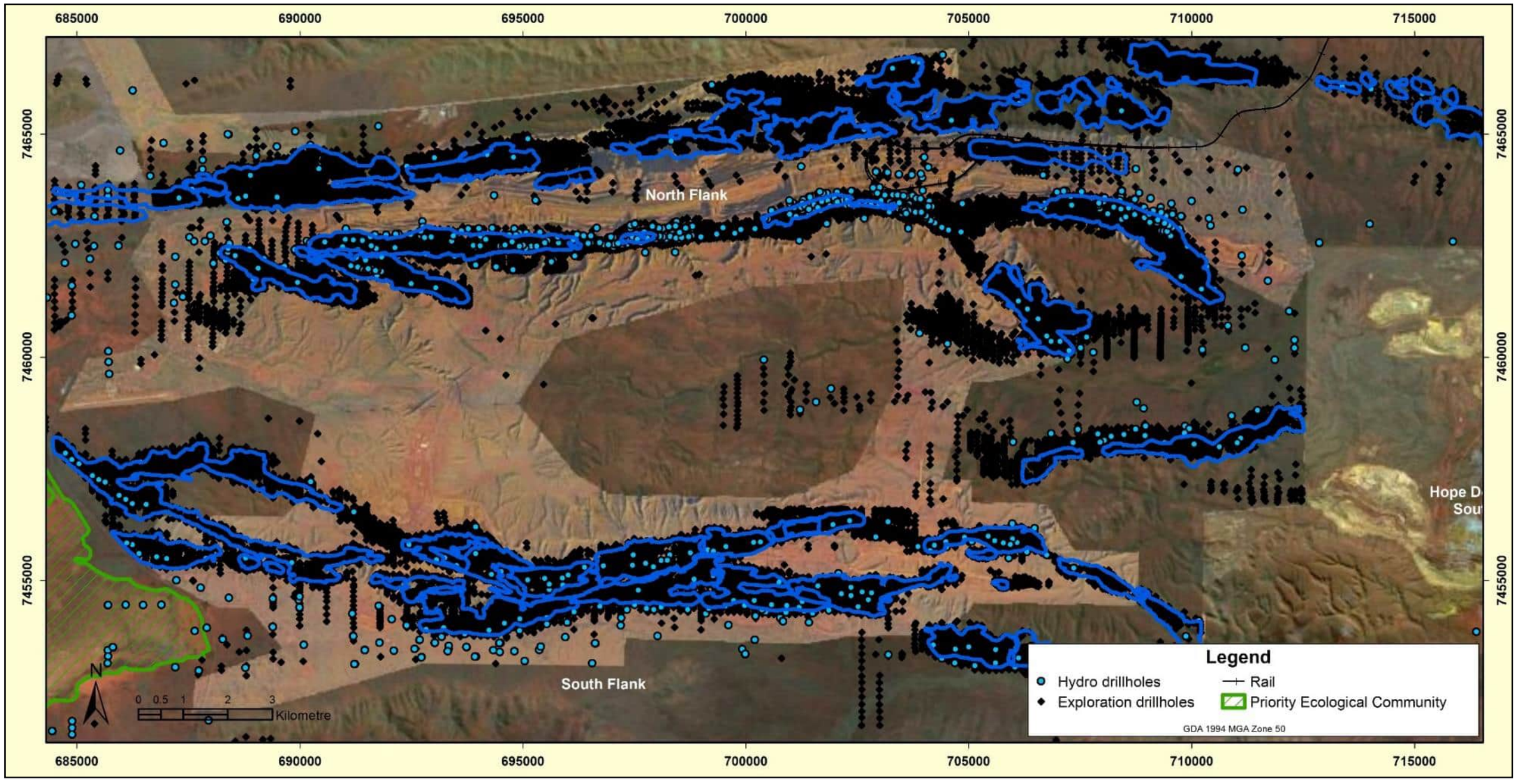


Figure 3.4
Exploration drilling coverage at North and South Flank (2021)

660000 665000 670000 675000 680000 685000 690000 695000 700000 705000 710000 715000 720000 725000 730000 735000

7475000 7470000 7465000 7460000 7455000 7450000 7445000 7440000

Brockman Iron Fm
Weeli Wolli Fm
Weeli Wolli Fm
Brockman Iron Fm
Alluvium
Brockman Iron Fm
Packsaddle
North Flank
Weeli Wolli Spring
Alluvium
Brockman Iron Fm
Hope Downs North
Oakover Limestone
Alluvium/Detritals
Marra Mamba Iron Fm
Hope Downs South
Brockman Iron Fm
Coondiwanna Flats
Marra Mamba Iron Fm
South Flank
Brockman Iron Fm
Alluvium
Marra Mamba Iron Fm
Brockman Iron Fm
Mt McRae/Sylvia Fm
Wittenoom dolomite
Bam's Oasis
Marra Mamba Iron Fm
Brockman Iron Fm
Marra Mamba Iron Fm
Dolerite sills
N
0 1.75 3.5 7 10.5
Kilometre

Legend

- Environmental receptors
- Conceptual Model boundary
- Rail
- Priority Ecological Community

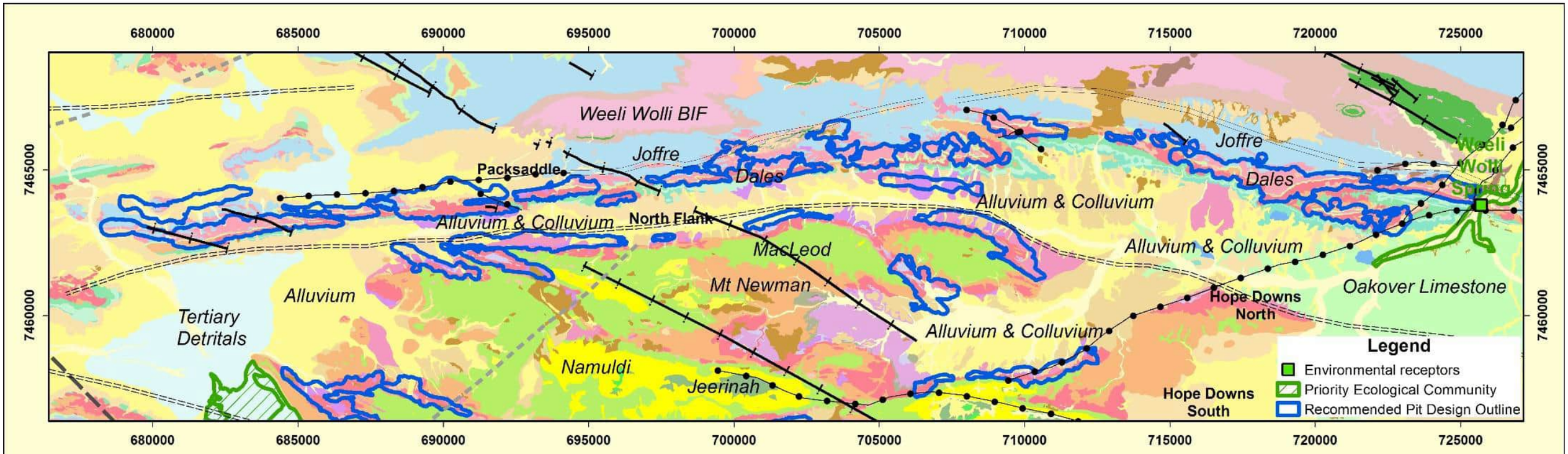
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BHP

Central Pilbara Conceptual Model
Geology
GSWA 250K

Scale: 1:299,303	Plotted: 10/08/2021	FIGURE 3.5
Coordinate System: GDA 1994 MGA Zone 50	Revised: 10/08/2021	
	File Name: 12	

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AFj - Jeerinah - Shale, chert, mudstone & dolomite
AFjd - Jeerinah - Dolerite sills
AFjm - Jeerinah - Roy Hill Shale (marker chert)
AFjr - Jeerinah - Roy Hill Shale
AHd - Wittenoom - Unknown Member
AHda - Wittenoom - West Angela Member
AHdb - Wittenoom - Bee Gorge Member
AHdp - Wittenoom - Paraburdoo Member
AHmm - Marra Mamba - MacLeod Member
AHmn - Marra Mamba - Mt Newman Member
AHmu - Marra Mamba - Nammuldi Member
AHr - Mt McRae Shale
AHs - Mt Sylvia Formation
CID - Robe - Oolitic channel iron deposit
Cza - Alluvium (consolidated)
Czb - Silcrete (indurated)
Czc - Colluvium & alluvium
Czcb - Colluvium & alluvium (chert & BIF clasts)
Czcg - Indurated colluvium (Canga)
Czci - Indurated Czc / Czcb
Czcm - Colluvium & alluvium (ore, chert & BIF clasts)
Czco - Colluvium & alluvium (ore clasts)
Czk - Calcrete
Czl - Ferricrete (laterite)
Czm - Oakover - Micritic lacustrine limestone
Czp - Playa deposits
Czpi - Consolidated ferruginous pisolites
H1 - Martite (microplatey haematite)
H2 - Martite goethitic supergene ore (ochereous)
H2/AHda - Martite goethitic supergene ore (ochereous)
H2/AHmm - Martite goethitic supergene ore (ochereous)
H2/AHmn - Martite goethitic supergene ore (ochereous)
H2/PHbd - Martite goethitic supergene ore (ochereous)
H2/PHbj - Martite goethitic supergene ore (ochereous)
H2/PHbw - Martite goethitic supergene ore (ochereous)
PHbd - Brockman - Dales Gorge (BIF & Shale)
PHbj - Brockman - Joffre (BIF with chert & shale)
PHbw - Brockman - Mt Whaleback Shale
PHby - Brockman - Yandicoogina Shale
PHj - Weeli Wolli - BIF
Pd - Dolerite dykes
Pdd - Dolerite dykes
Pds - Weeli Wolli - Dolerite sills
Qa - Alluvium (drainage channels) - unconsolidated silt, sand and gravel
Qc - Talus & colluvium
Tmco - Alluvial haematite (red ochre detritals)

Regional Faults

misc
thrust
normal

Regional Dykes

Pd4 - WNW (pre BRQ)
Pd5 - NW (pre mplH)
Pd7 - NE to NNE (post Bangemall & mplH)

BHP

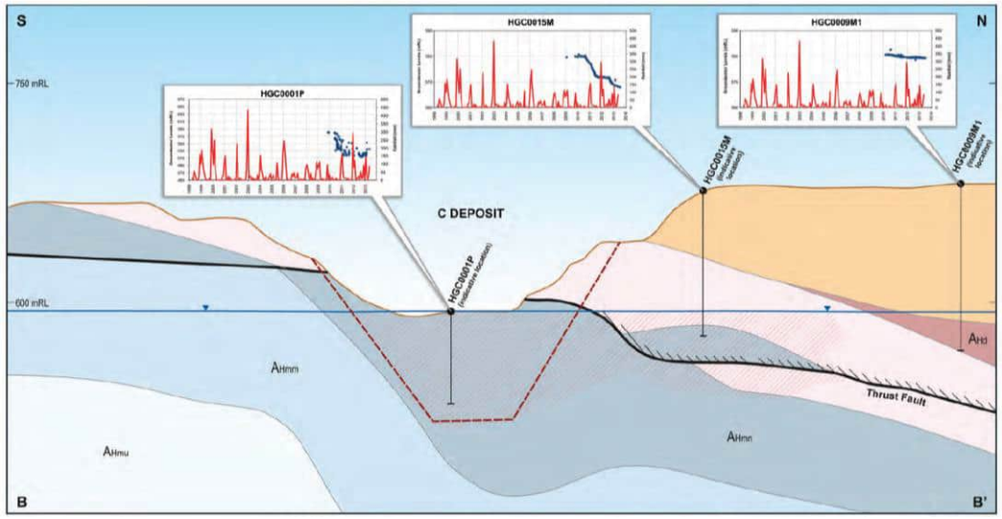
Central Pilbara Conceptual Model
North Flank & Packsaddle Geology (1:20000)

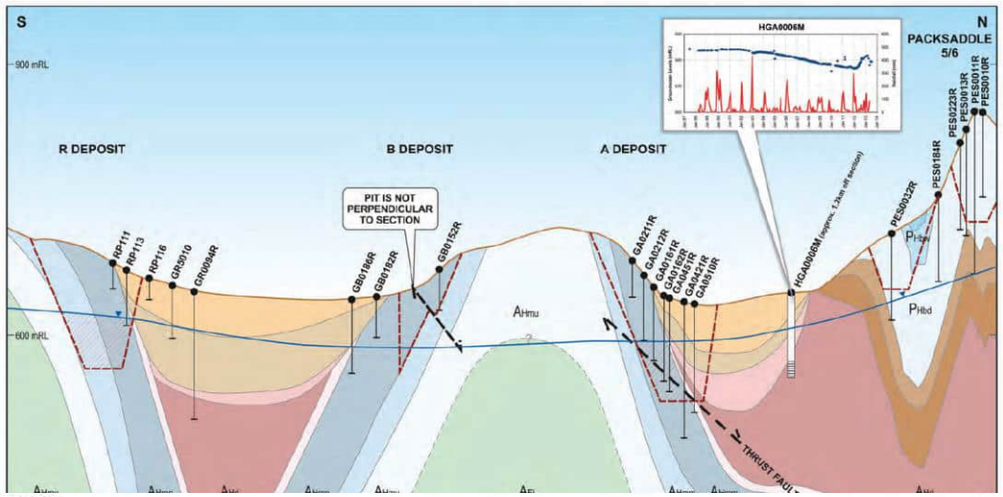
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Coordinate System: GDA 1994 MGA Zone 50	Revised: 10/08/2021	
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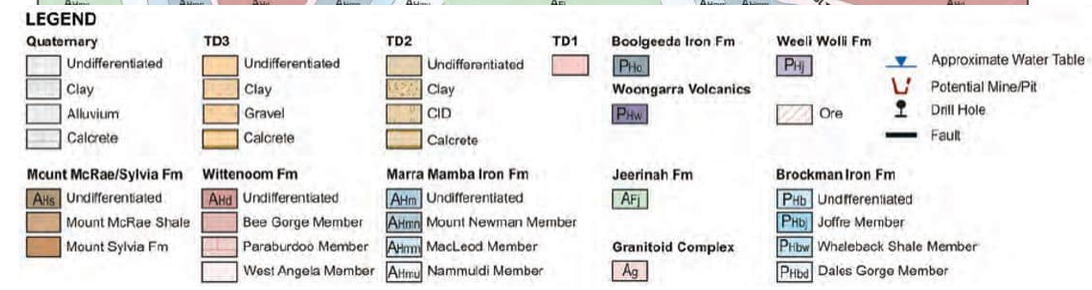
0 1 2 4 6 Kilometre

N

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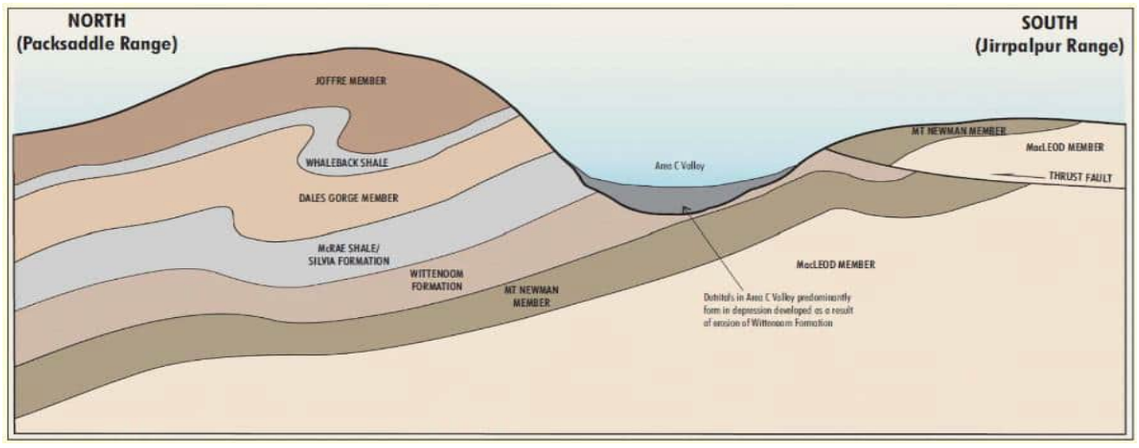
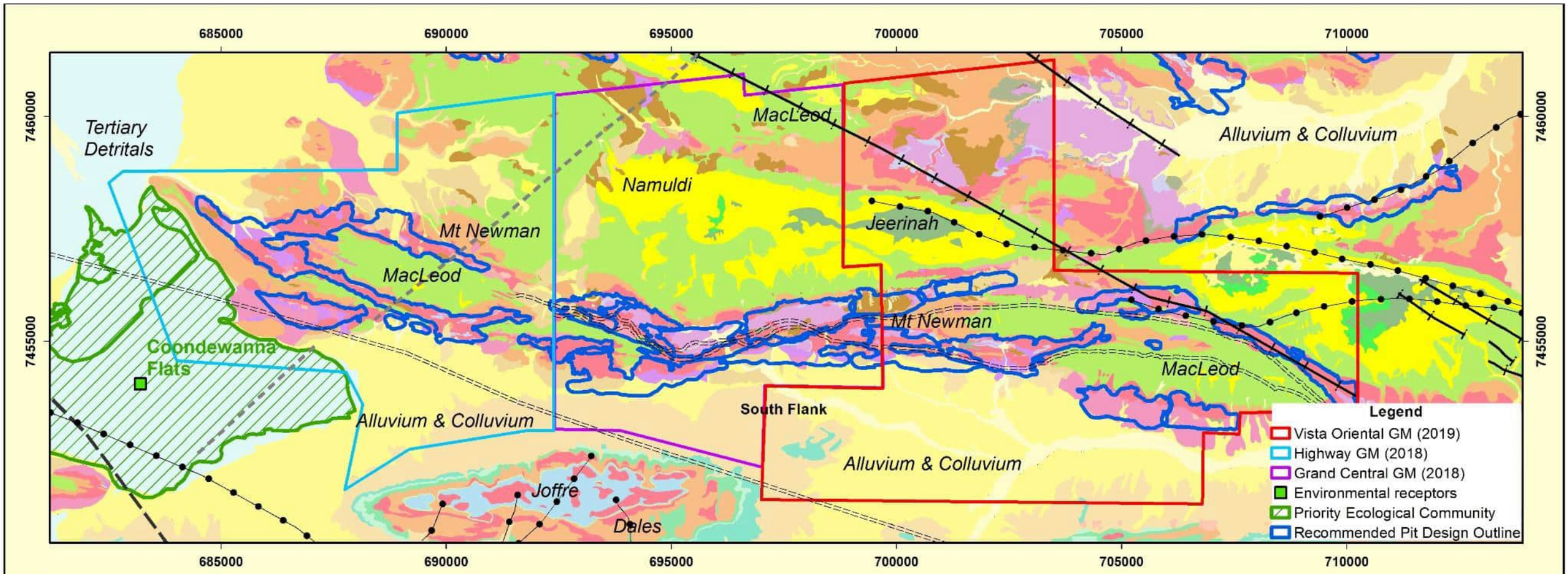


Figure 3.7
Geological section through C Deposit (top); A, B and R Deposits (middle); and the Packsaddle Range and Area C Valley (bottom)



AFj - Jeerinah - Shale, chert, mudstone & dolomite
AFjd - Jeerinah - Dolerite sills
AFjm - Jeerinah - Roy Hill Shale (marker chert)
AFjr - Jeerinah - Roy Hill Shale
AHd - Wittenoom - Unknown Member
AHda - Wittenoom - West Angela Member
AHdb - Wittenoom - Bee Gorge Member
AHmm - Marra Mamba - MacLeod Member
AHmn - Marra Mamba - Mt Newman Member
AHmu - Marra Mamba - Nammuldi Member
AHr - Mt McRae Shale
AHs - Mt Sylvia Formation
CID - Robe - Oolitic channel iron deposit
Cza - Alluvium (consolidated)
Czb - Silcrete (indurated)

Czc - Colluvium & alluvium
Czcb - Colluvium & alluvium (chert & BIF clasts)
Czcg - Indurated colluvium (Canga)
Czcm - Colluvium & alluvium (ore, chert & BIF clasts)
Czco - Colluvium & alluvium (ore clasts)
Czi - Unknown
Czl - Ferricrete (laterite)
Czp - Playa deposits
Czpi - Consolidated ferruginous pisolites
H2 - Martite goethitic supergene ore (ochereous)
H2/AHda - Martite goethitic supergene ore (ochereous)
H2/AHmm - Martite goethitic supergene ore (ochereous)
H2/AHmn - Martite goethitic supergene ore (ochereous)
H2/PHbd - Martite goethitic supergene ore (ochereous)
PHbd - Brockman - Dales Gorge (BIF & Shale)

PHbj - Brockman - Joffre (BIF with chert & shale)
PHbw - Brockman - Mt Whaleback Shale
Pd - Dolerite dykes
Qa - Alluvium (drainage channels) - unconsolidated silt, sand ar
Qc - Talus & colluvium
Tmco - Alluvial haematite (red ochre detritals)

Regional Faults
misc
thrust

Regional Dykes
Pd4 - WNW (pre BRQ)
Pd5 - NW (pre mplH)
Pd7 - NE to NNE (post Bangemall & mplH)

BHP

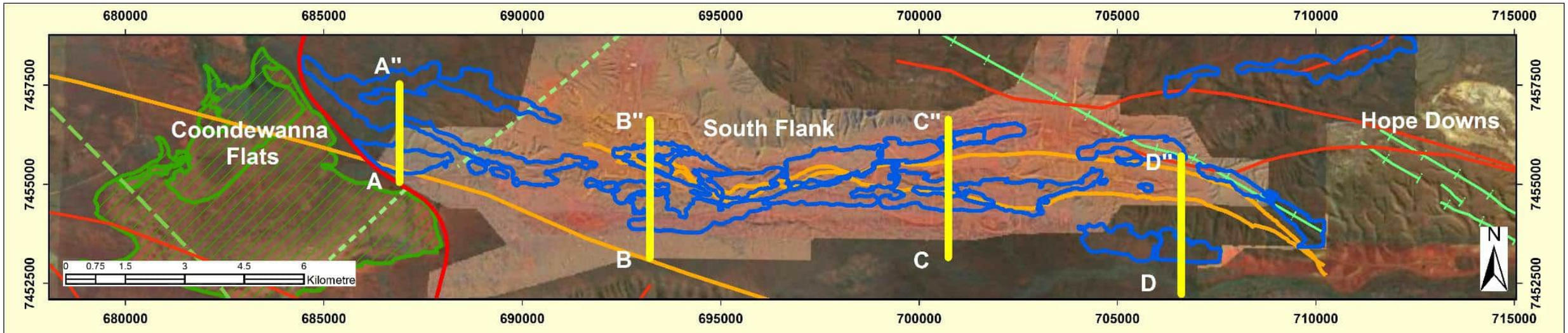
Central Pilbara Conceptual Model
South Flank Geology (1:20000)

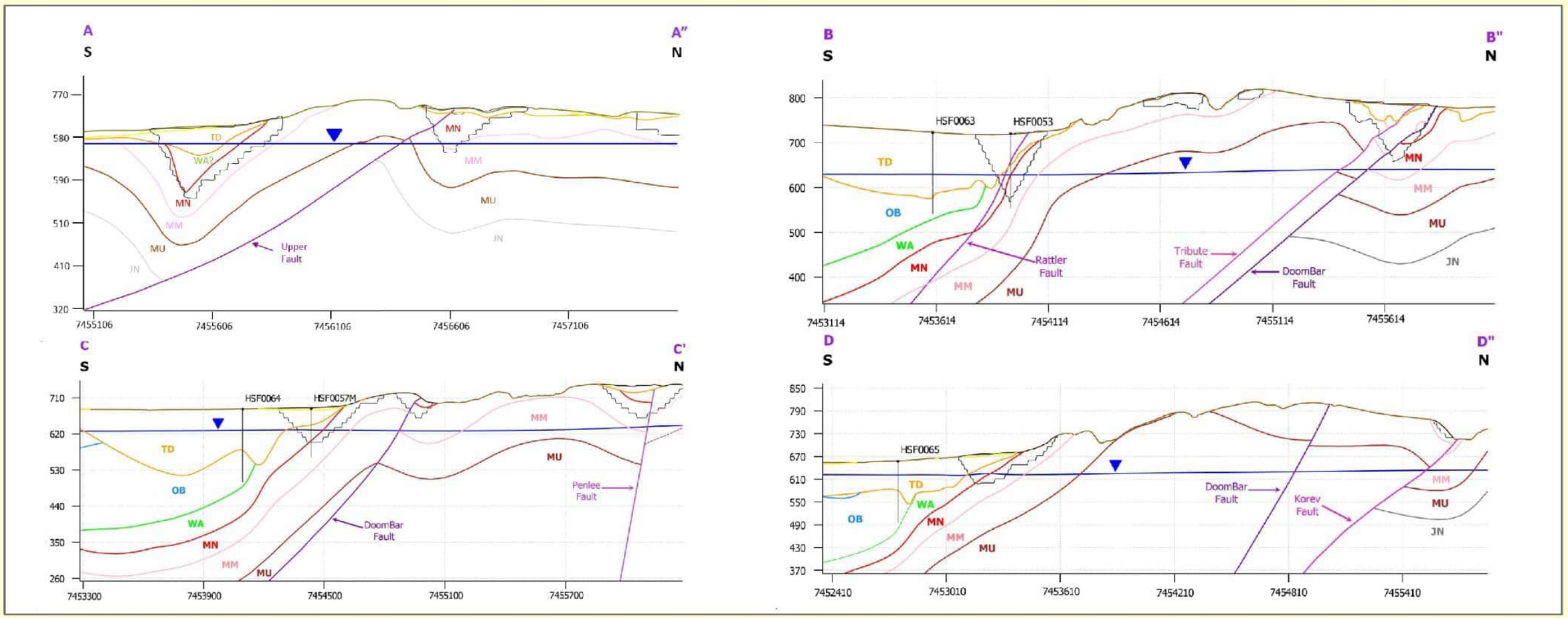
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Coordinate System: GDA 1994 MGA Zone 50	Revised: 10/08/2021	
	File Name: 15	

0 0.5 1 2 3 4 Kilometre

N

MXD Path: R:\03 ArcGIS\CPH\FY21\FY21 CPH_Conceptual_Model\MXD\CM_Report\15.mxd





Map Legend

- Highways
- Recommended Pit Design Outline

Regional Faults

- misc
- thrust

Regional Dykes

- Pd4 - WNW (pre BRQ)
- Pd5 - NW (pre mplH)
- Pd7 - NE to NNE (post Bangemall & mplH)
- Priority Ecological Community

Section Legend

- Pre-mine topography
- Pre-mine water table
- Indicative pit outline
- Fault
- Base surface scree
- Base Tertiary detritals
- Top Paraburdoo dolomite
- Top Mount Newman
- Top West Angela Shale
- Top McLeod
- Top Nammuldi
- Top Jeerinah

BHP **South Flank hydrogeological cross sections**

Scale 1:137,211	Plotted:	**FIGURE 3.9**
DATUM: GDA94 **Projection**: MGA50	Revised:	

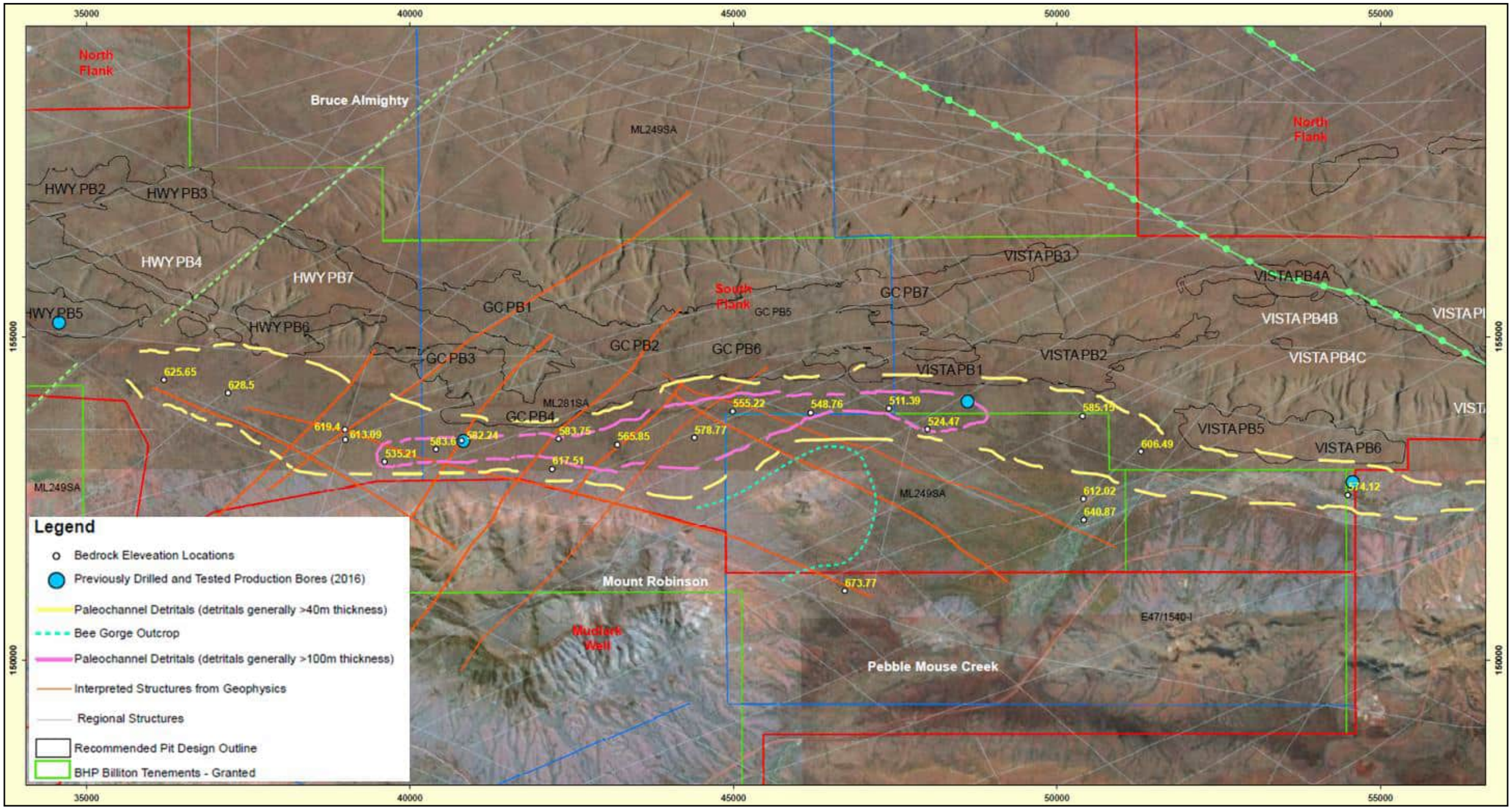


Figure 3.10
South Flank Valley Paleovalley

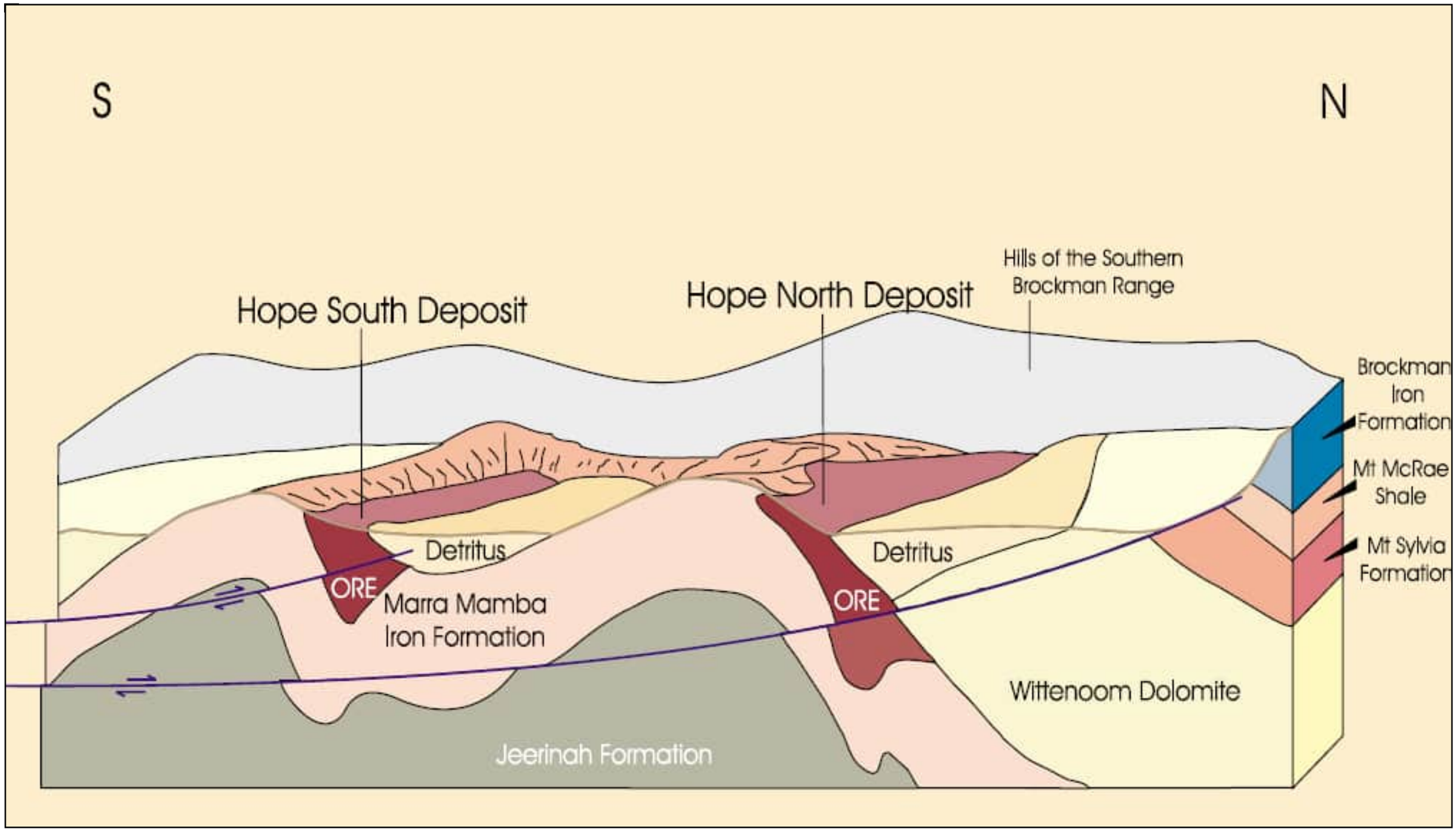


Figure 3.11
Conceptual geological cross section –
Hope Downs South and North deposits
(Hope Downs, 2000)

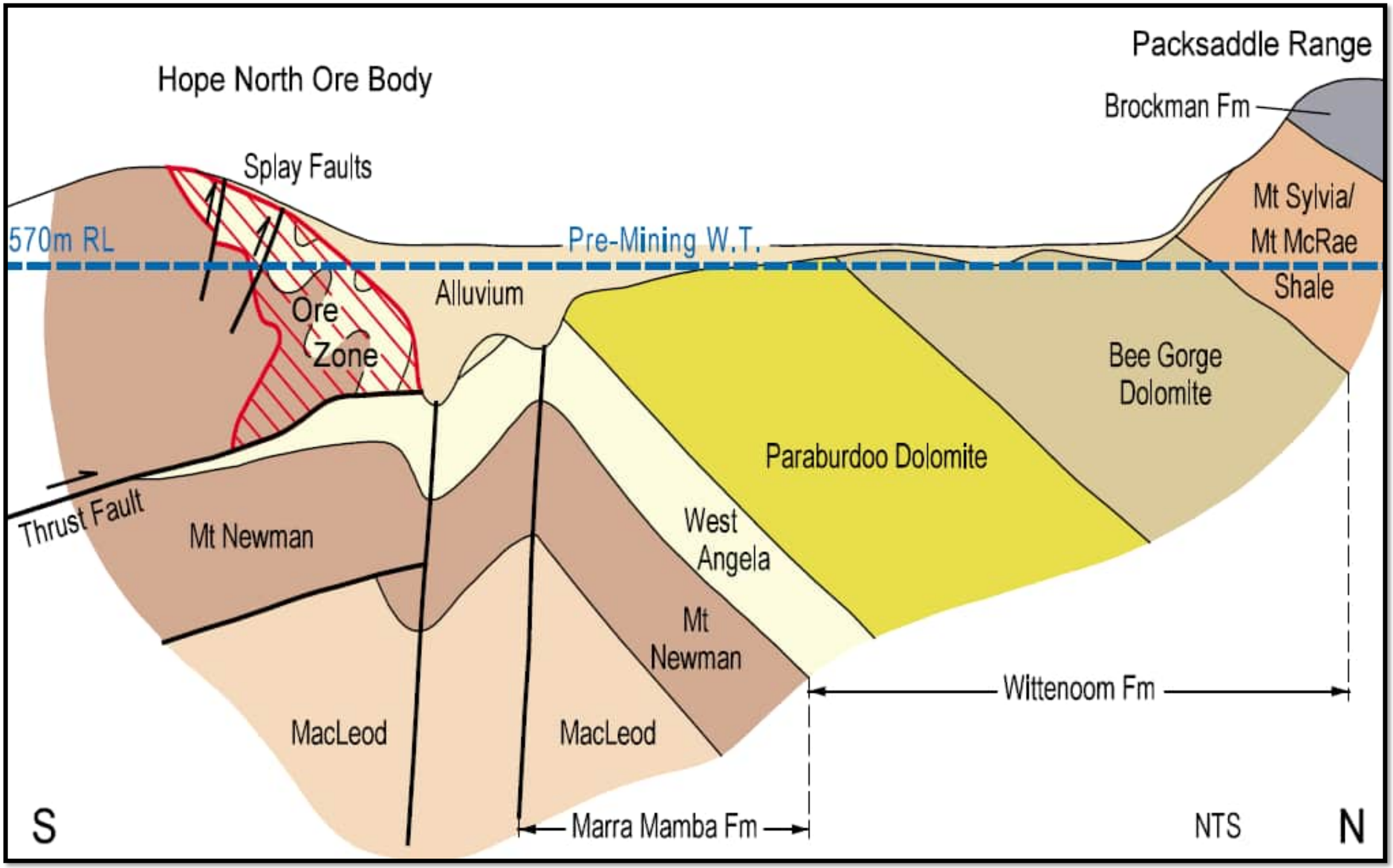


Figure 3.12
Conceptual geological cross section –
Hope Downs South and North deposits
(Hope Downs, 2000)

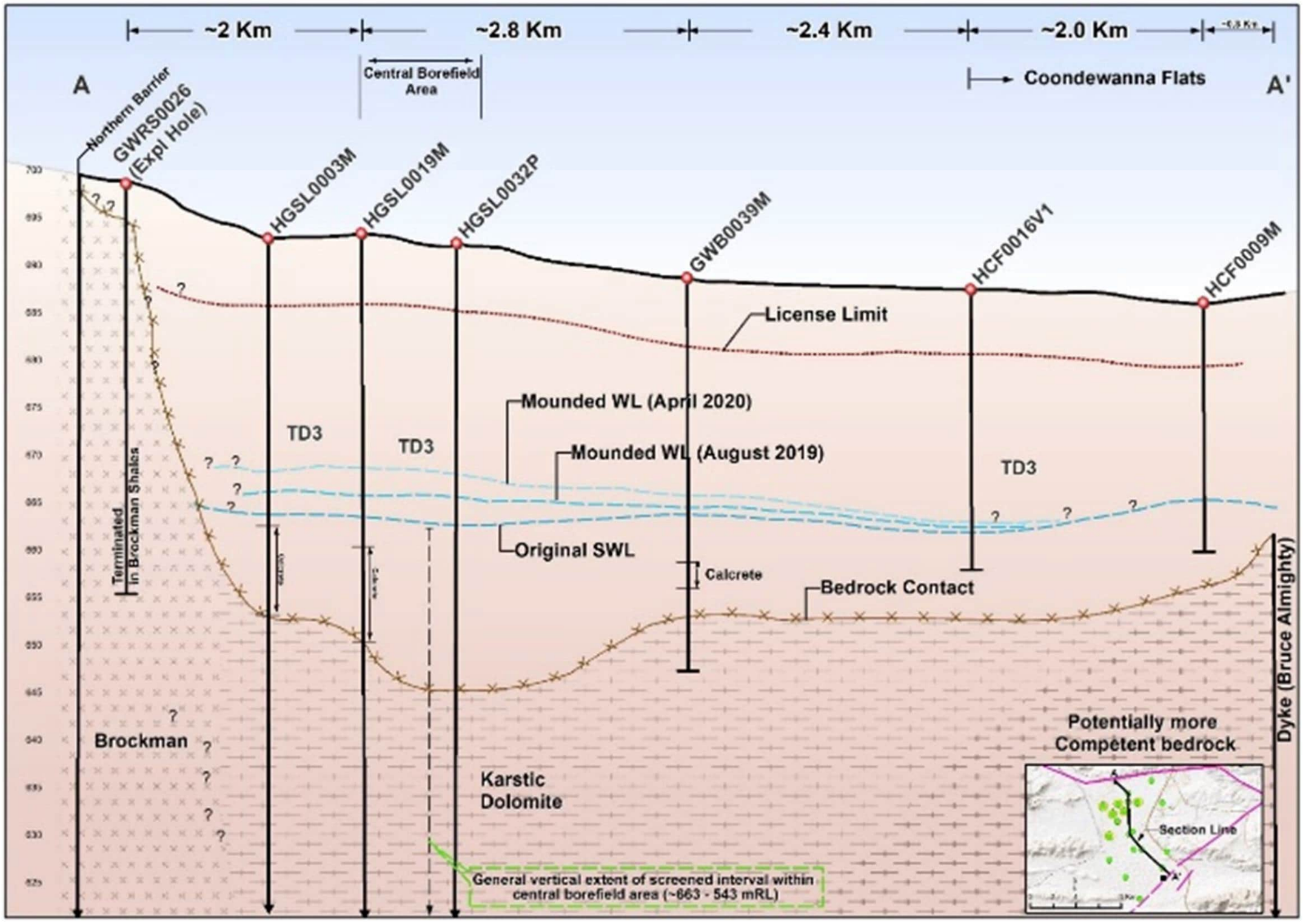


Figure 3.13
Cross section from NW to SE across Juna Downs and Coondewanna Flats (BHP 2020a)

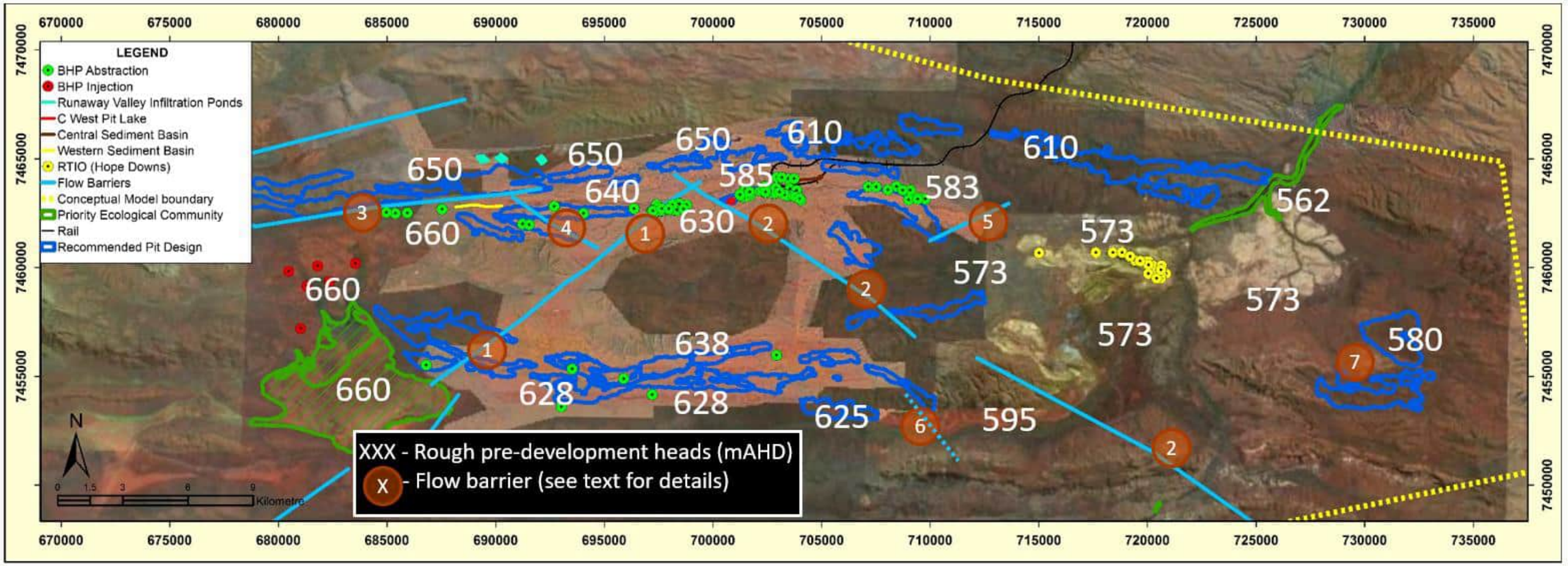
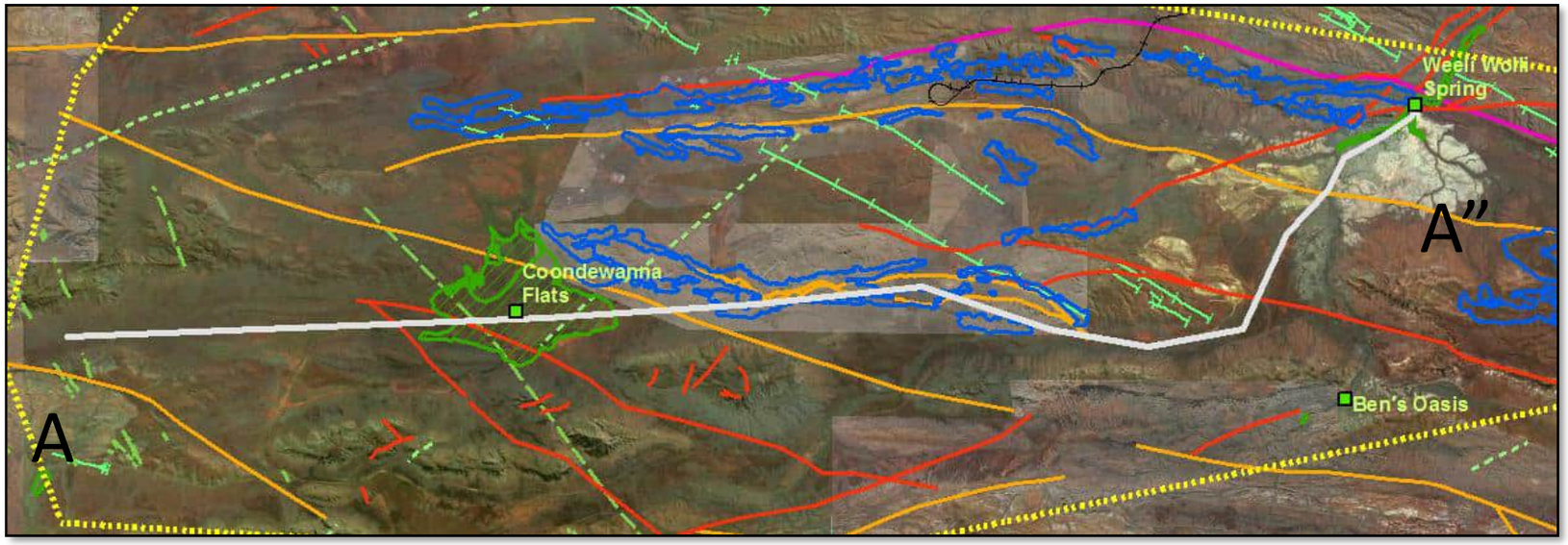


Figure 3.14
Key structural flow barriers and summary pre-development heads



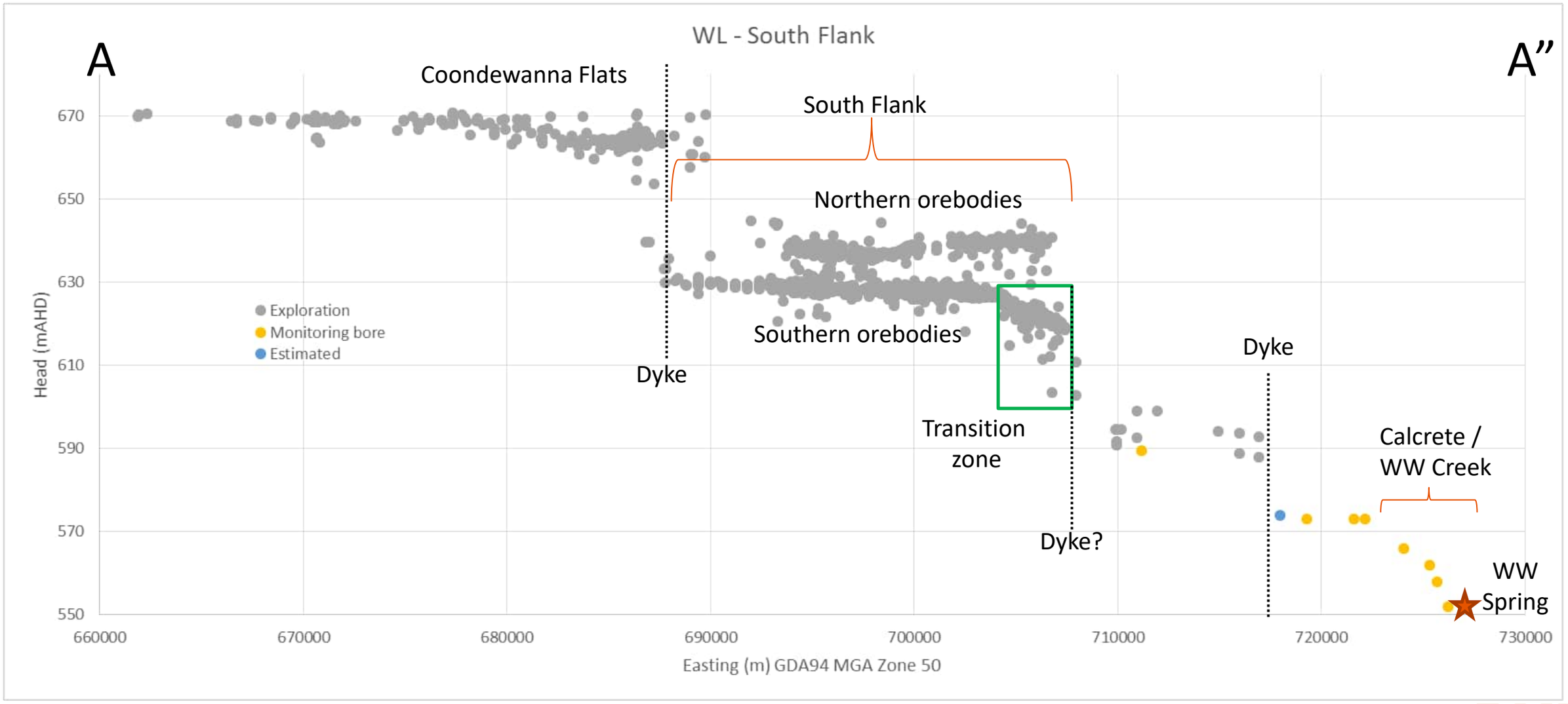
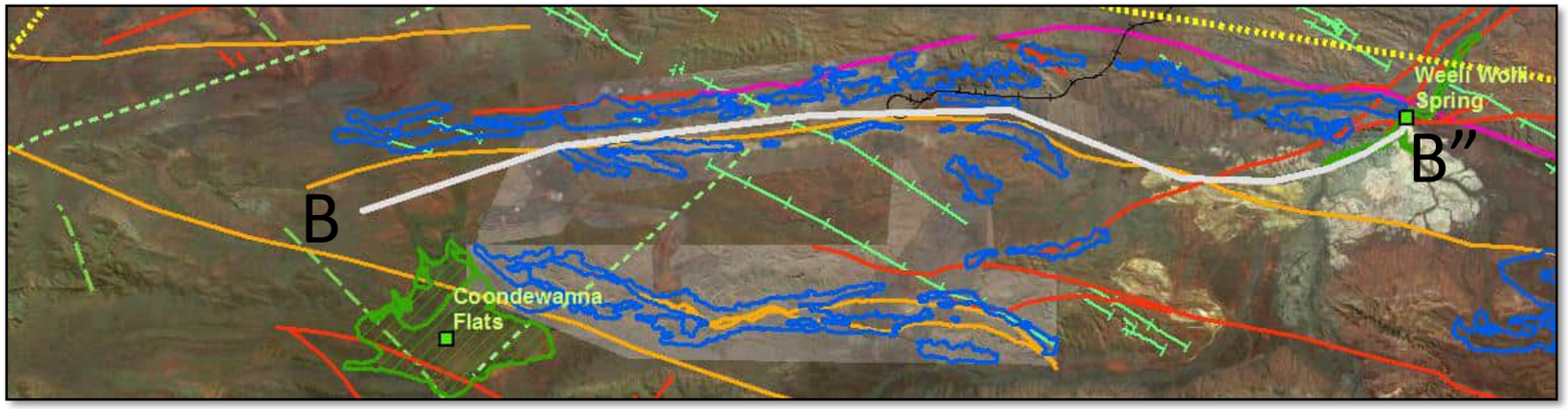


Figure 3.15
Pre-development groundwater level cross section through South Flank



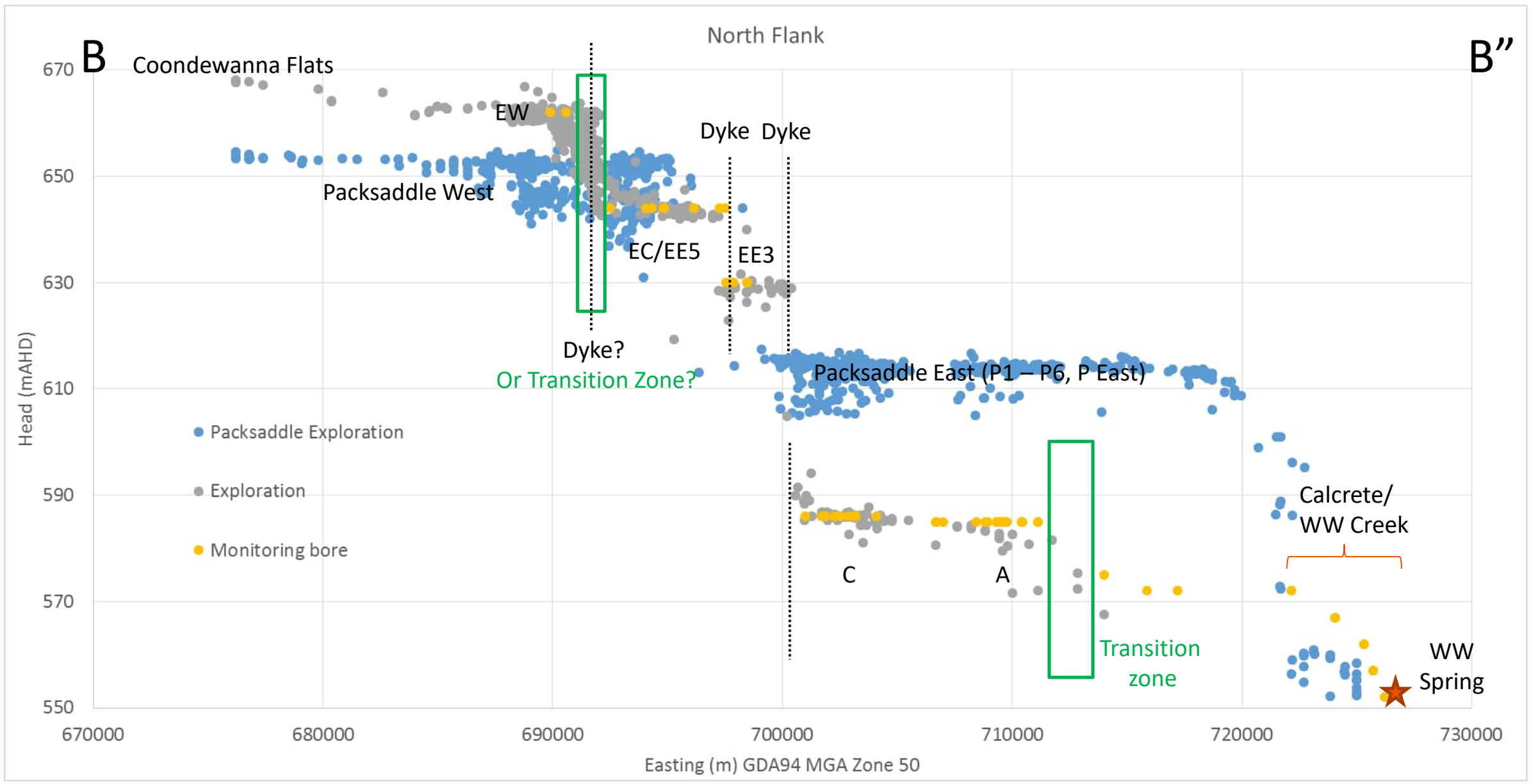


Figure 3.16
Pre-development groundwater level cross section through North Flank

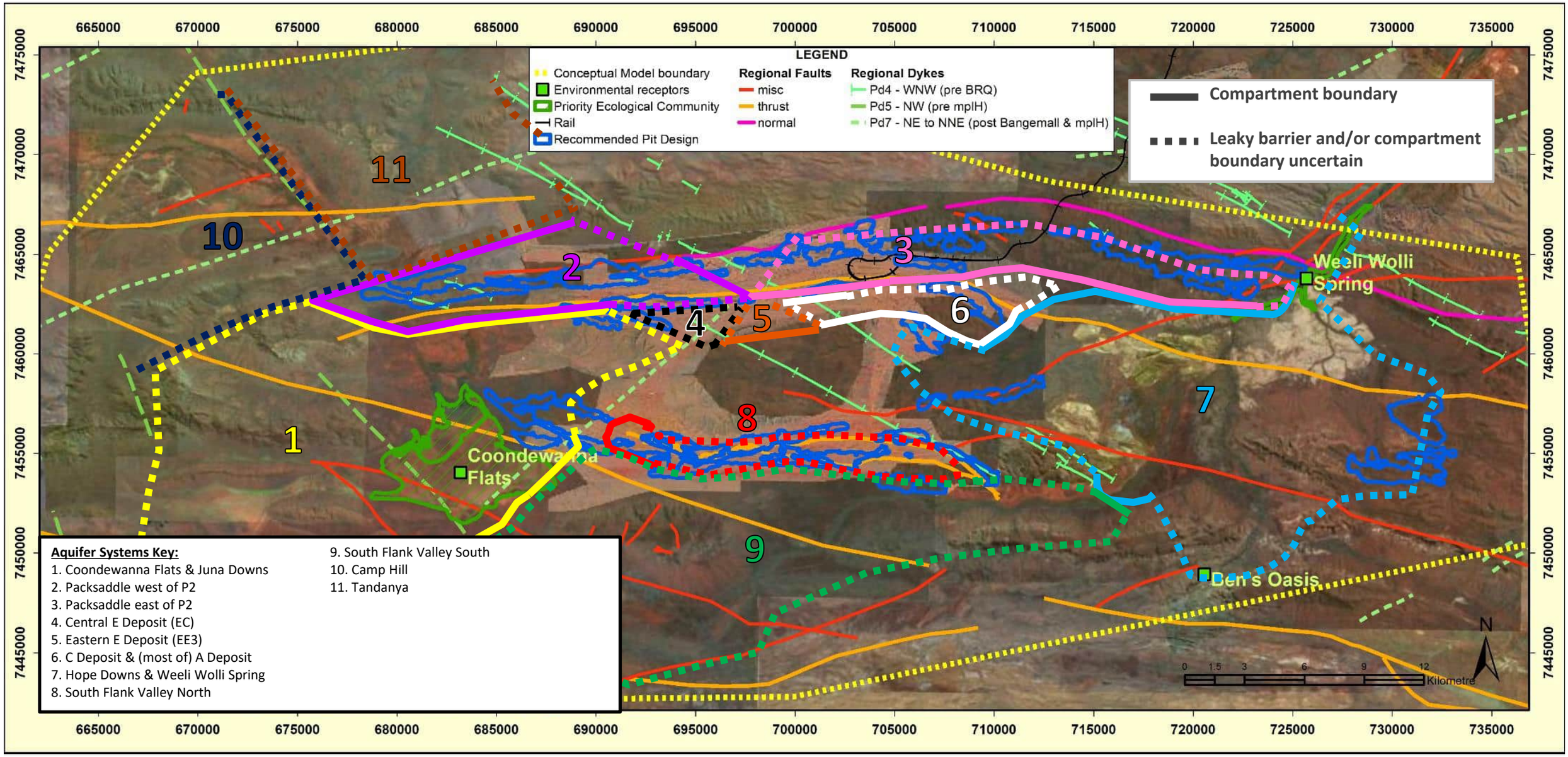


Figure 3.17
Central Pilbara aquifer systems

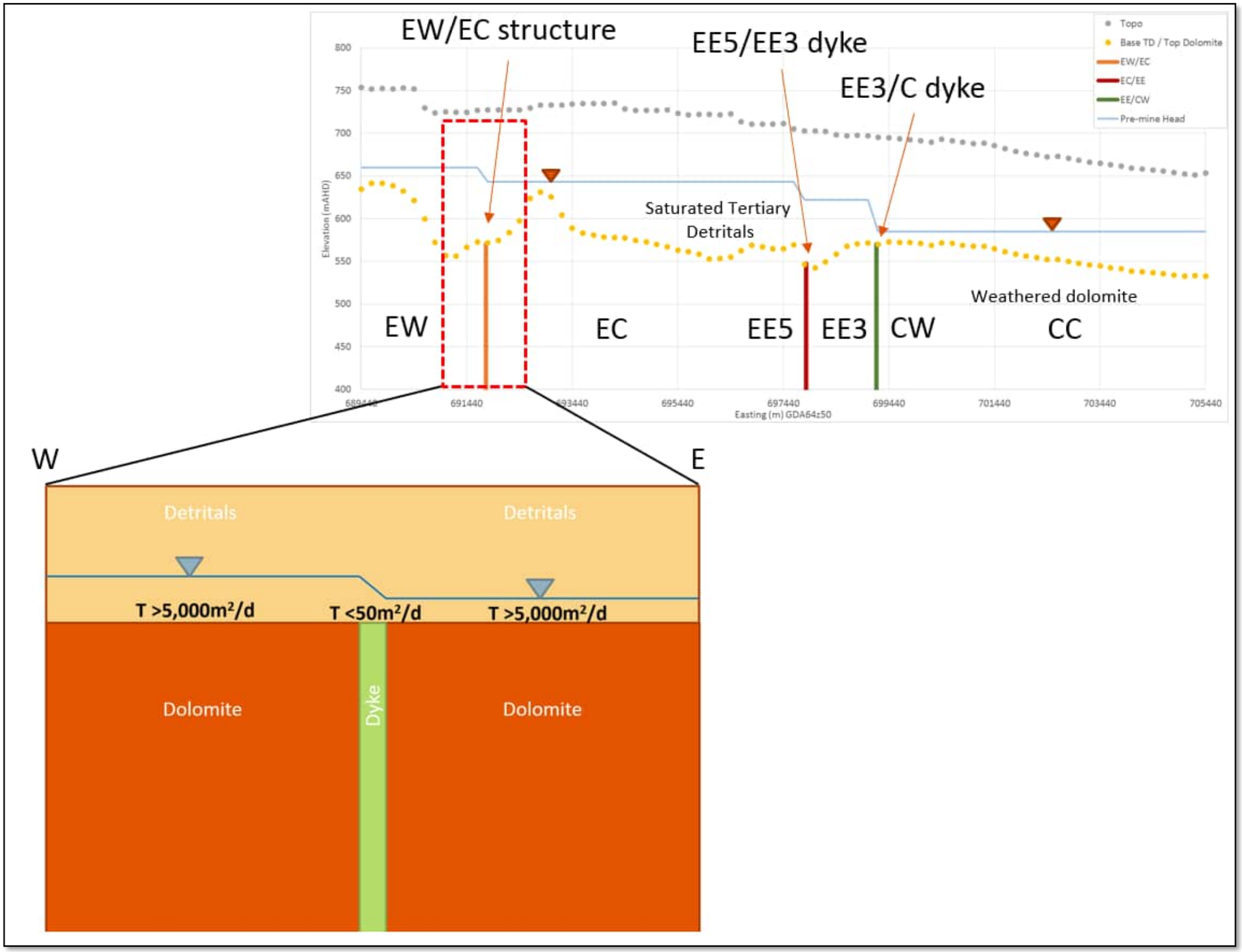


Figure 3.18
Conceptual model of flow across dyke flow barriers (through MAC E and C Deposits)

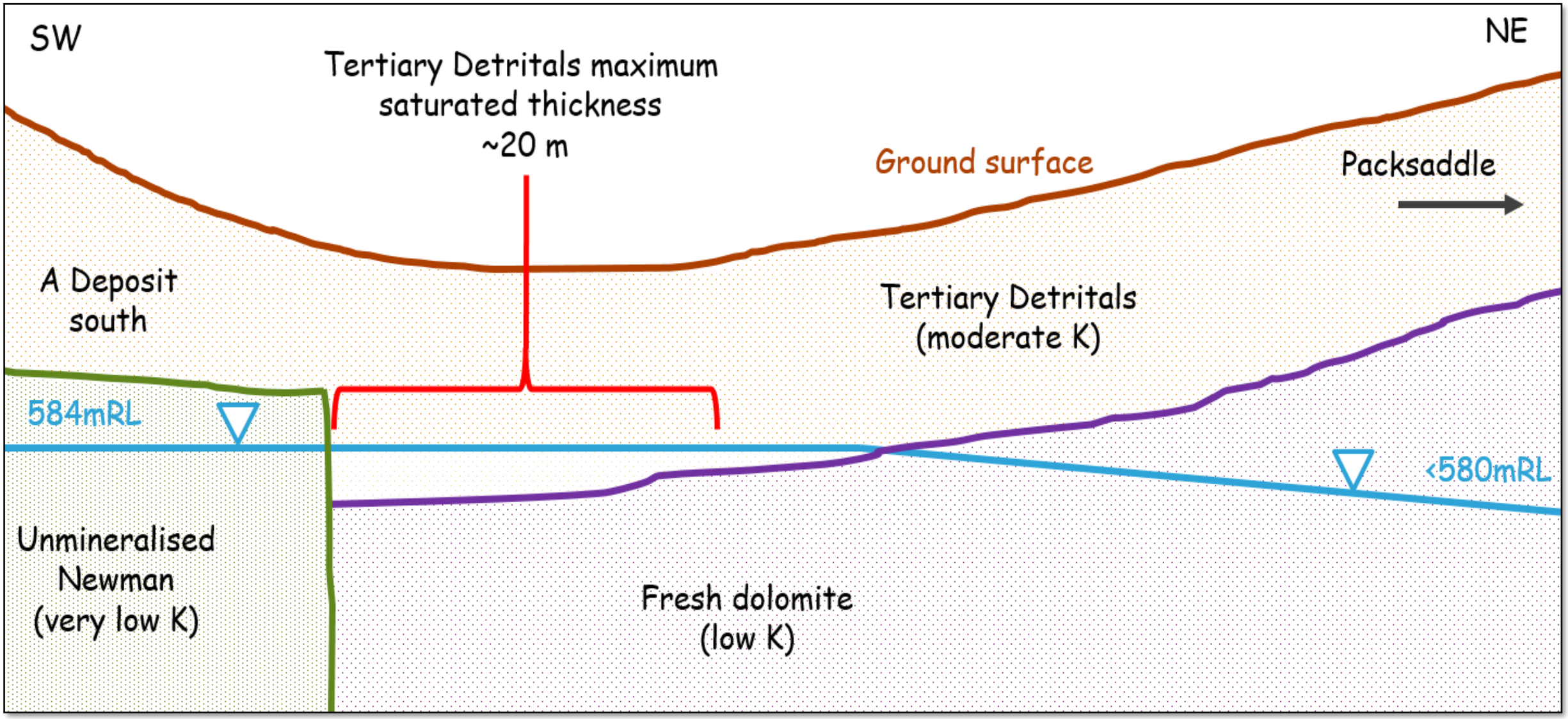


Figure 3.19
Conceptual model of flow barrier between A Deposit and Hope Downs aquifer systems

BHP

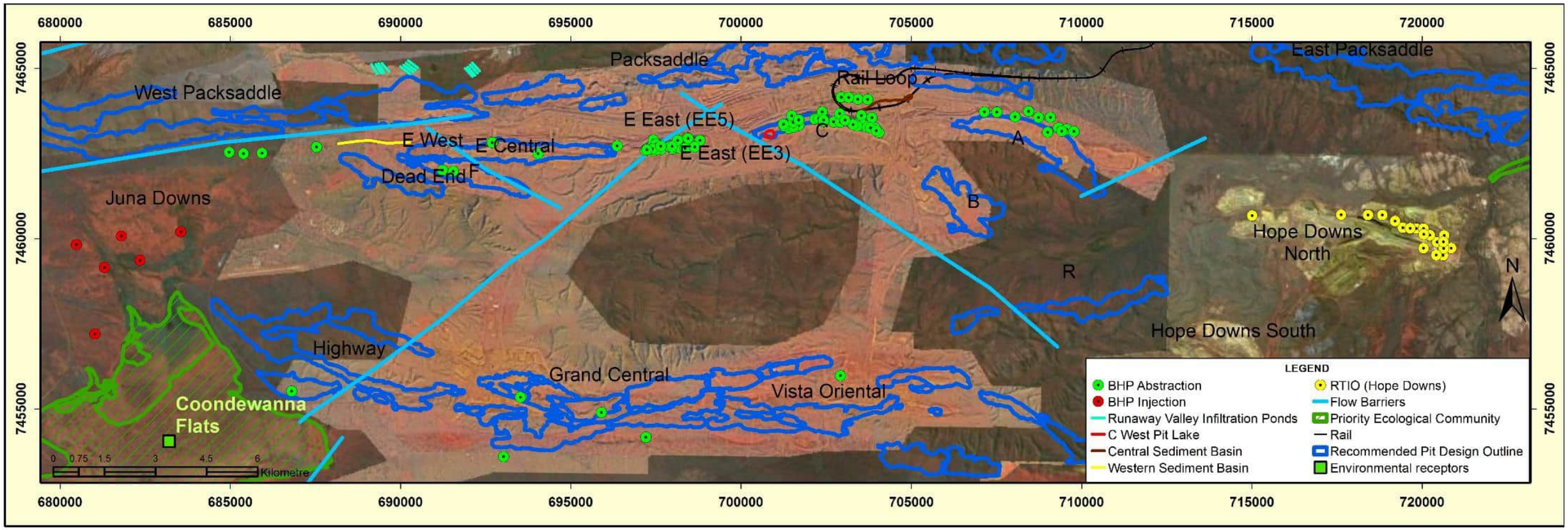
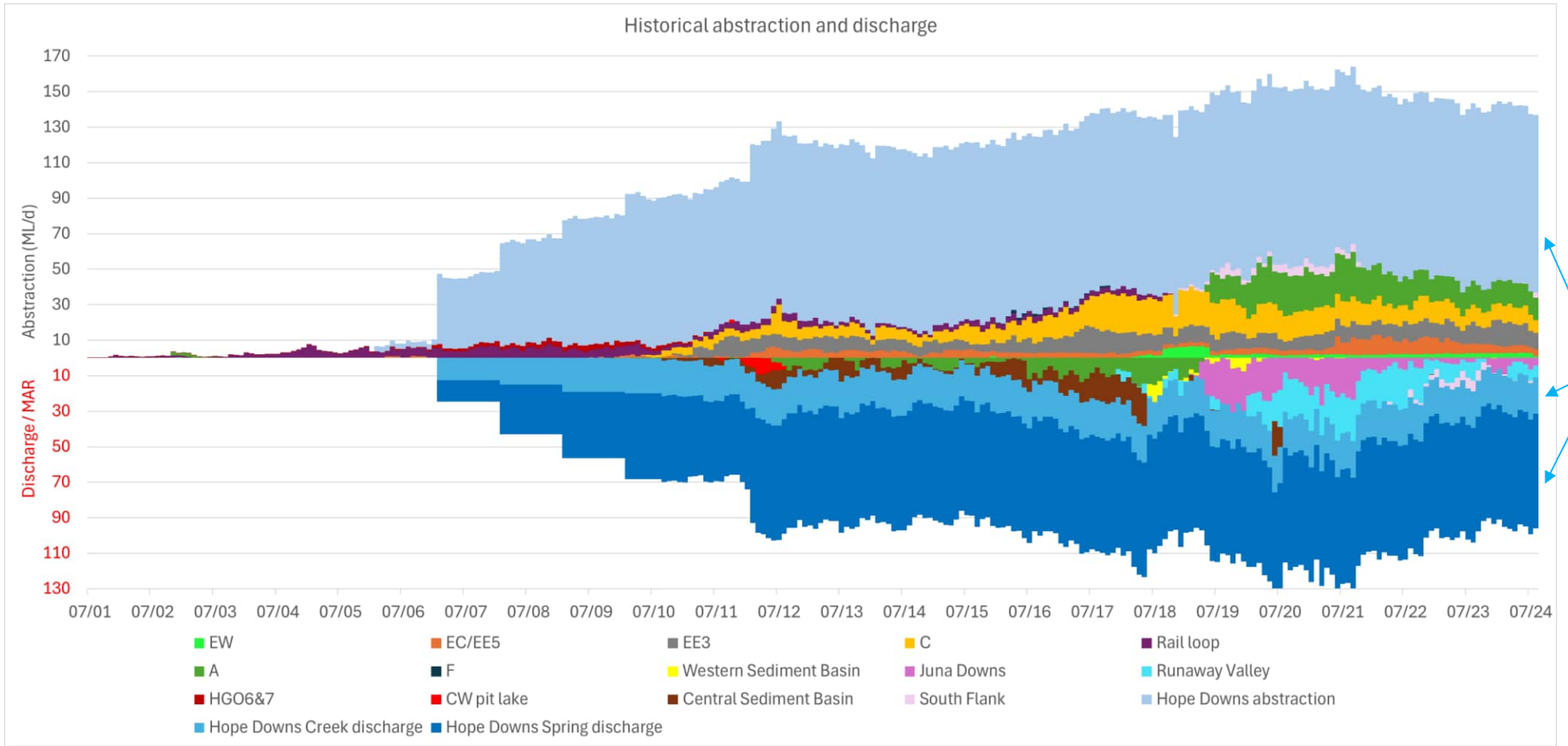


Figure 3.20
Locations of historical abstraction and discharge in the Central Pilbara catchment



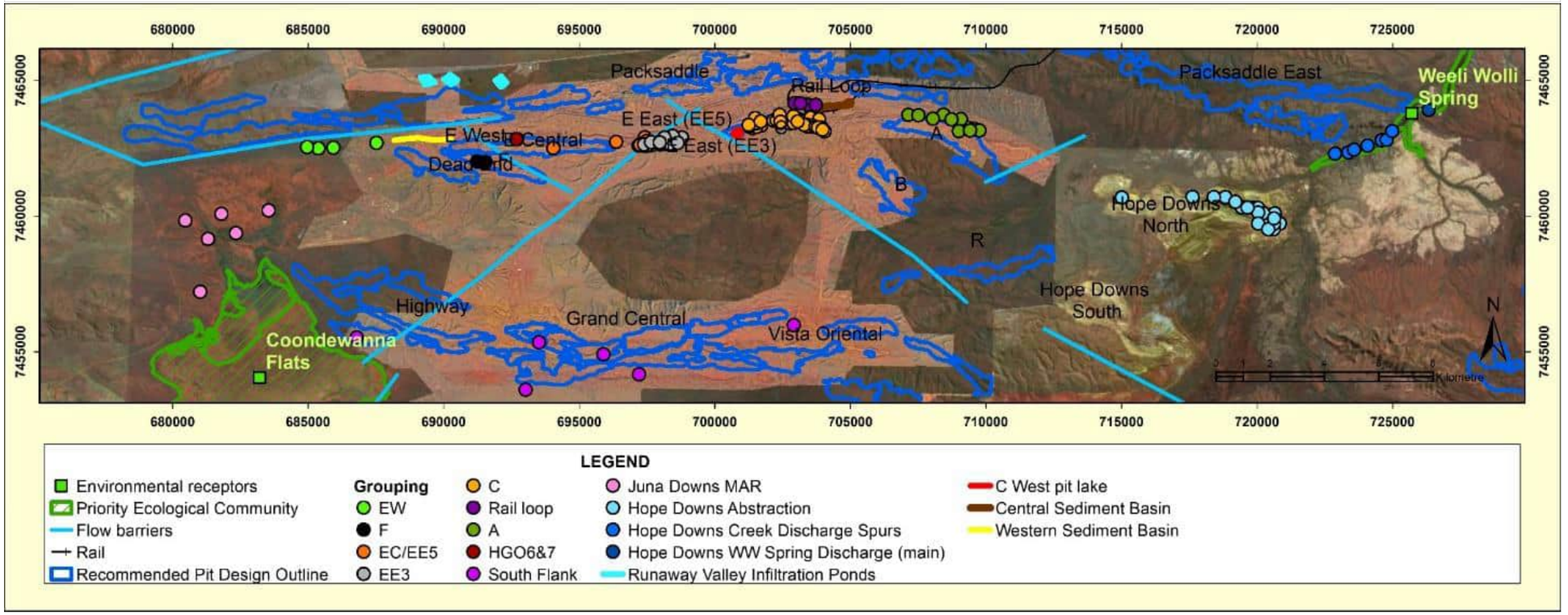
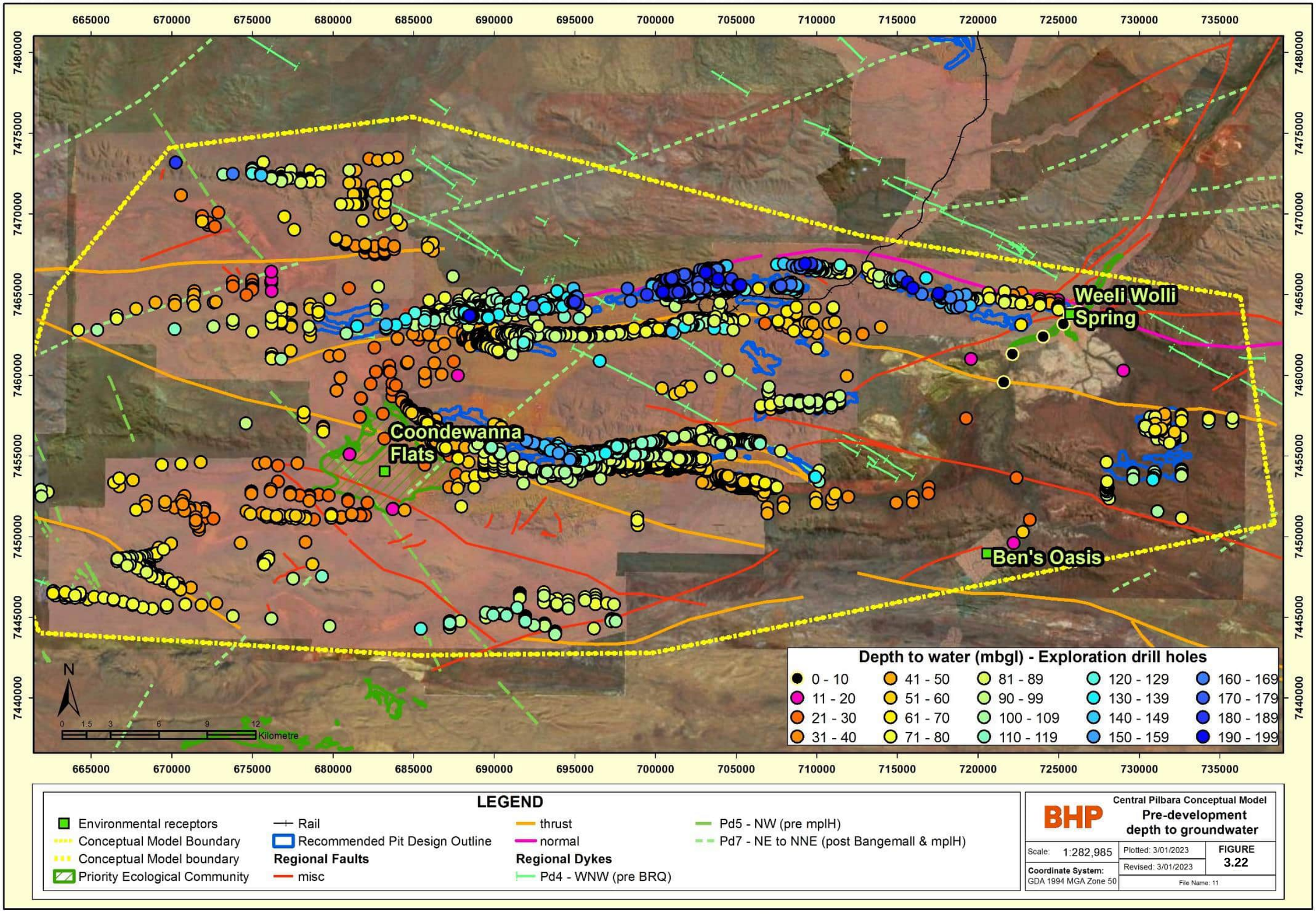


Figure 3.21
Historical abstraction and discharge rates in the catchment + geographic distribution



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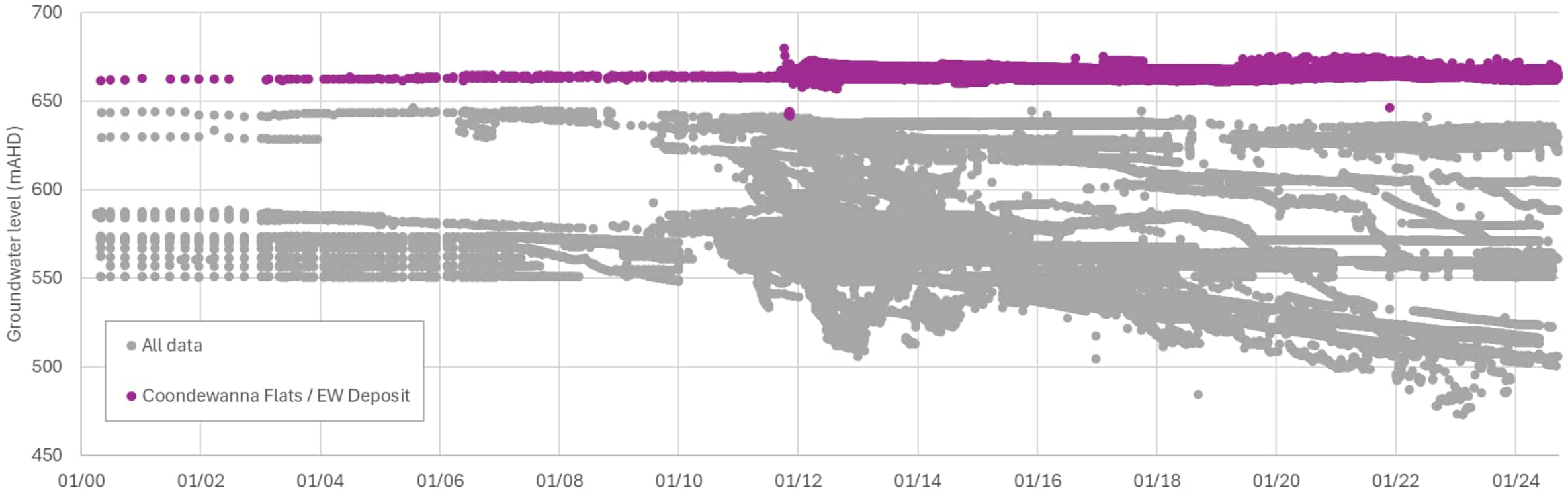
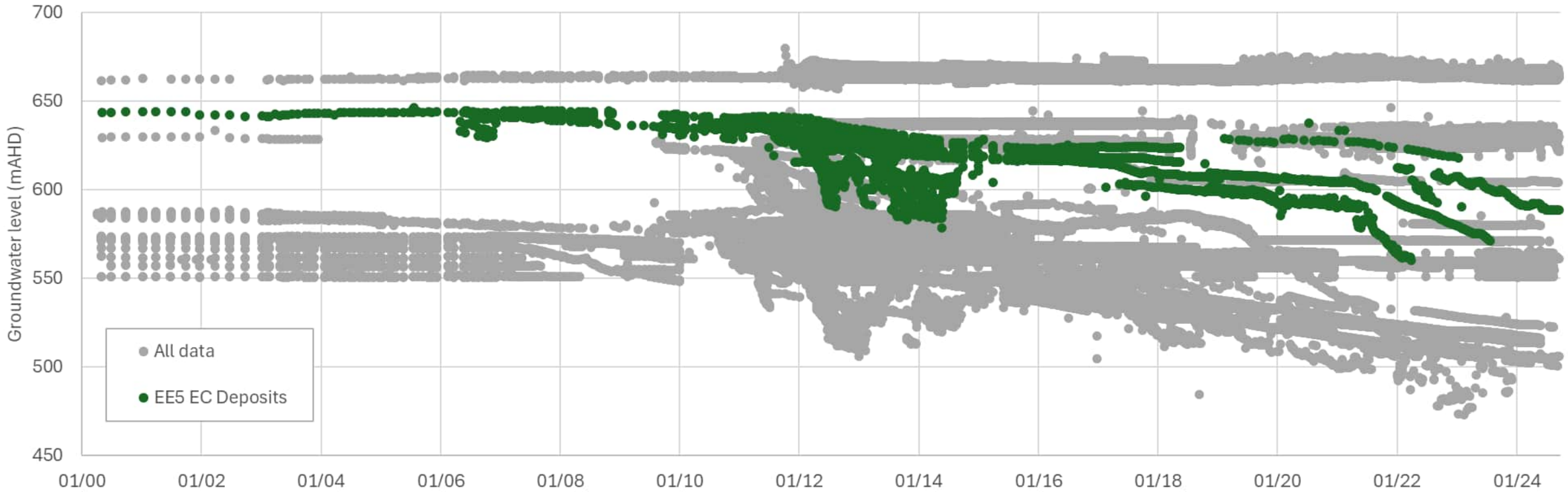


Figure 3.23
Groundwater levels Coondewanna Flats / EW Deposit and South Flank



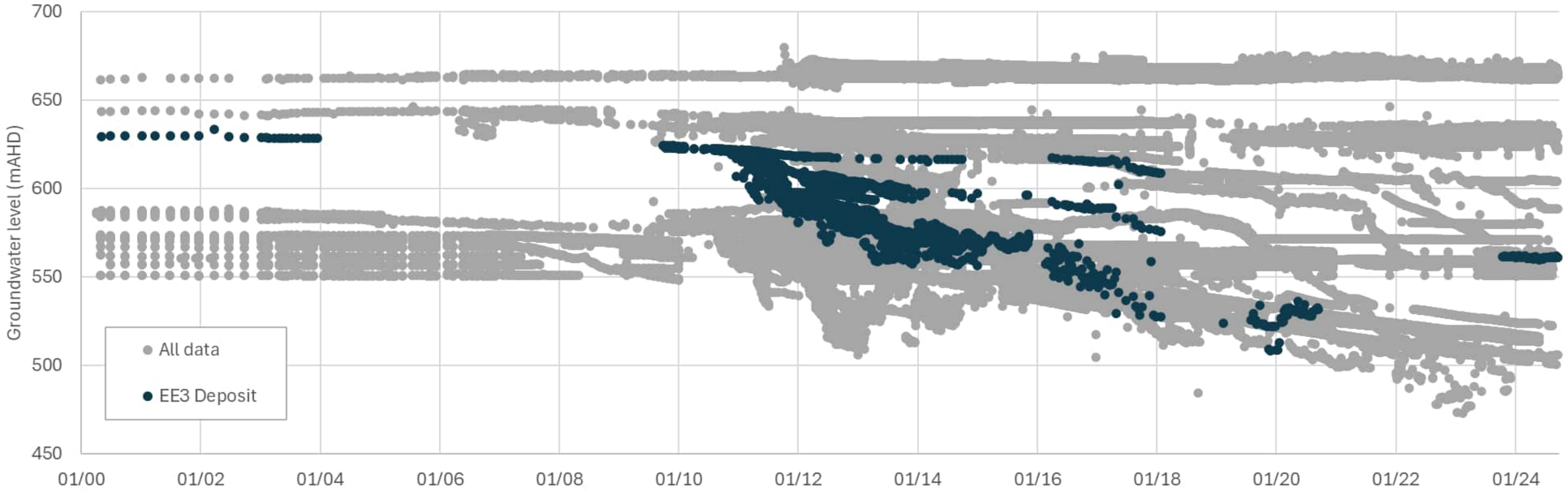


Figure 3.24
Groundwater levels EE5/EC and EE3 Deposits

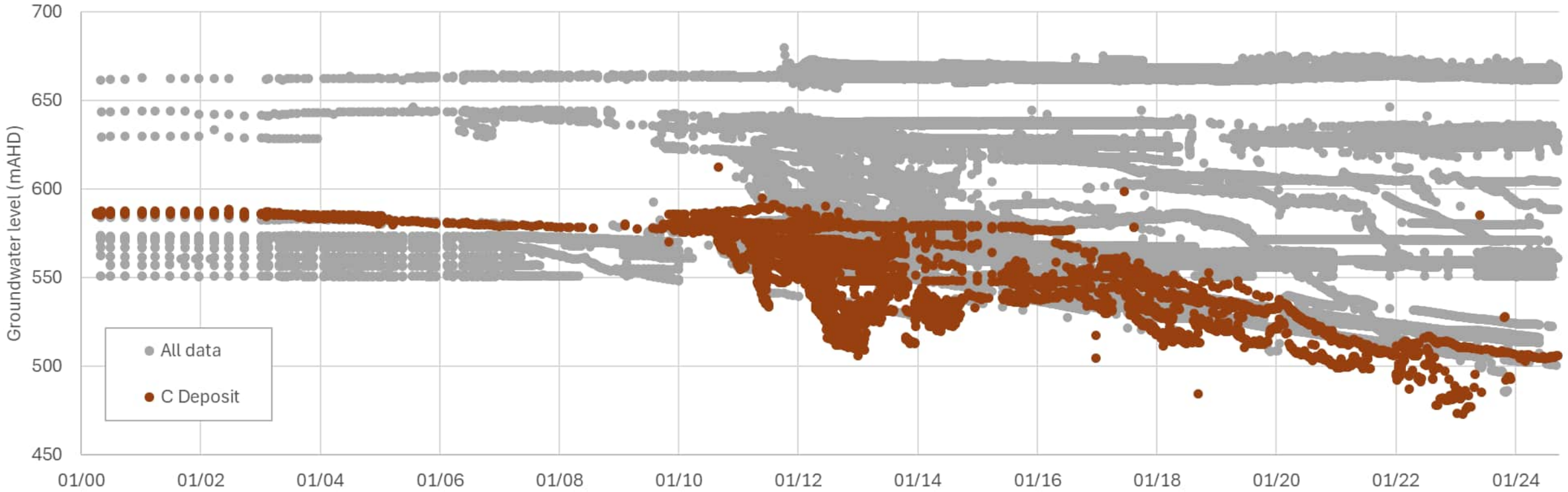


Figure 3.25
Groundwater levels A and C Deposits

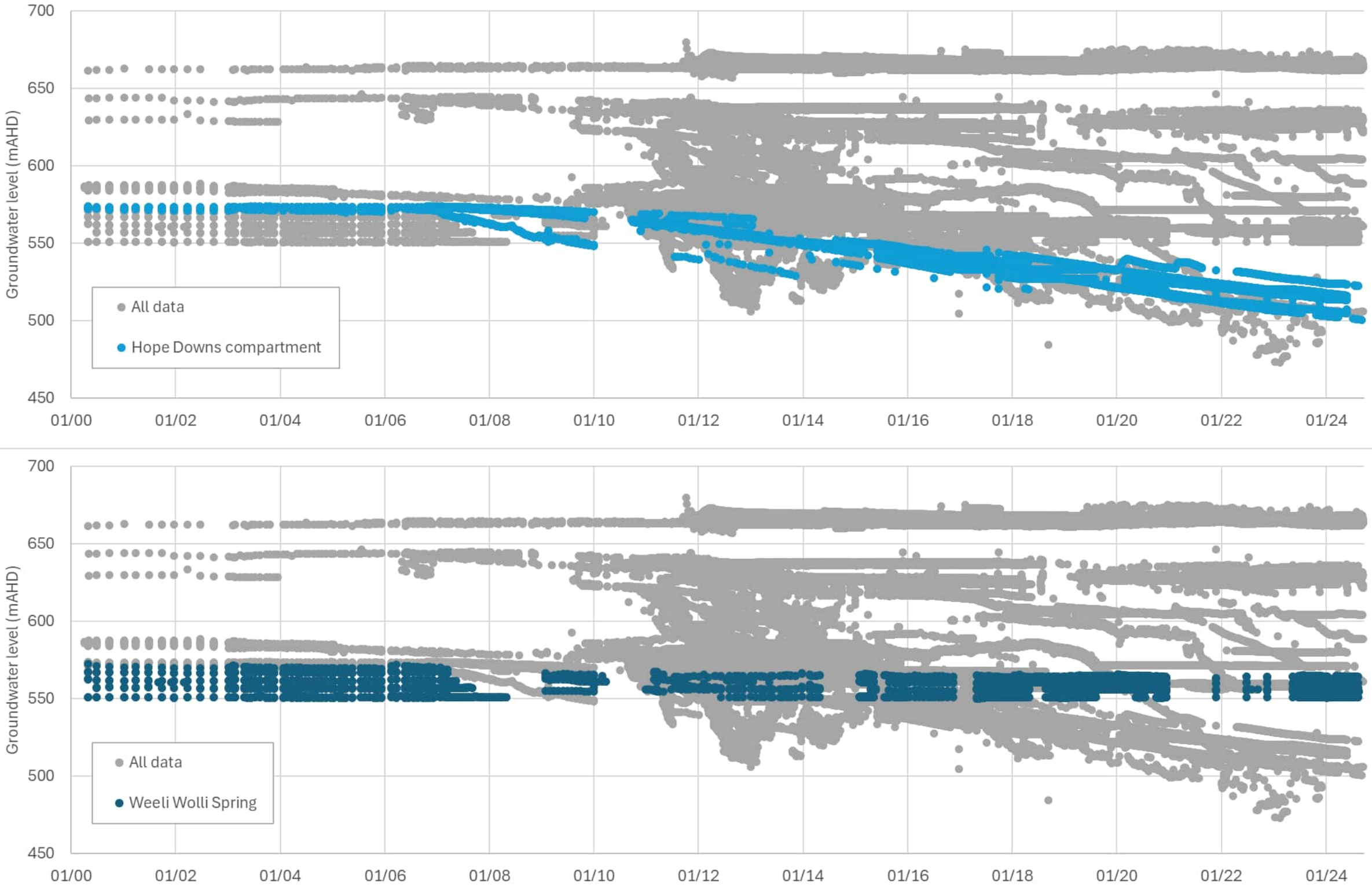


Figure 3.26
Groundwater levels Hope Downs compartment and Weeli Wolli Spring

BHP

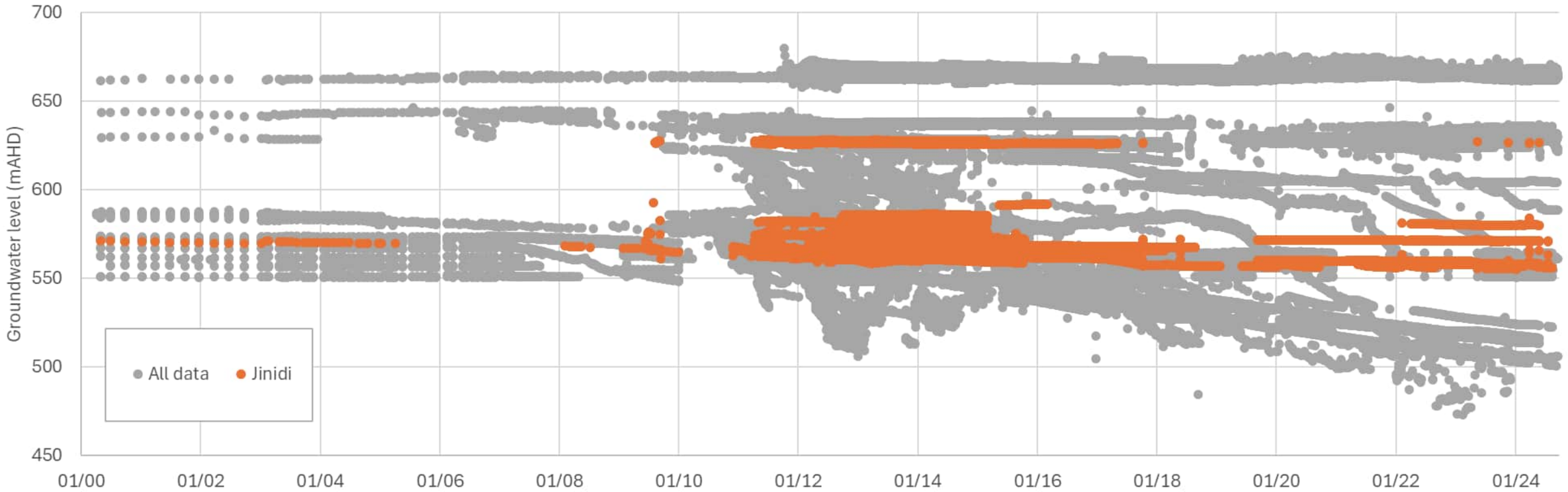


Figure 3.27
Groundwater levels Jinidi and Ben's Oasis

BHP

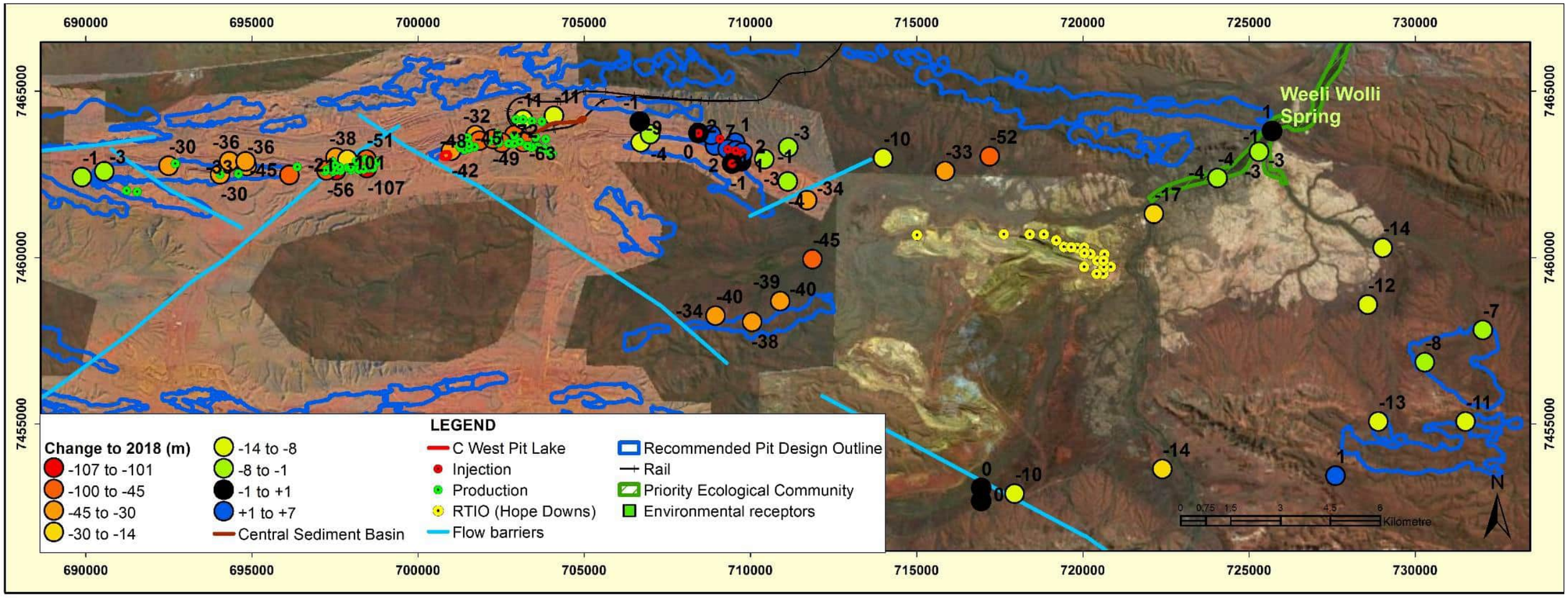


Figure 3.28
Change in heads from pre-development to 2018

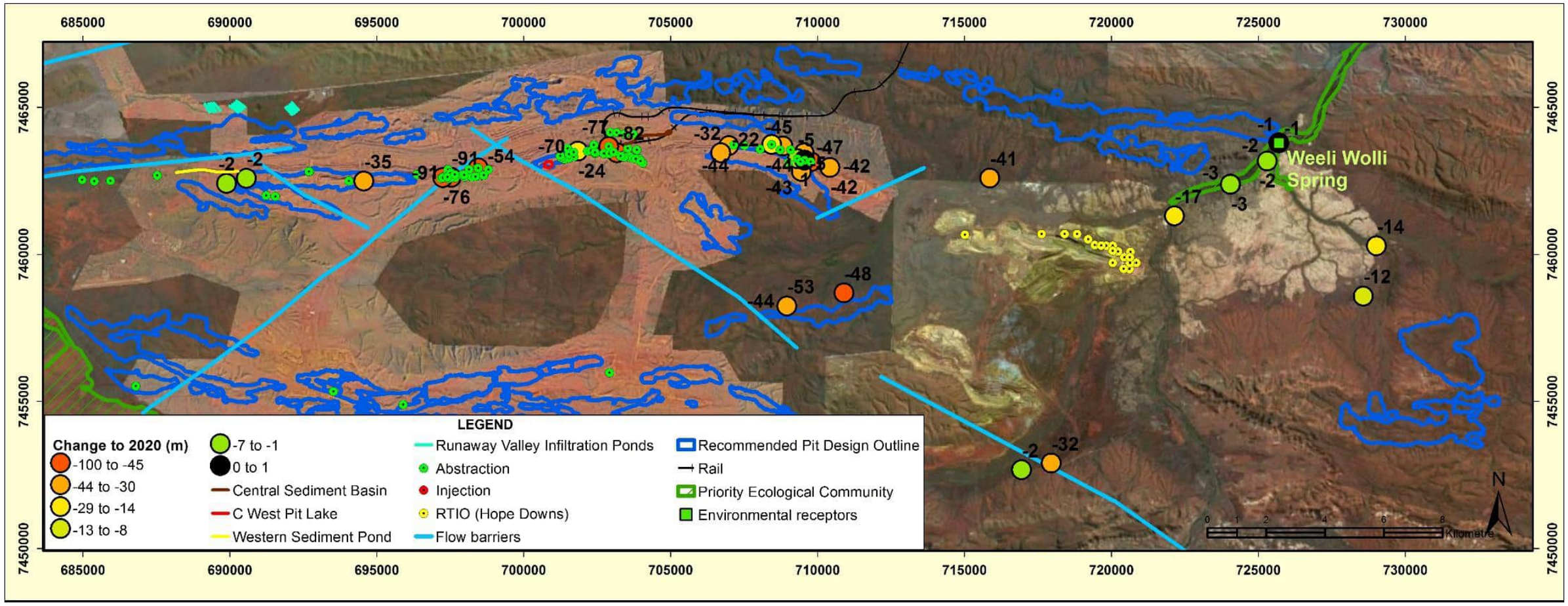
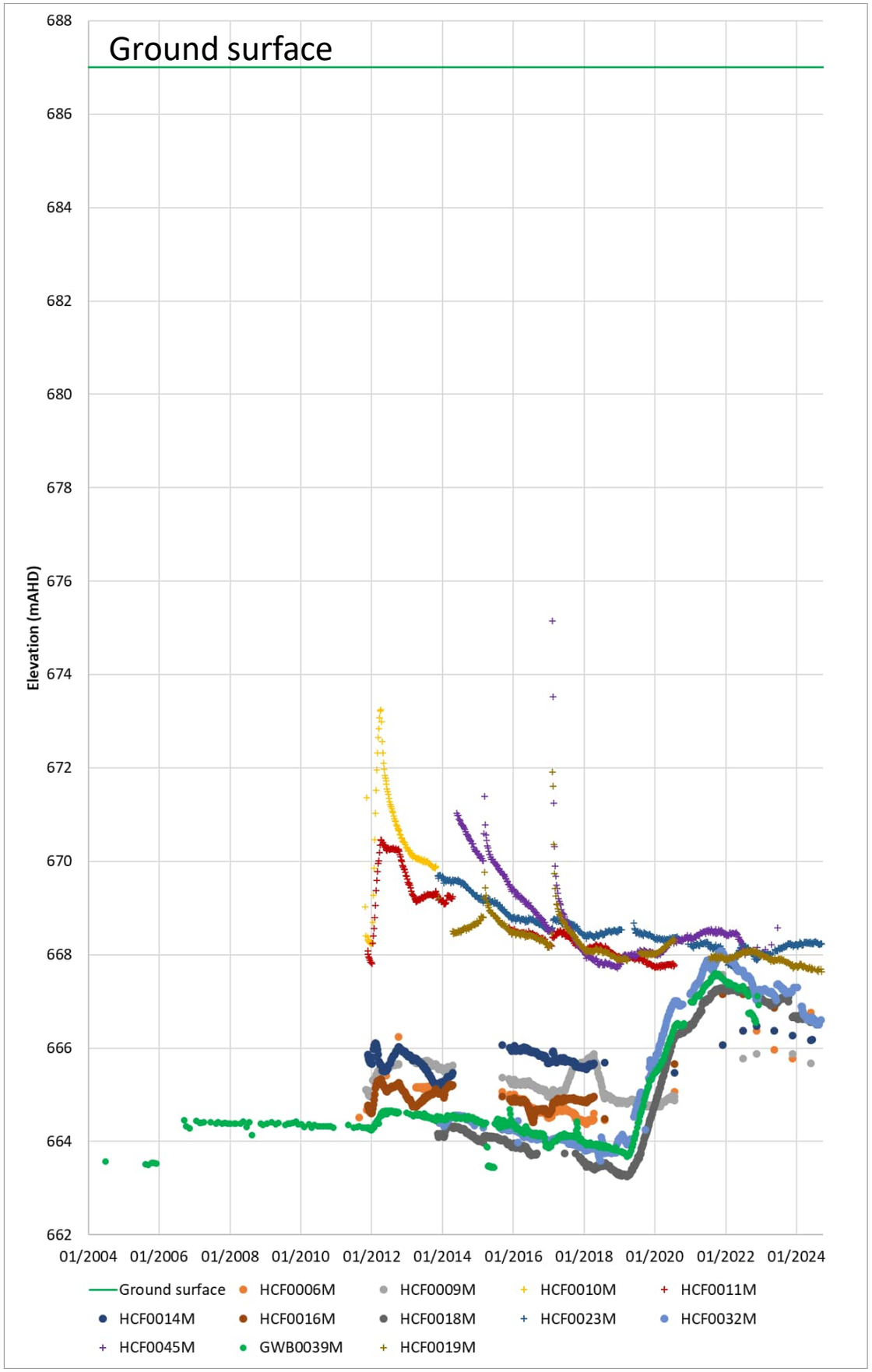


Figure 3.29
Change in heads from pre-development to 2020



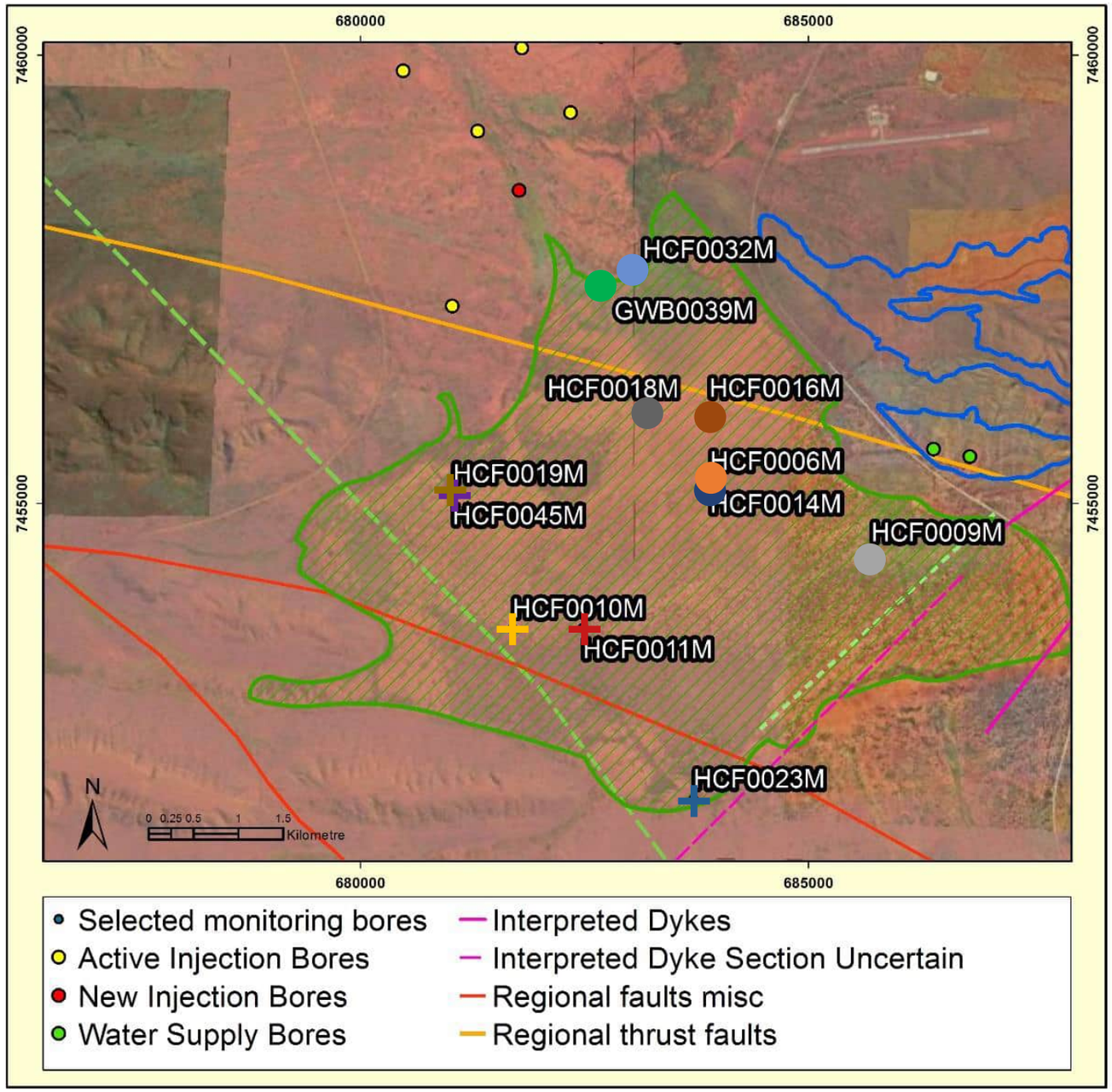


Figure 3.30
Coondewanna Flats groundwater levels

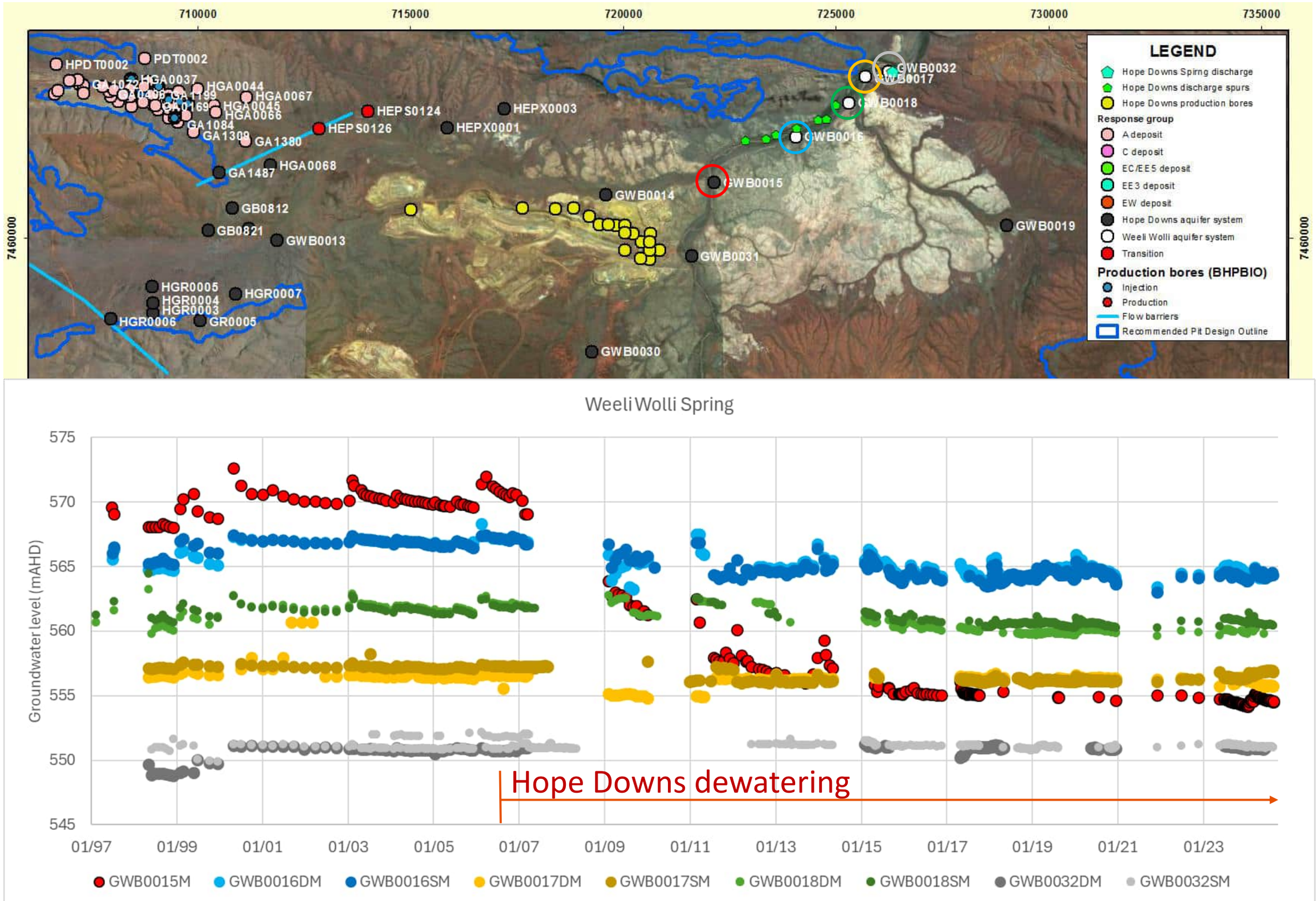


Figure 3.31
Weeli Wolli compartment groundwater levels

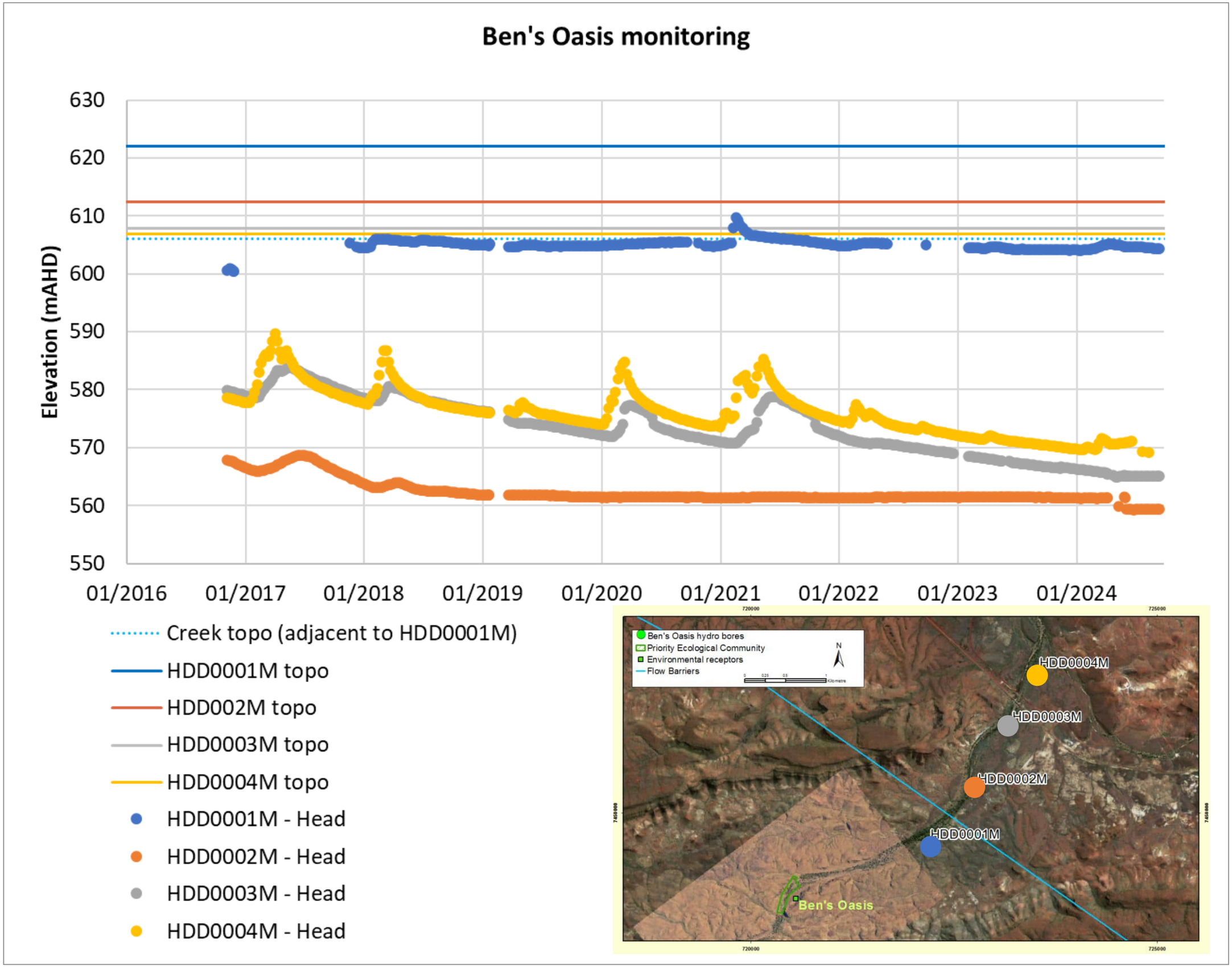


Figure 3.32
Ben's Oasis area groundwater levels

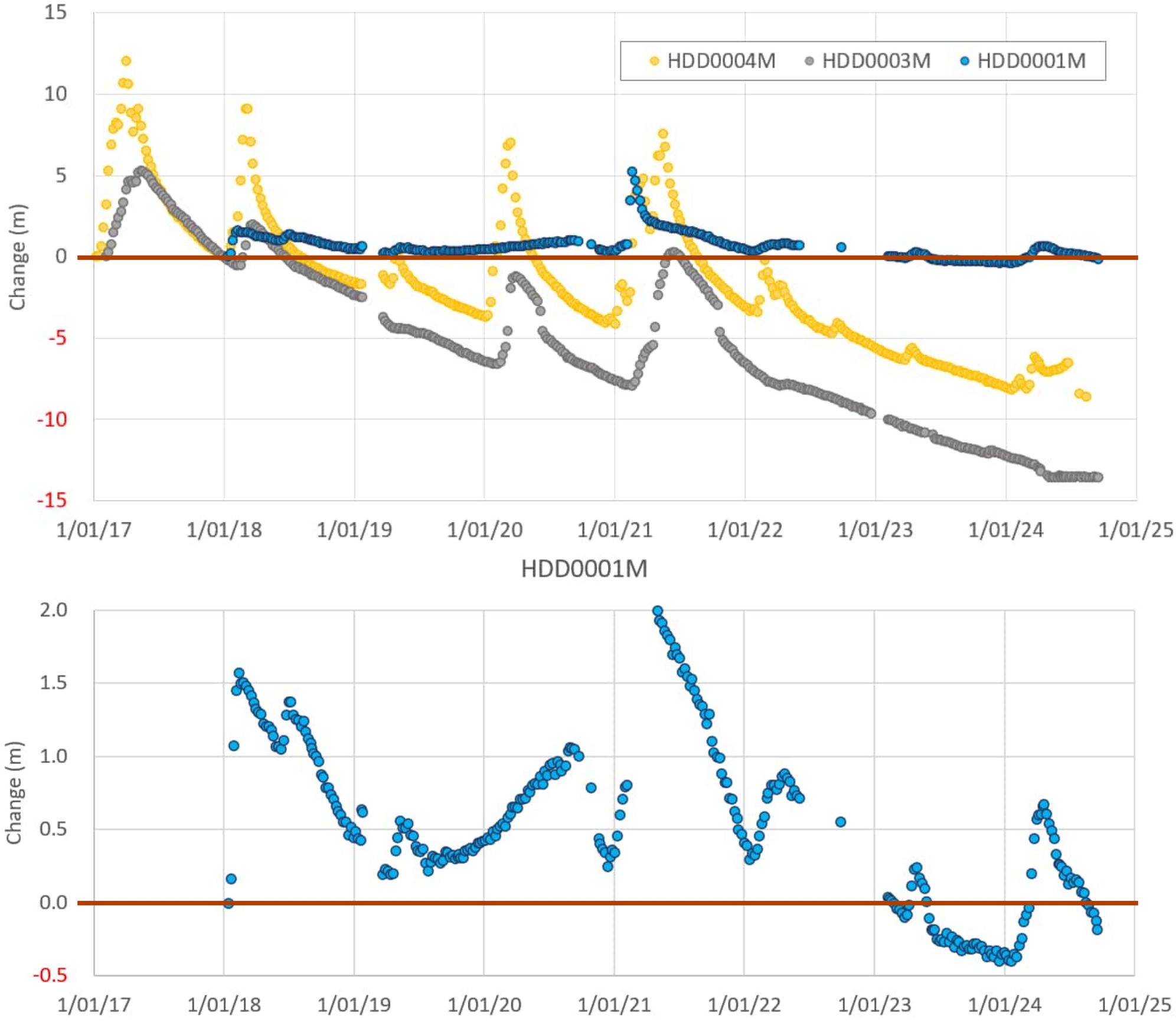
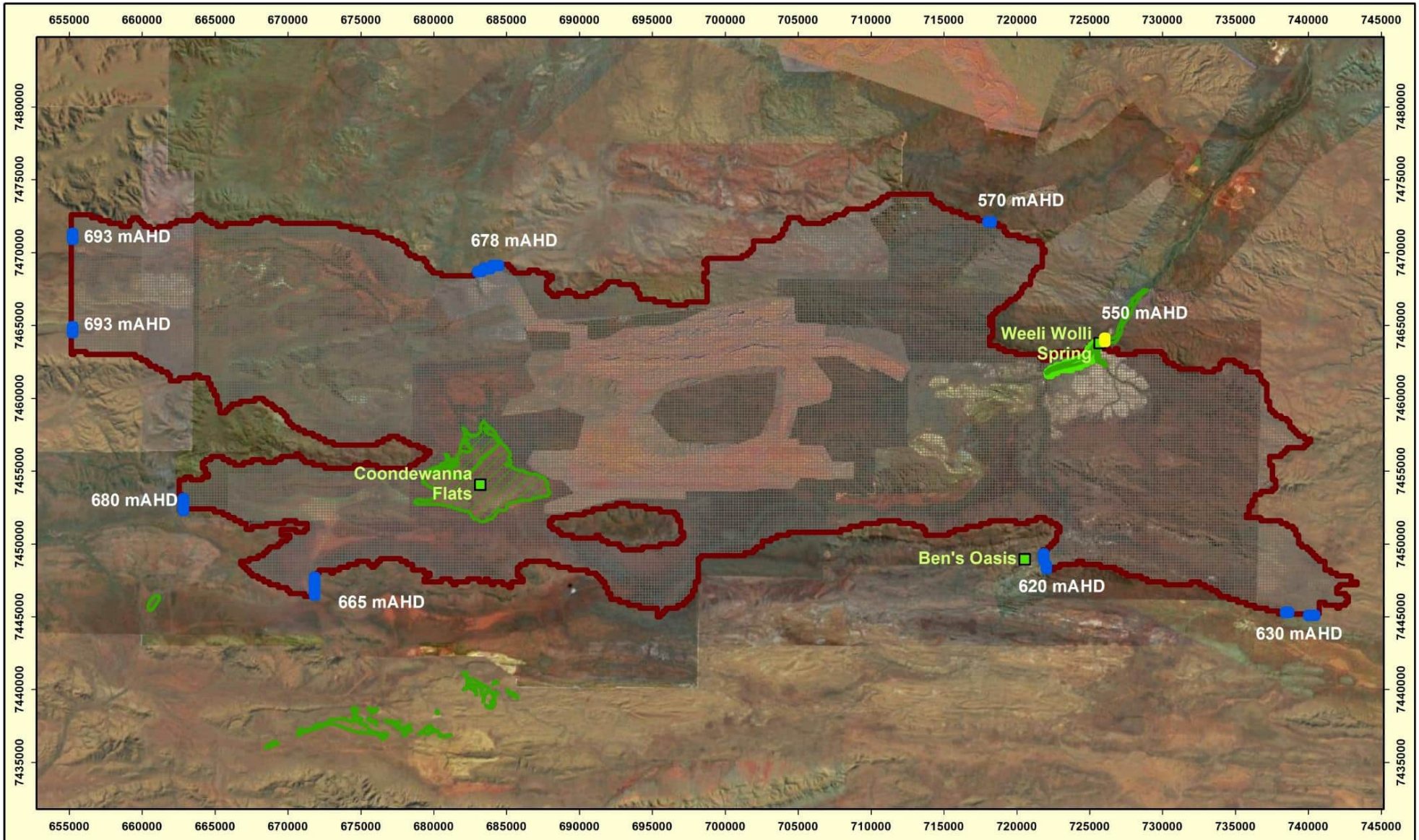
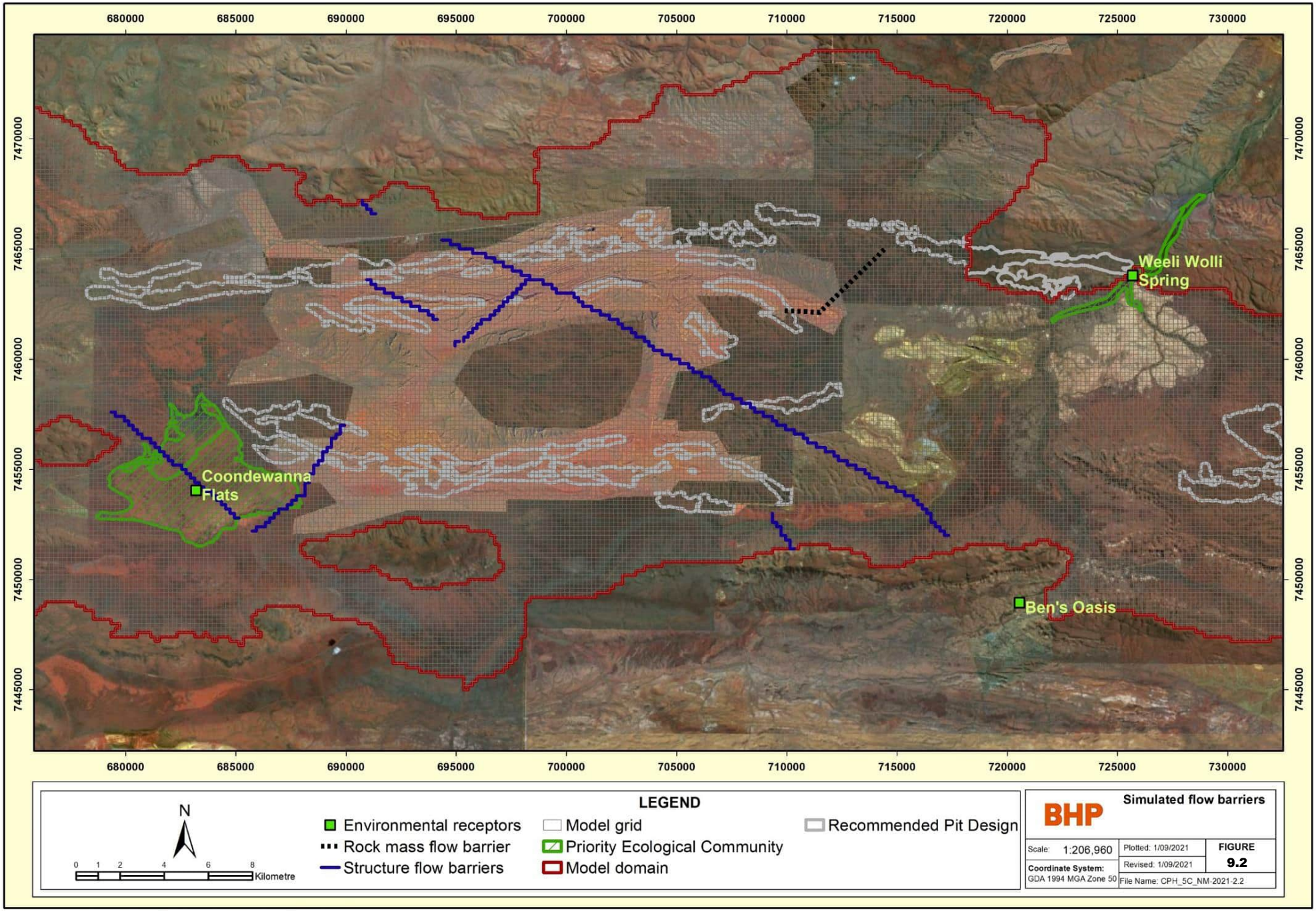


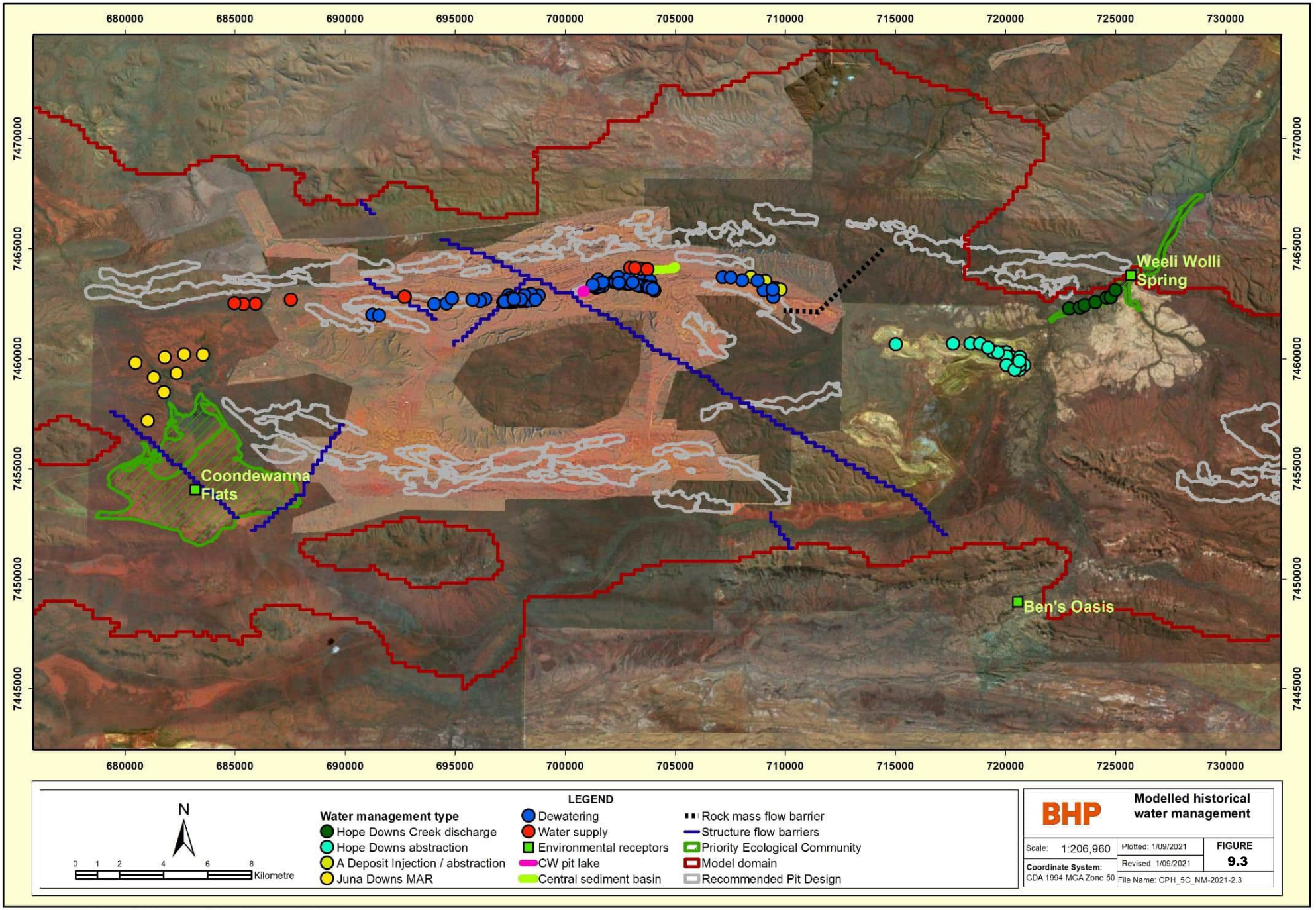
Figure 3.33
Ben's Oasis area groundwater level change



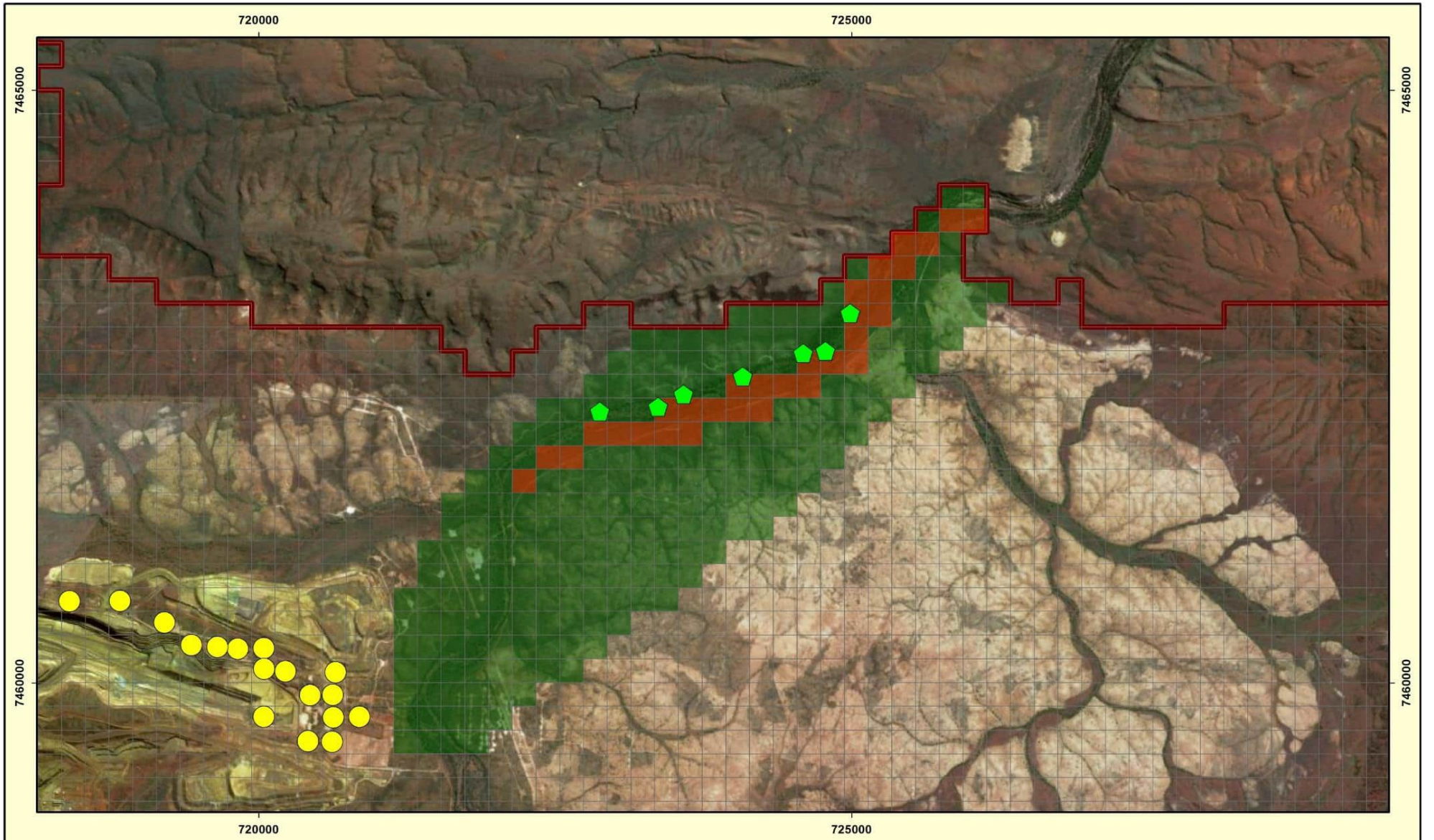
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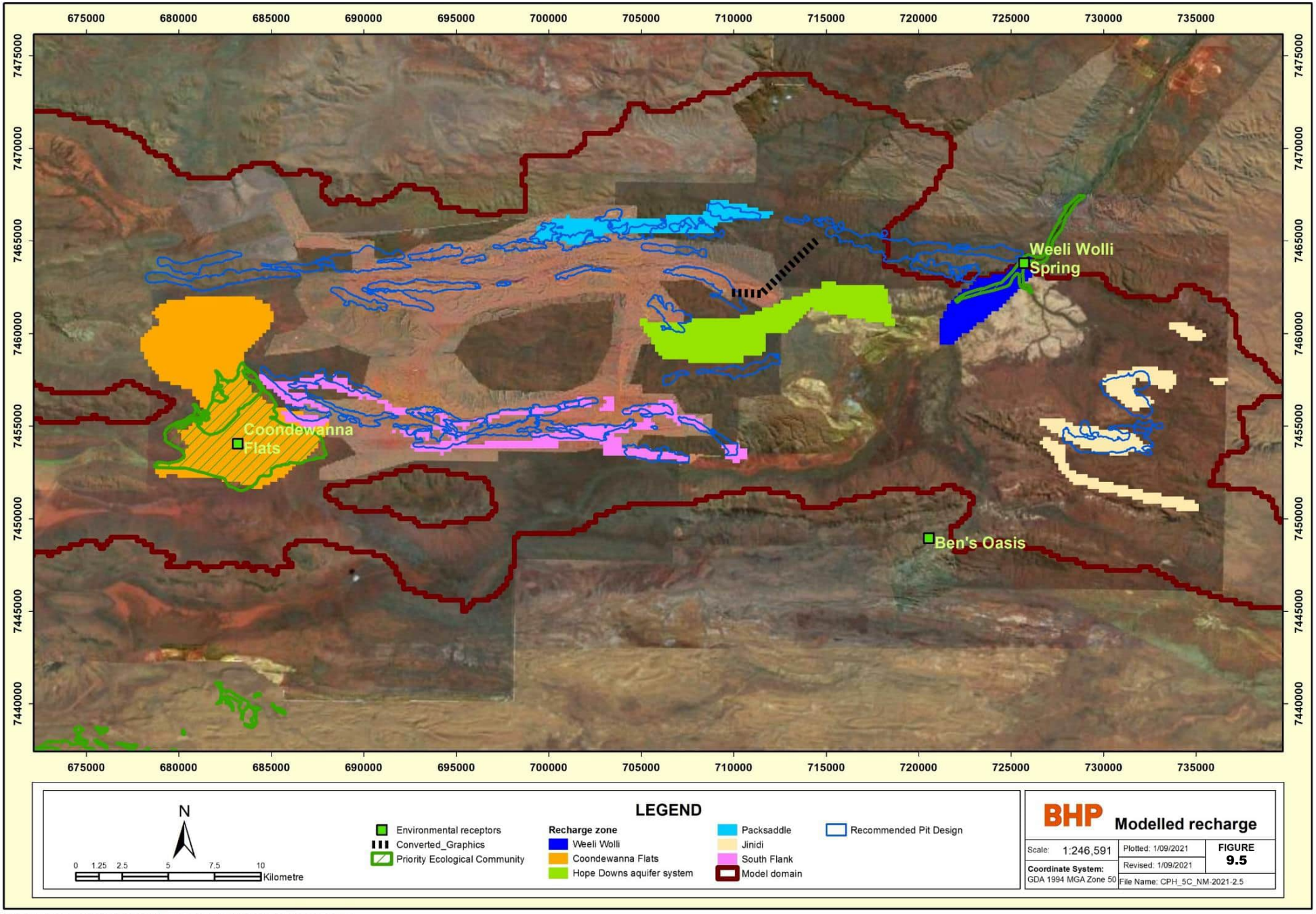


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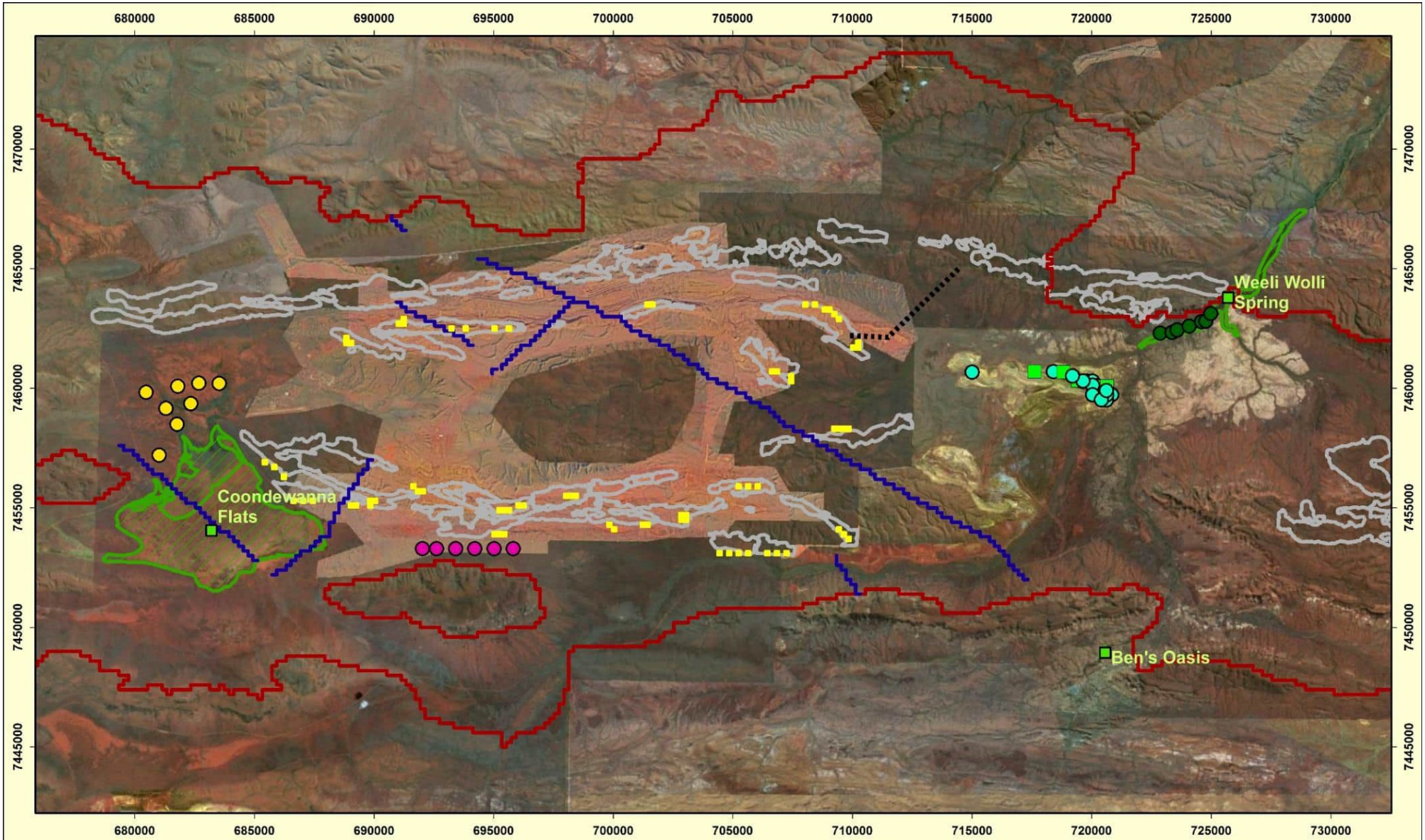
Modelled Weeli Wolli Creek / Spring system

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N

0 1 2 4 6 8 Kilometre

LEGEND

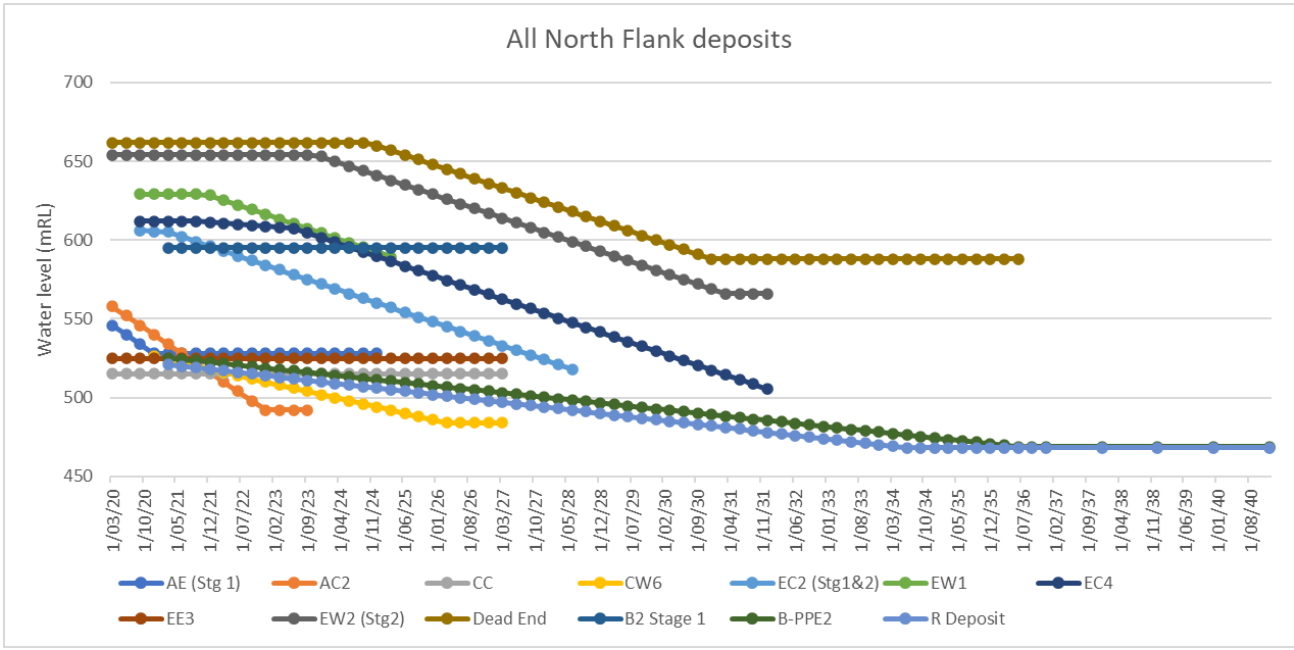
Water management type
- Hope Downs Creek discharge
- Hope Downs abstraction
- Hope Downs injection / abstraction
- Juna Downs MAR
- South Flank MAR
- Environmental receptors
- Rock mass flow barrier
- Structure flow barriers
- Drain boundary conditions
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

Modelled future water management

Scale: 1:206,960	Plotted: 31/08/2021	**FIGURE 9.6**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
	File Name: CPH_5C_NM-2021-2.6	

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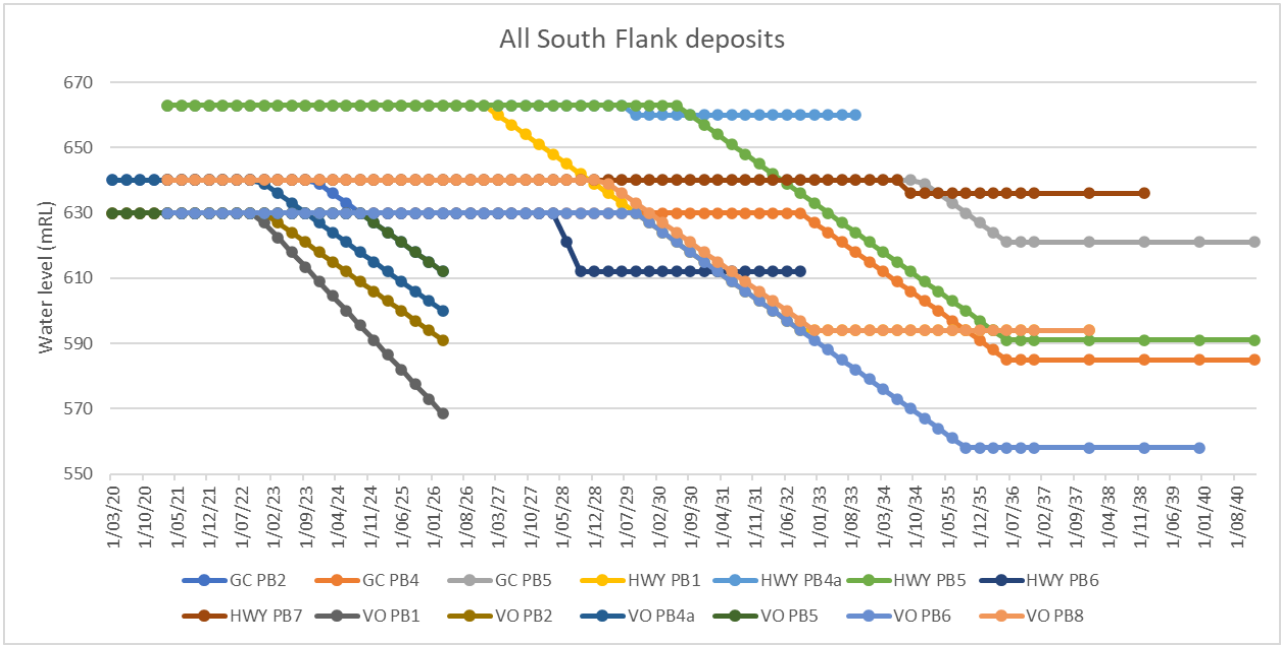
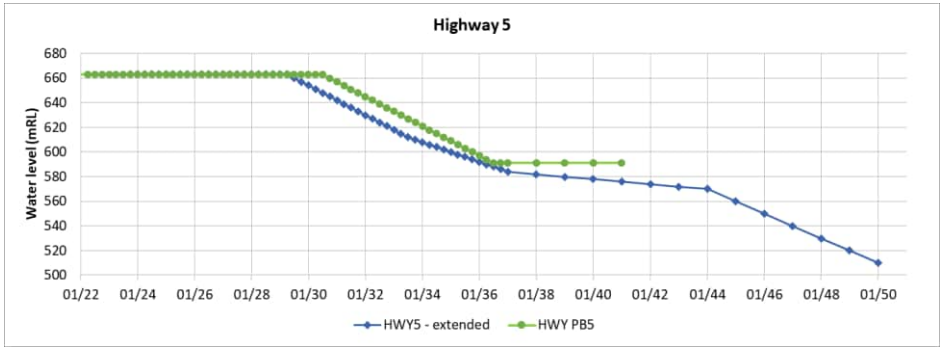
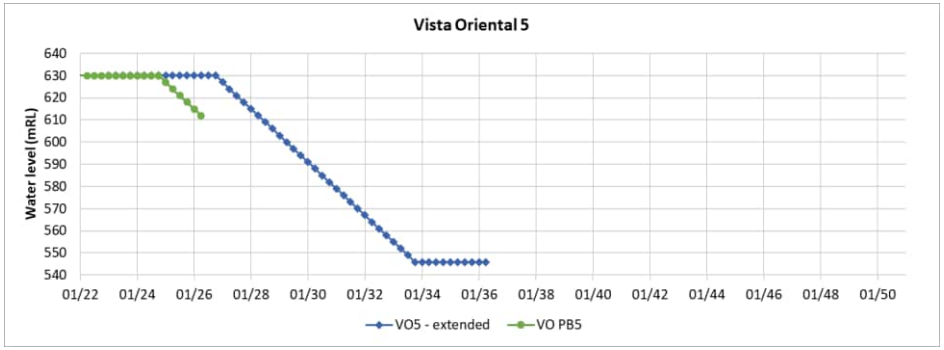
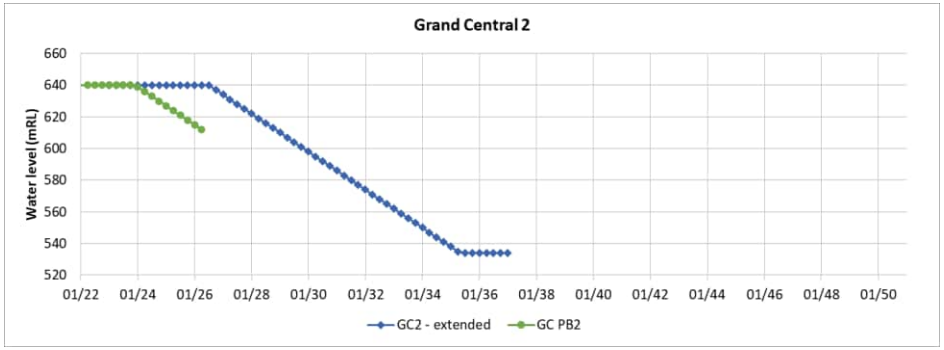
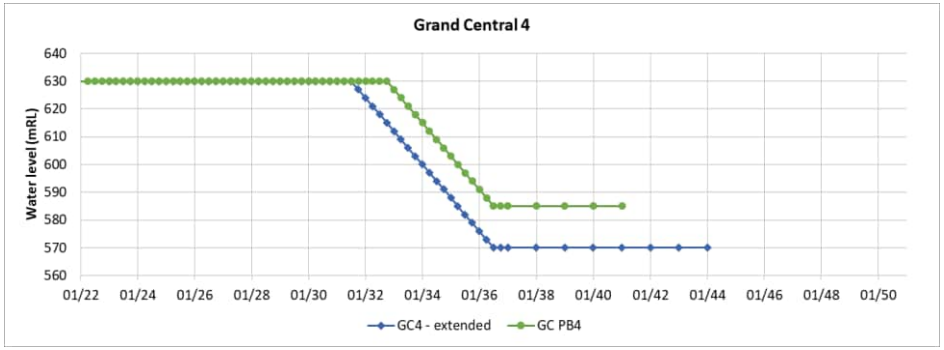


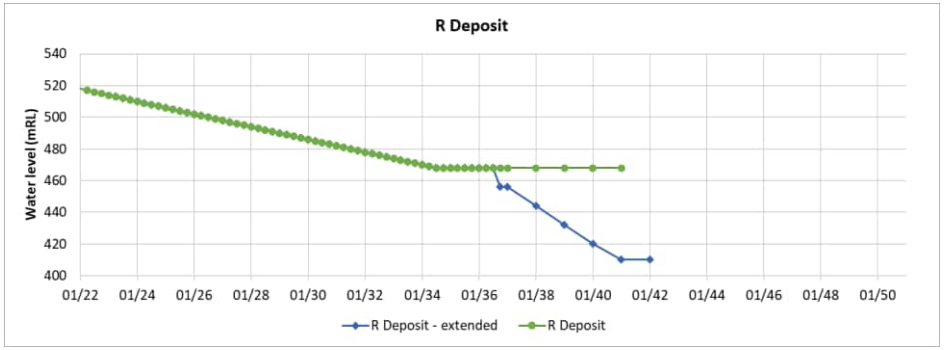
Figure 9.7
Target water levels

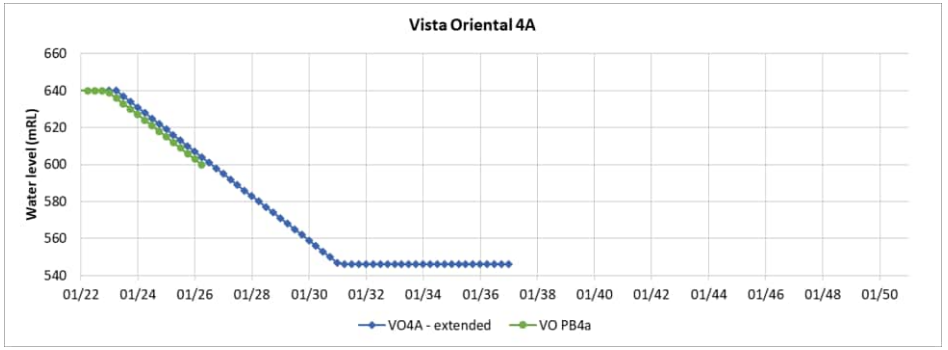












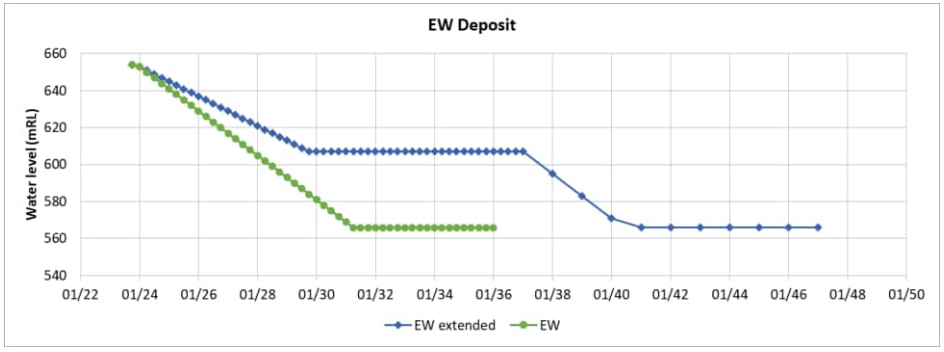
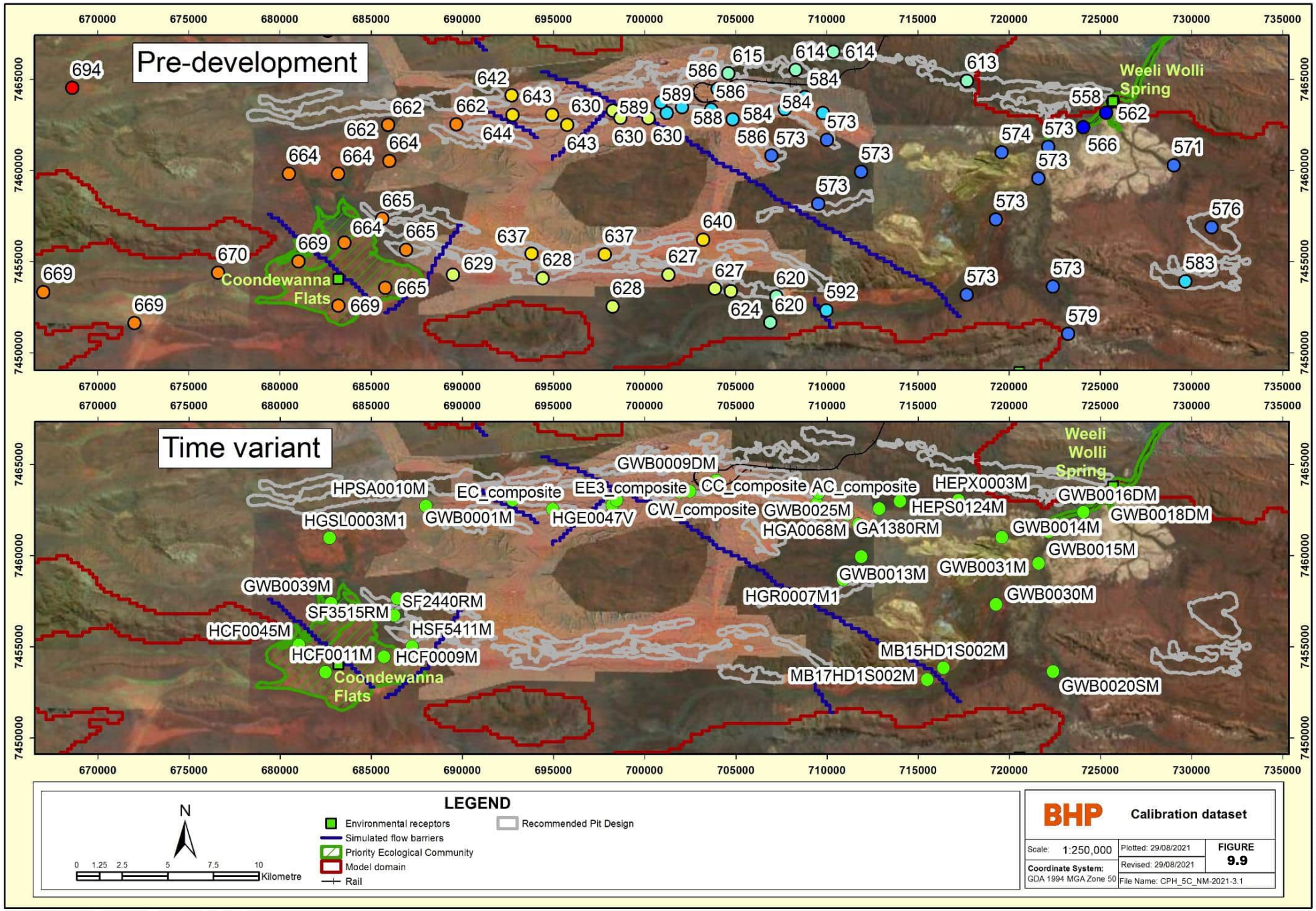
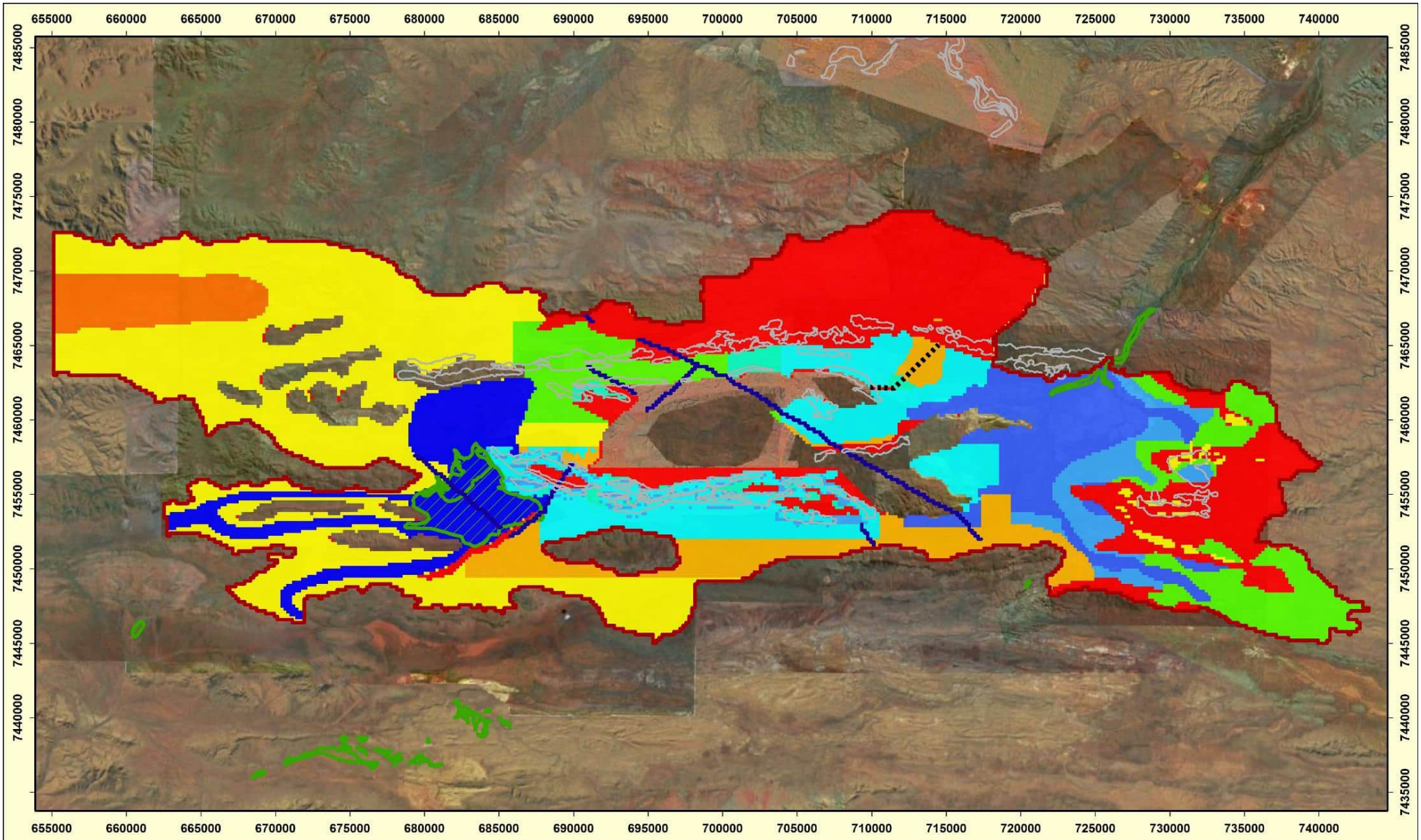


Figure 9.8
Target water levels – Extended



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N

0 1.75 3.5 7 10.5 14 Kilometre

LEGEND

Hydraulic conductivity (m/d)

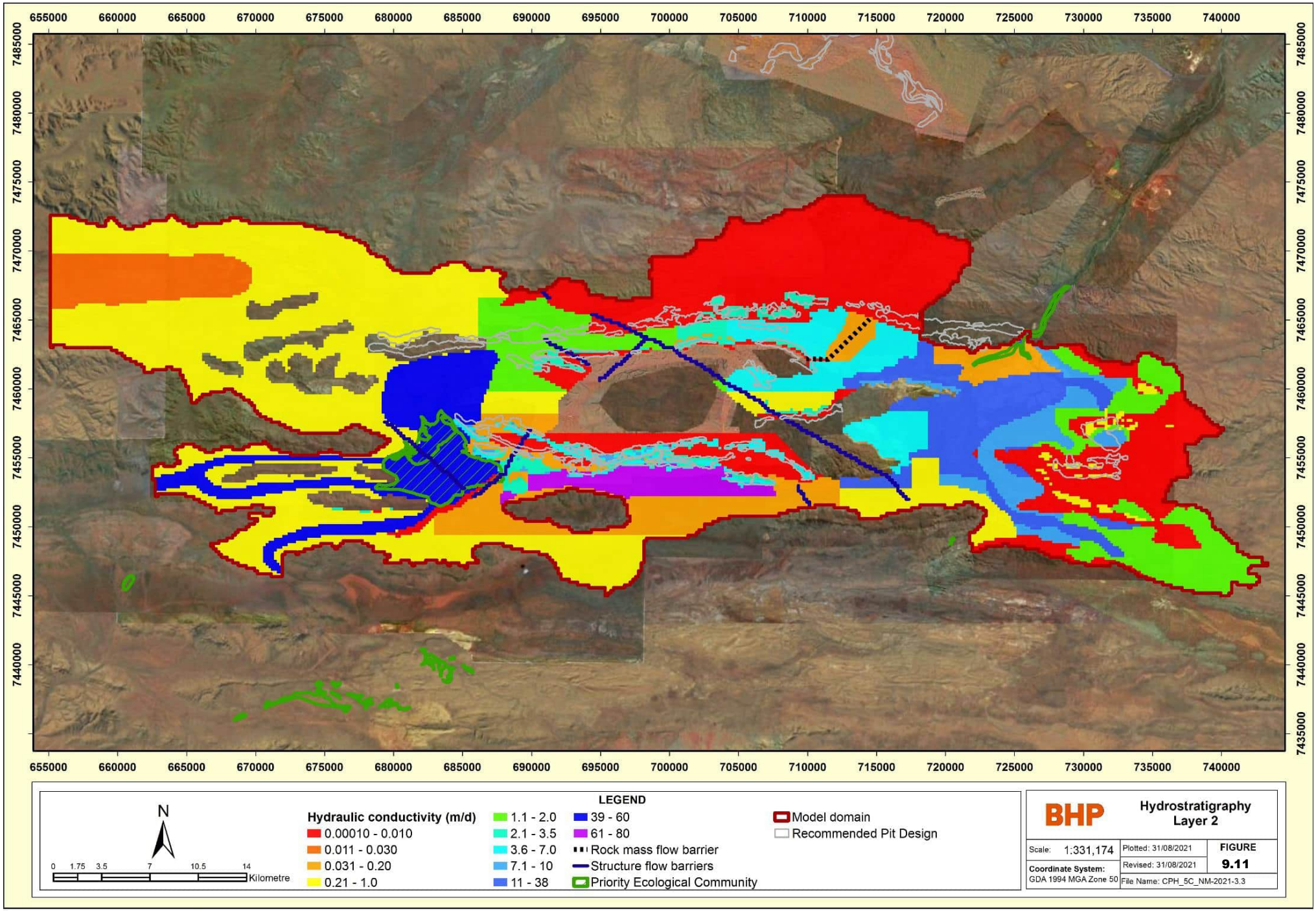
- 0.00010 - 0.010
- 0.011 - 0.030
- 0.031 - 0.20
- 0.21 - 1.0
- 1.1 - 2.0
- 2.1 - 3.5
- 3.6 - 7.0
- 7.1 - 10
- 11 - 38
- 39 - 60
- Rock mass flow barrier
- Structure flow barriers
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

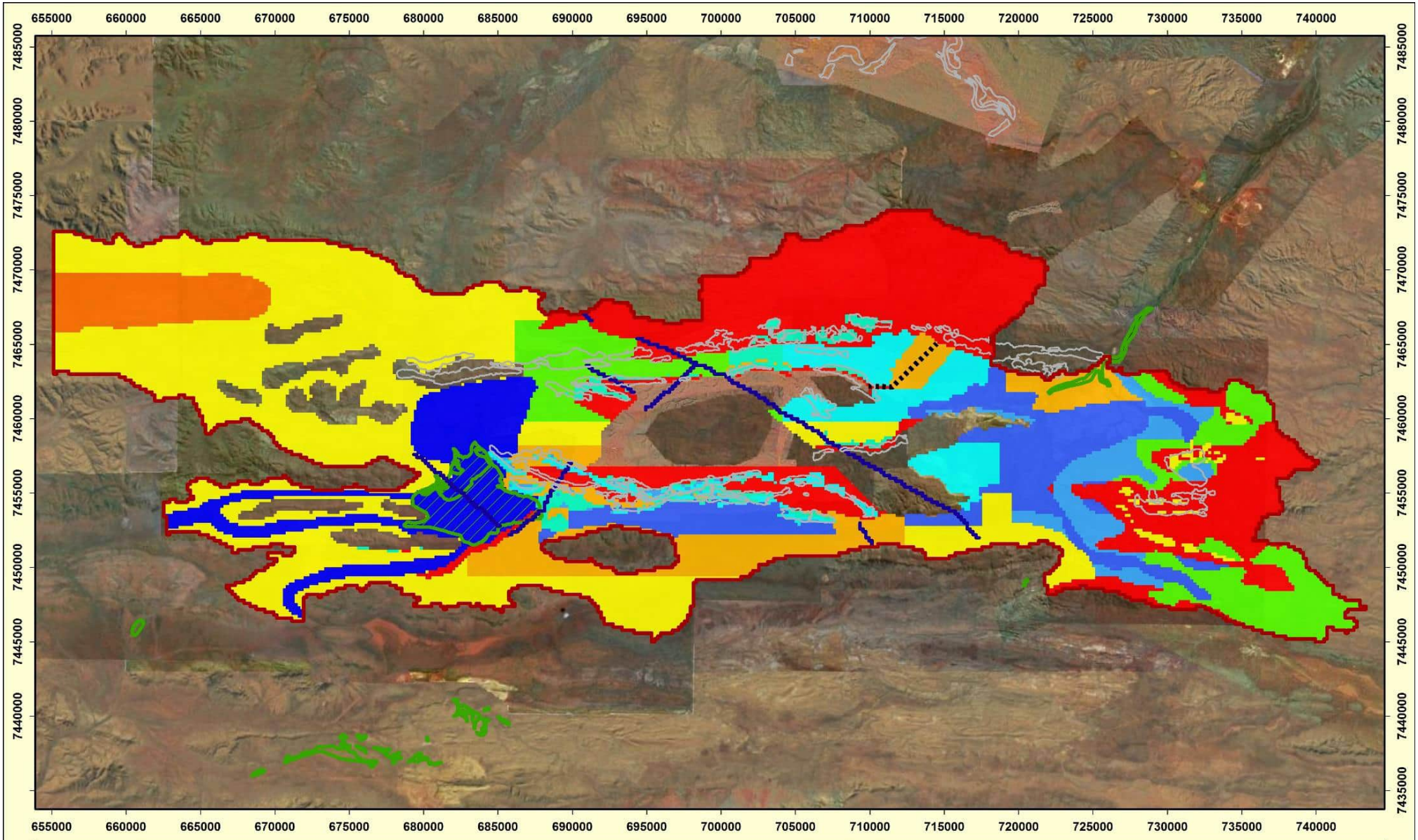
Hydrostratigraphy Layer 1

Scale: 1:331,174	Plotted: 31/08/2021	**FIGURE 9.10**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
	File Name: CPH_5C_NM-2021-3.2	

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N

0 1.75 3.5 7 10.5 14 Kilometre

LEGEND

Hydraulic conductivity (m/d)

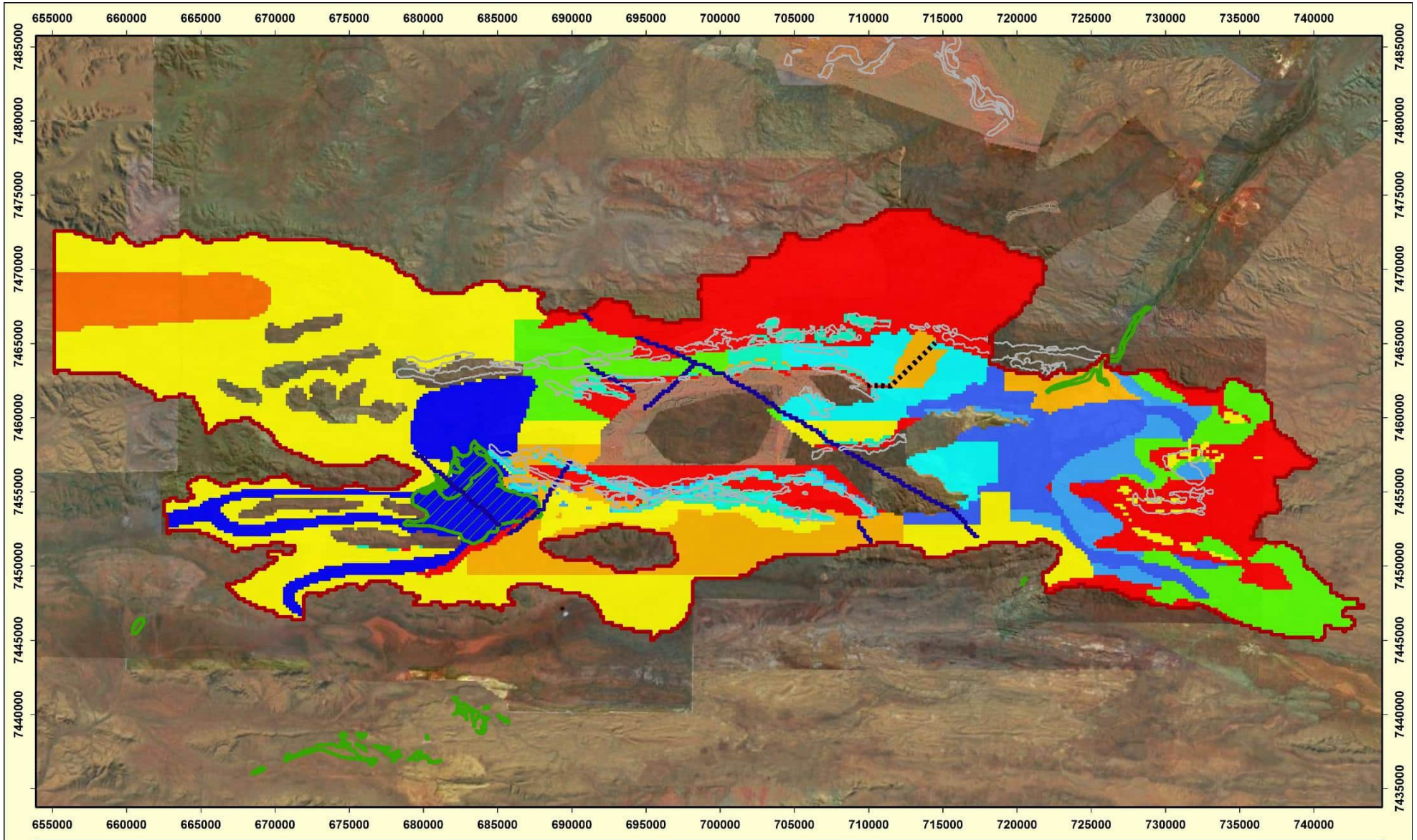
- 0.00010 - 0.010
- 0.011 - 0.030
- 0.031 - 0.20
- 0.21 - 1.0
- 1.1 - 2.0
- 2.1 - 3.5
- 3.6 - 7.0
- 7.1 - 10
- 11 - 38
- 39 - 60
- Rock mass flow barrier
- Structure flow barriers
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

Hydrostratigraphy Layer 3

Scale: 1:331,174	Plotted: 31/08/2021	**FIGURE 9.12**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
	File Name: CPH_5C_NM-2021-3.4	

MXD Path: R:\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2021-3.4.mxd



N

0 1.75 3.5 7 10.5 14 Kilometre

LEGEND

Hydraulic conductivity (m/d)

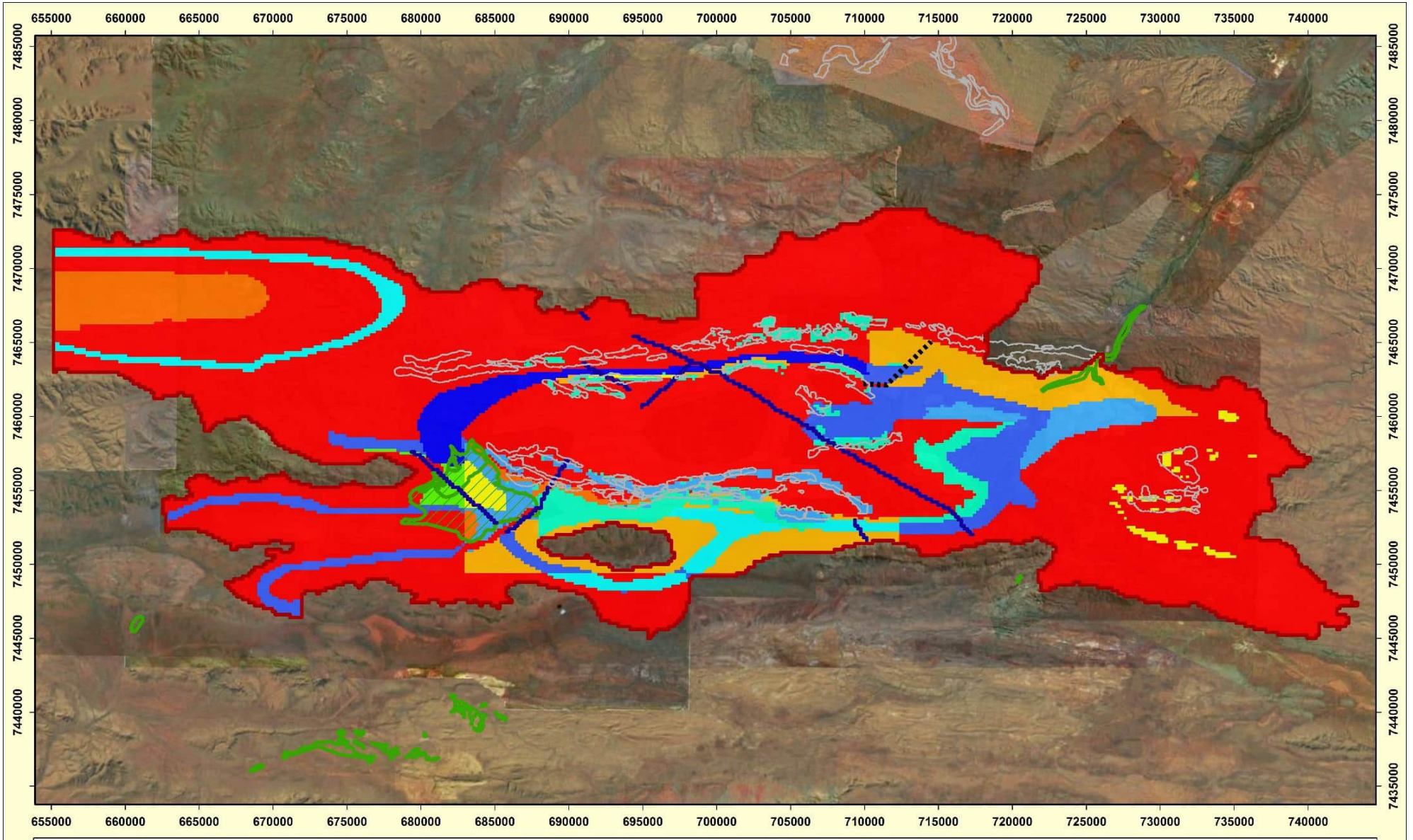
- 0.00010 - 0.010
- 0.011 - 0.030
- 0.031 - 0.20
- 0.21 - 1.0
- 1.1 - 2.0
- 2.1 - 3.5
- 3.6 - 7.0
- 7.1 - 10
- 11 - 38
- 39 - 60
- Rock mass flow barrier
- Structure flow barriers
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

Hydrostratigraphy Layer 4

Scale: 1:331,174	Plotted: 31/08/2021	**FIGURE 9.13**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
	File Name: CPH_5C_NM-2021-3.5	

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N

0 1.75 3.5 7 10.5 14 Kilometre

Hydraulic conductivity (m/d)

- 0.00010 - 0.010
- 0.011 - 0.030
- 0.031 - 0.20
- 0.21 - 1.0
- 1.1 - 2.0
- 2.1 - 3.5
- 3.6 - 7.0
- 7.1 - 10
- 11 - 38

LEGEND

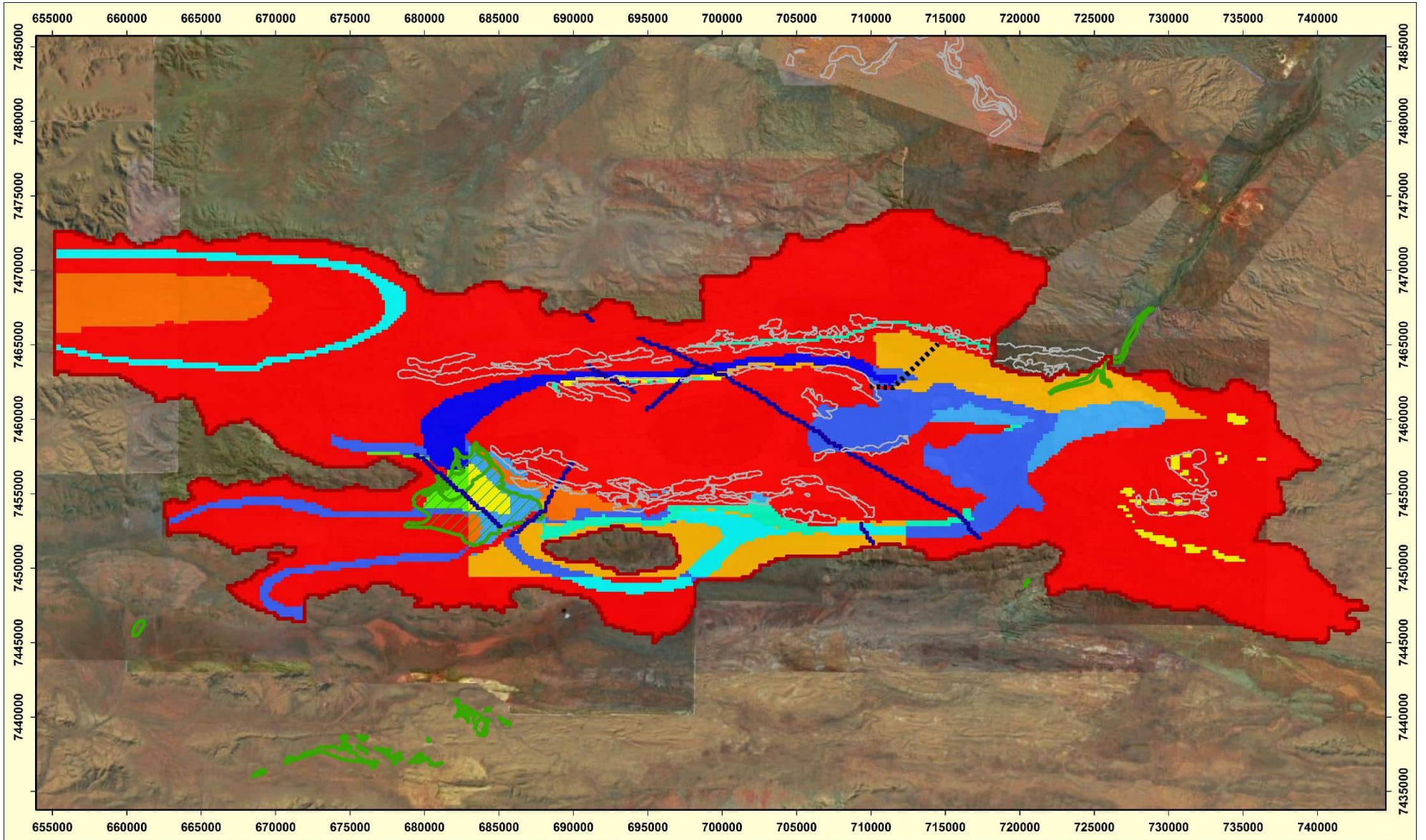
- 39 - 60
- Rock mass flow barrier
- Structure flow barriers
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

Hydrostratigraphy Layer 5

Scale: 1:331,174	Plotted: 31/08/2021	**FIGURE 9.14**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
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N

0 1.75 3.5 7 10.5 14 Kilometre

LEGEND

Hydraulic conductivity (m/d)
- 0.00010 - 0.010
- 0.011 - 0.030
- 0.031 - 0.20
- 0.21 - 1.0
- 1.1 - 2.0
- 2.1 - 3.5
- 3.6 - 7.0
- 7.1 - 10
- 11 - 38
- 39 - 60
- Rock mass flow barrier
- Structure flow barriers
- Priority Ecological Community
- Model domain
- Recommended Pit Design

BHP

Hydrostratigraphy Layer 6

Scale: 1:331,174	Plotted: 31/08/2021	**FIGURE 9.15**
Coordinate System: GDA 1994 MGA Zone 50	Revised: 31/08/2021	
	File Name: CPH_5C_NM-2021-3.7	

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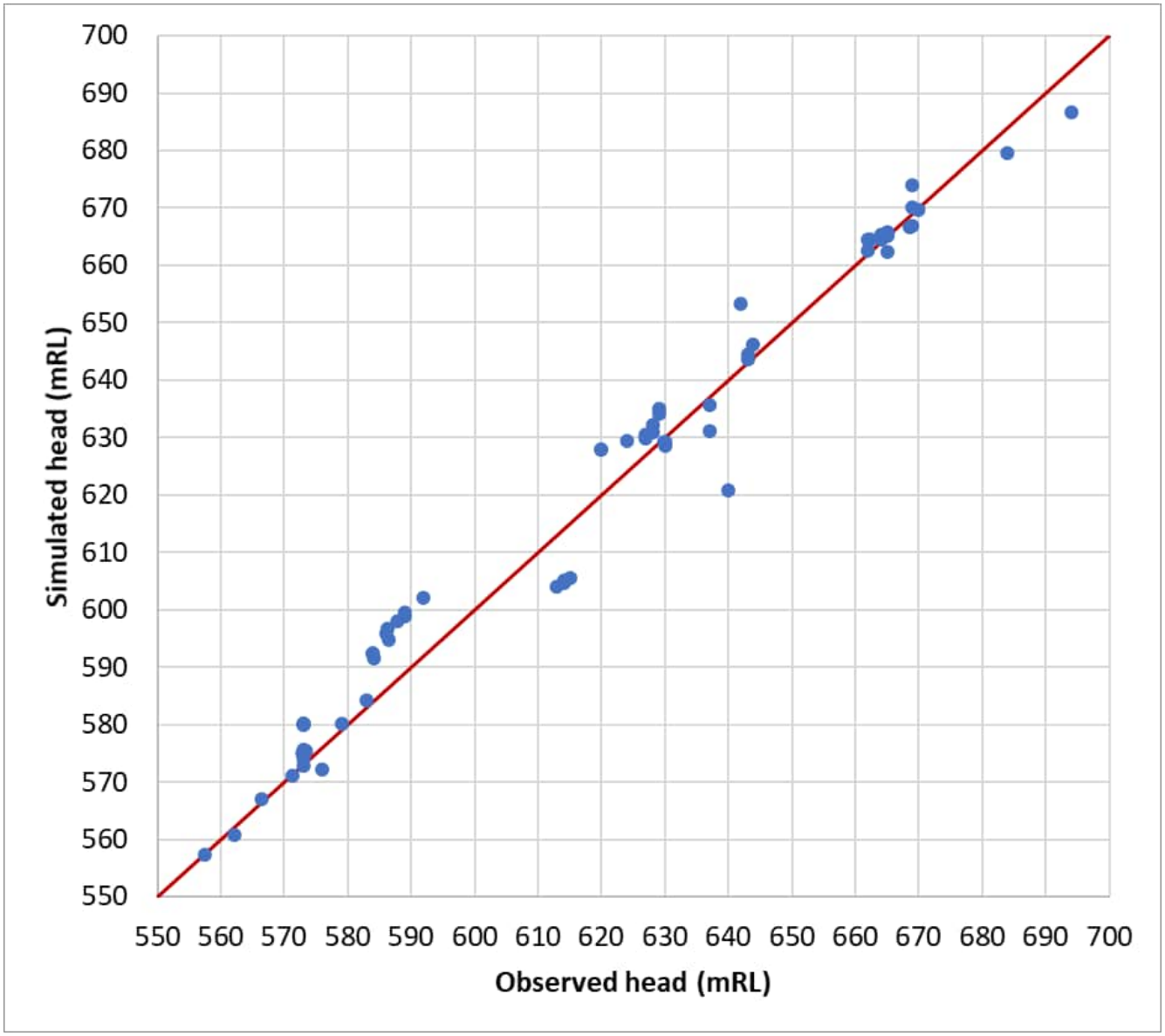
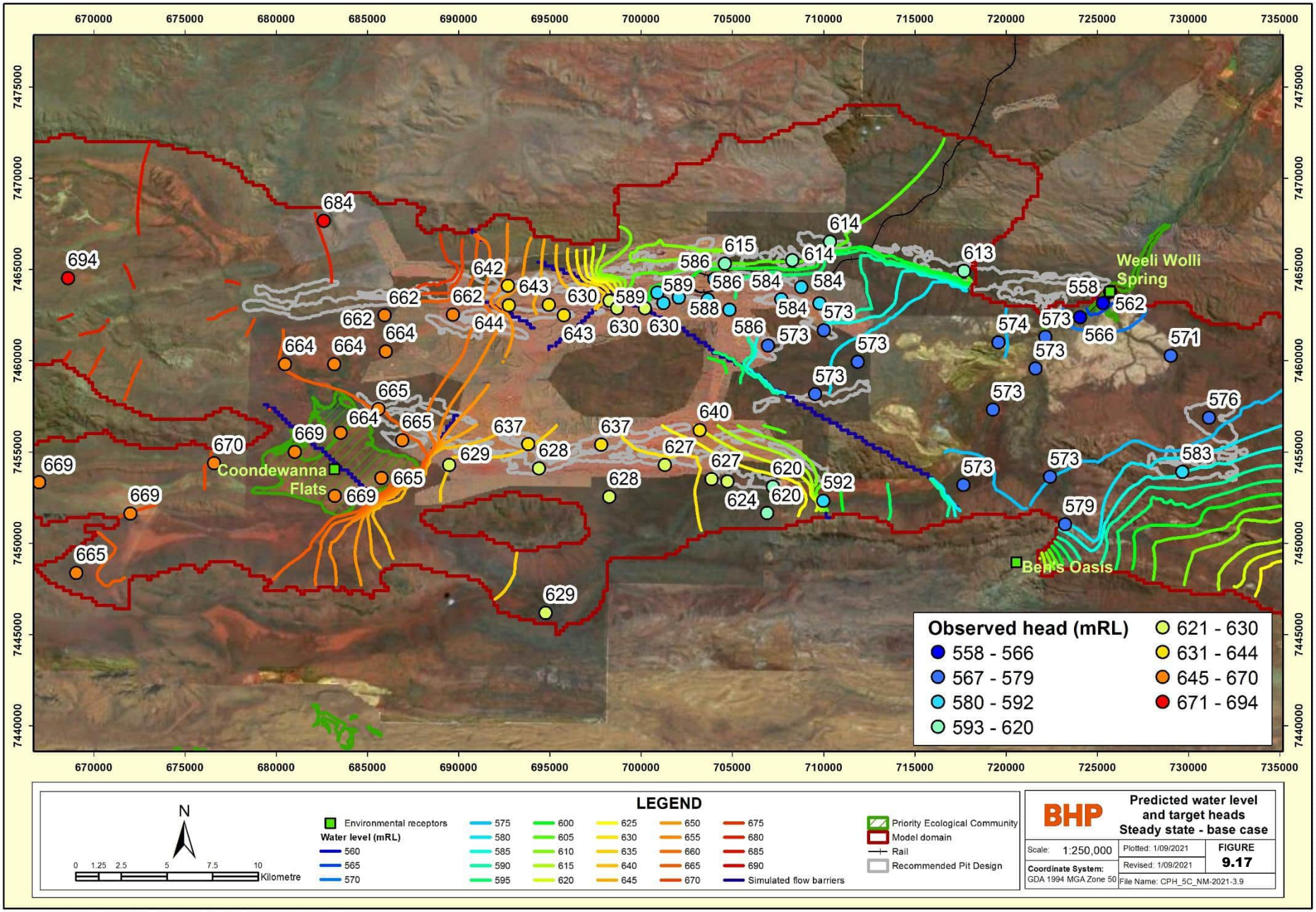
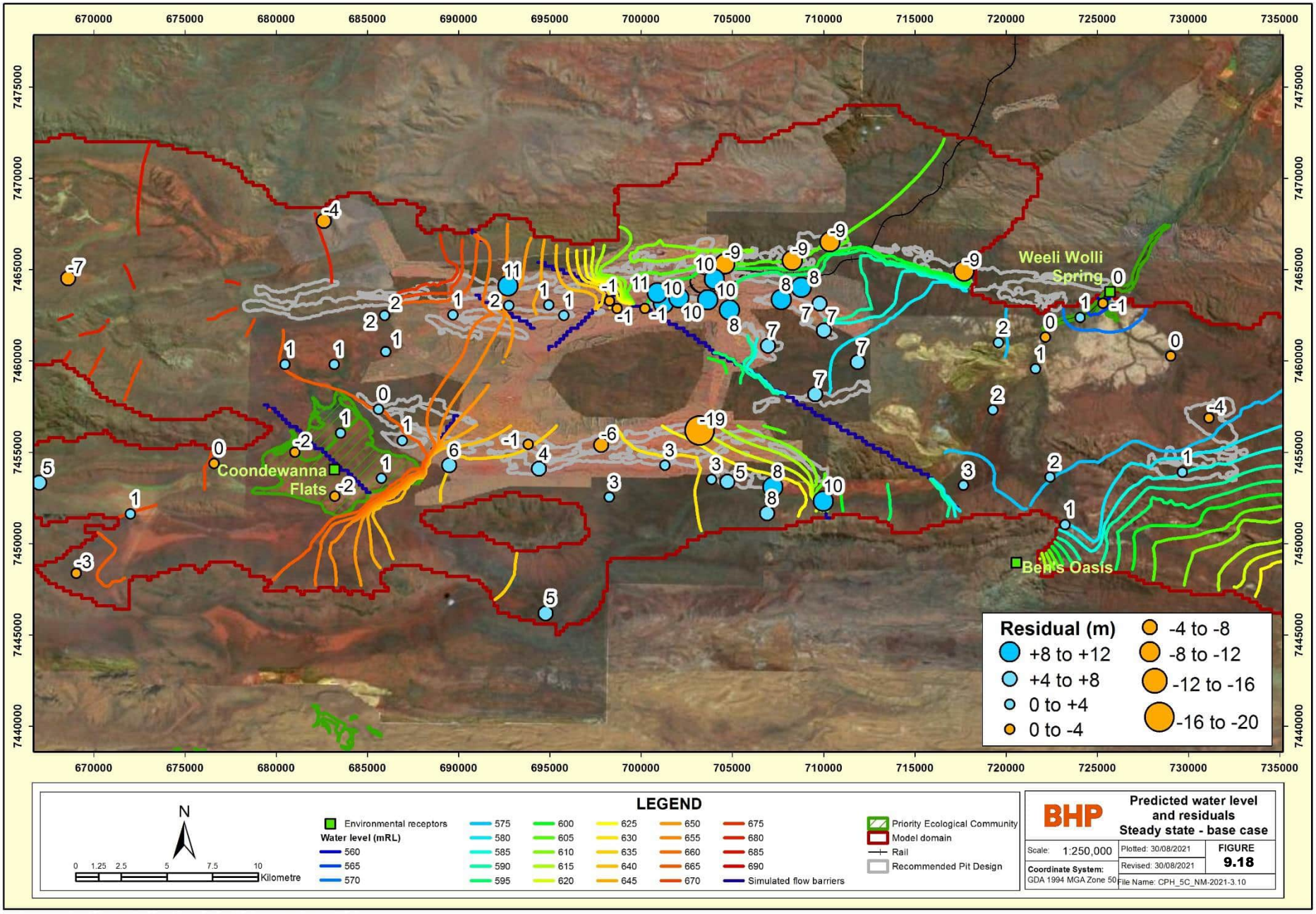


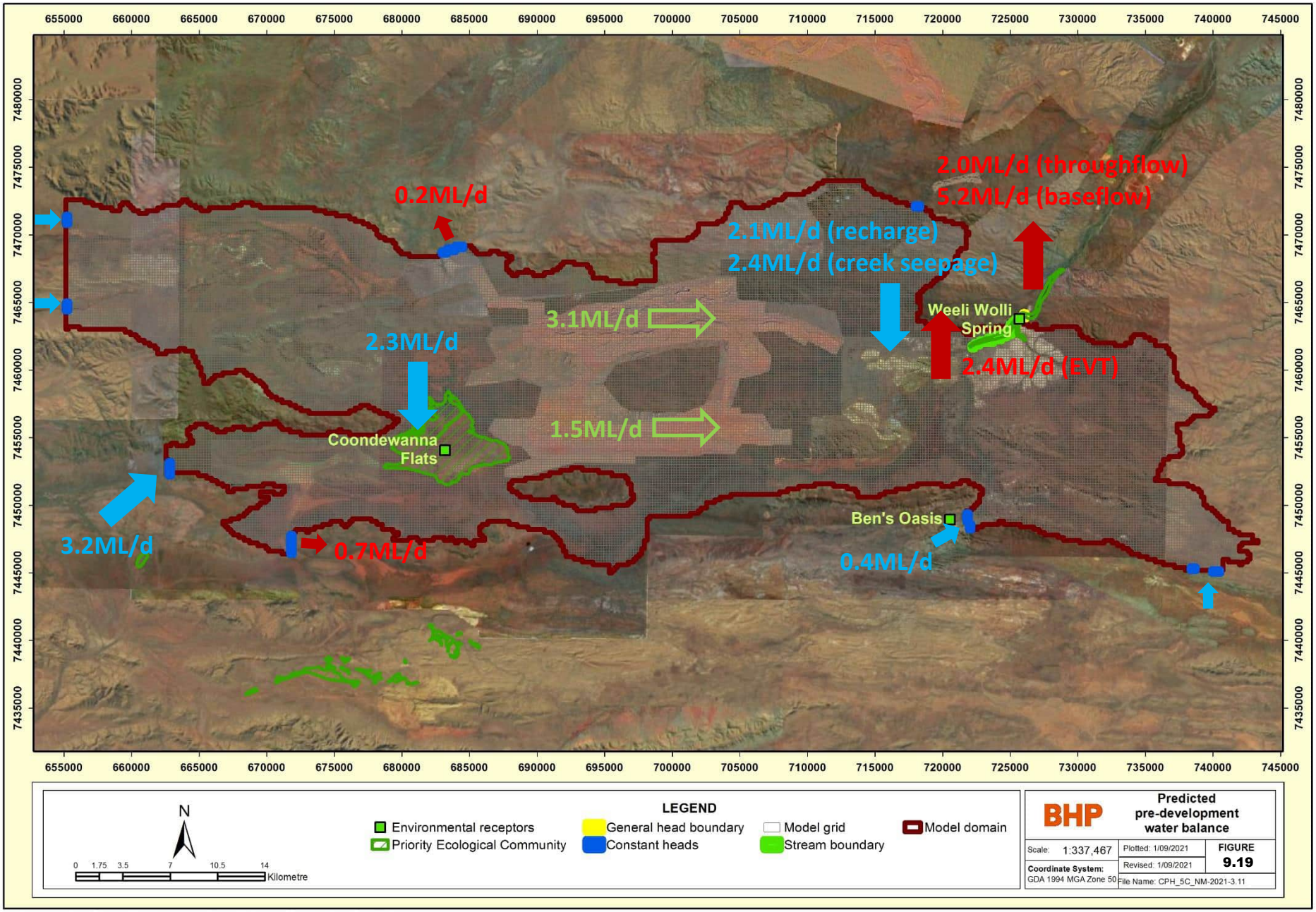
Figure 9.16
Steady state observed vs simulated heads
(base case)



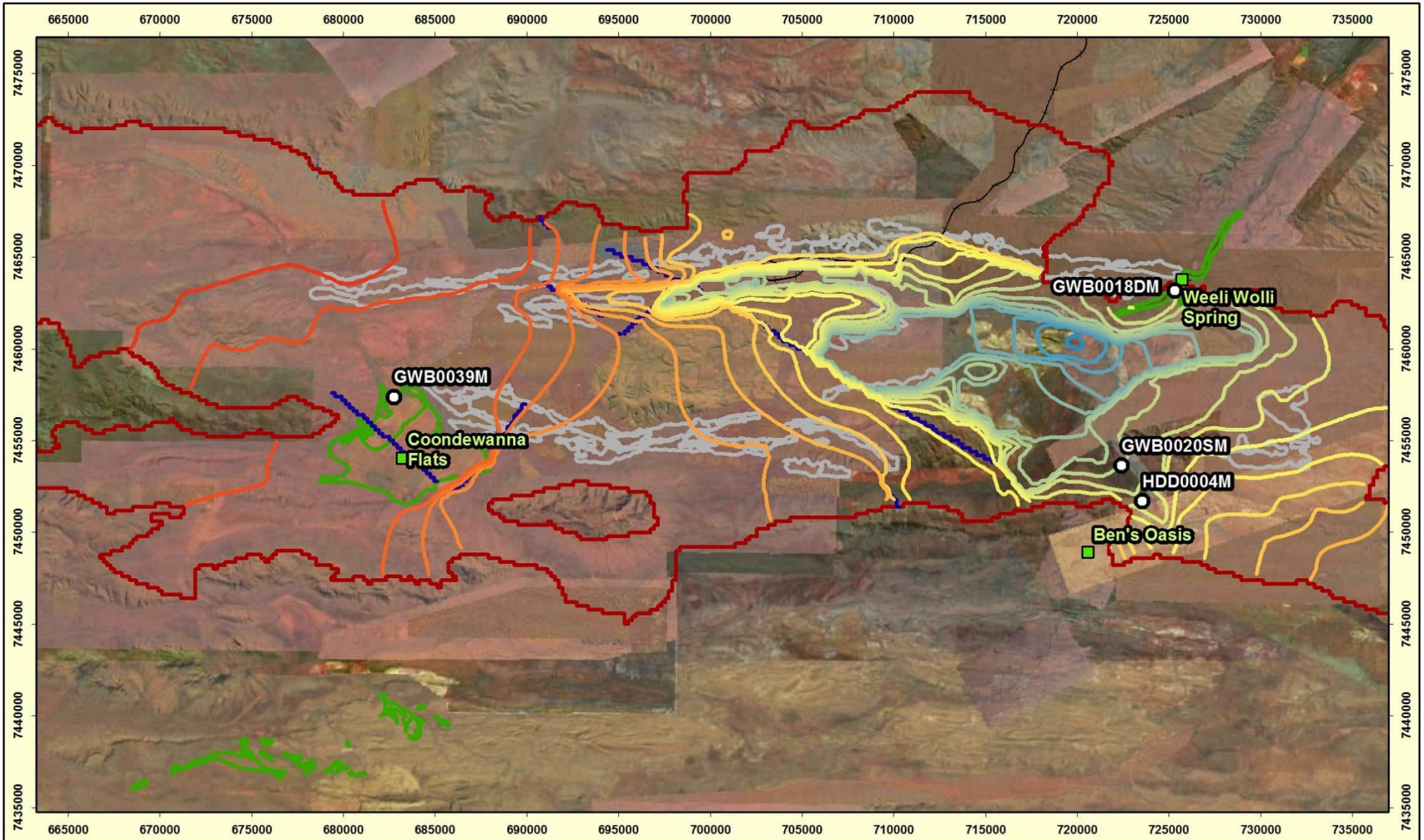
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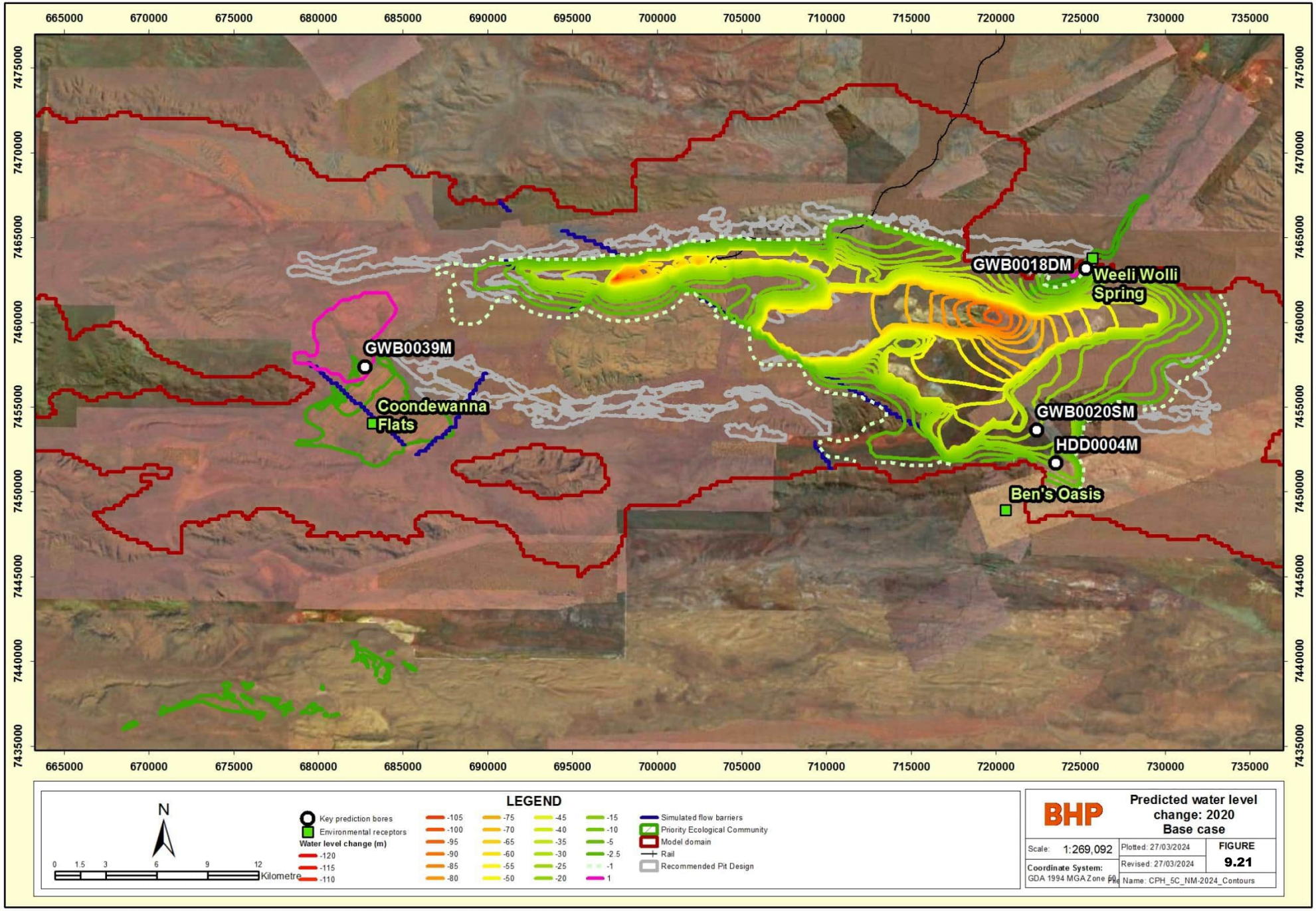
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MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_Contours.mxd



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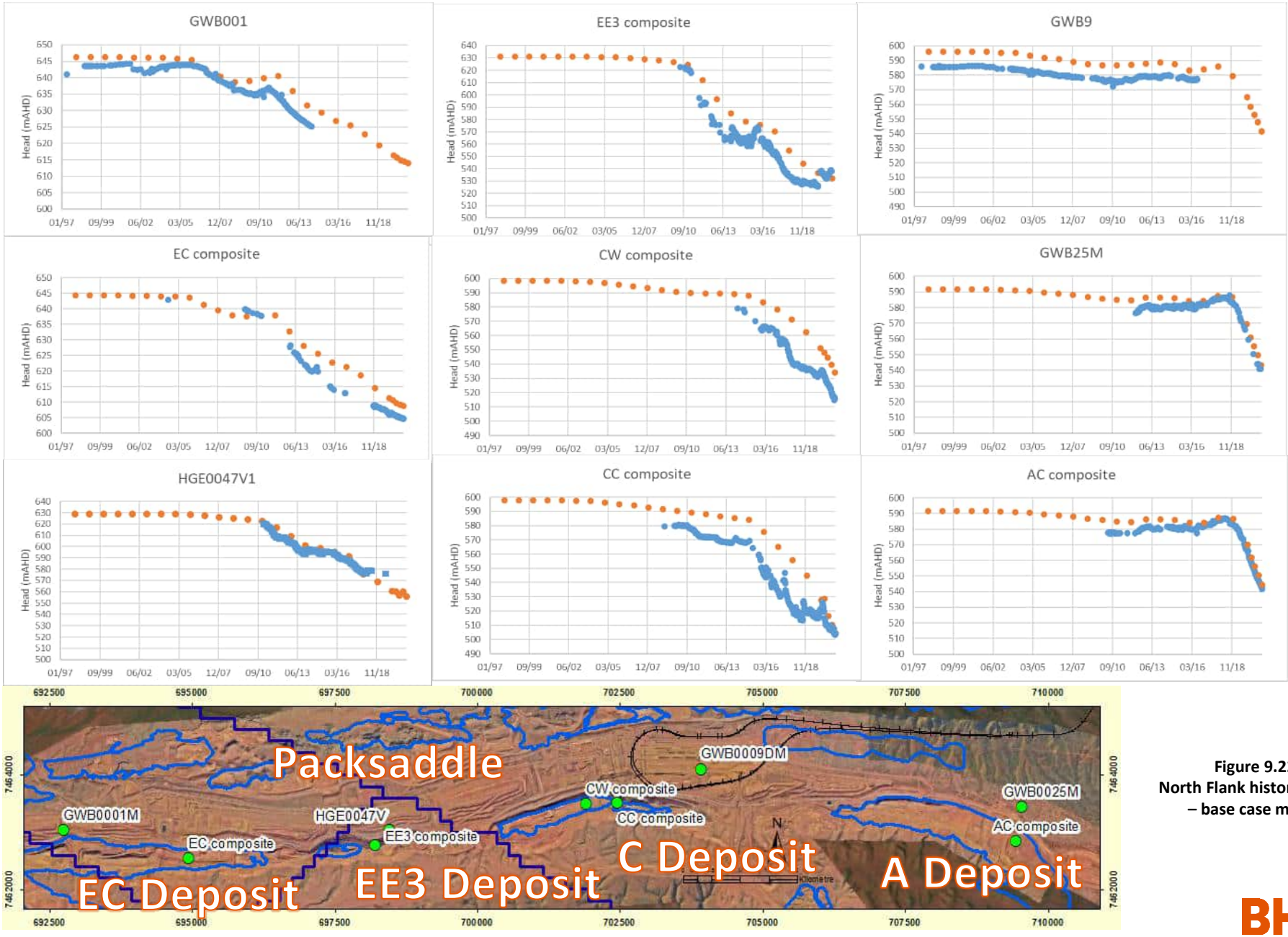
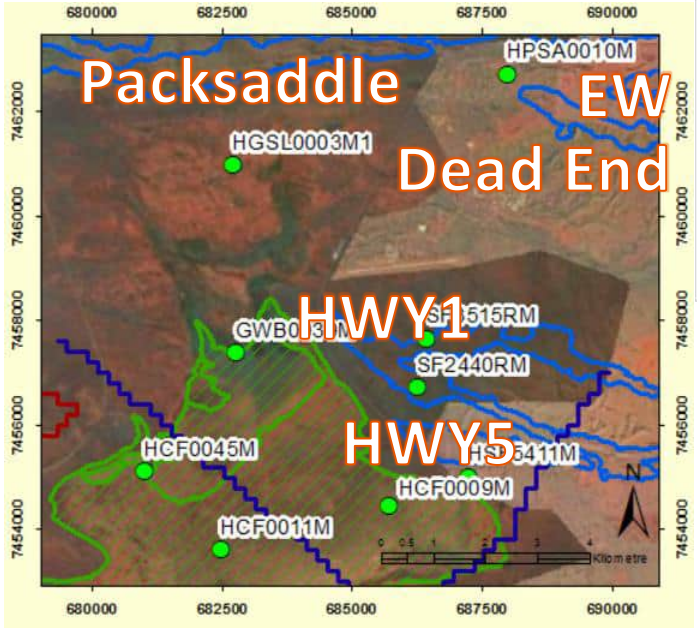
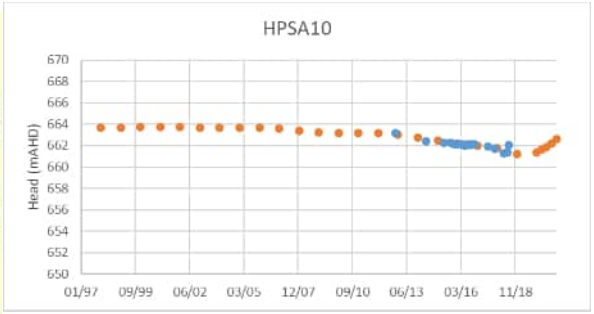
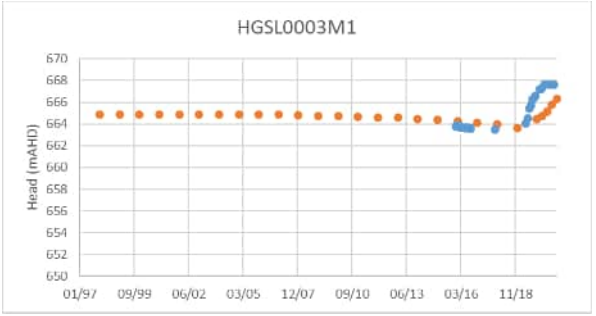


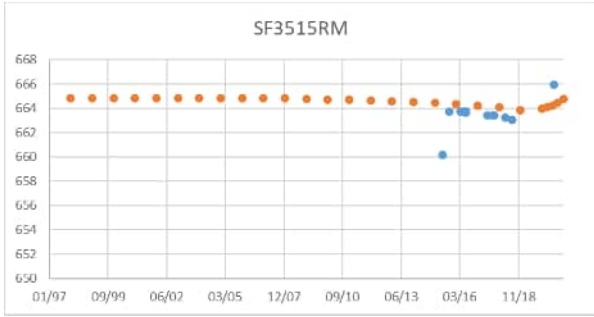
Figure 9.22
North Flank history match – base case model

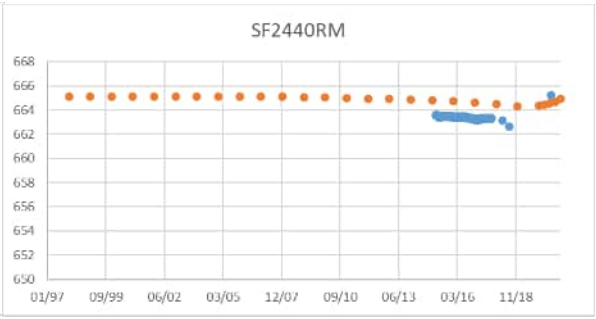
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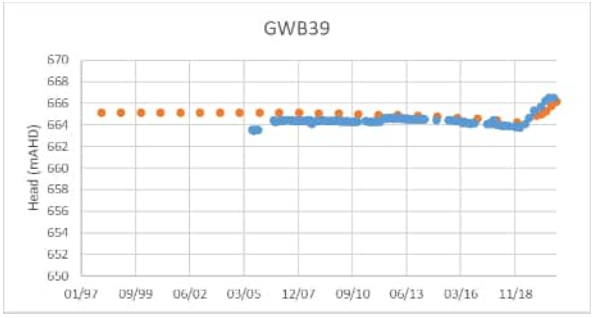


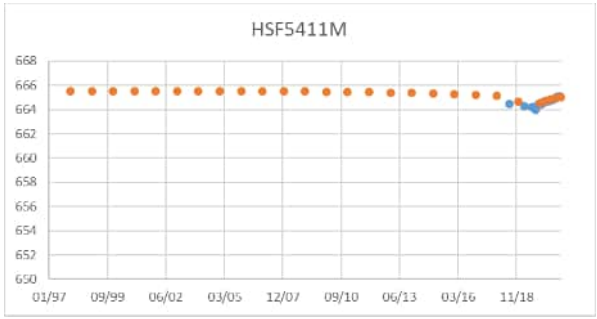


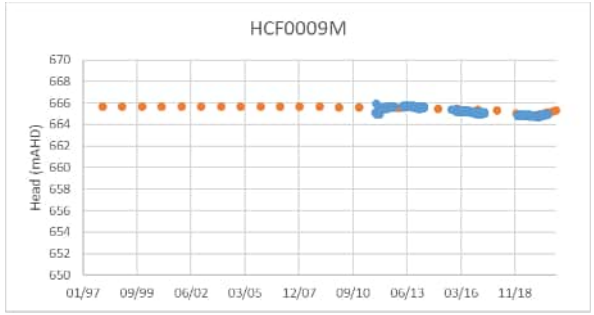


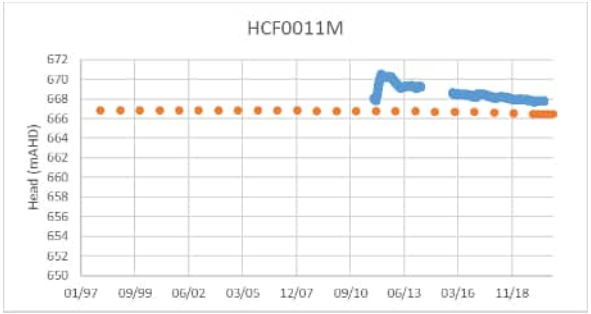












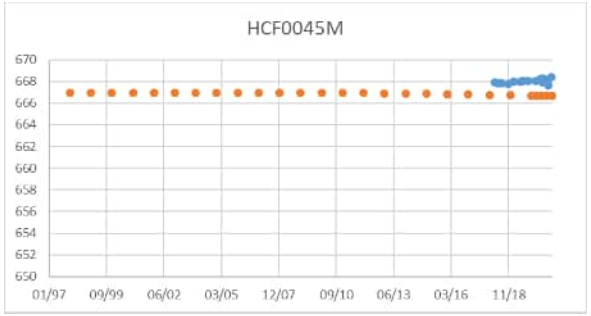
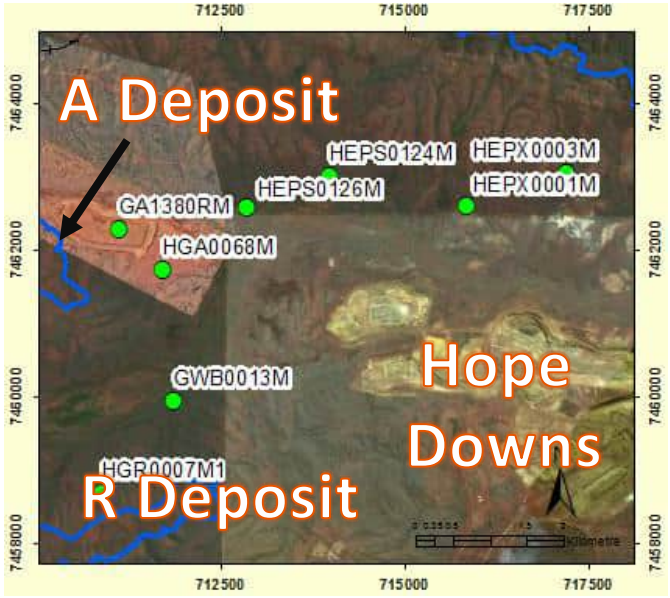
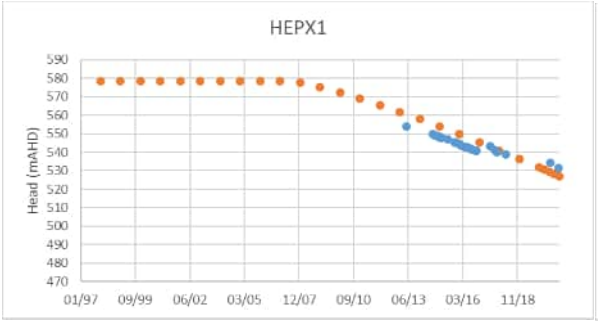
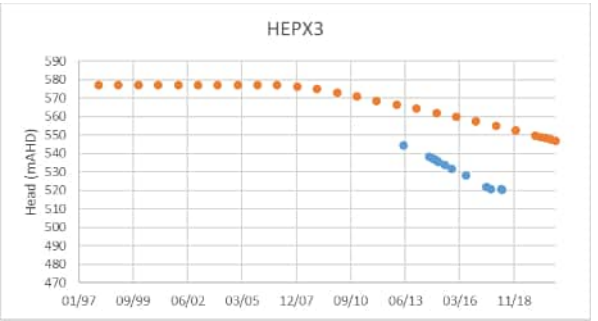


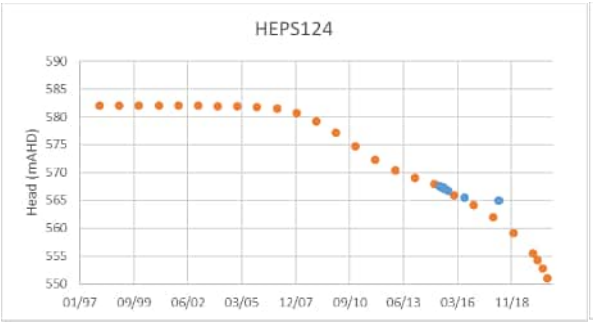
Figure 9.23
Coondewanna Flats history match – base case model

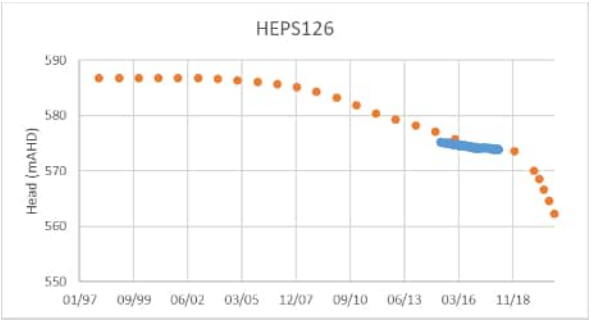
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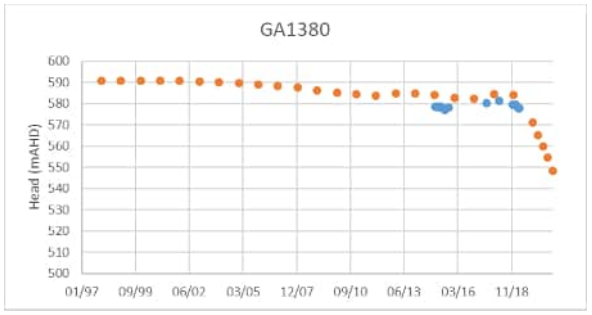


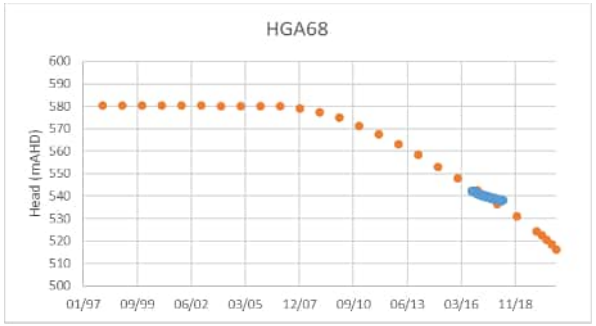














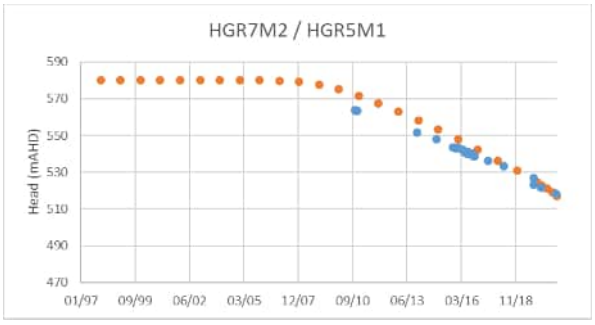
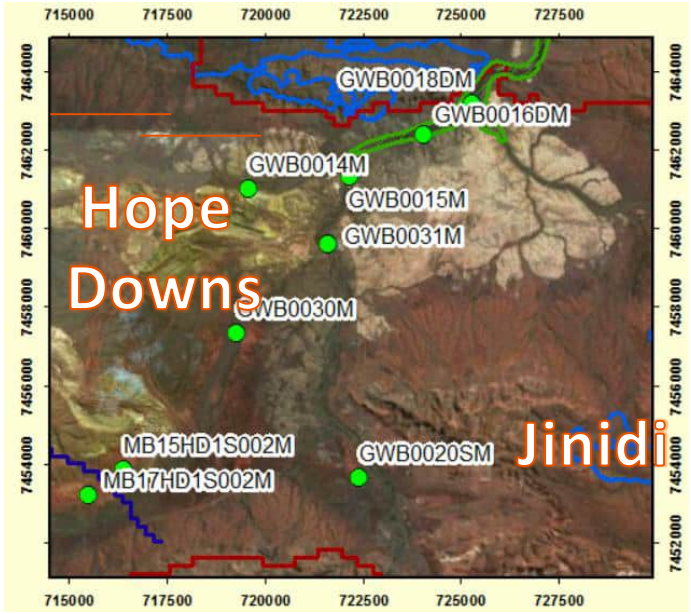
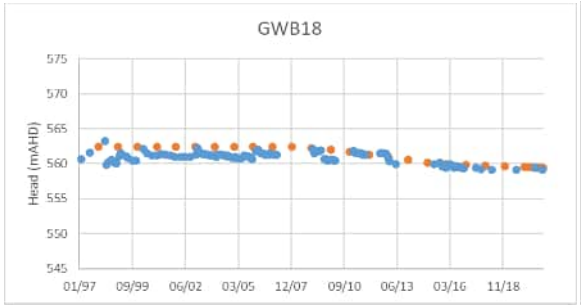
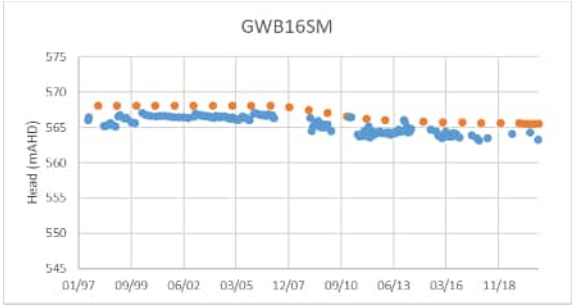


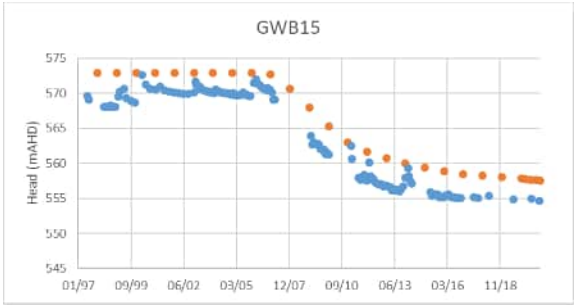
Figure 9.24
R Deposit and east of A Deposit history match – base case model

BHP

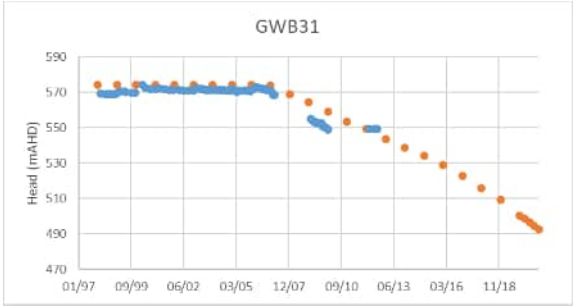




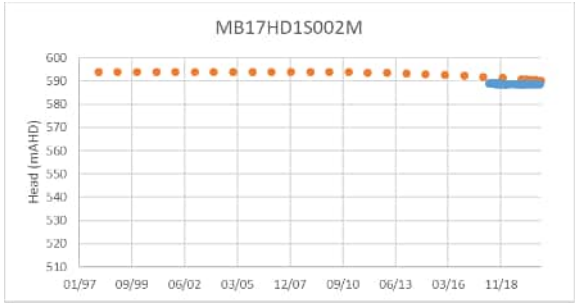














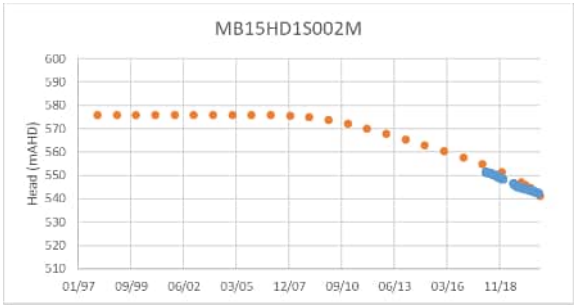
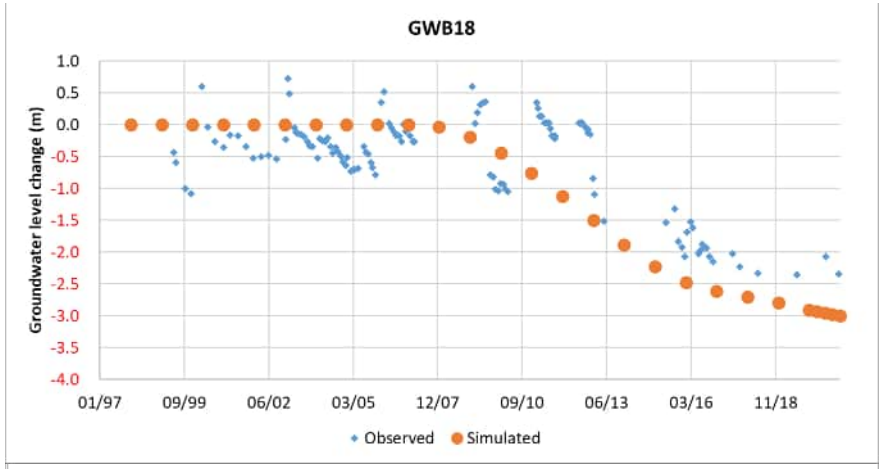
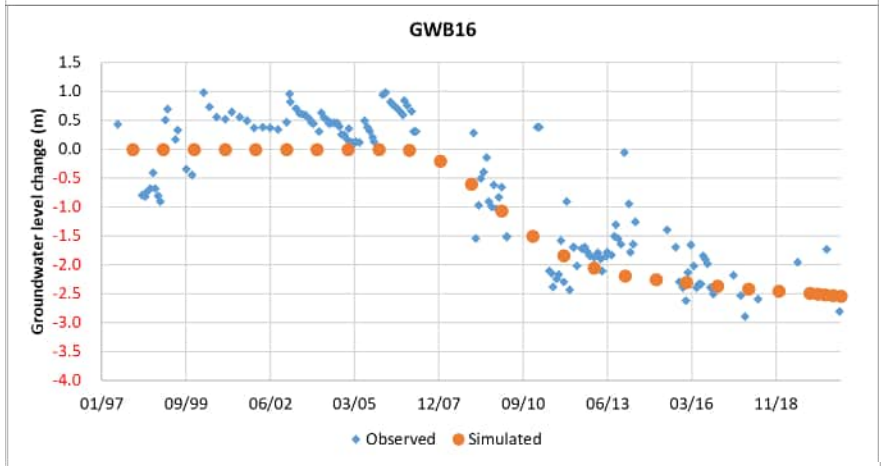
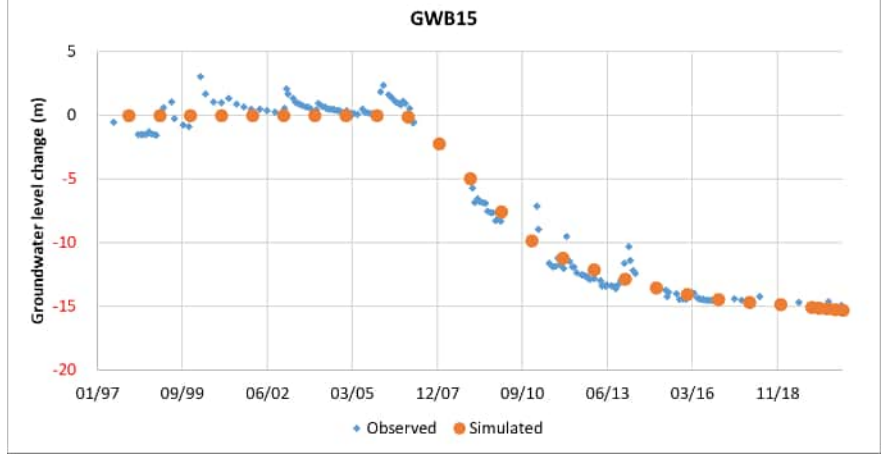


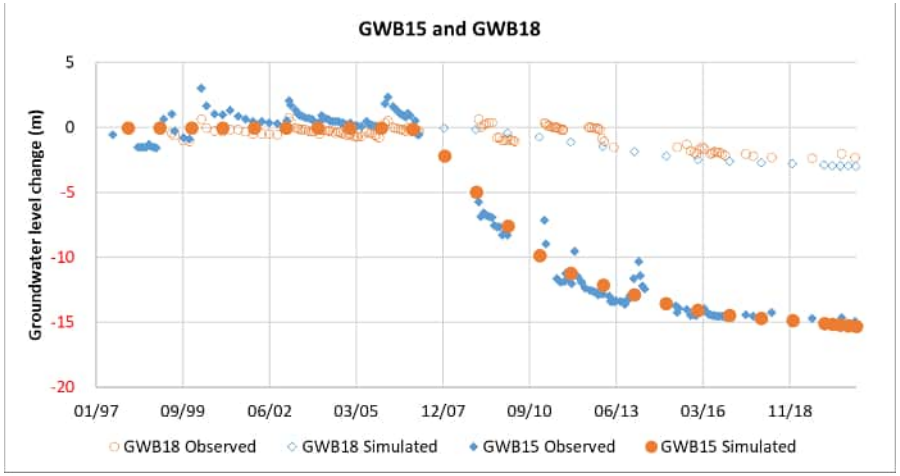
Figure 9.25
Hope Downs compartment history match – base case model

BHP









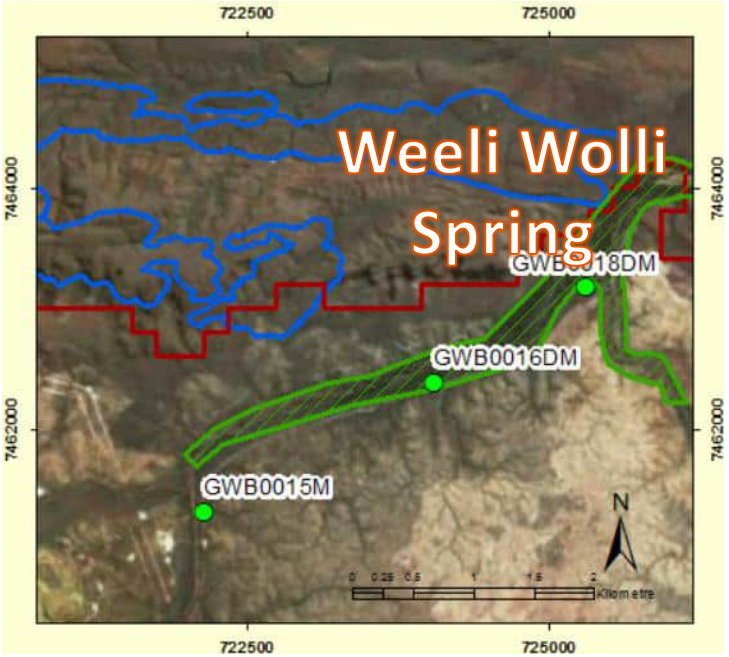


Figure 9.26
Weeli Wolli Spring history match drawdown – base case model

BHP

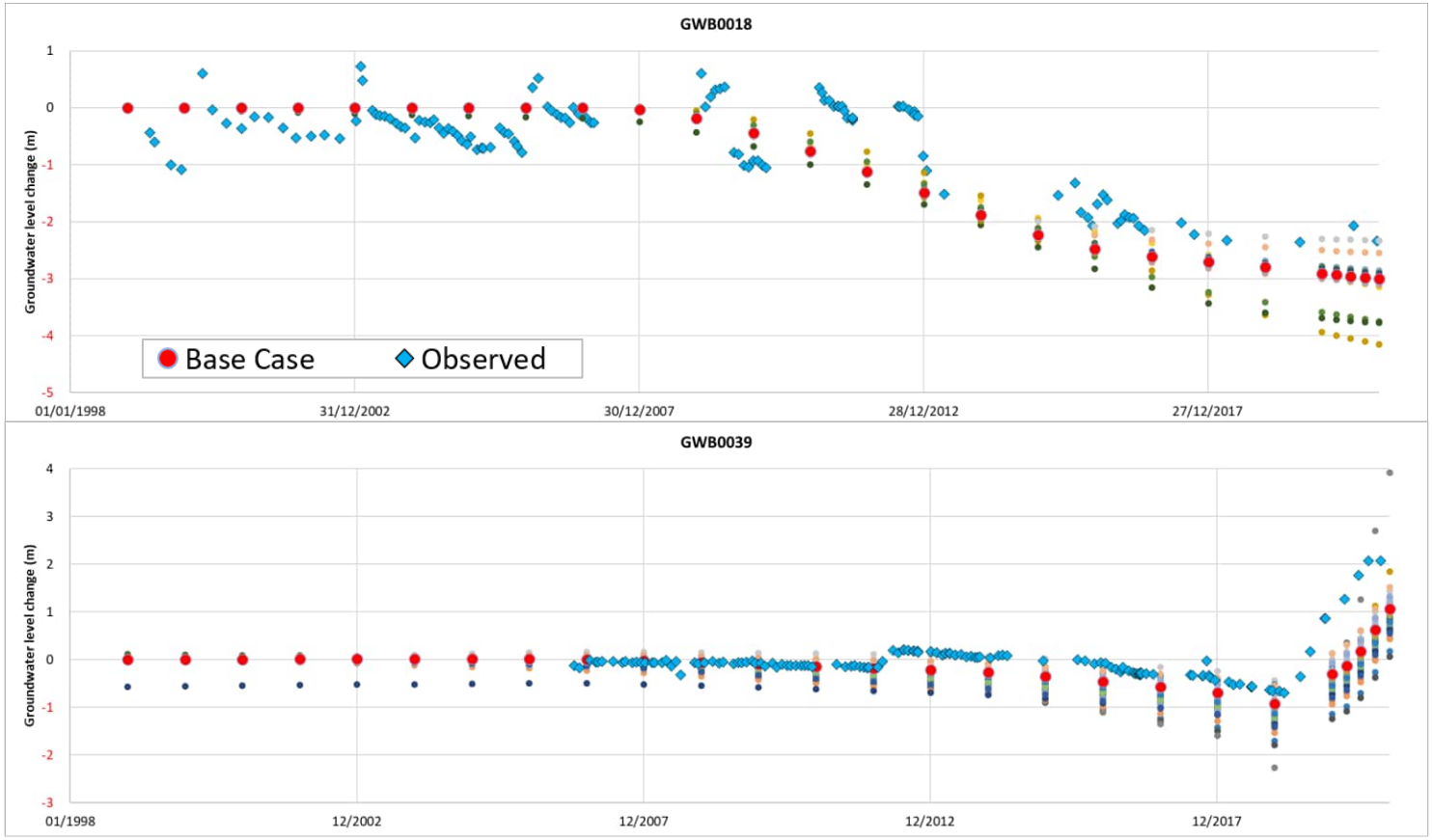


Figure 9.27
Sensitivity results: GWB18 and GWB39 (drawdown)

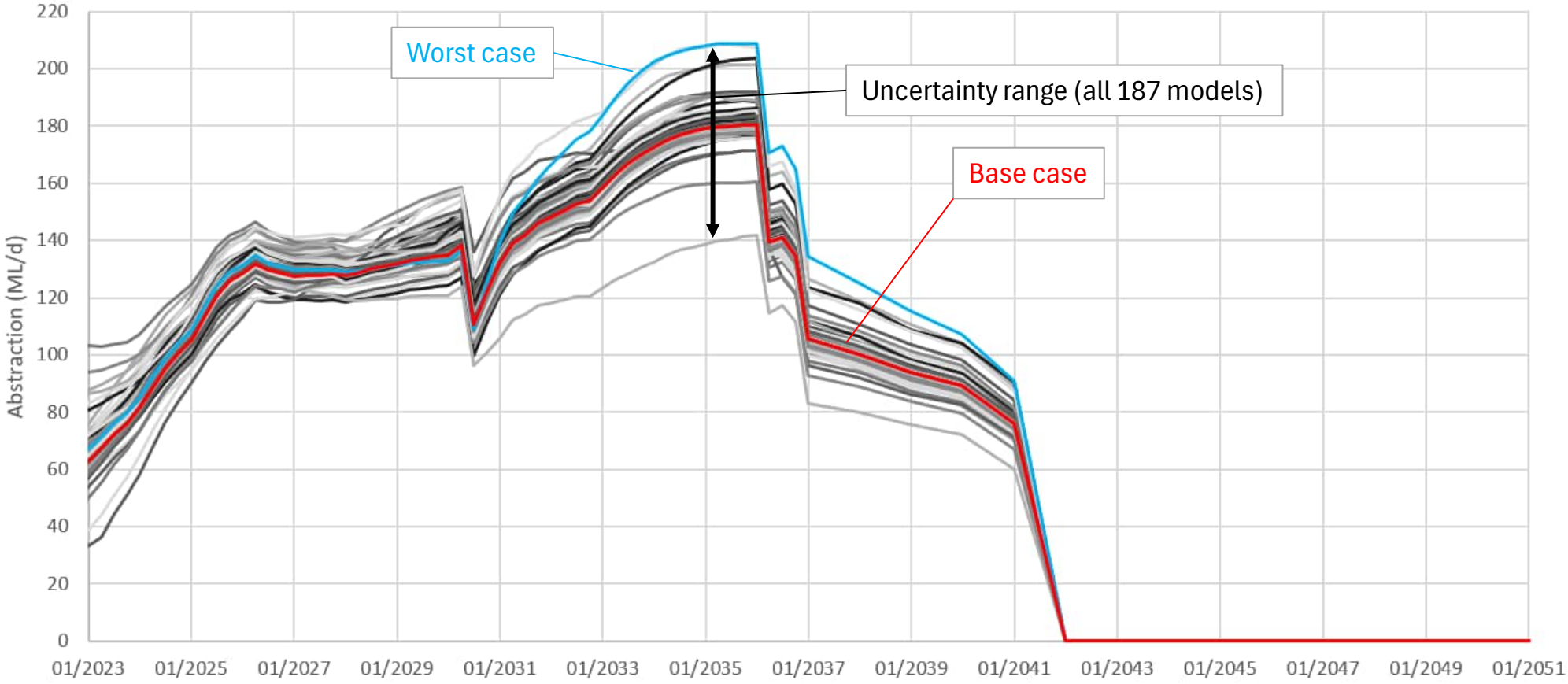


Figure 9.28
Predictive uncertainty:
Total dewatering

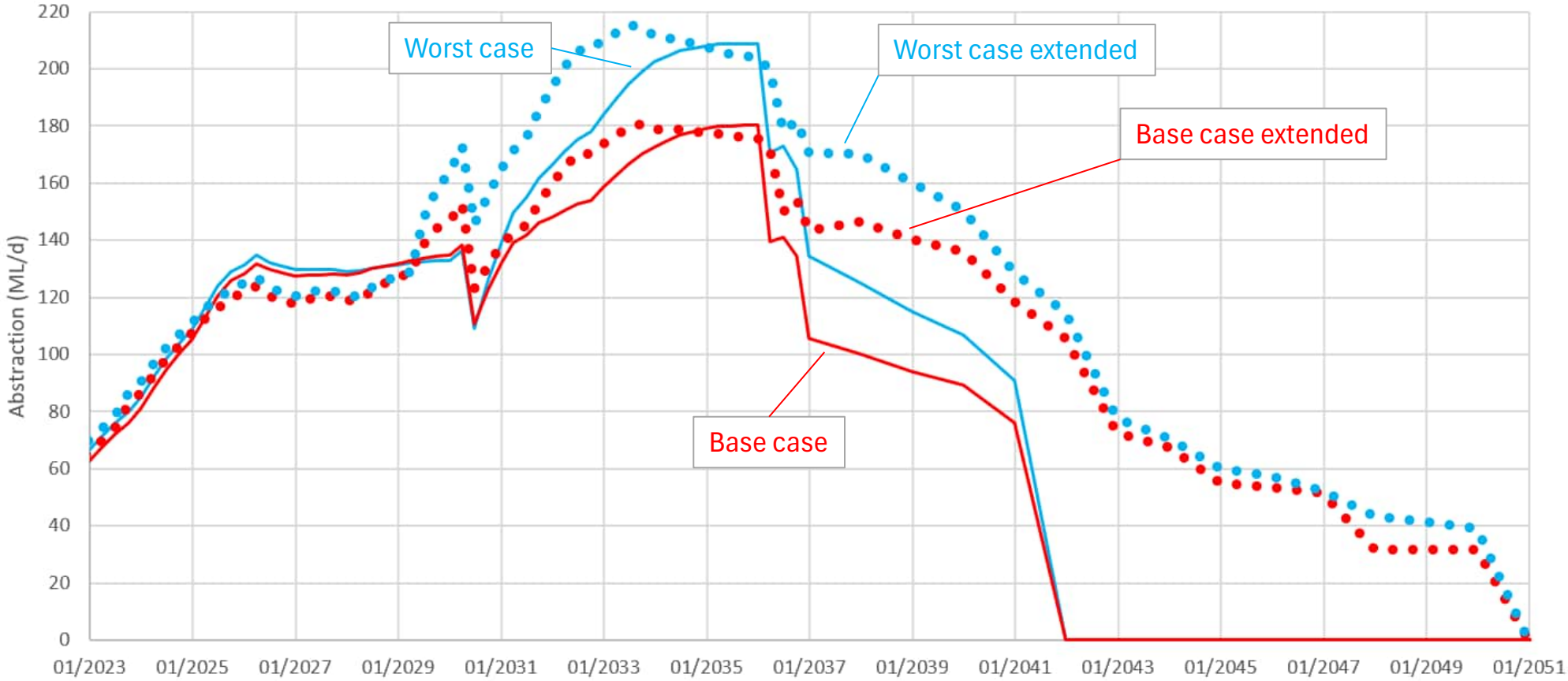
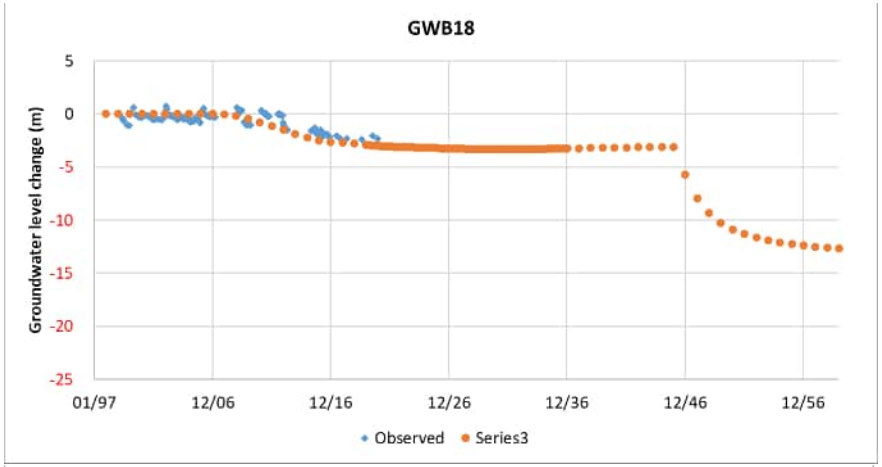
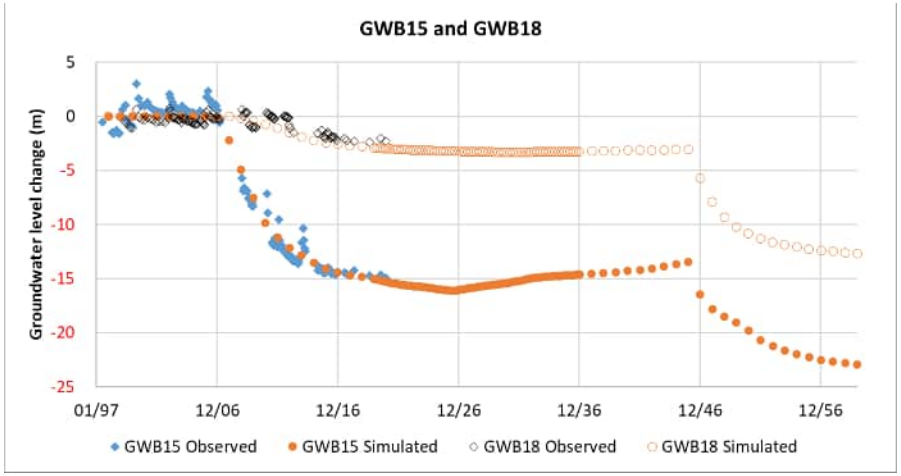
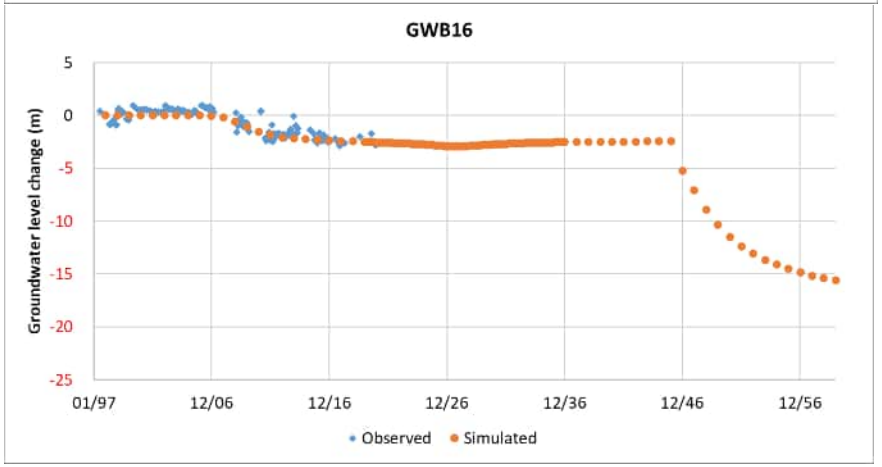
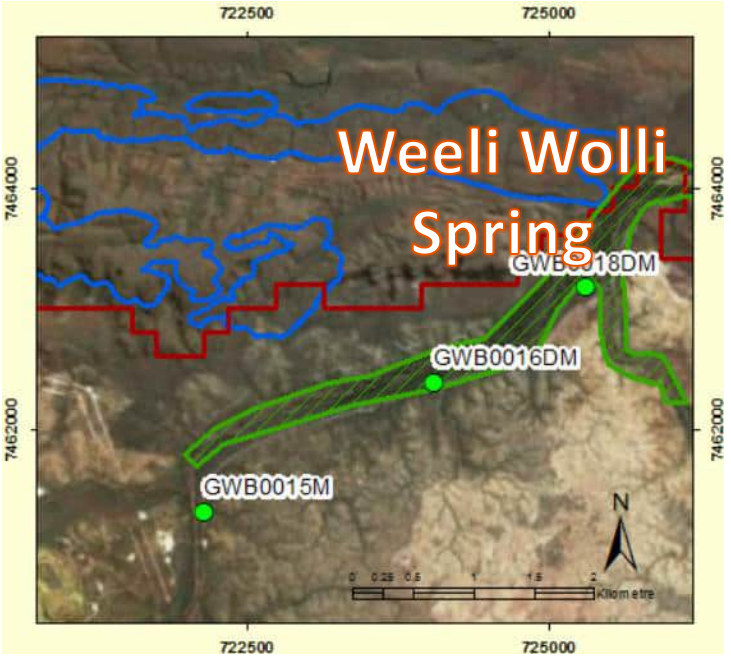


Figure 9.29
Predictive uncertainty: Total dewatering – extended mine plan









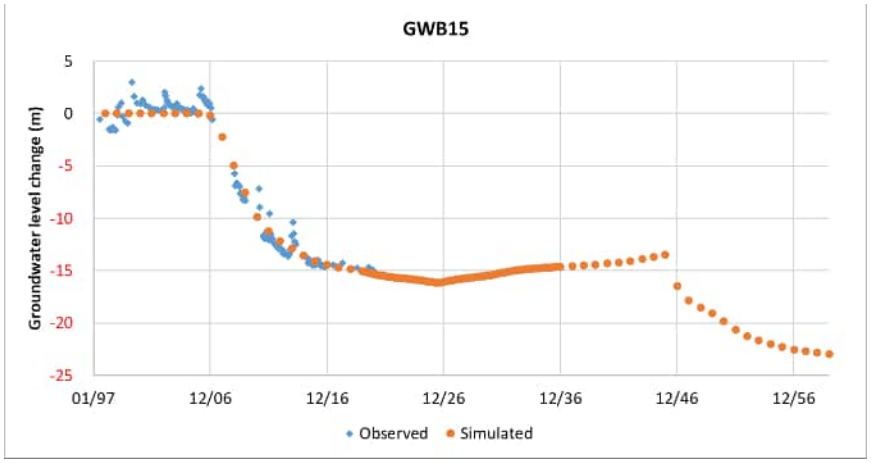


Figure 9.30
Predicted drawdown:
Base case

BHP

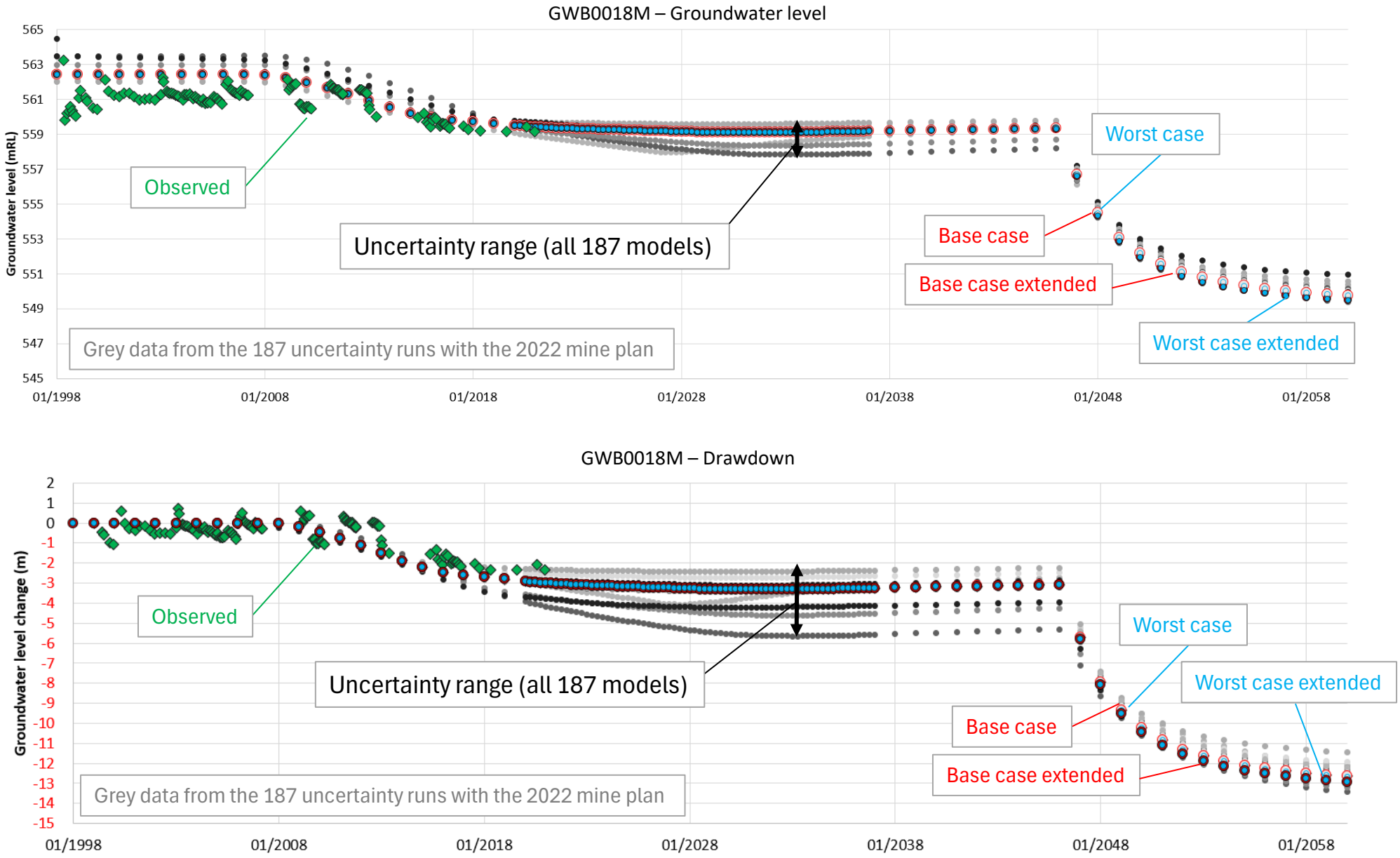


Figure 9.31
Predictive uncertainty: Weeli Wolli Spring (GWB0018)

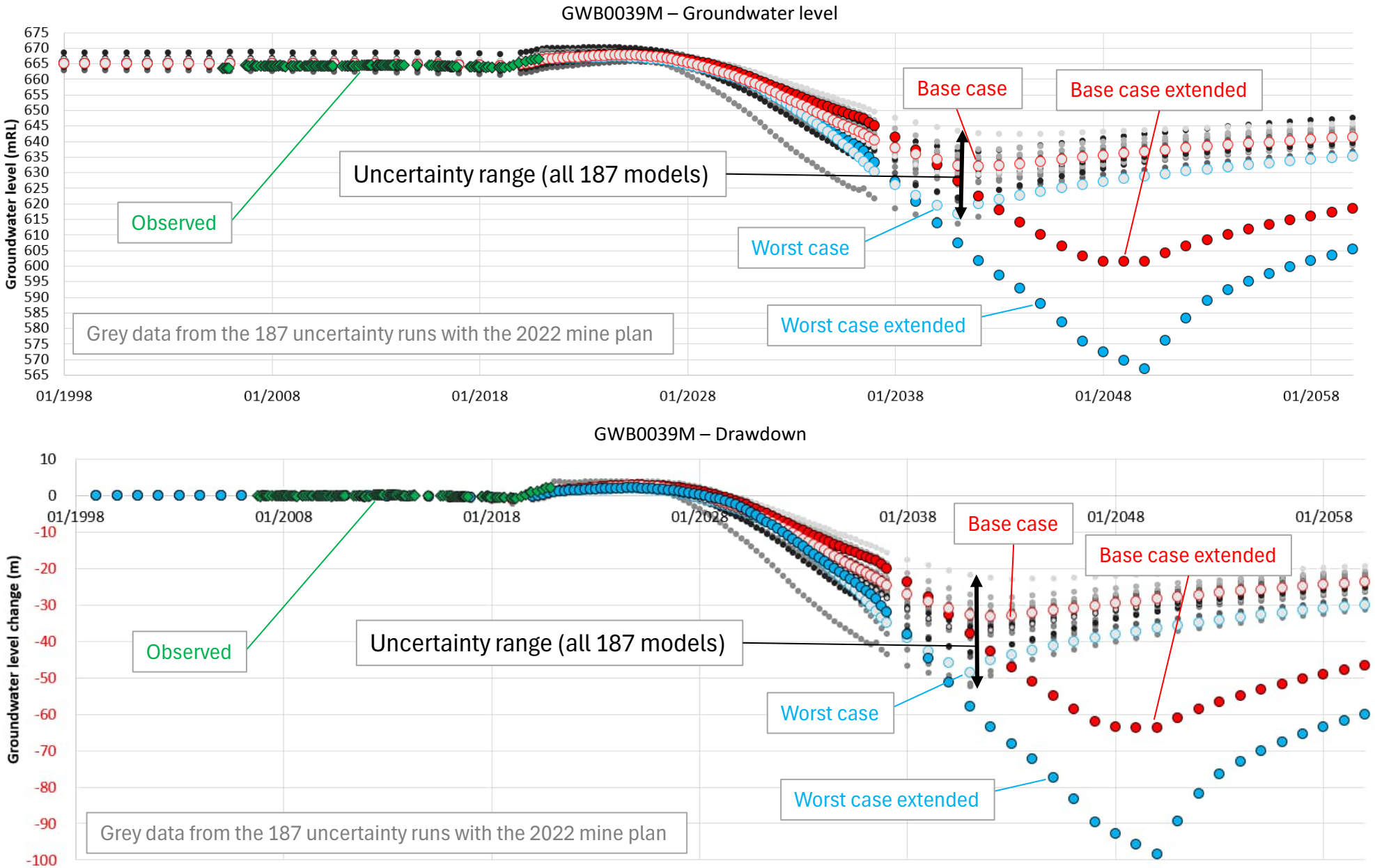


Figure 9.32
Predictive uncertainty: Coondewanna Flats (GWB0039)

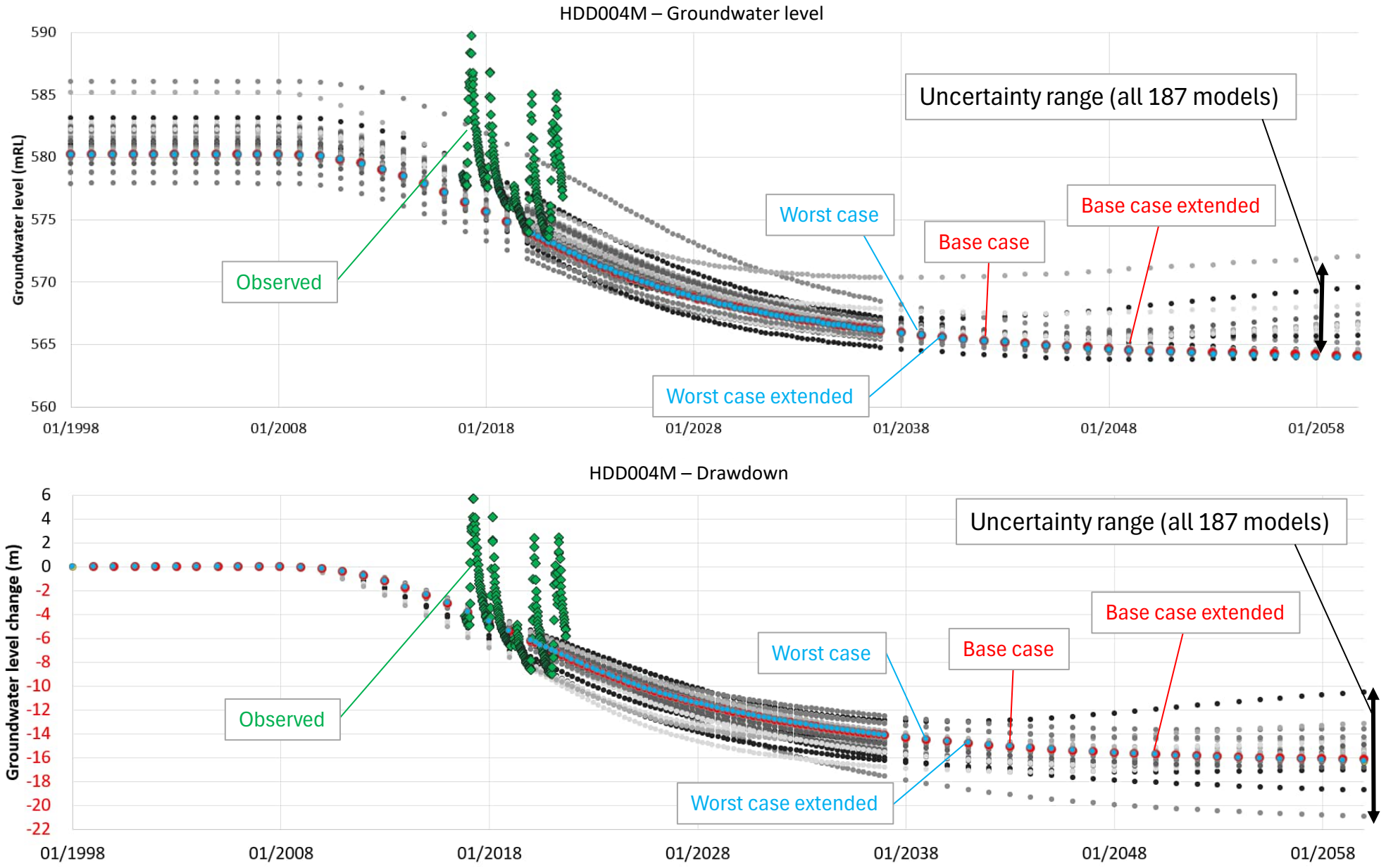
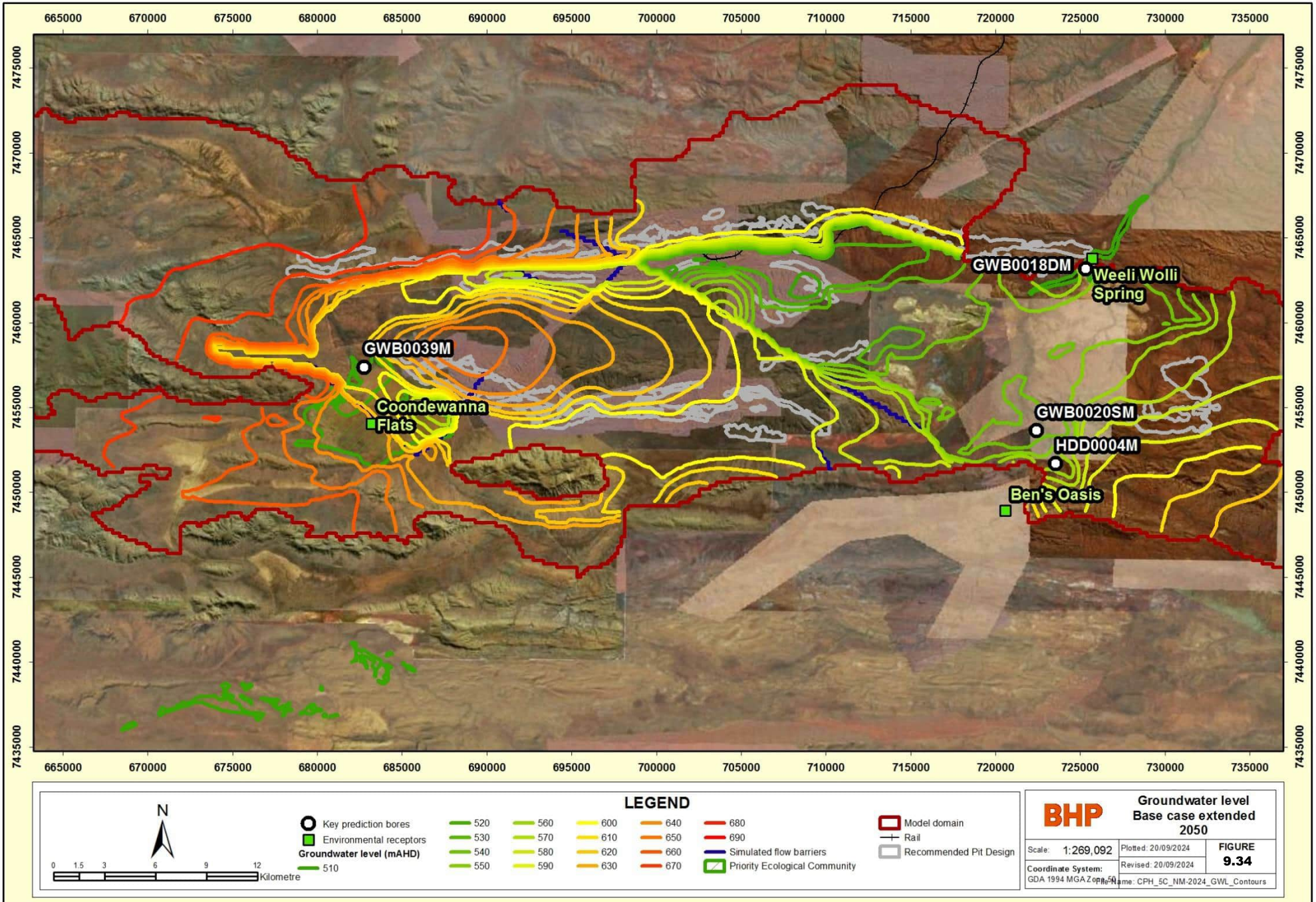
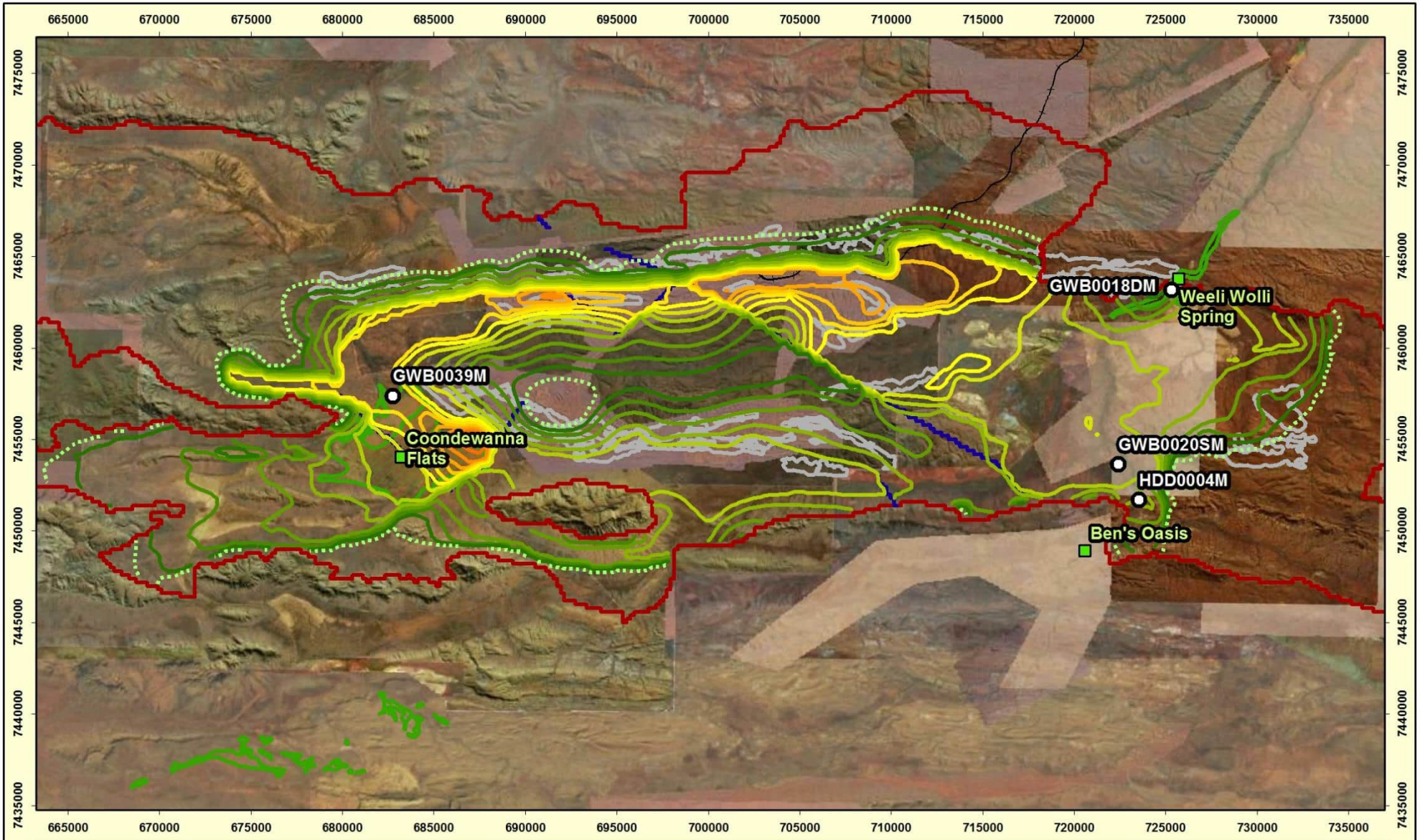


Figure 9.33
Predictive uncertainty:
Northeast of Ben's Oasis (HDD0004M)

BHP



MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_GWL_Contours.mxd



LEGEND

N

0 1.5 3 6 9 12 Kilometre

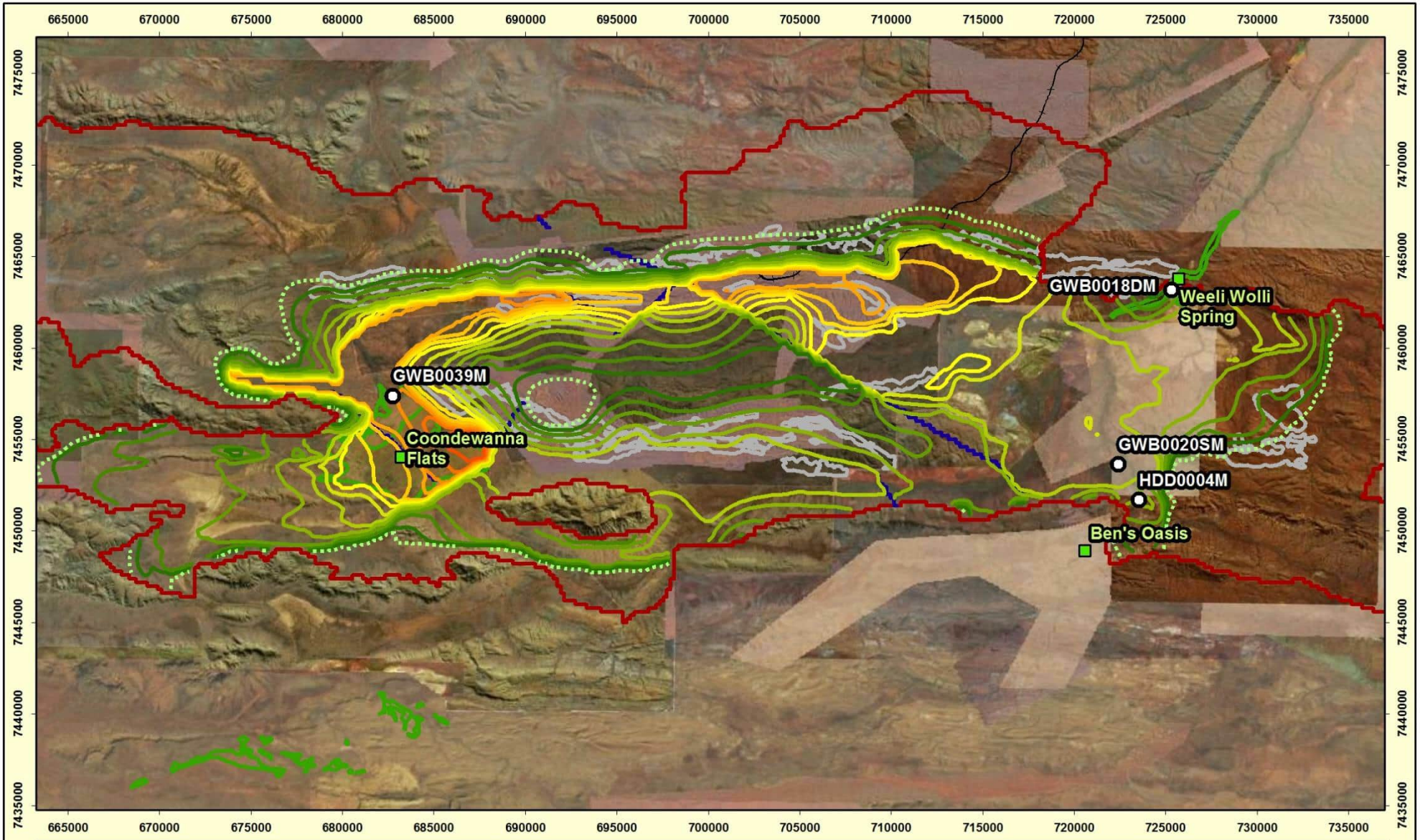
Key prediction bores
Environmental receptors
Water level change (m)
-120
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
-5
-2.5
-1
Simulated flow barriers
Priority Ecological Community
Model domain
Rail
Recommended Pit Design

BHP

Water level change Base case extended 2050

Scale: 1:269,092	Plotted: 20/09/2024	FIGURE 9.35
Coordinate System: GDA 1994 MGA Zone 50	Revised: 20/09/2024	File Name: CPH_5C_NM-2024_GWL_Contours

MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_GWL_Contours.mxd



LEGEND

N

0 1.5 3 6 9 12 Kilometre

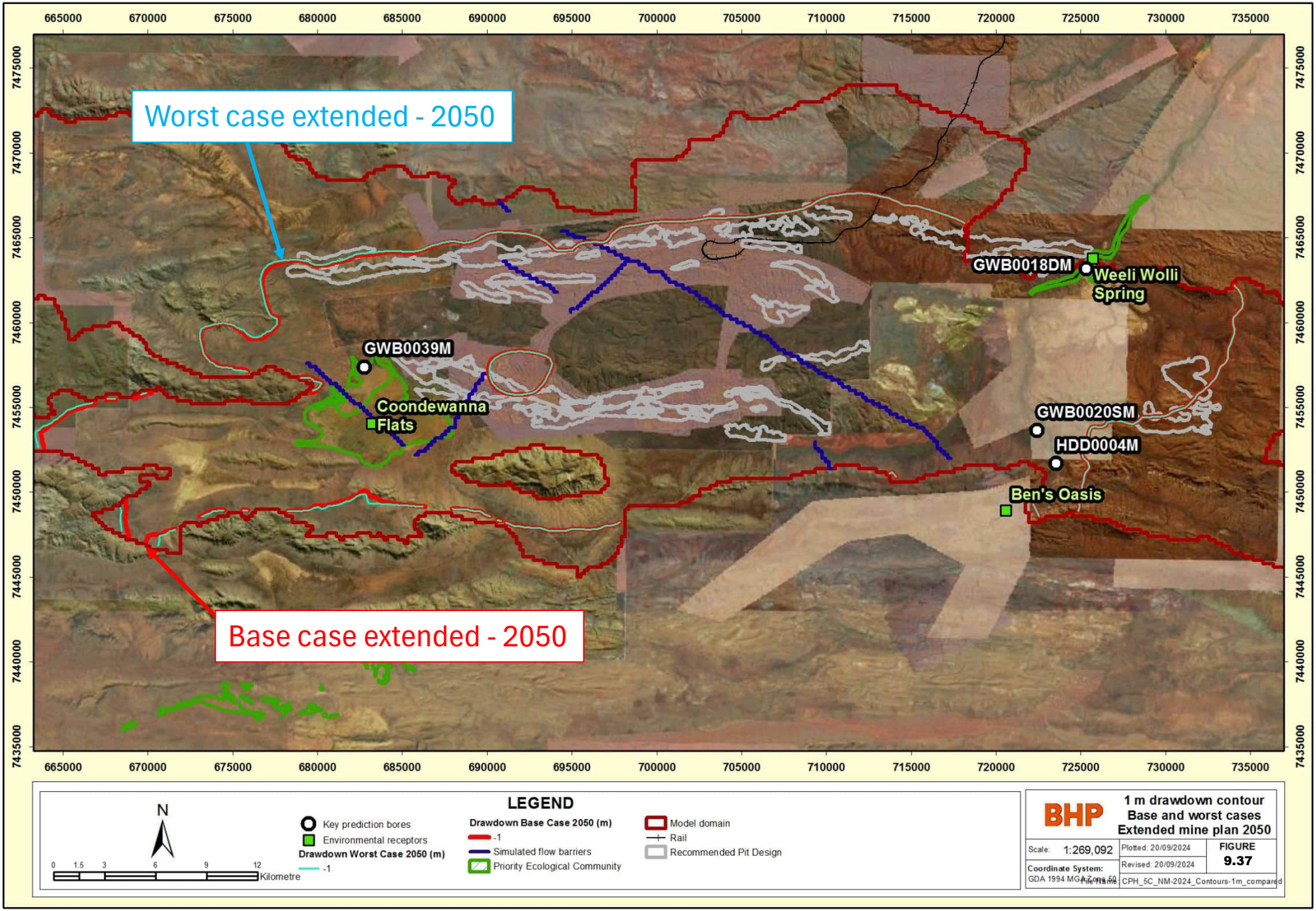
Key prediction bores
Environmental receptors
Water level change (m)
-120
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
-5
-2.5
-1
Simulated flow barriers
Priority Ecological Community
Model domain
Rail
Recommended Pit Design

BHP

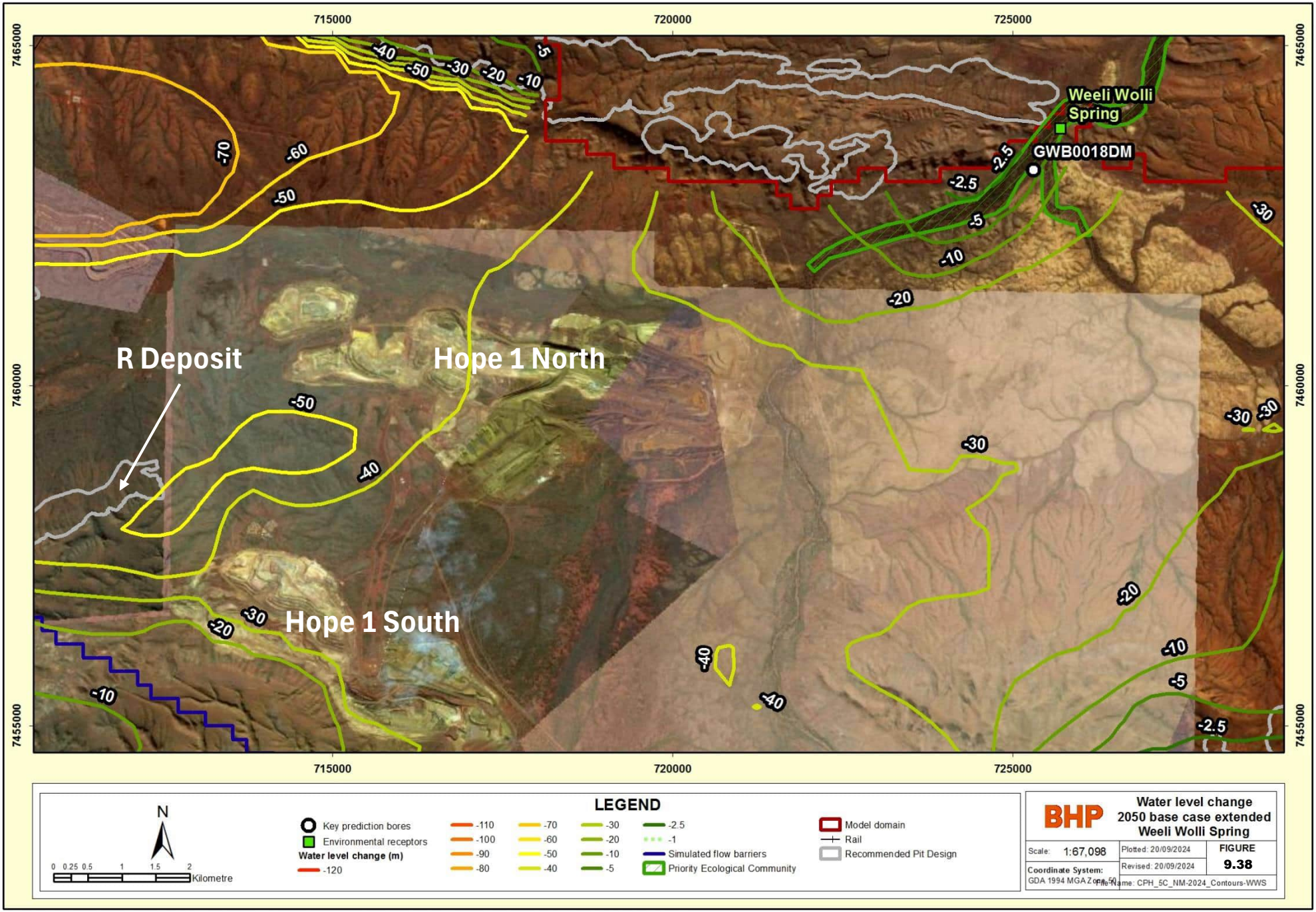
Water level change Worst case extended 2050

Scale: 1:269,092	Plotted: 20/09/2024	FIGURE 9.36
Coordinate System: GDA 1994 MGA Zone 50	Revised: 20/09/2024	
	Name: CPH_5C_NM-2024_Contours	

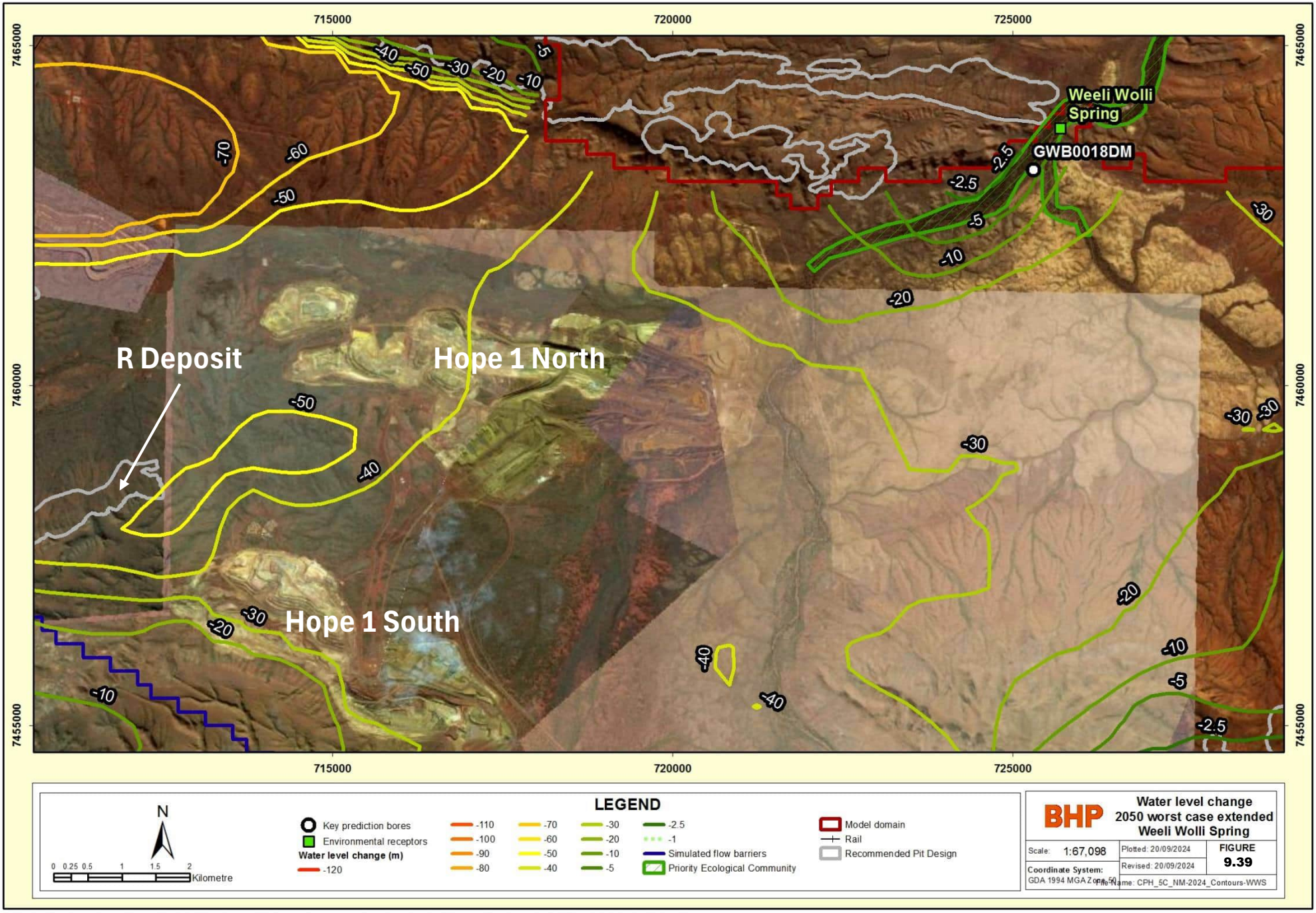
MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_Contours.mxd



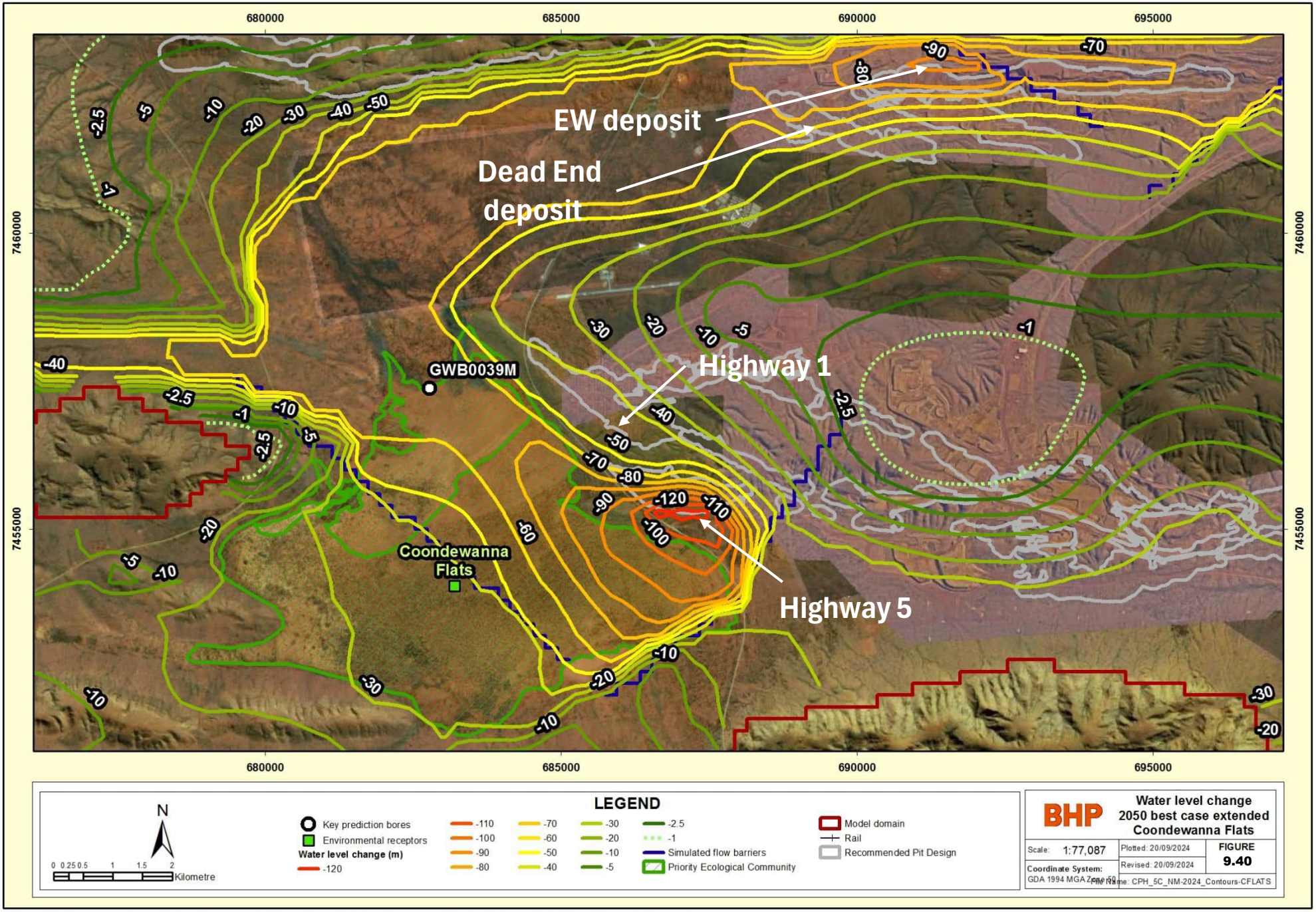
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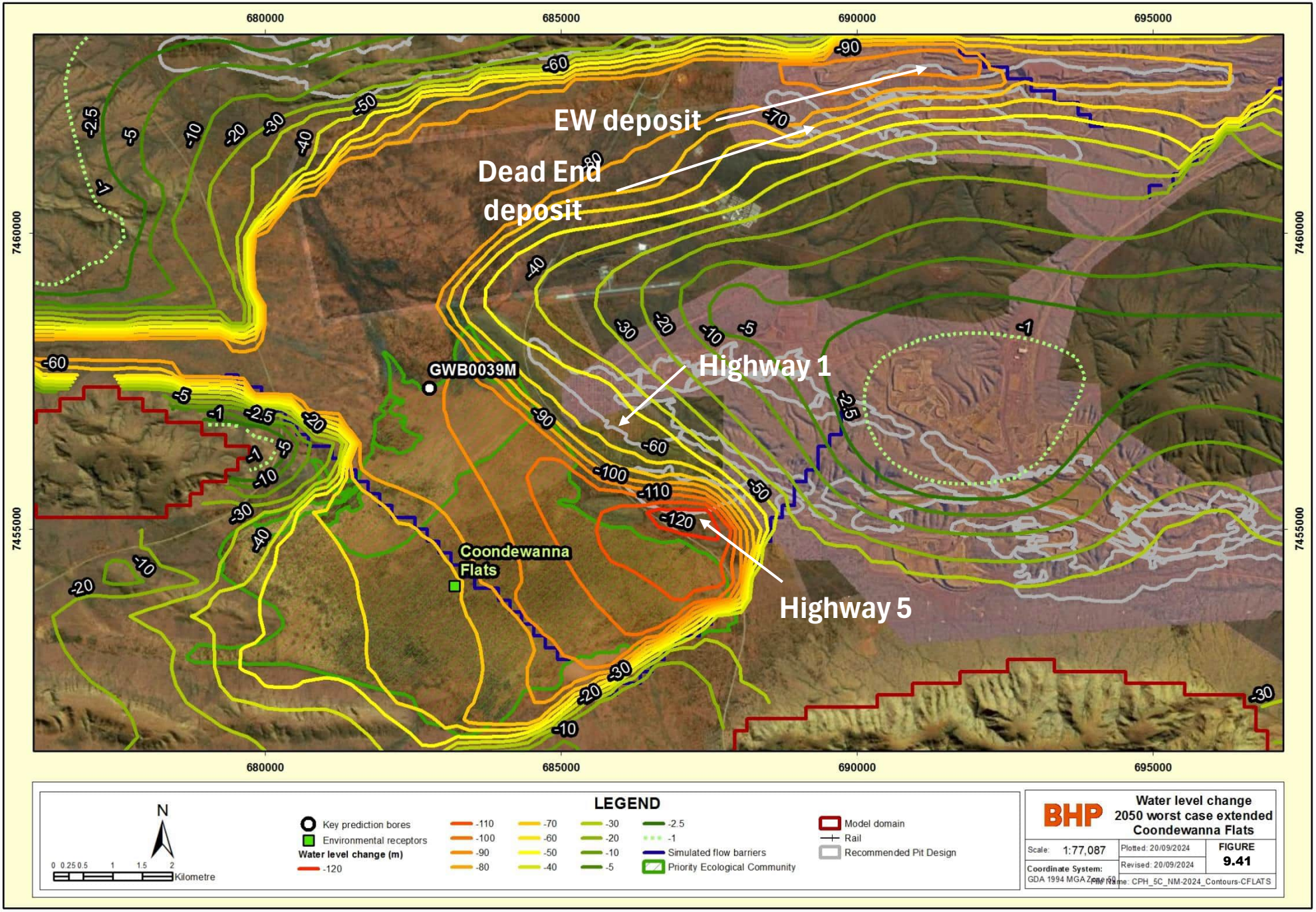
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MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_Contours-WWS.mxd



MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_Contours-CFLATS.mxd



LEGEND

N

0 0.25 0.5 1 1.5 2 Kilometre

- Key prediction bores
- Environmental receptors
- Water level change (m)
  - -120
  - -110
  - -100
  - -90
  - -80
  - -70
  - -60
  - -50
  - -40
  - -30
  - -20
  - -10
  - -5
  - -2.5
  - -1
- Simulated flow barriers
- Priority Ecological Community
- Model domain
- Rail
- Recommended Pit Design

BHP

Water level change 2050 worst case extended Coondewanna Flats

Scale: 1:77,087	Plotted: 20/09/2024	FIGURE 9.41
Coordinate System: GDA 1994 MGA Zone 50	Revised: 20/09/2024	File Name: CPH_5C_NM-2024_Contours-CFLATS

MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2024_Contours-CFLATS.mxd

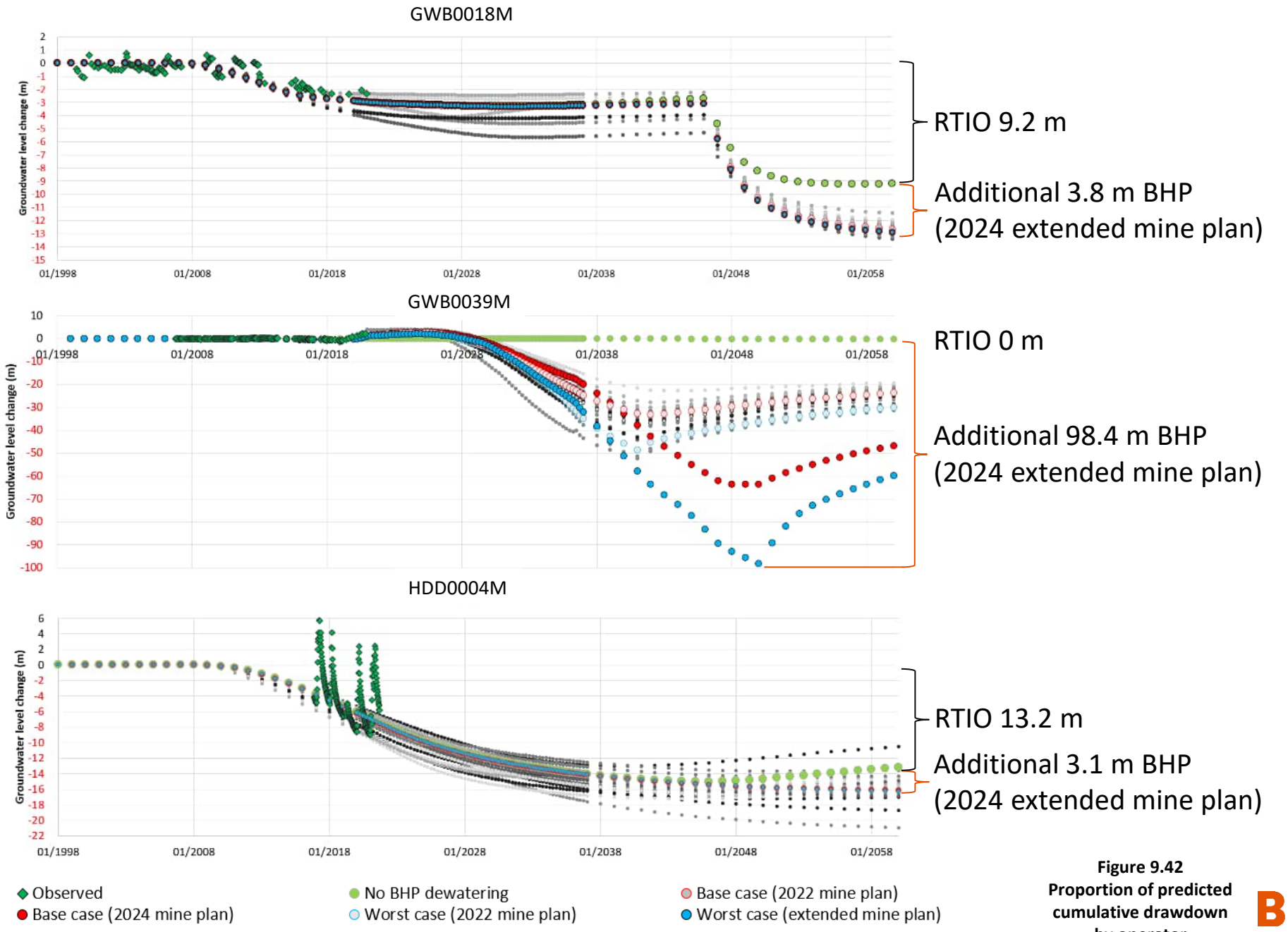
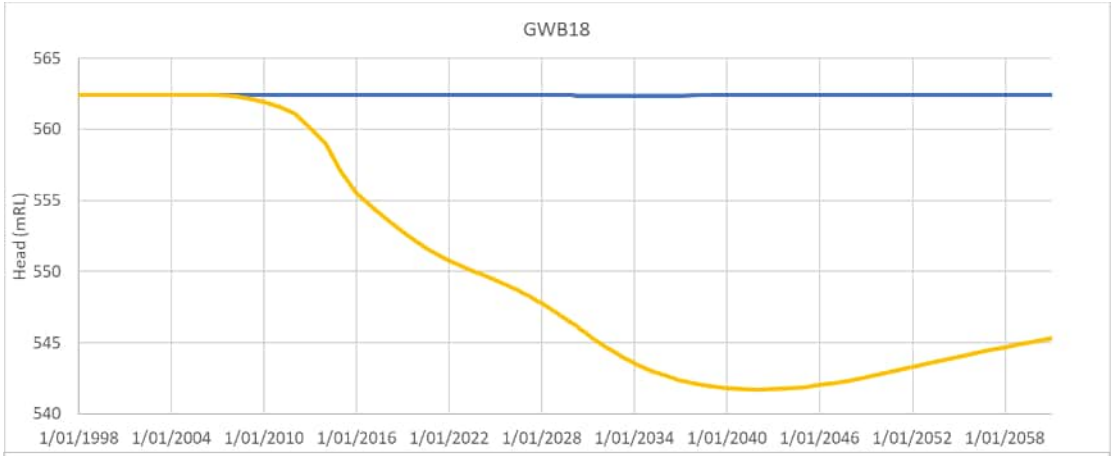
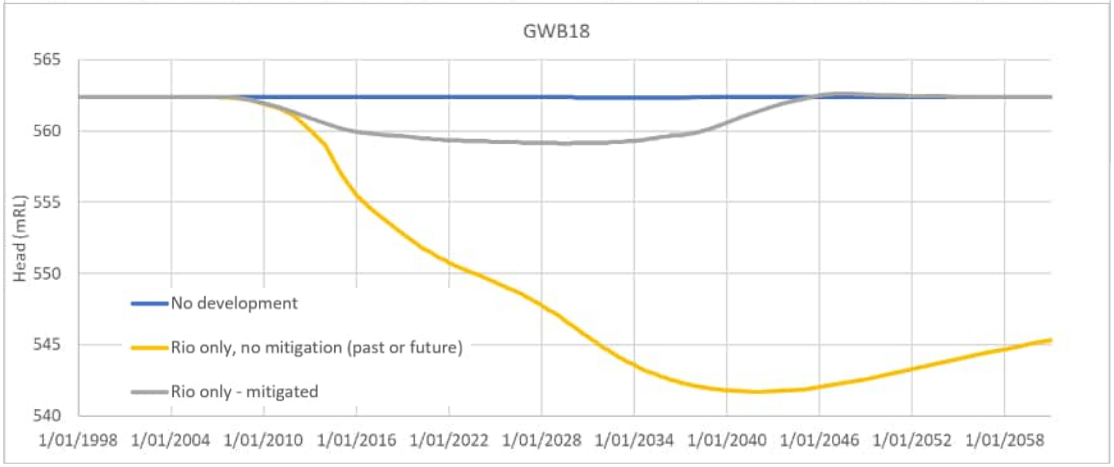


Figure 9.42
Proportion of predicted cumulative drawdown by operator





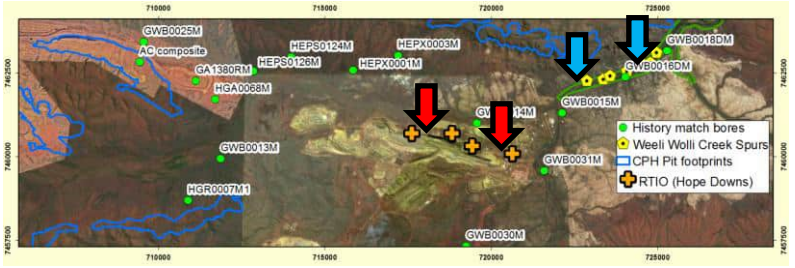
RTIO Mitigation					
MAR			Spur Irrigation		
Start	End	Rate (ML/day)	Start	End	Rate (ML/day)
2026	2045	55	2007	2025	20
			2025	2045	28

Rio dewatering, no mitigation



No BHP water management

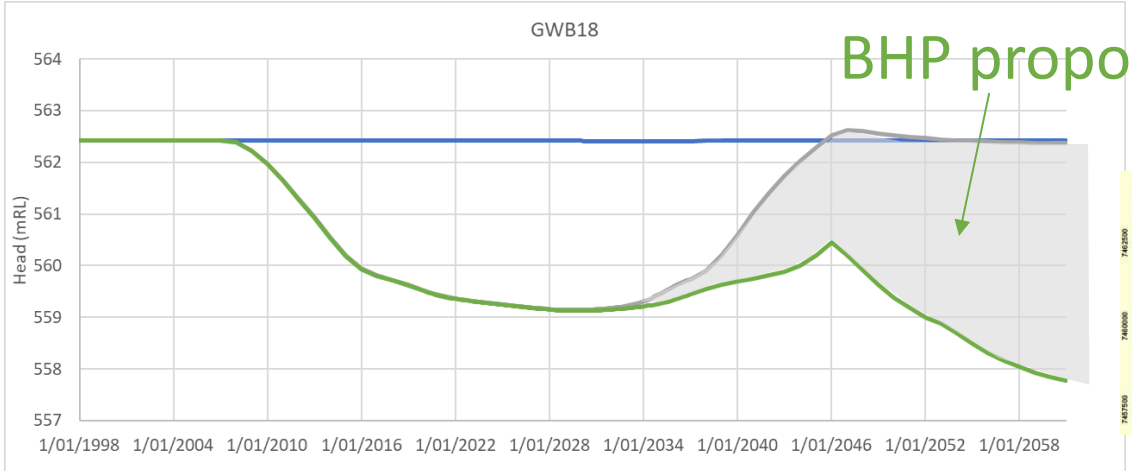
Rio dewatering, mitigation



No BHP water management

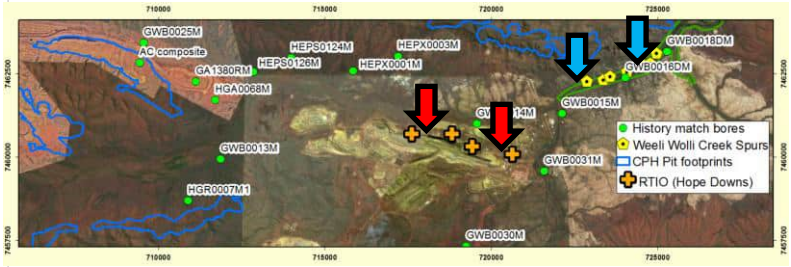
Figure 9.43
RTIO mitigation predictions

BHP

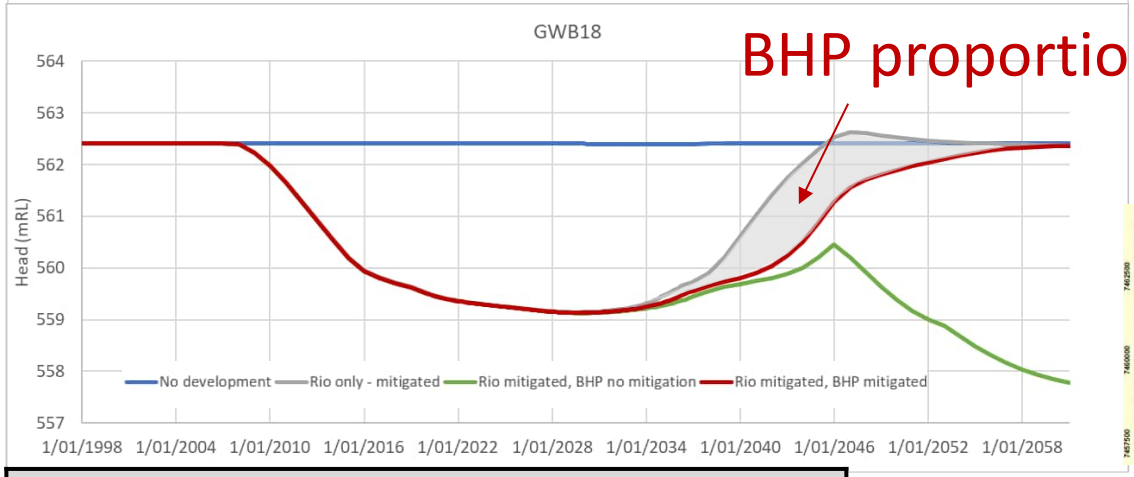


BHP proportion

Rio dewatering, mitigation

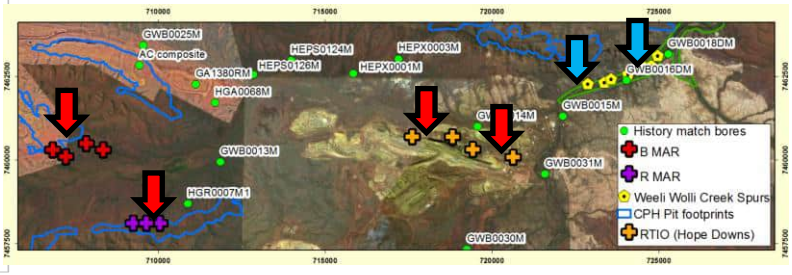


BHP dewatering, no mitigation



BHP proportion

Rio dewatering, mitigation



BHP dewatering, mitigation

RTIO Mitigation					
MAR			Spur Irrigation		
Start	End	Rate (ML/day)	Start	End	Rate (ML/day)
2026	2045	55	2007	2025	20
			2025	2045	28

BHP Mitigation					
B Deposit MAR			R Deposit MAR		
Start	End	Rate (ML/day)	Start	End	Rate (ML/day)
2041	2045	40	2041	2045	40
2046	2051	12	2046	2051	12

Figure 9.44
BHP mitigation predictions

BHP

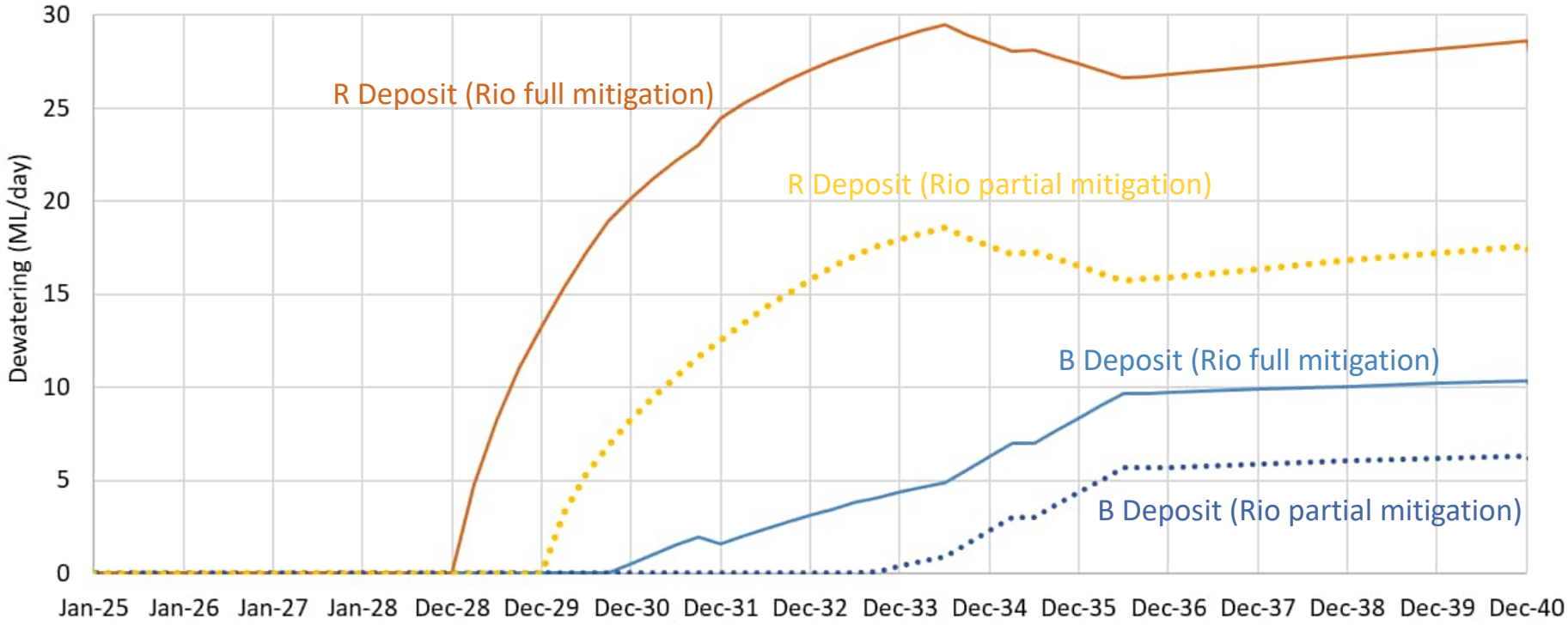
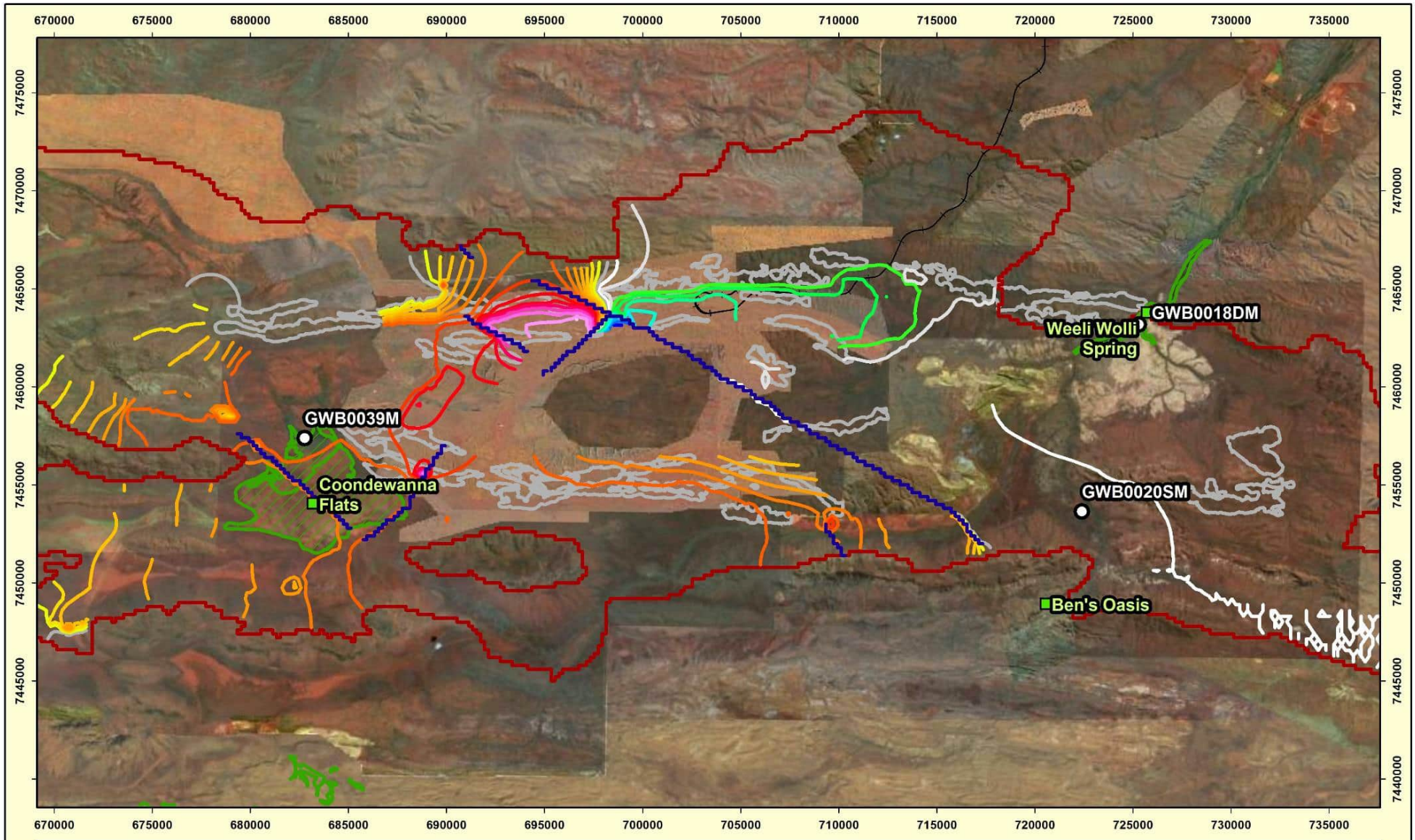


Figure 9.45
Rio Tinto MAR – impact on R and B Deposit dewatering

BHP



LEGEND

N

0 1.25 2.5 5 7.5 10 Kilometre

- Key prediction bores
- Environmental receptors
- Simulated flow barriers

Water level change (m)

4.5, 4, 3.5, 3, 2.5, 2, 1.5, 1, 0.5, 0, -0.5, -1, -1.5, -2, -2.5, -3, -3.5, -4, -4.5, -5, -5.5, -6, -6.5, -7, -7.5, -8

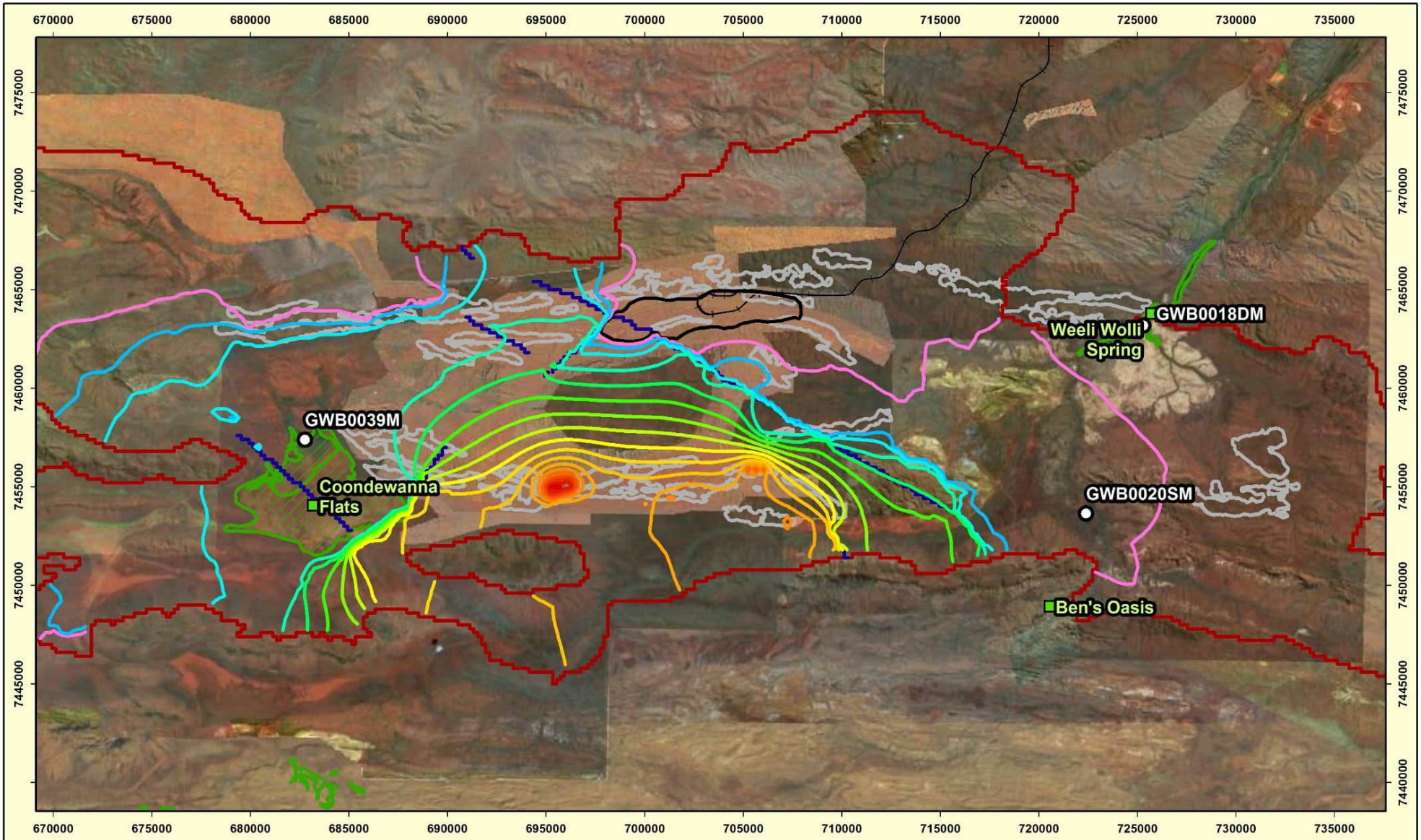
- Priority Ecological Community
- Model domain
- Rail
- Recommended Pit Design

BHP

Predicted equilibrium water level change: All pits backfilled

Scale: 1:250,000		Plotted: 5/01/2022	FIGURE
Coordinate System: GDA 1994 MGA Zone 50		Revised: 5/01/2022	9.46
		File Name: CPH_5C_NM-2021-6.1	

MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2021-6.1.mxd



LEGEND

N

0 1.25 2.5 5 7.5 10 Kilometre

- Key prediction bores
- Environmental receptors

Water level change (m)

- 0
- -1
- -2.5
- -5
- -10
- -15
- -20
- -25
- -30
- -35
- -40
- -45
- -50
- -55
- -60
- -65
- -70
- -75
- -80
- Simulated flow barriers
- Priority Ecological Community
- Model domain
- Rail
- Recommended Pit Design

BHP

Predicted equilibrium water level change: VO / GC voids

Scale: 1:250,000	Plotted: 5/01/2022	FIGURE 9.47
Coordinate System: GDA 1994 MGA Zone 50	Revised: 5/01/2022	
	File Name: CPH_5C_NM-2021-6.2	

MXD Path: \\entper-fil01\2groups\TSRD Application Drive\Resource Planning\Water Planning\03 ArcGIS\CPH\FY22\CPH-Numerical_Modelling\MXD\CPH_5C_NM-2021-6.2.mxd

Appendix A – Target Water Levels

North Flank (MAC)

Year	Quarter	AE	AC2	CC	CW6	EC2	EW1	EC4	EE3	EW2	Dead End	B2 Stage 1	B-PPE2	R
FY20	Q3	546	558	515					525	654	662			
	Q4	540	552	515					525	654	662			
FY21	Q1	534	546	515		606	629	612	525	654	662			
	Q2	528	540	515	526	606	629	612	525	654	662			
	Q3	528	534	515	524	605	629	612	525	654	662	595	525	521
	Q4	528	528	515	522	602	629	612	525	654	662	595	524	520
FY22	Q1	528	522	515	520	599	629	612	525	654	662	595	523	519
	Q2	528	516	515	518	596	628	611	525	654	662	595	523	518
	Q3	528	510	515	516	593	625	611	525	654	662	595	522	517
	Q4	528	504	515	514	590	622	610	525	654	662	595	521	516
FY23	Q1	528	498	515	512	587	619	609	525	654	662	595	520	515
	Q2	528	492	515	510	584	616	609	525	654	662	595	519	514
	Q3	528	492	515	508	581	613	608	525	654	662	595	518	513
	Q4	528	492	515	506	578	610	608	525	654	662	595	517	512
FY24	Q1	528	492	515	504	575	607	605	525	654	662	595	516	511
	Q2	528		515	502	572	604	602	525	653	662	595	515	510
	Q3	528		515	500	569	601	599	525	650	662	595	514	509
	Q4	528		515	498	566	598	596	525	647	662	595	513	508
FY25	Q1	528		515	496	563	595	593	525	644	662	595	512	507
	Q2	528		515	494	560	592	590	525	641	660	595	511	506
	Q3			515	492	557	589	587	525	638	657	595	510	505
	Q4			515	490	554		584	525	635	654	595	510	504
FY26	Q1			515	488	551		581	525	632	651	595	509	503
	Q2			515	486	548		578	525	629	648	595	508	502
	Q3			515	484	545		575	525	626	645	595	507	501
	Q4			515	484	542		572	525	623	642	595	506	500
FY27	Q1			515	484	539		569	525	620	639	595	505	499
	Q2			515	484	536		566	525	617	636	595	504	498
	Q3			515	484	533		563	525	614	633	595	503	497
	Q4					530		560		611	630		502	496

BHP

Year	Quarter	AE	AC2	CC	CW6	EC2	EW1	EC4	EE3	EW2	Dead End	B2 Stage 1	B-PPE2	R
FY28	Q1					527		557		608	627		501	495
	Q2					524		554		605	624		500	494
	Q3					521		551		602	621		499	493
	Q4					518		548		599	618		498	492
FY29	Q1							545		596	615		498	491
	Q2							542		593	612		497	490
	Q3							539		590	609		496	489
	Q4							536		587	606		495	488
FY30	Q1							533		584	603		494	487
	Q2							530		581	600		493	486
	Q3							527		578	597		492	485
	Q4							524		575	594		491	484
FY31	Q1							521		572	591		490	483
	Q2							518		569	588		489	482
	Q3							515		566	588		488	481
	Q4							512		566	588		487	480
FY32	Q1							509		566	588		486	479
	Q2							506		566	588		486	478
	Q3										588		485	477
	Q4										588		484	476
FY33	Q1										588		483	475
	Q2										588		482	474
	Q3										588		481	473
	Q4										588		480	472
FY34	Q1										588		479	471
	Q2										588		478	470
	Q3										588		477	469
	Q4										588		476	468
FY35	Q1										588		475	468
	Q2										588		474	468
	Q3										588		473	468
	Q4										588		473	468
FY36	Q1										588		472	468
	Q2										588		471	468
	Q3										588		470	468
	Q4										588		469	468

BHP

Year	Quarter	AE	AC2	CC	CW6	EC2	EW1	EC4	EE3	EW2	Dead End	B2 Stage 1	B-PPE2	R
FY37	Q1												469	468
	Q2												469	468
2038	-												469	468
2039	-												469	468
2040	-												469	468
2041	-												469	468

South Flank

Year	Quarter	GC PB2	GC PB4	GC PB5	HWY PB1	HWY PB4a	HWY PB5	HWY PB6	HWY PB7	VO PB1	VO PB2	VO PB4a	VO PB5	VO PB6	VO PB8
FY20	Q3	640								630	630	640	630		
	Q4	640								630	630	640	630		
FY21	Q1	640								630	630	640	630		
	Q2	640								630	630	640	630		
	Q3	640	630	640	663	663	663	630	640	630	630	640	630	630	640
	Q4	640	630	640	663	663	663	630	640	630	630	640	630	630	640
FY22	Q1	640	630	640	663	663	663	630	640	630	630	640	630	630	640
	Q2	640	630	640	663	663	663	630	640	630	630	640	630	630	640
	Q3	640	630	640	663	663	663	630	640	630	630	640	630	630	640
	Q4	640	630	640	663	663	663	630	640	630	630	640	630	630	640
FY23	Q1	640	630	640	663	663	663	630	640	630	630	640	630	630	640
	Q2	640	630	640	663	663	663	630	640	627	630	639	630	630	640
	Q3	640	630	640	663	663	663	630	640	623	627	636	630	630	640
	Q4	640	630	640	663	663	663	630	640	618	624	633	630	630	640
FY24	Q1	640	630	640	663	663	663	630	640	614	621	630	630	630	640
	Q2	639	630	640	663	663	663	630	640	609	618	627	630	630	640
	Q3	636	630	640	663	663	663	630	640	605	615	624	630	630	640
	Q4	633	630	640	663	663	663	630	640	600	612	621	630	630	640
FY25	Q1	630	630	640	663	663	663	630	640	596	609	618	630	630	640
	Q2	627	630	640	663	663	663	630	640	591	606	615	627	630	640
	Q3	624	630	640	663	663	663	630	640	587	603	612	624	630	640
	Q4	621	630	640	663	663	663	630	640	582	600	609	621	630	640
FY26	Q1	618	630	640	663	663	663	630	640	578	597	606	618	630	640
	Q2	615	630	640	663	663	663	630	640	573	594	603	615	630	640
	Q3	612	630	640	663	663	663	630	640	569	591	600	612	630	640

BHP

Year	Quarter	GC PB2	GC PB4	GC PB5	HWY PB1	HWY PB4a	HWY PB5	HWY PB6	HWY PB7	VO PB1	VO PB2	VO PB4a	VO PB5	VO PB6	VO PB8
	Q4	609	630	640	663	663	663	630	640		588	597	609	630	640
FY27	Q1	606	630	640	663	663	663	630	640		585	594	606	630	640
	Q2	603	630	640	663	663	663	630	640		582	591	603	630	640
	Q3	600	630	640	660	663	663	630	640		579	588	600	630	640
	Q4	597	630	640	657	663	663	630	640		576	585	597	630	640
FY28	Q1	594	630	640	654	663	663	630	640		573	582	594	630	640
	Q2	591	630	640	651	663	663	630	640		570	579	591	630	640
	Q3	588	630	640	648	663	663	630	640		570	576	588	630	640
	Q4	585	630	640	645	663	663	621	640		570	573	585	630	640
FY29	Q1	582	630	640	642	663	663	612	640		570	570	582	630	640
	Q2	579	630	640	639	663	663	612	640		570	567	579	630	640
	Q3	576	630	640	636	663	663	612	640		570	564	576	630	639
	Q4	573	630	640	633	663	663	612	640		570	561	573	630	636
FY30	Q1	570	630	640	630	660	663	612	640		570	558	570	630	633
	Q2	567	630	640	627	660	663	612	640		570	555	567	627	630
	Q3	564	630	640	624	660	663	612	640		570	552	564	624	627
	Q4	561	630	640	621	660	663	612	640		570	549	561	621	624
FY31	Q1	558	630	640	618	660	660	612	640		570	546	558	618	621
	Q2	555	630	640	615	660	657	612	640		570	546	555	615	618
	Q3	552	630	640	612	660	654	612	640		570	546	552	612	615
	Q4	549	630	640	609	660	651	612	640		570	546	549	609	612
FY32	Q1	546	630	640	606	660	648	612	640		570	546	546	606	609
	Q2	546	630	640	603	660	645	612	640		570	546	546	603	606
	Q3	546	630	640	600	660	642	612	640		570	546	546	600	603
	Q4		630	640	597	660	639	612	640		570	546	546	597	600
FY33	Q1		630	640	594	660	636	612	640		570	546	546	594	597
	Q2		627	640	594	660	633		640					591	594
	Q3		624	640	594	660	630		640					588	594
	Q4		621	640	594	660	627		640					585	594
FY34	Q1		618	640	594	660	624		640					582	594
	Q2		615	640	594		621		640					579	594
	Q3		612	640	594		618		640					576	594
	Q4		609	640	594		615		640					573	594
FY35	Q1		606	640	594		612		636					570	594
	Q2		603	639	594		609		636					567	594
	Q3		600	636	594		606		636					564	594

BHP

Year	Quarter	GC PB2	GC PB4	GC PB5	HWY PB1	HWY PB4a	HWY PB5	HWY PB6	HWY PB7	VO PB1	VO PB2	VO PB4a	VO PB5	VO PB6	VO PB8
	Q4		597	633	594		603		636					561	594
FY36	Q1		594	630	594		600		636					558	594
	Q2		591	627	594		597		636					558	594
	Q3		588	624	594		594		636					558	594
	Q4		585	621	594		591		636					558	594
FY37	Q1		585	621	594		591		636					558	594
	Q2		585	621	594		591		636					558	594
2038	-		585	621	594		591		636					558	594
2039	-		585	621			591		636					558	
2040	-		585	621			591							558	
2041	-		585	621			591								

Appendix B – Uncertainty Analysis

Regional aquifer (hydraulic conductivity)

North Flank

	Tertiary EW		Tertiary EC		Tertiary – EE3		Tertiary - C		Alluvial		Dolomite		Alluvial		Calcrete		Dolomite (C – A Deposits)	
Run	Kx137	Kz137	Kx5	Kz5	Kx135	Kz135	Kx151	Kz151	Kx162	Kz162	Kx99	Kz99	Kx161	Kz161	Kx197	Kz197	Kx10	Kz10
1	2	0.2	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
2	5	0.5	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
3	10	1	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
4	15	1.5	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
5	1.5	0.15	5	0.5	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
6	1.5	0.15	10	1	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
7	1.5	0.15	20	2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
8	1.5	0.15	2	0.2	3	0.3	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
9	1.5	0.15	2	0.2	5	0.5	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
10	1.5	0.15	2	0.2	10	1	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
11	1.5	0.15	2	0.2	15	1.5	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
12	1.5	0.15	2	0.2	1.5	0.15	5	0.5	5	0.5	0.1	0.1	5	0.5	25	25	50	5
13	1.5	0.15	2	0.2	1.5	0.15	10	1	5	0.5	0.1	0.1	5	0.5	25	25	50	5
14	1.5	0.15	2	0.2	1.5	0.15	20	2	5	0.5	0.1	0.1	5	0.5	25	25	50	5
15	1.5	0.15	2	0.2	1.5	0.15	30	3	5	0.5	0.1	0.1	5	0.5	25	25	50	5
16	1.5	0.15	2	0.2	1.5	0.15	3	0.3	10	1	0.1	0.1	5	0.5	25	25	50	5
17	1.5	0.15	2	0.2	1.5	0.15	3	0.3	20	2	0.1	0.1	5	0.5	25	25	50	5
18	1.5	0.15	2	0.2	1.5	0.15	3	0.3	30	3	0.1	0.1	5	0.5	25	25	50	5
19	1.5	0.15	2	0.2	1.5	0.15	3	0.3	40	4	0.1	0.1	5	0.5	25	25	50	5
20	1.5	0.15	2	0.2	1.5	0.15	3	0.3	50	5	0.1	0.1	5	0.5	25	25	50	5
21	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.5	0.5	5	0.5	25	25	50	5
22	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	1	1	5	0.5	25	25	50	5
23	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	5	5	5	0.5	25	25	50	5

BHP

24	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	10	1	25	25	50	5
25	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	20	2	25	25	50	5
26	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	30	3	25	25	50	5
27	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	40	4	25	25	50	5
28	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	50	5	25	25	50	5
29	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	5	5	50	5
30	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	10	10	50	5
31	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	30	30	50	5
32	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	40	40	50	5
33	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	50	50	50	5
34	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	5	0.5
35	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	10	1
36	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	20	2
37	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	30	3
38	1.5	0.15	2	0.2	1.5	0.15	3	0.3	5	0.5	0.1	0.1	5	0.5	25	25	40	4

Regional aquifer (hydraulic conductivity) - continued

	North Flank		Juna Downs / HWY / South Flank															
	Dolomite (East A)		WEST of catchment + some spots centre and southeast - massive zone		Detritals		Alluvial		Alluvial		Newman un-mineralised		SF Dolomite Upper		SF Dolomite Lower		West Angela	
Run	Kx9	Kz9	Kx 108	Kz 108	Kx 158	Kz 158	Kx 107	Kz 107	Kx 103	Kz 103	Kx 116	Kz 116	Kx 201	Kz 201	Kx 188	Kz 188	Kx 111	Kz 111
39	5	1	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
40	10	3	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
41	30	10	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
42	40	15	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
43	50	20	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
44	24.1	7.2	5	5	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1

BHP

45	24.1	7.2	10	10	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
46	24.1	7.2	1	1	10	2	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
47	24.1	7.2	1	1	20	5	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
48	24.1	7.2	1	1	30	6	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
49	24.1	7.2	1	1	40	10	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
50	24.1	7.2	1	1	50	15	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
51	24.1	7.2	1	1	5	1.65	0.5	0.5	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
52	24.1	7.2	1	1	5	1.65	1	1	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
53	24.1	7.2	1	1	5	1.65	2	2	0.117	0.036	3	3	80	8.49	20	1.86	0.5	0.1
54	24.1	7.2	1	1	5	1.65	0.2	0.2	0.5	0.1	3	3	80	8.49	20	1.86	0.5	0.1
55	24.1	7.2	1	1	5	1.65	0.2	0.2	1	0.3	3	3	80	8.49	20	1.86	0.5	0.1
56	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	5	5	80	8.49	20	1.86	0.5	0.1
57	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	10	10	80	8.49	20	1.86	0.5	0.1
58	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	20	20	80	8.49	20	1.86	0.5	0.1
59	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	30	30	80	8.49	20	1.86	0.5	0.1
60	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	8	0.85	20	1.86	0.5	0.1
61	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	20	2.12	20	1.86	0.5	0.1
62	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	40	4.25	20	1.86	0.5	0.1
63	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	60	11.32	20	1.86	0.5	0.1
64	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	2	0.19	0.5	0.1
65	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	10	0.93	0.5	0.1
66	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	30	1.24	0.5	0.1
67	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	40	3.72	0.5	0.1
68	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	50	4.65	0.5	0.1
69	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	1	0.1
70	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	2	0.2
71	24.1	7.2	1	1	5	1.65	0.2	0.2	0.117	0.036	3	3	80	8.49	20	1.86	5	0.5

Regional aquifer (hydraulic conductivity) - continued

Juna Downs / HWY / South Flank

	Dolomite		Dolomite		Alluvial		R Deposit dolomite		Coondewanna dolomite		Dolomite (west)		Dolomite	
Run	Kx173	Kz173	Kx153	Kz153	Kx190	Kz190	Kx187	Kz187	Kx199	Kz199	Kx200	Kz200	Kx183	Kz183
72	5	6.8	4.87	10.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
73	20	27.2	4.87	10.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
74	30	40.8	4.87	10.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
75	40	54.4	4.87	10.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
76	50	68	4.87	10.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
77	10	13.6	10	22.4	24.1	7.2	20	1	60	60	60	6	12.4	12.4
78	10	13.6	20	44.8	24.1	7.2	20	1	60	60	60	6	12.4	12.4
79	10	13.6	30	67.1	24.1	7.2	20	1	60	60	60	6	12.4	12.4
80	10	13.6	40	89.5	24.1	7.2	20	1	60	60	60	6	12.4	12.4
81	10	13.6	50	111.9	24.1	7.2	20	1	60	60	60	6	12.4	12.4
82														
83						Combinations of highest values								
84	10	13.6	4.87	10.9	5	1.5	20	1	60	60	60	6	12.4	12.4
85	10	13.6	4.87	10.9	10	3.0	20	1	60	60	60	6	12.4	12.4
86	10	13.6	4.87	10.9	15	4.5	20	1	60	60	60	6	12.4	12.4
87	10	13.6	4.87	10.9	30	9.0	20	1	60	60	60	6	12.4	12.4
88	10	13.6	4.87	10.9	40	12.0	20	1	60	60	60	6	12.4	12.4
89	10	13.6	4.87	10.9	50	14.9	20	1	60	60	60	6	12.4	12.4
90	10	13.6	4.87	10.9	24.1	7.2	10	0.5	60	60	60	6	12.4	12.4
91	10	13.6	4.87	10.9	24.1	7.2	30	1.5	60	60	60	6	12.4	12.4
92	10	13.6	4.87	10.9	24.1	7.2	40	2	60	60	60	6	12.4	12.4
93	10	13.6	4.87	10.9	24.1	7.2	20	1	20	20	60	6	12.4	12.4
94	10	13.6	4.87	10.9	24.1	7.2	20	1	40	40	60	6	12.4	12.4
95	10	13.6	4.87	10.9	24.1	7.2	20	1	80	80	60	6	12.4	12.4
96	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	20	2	12.4	12.4
97	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	40	4	12.4	12.4
98	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	80	6	12.4	12.4

99	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	60	6	5	5
100	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	60	6	10	10
101	10	13.6	4.87	10.9	24.1	7.2	20	1	60	60	60	6	20	20

Non-aquifer connection (hydraulic conductivity)

	North Flank				South Flank/JD/HWY			
	WA Shale – EC		West Angela Shale C		Marra Mamba unmineralised		West Angela	
Run no	Kx204	Kz204	Kx98	Kz98	Kx76	Kz76	Kx88	Kz88
1	0.8	0.8	0.1	0.01	0.01	0.01	0.0118	0.01
2	2	2	0.1	0.01	0.01	0.01	0.0118	0.01
3	5	5	0.1	0.01	0.01	0.01	0.0118	0.01
4	10	10	0.1	0.01	0.01	0.01	0.0118	0.01
5	0.8	0.8	0.5	0.05	0.01	0.01	0.0118	0.01
6	0.8	0.8	1	0.1	0.01	0.01	0.0118	0.01
7	0.8	0.8	5	0.5	0.01	0.01	0.0118	0.01
8	0.8	0.8	0.1	0.01	0.1	0.1	0.0118	0.01
9	0.8	0.8	0.1	0.01	0.5	0.5	0.0118	0.01
10	0.8	0.8	0.1	0.01	1	1	0.0118	0.01
11	0.8	0.8	0.1	0.01	0.01	0.01	0.1	0.1
12	0.8	0.8	0.1	0.01	0.01	0.01	0.5	0.5
13	0.8	0.8	0.1	0.01	0.01	0.01	1	1

Orebody storage (specific storage and specific yield)

	North Flank						South Flank / HWY			
Run no	Ss27	Sy27	Ss55	Sy55	Ss203	Sy203	Ss174	Sy174	Ss173	Sy173
1	5.00E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
2	1.00E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
3	1.00E-05	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
4	2.70E-04	30%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
5	2.70E-04	10%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%

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6	2.70E-04	22%	5.00E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
7	2.70E-04	22%	1.00E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
8	2.70E-04	22%	1.00E-05	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
9	2.70E-04	22%	2.70E-04	5%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
10	2.70E-04	22%	2.70E-04	10%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
11	2.70E-04	22%	2.70E-04	20%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	2%
12	2.70E-04	22%	2.70E-04	1%	5.00E-04	0.01%	2.70E-04	5%	2.70E-04	2%
13	2.70E-04	22%	2.70E-04	1%	1.00E-05	0.01%	2.70E-04	5%	2.70E-04	2%
14	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.10%	2.70E-04	5%	2.70E-04	2%
15	2.70E-04	22%	2.70E-04	1%	9.18E-05	1.00%	2.70E-04	5%	2.70E-04	2%
16	2.70E-04	22%	2.70E-04	1%	9.18E-05	5.00%	2.70E-04	5%	2.70E-04	2%
17	2.70E-04	22%	2.70E-04	1%	9.18E-05	10.00%	2.70E-04	5%	2.70E-04	2%
18	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	5.00E-04	5%	2.70E-04	2%
19	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	1.00E-04	5%	2.70E-04	2%
20	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	1.00E-05	5%	2.70E-04	2%
21	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	1%	2.70E-04	2%
22	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	10%	2.70E-04	2%
23	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	20%	2.70E-04	2%
24	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	5.00E-04	2%
25	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	1.00E-04	2%
26	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	1.00E-05	2%
27	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	1%
28	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	5%
29	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	10%
30	2.70E-04	22%	2.70E-04	1%	9.18E-05	0.01%	2.70E-04	5%	2.70E-04	20%

Regional aquifer storage (specific storage and specific yield)

Run no	Ss17	Sy17	Ss18	Sy18	Ss112	Sy112	Ss113	Sy113	Ss145	Sy145	Ss115	Sy115	Sy1	Sy5
1	5.00E-05	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%

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2	1.00E-05	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
3	1.00E-04	1.00%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
4	1.00E-04	5.00%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
5	1.00E-04	10.00%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
6	1.00E-04	20.00%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
7	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
8	1.00E-04	0.50%	0.00%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
9	1.00E-04	0.50%	0.01%	1.00%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
10	1.00E-04	0.50%	0.01%	5.00%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
11	1.00E-04	0.50%	0.01%	10.00%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
12	1.00E-04	0.50%	0.01%	20.00%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
13	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
14	1.00E-04	0.50%	0.01%	0.10%	0.00%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
15	1.00E-04	0.50%	0.01%	0.10%	0.01%	1.00%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
16	1.00E-04	0.50%	0.01%	0.10%	0.01%	5.00%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
17	1.00E-04	0.50%	0.01%	0.10%	0.01%	10.00%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
18	1.00E-04	0.50%	0.01%	0.10%	0.01%	20.00%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
19	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
20	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.00%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
21	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	1.00%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
22	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	5.00%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
23	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	10.00%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
24	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	20.00%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	10.00%
25	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	5.00E-05	0.10%	1.00E-04	0.50%	10.00%	10.00%
26	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-05	0.10%	1.00E-04	0.50%	10.00%	10.00%
27	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	1.00%	1.00E-04	0.50%	10.00%	10.00%
28	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	5.00%	1.00E-04	0.50%	10.00%	10.00%
29	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	10.00%	1.00E-04	0.50%	10.00%	10.00%
30	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	20.00%	1.00E-04	0.50%	10.00%	10.00%
31	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	5.00E-05	0.50%	10.00%	10.00%
32	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-05	0.50%	10.00%	10.00%

BHP

33	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	1.00%	10.00%	10.00%
34	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	5.00%	10.00%	10.00%
35	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	10.00%	10.00%	10.00%
36	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	20.00%	10.00%	10.00%
37	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	1.00%	10.00%
38	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	5.00%	10.00%
39	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	20.00%	10.00%
40	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	1.00%
41	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	5.00%
42	1.00E-04	0.50%	0.01%	0.10%	0.01%	0.10%	0.01%	0.50%	1.00E-04	0.10%	1.00E-04	0.50%	10.00%	20.00%

Regional aquifer storage (specific storage and specific yield) - continued

Run no	Sy61	Sy6	Sy63	Sy65	Sy64	Sy67	Sy54	Sy2	Sy126	Sy173	Sy175	Sy166	Sy174	Sy176	Sy66
43	0.1%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
44	5.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
45	10.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
46	1.0%	1.0%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
47	1.0%	5.0%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
48	1.0%	10.0%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
49	1.0%	0.1%	1%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
50	1.0%	0.1%	5%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
51	1.0%	0.1%	20%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
52	1.0%	0.1%	10%	1%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
53	1.0%	0.1%	10%	5%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
54	1.0%	0.1%	10%	20%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
55	1.0%	0.1%	10%	11%	0.1%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
56	1.0%	0.1%	10%	11%	5.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
57	1.0%	0.1%	10%	11%	10.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
58	1.0%	0.1%	10%	11%	1.0%	1.0%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
59	1.0%	0.1%	10%	11%	1.0%	5.0%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
60	1.0%	0.1%	10%	11%	1.0%	10.0%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%

BHP

61	1.0%	0.1%	10%	11%	1.0%	0.1%	5%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
62	1.0%	0.1%	10%	11%	1.0%	0.1%	10%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
63	1.0%	0.1%	10%	11%	1.0%	0.1%	40%	8%	0.1%	2.0%	5%	10%	5%	0.5%	10%
64	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	1%	0.1%	2.0%	5%	10%	5%	0.5%	10%
65	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	15%	0.1%	2.0%	5%	10%	5%	0.5%	10%
66	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	20%	0.1%	2.0%	5%	10%	5%	0.5%	10%
67	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	1.0%	2.0%	5%	10%	5%	0.5%	10%
68	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	5.0%	2.0%	5%	10%	5%	0.5%	10%
69	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	10.0%	2.0%	5%	10%	5%	0.5%	10%
70	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	0.1%	5%	10%	5%	0.5%	10%
71	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	10.0%	5%	10%	5%	0.5%	10%
72	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	20.0%	5%	10%	5%	0.5%	10%
73	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	1%	10%	5%	0.5%	10%
74	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	10%	10%	5%	0.5%	10%
75	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	20%	10%	5%	0.5%	10%
76	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	1%	5%	0.5%	10%
77	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	5%	5%	0.5%	10%
78	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	20%	5%	0.5%	10%
79	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	1%	0.5%	10%
80	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	10%	0.5%	10%
81	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	20%	0.5%	10%
82	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	1.0%	10%
83	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	5.0%	10%
84	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	10.0%	10%
85	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	1%
86	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	5%
87	1.0%	0.1%	10%	11%	1.0%	0.1%	25%	8%	0.1%	2.0%	5%	10%	5%	0.5%	20%

BHP

Flow barrier conductivities (m/d)

Run no	Reach (0)	Reach (3)	Reach (7)	Reach (6)	Reach (5)	Reach (9)	Reach (10)
1	0.00001	0.0000001	0.0001	0.00015	0.0001	0.0001	0.001
2	0.0001	0.0000001	0.0001	0.00015	0.0001	0.0001	0.001
3	0.0005	0.0000001	0.0001	0.00015	0.0001	0.0001	0.001
4	0.001	0.0000001	0.0001	0.00015	0.0001	0.0001	0.001
5		0.000001	0.0001	0.00015	0.0001	0.0001	0.001
6		0.00001	0.0001	0.00015	0.0001	0.0001	0.001
7		0.0001	0.0001	0.00015	0.0001	0.0001	0.001
8		0.001	0.0001	0.00015	0.0001	0.0001	0.001
9		0.0000001	0.0005	0.00015	0.0001	0.0001	0.001
10		0.0000001	0.001	0.00015	0.0001	0.0001	0.001
11		0.0000001	0.00001	0.00015	0.0001	0.0001	0.001
12		0.0000001	0.0001	0.0005	0.0001	0.0001	0.001
13		0.0000001	0.0001	0.001	0.0001	0.0001	0.001
14	Variable	0.0000001	0.0001	0.00001	0.0001	0.0001	0.001
15		0.0000001	0.0001	0.00015	0.0005	0.0001	0.001
16		0.0000001	0.0001	0.00015	0.001	0.0001	0.001
17		0.0000001	0.0001	0.00015	0.00001	0.0001	0.001
18		0.0000001	0.0001	0.00015	0.0001	0.0005	0.001
19		0.0000001	0.0001	0.00015	0.0001	0.001	0.001
20		0.0000001	0.0001	0.00015	0.0001	0.00001	0.001
21		0.0000001	0.0001	0.00015	0.0001	0.0001	0.005
22		0.0000001	0.0001	0.00015	0.0001	0.0001	0.0005
23		0.0000001	0.0001	0.00015	0.0001	0.0001	0.0001

Appendix C – Hydrogeological Conceptual Model

Central Pilbara 5C
Appendix C
Basis for conceptual model

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1 Introduction

This document provides the technical basis for the Central Pilbara conceptual hydrogeological model which was used to support the 5C abstraction licence request (2023). The study in support of this licence increase has focussed on dewatering from the MAC A, B, C, E and R Deposits, the South Flank Vista Oriental, Highway and Grand Central Deposits and the Hope Downs Deposit and the impacts of this on the ecological receptors in the catchment.

The document therefore includes a detailed analysis of data within the area pertinent to the study, predominantly the Coondewanna Flats, North Flank Valley, South Flank Valley, Hope Downs and Weeli Wolli aquifer systems.

2 Geology

2.1 Introduction

The current extent of geological drilling in CPH is shown in **Figure 2.1** and **Figure 2.2**. Tens of thousands of holes have been drilled in the area, however the distribution is massively biased to the orebodies. Geological confidence is therefore very high in these areas but much more variable in the areas of the regional aquifers. The main stratigraphy within the conceptual model domain is described below and summarised in **Table 2.1**. A geological outcrop map is shown in **Figure 2.3.**

The formations of the Hamersley Group comprise a series of siliceous and carbonate-rich moderate-to deep-water sediments (i.e. chert and shale) that have been chemically altered and iron-enriched to form Banded Iron Formation (BIF) and dolomite**.** Subsequent additional iron-enrichment of the BIF has formed orebodies. The Brockman and the Marra Mamba have notable occurrences of iron-enrichment and these two formations host most orebodies. There is a marked increase in both porosity and permeability associated with the mineralisation process, as such the orebodies form important aquifers.

The geology of the Regional, North Flank and South Flank aquifer systems is explored in more detail below.

Table 2.1. Central Pilbara stratigraphic log

Age	Group	Formation	Member / description	Code
Young	Alluvium			
	Tertiary Detritals	TD3		TD3
		TD2	Inc. calcrete	TD2
		TD1		TD1
	Hamersley	Boolgeeda Iron		HO
		Woongarra Rhyolite		HW
		Weeli Wolli		HJ / WW
		Brockman Iron	Yandicoogina	Y
			Joffre	J1 – J6
			Whaleback Shale	W
			Dales Gorge	D1 – D4
		Mount McRae Shale		R
		Mount Sylvia		S
		Wittenoom	Bee Gorge	OC/OD
			Paraburdoo	OB
			West Angela	WA
		Marra Mamba Iron	Mount Newman	N1 – N3
			McLeod	MM
			Nammuldi	MU
	Fortescue	Jeerinah		JN
Old		Granatoid Complex		

2.2 Regional system

2.2.1 Basement

A key occurrence of dolomite is the Paraburdoo Member of the Wittenoom Formation which forms part of the regional aquifer where it is weathered and karstic.

In the Wanna Munna area in the south of the CPH, the Hamersley Group is absent exposing members of the Jeerinah Formation of the Fortescue Group that underlies the Hamersley Group. The lithology comprises basalt, dolerite sills and mudstone.

2.2.2 Tertiary

The Wittenoom Formation is less resistant to weathering than the surrounding formations and has been eroded to form the subcrop in most of the low lying areas, such as valley floors and alluvial plains. Bedrock relief has been reduced since the Tertiary by infilling with erosional detritus from the surrounding outcrop (such that the subcropping Wittenoom Formation rarely occurs in outcrop). On the margins of hills, there are colluvial deposits (scree) that fine into alluvial deposits (sand and silt) further into the valley. In places, secondary cementation and chemical alteration of these sediments has occurred forming calcrete, silcrete and pisolite. These Tertiary detrital sediments (collectively referred to as Tertiary Detritals) can be in excess of 100 m thick in some places.

Weathering is often present at the contact between the Tertiary Detritals and underlying basement, possibly representing a paleo-lateritic horizon and marked by a vuggy hardcap zone with interspersed pisolite or manganese deposits. This zone can be permeable and often forms part of a regional aquifer in combination with permeable units in the overlying sediments and underlying karstic Paraburdoo Member dolomite (where present).

2.2.3 Quaternary to recent

Active creek channels and floodplains are infilled with recent alluvium. This ranges from silt and clay to coarse gravel and is often poorly sorted - a characteristic of the ephemeral flow regime.

In places where groundwater levels are shallow and calcrete occurs as extensive outcrops it is possible that calcrete is still actively forming (based on the morphology of groundwater calcrete in Australia (Horwitz and Mann 1979)). In such settings, calcrete formation occurs just below the groundwater table and occurs typically over a wide area where groundwater is at shallow depth. Active calcrete formation at the water table pushes the overlying calcrete upwards. Ultimately, a plateau or dome of calcrete emerges, with the youngest units at its base (around the water table). As the plateau emerges, it is dissected by streams flowing across it - as is the case with the extensive calcrete outcrop upstream of Weeli Wolli Spring. In such environments, there will be a saturated zone (of approximately 5 m to 10 m) of high permeability calcrete at the water table forming a potential aquifer stygofauna community.

Figure 2.1. Central Pilbara BHP exploration and hydrogeological drilling coverage

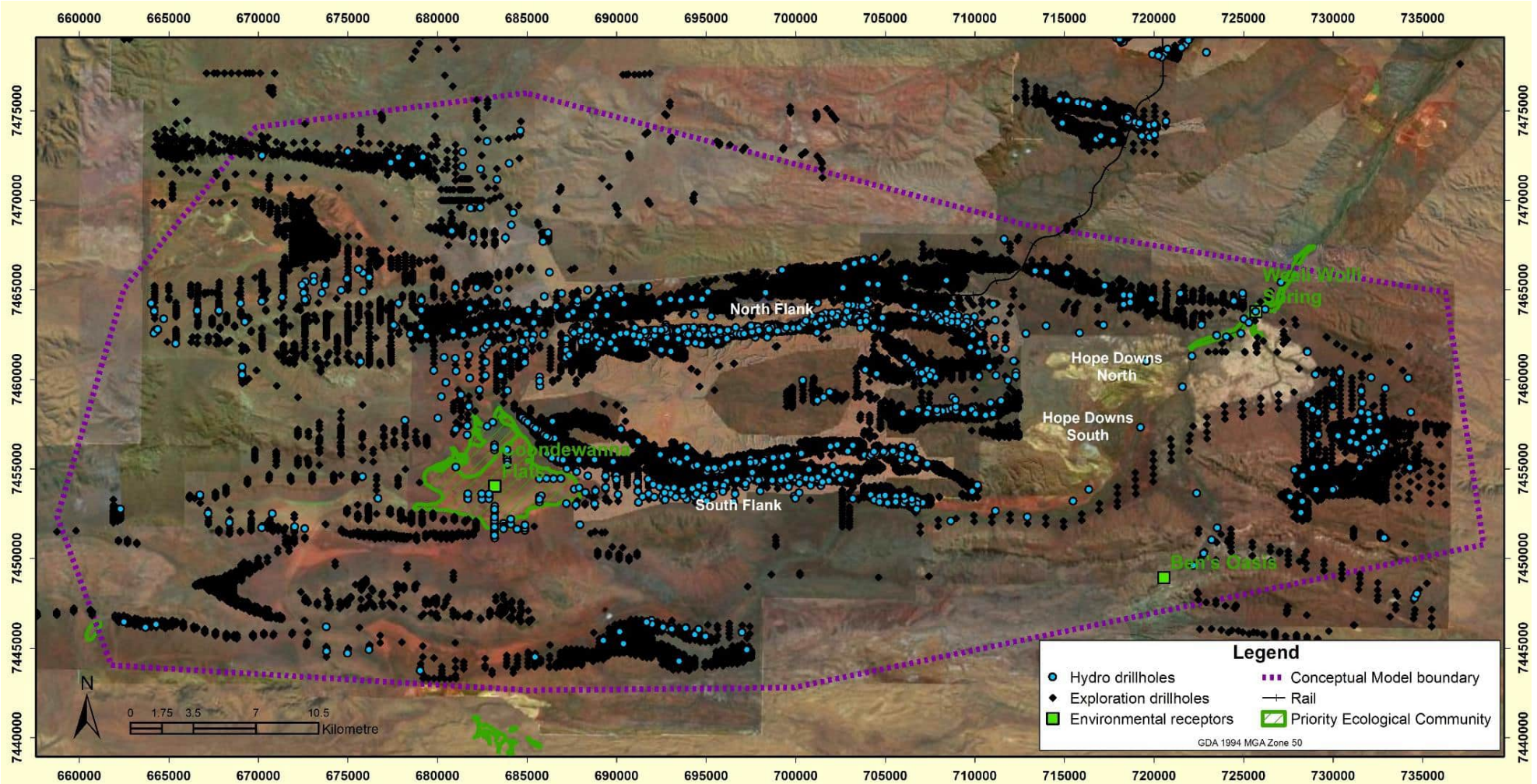
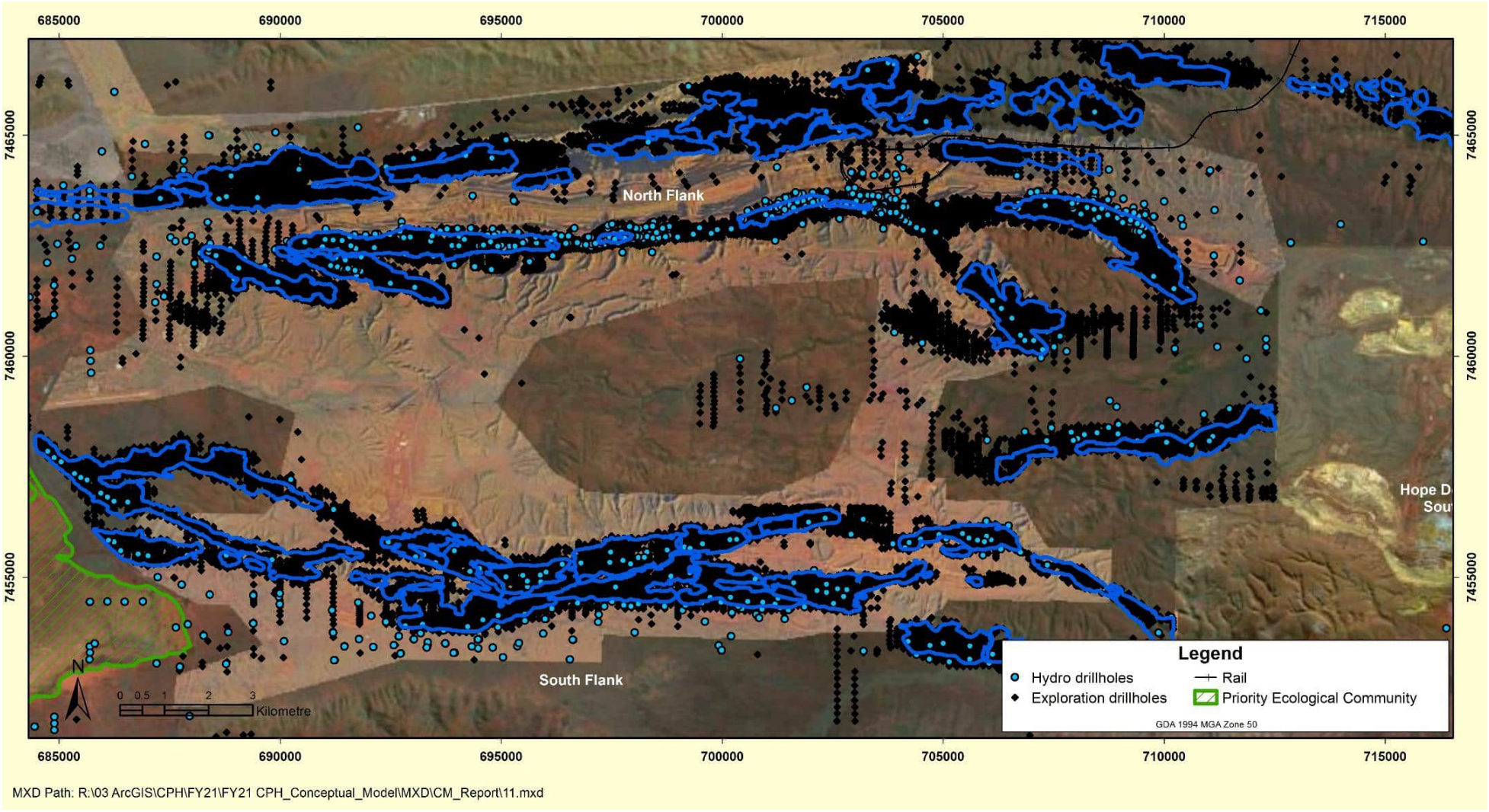
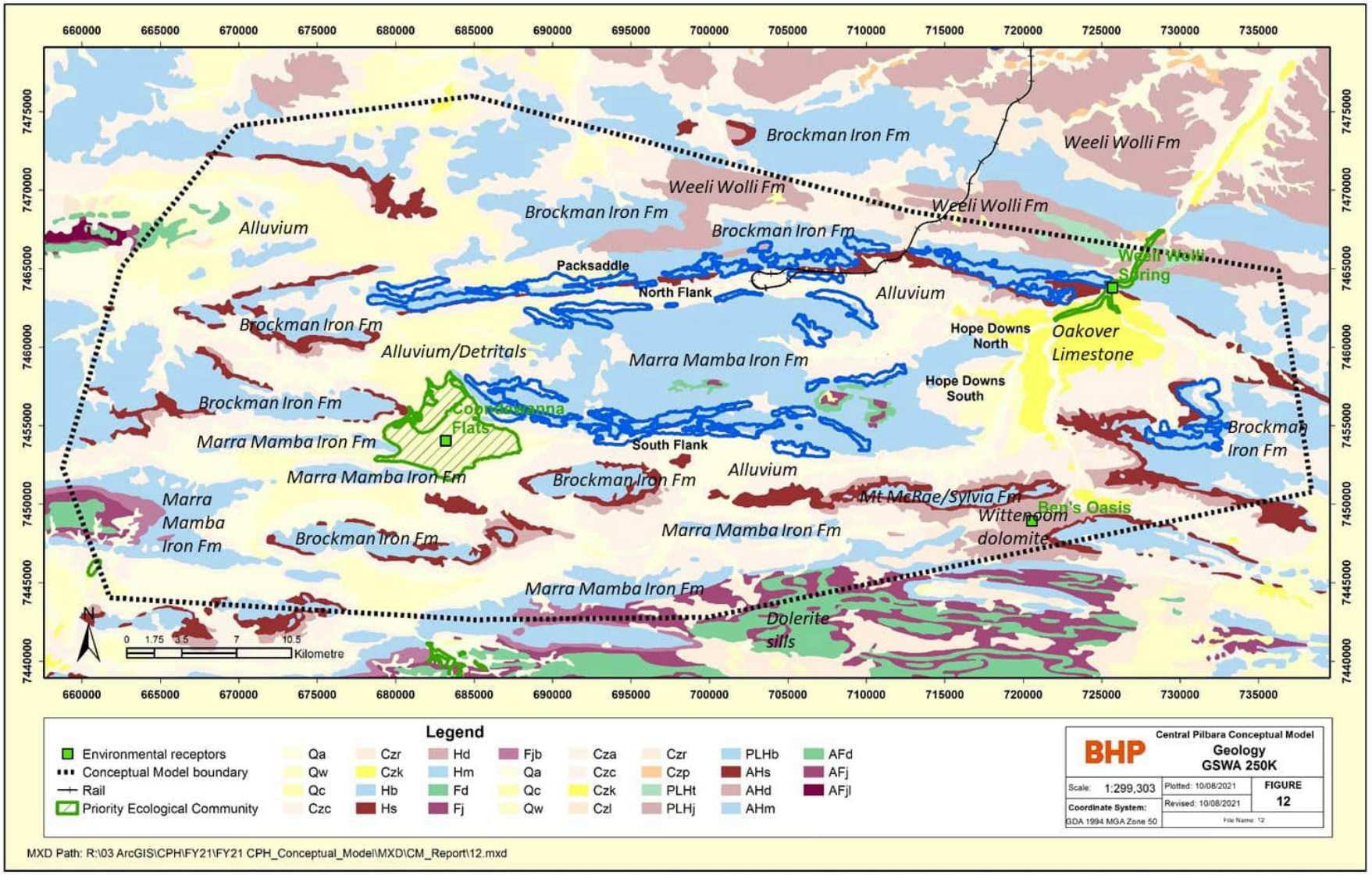


Figure 2.2. North and South Flank BHP exploration and hydrogeological drilling coverage



MXD Path: R:\03 ArcGIS\CPH\FY21\FY21 CPH_Conceptual_Model\MXD\CM_Report\11.mxd

Figure 2.3 CPH Geology (GSWA 250K)



2.3 North Flank and Packsaddle system

2.3.1 Introduction

Geological outcrop maps and cross sections through North Flank and Packsaddle are shown in **Figures 2.4** and **2.5** and the features shown are described below.

Figure 2.4. North Flank and Packsaddle Geology

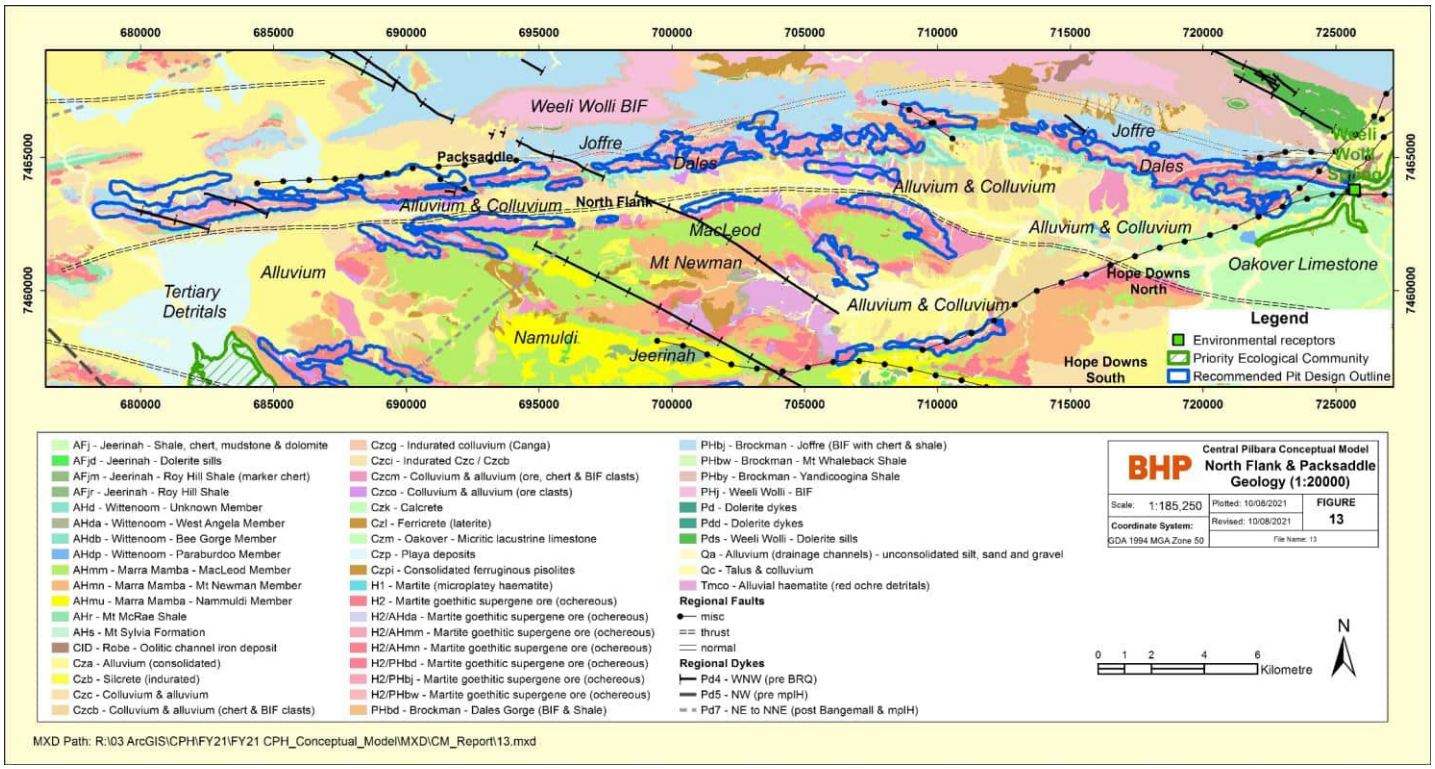
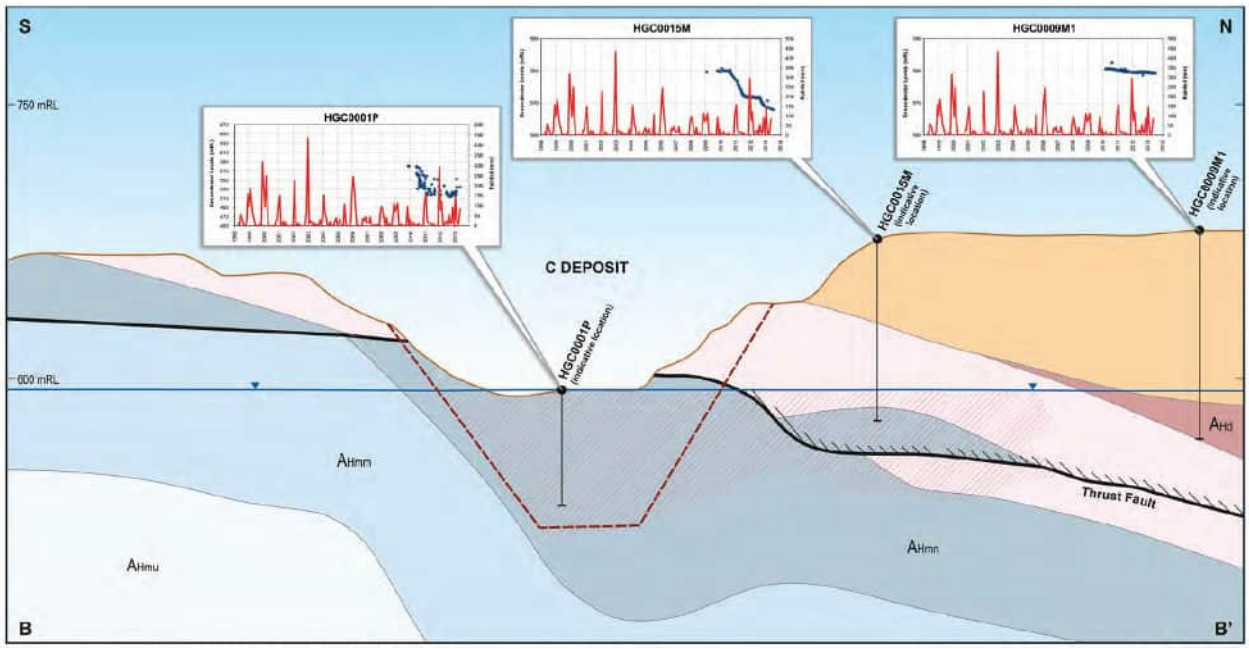
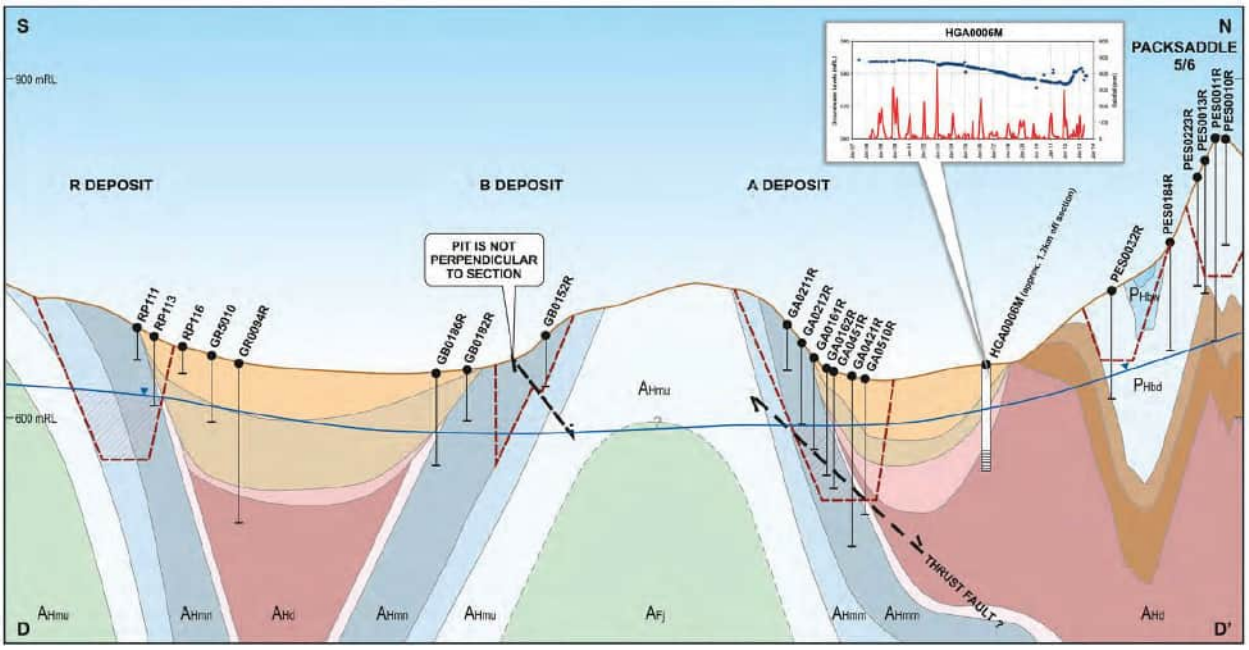


Figure 2.5. Geological section through C Deposit (top); A, B and R Deposits (middle); and the Packsaddle Range and Area C Valley (bottom)





LEGEND

Quaternary
- Undifferentiated
- Clay
- Alluvium
- Calcrete

TD3
- Undifferentiated
- Clay
- Gravel
- Calcrete

TD2
- Undifferentiated
- Clay
- CID
- Calcrete

TD1

Boolgeeda Iron Fm — PHb

Woongarra Volcanics — PHw

Weeli Wolli Fm — PHj
- Ore

- Approximate Water Table
- Potential Mine/Pit
- Drill Hole
- Fault

Mount McRae/Sylvia Fm
- AHs Undifferentiated
- Mount McRae Shale
- Mount Sylvia Fm

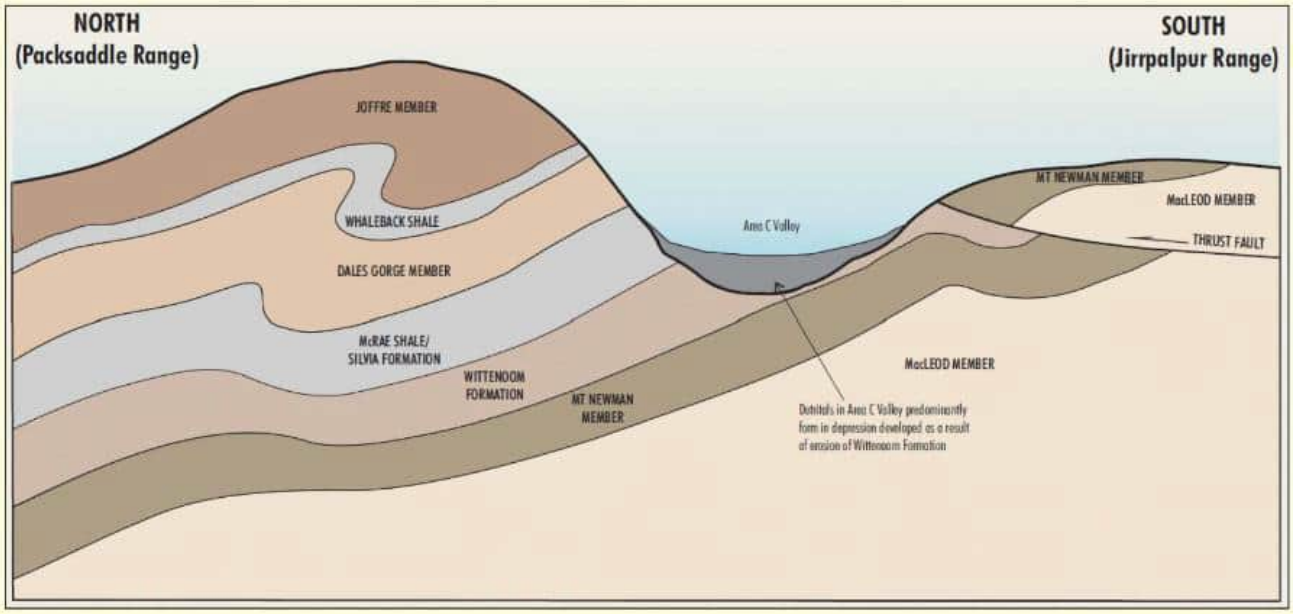
Wittenoom Fm
- AHd Undifferentiated
- Bee Gorge Member
- Paraburdoo Member
- West Angela Member

Marra Mamba Iron Fm
- AHm Undifferentiated
- AHmn Mount Newman Member
- AHmm MacLeod Member
- AHmu Nammuldi Member

Jeerinah Fm — AFj

Granitoid Complex — Ag

Brockman Iron Fm
- PHb Undifferentiated
- PHbj Joffre Member
- PHbw Whaleback Shale Member
- PHbd Dales Gorge Member



2.3.2 Basement

Two major orogenies affected the Hamersley Basin (the Ophthalmian Orogeny and the Ashburton Orogeny) both of which contributed to the predominant east–west striking regional synclines and anticlines. MAC is on the northern flank of one such anticline (the Weeli Wolli Anticline) and the local geology strikes east west and dips (and youngs) to the north off the flank of the anticline.

A series of more intense tight folds to over-folds are superimposed on the northern flank of the Weeli Wolli anticline and this has overturned the bedding in places, resulting in areas of steep/vertical dips in the Marra Mamba which otherwise dips more moderately to the north (Solid Geology 2013). Vertical faults along the axes of these folds are inconsistently incorporated in the geological model of E Deposit (but none of the other deposits). Whether as a result of overturned bedding alone or overturned bedding in combination with vertical faults, the fold axes appear to have controlled mineralisation and resulted in enhanced permeability along the strike of the mineralised zone.

Lateral thrust faulting has also occurred, caused by strain associated with the over-folds. In particular, thrusting occurred along the contact between the Marra Mamba Formation and the overlying Wittenoom Formation in an "older over younger" (south over north) pattern (e.g. Kepert 2001). This pattern of over-folds and thrusting is commonly associated with both steepened dips and mineralisation in the Marra Mamba Formation. Displacement along the thrust planes is in the order of 200m, overlaying “slices” of Marra Mamba onto Wittenoom Formation. The Wittenoom Formation is the regional aquifer and thrusting and can bring Marra Mamba orebodies in close proximity to or even into direct hydraulic connection with the regional groundwater system. Thrust faults have been confirmed at E Deposit, C Deposit and Hope Downs. Their presence in the geological structure in intervening deposits (i.e. A Deposit) seems likely although a thrust fault is not included in the current geological model for A Deposit (as of May 2014). The thrust-fault zones are believed to be zones of increased permeability and have an important influence on mine dewatering.

2.3.3 Tertiary

The Wittenoom Formation is less weathering resistant than the surrounding geology and has been eroded to form the North Flank Valley flanked by ridges of Marra Mamba to the south and Brockman Iron Formation to the north. Erosion has resulted in karst development in the Wittenoom Formation, particularly in dolomite of the Paraburdoo Member. The valley has been infilled with sediments that comprise erosional detritus from the surrounding outcrop. Three broad units can be defined in the Tertiary. From oldest to youngest: Tertiary Detritals (TD1, TD2 and TD3). TD1 and TD3 comprise scree and colluvial deposits close to the hills that become finer grained away from the ridges to be matrix-dominant gravelly-silts. The middle of the Tertiary sequence (TD2) is marked by sediments comprising clay and iron-precipitates indicating a period of low-energy deposition. The Tertiary sediments have been altered in places through:

- The precipitation of manganese, often at the basement contact, to form a vuggy hardcap
- The precipitation of iron-cement of both goethite and hematite to form cemented scree at the valley margins and vitreous goethite in the more distal environment which forms localised zones of pisolitic channel iron deposit
- The precipitation of calcrete within the TD2 sequence. It is believed the calcrete is actually micritic limestone rather than a groundwater calcrete (pers. com. Mal Kneeshaw) and represents deposition in a mid-Tertiary lacustrine environment.

2.4 South Flank system

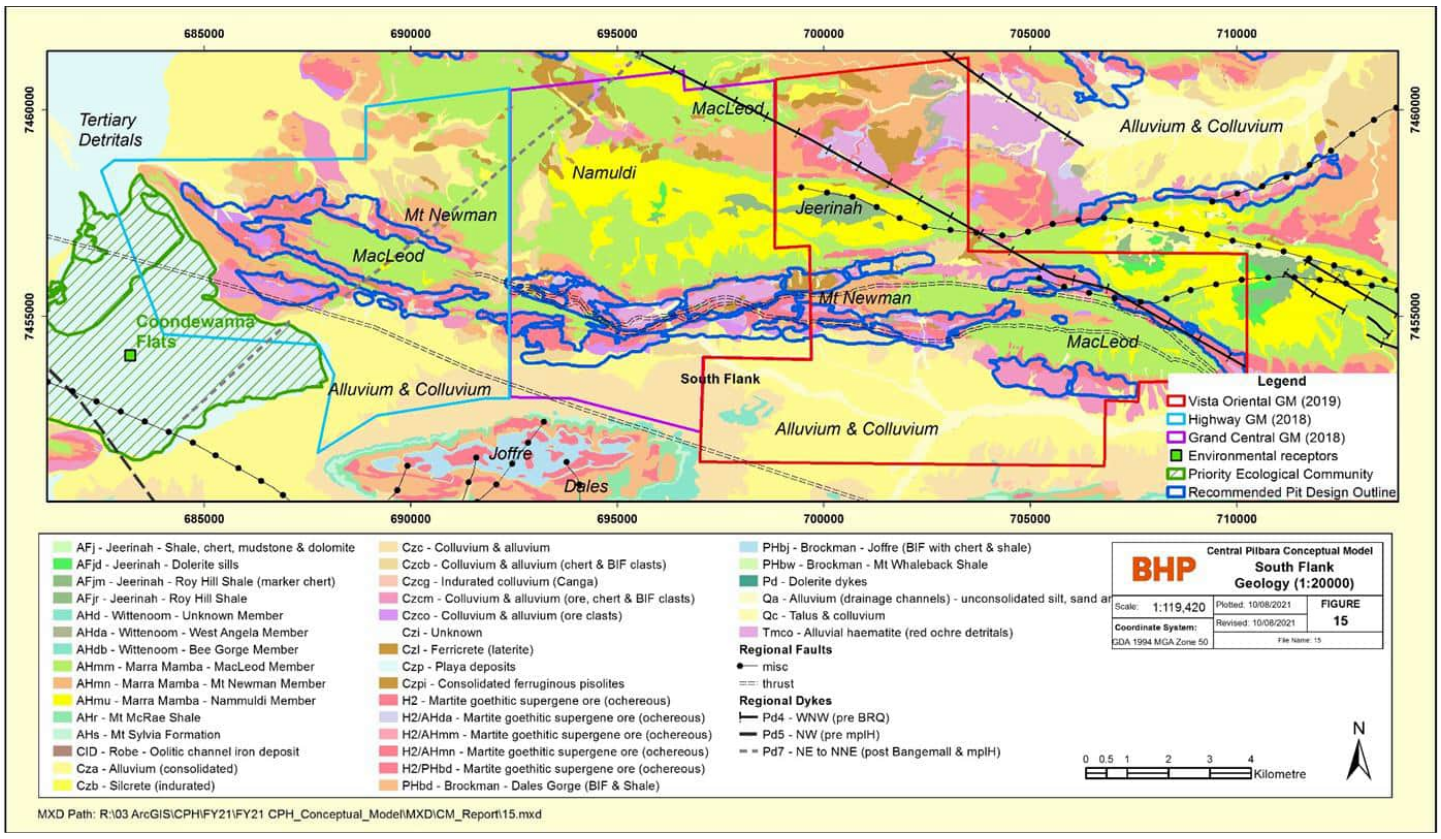
South Flank surface geology is shown in **Figure 2.6,** and geological cross sections in **Figure 2.8**, and the South Flank Valley Paleochannel in **Figure 2.7**.

The geology within the South Flank tenement area is dominated by the upper Hamersley group lithologies, intersected by dolerite dykes and overlain by a thin layer of Tertiary Detritals, with detrital thicknesses increasing towards the longitudinal axis of the valley. The dykes are interpreted to be on the order of kilometres deep and also readily weather into low permeability clays which create barriers to groundwater flow. The southern extent of the tenement area is inferred to be dominated by karstic / massive dolomite extending laterally to the south and pinching out towards the north.

Semi continuous mineralisation within the Marra Mamba Formation is split into northern and southern orebodies (**Figure**). The northern orebodies are mostly contained within a secondary synclinal trough and the southern orebodies occur further down the limb at or near the southern portion of the outcropping Marra Mamba and where

the Marra Mamba dips below Tertiary Detritals. The northern and southern orebodies are very close to each other in the central part of the South Flank deposit and at the western margins of the mining area. Generally the northern orebodies are at a higher elevation and have a lower proportion of below water table ore.

Figure 2.6. South Flank geology



Structurally the South Flank mining area is located on the southern limb of the Weeli Wolli Anticline, which has resulted in a rounded, east–west trending ridgeline of outcropping Marra Mamba. The area comprises three (3) local E-W faults, one (1) larger NE-SW regional fault and large scale anticlines and synclines, with much of the mineralisation constrained to the upper Mount Newman Formation along the fold limbs and within the synclines. A palaeochannel underlies a major portion of the South Flank valley floor (i.e. to the south of the southern orebodies). Its extent, as defined by drilling in the area, is shown in **Figure 2.7**Error! Reference source not found.. In some locations the channel extends to depths of up to 140 mbgl.

During the Cretaceous Period the majority of the Pilbara was subjected to high rainfall, resulting in significant runoff and the associated erosional features incising into the Proterozoic bedrock.

The palaeo Pebble Mouse Creek has eroded back to the west through the shales and dolomites of the West Angela shale and Wittenoom Formation dolomite. In a number of places significant features such as faults and dolerite dykes have influenced or reduced the rate of erosion, resulting in waterfall like features or sudden changes in the drainage direction.

The far western section of the palaeochannel appears to be near the head or terminus of the palaeo-drainage system, with the impact of the Bruce Almighty dyke and/or Palladium Fault potential resulting in a waterfall feature. At the onset of drier climate following the wet Cretaceous period, erosion and incision reduced, and deposition and backfilling of the palaeochannel commenced.

At the same time the backfilling of the valley was occurring, surface water ponding, particularly over the underlying dolomitic sequence, resulted in dissolution of carbonates and the development of karstic features. This ultimately resulted in a relatively thin zone of high permeability at or below the palaeochannel floor, occasionally extending to greater depths when associated with faulting or shear zones.

The relatively thick sequence of the Vuggy Breccia unit (VB2) within the backfilled palaeochannel may represent the accumulation of detrital matter from the adjacent Brockman and Marra Mamba Formation hills, being

consolidated by the additional clayey material occupying the interstitial space between the fragments. The role of an interpreted dolerite dyke to the east of the South Flank valley cutting across the Pebble Mouse Creek may have influenced the nature of the Vuggy Breccia.

Overlying the Vuggy Breccia is a flat lying, wide spread, 10 to 20 m thick, calcrete horizon that appears to represent a period of elevated water table precipitation of carbonates, perhaps during wetter periods in more recent times.

The palaeochannel is bounded to the north by the South Flank orebodies and to the south by Mt Robinson and outcropping/subcropping bedrock to the east of Mt. Robinson.

Figure 2.7. South Flank Valley paleochannel

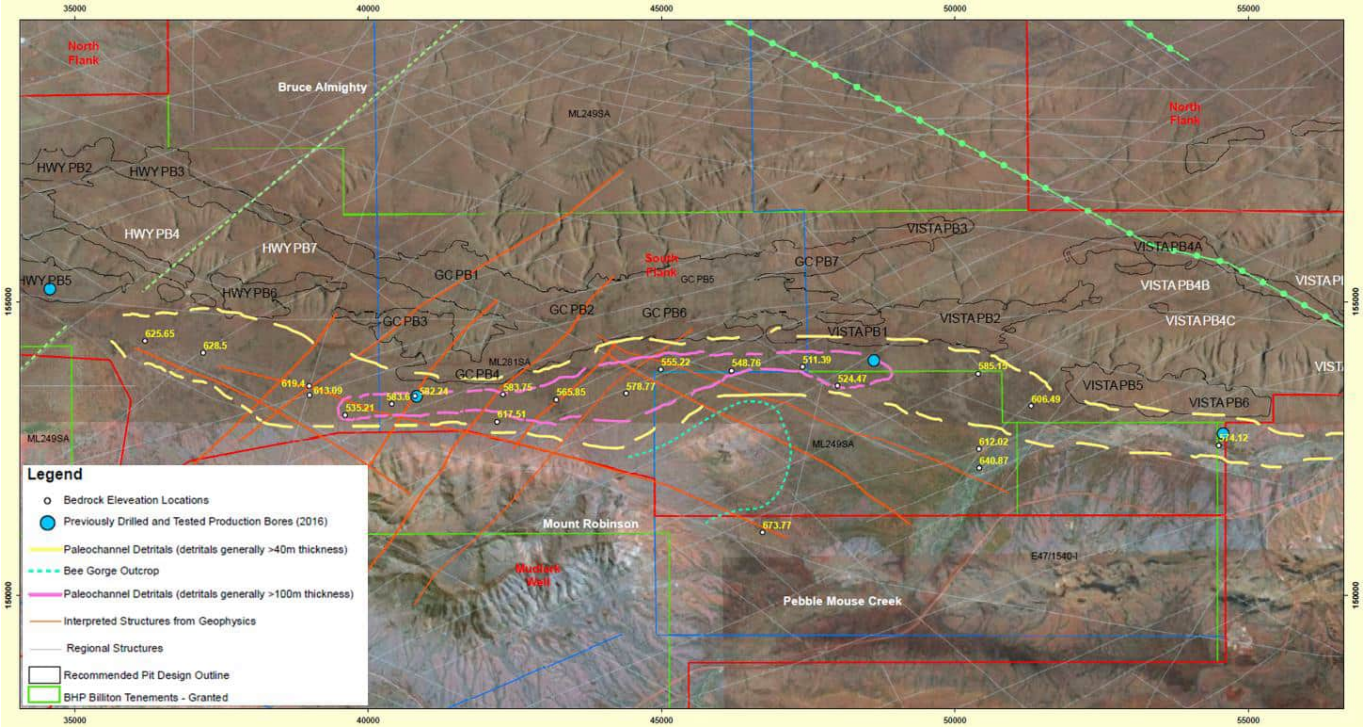
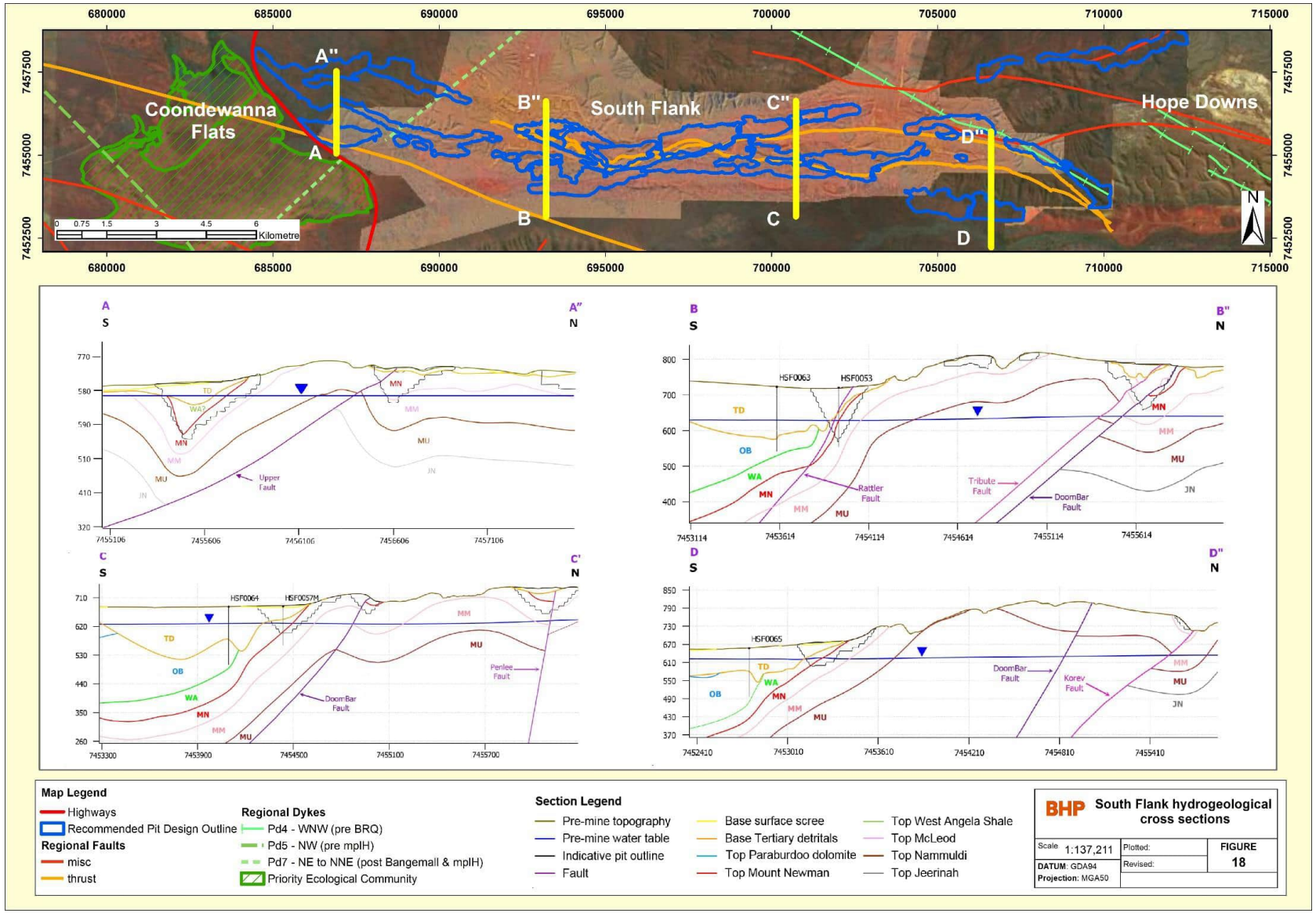


Figure 2.8. South Flank hydrogeological cross sections



2.5 Hope Downs system

The Hope Downs Public Environmental Report (Hope Downs, 2000) provides information on the regional and site geology. The Hope Downs orebodies are part of the same geological regime as the BHP North Flank and South Flank deposits and as such is formed from the weathering and infilling of the Weeli Wolli Anticline.

According to Hope Downs (Hope Downs, 2000), the bulk of the mineralisation at Hope North and South is confined to the Mount Newman Member and the base of the West Angela Member. The Nammuldi Member is only enriched at Hope South. The MacLeod Member is partially mineralised at both deposits.

Figure 2.9 and **Figure 2.10** provide some further context. The Hope North Deposit is adjacent to a significant subcrop of Wittenoon Dolomite whereas the Hope South Deposit is not. They also show that thrust faulting has had an impact on the local geology.

Figure 2.91. Conceptual geological X-section: Hope Downs South & North deposits (Hope Downs, 2000)

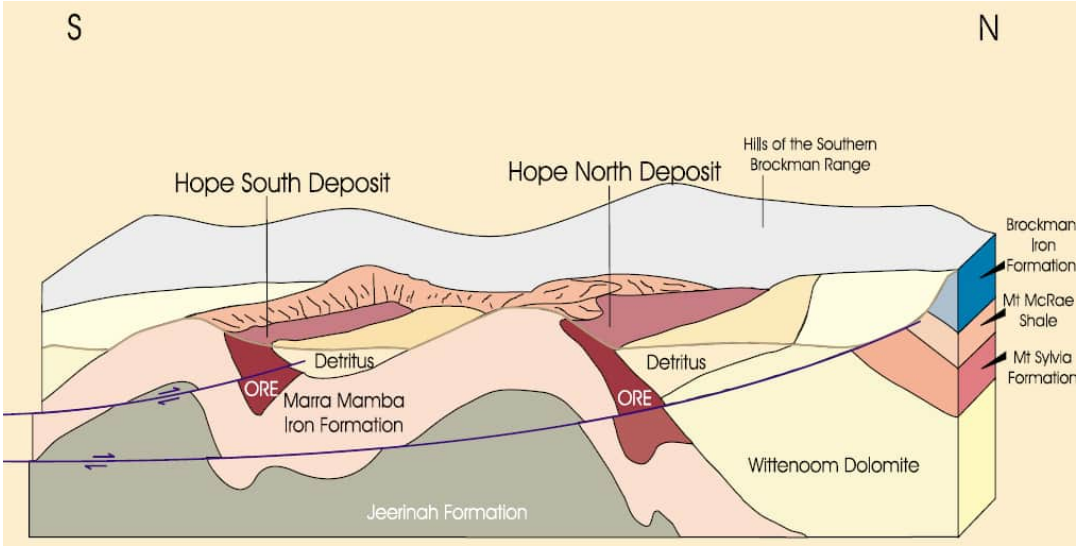
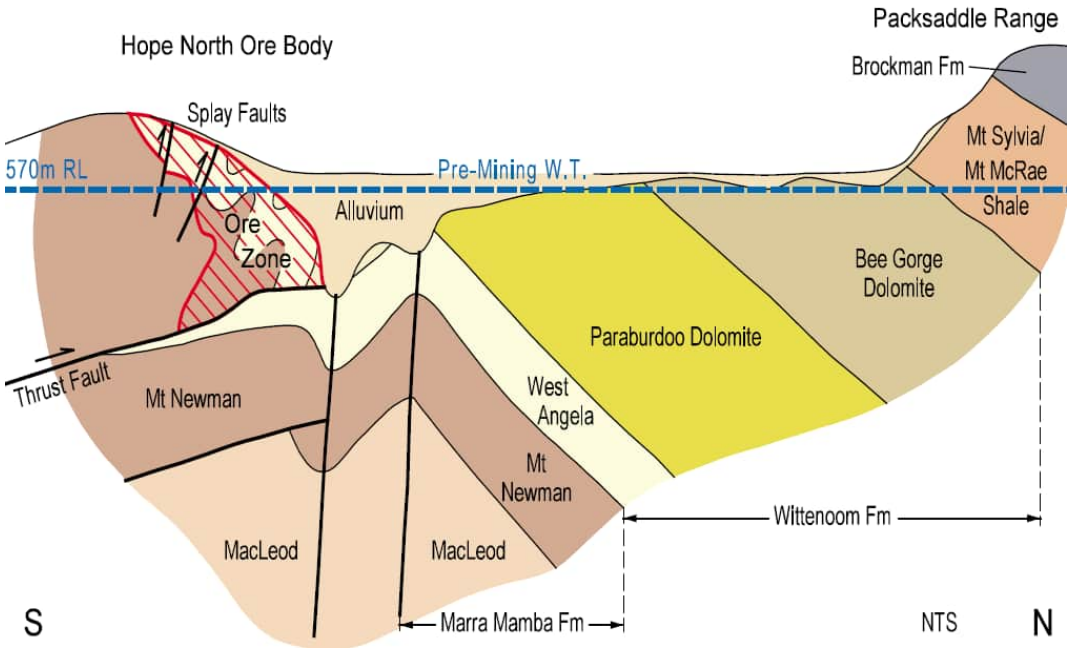


Figure 2.10. Conceptual geological and hydrogeological cross section – Hope Downs North deposit (Hope Downs, 2000)

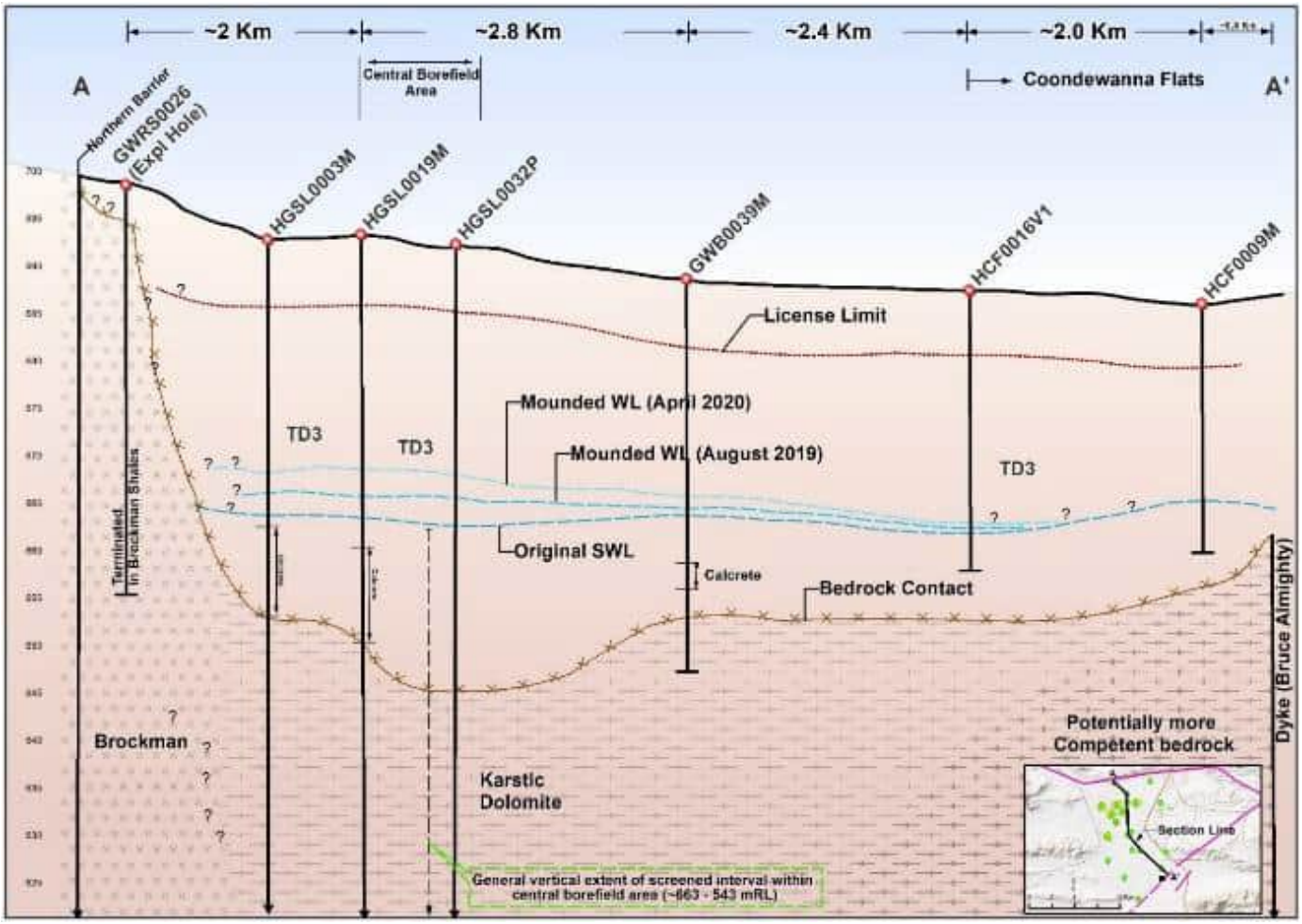


2.6 Coondewanna Flats system

Coondewanna Flats is bounded by hills of Marra Mamba and Brockman. Preferential weathering of the Wittenoom Formation between these outcrops resulted in a low-lying area which has subsequently been infilled with Tertiary deposits of alluvium and colluvium. The geological sequence comprises an upper Tertiary sequence (TD3) of variable sand, silt and gravel overlying a middle Tertiary sequence (TD2) of variable calcrete and silty gravel overlying shale and dolomite of the Paraburdoo Member (**Figure 2.11**). The calcrete lies close to the water-table and the extent to which it is saturated varies with recharge state (up to a 5 m change in groundwater levels has been observed following inundation of the Flats).

The Wittenoom Dolomite constitutes an upper shaley Bee Gorge Member, Paraburdoo Dolomite Member and underlying low-permeability West Angela Member. Regionally, erosion has resulted in karst development in the Wittenoom Formation, particularly in dolomite of the Paraburdoo Member, and significantly elevated permeability has been intersected (e.g. holes HNPIAC0001 to HNPIAC0004). Final airlift yields in production bores HNPIAC0001 and HNPIAC0002 were up to 30 L/s. Weathered / fractured sections of the Paraburdoo dolomite are typically succeeded by competent crystalline dolomite of lower permeability. Following performance reviews of the Juna Downs MAR scheme, estimates of the transmissivity of the dolomite range from 1200 to 1530 m^2/d (BHP 2019, BHP 2020a).

Figure 2.11. Cross section from NW to SE across Juna Downs and Coondewanna Flats (BHP 2020a)

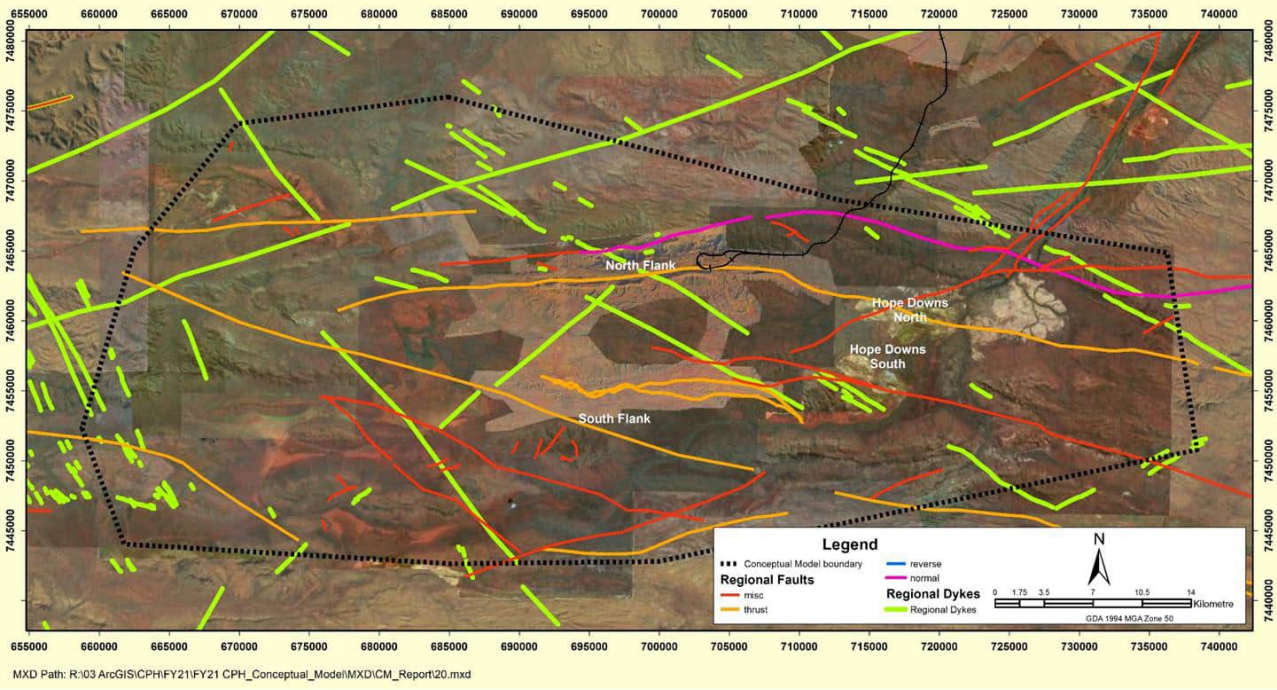


2.7 Structure

The Central Pilbara has been intruded by a series of dolerite dykes which trend NW–SE and NE–SW. These mafic dykes readily weather to clay and form a low-permeability restriction to groundwater flow, particularly as their orientation transects the predominantly east–west orientated strike valleys along which regional groundwater flow trends. Mapped structures in the catchment are shown in **Figure 2.12**.

Lateral thrust faulting has also occurred, caused by strain associated with the over-folds. In particular, thrusting occurred along the contact between the Marra Mamba Formation and the overlying Wittenoom Formation in an "older over younger" (south over north) pattern (e.g. Kepert 2001). This pattern of over-folds and thrusting is commonly associated with both steepened dips and mineralisation in the Marra Mamba Formation. Displacement along the thrust planes is in the order of 200 m, overlaying “slices” of Marra Mamba onto Wittenoom Formation. The Wittenoom Formation is the regional aquifer and thrusting and can bring Marra Mamba orebodies in close proximity to, or even into direct hydraulic connection with, the regional groundwater system. Thrust faults have been confirmed at E Deposit, C Deposit and Hope Downs.

Figure 2.12. Mapped regional structures

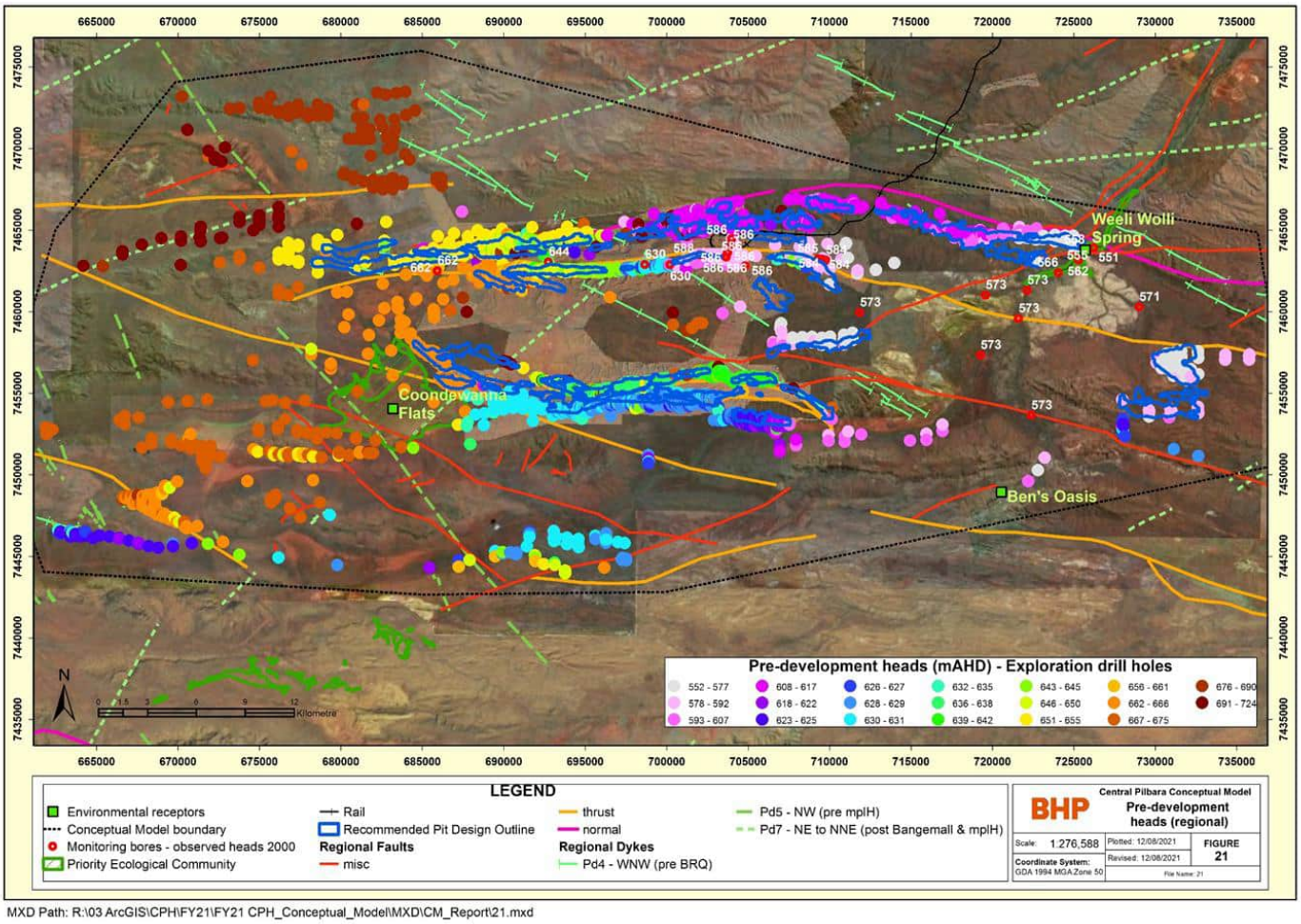


Key uncertainty: The main areas of geological uncertainty in the catchment are associated with the spatial extent of drill holes. Exploration is focussed on orebodies rather than the regional aquifers and this means that there is significant lateral and vertical extrapolation in the areas of regional aquifers (dolomite and Tertiary Detritals) as well as the adjacent lithologies. Ongoing hydrological drilling has improved understanding but drill coverage is at a much lower density.

3 Pre-development water levels

The observed heads from exploration drill holes are shown in **Figure 3.1**. The data is supplemented with observations from monitoring bores also collected before anthropogenic groundwater activities commenced. The coverage is excellent from a regional perspective. Initial divisions or 'compartmentalisation' of aquifer systems can be seen based on similar groupings of pre-development heads.

Figure 3.1. Pre-development water levels



A cross section of the predevelopment groundwater levels through the southern aquifer systems from Coondewanna through to Weeli Wolli is shown in **Figure 3.2** and a section through the northern aquifer systems is shown in **Figure 3.3**.

The figures delineate some of the most important hydrogeological features in the catchment. They are:

- The various flow barriers – evidenced by the abrupt changes in water level across them
- The aquifer compartments produced by these flow barriers and the consistency of water levels within them
- The flow gradient from Coondewanna Flats (West) to Weeli Wolli Spring (East)
- The distribution of water level data (i.e. where gaps in knowledge exist)
- The relationship between the Packsaddle and North Flank Deposits
- The relationship between the northern and southern orebody aquifers of South Flank.

Figure 3.2. Southern aquifer system pre-development heads

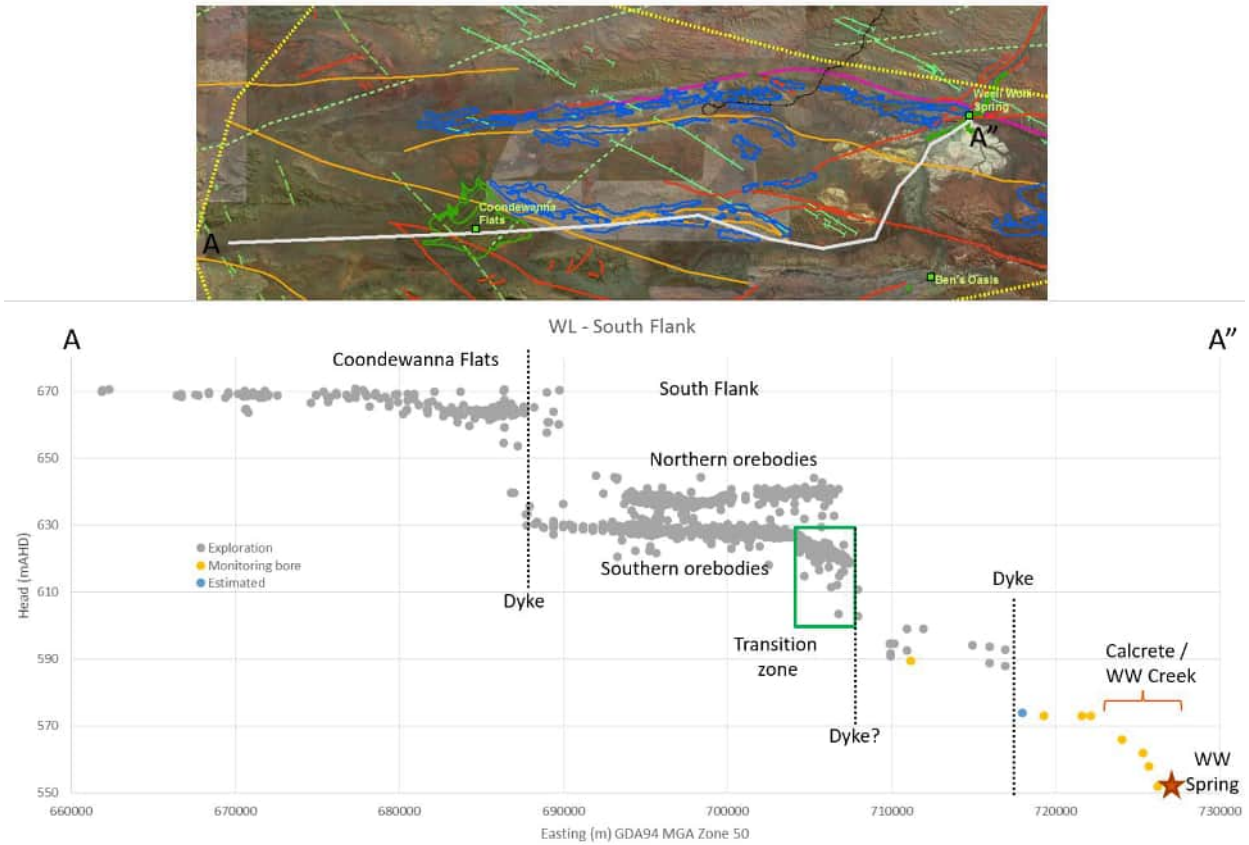
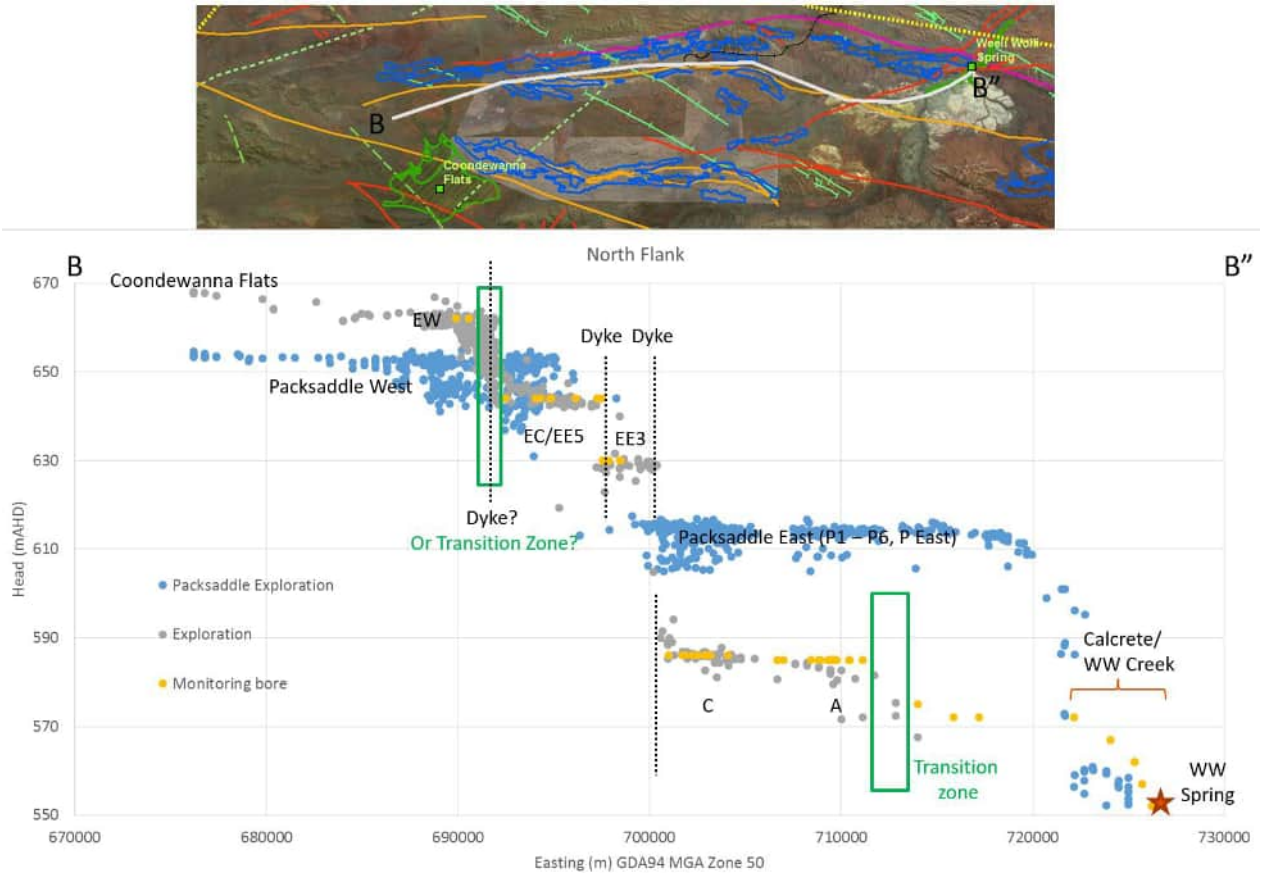


Figure 3.3. Northern aquifer system pre-development heads



4 Time variant water levels

4.1 Introduction

The main anthropogenic stresses in the catchment have been (**Figure 4.1** and **Figure 4.2**):

- BHP water supply abstraction from:
    - the MAC rail loop in the dolomite adjacent to C Deposit since 2001
    - the dolomite adjacent to E Central Deposit between 2001 and 2011 (HGO6&7)
    - the regional aquifers west of E West Deposit, intermittently since 2002, but sustained abstraction since 2014
    - the South Flank Highway, Grand Central and Vista Oriental bores since 2018
- Dewatering abstraction from:
    - MAC C Deposit since mid-2010
    - MAC E East (EE3) Deposit since late 2010
    - MAC E Central (EC/EE5) Deposit since 2009
    - MAC F Deposit during 2016 and 2017
    - Hope Downs North since 2006
    - MAC A Deposit since 2019
- Discharge of MAC surplus water to:
    - the C West pit during 2011/12
    - the C Deposit sediment pond since late 2010
    - the Western sediment pond since 2018
    - the dolomite adjacent to A Deposit via injection bores from 2009 – 2019
    - the Runaway Valley Infiltration Ponds at Packsaddle since 2018
    - the dolomite aquifer in Juna Downs since 2019
- Discharge of Hope Downs surplus water (since 2007):
    - At various locations (spurs) along the Weeli Wolli Creek
    - At the location of the Weeli Wolli Spring

Figure 4.1. Geographical division of historical MAC abstraction / discharge

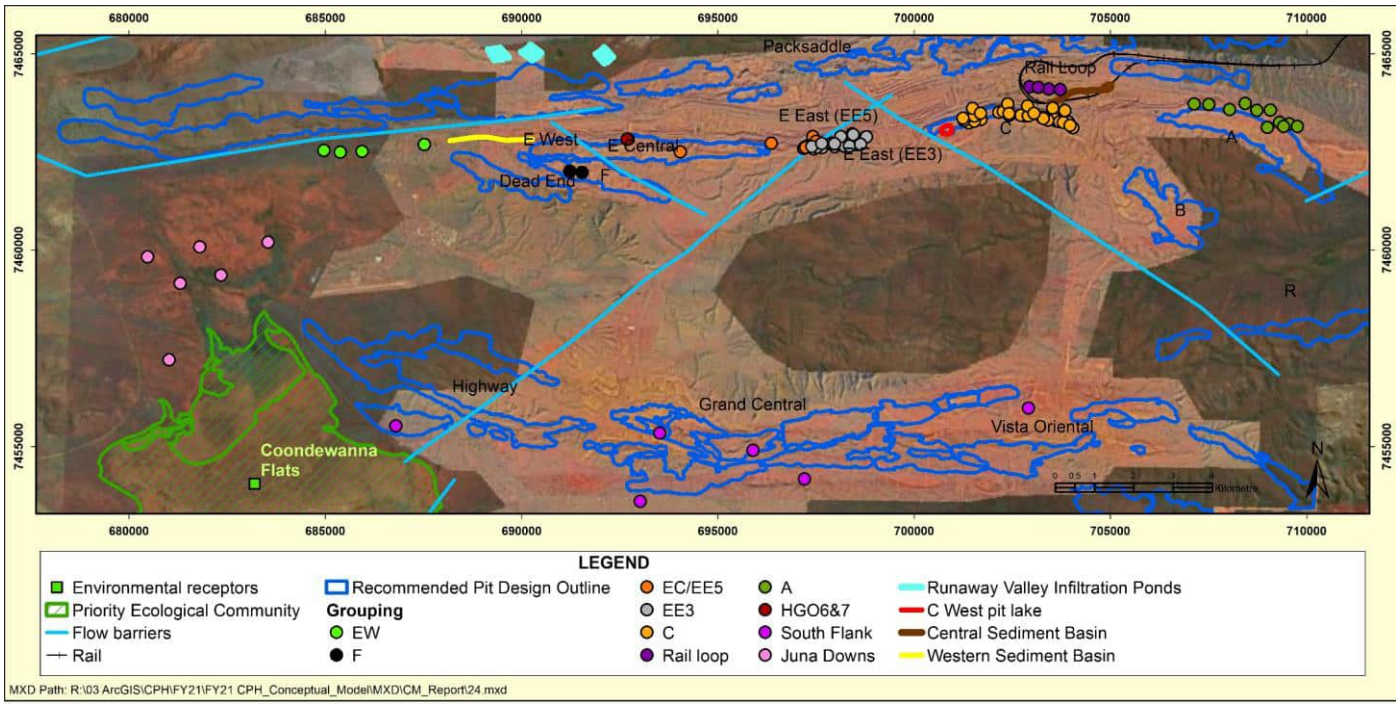
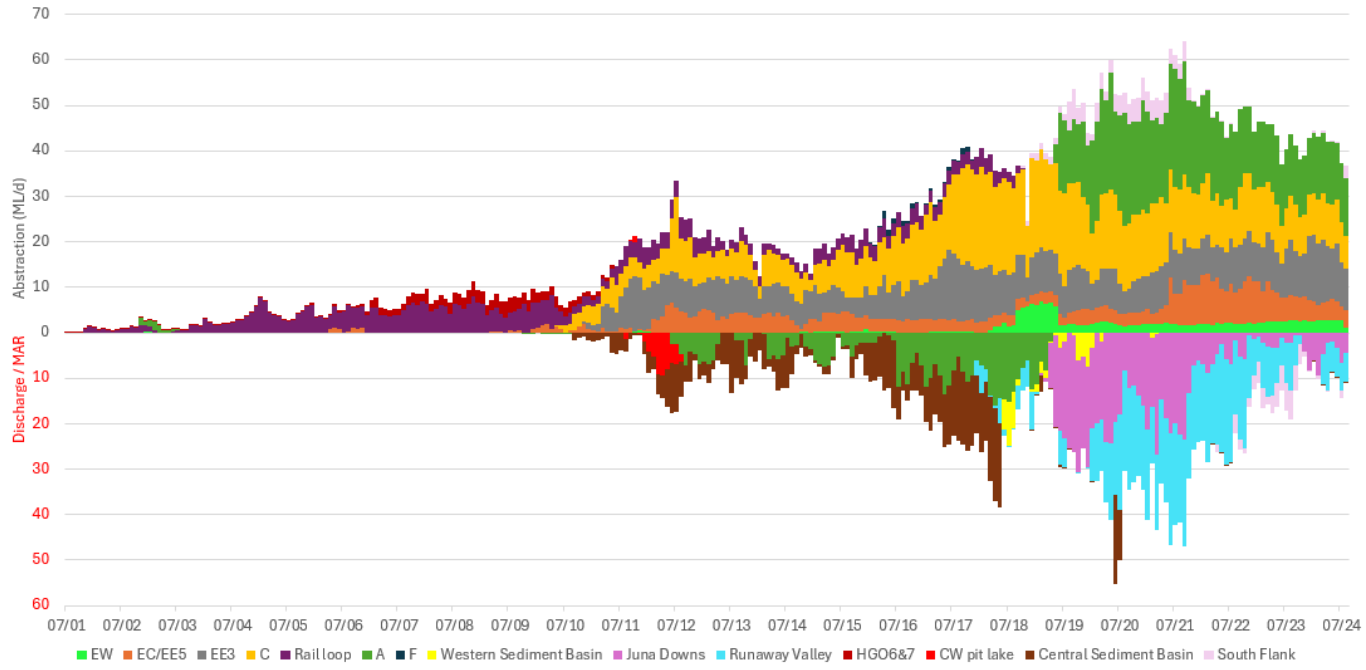


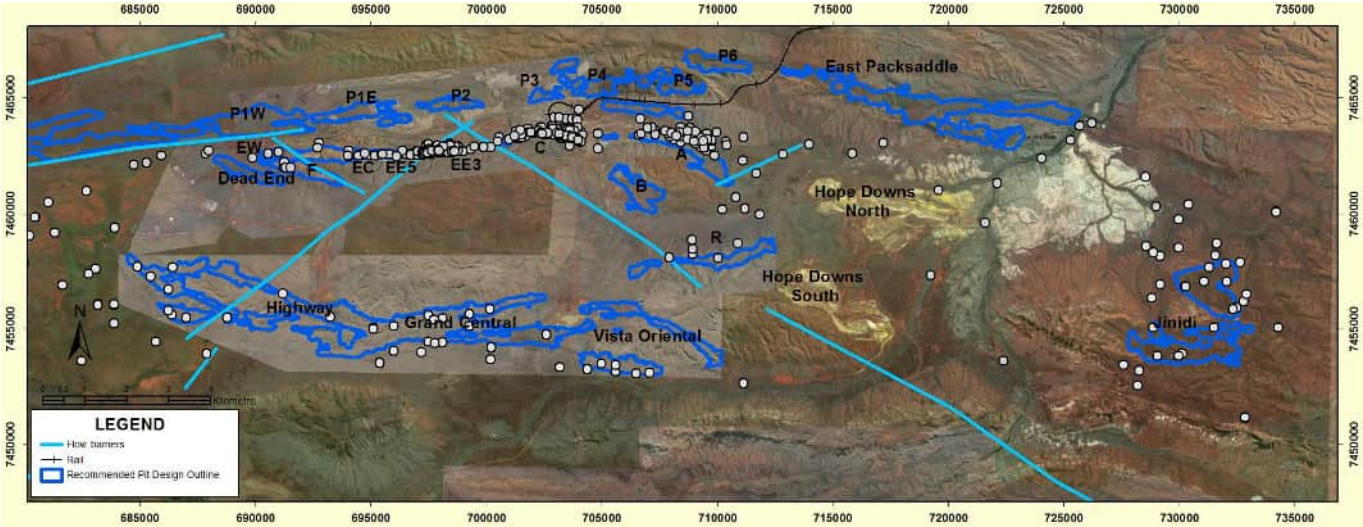
Figure 4.2. Rates of historical MAC abstraction / discharge



4.2 Regional groundwater level trends

Around 35,000 manual dips have been performed on BHP groundwater monitoring bores (numbering 774 as of January 2019) in the Central Pilbara region (**Figure 4.3**). The responses to the various anthropogenic and natural stresses over the last 20 years recorded in this dataset is the main basis for the regional conceptual model of the Central Pilbara. Numerous data loggers and vibrating wire piezometers (VWPs) have also been installed in the area but these, especially the latter, provide a much finer detail record of the groundwater system and are used to analyse the local, rather than regional, hydrogeology.

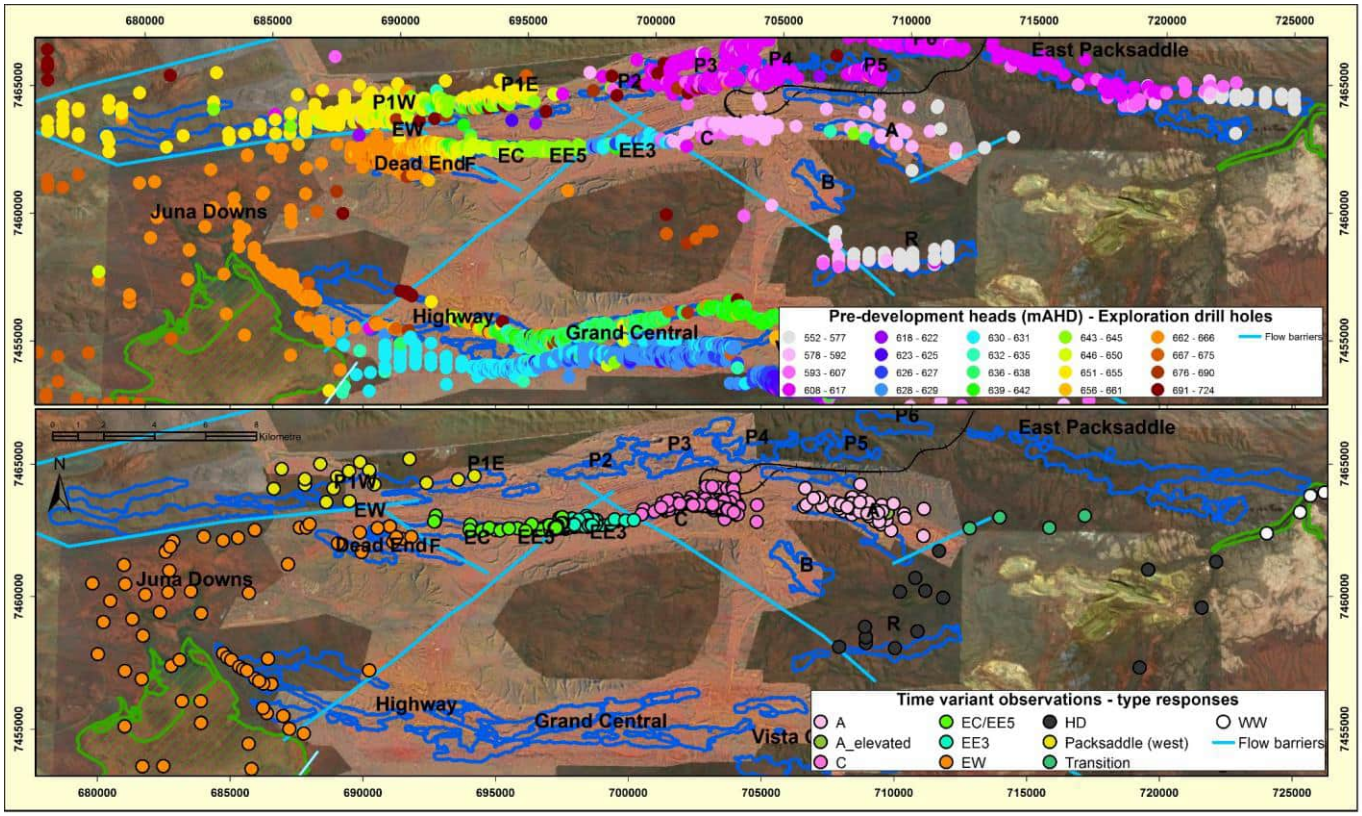
Figure 4.3. Monitoring bores with at least 10 water level observations



Several methods have been used to plot these data, as shown in **Figures 2.20** to **2.32**.

As there are obvious head differences between the time variant heads in each aquifer 'compartment' (even after anthropogenic water management) the data can be grouped based on these differences (**Figure 4.4**). The first finding is that these observations match the regional scale findings from the pre-development exploration drilling data very well. The data clearly delineate the step in groundwater levels across flow barriers and the relatively flat water levels in the compartments between them.

Figure 4.4. Pre-development time variant groundwater data vs exploration data



The entire dataset has been plotted in **Figures 21 to 30** with the colouring kept consistent with the pre-development head maps to allow for a clear analysis of the behaviours of the different groundwater systems.

Figure 4.5. MAC E West Deposit (EW)/Coondewanna Flats time variant groundwater observations (manual dips)

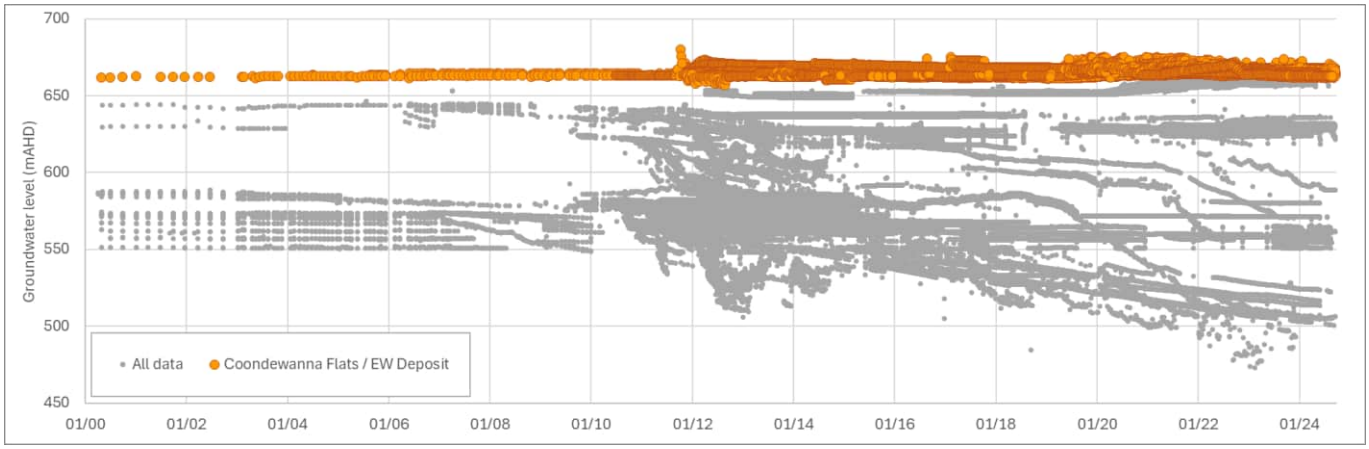


Figure 4.6. MAC E Central / East 5 Deposits (EC/EE5) time variant groundwater observations (manual dips)

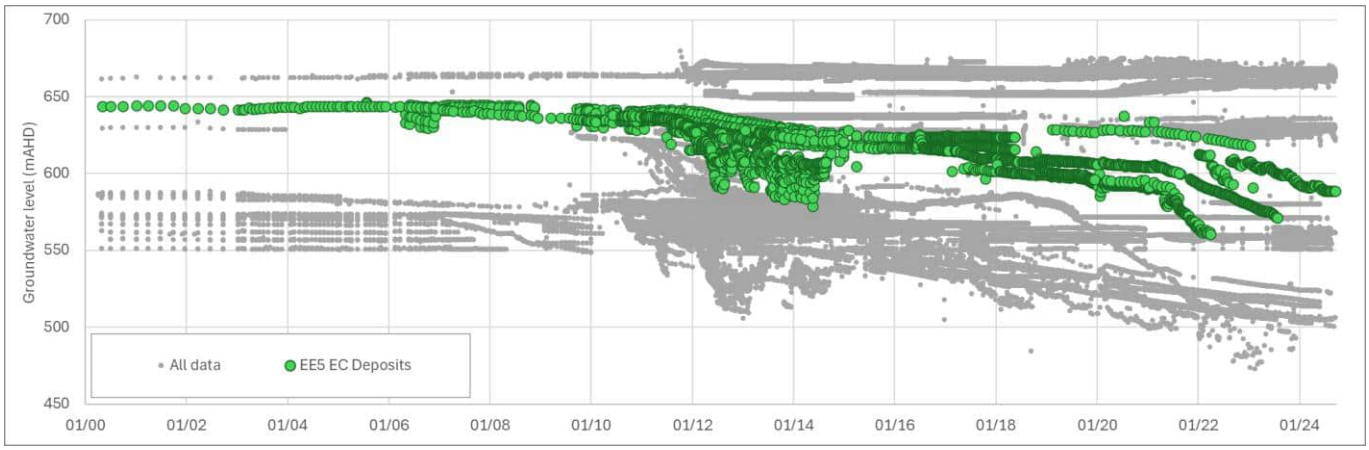


Figure 4.7. MAC E East 3 Deposit (EE3) time variant groundwater observations (manual dips)

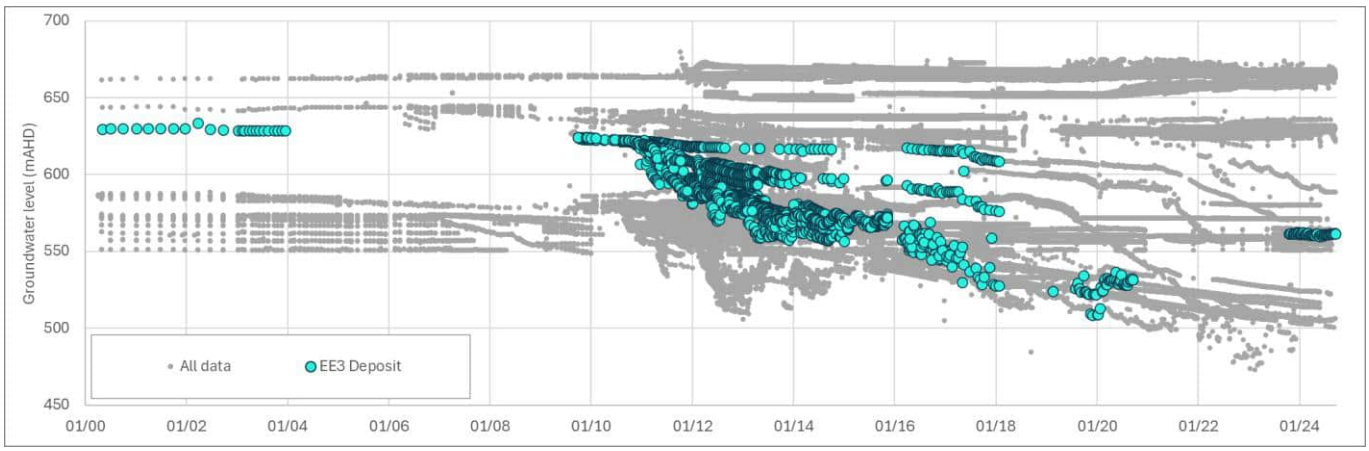


Figure 4.8. MAC C Deposit time variant groundwater observations (manual dips)

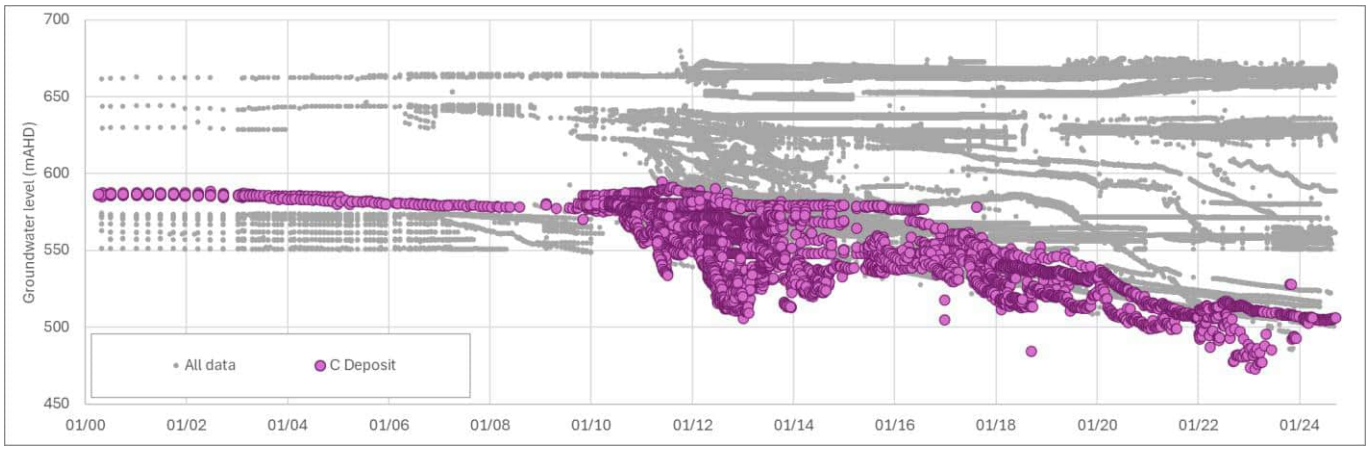


Figure 4.9 MAC A Deposit time variant groundwater observations (manual dips)

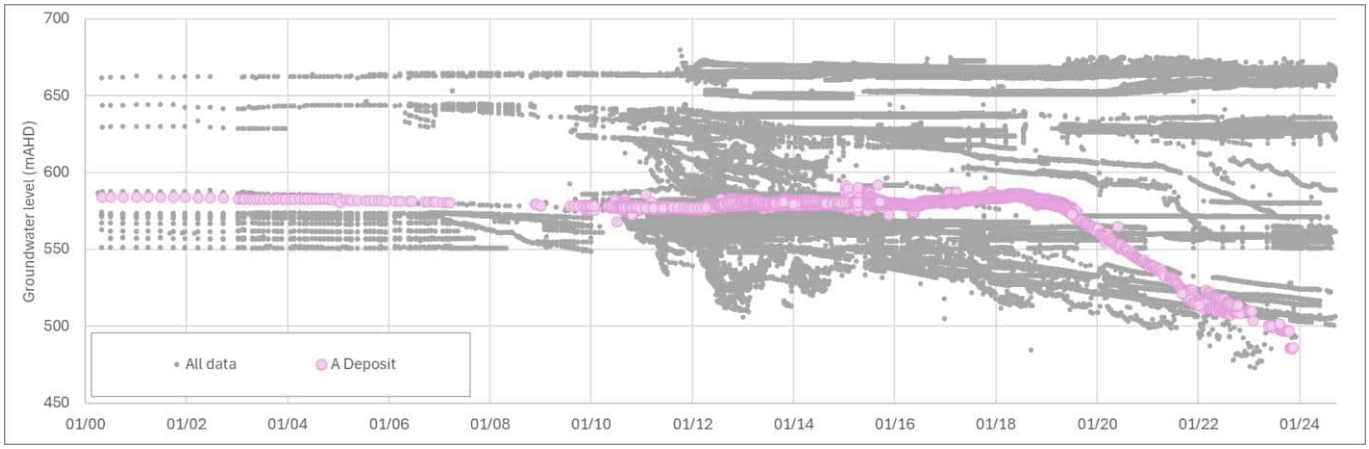


Figure 4.10. Hope Downs aquifer system time variant groundwater observations (manual dips)

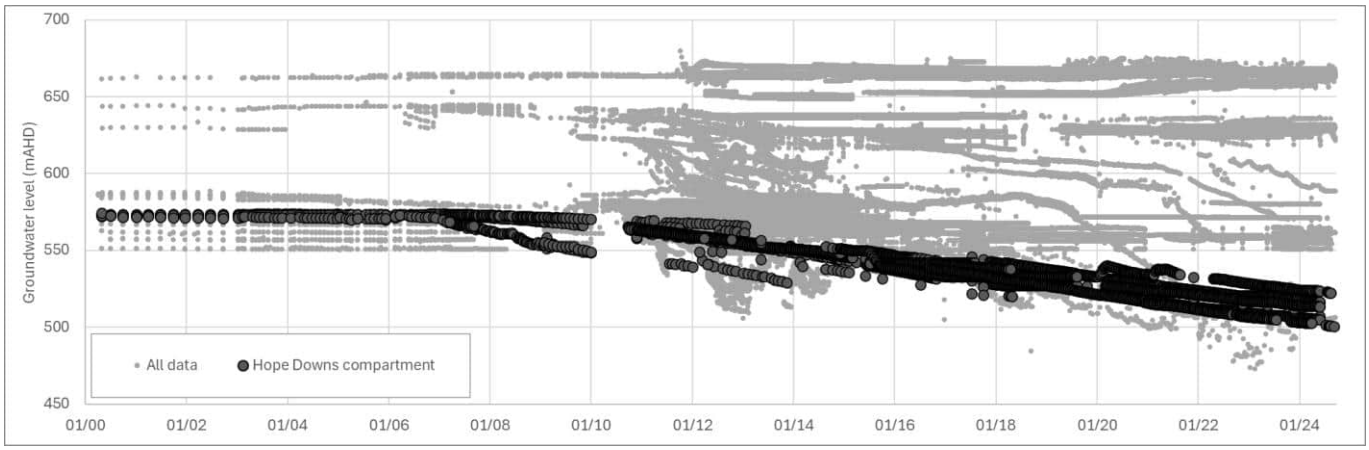


Figure 4.11. Weeli Wolli aquifer system time variant groundwater observations (manual dips)

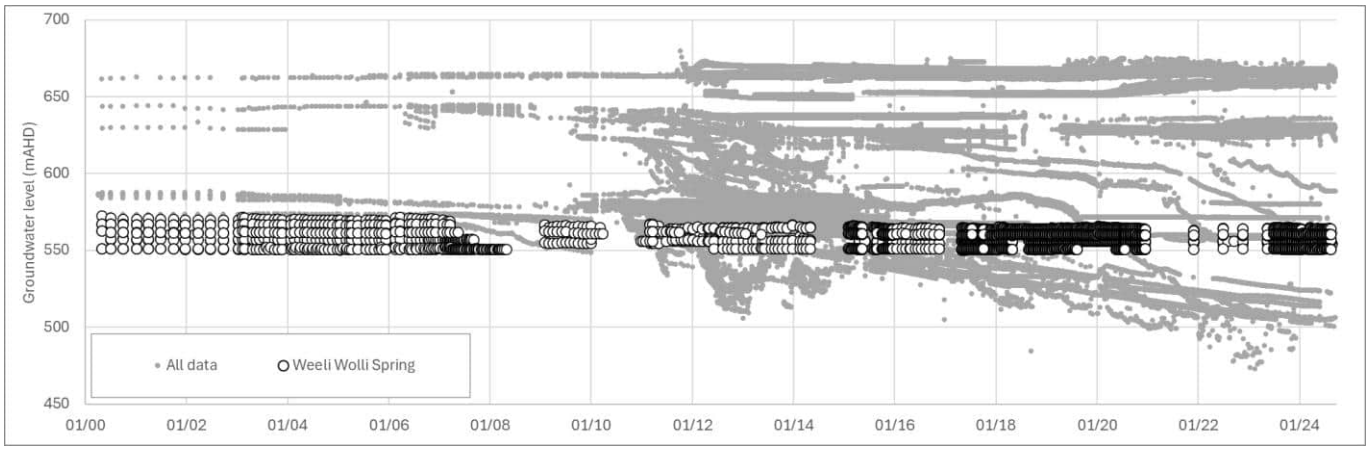


Figure 4.12. Jinidi aquifer system time variant groundwater observations (manual dips)

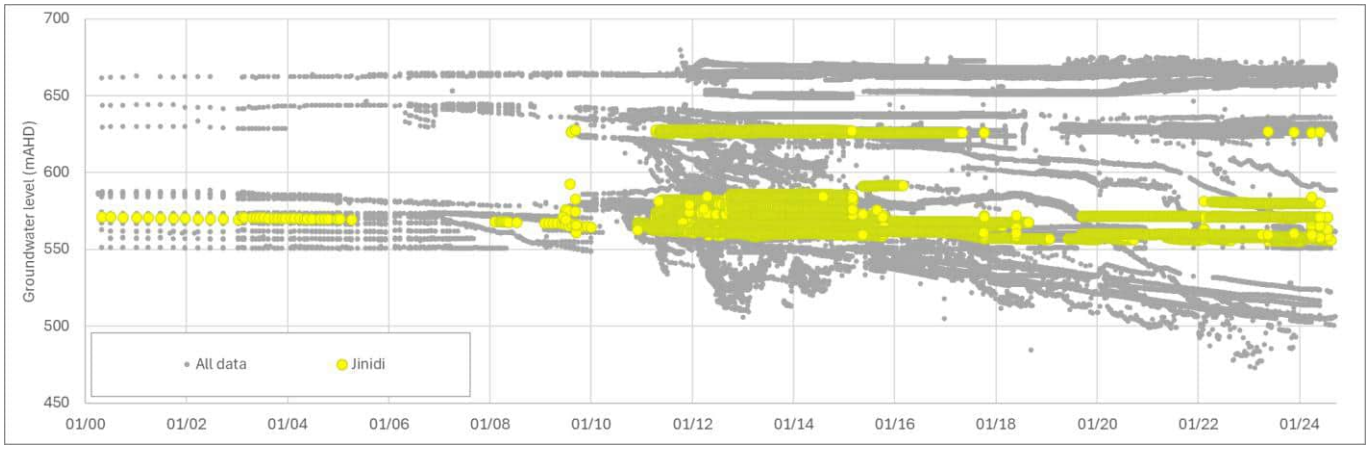


Figure 4.13. Transition zone heads time variant groundwater observations (manual dips)

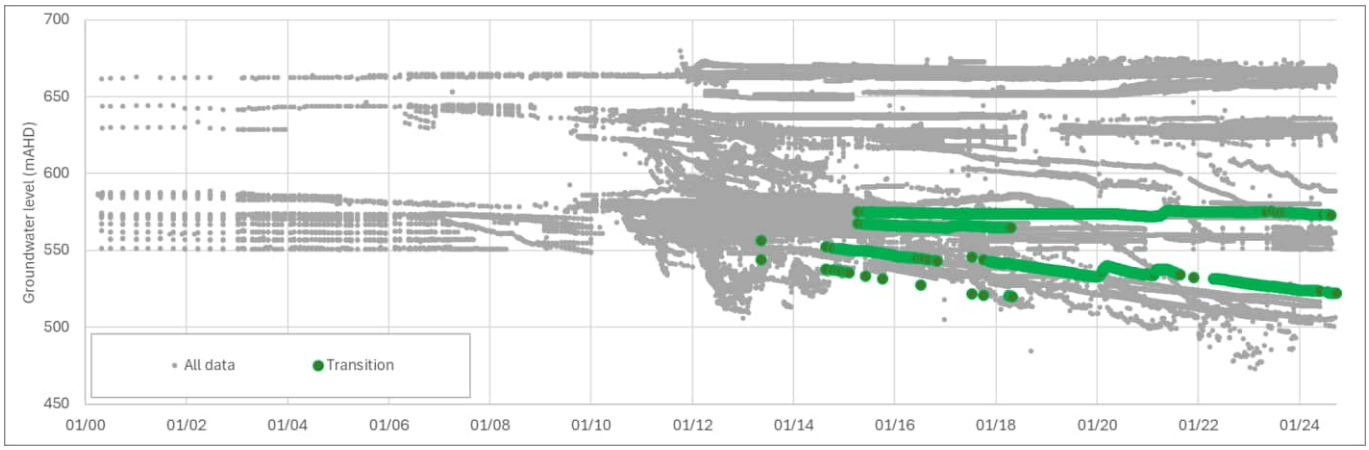
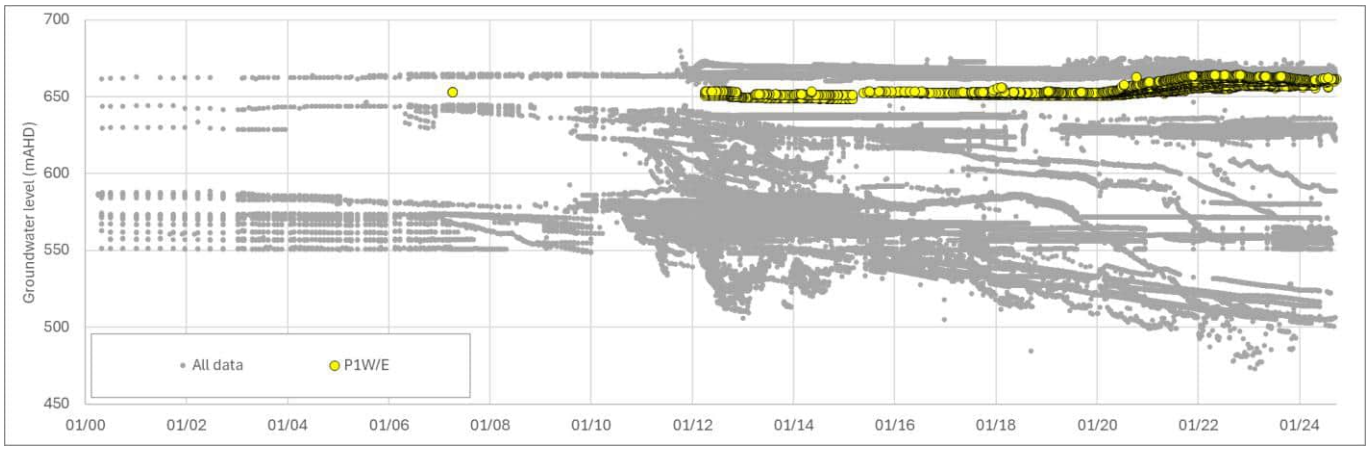


Figure 4.14. Packsaddle (west) system time variant groundwater observations (manual dips)



These data show that:

- The pre-development steps in head across the various flow barriers have not changed significantly through time due to natural variations in climate.
- The greatest step change in heads throughout the North Flank system occurs across the EE3 / C Deposit dyke (~40 m).
- Between the MAC E West flow barrier and the Weeli Wolli aquifer system, groundwater levels have been impacted significantly by dewatering. The area of impact (equivalent to the aquifer system lateral extent) is:
    - Roughly 18 km^2 in the North Flank aquifer system (including A Deposit).
    - Roughly 115 km^2 in the Hope Downs aquifer system.
- The impacts to groundwater levels west of the E West barrier and close to the Weeli Wolli Spring from dewatering are orders of magnitude less than those observed between these systems.

The 2020 data can also be used to estimate total drawdown since groundwater management commenced in the system. This data is plotted as drawdown by borehole in **Figure 4.15** and along the cross section of water levels through the North Flank Valley to Weeli Wolli Spring in **Figure 4.16**.

Figure 4.15. Observed change in groundwater levels by 2020

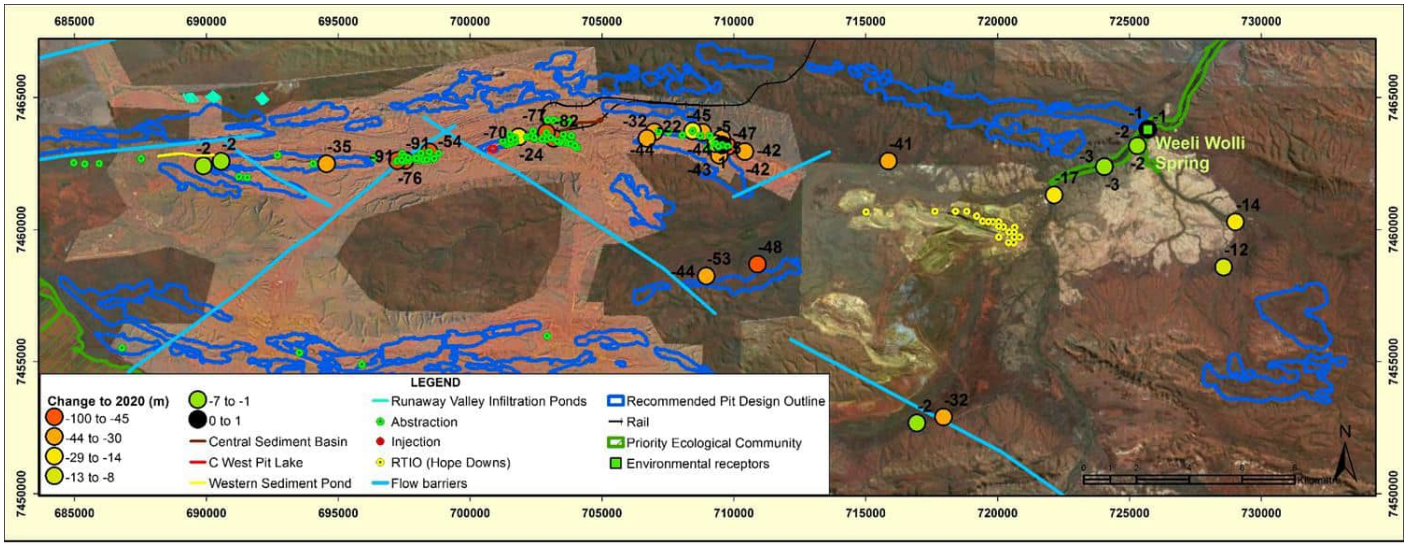
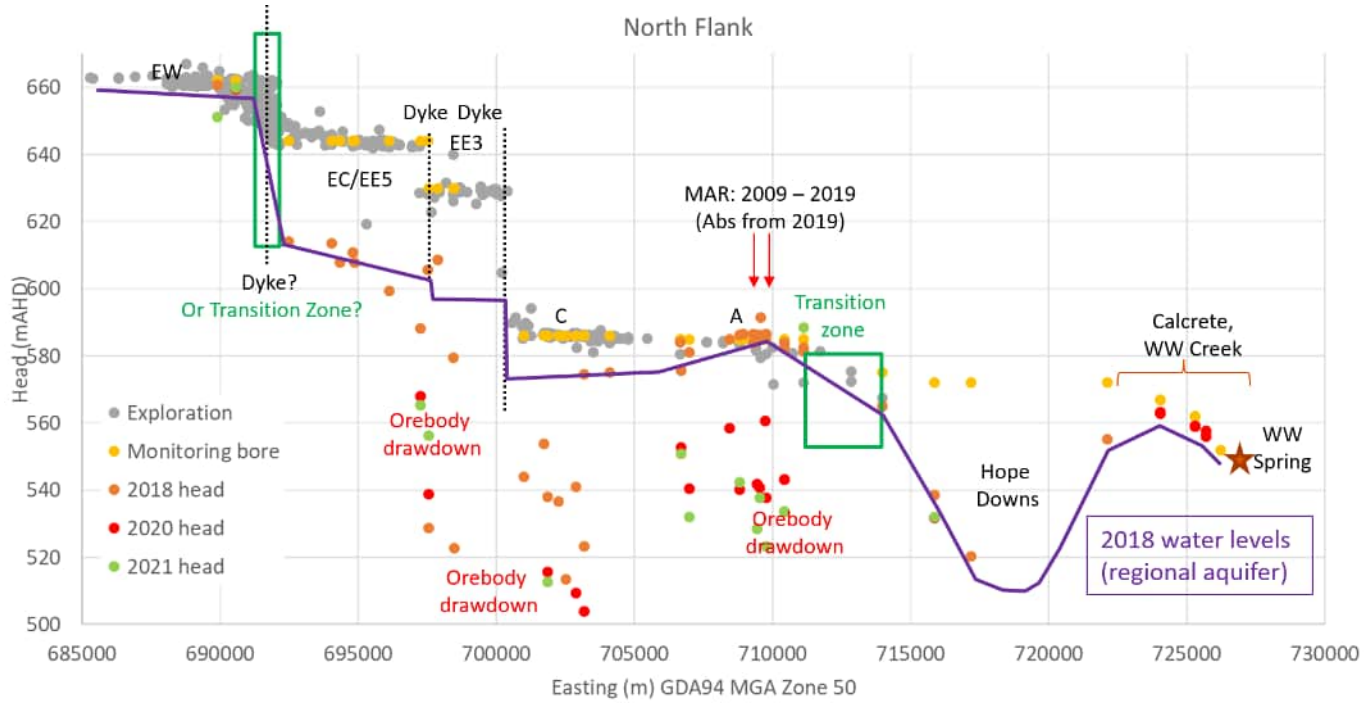


Figure 4.16. Comparison of observed North Flank pre-development and 2018, 2020 and 2021 heads

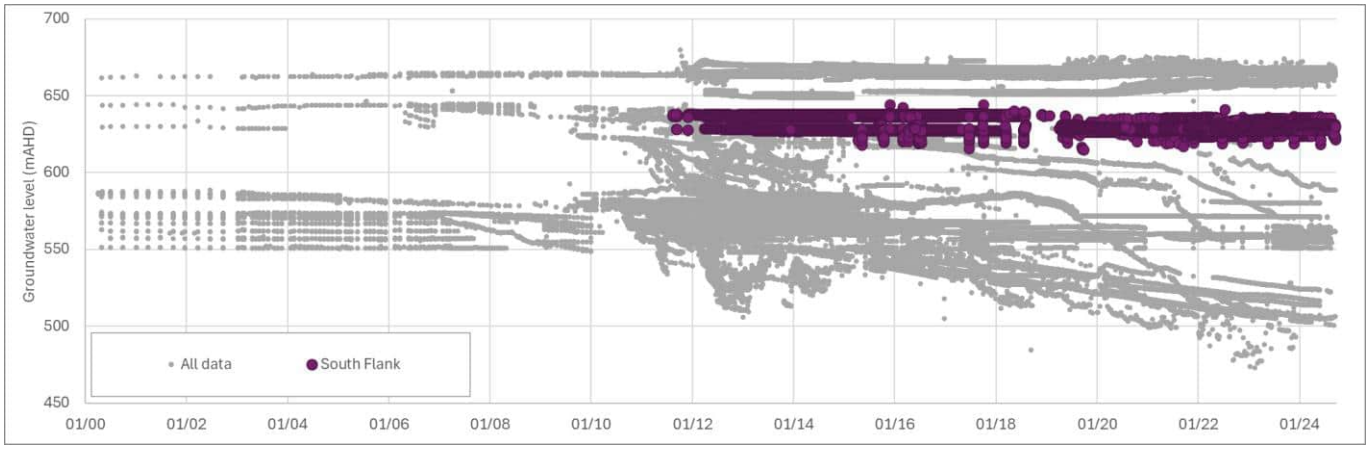


The analysis shows that:

- There is now a clear groundwater divide in the system close to Weeli Wolli Spring.
- Drawdown in the regional Hope Downs aquifer is much greater than drawdown in the regional aquifers adjacent to the MAC deposits (i.e. comparing regional dolomite drawdown, not orebody drawdown).
- A significant head gradient has been built up between the regional dolomite aquifer and some of the MAC orebodies (particularly EE3 and C Deposit).
- There has been significant orebody drawdown near EE3, C and A Deposits.

The time variant water levels available in South Flank (east of the Bruce Almighty dyke) are shown in **Figure 4.17**. These confirm that, by the start of 2021, the groundwater levels here are as yet unaffected by dewatering either from BHP or RTIO operations.

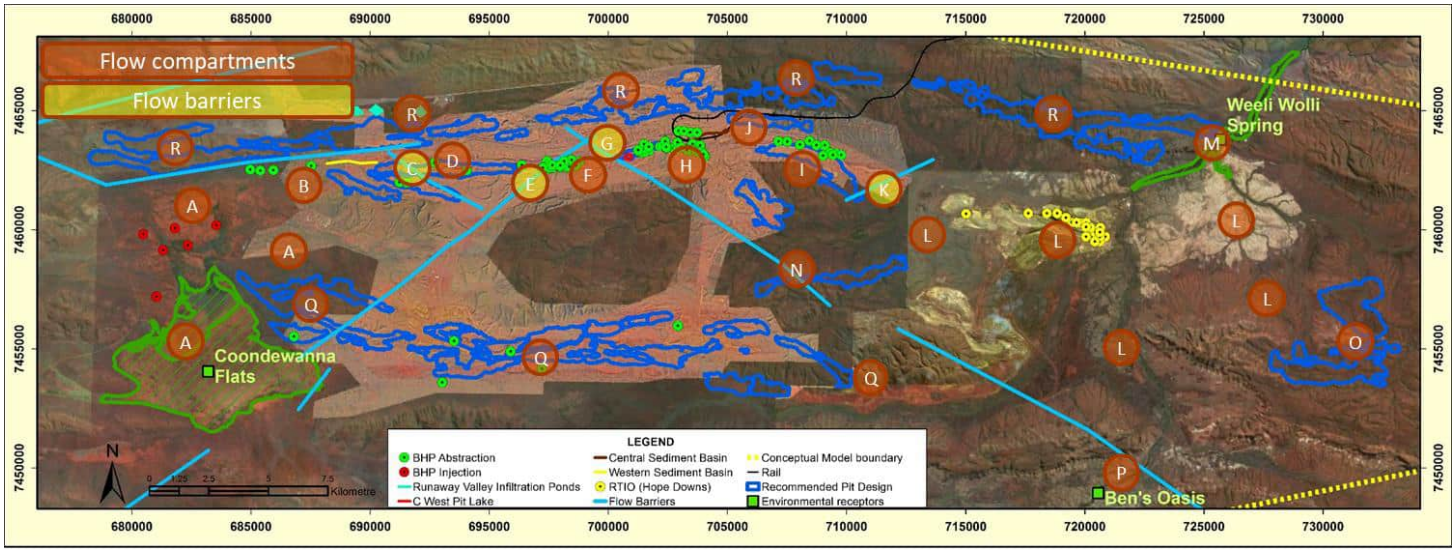
Figure 4.17. South Flank (east of Bruce Almighty dyke) system time variant groundwater observations



5 Flow systems and flow barriers

As this is a very large and relatively complex system and dataset, the detailed analysis is broken into various elements (shown in **Figure 5.1**) each of which are discussed in turn below.

Figure 5.1. Water level interpretation key

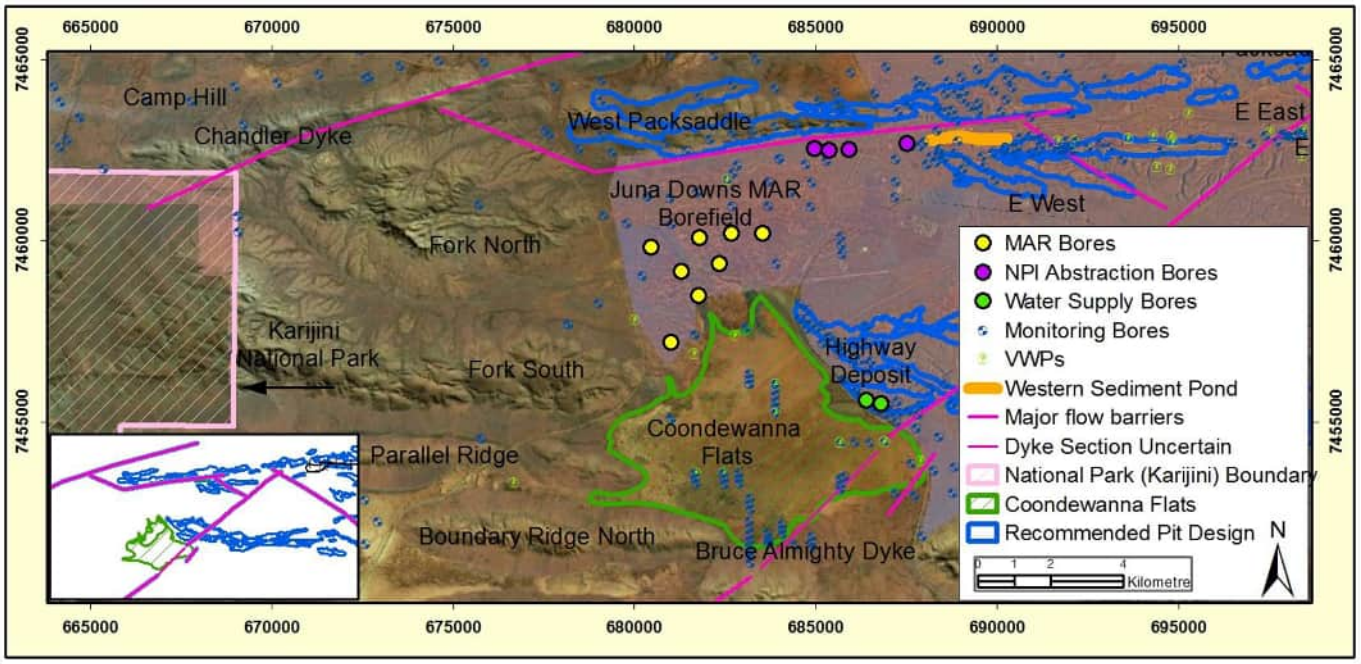


5.1 Coondewanna aquifer system (A)

5.1.1 Introduction

Coondewanna Flats and Juna Downs are located south of Packsaddle and west of the North and South Flank orebodies, on the western side of Great Northern Highway.

Figure A.1. Location Map



This area hosts the following features (Figure A.1):

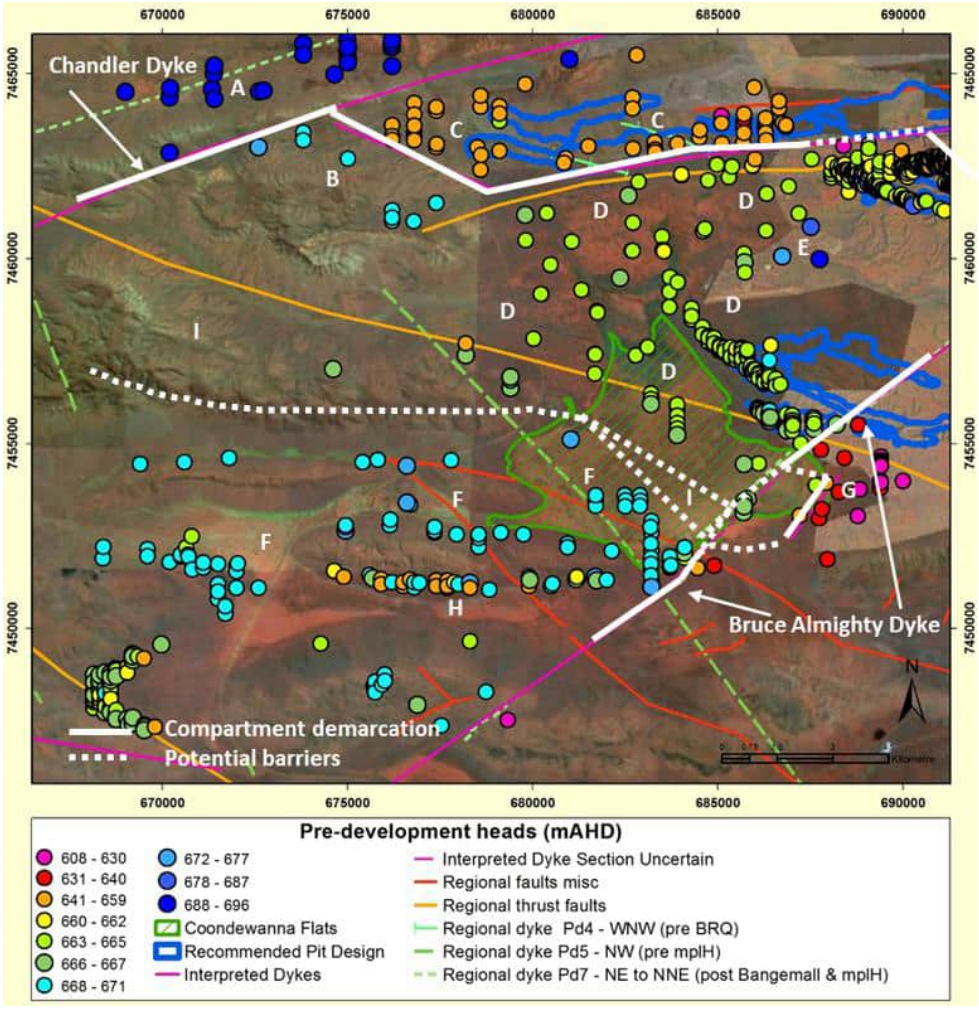
- Coondewanna Flats
- Juna Downs Managed Aquifer Recharge (MAR) borefield
- NPI potable supply borefield in the north east
- Two water supply wells in the south east at Highway Deposit
- Western Sediment recharge pond
- Several future deposits, including Highway and Dead End/E West deposits

Coondewanna Flats, an internally draining alluvial basin for the surrounding catchment, includes several vegetation communities with ecological value and is listed by the Department of Parks and Wildlife (DPaW) as a Priority Ecological Community (PEC). The area supports distinct Eucalyptus victrix woodland vegetation communities. Because of this, monitoring of water level change in this area is extensive and ongoing. Between 2004 and 2014, depth to groundwater beneath Coondewanna Flats was approximately 24 to 25 mbgl.

5.1.2 Pre-development heads

The observed heads from exploration and hydrogeology drill holes (pre-2016) are shown in **Figure A.2**

Figure A.2. Pre-development heads and compartmentalisation



The Figure shows (features marked on the figure as A to I):

- Camp Hill heads (688 – 695 mRL) are ~30 m higher than heads south of Chandler Dyke (A).
- Heads south of Chandler Dyke are separated by a NW-SE trending dyke into two distinct categories: 668 – 671 mRL in west (B; light blue) and 641 – 659 mRL (C; orange) in West Packsaddle.
- Heads in West Packsaddle are ~20 m lower compared to heads in Juna Downs. (C vs D)
- Heads are relatively uniform (660 – 667 mRL) across a large area spanning: Juna Downs MAR borefield, northeast and east towards E West Deposit, southeast towards Highway 1 and 5 Deposits and in the eastern portion of Coondewanna Flats. (D)
- There is a small area of higher heads (10+ m) towards Dead End deposit, where low K Marra Mamba has been encountered. (E)
- Heads in the south and west of Coondewanna Flats and further west towards Fork South are marginally higher than heads in Juna Downs, and are not too dissimilar from heads in B. (F)
- Heads south east of the Bruce Almighty Dyke are ~35 m lower than heads northwest of the dyke in Coondewanna Flats and towards Highway 5 Deposit. (G)
- Heads south west of Coondewanna Flats fluctuate between 641 – 659 mRL and 668 – 671 mRL over small distances indicating potential influence of geological/structural features. (H)
- There is limited data through the centre of Coondewanna Flats and further West towards Fork North and Karijini National Park. (I)

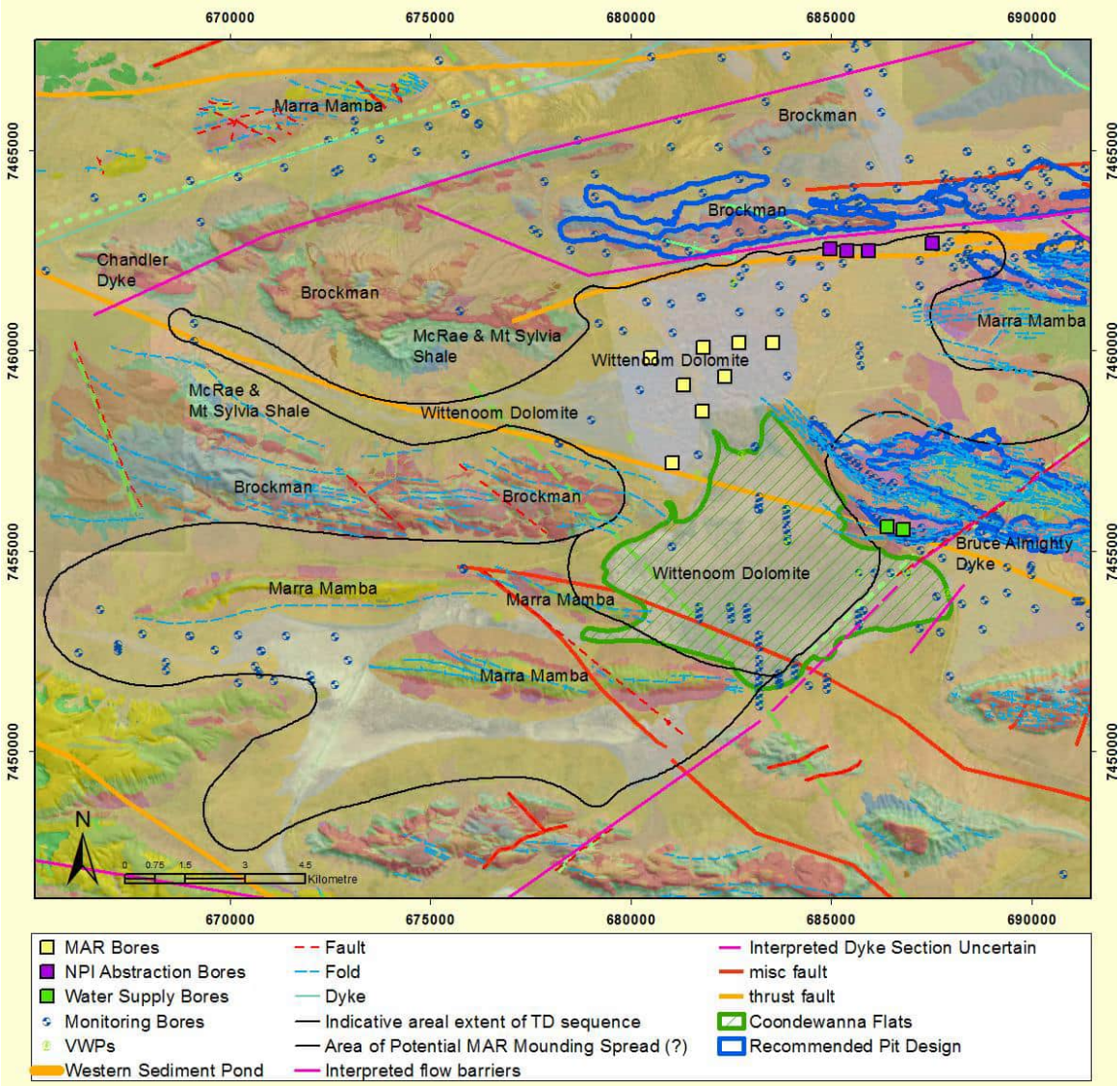
These heads provide a basis for delineating the Juna Downs/Coondewanna Flats aquifer compartment as follows:

- Structural and geological hydraulic flow barriers bound the aquifer system to the north, east and south as evidenced by changes in heads over small distances.
- There may exist some degree of hydraulic disconnection between the northeast and southwest of the aquifer beneath Coondewanna Flats.
- Potential boundaries to the west towards Karijini National Park are relatively unknown and untested.

5.1.3 Geology

Geology and mapped/inferred structures for this region are shown in **Figure A.3**. The figure indicates extensive Paraburdoo dolomite (regional aquifer) particularly beneath the Juna Downs borefield and Coondewanna Flats. Recent analyses of drillhole information and hydrogeological data have been used to determine an approximate aerial extent of Tertiary Detritals, believed to extend further west beyond Parallel Ridge. Several structures exist within this compartment, predominantly NW-SE and SW-NE trending dykes typical of the CPH region, and extensive folding near E West deposit, the Highway deposits and south of Boundary Ridge North.

Figure A.3. Geology and structures



5.1.4 Groundwater levels and stresses

There is natural temporal variability in water levels beneath Coondewanna Flats owing to the topographical surface water terminus which creates a periodic standing lake (and infiltrating water source) in particularly wet seasons, known as Lake Robinson. In addition, there has been a long history of water management in this area. Abstraction commenced in late 2002 for NPI water supply. Commencing in 2018, a number of other anthropogenic stressors have been introduced into the system, discussed in more detail below.

The abstraction/discharge stressors, time variant heads and their locations are shown in **Figures A.4 and A.5**.

Abstraction:

- NPI borefield in the north east - comprises four abstraction bores used for potable supply. Data suggest that abstraction from the borefield has been between 2 – 7 ML/d from June 2018 to October 2024. The average over this period was 2.6 ML/d. It is unknown whether abstraction data gaps between 2003 – 2011 and 2011 – 2014 are due to lack of abstraction, or lack of data collection.
- Two water supply wells in the south east - comprises two abstraction bores used for exploration water supply around South Flank: HSF0061P and HSF0101P. Since mid-2019 abstraction has been in the range of 0.1 – 1 ML/d.

Discharge of Surplus Water:

- Juna Downs MAR borefield - comprises eight injection bores which have been injecting surplus mine dewatering water from the North Flank orebodies since late March 2019. The average injection up to October 2024 has been 11 ML/d and peaked at 26 ML/d in February 2021.
- Western Sediment Pond - a recharge basin which has been in operation since mid-2018 and has periodically received up to 10 ML/d surplus mine dewatering water from the North Flank orebodies.

Groundwater level monitoring:

Monitoring of groundwater levels commenced in 1998. The spatial and temporal frequency of data collection has increased since the commencement of MAR in 2019, partly driven by environmental license requirements dictating monitoring of regional impact of draw-up, particularly in Coondewanna Flats. Although many of the installations have not been consistently monitored over the years, the monitoring dataset consists of:

- 102 monitoring bores with greater than 10 observations
- 73 monitoring bores with loggers installed and data available (>1 head observation)

The entire manual dip dataset is shown in Figure A.5.

Figure A.4. Time series Q and corresponding locations.

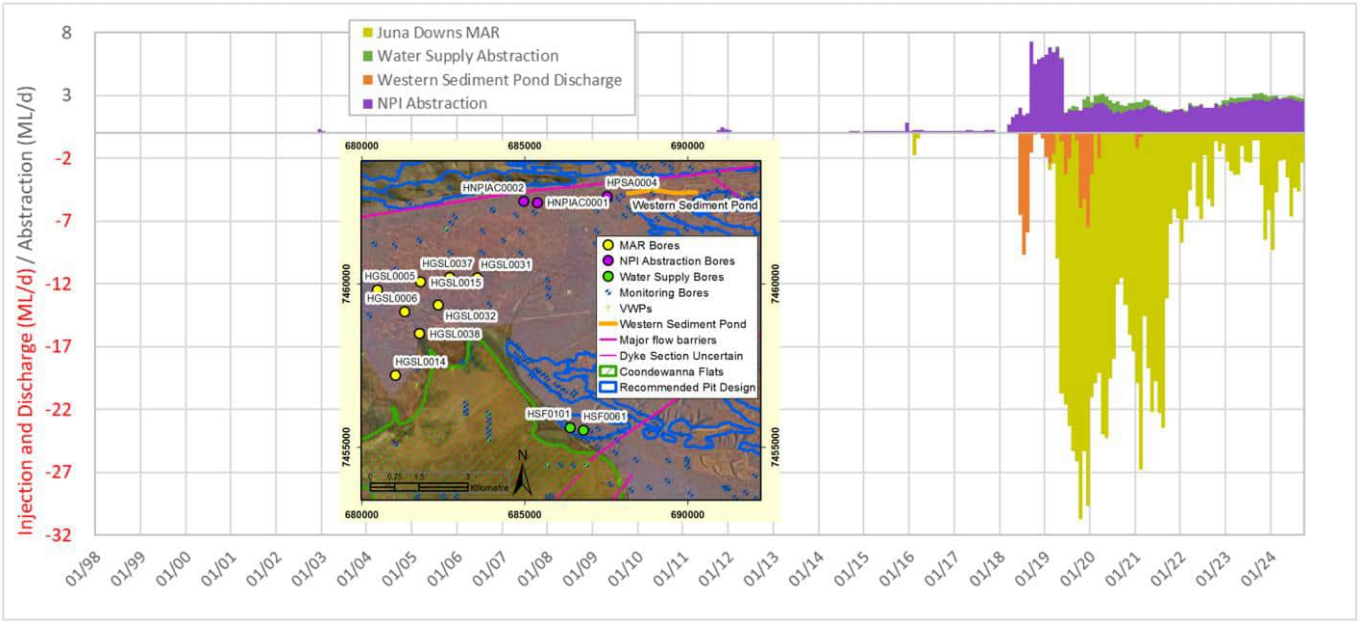
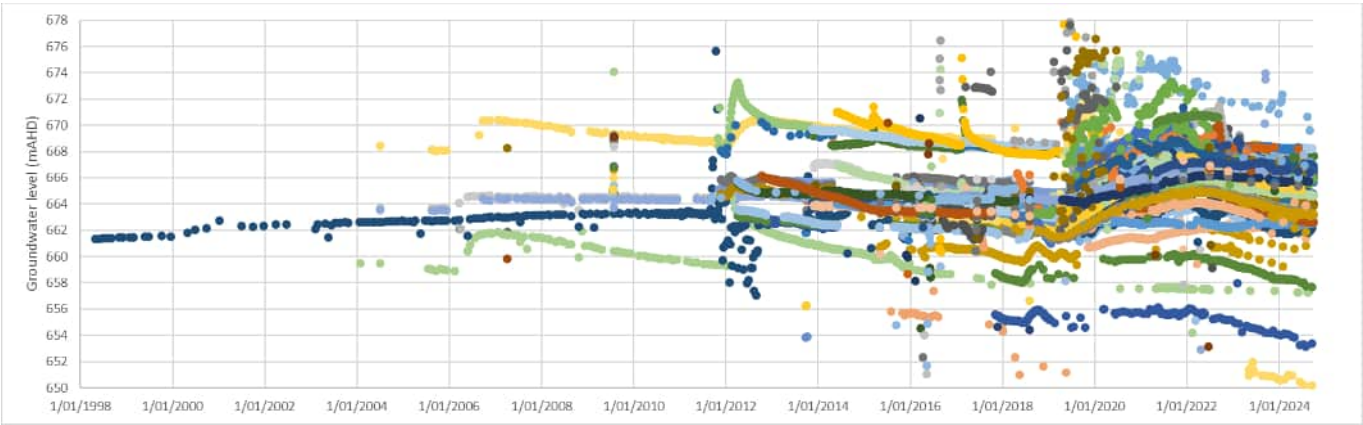


Figure A.5. Coondewanna aquifer system - time series heads



As this is quite a large compartment with a number of spatial and temporal elements, detailed analysis of the data will be broken into the following sub-sections based on main areas of interest and the two time scales: pre and post the operation of the Juna Downs MAR:

- Pre-Juna Downs MAR evidence for recharge, long term trends and connection to North Flank
- Evidence for NW-SE barrier through Coondewanna Flats
- Response to Juna Downs MAR:
  - To the northeast (towards North Flank)
  - To the west (to the unknown)
  - To the east (towards South Flank Highway)
  - To the southeast (Bruce Almighty Dyke)

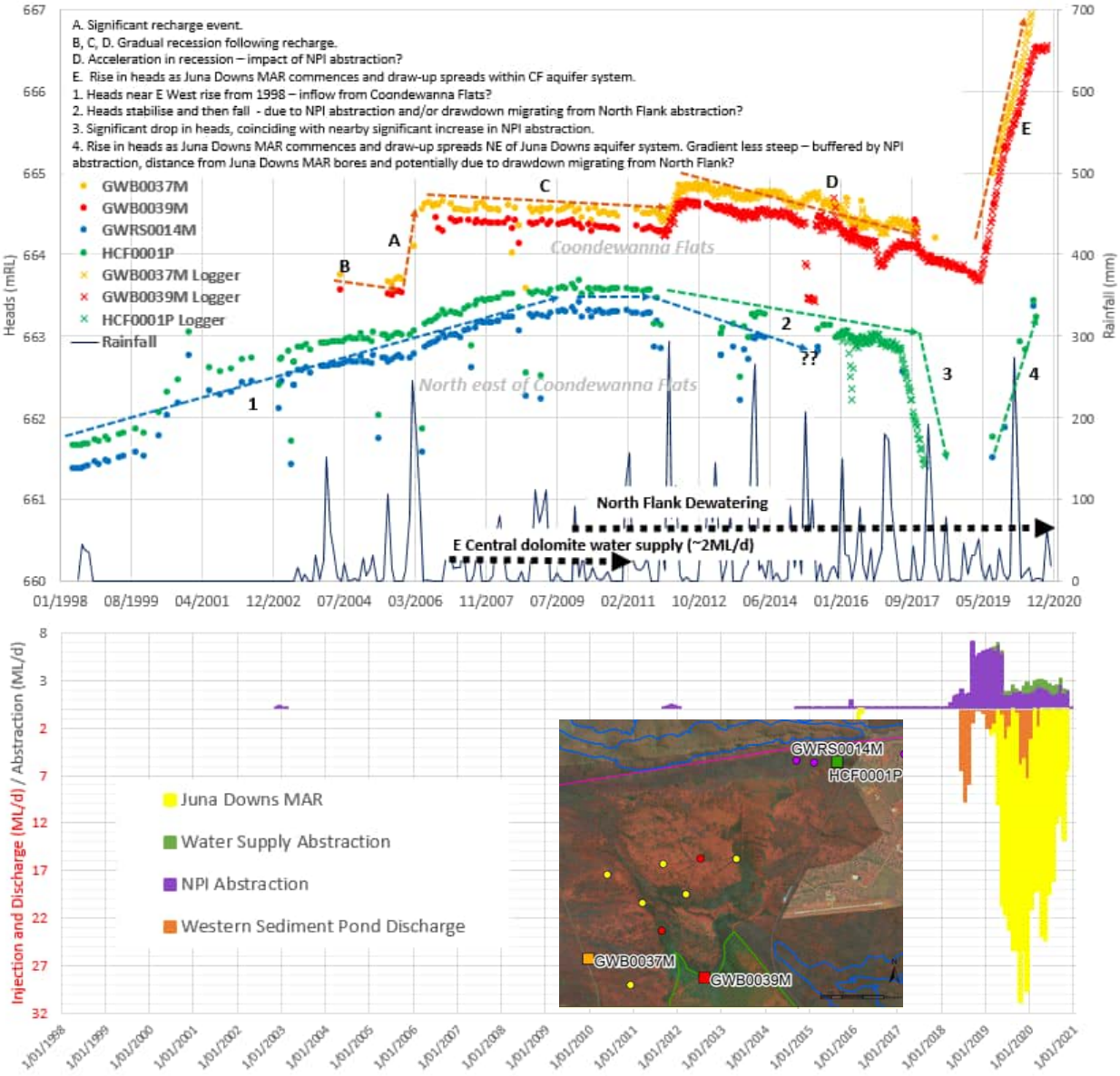
5.1.5 Pre-Juna Downs MAR evidence for recharge, long term trends and connection to North Flank

Four monitoring bores in the north of Coondewanna Flats and northeast towards E West Deposit have good historical head data and allow comparison of trends pre and post Juna Downs MAR. The data is plotted in **Figure A.6**.

The data show that:

- **1998 – 2010**: Heads in Coondewanna Flats appear to rise rapidly in response to rainfall and then recede slowly (A, B, C), whereas heads in the northeast rise steadily (1) and show very little immediate response to rainfall. There is no surplus discharge during this period so the increases can only be representative of natural processes.
- **2010/2011**: Heads in the northeast plateau for ~1.5 years. There is no obvious anthropogenic reason for this, so it may signify that the whole aquifer compartment has reached equilibrium.
- **2011 – 2017**: Heads in all bores start to fall in 2011/2012 (D, 2). This coincides with the commencement of longer term NPI abstraction for water supply (although the rate is uncertain) and later, dewatering at E Deposit. This recession could be due to natural processes, drawdown from NPI abstraction, drawdown from North Flank dewatering or a combination of all these. During this time the gradient of the recession in the Coondewanna Flats bores appears to increase slightly.
- **2017 – 2019:** Heads in the Coondewanna Flats bores continue to drawdown at a steady rate, whereas heads in the northeast (in particular HCF0001P - green) begin to fall at a rapid rate in 2017 (3). This coincides with an increase in NPI abstraction. Head data for the northeast bores is not available from 2018 – 2019, so the impact of surplus discharge to the Western Sediment Pond is unknown.
- **2019 – Present:** Heads in all bores rise rapidly in response to Juna Downs MAR commencing in early 2019 (E, 4). The draw-up gradient appears to be marginally less steep in the northeast bores (4), possibility due to a combination of factors: further distance from Juna Downs injection bores, buffering from NPI abstraction bores, or possibly buffering from other North Flank drawdown. It is interesting to note, however, that from September 2020 the two Coondewanna Flats bores diverged with GWB0039M heads appearing to plateau.

Figure A.6. North Coondewanna Flats and north east heads and locations



These observations indicate a good hydraulic connection between the north of Coondewanna Flats and the northeast of the compartment. The conceptualisation of this area and over this time period can be summarised as:

- Large quantities of water rapidly infiltrated into the aquifer beneath Coondewanna Flats following the 1999/2000 wet season and potentially also the 2006 and 2011 rainfall events (as seen at GWB0037M and GWB0039M). This caused localised but significant mounding beneath the flats.
- The groundwater mound slowly flowed (equilibrated) into the northeast of the compartment, resulting in a steady increase in heads in that area.
- In 2010/2011 heads in the northeast plateaued. There is a possibility that an equilibrium was reached whereby groundwater throughflow from Coondewanna Flats was buffered by abstraction (from the NPI bores or from dewatering in EC deposit) and / or natural flows out of the system.
- From 2012 the recession in water levels was probably due to a combination of natural recession and effect of water supply and dewatering (from E Deposit).

Overall the dataset furthers understanding of recharge processes and indicates a connection toward the North Flank orebodies. This implies therefore that Juna Downs MAR will result in recirculation when the orebodies in the northeast (Dead End and E West deposits) are dewatered.

5.1.6 Evidence for a NW-SE flow barrier through Coondewanna Flats

There are three main lines of evidence that point to a NW-SE trending flow barrier through the Coondewanna Flats area. These are:

- A small but consistent difference in pre-development heads
- A small but consistent difference in time series heads
- No obvious response to Juna Downs MAR across this feature (to the west)

This flow barrier may be a structural barrier (possible given that there is a NW-SE trending dyke in the west of the Flats), a lower permeability rock mass or a transition zone (~1.5 km wide).

Difference in pre-development heads

Pre-development heads using exploration and hydrogeology drillhole data is shown in **Figure A.7**. Two distinct groupings can be seen from this data:

- East Coondewanna Flats (and further north and east towards Packsaddle, E West Deposit and Highway Deposit)
- West Coondewanna Flats (and further west towards Fork South and south towards Bruce Almighty Dyke)

Heads are 3 – 8 m higher in the western area.

Difference in time series heads (prior to MAR)

Time series head data and corresponding locations are shown in **Figure A.8**. The data has been similarly divided into two distinct groupings: bores to the east (greyscale) and to the west (coloured). The bores are screened within the Tertiary Detritals (TD2, TD3), Oakover formation (TO) and dolomite (OB). Most bores screened in the TD2 and TD3 appear in the east, and most bores screened in the TO appear in the west. Logging comments indicate dolomite ranges from karstic and fractured to somewhat fresh and crystalline.

The following observations can be made:

- The western bores all return heads that are higher than the eastern bores (consistent with pre-dev heads).
- The western bores respond very rapidly and significantly to rainfall. The eastern bores show slower and more subdued responses.
- Over the observation period there is a downward trend in both datasets (pre-MAR).

Figure A.7. Coondewanna Flats pre-development heads

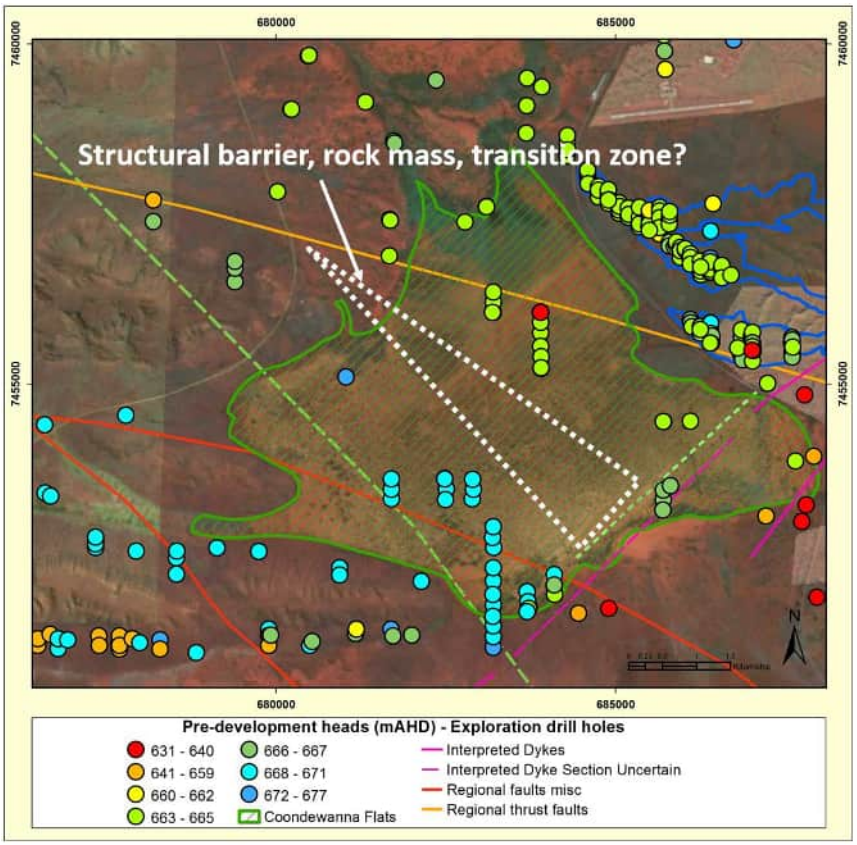


Figure A.8. Coondewanna Flats time series heads and locations

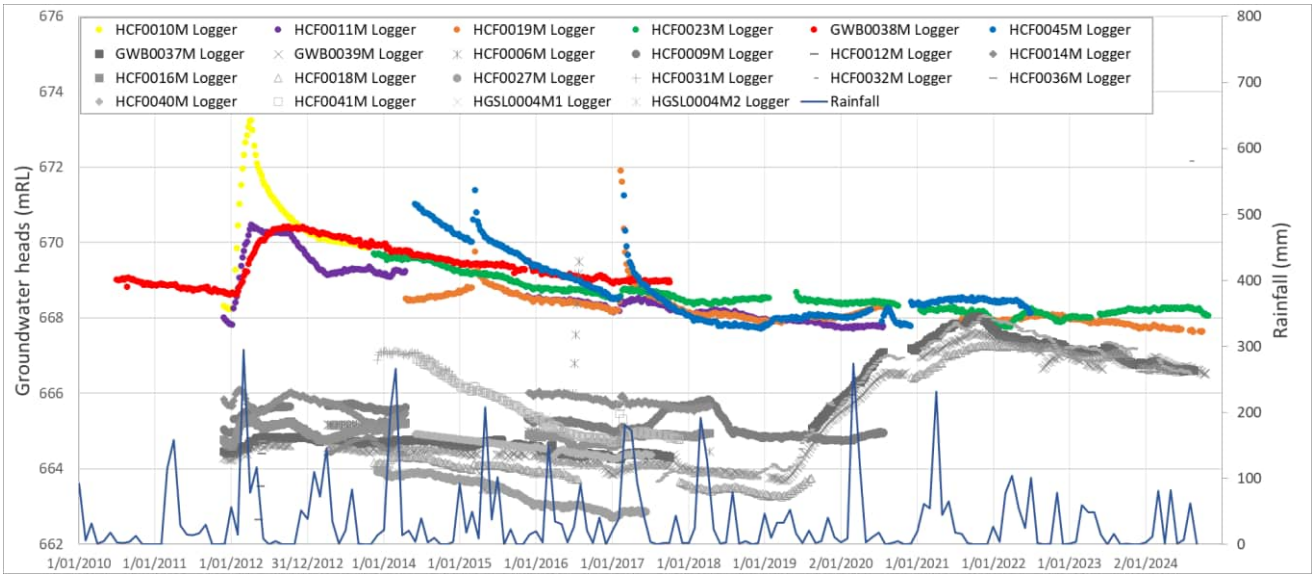
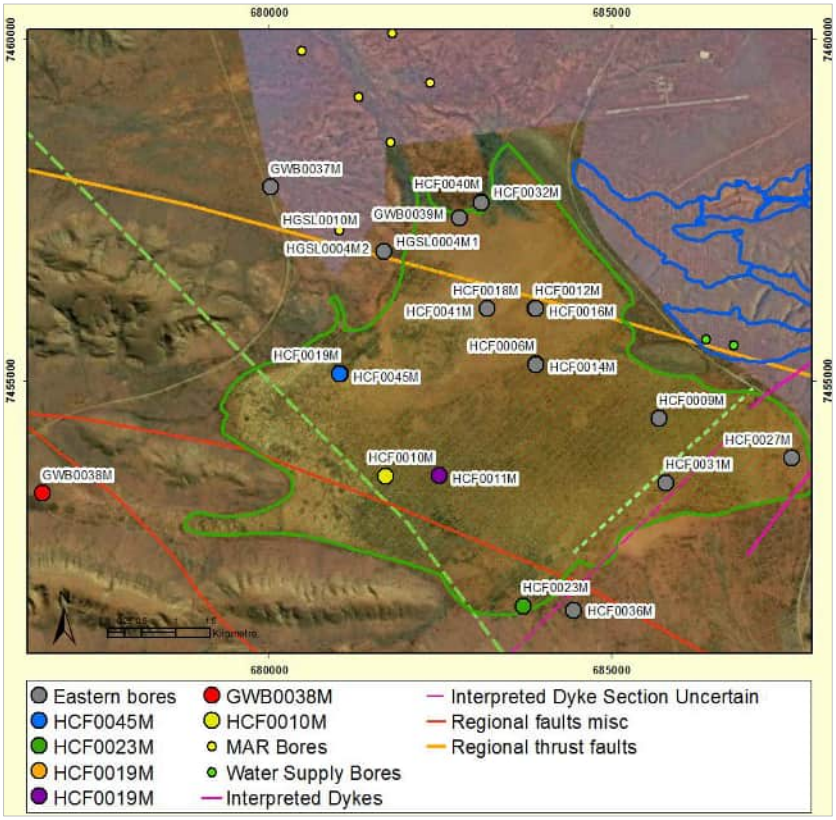


Figure A.8. Coondewanna Flats time series heads and locations (continued)



Difference in Juna Downs MAR response

All bores to the east, including those to the southeast (e.g. HCF0009M) show a response to Juna Downs MAR. In contrast, the bores to the west show a mixed response (**Figure A.8**). The water level in:

- HCF0045M appears to rise a little at the same time MAR starts, but reaches a peak prior to the peak in the bores to the east.
- HCF0023M rises a small amount from the start of 2019.
- HCF0019M continues to fall throughout.

Summary

The head data consistently point to the presence of a NW-SE flow barrier across Coondewanna Flats. However, the degree of connection across this barrier is unknown. This will have implications on available mounding of the Juna Downs MAR and dewatering of adjacent orebodies, but the extent is uncertain.

5.1.7 Juna Downs MAR

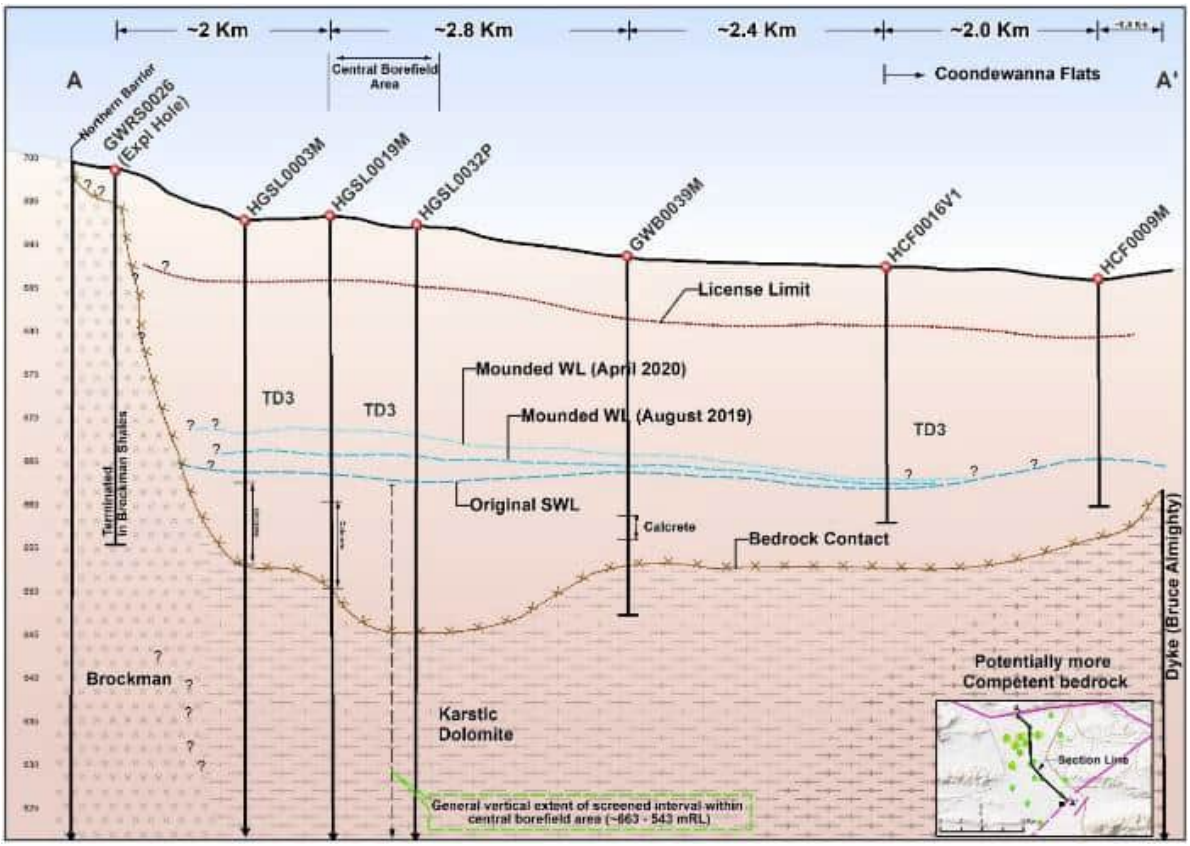
The Juna Downs MAR scheme commenced operation in late March 2019 and was developed to manage surplus water from MAC with a design capacity of 20 ML/d based on the MAC water balance (FY17) and anticipated capacity of the borefield.

The mechanism of MAR at Juna Downs is thought to rely on injection into high transmissivity (but relatively low storage) dolomite. The water is inferred to move radially (although also controlled by structure) away from the primary borefield area and ultimately upwards into the Tertiary Detritals where there is significant unconfined storage capacity. Estimates of the transmissivity of the dolomite range from 1200 to 1530 m^2/d.

A cross section conceptualising this region is shown in **Figure A.9**. The regional response is explored in more detail below.

The following analysis is focussed on the observed response to the Juna Downs MAR.

Figure A.9. Cross section from NW to SE across Juna Downs and Coondewanna Flats



5.1.8 Juna Downs MAR response to the Northeast (towards North Flank)

Head data to the northeast are shown in **Figures A.10 and A.11**. The following observations can be made:

- From 2011 until late 2017, heads in this region drawdown steadily and at a similar rate, with the exception of GF0939RM (brown) which records a steeper gradient.
- In late 2017, drawdown gradients across the region shift, probably due to a ramp-up of NPI abstraction earlier than recorded.
- In June 2018, the addition of discharge into the Western Sediment pond results in head increases, with the highest response in the nearest bores.
- Following the commencement of Juna Downs MAR, head responses also fall into three main categories (corresponding to numbers marked on **Figure A.11**):
    1. HNPIAC0004M/GWRS0014M/HCF0001P: show significant rise in heads between April 2019 and November 2020 (~3.3 m).
    2. GF0939RM: no recent data available, however heads following the first 5 months of injection increased less than the group above.
    3. GF0914RM and HGE0175M: limited recent data and what data is available showing significant fluctuation. These trends are hard to decipher and could be controlled by the combination of Juna Downs MAR, Western Sediment Pond discharge, and NPI and North Flank abstraction.

The data therefore confirm a connection between the Juna Downs MAR borefield and the northern part of the aquifer system. The connection through to the north east is however harder to define, partly due to the limited amount of time variant data in that area but also because of the many overlapping anthropogenic stresses.

Figure A.10. North east pre-development heads, geology and bore locations

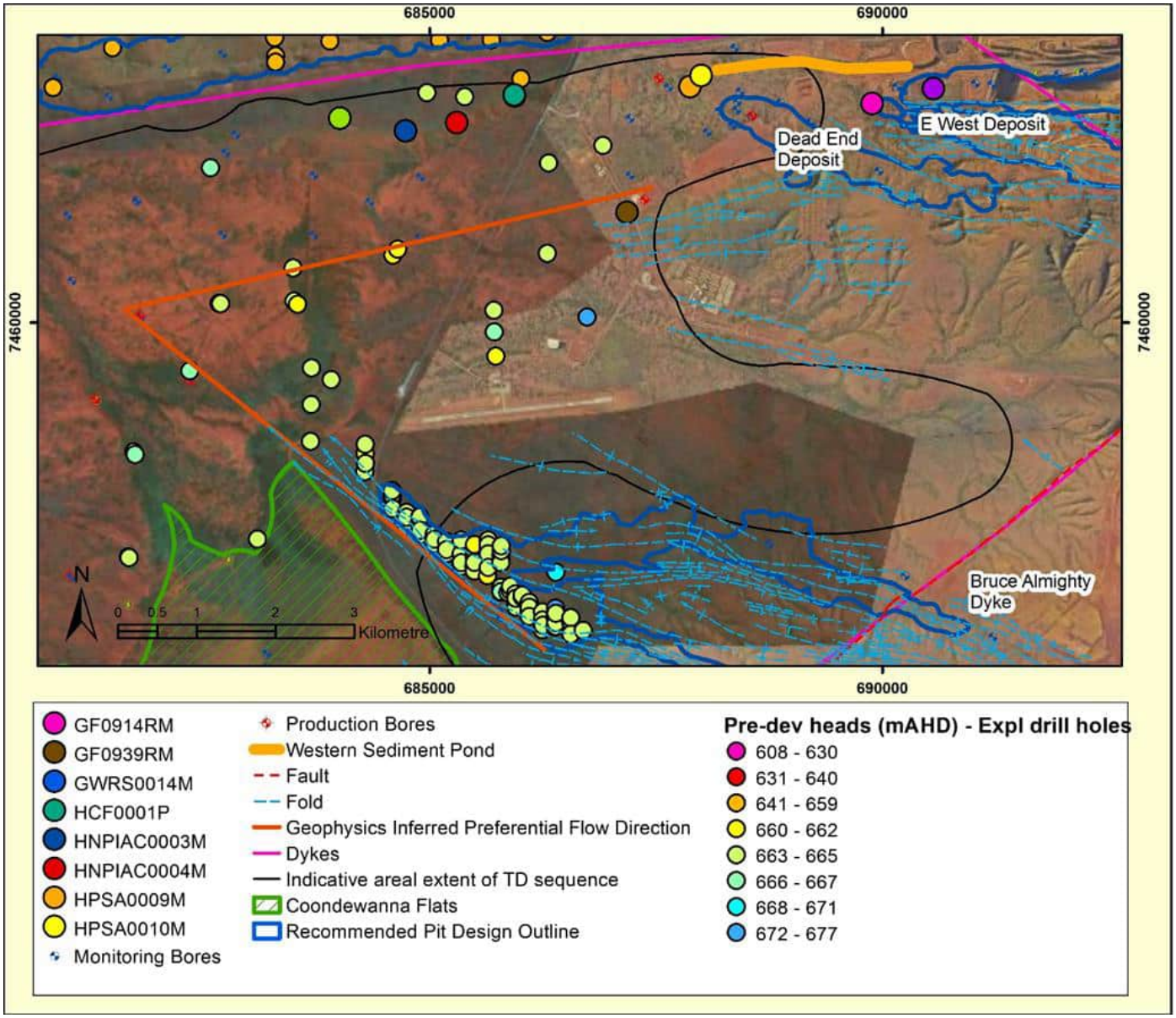
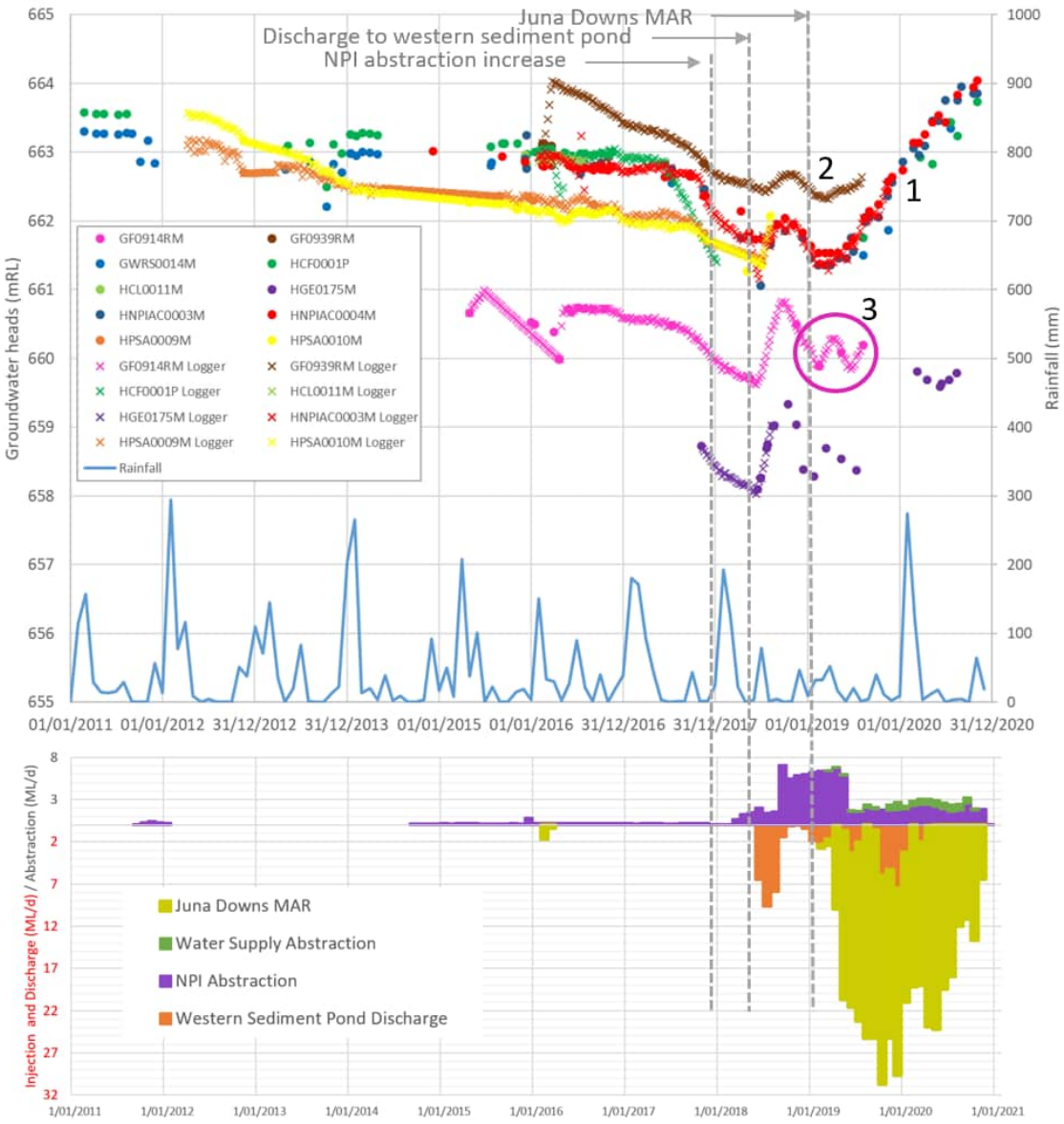


Figure A.11. North east time series data



5.1.9 Juna Downs MAR response to the Southeast (towards South Flank Highway Deposits)

Eight monitoring bores are available to the southeast of Coondewanna Flats (shown in **Figure A.12**). The Highway 1 Deposit heads are plotted against GWB0039M (north of Coondewanna Flats) to show relative response to MAR injection. The data show that:

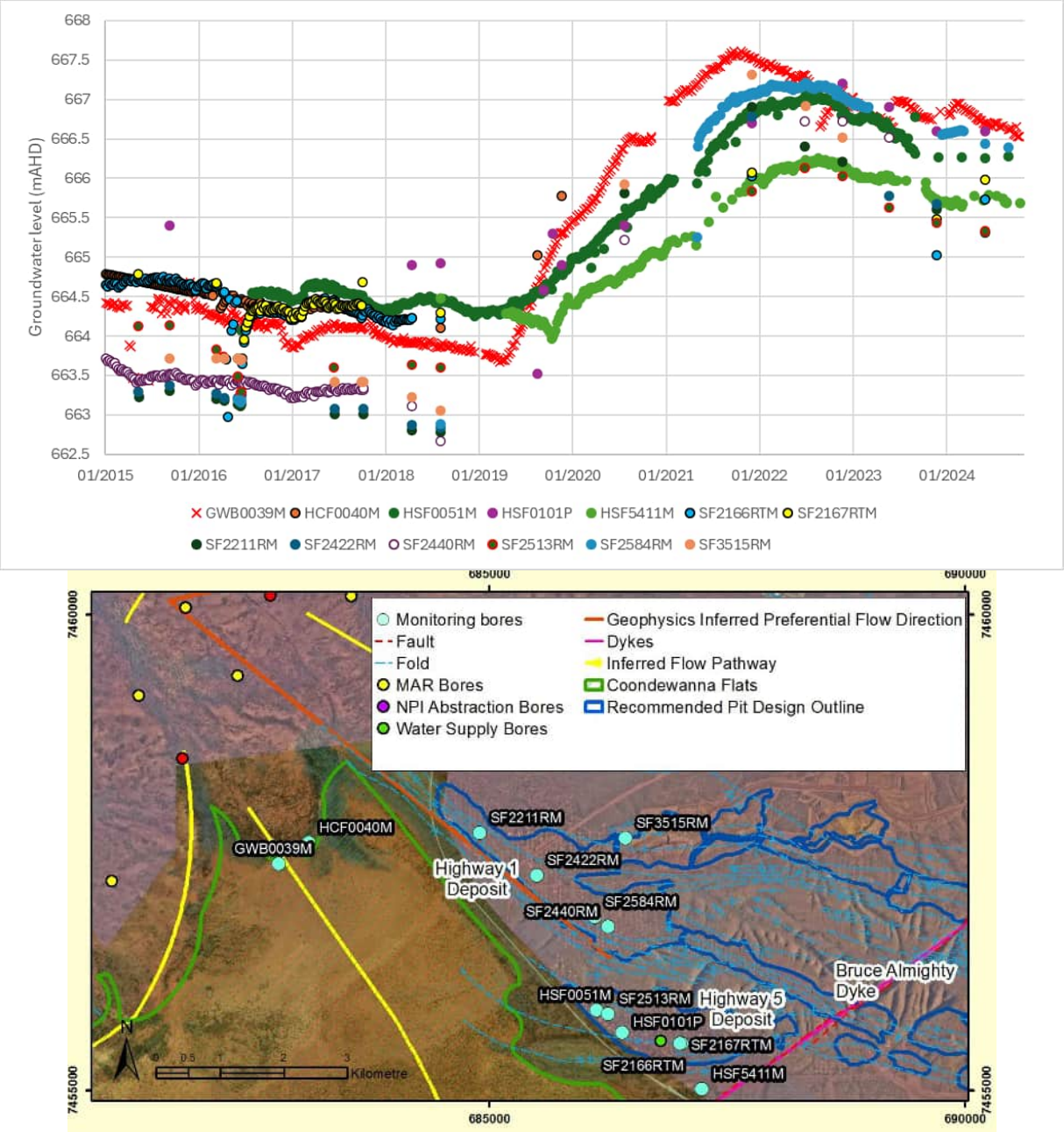
- Groundwater levels at all locations appear to be falling prior to MAR and at the same rate as in the main Coondewanna Flats aquifer (GWB0039M).
- The rate of drawdown seems to accelerate at locations close to the NPI production bores as abstraction from them increases (e.g. SF2440RM) at the start of 2018. This provides evidence that the Highway 5 and Highway 1 orebody aquifers are in hydraulic connection.
- All bores monitored since MAR commenced show significant head increases. For example, the peak increase (mounding) at:
  - GWB0039M (just south of the MAR borefield) was almost 4 m
  - SF2440RM (southern part of South Flank Highway 1 deposit) was just over 4 m

- HSF5411M (southeast of Highway 5 deposit) was approximately 2.2 m
- HSF0051M (western part of Highway 5 deposit) was approximately 2.7 m

- The water level in the Highway orebody bores peak up to 6 months after the peak at GWB0039M.

The data therefore confirm that the Highway 1 and Highway 5 orebody aquifers are hydraulically connected to the Juna Downs area. Not only that, but as the response is so strong throughout both deposits, that here may be a preferential flow pathway between the two locations.

Figures A.12. East time series data and locations



5.1.10 Juna Downs MAR response to the West

Pre-development heads, geological information and hydrogeological features for the western region are shown in **Figure A.13**. Time series heads (>1 observation) are shown in **Figure A.14a** and **b** and depth to water in **Figure A.15**.

Figure A.13. West geological map, pre-development heads

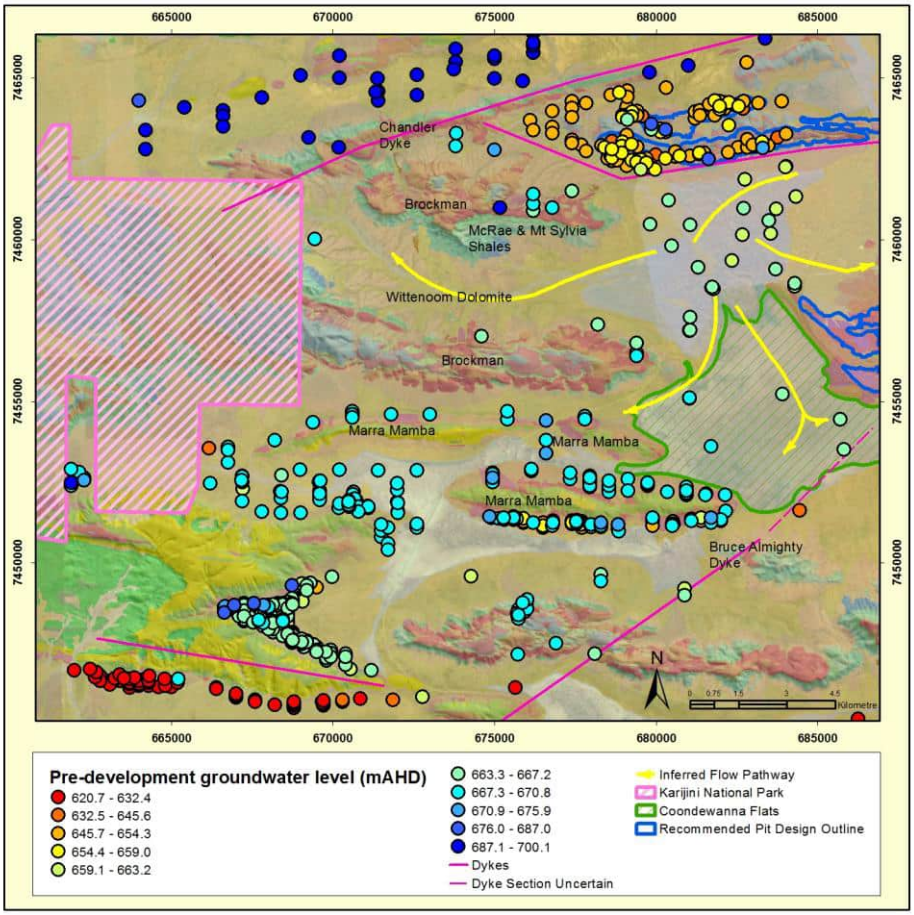


Figure A.14a. West time series heads - hydrographs

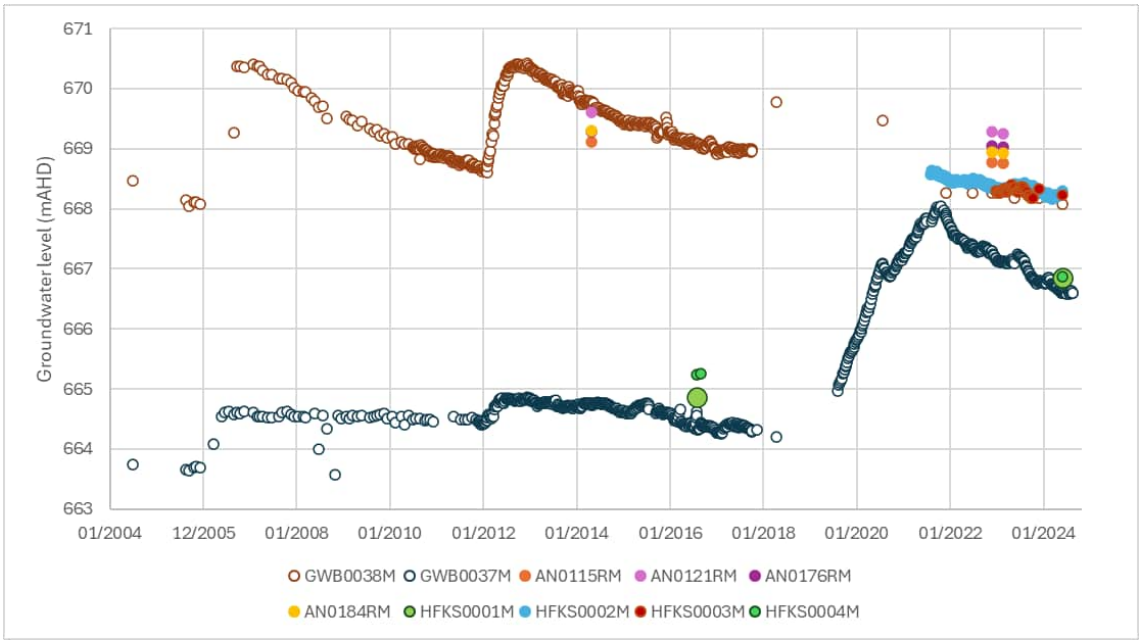


Figure A.14b. West time series heads – bore locations

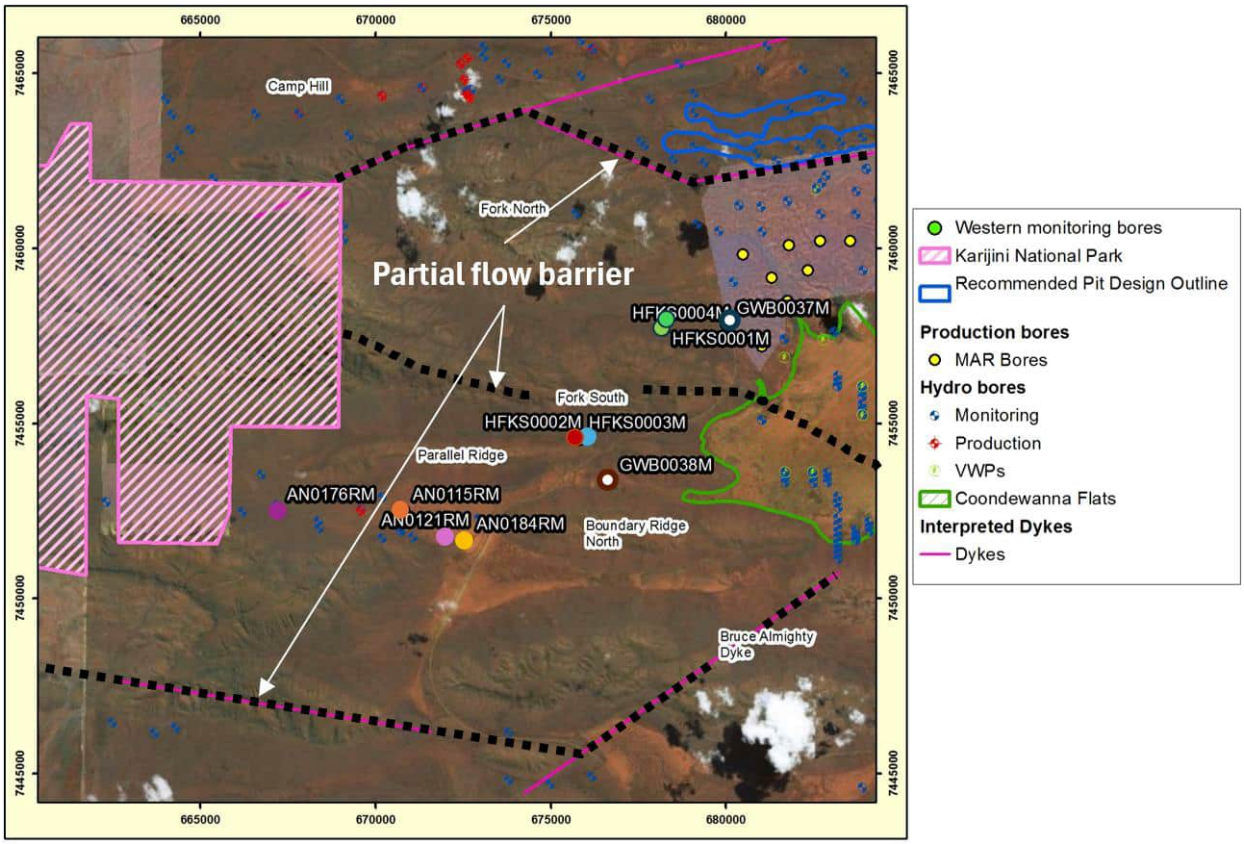
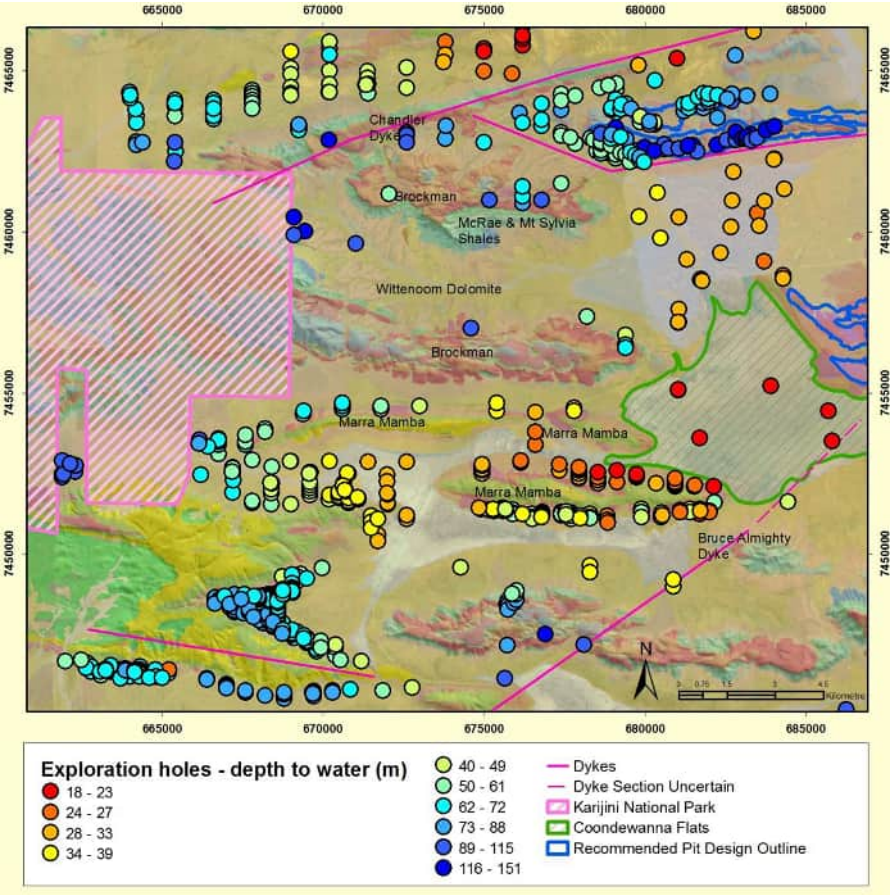


Figure A.15. Western Coondewanna Flats, pre-development depth to groundwater



The Figures show that:

- The boundaries to the Coondewanna aquifer system to the north and south are clearly defined by the data (**Figure A.13**).
- The partial flow barrier that passes through the centre of Coondewanna Flats (which is described in Section 5.1.6) is not obvious in these figures. However, the transient data indicate that it may be linked with a flow barrier coincident with the “Fork South” ridgeline (most likely the result of unmineralised Brockman Formation in that area). This therefore results in the splitting of the Coondewanna aquifer system into these two roughly north and south sub-compartments.
- There are many more monitoring bores in the southern sub-compartment than the northern one.
    - Those in the south are sufficient in number and location to track the migration of mounding / drawdown if it passes across the partial flow barrier that passes through the centre of Coondewanna Flats.
    - Additional monitoring should be considered in the northern sub-compartment, as there is currently no monitoring west of HKSF0001M and HKSF0004M, the groundwater levels in both of which have responded to Juna Downs MAR (**Figure A.14**).
- Mounding from Juna Downs MAR and drawdown from dewatering the South Flank Highway and North Flank EW deposits in this aquifer compartment is likely to migrate more readily to the west in the northern sub-compartment than the southern one.
- The depth to water is least at Coondewanna Flats (18 to 23 m in **Figure A.15**) and increases to the east. At the border of Karijini National Park, depth to groundwater is greater than 70 m both south and north of the Fork South ridgeline.

5.1.11 Juna Downs MAR response to the Southeast (towards Bruce Almighty Dyke)

Pre-development heads are shown in **Figure A.16**, and time series heads and corresponding locations are shown in **Figure A.17**.

Figure A.16. Pre-development heads

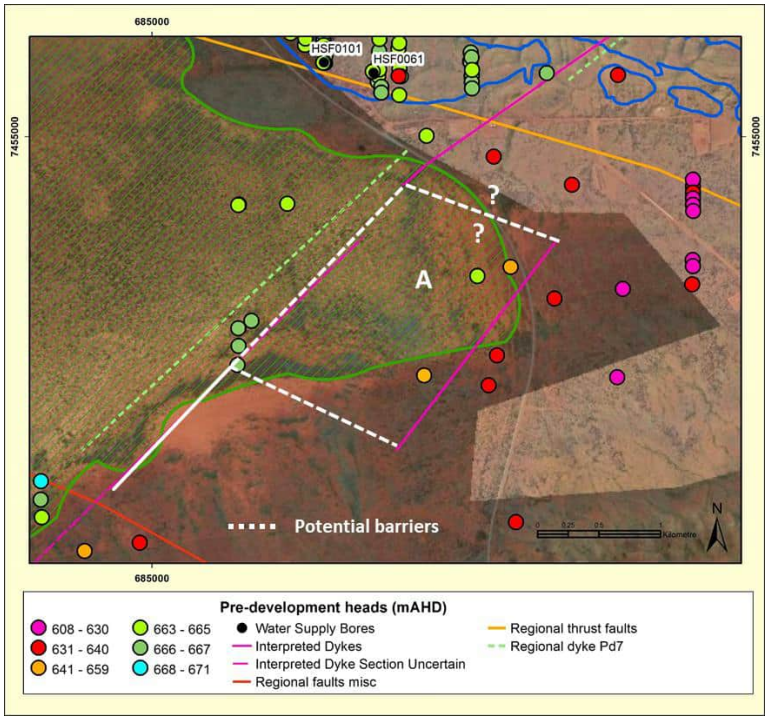
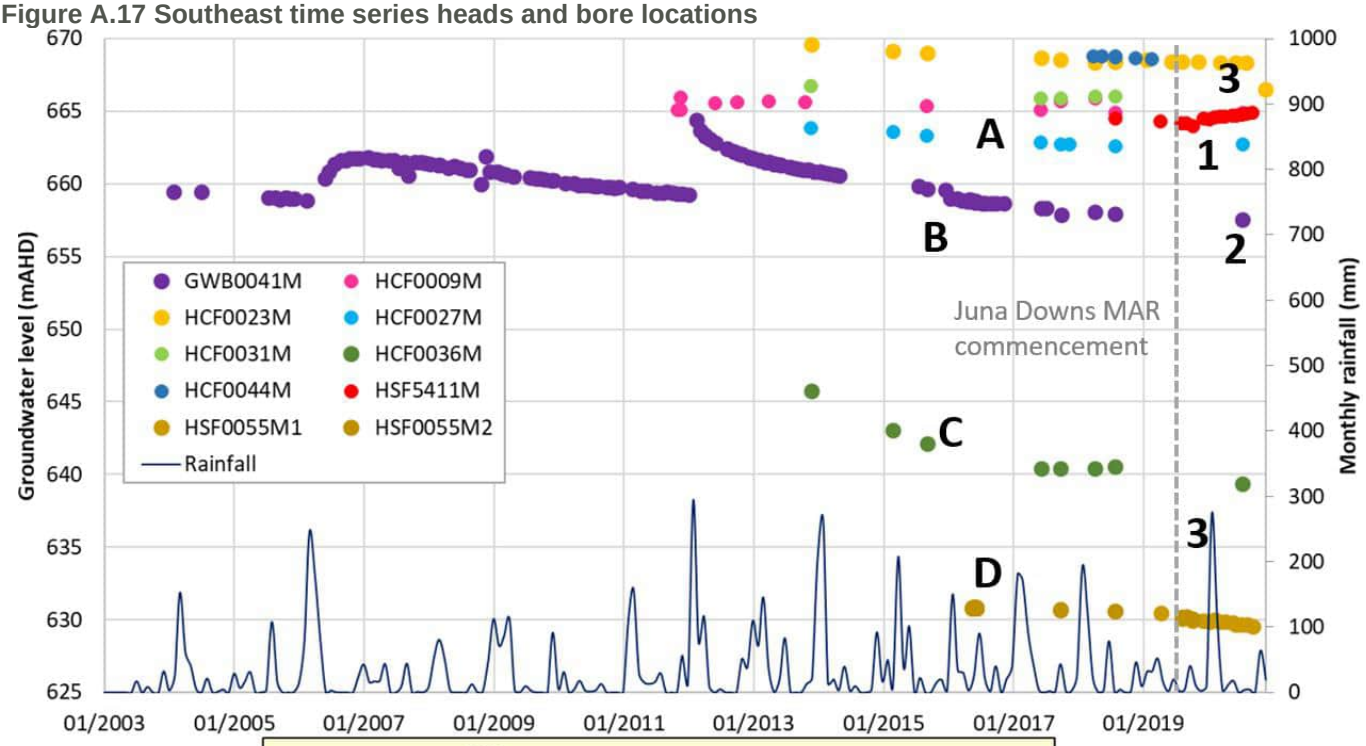
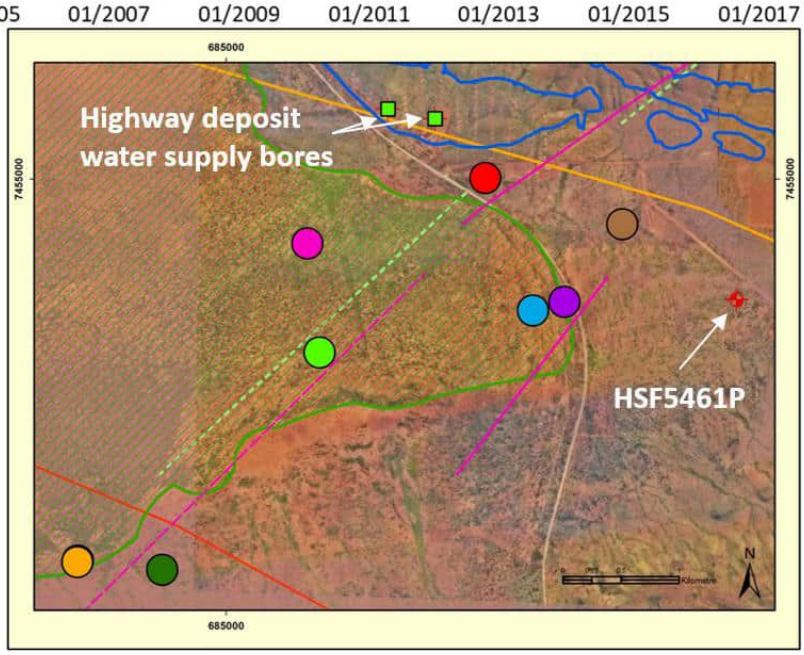


Figure A.17 Southeast time series heads and bore locations





The following observations can be made:

- The location of the dyke coincides with a significant step in heads (35 m higher on the Coondewanna Flats side). However, there is a 'pocket' containing GWB0041M where the higher heads are observed much further east than the dyke (A – labelled on **Figure A.16**). This suggests then that the exact mechanism by which this feature works as a flow barrier and its geometry is unknown (i.e. it is more complicated than a single line on a map).
- Mounding from the Juna Downs MAR is observed at HSF5411M just northeast of the dyke. However, there is no sign of mounding in bores on the other side of the dyke (although in most cases monitoring is quite limited over the MAR period)
- It is currently unknown how leaky this barrier is, although the flows under current conditions are almost certainly very low. This will probably only become clear when dewatering commences on the eastern side and the head gradient is increased. Mechanisms whereby flow across this feature might occur include:
  - leakage driven by fracturing/splaying in the dyke, i.e. where the multiple step change in heads are observed

- if water levels rose enough then the 20 – 30 m of unsaturated Tertiary sequence above the dyke would provide a flow pathway
- small flows may occur directly through the dyke

Whilst the exact nature of the mechanism and geometry remains uncertain, the Bruce Almighty Dyke clearly behaves as a significant barrier to flow.

5.1.12 Conclusions

The following conclusions can be drawn from the analysis above:

- The Juna Downs and Coondewanna Flats aquifer compartment covers a very large area and is hydrogeologically complex.
- The area is characterised by an extensive regional aquifer comprised of dolomite (presenting high transmissivity) and Tertiary Detritals (high storage).
- The boundaries to the compartment are well defined to the north, east and south. The boundary to the west is not defined.
- There is a flow barrier of unknown efficacy running through the centre of Coondewanna Flats (orientated NW-SE).
- Most observation bores in Coondewanna Flats respond to rainfall. The Flats is an area of enhanced rainfall recharge.
- Groundwater flow is likely to occur out of this compartment via both the North Flank and South Flank Valleys. The flows are not likely to be large however due to the nature of the hydraulic boundaries in these locations.
- Hydraulic connections in the system exist between:
  - Juna Downs and the north east of the compartment (towards North Flank)
  - Juna Downs and Highway 1 deposit (and likely Highway 5 deposit)
- The area to the west remains relatively unknown and untested.
- The proven hydraulic connection between the main Coondewanna Flats / Juna Downs aquifer compartment and the South Flank Highway 1 and 5 Deposits means that a significant dewatering effort is likely at these orebodies and there will be recirculation between dewatering and Juna Downs MAR.
- Additional monitoring may be beneficial in the following locations:
  - To the west – to delineate boundaries and potential for mounding / drawdown to travel in this direction
  - In the dolomite beneath Coondewanna Flats (there is currently no monitoring of this key unit here)

5.1.13 Uncertainties

Several hydrogeological uncertainties remain in this aquifer compartment. They are:

- How the compartment will respond to dewatering. There is high confidence that the Highway 1 and 5 Deposits are hydraulically connected to the Juna Downs/Coondewanna Flats area. However, it is unknown whether that connection will continue with depth.
- The potential for mounding in response to Juna Downs MAR and/or drawdown from dewatering to extend west towards the Karijini National Park boundary (though this is some 12 km away). This is particularly true in the northern part of the Coondewanna aquifer system.
- The extent of disconnection across Coondewanna Flats and the potential implications on injection and dewatering. This will become clearer as Juna Downs MAR continues and when dewatering commences.
- Parameters, geometry and extent of regional aquifer.
- Large seasonal / long term climatic variations make judging drawdown from MAC uncertain.

5.2 North Flank – E West Deposit (B)

Although part of the Coondewanna Flats aquifer system, the MAC E West (EW) and Dead End Deposits are considered separately here, as the orebodies extend significantly below the water table and will therefore be the focus of future dewatering.

The locations of monitoring and production bores and the data from them are shown in **Figures B.1 and B.2**. Abstraction from this area has been minimal, with a few short term, low magnitude efforts in 2001 and 2002, but some more sustained (but still low magnitude) abstraction since 2015 which includes dewatering of F Deposit.

Figure B.1. E West Deposit monitoring bore locations

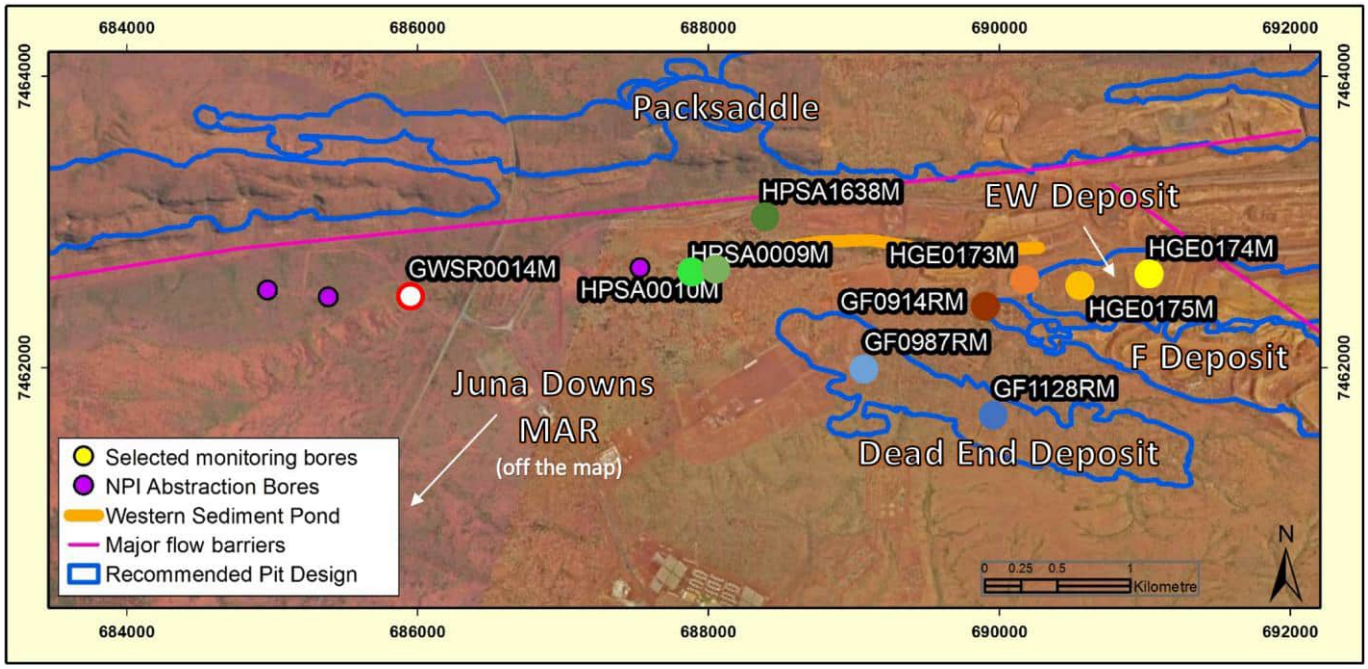
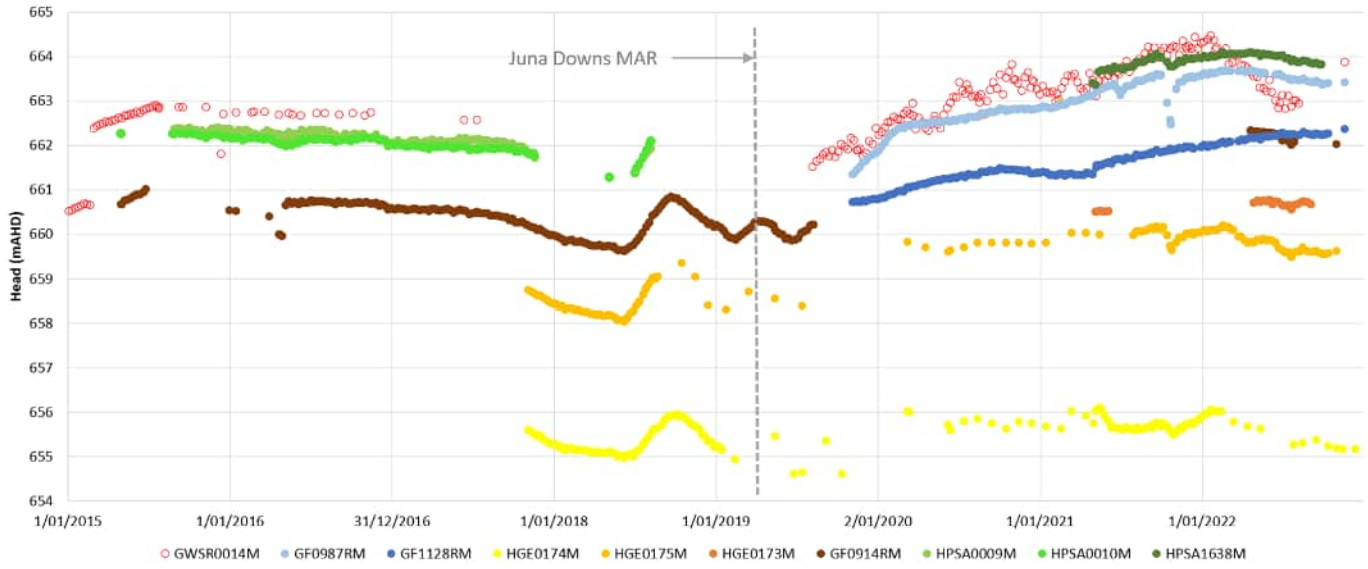


Figure B.2. E West Deposit hydrographs since 2015.



The data show that:

- Hydrographs from the area around the NPI borefield, the western end of the Western Sediment Pond and the north-western end of Dead End deposit display similar heads and similar responses to the neighbouring stresses (notably Juna Downs MAR). This suggests that this area presents relatively high transmissivity and hydraulic connectivity. Flows in this system are likely dominated by the dolomite aquifer.
- The south-eastern part of Dead End deposit is also responding to Juna Downs MAR, but at a slightly reduced rate, and at a level about 1 m lower compared to the north-eastern part. This suggests a slightly lower transmissivity across the Dead End orebody aquifer compared to the regional system to the north-west of it.
- The groundwater levels in EW Deposit drop significantly from west to east. In 2022, the difference was 7 m (662 mAHD in GF0914RM to 655 mAHD in HGE0174M). The eastern bores (e.g. HGE0174M) show very little, to no response, to Juna Downs MAR. The head gradient and the lack of response to MAR suggests that the EW Deposit aquifer presents a relatively low transmissivity.

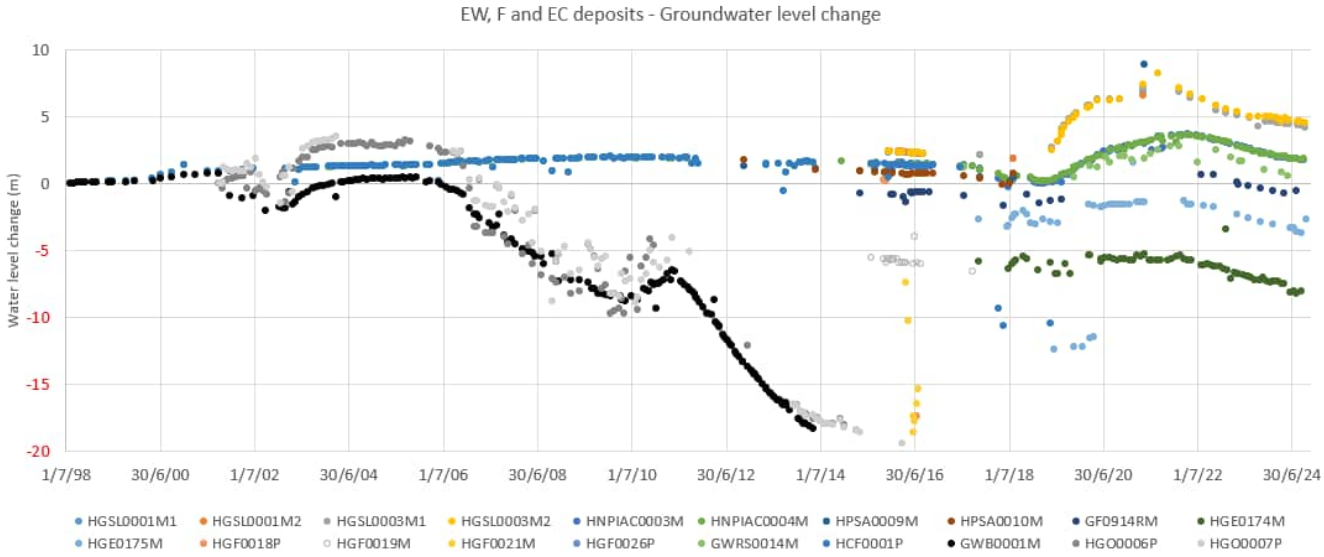
5.3 Flow barrier between E west and E Central Deposits (C)

Data adjacent to the E West / E Central flow barrier is shown in **Figure C.1**.

The pre-development head difference across barrier was about 15 m. By 2018 this had increased to about 35 m. A key bore here is HCF0001P (blue in the graph), which was analysed as part of the Coondewanna aquifer system discussion. Here it is shown against the heads east of the flow barrier. This shows that the plateauing in heads to west of barrier and then downward trend occurs at roughly the same time that drawdown takes off to the east of the barrier. On its own this is not particularly conclusive of a connection, however, it does suggest that if there is a connection then the barrier is either:

- Very tight, only letting a small amount of flow to flow across it, or
- That the barrier may let a reasonable amount of flow across it, but that the permeability and storage in the west is high enough to result in only a small response on that side of the barrier.

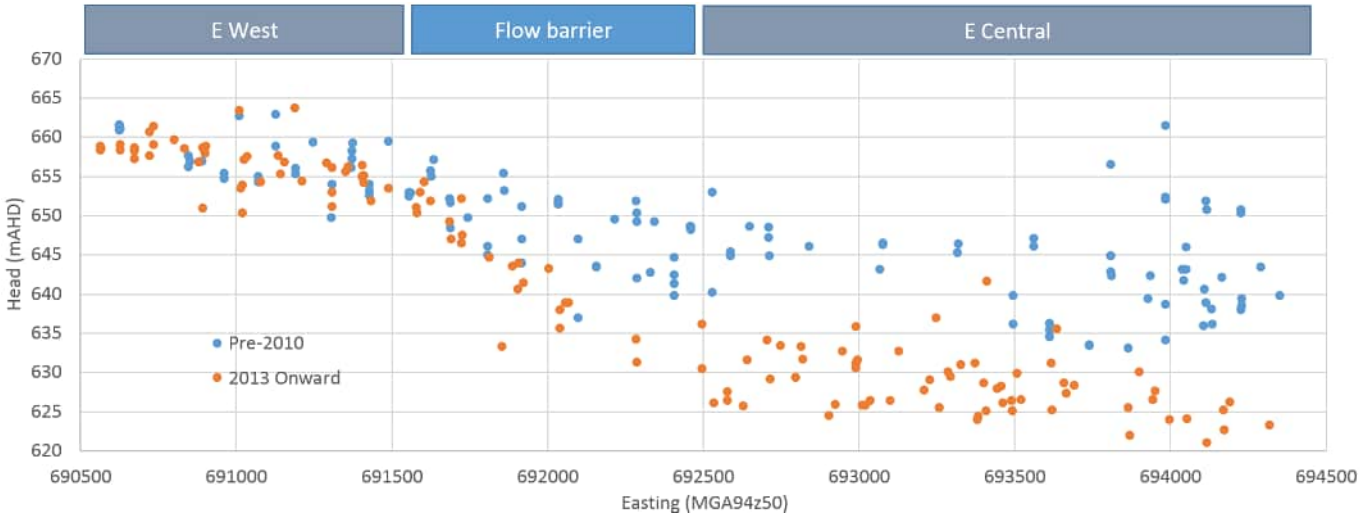
Figure C.1. Change in water levels since 1998, area of E West / E Central flow barrier



Nb. Grey scale = E Central bores eastern side of barrier (E Central), coloured bores western side (E West)

The analysis of water strikes from exploration drilling in this area (**Figure C.2**) suggests that the barrier is not particularly distinct, such as that seen at other dykes in the area. Structural geological mapping does not indicate a dyke in this area (although the orientation is consistent with other dykes). However, this effect may also be due to a dyke passing through at an oblique angle.

Figure C.2. EC/EW water level data from exploration drilling



Key uncertainty: The barrier itself is not well defined (could be a dyke or rock mass or a combination). Still uncertainty as to whether drawdown really crossing this barrier.

5.4 North Flank – E Central and E East 5 (EE5) Deposits (D)

Monitoring bore data

Groundwater data within the E Central and E East 5 Deposits are shown in **Figures D.1 and D.2**. There has been a significant amount of monitoring and abstraction in this compartment, although both are predominantly to the east (around EE5). The understanding of the hydrogeology here is therefore much better to the east than the west.

Figure D.1. EC / EE5 Deposit monitoring and abstraction locations

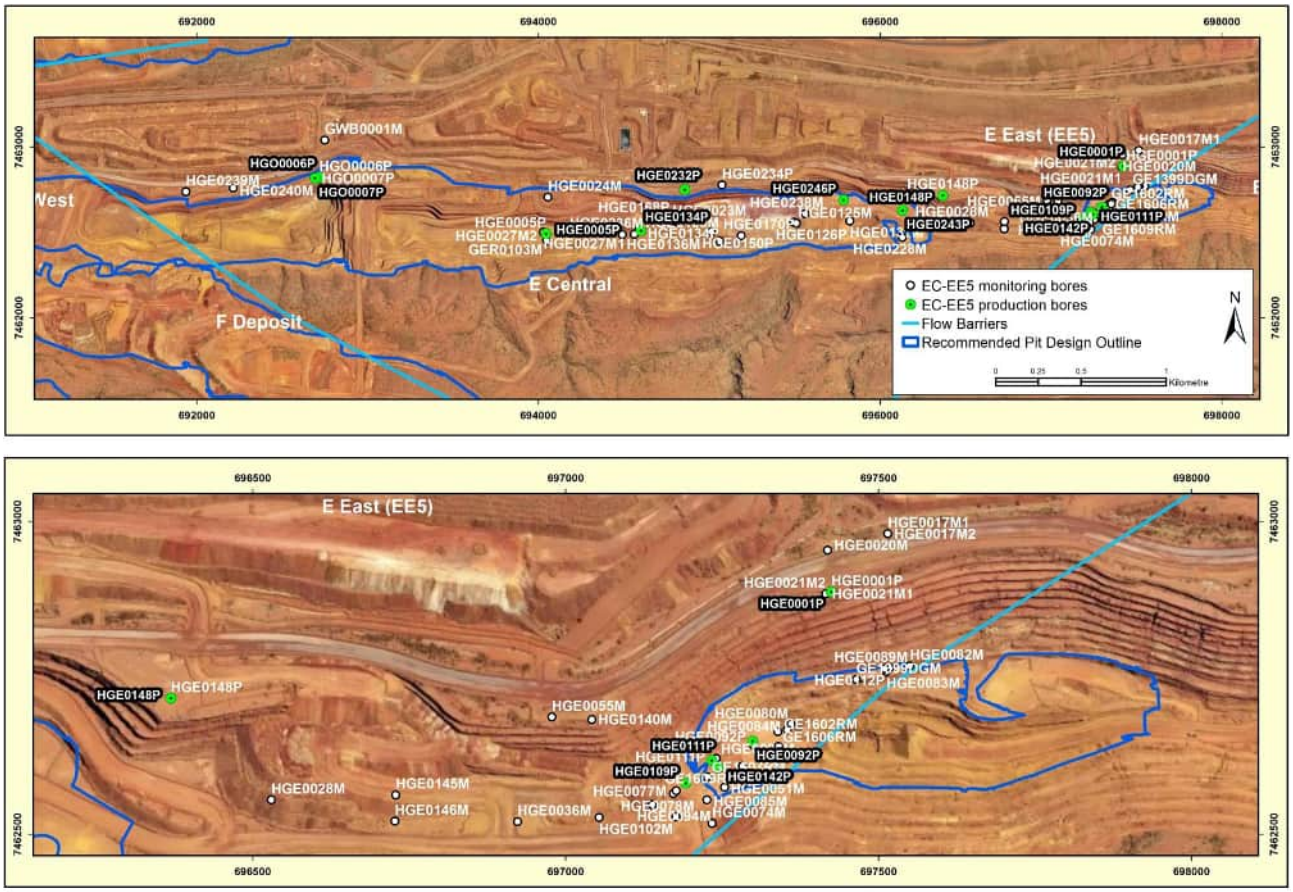


Figure D.2. EC / EE5 Deposit abstraction

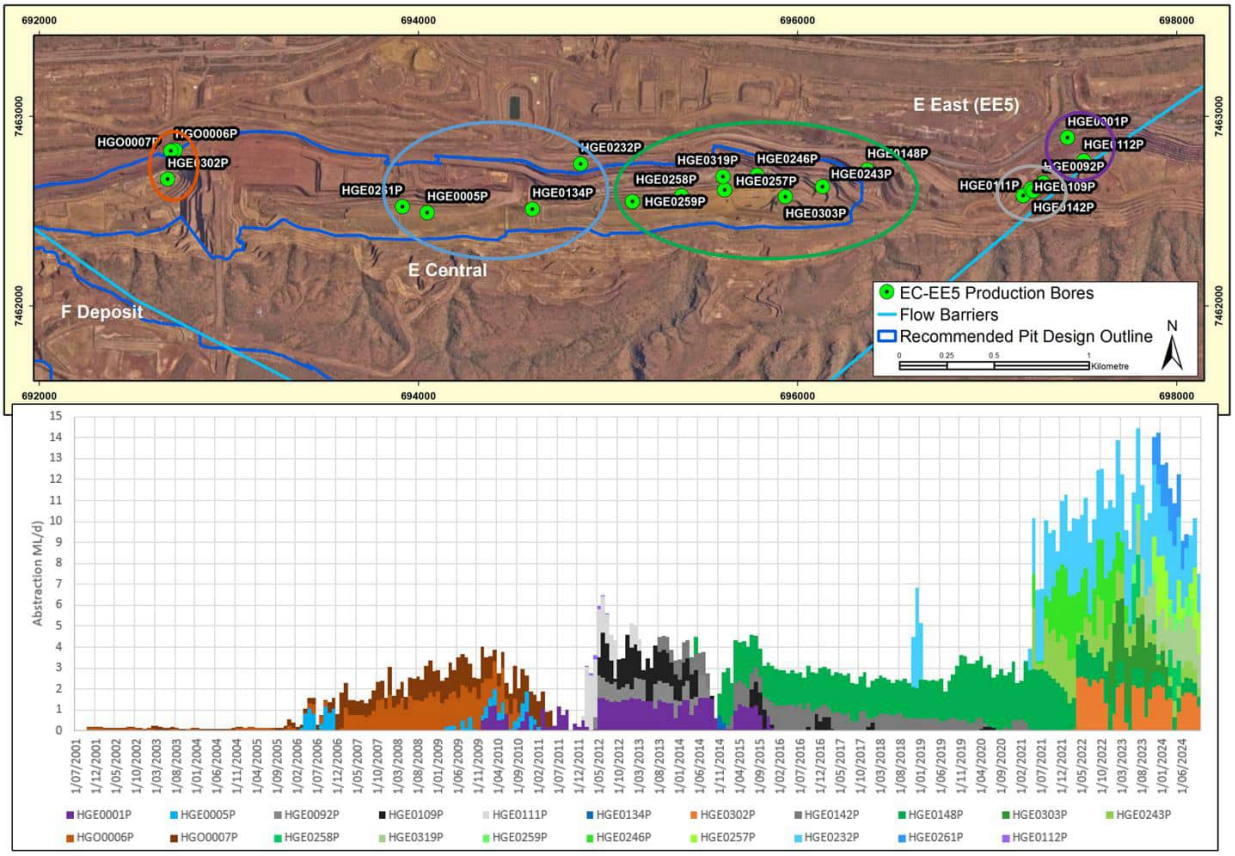
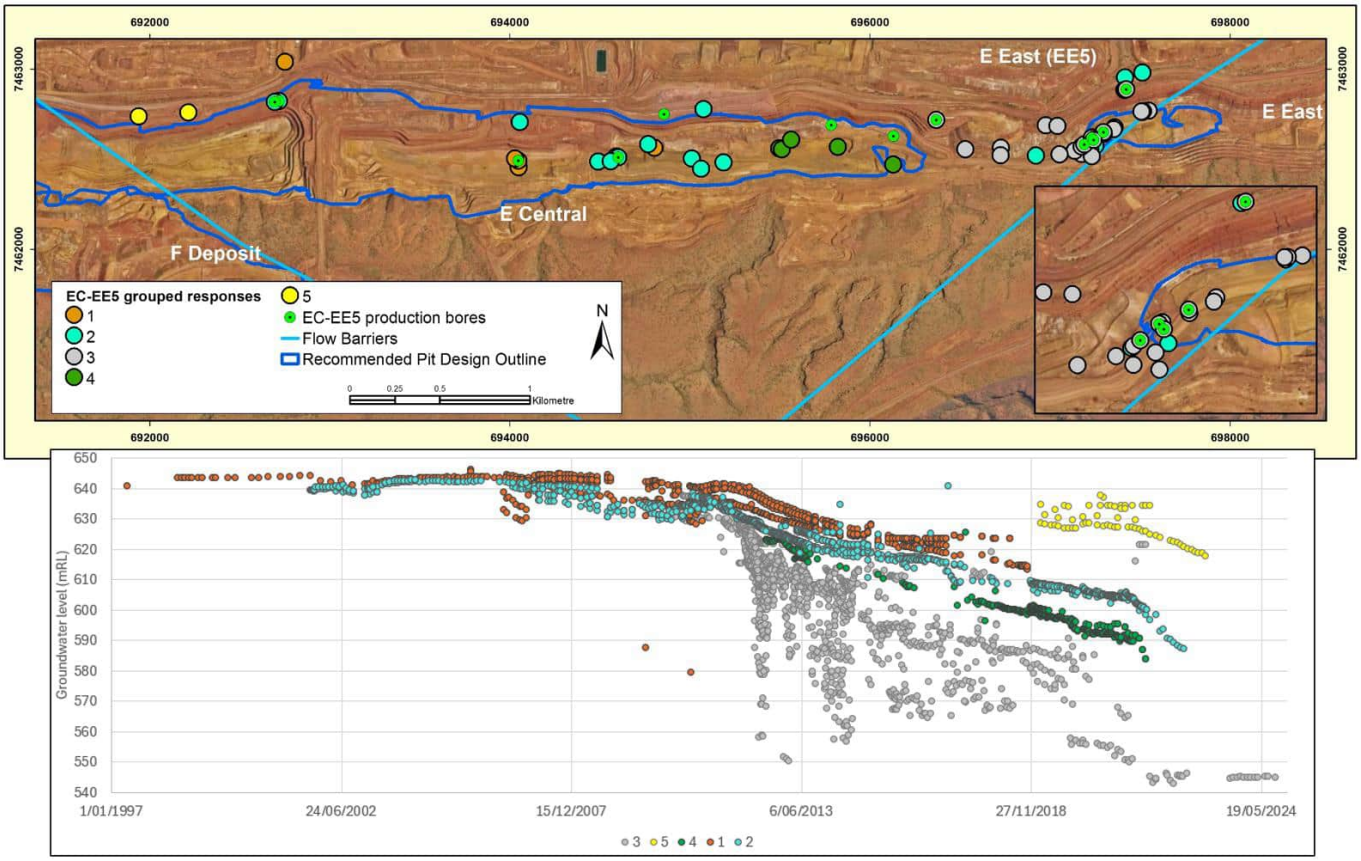


Figure D.3. EC / EE5 Deposit hydrographs



The data suggest that:

- Most abstraction was from the two dolomite bores early on (HGO0006P & HGO0007P), followed then by dewatering of EE5, with both in-pit and ex-pit bores (grey and yellow respectively). Since 2015 ex-pit EE5 abstraction has stopped but additional abstraction has commenced from HGE0148P, an in-pit bore a little to the east of EE5.
- EC and EE5 orebody heads are relatively unaffected by the HGO pumping (from the dolomite to the west) with almost a 10 m head difference built up over a few years.
- There has been very little abstraction from the EC orebody to date.
- The EC orebody head is affected by EE5 abstraction, with clear drawdown observed from 2011.
- There is no monitoring in last few years in region of HGO bores. The data show that the regional dolomite here responds to EE5 dewatering but this includes abstraction from the dolomite (HGE0001P). When the EE5 dolomite abstraction stops monitoring also ceases, so we cannot ascertain any proportional contribution from in-pit/ex-pit EE5 abstraction to drawdown in the dolomite to the west and therefore any indication as to orebody/dolomite connection at EE5.
- In 2014 the regional (HGO and EE5) heads appear to be levelling off (whilst the ex-pit and in-pit abstraction is quite stable), suggesting that an equilibrium may have been reached between flows across the barriers (assumed to be the only source of water into this compartment) and into the production bores.
- From 2016 abstraction from the regional aquifer ceases. The regional heads do not appear to recover however, and, from 2017, the little data available suggests that drawdown increases. This may indicate that the regional aquifer is being affected by drawdown from the east (EE3) across the flow barrier.
- The response in the EC orebody suggests that heads here are not being significantly drawdown by abstraction from the EE5 orebody. Significant drawdown does occur up to bore HGE0228M but beyond this there is little impact (i.e. in the water levels coloured green in the graph).

- The main EC group (green) appears to be relatively disconnected from the regional dolomite too, with a head difference of 10 m building up during the first stage of EC dolomite abstraction.
- From 2021 the groundwater levels dropped significantly in response to the increased abstraction from the central and eastern parts of this pit. Monitoring in this area has been limited since then.

This analysis suggests that the hydraulic connection between the orebody and regional aquifers in this compartment is moderate and possibly variable along strike. There is however very good connection throughout the dolomite as well as along strike in the EC orebody and the EE5 orebody. Connection between the EE5 and EC orebodies however seems to be limited.

Vibrating wire piezometers

There are 18 VWPs split across the North and South walls (**Figures D.4 and D.5**), which target the following stratigraphies: Mt Newman, Tertiary Sediments, West Angela Shale and Dolomite. None of the VWPs are in-pit, and hence, do not target the orebody.

Production bores are predominantly located in-pit, and pumping has been concentrated in EE5 (towards the East).

Figure D.4. Location of VWPs, monitoring and production bores in EC-EE5 compartment

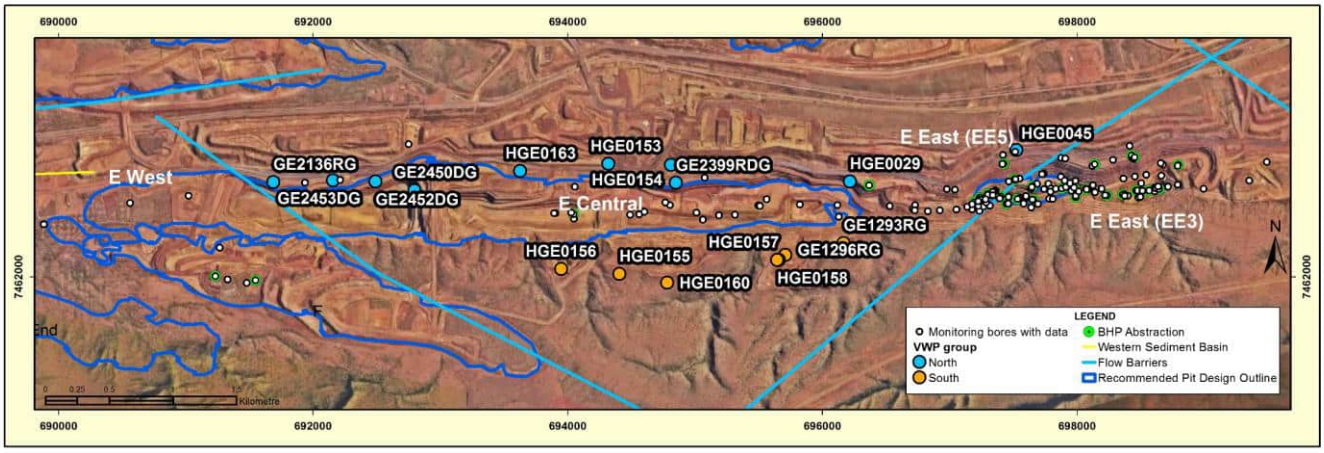
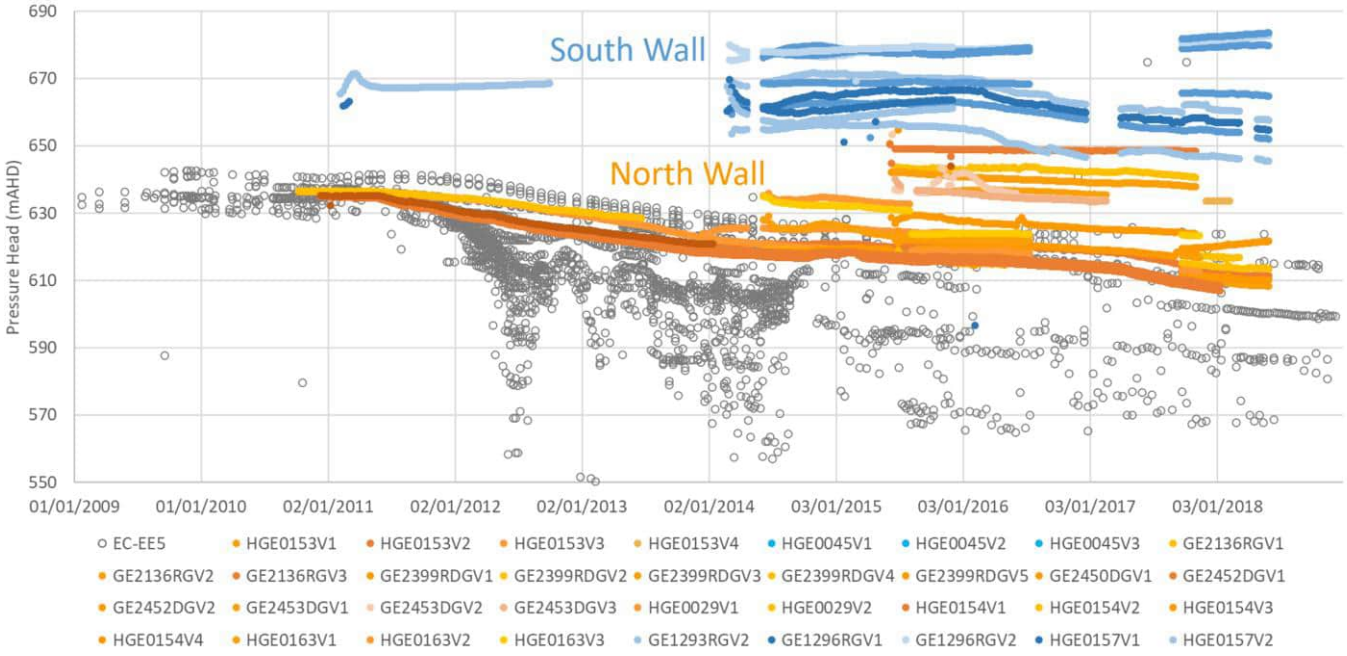


Figure D.5. Time-variant Pressure Head Levels for VWPs in EC-EE5 Compartment



The VWPs in the north are installed in the Mt Newman, Tertiary Detritals (including clay), West Angela Shale and Dolomite. VWPs in the south are installed in the Macleod and Nammuldi Members.

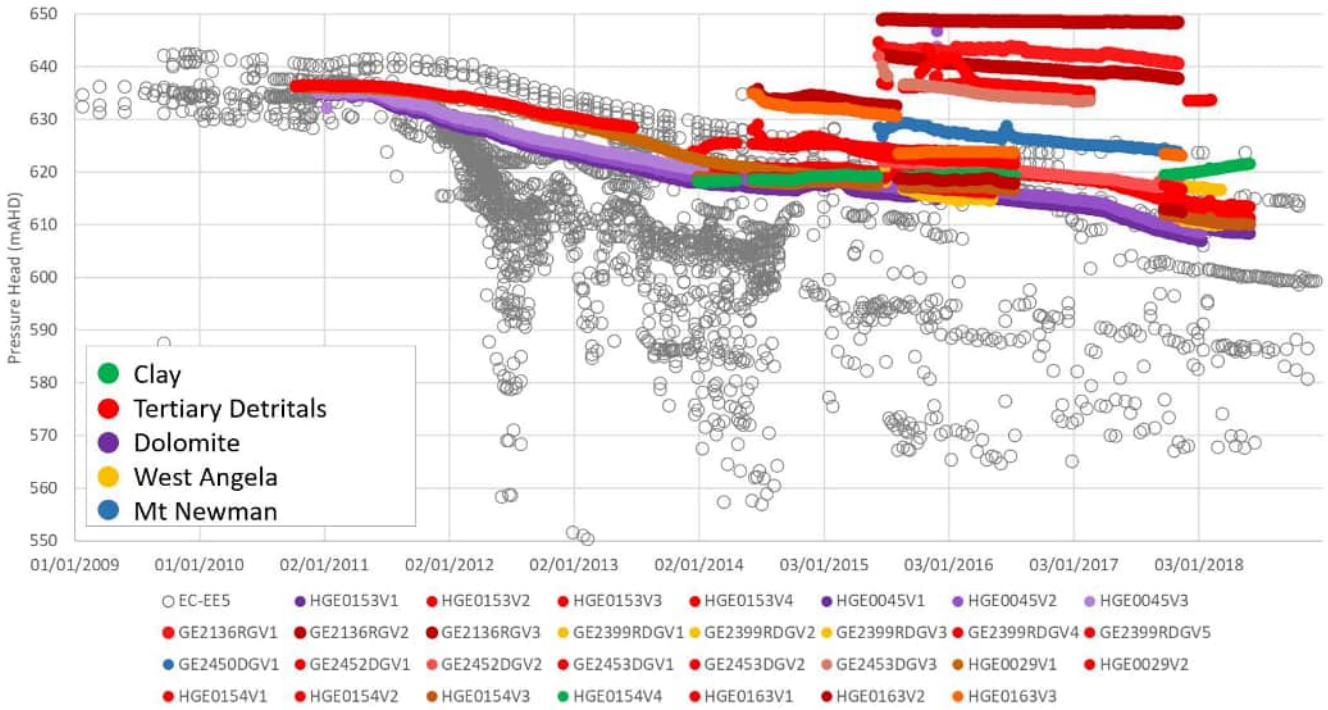
The data shows that, over the monitoring period:

- There is a significant difference in water levels (~20 to 40 m) between VWPs screened in the north wall (gold), and VWPs screened in the south wall (blue).
- Water levels in the north have generally trended downwards and fall into two groups
- Water levels in south are higher than the pre-development levels in this compartment. Whilst water levels in the orebody and regionally are trending down due to dewatering, these heads return a wide range of responses, some going up, others going down and others remaining unchanged.

Water levels in the northern VWPs are presented by lithology in **Figure D.6**. This shows that:

- The response in the Tertiary Detritals is variable. Compared to the regional response (i.e., the dolomite):
    - some VWPs in this unit respond in the same way (falling 10 to 20 m since dewatering commenced),
    - some respond more slowly and remain elevated (by 20 to 30 m)
- The response in the Mt Newman, West Angela Shale and Dolomite are all aligned with the regional response to dewatering.
- The water level in the one VWP installed in the clay remains unchanged throughout most of the monitoring period and increases at the end. However, the pressure head is between 2 and 4 m for most of the record, suggesting that the water table is below this sensor. In this case then it is likely that this material drains well (i.e., presents moderate permeability) as it is installed about 20 m lower than the pre-development head.

Figure D.6. Time-variant pressure head levels for VWPs in the North Wall of the EC-EE5 Compartment, coloured by Stratigraphy



Conclusions:

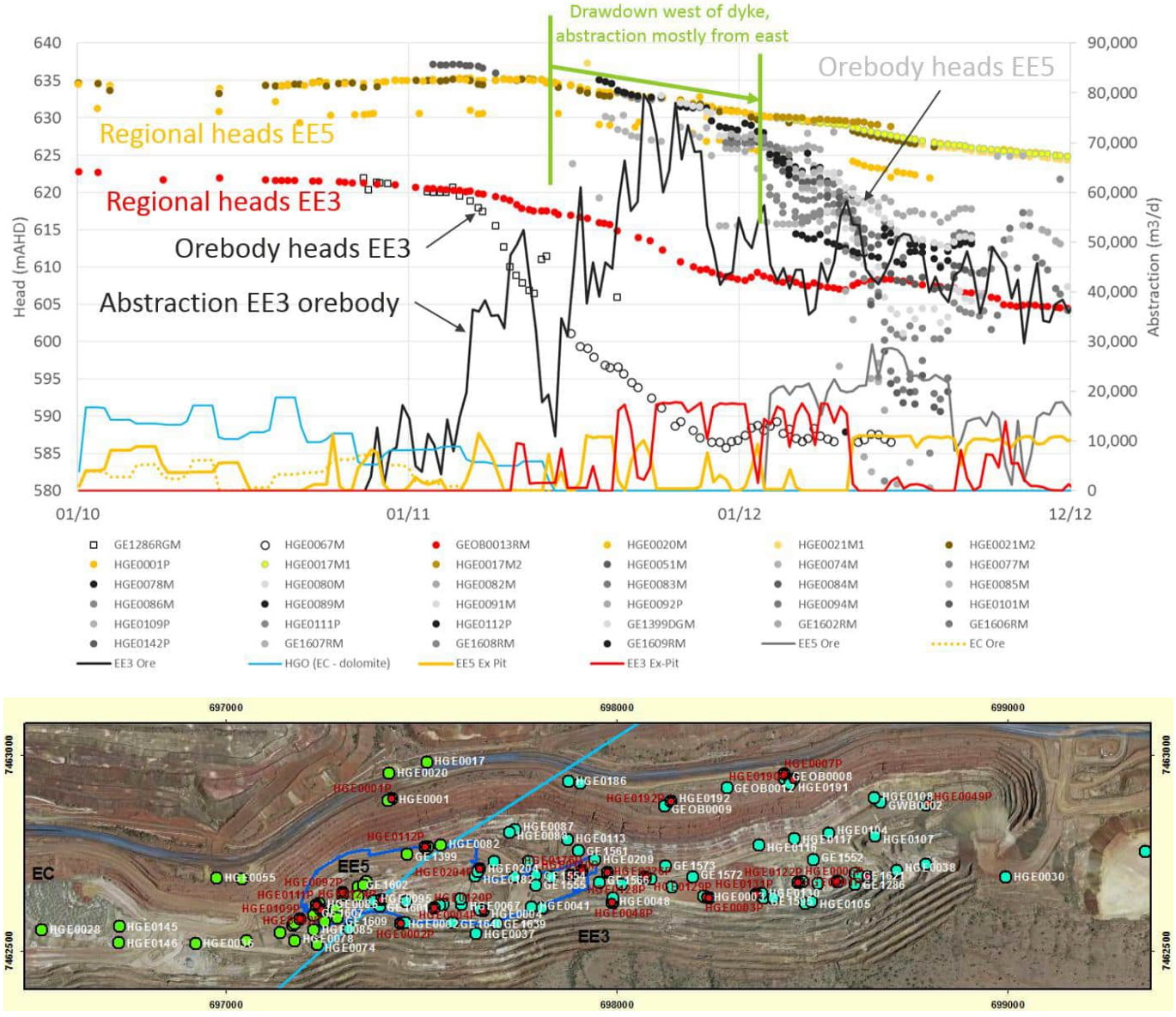
- Macleod and Nammuldi in south are low permeability and do not drain in response to dewatering of the orebody (see **Figure D.5**).
- The north wall hydrogeology is relatively complex:
    - The bedrock appears to be uniform and responds as per regional system.
    - The Tertiary Detrital units are variable:
        - Some respond as per regional system (i.e. falling steadily and significantly in response to dewatering)
        - Others fall only a small amount in response to dewatering.

Key uncertainty: Local scale variations in hydrostratigraphy and future behaviour.

5.5 Dyke between EE5 and EE3 Deposits (E)

There is a significant amount of groundwater level data around the dyke that separates EE3 from EE5. In this area there has also been a significant amount of dewatering, although at different times, from both sides of the dyke and from both the orebody and regional aquifers (**Figure E.1**).

Figure E.1. EE3 / EE5 dyke hydrographs



The hydrograph shows that many conflicting stresses have been acting on this part of the groundwater system which in turn makes analysis of the system wide response difficult. However, during the period from early 2011 to early 2012, there is little abstraction in the EC/EE5 compartment but a significant increase in abstraction across the dyke in EE3. This is therefore the best opportunity to judge the extent to which drawdown is moving across this barrier. The hydrograph shows that, during this period:

- drawdown in EE5 was about 5 m, and
- drawdown in the regional EE3 aquifer was just over 10 m

This therefore provides some evidence that there is flow across the EE5/EE3 dyke.

5.6 North Flank – E East 3 (EE3) Deposit (F)

Monitoring bore data

Data from EE3 Deposit is shown in **Figures F.1 to F.5**. In this case the majority of abstraction and observation data is in the west of this compartment.

Figure F.1. EE3 Deposit monitoring and abstraction

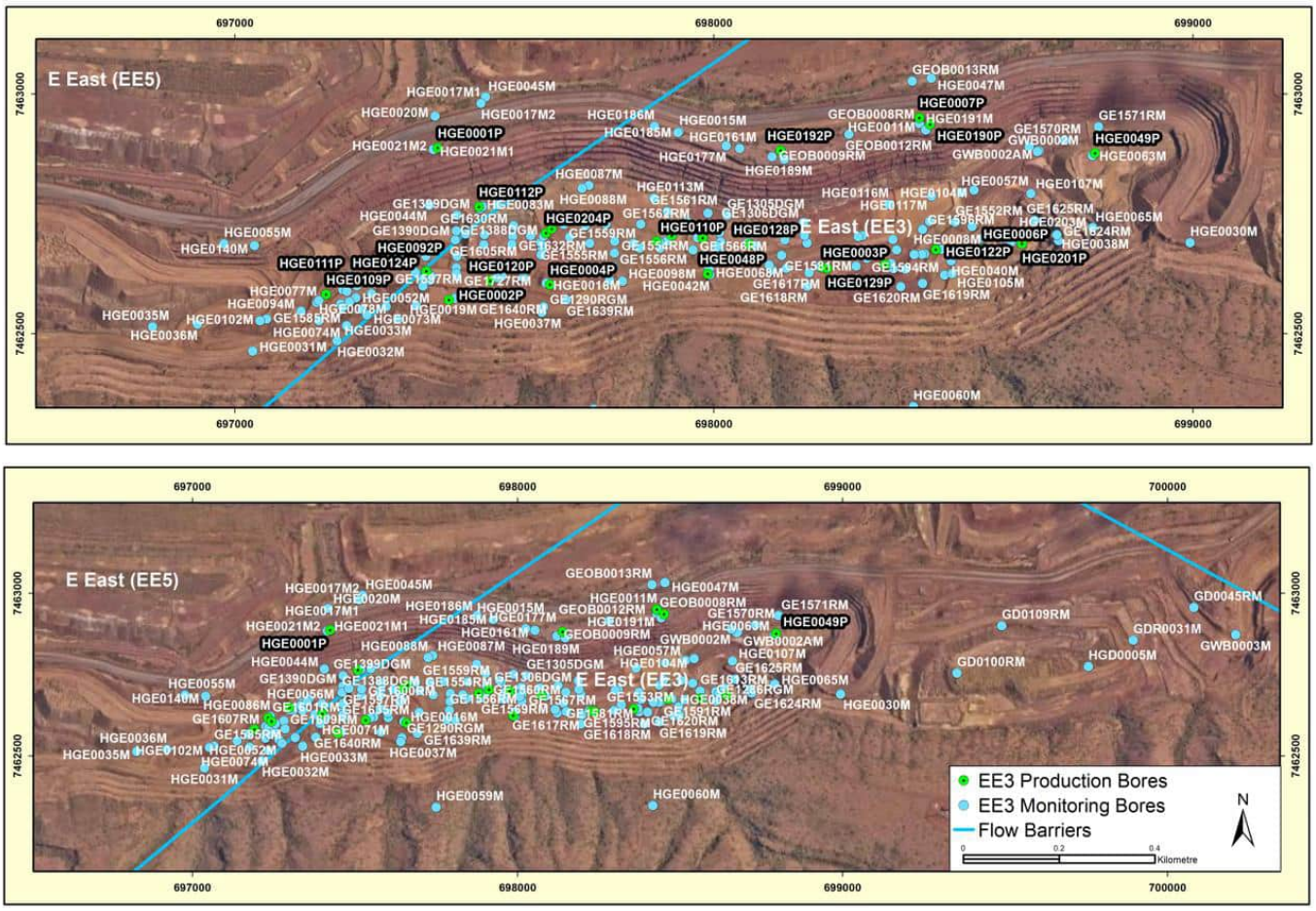


Figure F.2. EE3 abstraction

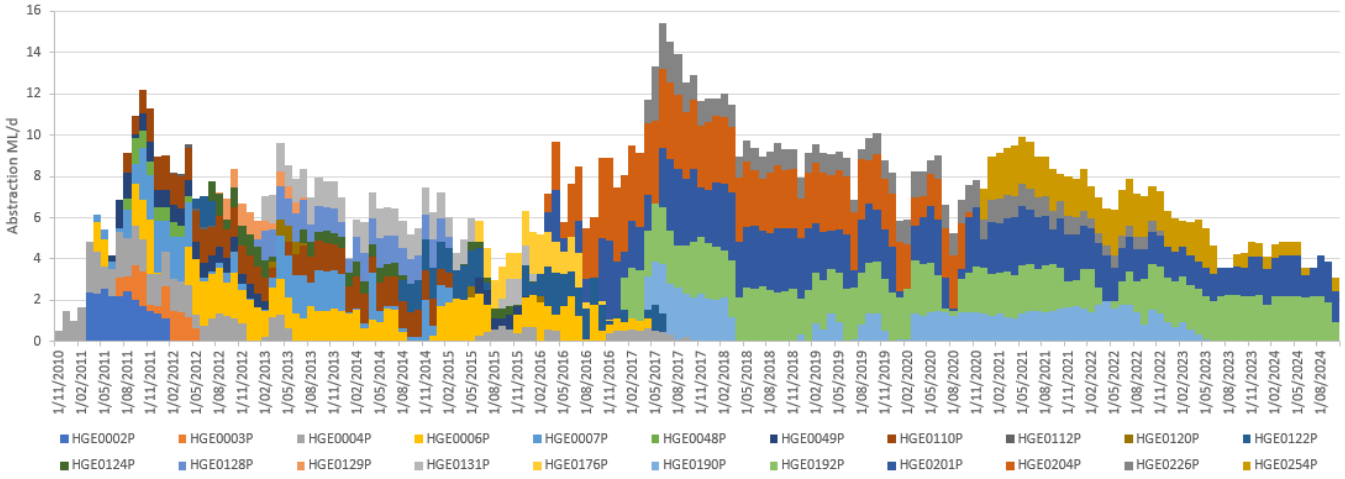


Figure F.3. EE3 Deposit hydrographs (all manual dip data)

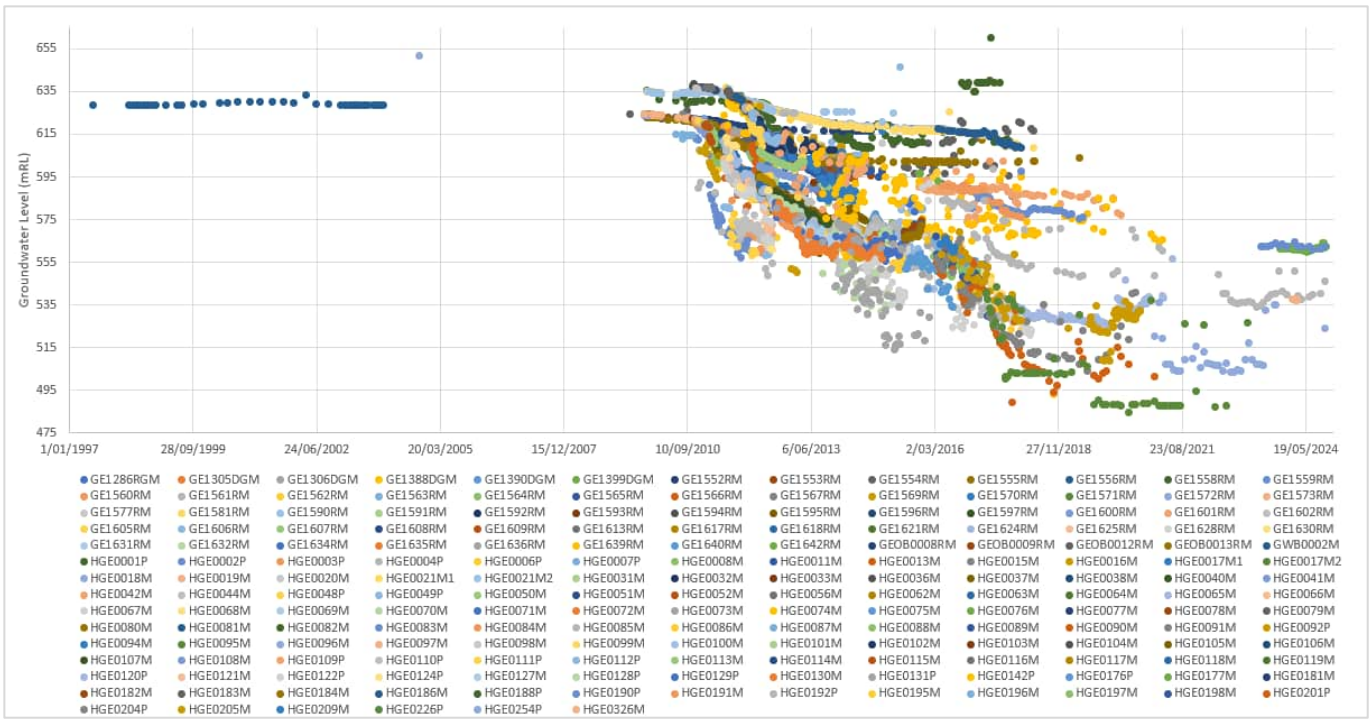


Figure F.4. EE3 Deposit hydrographs (response groups)

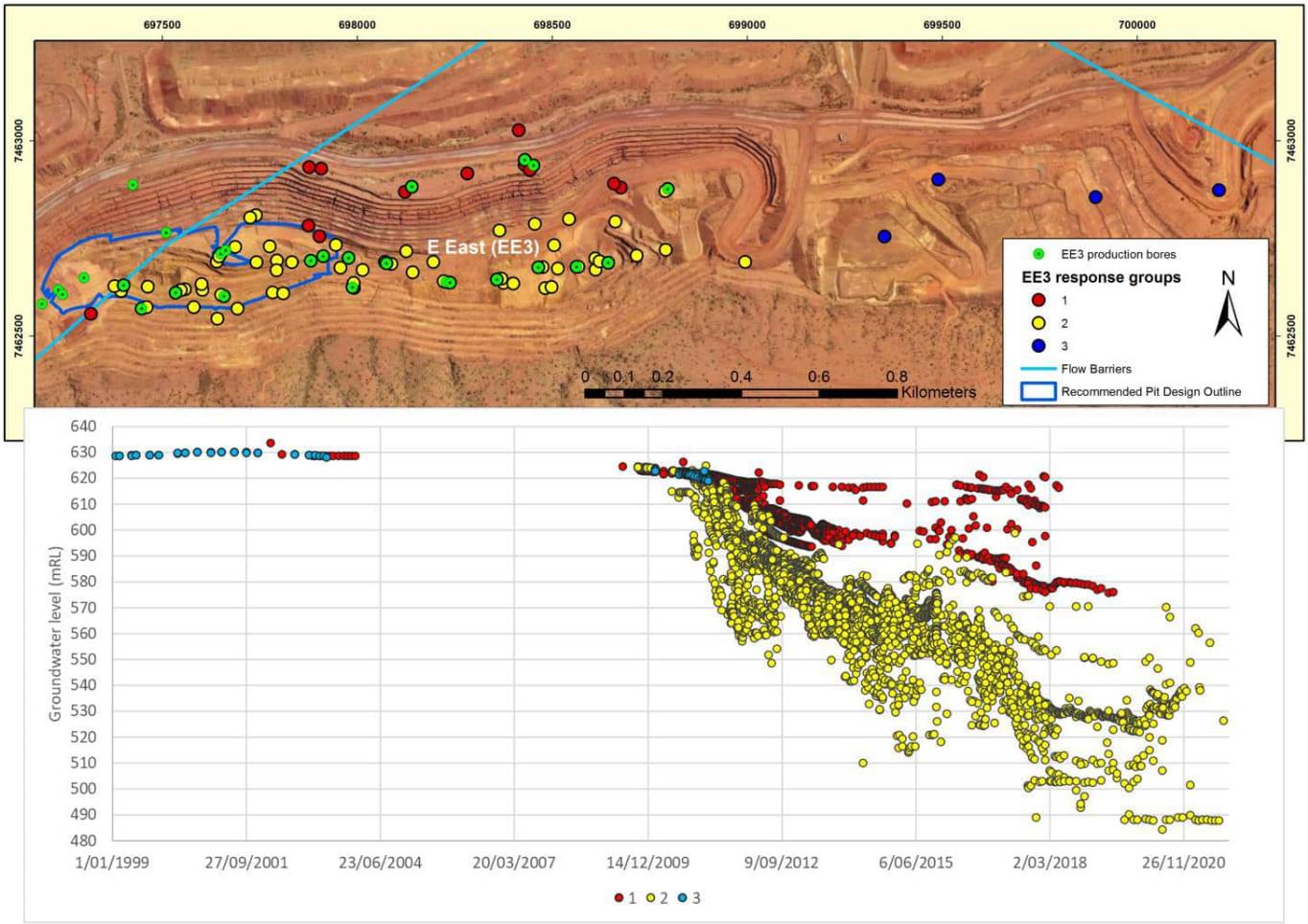
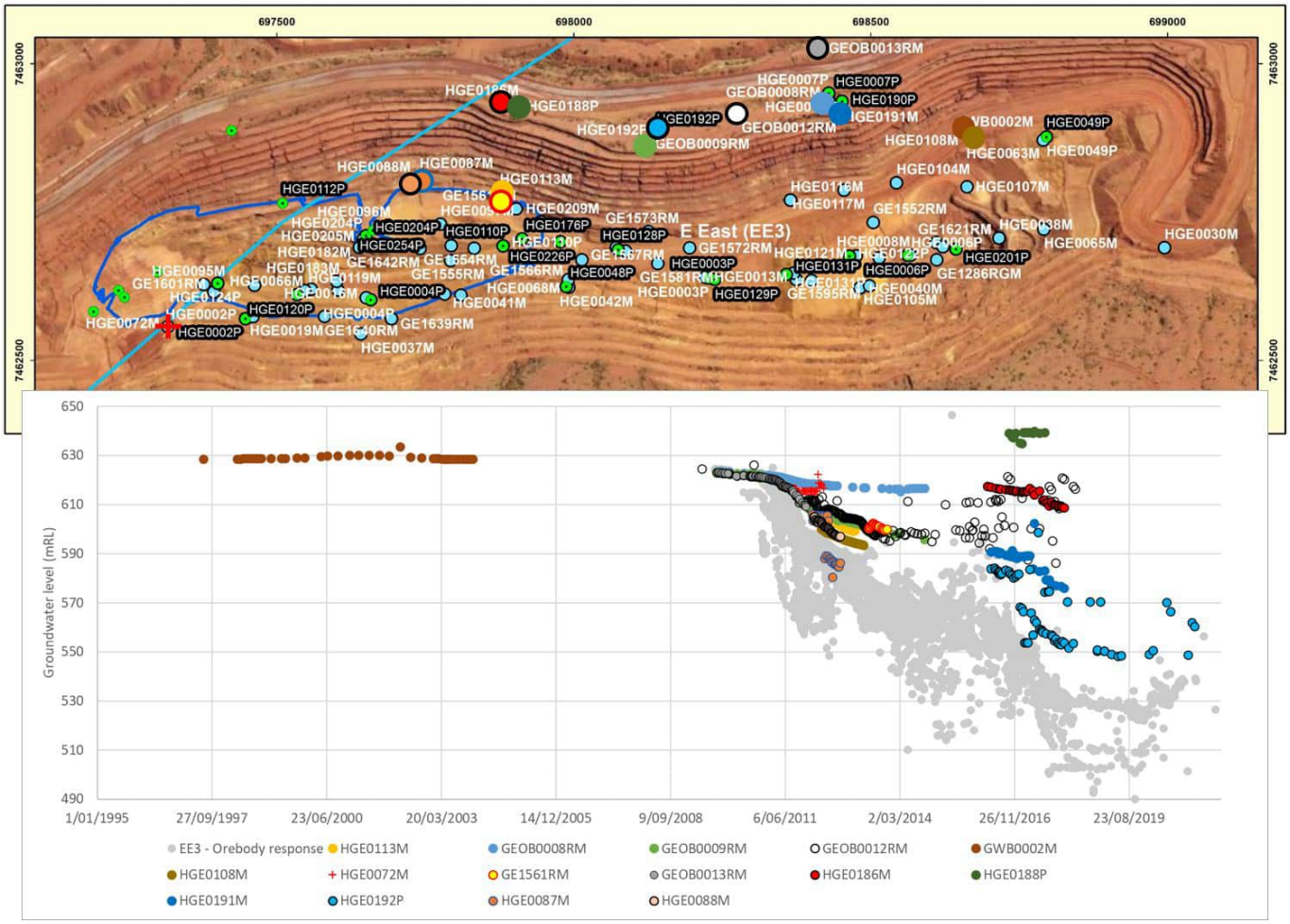


Figure F.5. EE3 Deposit hydrographs (non-orebody responses)



The monitoring bores are predominantly located in the orebody aquifer, the following however are located in the regional aquifers or non-aquifers:

- North of the pit walls:
    - GEOB0012RM: Tertiary Detritals, West Angela Shale, Dolomite
    - HGE0191M: Tertiary Detritals, West Angela Shale, Dolomite
    - HGE0192P: Tertiary Detritals, Dolomite
    - GEOB0008RM: Tertiary Detritals, West Angela Shale, Dolomite, Mount Newman
    - GEOB0009RM: Tertiary Detritals, West Angela Shale
    - GEOB0013RM: Tertiary Detritals, Dolomite
    - HGE0108M: Tertiary Detritals, West Angela Shale
    - GWB0002AM: Unknown
    - HGE0186M: Tertiary Detritals, West Angela Shale
    - HGE0188P: Tertiary Detritals, Dolomite
- In the north wall:

- HGE0087M: Unknown
- HGE0088M: Tertiary Detritals
- GE1561RM: West Angela Shale, Mount Newman
- HGE0113M: West Angela Shale, Mount Newman

The bores just to the north of the pit walls then (**Figure F.5**) are in the regional aquifer. Some of the northerly bores located in the pit walls themselves are representative of the material between the orebody and the regional aquifers.

The data show that:

- Dewatering started in November 2010 and has averaged 7.8 ML/d since then (up to October 2021). The majority of this water has come from in-pit bores (**Figure F.2**).
- There is a clear difference between the orebody and the regional groundwater level response to abstraction (**Figure F.4 and F.5**).
- Those observations that do not align with the orebody response are shown in **Figures F4 and F5**. These show that:
  - All but one of these observations are to the north.
  - Particularly from 2015, the observations are limited to just a few bores and interference from productions bores makes the analysis problematic. Only one of these bores has been monitored since 2017 (an active production bore).
  - The observations are quite consistent early on in dewatering (2011 to 2014) and return a strong but subdued response compared to the orebody. By 2014 the water level in the orebody aquifer is between 550 and 570 mRL compared to the regional aquifer which is just under 600 mRL (and a pre-development level of 630 mRL in both).
  - Based on the limited data and some extrapolation, present day (October 2021) water levels are likely to be between 510 and 530 mRL in the orebody and about 570 mRL in the regional aquifer (assuming that the lower recorded levels in HGE0192P are reflective of the pumped level rather than the background regional aquifer).
  - The four bores in the western part of the north wall (HGE0087M, HGE0088M, HGE1561RM and HGE0113M) respond as per the regional aquifer rather than the orebody.
  - Water levels at HGE0186M and HGE0188M are much higher than the rest and may well be part of the EE5 system (i.e., west of the dyke), or the transition between them.
  - The lack of significant water level response at GEOB0008RM is surprising given it is installed in both the Tertiary Detritals and dolomite and is 243 m deep.
  - The observation to the south is at HGE0072M. This is installed within the Mount Newman Formation and very close to the EE3/EE5 dyke.
- A few periods return flat water levels both in the orebody and regionally. For example in 2014 – 2016 when abstraction was relatively steady at about 5 ML/d (only from the orebody). This seems to suggest that during this period inflows and outflows from the compartment are equal, which would also suggest that inflow across the flow barriers into EE3 might be in the order of 5 ML/d.
- Monitoring in the eastern part of EE3 has not occurred since 2011 so it is not possible to say how far the orebody aquifer extends in this direction (**Figure F.4**).

The EE3 orebody appears to be homogeneous and has been dewatered successfully. The subdued drawdown response in the regional dolomite to the north suggests that connection between the two aquifer systems is controlled by a lower permeability rock mass between them, most likely the West Angela Shale.

Vibrating wire piezometers

There are three VWPs in the EE3 compartment, one in the North and two in the South Wall (**Figure F.6**). The observed water levels in the sensors are shown in **Figure F.7**.

Figure F.6. Location of VWPs, manual dip readings and production bores in the EE3 compartment

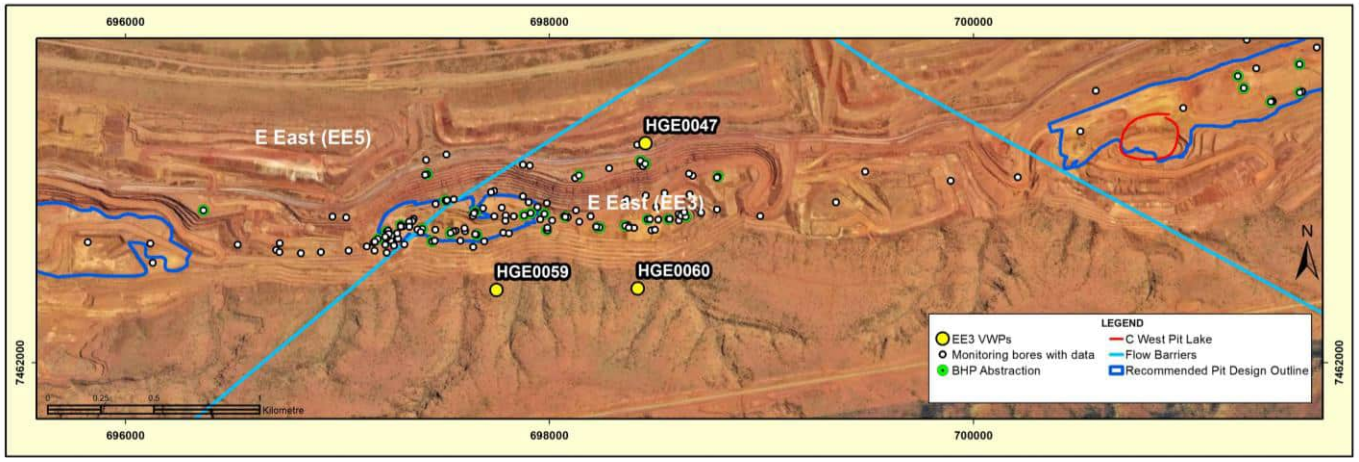
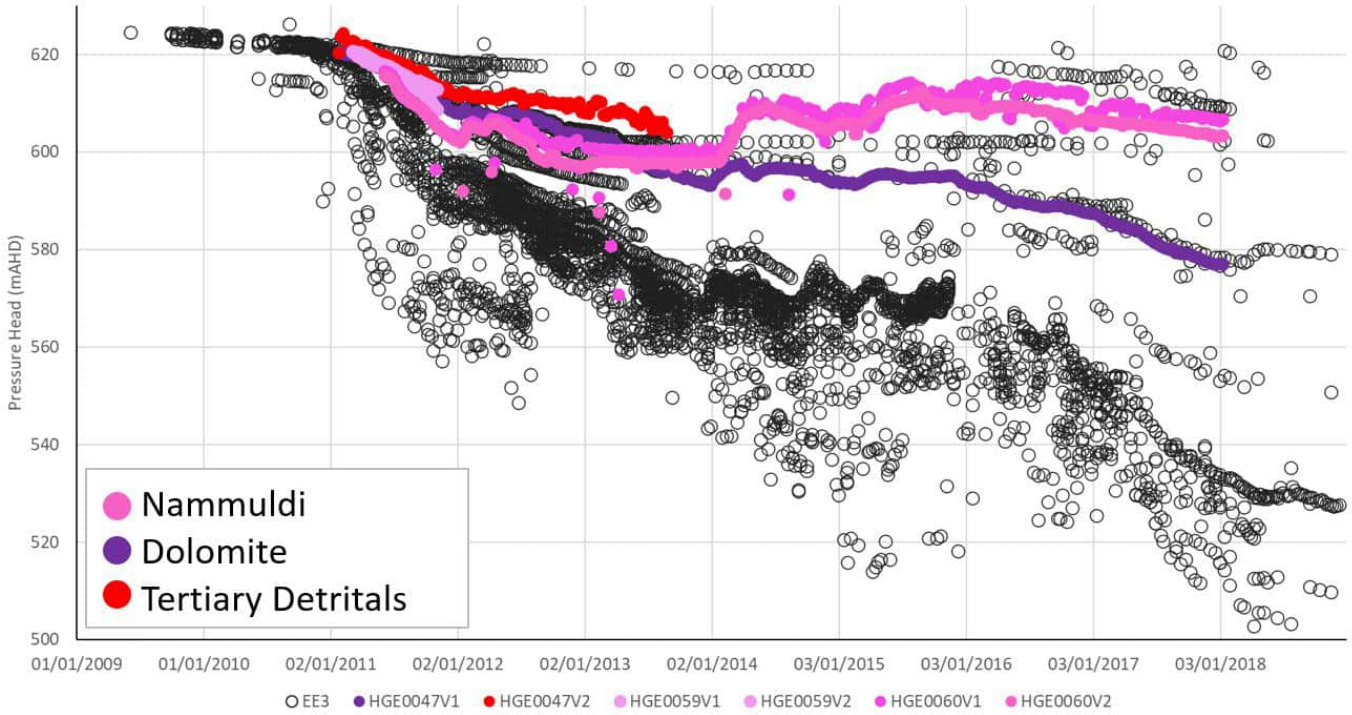


Figure F.7. Time-Variant Pressure Head for VWP bores in the EE3 Compartment.



The data shows that in the south (Nammuldi Member) the water level:

- Initially responds very well to dewatering (i.e., declines),
- Stabilises from 2013, even though the orebody water level continues to fall,

- Increases significantly and rapidly at the start of 2014 (probably due to rainfall) and then remains roughly stable for the remainder of the observation record.

The data shows that in the north the water level in the:

- Dolomite follows the trends and levels observed in monitoring bores in the regional system (especially HGE0191M).
- Tertiary Detrital responds to dewatering but not to the same extent as the regional system. From mid 2014 the water level falls below this sensor (i.e., it becomes dry).

The data from these VWPs therefore show that:

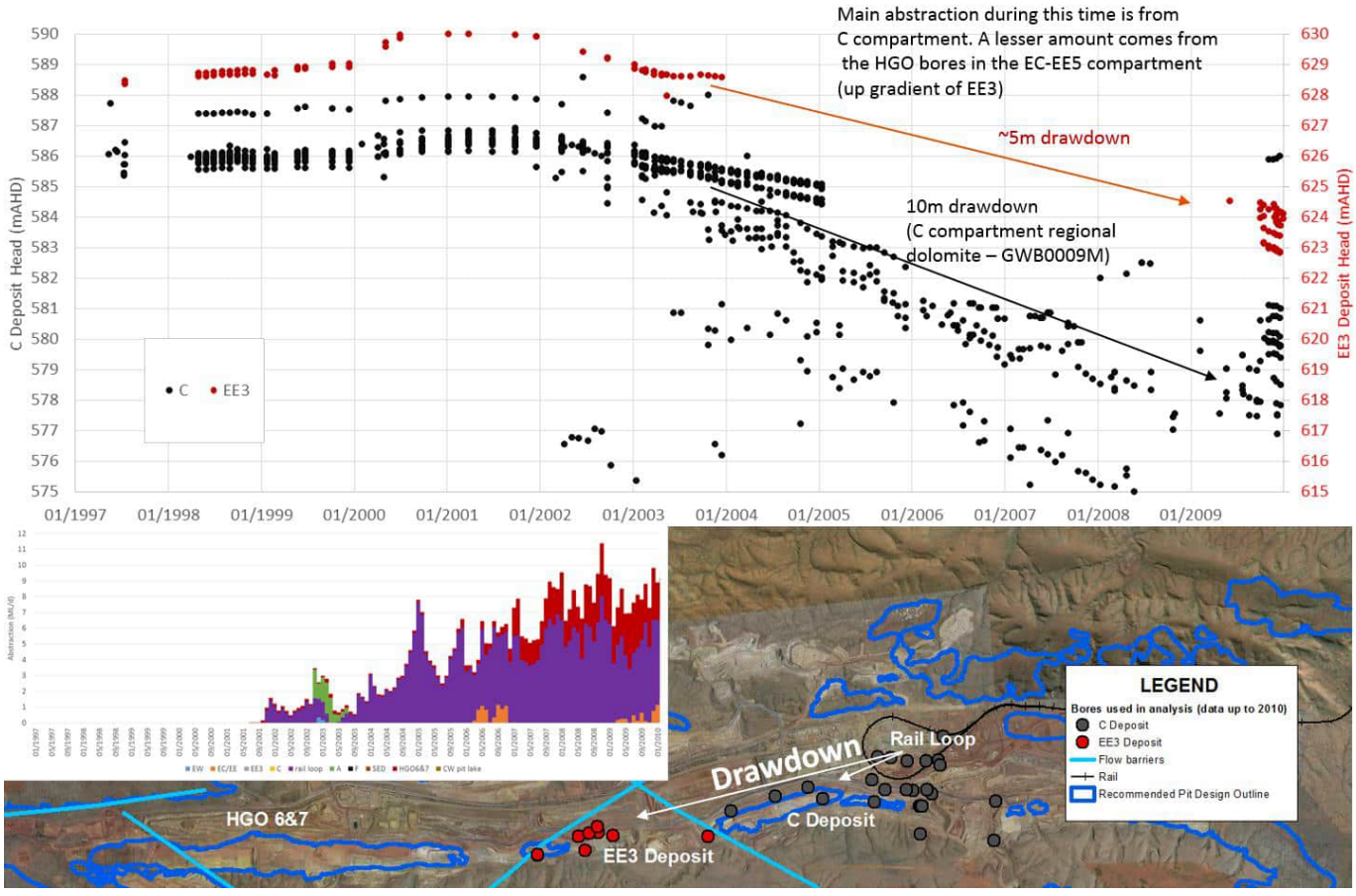
- After responding to initial dewatering in EE3, the Nammuldi to the south is not responding anymore and is retaining pressure as water levels to the north (orebody) fall further.
- Both the dolomite and Tertiary Detritals respond to dewatering, but much less than the orebody.

Key uncertainty: N/A, dewatering has reached required water level.

5.7 Dyke between EE3 and C Deposits (G)

Monitoring and abstraction on either side of the dyke separating EE3 and C Deposits is shown in **Figure G.1**.

Figure G.1. EE3 / C Deposit hydrographs

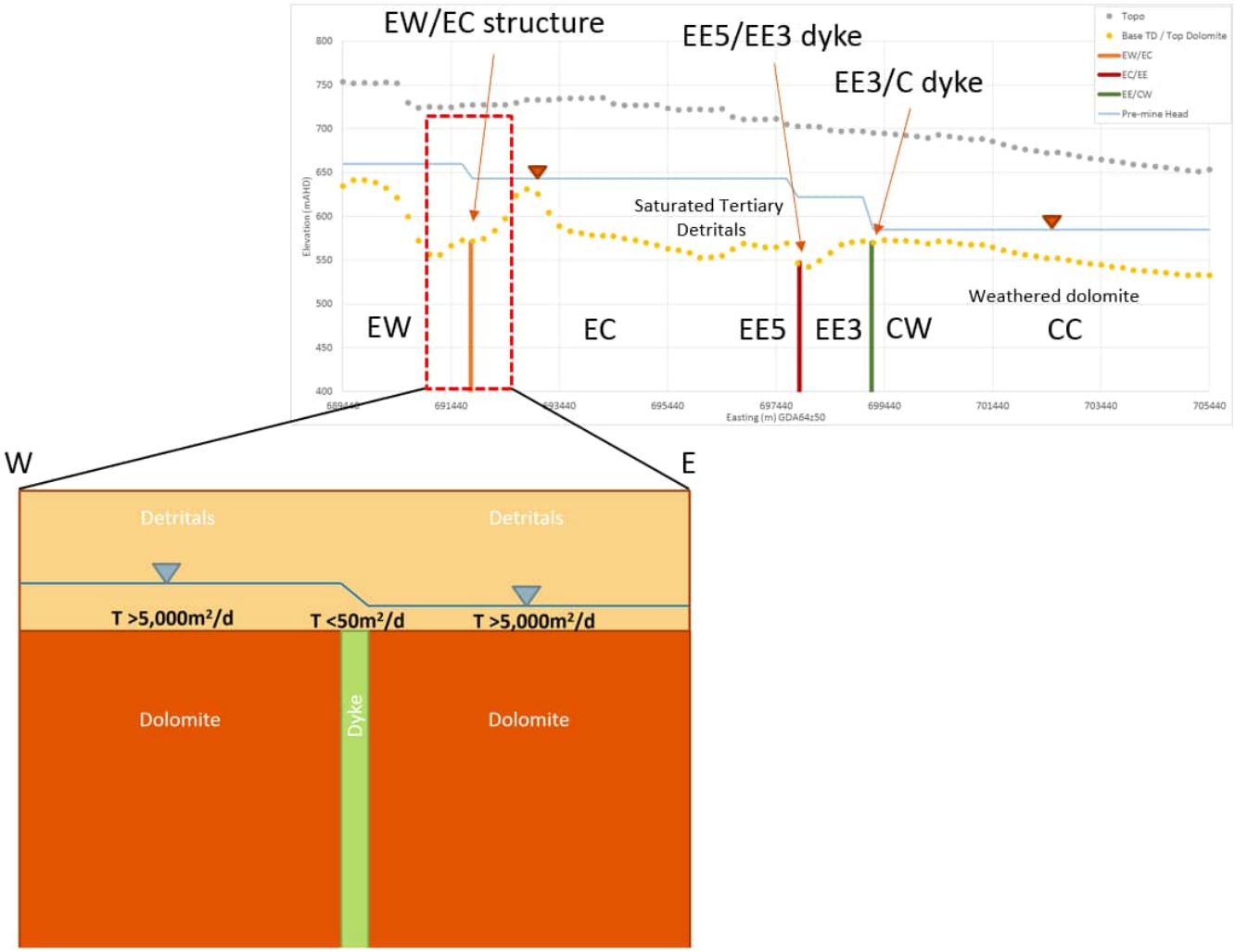


This data clearly shows drawdown from regional C Deposit (rail loop) bores affecting heads in EE3. This drawdown occurs across the dyke which also presented the greatest head difference of all flow barriers through North Flank prior to abstraction.

The drawdown on the west (EE3) is roughly half the drawdown on the east (C Deposit) with drawdown by 2010 of 5 m and 10 m respectively. This is very unlikely to be due to a natural recession as there is no precedent in the catchment or obvious change other than abstraction from the rail loop bores.

Conceptually this flow is thought to occur through the saturated alluvium that exists above the basement material. The dyke does not extend into the alluvium (**Figure G.2**). Heads throughout the North Flank Valley corroborate this model, confirming that the alluvium was saturated throughout the valley pre-development. Validation for this mechanism should come from the observed response once heads in the regional aquifer fall below the alluvium on both sides of the dyke. Once water levels reach this point, the compartments would be assumed to be disconnected.

Figure G.2. Conceptual model of flow across dyke flow barriers through MAC E and C Deposits.



Key uncertainty: Rate of flow across the dyke once the water level falls below the base of the Tertiary Detritals.

5.8 North Flank – C Deposit (H)

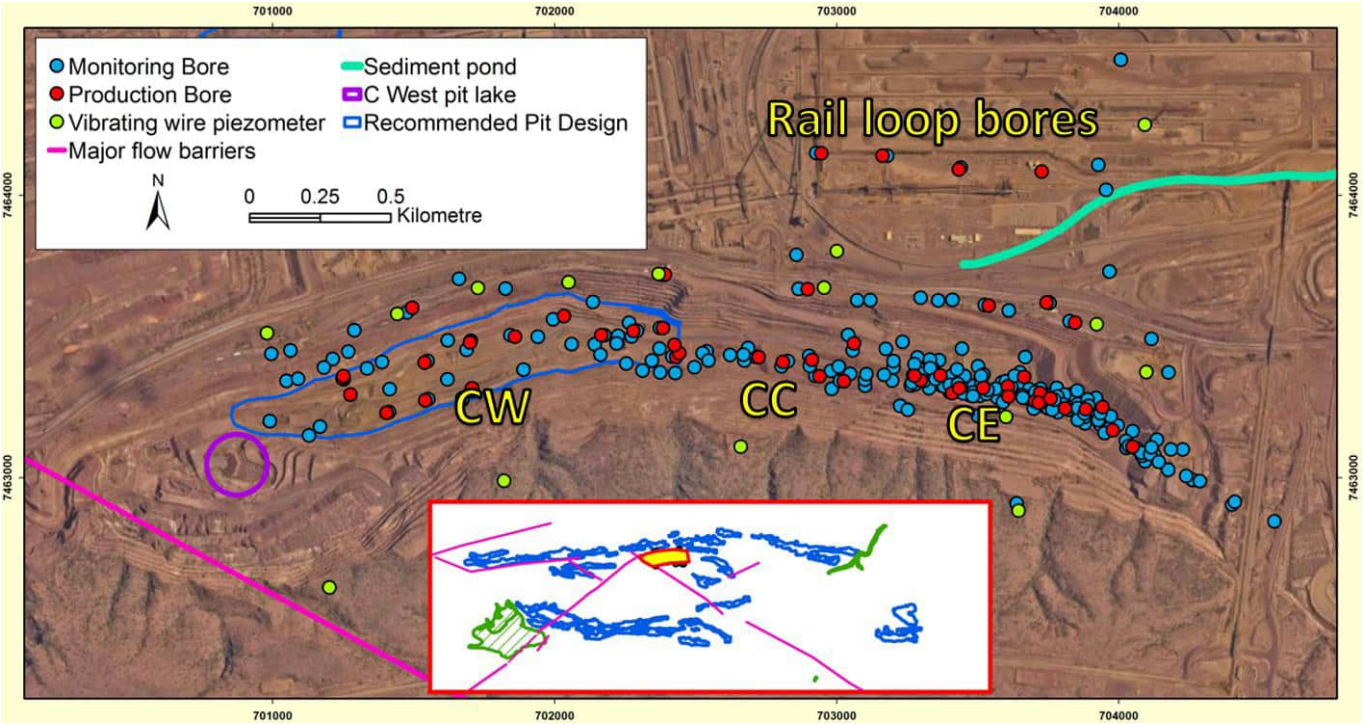
5.8.1 Introduction

Although the C and A Deposits sit within the same groundwater compartment, they are separated by a significant lateral distance and will be analysed separately in terms of their response to abstraction and discharge. **Figure H.1** displays the location of groundwater monitoring installations and other relevant data around C Deposit.

For the purposes of mining and dewatering, C Deposit has been divided into 3 distinct orebodies:

- C East (CE)
- C Central (CC)
- C West (CW)

Figure H.1. C Deposit monitoring and abstraction



5.8.2 Pre-development heads

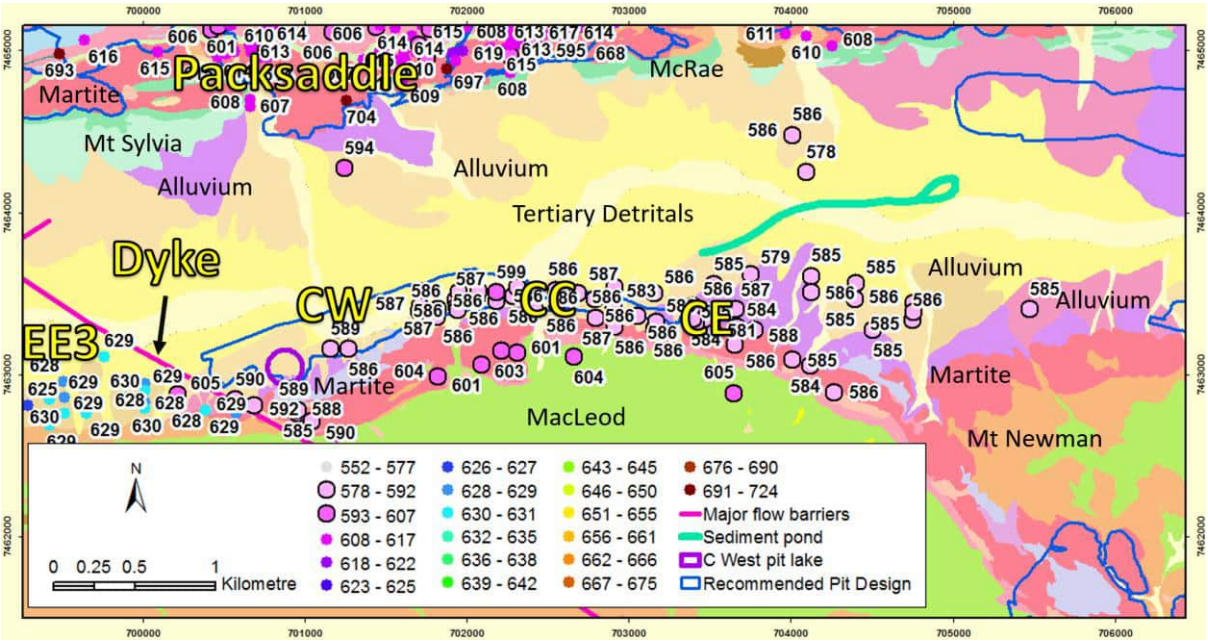
The observed heads from exploration drill holes (almost all drilled between 1995 and 1996) are shown in **Figure H.2**. These show that:

- There are no obvious water level steps within the C Deposit orebody
- There is limited data in the regional aquifer
- There is a small water level gradient from west to east, from 590 mRL at western end (i.e. at the dyke between the EE3 pit and C Deposit) to 585 mRL at eastern end of C Deposit
- The Packsaddle area to the north presents higher heads (~615 mRL)
- The southern area also presents higher heads (~>600 mRL)

The data therefore suggest (or offer no evidence to suggest otherwise) that the C Deposit orebody aquifer system is:

- Connected along strike (i.e. within the orebody)
- Possibly connected to the regional aquifer (i.e. heads are the same in both)
- Constrained at the western end by the EE3/C Deposit dyke
- Constrained to the north by the Packsaddle geology (the low permeability Mt Sylvia and McRae shales)
- Constrained to the south by the low permeability Nammuldi, McLeod and Jeerinah Formations
- Possibly connected to the east towards A Deposit

Figure H.2. C Deposit pre-development heads (mRL) and surface geology



5.8.3 Anthropogenic stresses

There has been a long history of water management and monitoring in this area. Abstraction started here in 2001 in the form of water supply with some monitoring occurring before that. Since then the area has been subject to many different forms of anthropogenic stress and from many different locations (**Figure H.1 and H.3**). Many of the stresses have also overlapped temporally. They are:

Abstraction:

Rail Loop bores (regional dolomite): from 2001 to 2018 (peaking at 6 or 7 ML/d during that time).

C Deposit dewatering (orebody): from 2010 onwards.

- CE from June 2010 to April 2020
- CC from January 2015 onwards
- CW from May 2015 onwards

A Deposit dewatering (orebody and regional dolomite): from May 2019 onwards.

Discharge of surplus water:

CW pit lake(orebody): between August 2011 and September 2012.

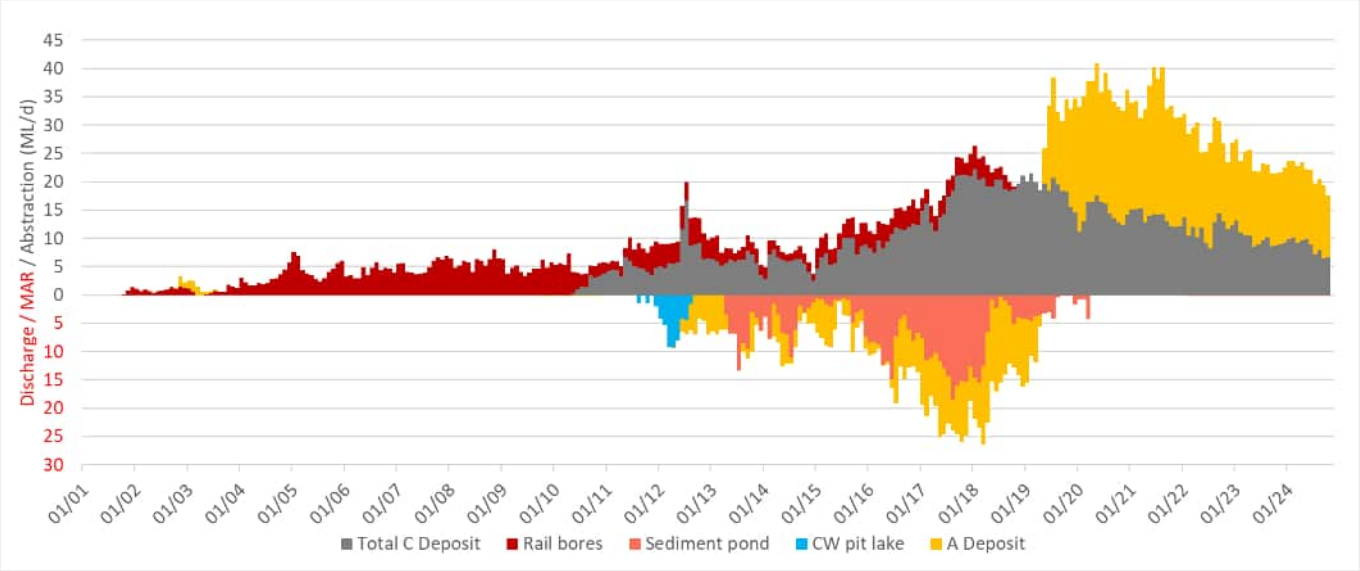
Sediment pond (regional): between March 2013 and March 2020.

A Deposit MAR (regional): between April 2012 and May 2019.

After almost 10 years of abstraction for water supply from the Rail Loop bores, dewatering started in 2010. The abstraction rate exceeded water demand at the mine soon after this requiring solutions for the disposal of surplus water. These took several forms, all local to the C / A Deposit aquifer compartment until very recently (when A Deposit switched to dewatering and all surplus was taken out of this compartment).

From 2010 there was a steady increase in both dewatering and surplus discharge until mid 2018 when both peak at about 26 ML/d. After this time surplus discharge rapidly declines and ceases completely into both A Deposit MAR and the sediment pond by the end of 2019. Dewatering from C Deposit reduces more gradually, from a peak of about 20 ML/d (mid 2018) to about 13 ML/d at the end of 2020. Water management at A Deposit switches to a dewatering operation from MAR in mid 2019 and achieved abstraction rates of between 15 and 20 ML/d since then.

Figure H.3. C / A Deposit abstraction and discharge rates



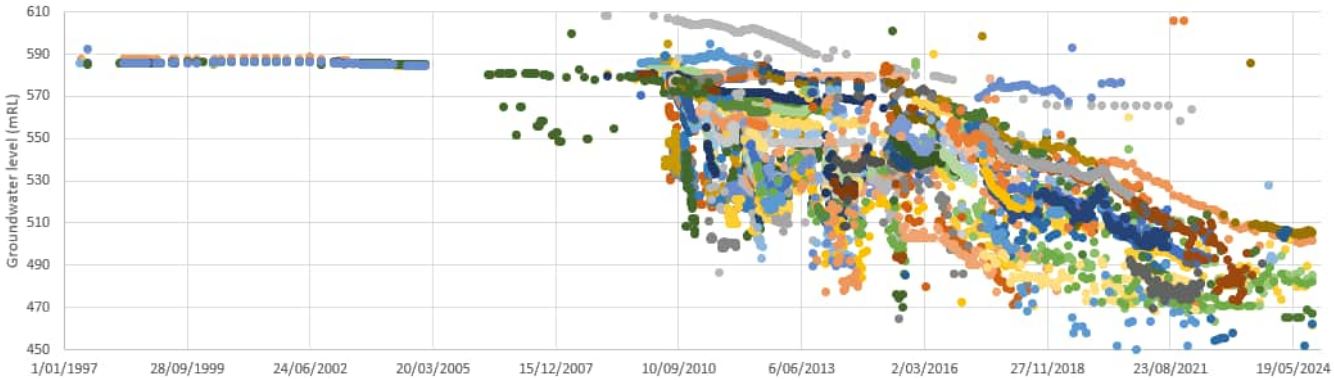
5.8.4 Groundwater level monitoring

Monitoring of groundwater levels started in 1997 and the network of bores and methods has expanded since then. Although many of these installations have been destroyed by mining or abandoned over the years, the monitoring dataset consists of:

- 284 monitoring bores (providing a total of 11,200 manual dips)
- 182 monitoring bores with greater than 9 observations
- 30 vibrating wire piezometers in the C Deposit north wall
- 14 vibrating wire piezometers in the C Deposit south wall
- 11 monitoring bores with loggers installed

The full manual dip dataset is shown in **Figure H.4**. This shows that the dataset contains a huge amount of information, which is hard to decipher in this format. It does show however that dewatering has had a varied impact on these levels through time.

Figure H.4. C Deposit and regional aquifer manual dips

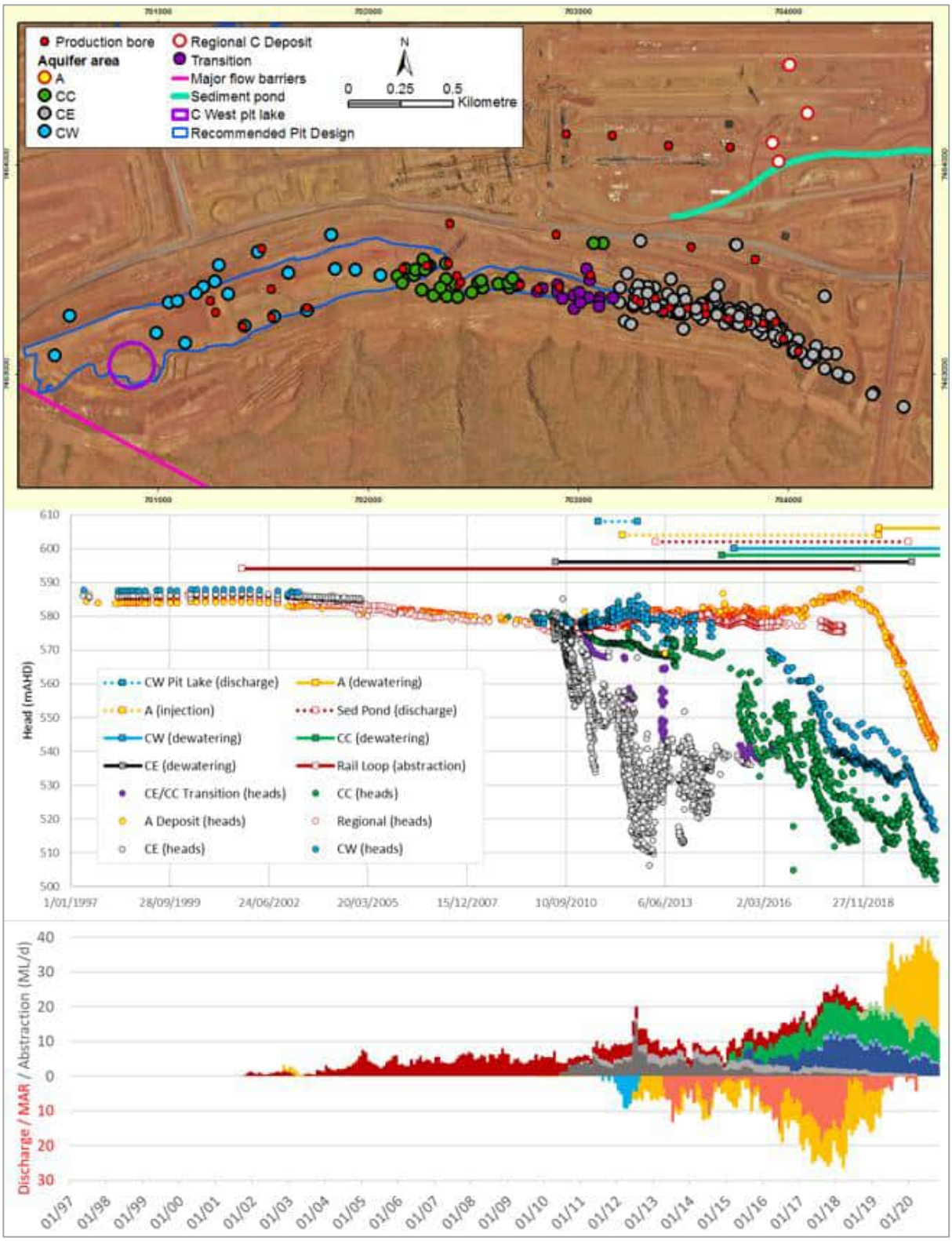


5.8.5 Grouping the data

The head and abstraction / discharge data can be simplified however based on the location of the bores and stresses (**Figure H.5**) into:

- CW / CC and CE orebodies
- A transition zone between CE and CC orebodies (analysed in more detail below)
- Regional aquifer
- A Deposit (orebody and regional aquifer)

Figure H.5. C / A Deposit grouped heads / stresses / locations



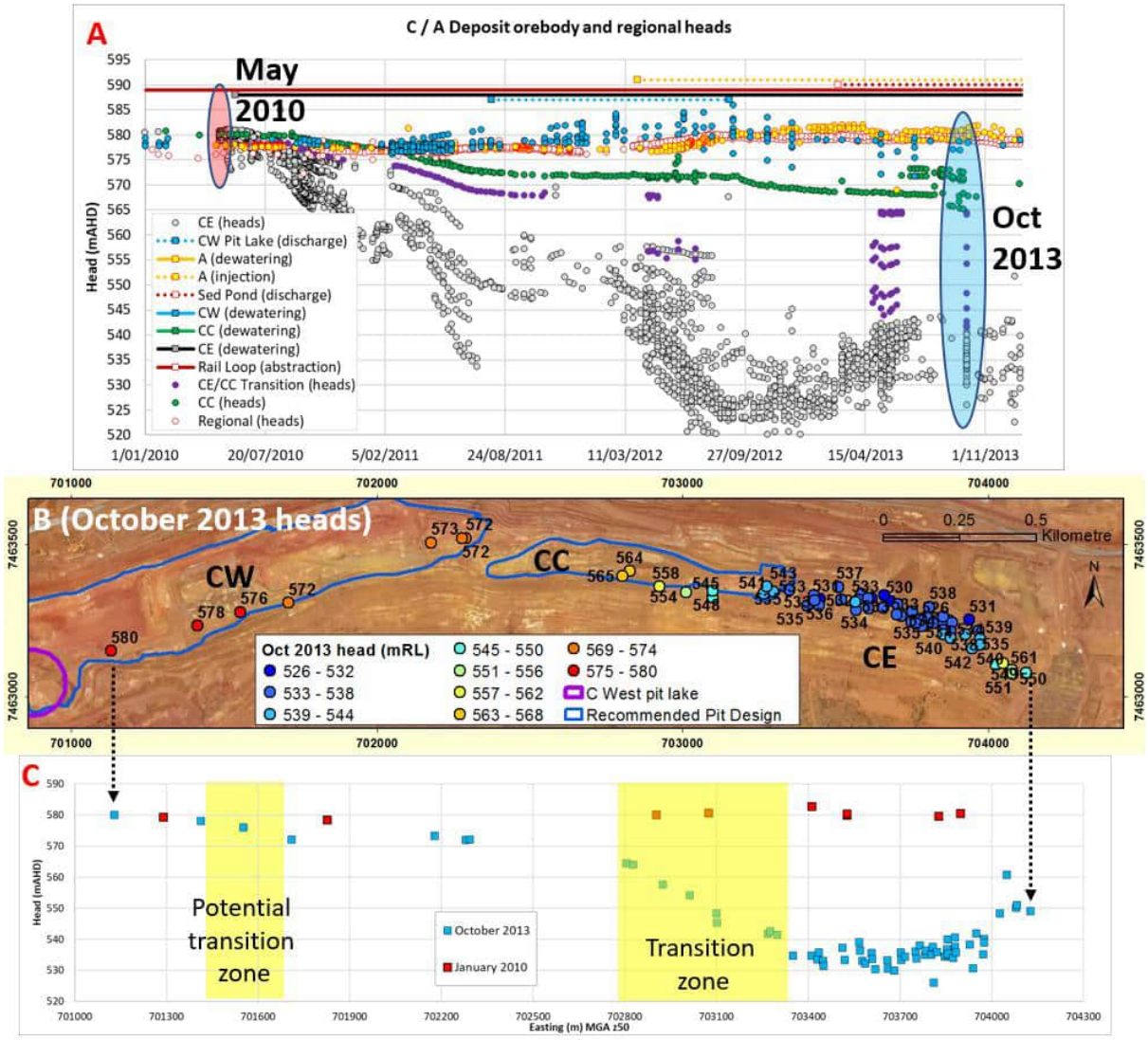
Once this is done clear spatial and temporal distinctions and responses to stresses become clearer. In general, this shows that the divisions between the areas are distinct. The only area that shows a gradation in heads across it sits in a 400 m zone between CC and CE orebodies. The heads from January 2010 (pre C Deposit dewatering) and May 2013 (pre CW and CC dewatering but during CE dewatering) are plotted in **Figure H.6**.

This shows that:

- The heads in this zone appear to smoothly transition from the CC heads in the west (green) and CE heads in the east (grey), particularly in October 2013 (shown in the red oval).
- When plotted on a map and cross section, the October 2013 heads show:
    - CE groundwater levels are significantly lowered by dewatering in that orebody
    - From CE to CC there is a smooth transition from the lower (dewatered) CE heads to the higher CC heads. There is no distinctive step in water levels betraying the location of a dyke.
- When plotted on a cross section, the January 2010 and October 2013 heads show the extent of dewatering in CE deposit and the subdued response in CC and particularly CW. In fact, at this time the data suggest that water levels were actually lower in the regional aquifer than in CW, which was slightly lower than CC which was again slightly lower than CE.

Furthermore, several production bores have been installed in this zone, but none were utilised for a significant period and if pumped at all, produced only small volumes.

Figure H.6. CC/CE transition zone analysis



KEY: **A:** Analysis on data from May 2010 (red oval) and October 2013 (blue oval) **B:** October 2013 heads through CW/CC and CE orebodies (birds eye view) **C:** January 2010 and October 2013 heads through CW/CC and CE orebodies (cross section)

Overall, a comparison of dewatering rates and drawdown at each of the orebodies shows that (**Figure H.5 and Figure H.6):**

- the magnitude of dewatering required at CC was less than that at both CW and CC.
- this lower rate of dewatering at CC produced significantly more drawdown than the higher rates that both CW and CC have produced
- the dewatering of CC occurred before dewatering of the other orebodies, when water levels were relatively unaffected by other stresses. Meaning that if all other things were equal this would be expected to require higher dewatering rates than CW and CC.
- The dewatering of CW and CC occurred concurrently and after CE had already been significantly dewatered. Meaning that if all other things were equal these would be expected to require lower dewatering rates than CE.

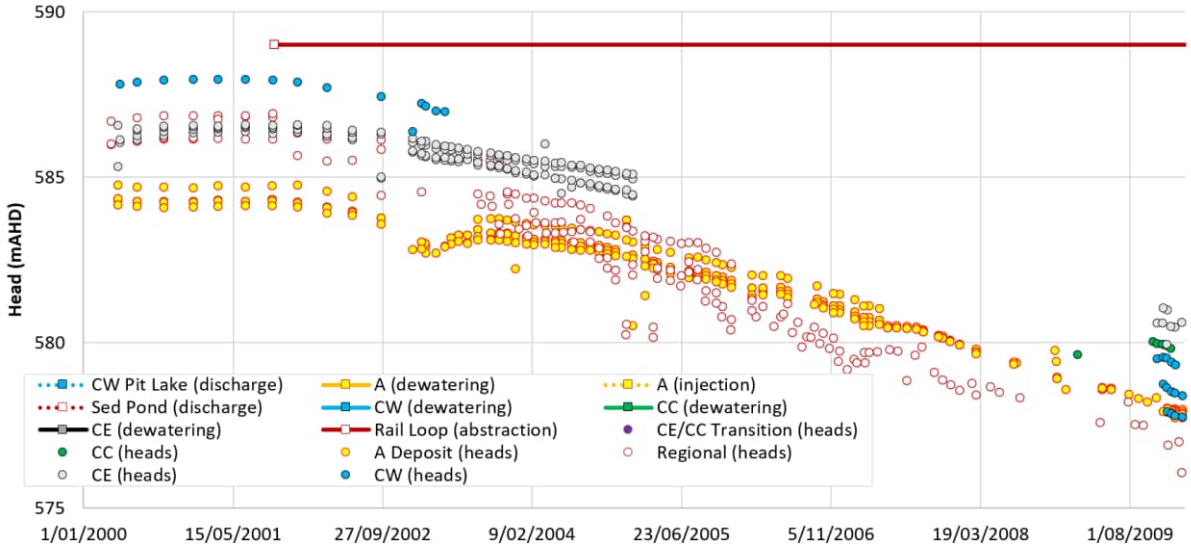
5.8.6 Grouped data analysis

The data set contains a significant amount of information. The following analysis has therefore been focused on specific time frames that reveal aspects of the hydrogeology.

2000 to 2010

The data between 2000 and 2010, the period prior to dewatering at C Deposit, but during water supply abstraction at the Rail Loop bores is displayed in **Figure H.7**.

Figure H.7. Grouped data – pre-C Deposit dewatering analysis



The data prior to abstraction (pre 2001) shows that groundwater levels range between 588 mRL in CW and 586 mRL in the regional system north of C Deposit and 584 mRL at A Deposit.

The data coincident with water supply abstraction (post 2001) shows that:

- The regional system is drawn down by about 10 m by 2010.
- Although the starting head at CW is higher than the regional system, the total drawdown by 2010 is almost the same in these two locations.

- Drawdown has occurred in CC (based on comparison with pre-development heads). There are no transient observations until 2010, so it is not possible to compare magnitude of drawdown in CC with the other locations with high confidence.
- Drawdown in CE seems to be materially less than drawdown in CW and the regional system. This is shown in the gradient during 2003 and 2004 and in the total drawdown by 2010 (about 6 m, compared to 10 m in CW and the regional system).

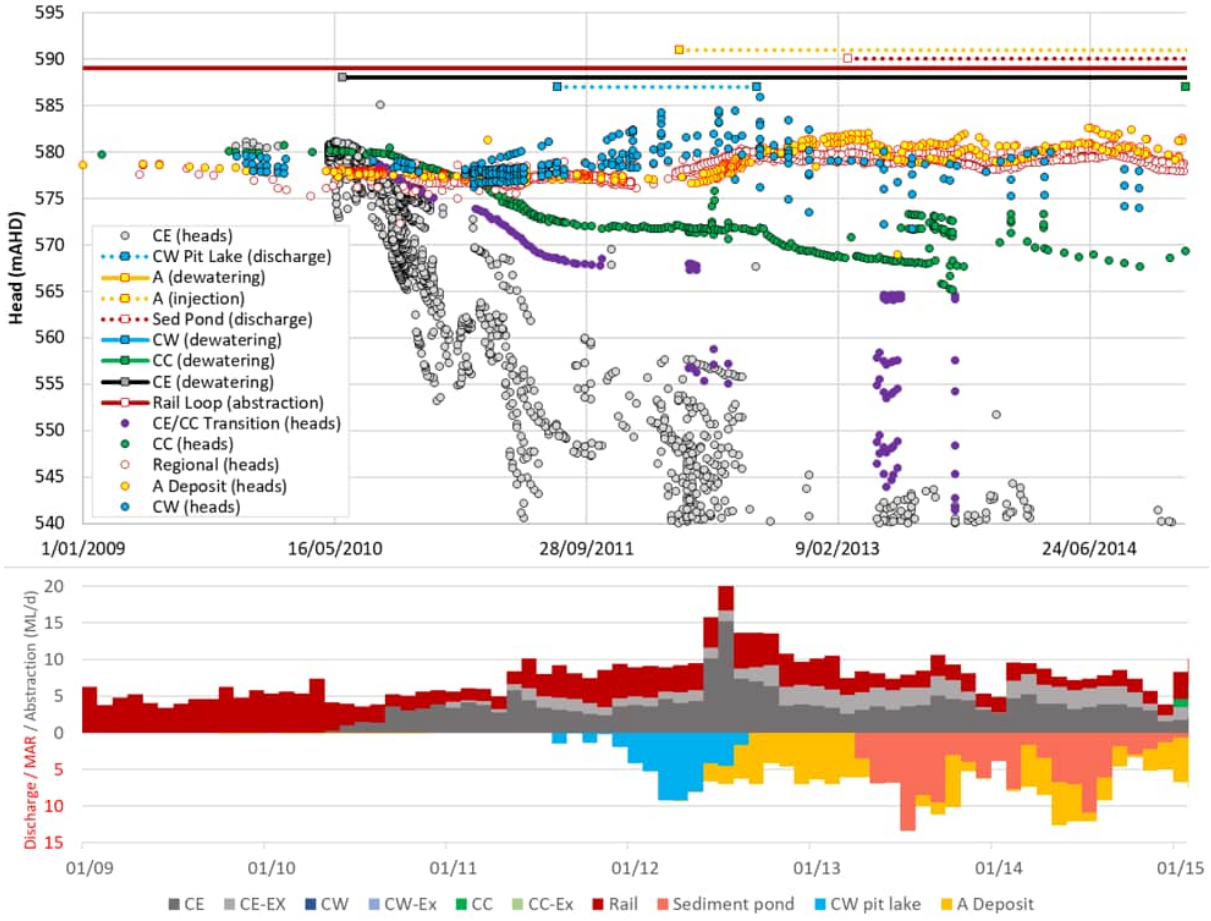
This suggests then that:

- the CW and regional systems are hydraulically connected.
- the CE and CW and/or the regional systems are hydraulically connected, but to a significantly lesser degree than CW.

2010 to 2015

The data collected during coincident abstraction from the Rail Loop bores and CE dewatering bores as well as operation of the CW pit lake, initial sediment pond discharge and A Deposit MAR (the period between 2010 and 2015) is shown in **Figure H.8**.

Figure H.8. Grouped data – post CE dewatering analysis



* Ex denotes Ex-pit production bores (i.e. generally outside of the orebody aquifer)

The data show that:

- During the initial dewatering of CE (before any discharge of surplus back into the compartment), drawdown in CE is significantly more than that seen in either CC or CW and the regional system. During this period:
    - Drawdown in CC (~3 m) is greater than in CW (~1.5 to 2.0 m)

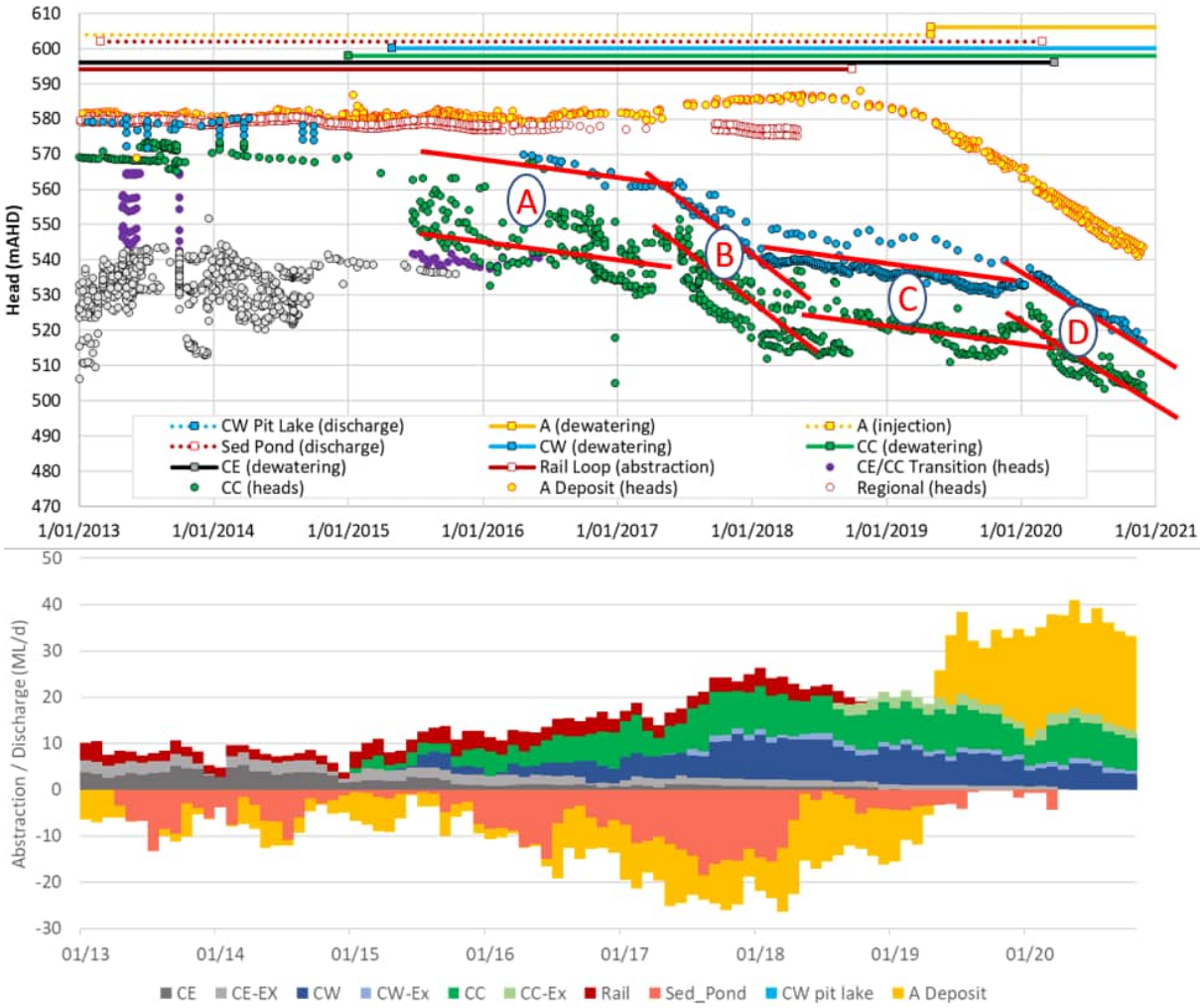
  - Water levels in the regional aquifers stabilise (i.e. no longer drawdown) over this period, probably because abstraction from the rail loop bores reduces at the same time that dewatering from CE starts.

- After the initial period of CE abstraction and associated drawdown in CE, CC and CW, heads in CW and CC appear to stabilise, even though heads in CE continue to draw down. This may indicate the reduction in hydraulic connection between CE and CC / CW with depth.
- Once the CW pit lake is used, the CW and CC heads diverge. CW heads increase and CC heads continue to fall in response to CE dewatering.
- From the start of 2013 heads in CW, CC and the regional system seem to reach an equilibrium, where inputs (surplus water discharge, aquifer throughflow) match outputs (dewatering). At the same time heads in CE continue to fall.
- The CW heads appear to start to rise several months before the discharge to the CW pit lake begins (suggesting that the CW pit lake discharge data is missing during this period).
- The CW pit lake discharge impacts heads in CW and possibly the regional system. The regional system heads react at roughly the same time as the CW heads (suggesting good hydraulic connection). The data from A Deposit suggest that heads here do not immediately respond to the CW pit lake and only rise when A Deposit MAR starts.
- When CW Pit lake discharge stops, CW heads fall but do not reach the levels observed in CC. In fact, they remain closer to head in the regional C aquifers.
- Operation of the sediment pond doesn't seem to have a significant impact on heads anywhere.
- At the end of this period (with dewatering only active in the CE orebody, but discharge of surplus active to the sediment pond and A Deposit MAR) heads in the various units were:
  - CE = <540 mRL
  - CC = 570 mRL
  - CW = circa 576 mRL
  - Regional C aquifers = 578 mRL
  - A Deposit = 580 mRL

2013 to 2020

The data collected from the commencement of CC / CW dewatering onwards is shown in **Figure H.9**. Monitoring in CE (and the transition zone) ceased just after dewatering at CW / CC commenced, so it is not possible to tell what the water levels were in the CE orebody during most of this period. Monitoring also ceased in the regional aquifer (in the vicinity of C Deposit) at the start of 2018, so for the last two years of this analysis the water levels in this unit are unknown. This is the period when dewatering and surplus discharge volumes are highest, and the period when A Deposit switches from MAR to dewatering.

Figure H.9. Grouped data – pre-C Deposit dewatering analysis



The data show that:

- The difference in heads between CC and CW orebodies remains roughly the same (CW is about 15 m higher than CC) during the entire period, even though the water level reduces significantly in both locations.
- Monitoring is very limited in the transition zone between CE and CC, but it seems likely that water levels in CC fell below those in the transition zone sometime in 2016.
- During the first 12 months of CW/CC dewatering, the regional C aquifer and A Deposit heads remain close. However, as dewatering rates (and surplus discharge) increase into 2017 and 2018, the regional C aquifer and A Deposit heads start to diverge for the first time (i.e. since 1997). It seems that the increased stresses have had the effect of changing the balance in the system, with A Deposit heads increasing with a higher MAR rate and the regional C aquifer heads falling slightly (even with greater sediment pond discharge) due to the increasing dewatering and drawdown in CC and CW.
- The observed heads in the various areas in the first half of 2018 were:
    - CE = unknown
    - CC = 515 to 530 mRL
    - CW = 540 to 550 mRL
    - Regional C aquifers = 577 mRL

- A Deposit = 585 mRL

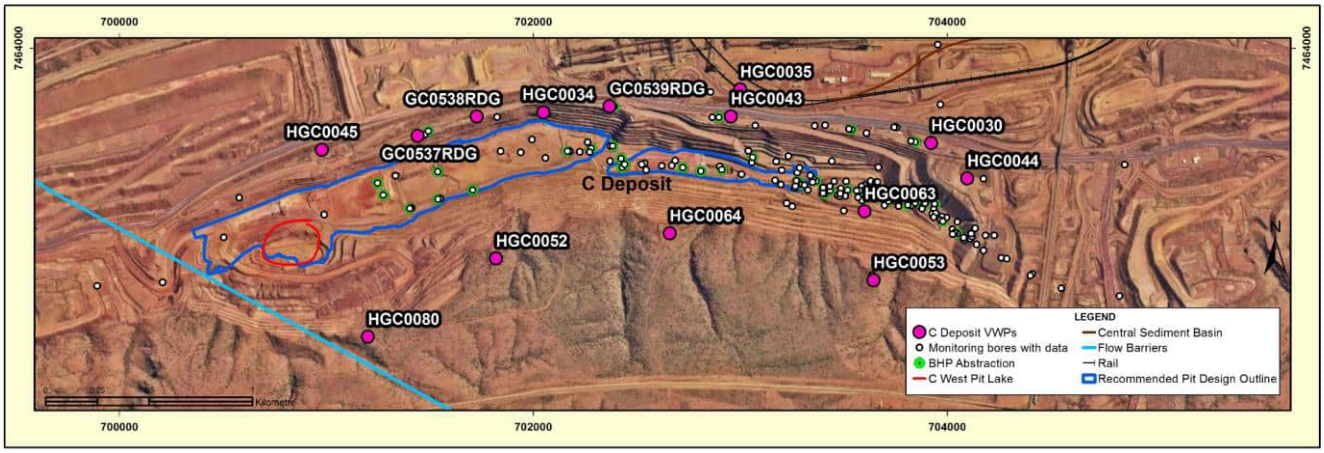
- The heads in CW and CC display the following features (marked on the graph as A to C):
  - (A) Gradual drawdown in 2016 and first half of 2017 – associated with:
    - Dewatering at ~6 ML/d from CC and 3 ML/d from CW
    - Average (but very variable) discharge to the sediment pond of 9 ML/d
  - (B) The rapid drawdown in the last half of 2017 – associated with an increase in both dewatering and surplus discharge:
    - Dewatering at ~9 ML/d from CC and 9 ML/d from CW
    - Average discharge to the sediment pond of about 15 ML/d
  - (C) Then gradual drawdown in 2018 and 2019 – associated with:
    - Quite steady dewatering rates (as per previous period) but with more ex-pit bores (i.e. dolomite)
    - Rapid reduction in discharge to the sediment pond to less than 5 ML/d
    - Cessation of MAR and commencement of dewatering at A Deposit from mid 2019 (average 19 ML/d)
  - (D) Then rapid drawdown in 2020 – associated with:
    - Reduction in dewatering from both CC and CW
    - No sediment pond discharge (or A Deposit MAR)
    - Increase in A Deposit abstraction to 20 ML/d.

- Dewatering from CC and CW has been falling since 2019. This doesn't seem to have affected drawdown in these two areas however.

Vibrating wire piezometers

Water level observations from all vibrating wire piezometers (VWPs) in C Deposit (**Figure H.10**) have been assessed to determine the level of hydraulic connection between the C Deposit orebodies and adjacent areas; to the north (regional aquifers) and south (unmineralised Marra Mamba). The analysis excludes HGC0063V as this is installed in the orebody and provides orebody aquifer water levels (which are well understood through the main monitoring dataset).

Figure H.10. Location of VWPs in C Deposit



Figures H.11 to H.13 show the data from the north of CE, CC and CW respectively and **Figure H.14** shows the data to the south of all the orebodies.

They show that:

In the north wall of CE orebody (**Figure H.11**):

- Of the 5 VWPs, the installed lithology is only known for 2 (Newman and West Angela Shale)
- The observations seem to follow very similar trends. They respond well to rainfall and drawdown roughly at half the rate of the CE orebody.
- HGC0030V4, which is installed in the West Angela Shale shows the least drawdown (over a shorter monitoring period however).
- These VWPs show a marked response to rainfall on several occasions.

- In the north wall of CC orebody (**Figure H.12**):
  - One VWP (HGC0043V1) responds in a similar way to the CC orebody, especially for the first few years, after which the drawdown in the VWP is less than the orebody. This VWP is installed in the West Angela Shale.
  - The two other VWPs installed in HGC0043 (V2 and V3) are located within the Tertiary Detritals. The starting heads (after reaching equilibrium) are higher than the regional aquifer, which suggests they have not been particularly impacted by the rail loop abstraction. Both are drawn down gradually and do not show a marked acceleration in drawdown when CC dewatering starts.
  - The three VWPs in HGC0035V are installed in the Tertiary Detritals or lithology is unknown. These record limited drawdown (much the same as HGC0043V2 and V3) but do show some acceleration in drawdown when CC dewatering starts.
- In the north wall of CW orebody (**Figure H.13**):
  - Of the VWPs recording during dewatering of CW, all but one (GC0538RDGV4) show significant response, not dissimilar to the orebody response. The installed lithologies of these bores are either dolomite or West Angela Shale. There is no obvious difference in the responses at these lithologies at this location.
  - GC0538RDGV4, installed in the dolomite, does not respond to the same extent as the other VWPs and is closer to the regional aquifer heads than the CW heads.
- To the south of C Deposit (**Figure H.14**):
  - All VWPs south of C Deposit are installed in the Nammuldi Member.
  - All initial water levels (2010) are higher than in the orebodies to the north.
  - All VWPs record drawdown, with roughly the same gradient at all locations between 2011 and 2018.
  - The data is more limited in 2020 but what is available (HGC0052V1, HGC0064V1 to V3) shows a levelling off of drawdown and possible a small recovery. These are located south of CW and CC where water levels continued to fall during this period.

The trend seems to be that:

- VWPs installed in the North wall material in CE and CC do not respond to dewatering of the adjacent orebodies as much as the orebody itself. They do however respond more than the regional aquifer. These lithologies are mostly West Angela Shale and Tertiary Detrital (unless unknown).

- VWPs installed in the North wall material in CW do respond to dewatering as much as, or nearly as much as, the CW orebody. These are installed in dolomite and West Angela Shale. There is no relationship between the response and the installed lithology.
- The south wall VWPs show that the water levels in the Nammuldi along the entire C Deposit strike are initially higher than in the orebody, but they do respond to dewatering with significant, albeit subdued in comparison to the orebody, drawdown.

This suggests then (although it is not definitive) that the north wall material of CE and CC orebodies may present a reduced connection (in terms of rock mass, unfortunately this tells us nothing of presence of structures that may provide flow pathways) to the regional aquifers in the north. There is also some evidence that the same material in the north wall of CW orebody presents a greater hydraulic connection to the regional aquifers in the north.

This could also mean that the main flow pathway between the regional aquifer and the three orebodies is through the north of CW (well connected), with some additional but limited connection through the north of CC and CE. Therefore, pumping from CC may source significant water from the regional aquifer through CW. This might also explain why concurrent (and at similar rates) dewatering of CW/CC, results in the lowest heads at CC (poorest connection), intermediate in CW and highest in regional aquifer and these heads maintain the same gradient (difference) between them through time.

Also, CE may be more isolated than the other orebodies which is borne out in the lower dewatering rates needed to lower water levels further and faster than seen in CC or CW. So throughflow from the regional aquifer is higher into CW than CC and higher into CC than CE.

Figure H.11. VWPs in the CE orebody north wall

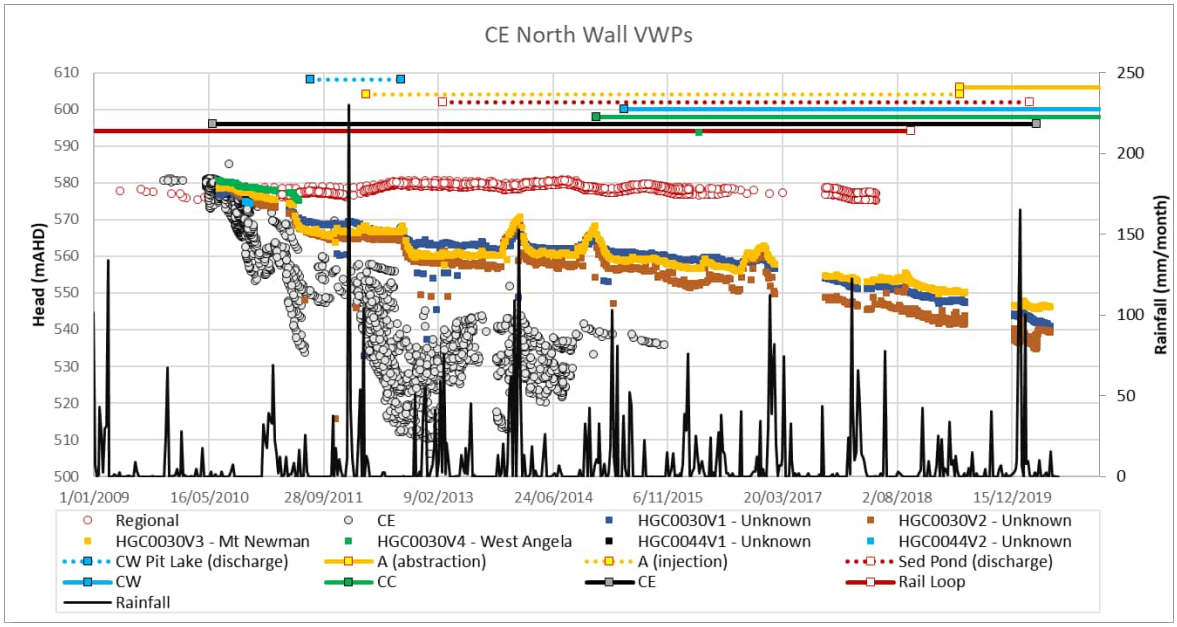


Figure H.12. VWPs in the CC orebody north wall

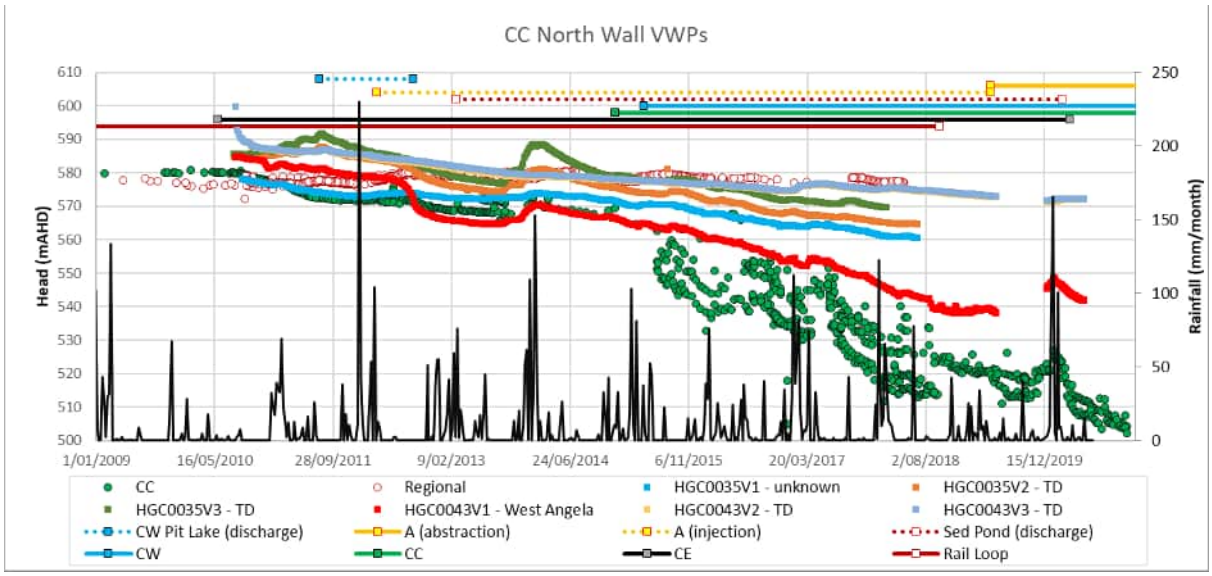


Figure H.13. VWPs in the CW orebody north wall

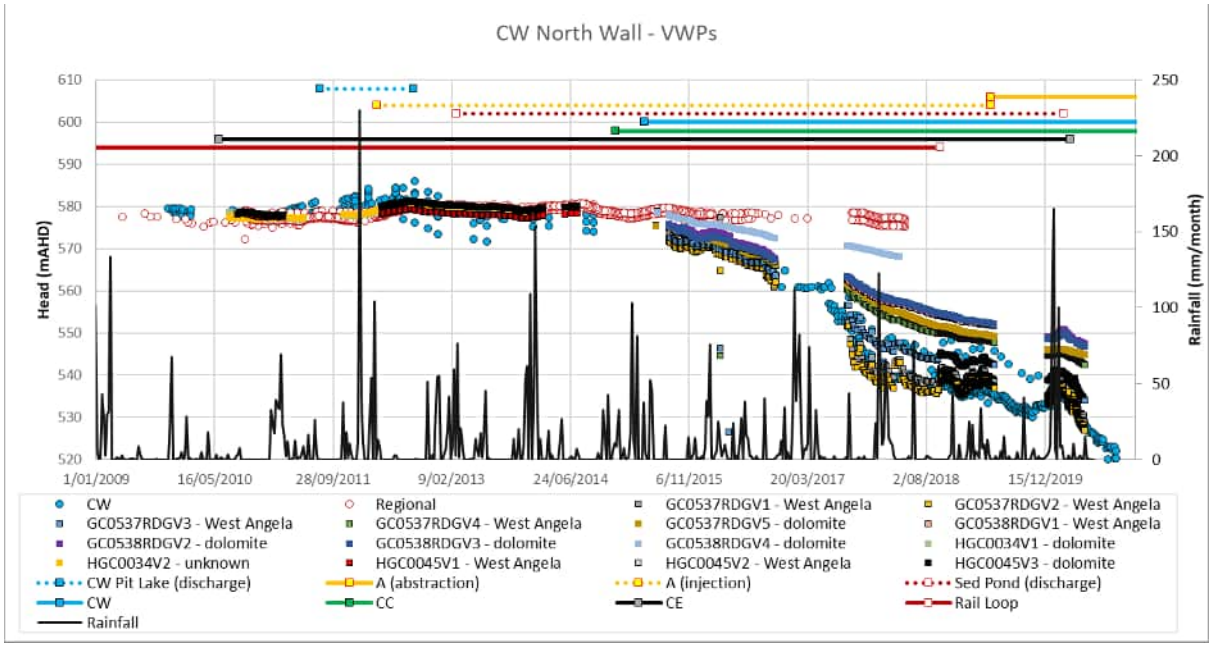
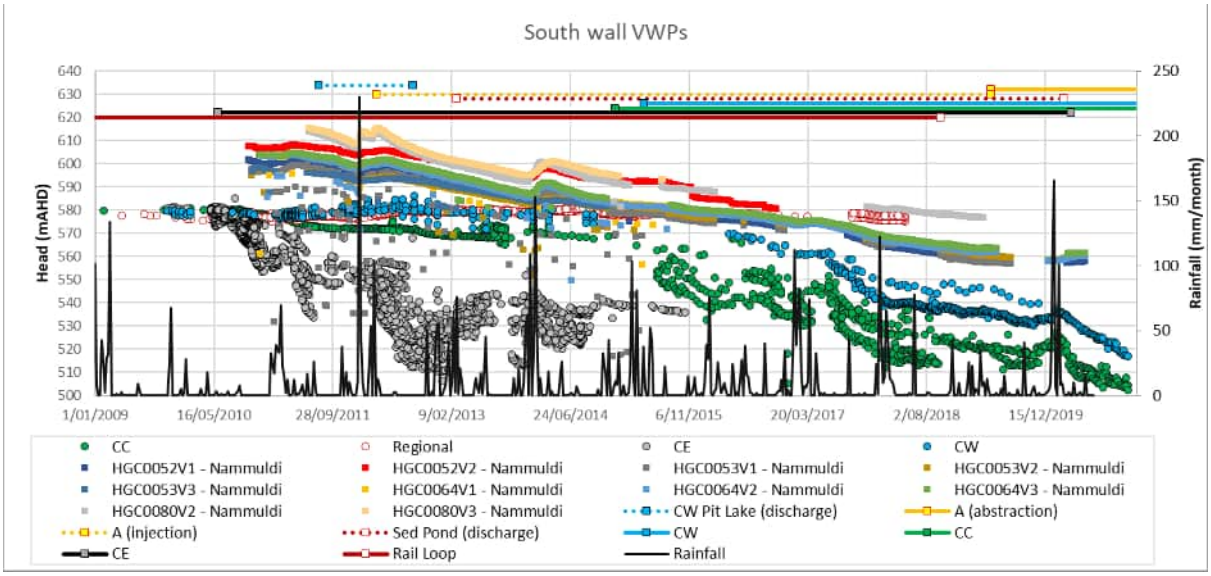


Figure H.14. VWPs south of C Deposit



5.8.7 Conclusions

The following conclusions can be drawn from the analysis.

- The C Deposit aquifer system comprises the orebody aquifer and the regional Tertiary detrital and dolomite aquifers.
- The aquifer system is bound to:
    - The west by a dyke (adjacent to EE3)
    - The north and south by low permeability rock mass
- The aquifer system is open to the east through the regional aquifers (towards A Deposit).
- The C Deposit aquifer is comprised of three distinct subaquifers:
    - CW
    - CC
    - CE
- The subaquifers display a moderate level of hydraulic connection between them. The disconnection:
    - between CE and CC occurs across a 400 m zone of unmineralised Marra Mamba between the two.
    - between CC and CW has not been delineated by the data
- The orebody aquifers are hydraulically connected to the regional aquifers:
    - The highest degree of connection is with CW
    - Some connection is likely to CC and CE, but it is unclear to what extent this connection occurs:
        - Directly
        - Indirectly through CW
- Further analysis of the balance between dewatering of the orebody and falling heads in the regional aquifer is impossible without monitoring of the regional aquifer

5.9 North Flank – A Deposit (I)

Monitoring bore data

Abstraction, injection and monitoring in the vicinity of A Deposit is shown in **Figures I.1 to I.3**. There was little groundwater management activity here until 2012 when injection into the MAR scheme commenced. In May 2019 MAR was switched off and dewatering commenced.

Figure I.1. A Deposit monitoring and production bores

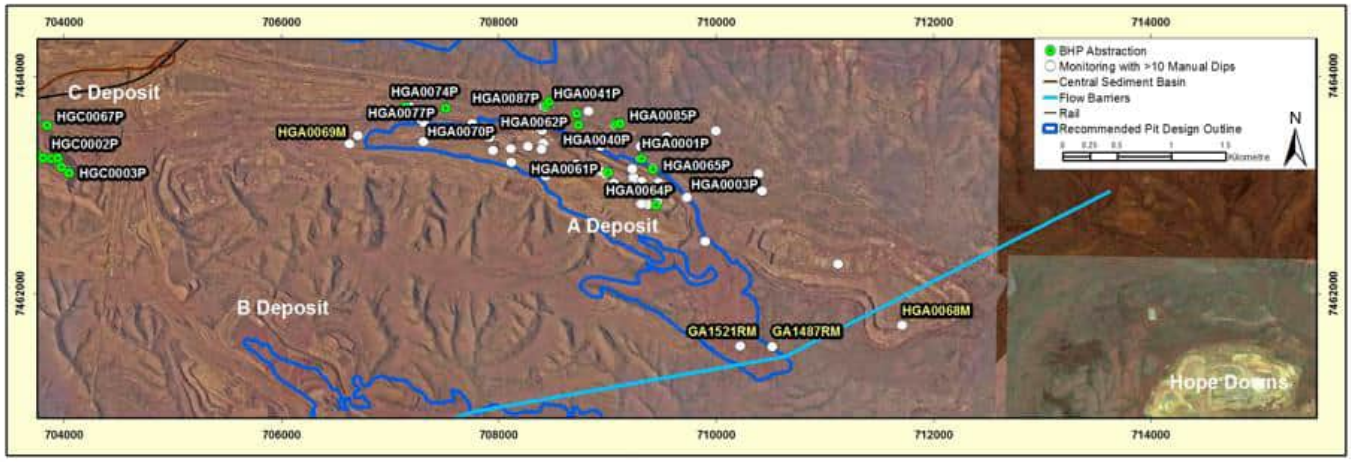


Figure I.2. A Deposit water management

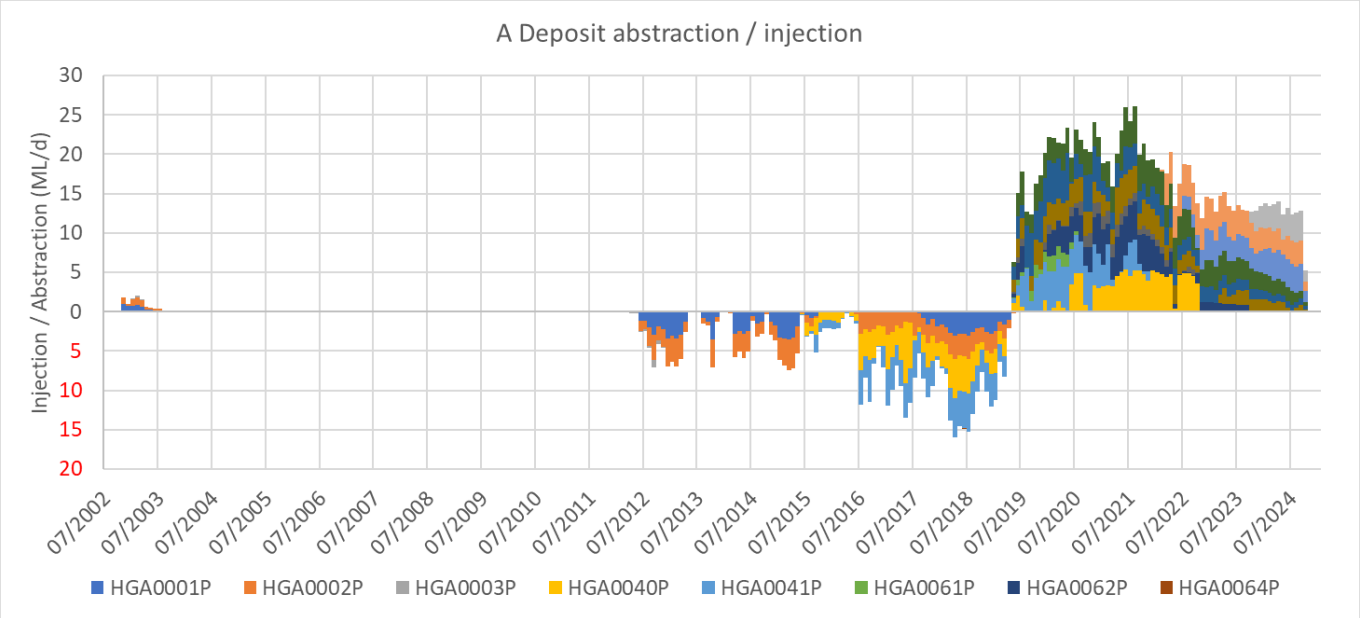
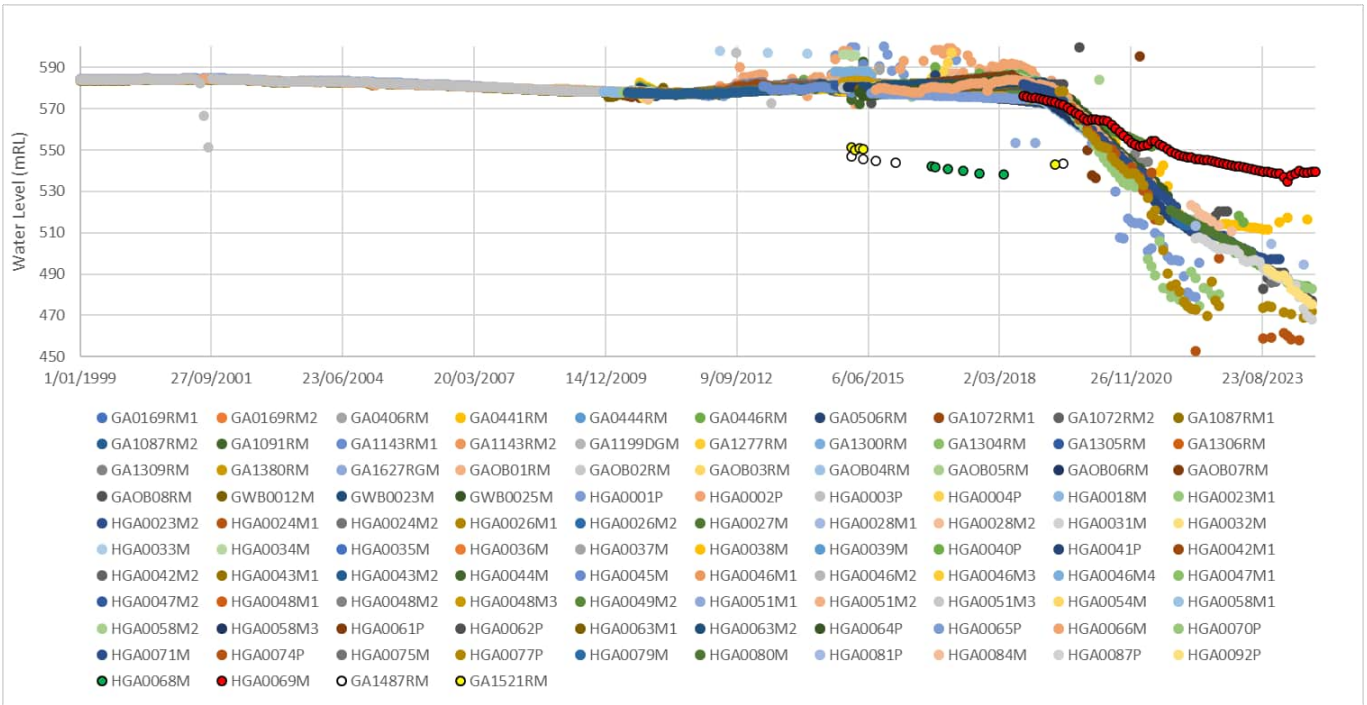


Figure I.3. A Deposit manual dips



General comments on the response are:

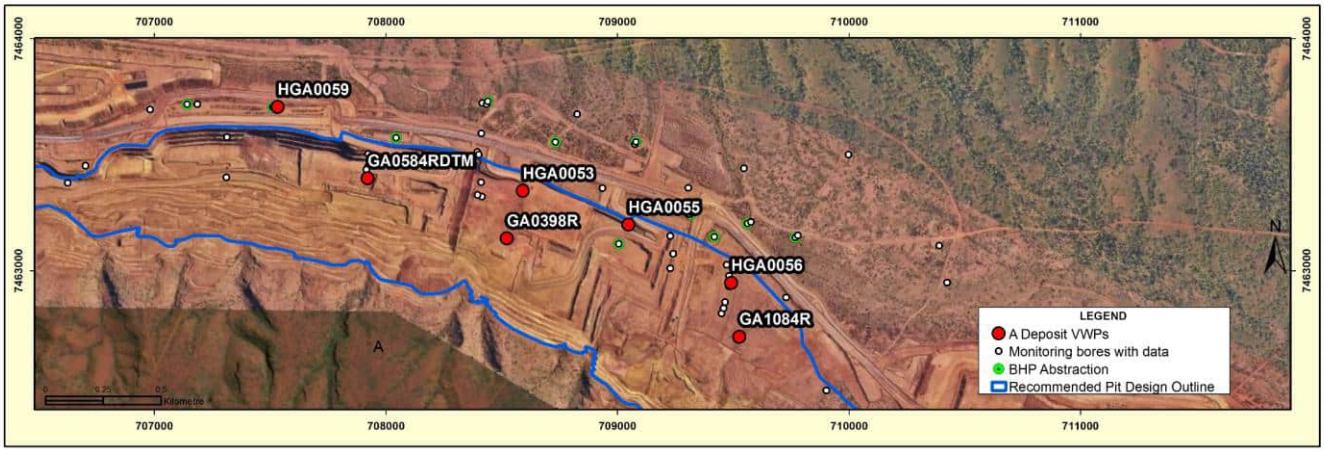
- This dataset covers ~5 km east to west
- The monitoring bores are generally screened or open to orebody and dolomite / Tertiary Detrital lithologies.
- There is virtually no variation between the observations. Out of the 93 monitoring bores that have been dipped more than 10 times, only three vary from the main response. These are:
    - HGA0069M in the far west of A Deposit. This response to both abstraction and injection is subdued at this location and could indicate a transition out of the local aquifer here (and therefore lower permeability material).
    - GA1521RM, GA1487RM and HGA0068M in the far east of A Deposit. The time series data is limited at these bores but they clearly show heads aligned with the Hope Downs aquifer compartment and a response to Hope Downs dewatering.
- There is a clear response to both rail loop abstraction (to the west) and then injection. The variation in heads due to these stresses between 2001 and 2019 was: minimum 577 and maximum 587 mAHD (i.e. 10 m).
- Dewatering has reduced the water level substantially; from about 578 mRL in May 2019 to about 470 mRL in May 2024 (i.e., almost 110 m over 5 years).

The data shows therefore that the A Deposit orebody and regional aquifers are very well hydraulically connected. So much so that the response to dewatering is identical in both. This connection has been sustained even as the groundwater level has been lowered significantly.

Vibrating Wire Piezometers

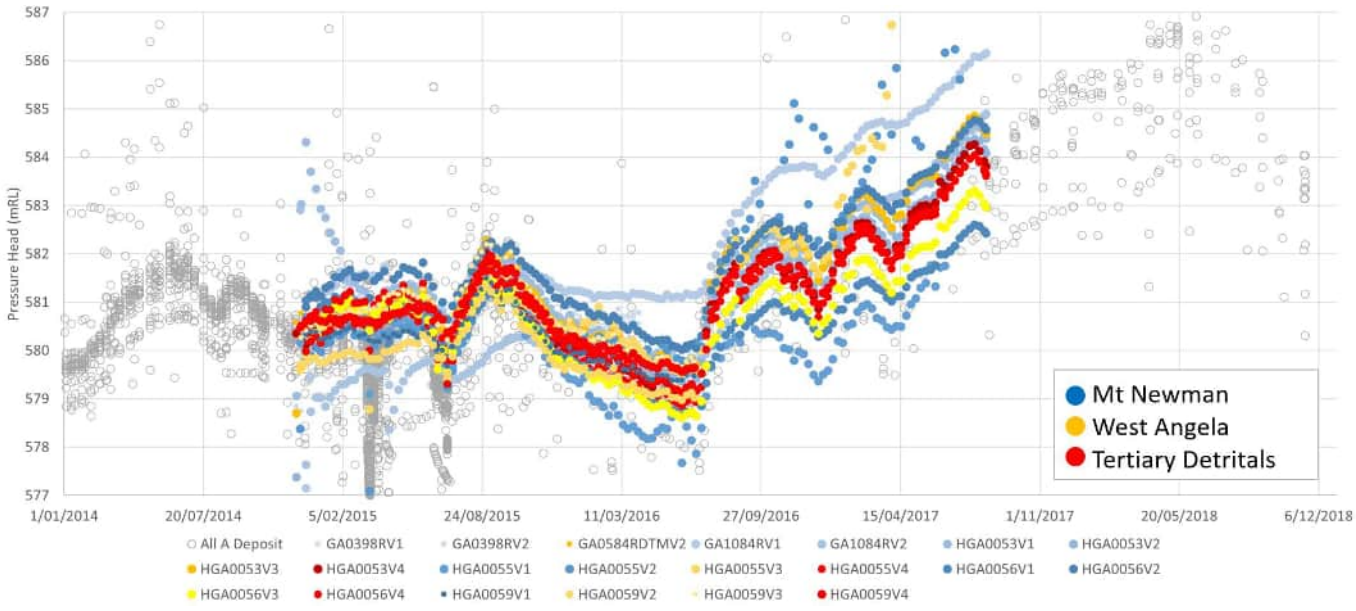
Vibrating Wire Piezometer (VWP) pressure heads and locations are presented in **Figures I.4 and I.5**. VWP data is only available from 2015 to end of 2017. There are 7 VWPs spread East to West, and mainly concentrated in the Northern half of the orebody.

Figure I.4. Location of VWPs, manual dip readings and production bores for the A Deposit compartment



The VWPs are screened across the Tertiary Sediments, West Angela Shale and the Mt Newman stratigraphies (**Figure I.5**).

Figure I.5. A Deposit Time-Variant VWP Pressure Heads



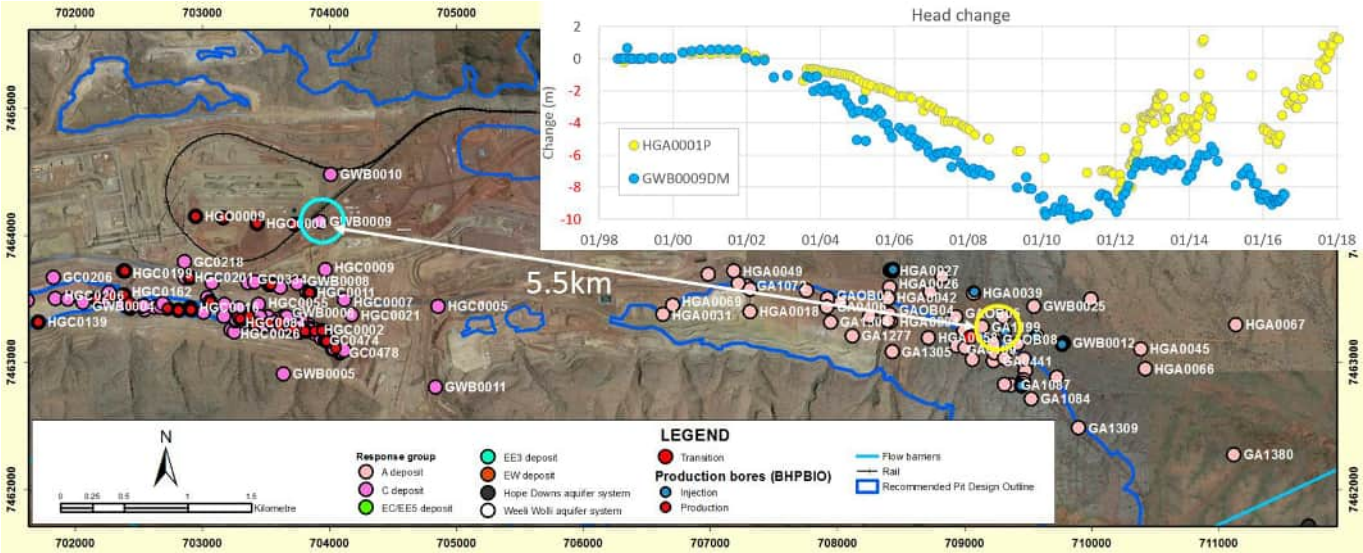
Regardless of stratigraphy in which these VWPs are located, they have returned roughly the same response over the monitoring period. The response is also very similar to that recorded at the A Deposit monitoring bores which predominantly target the orebody and regional aquifers. This suggests that the non-aquifer lithologies in the north wall are highly permeable.

Key uncertainty: Sixty metres of dewatering as of October 2021, leaving only 30 m to go. Uncertainties quite limited given maturity of dewatering. Quantification of hydraulic link between A Deposit and Hope Downs regional aquifers still uncertain however.

5.10 North Flank – A and C Deposits – Regional dolomite (J)

The analysis of C and A Deposit data above has shown that the regional dolomite in this flow compartment is hydraulically well connected. Further to this, a brief comparison of changes observed between the dolomite north of C and north of A Deposits is presented in **Figure J.1**.

Figure J.1. Regional A/C Deposit dolomite hydrographs



Discharge of surplus water has been undertaken via the sediment pond near the rail loop and via the injection bores at A Deposit. This has occurred concurrently since 2011 and makes analysis of the regional dolomite response during this period difficult. Before this however, abstraction from the rail loop bores (regional dolomite north of C Deposit) was the only major stress in the area. Analysis of the response to this stress therefore provides a very clear understanding of the regional response.

Eight years of abstraction (i.e. from 2002 to 2010) from the rail loop bores resulted in drawdown of:

- 10 m by the rail loop
- 7 m at A Deposit.

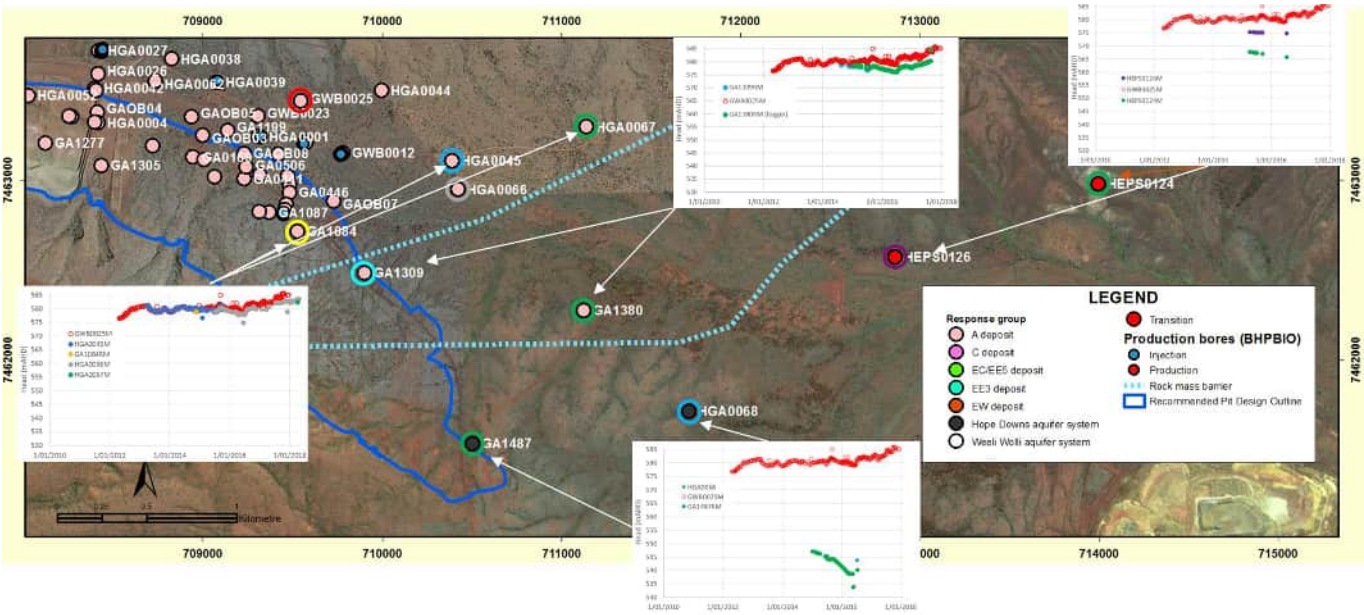
This response suggests therefore that the regional dolomite is well connected within this area.

Key uncertainty: Monitoring in the vicinity of the rail loop / C Deposit regional aquifer has been compromised since 2017. As the stresses in this system increase, the response in this area will be unknown.

5.11 Flow barrier between A Deposit and Hope Downs aquifer system (K)

Data in the vicinity of the flow barrier (or transition zone) between the A Deposit and Hope Downs aquifer systems is shown in **Figure K.1**.

Figure K.1. A Deposit / Hope Downs aquifer system monitoring locations



Monitoring data in the transition zone itself is limited, both temporally and spatially, however, the overall head response is quite clear:

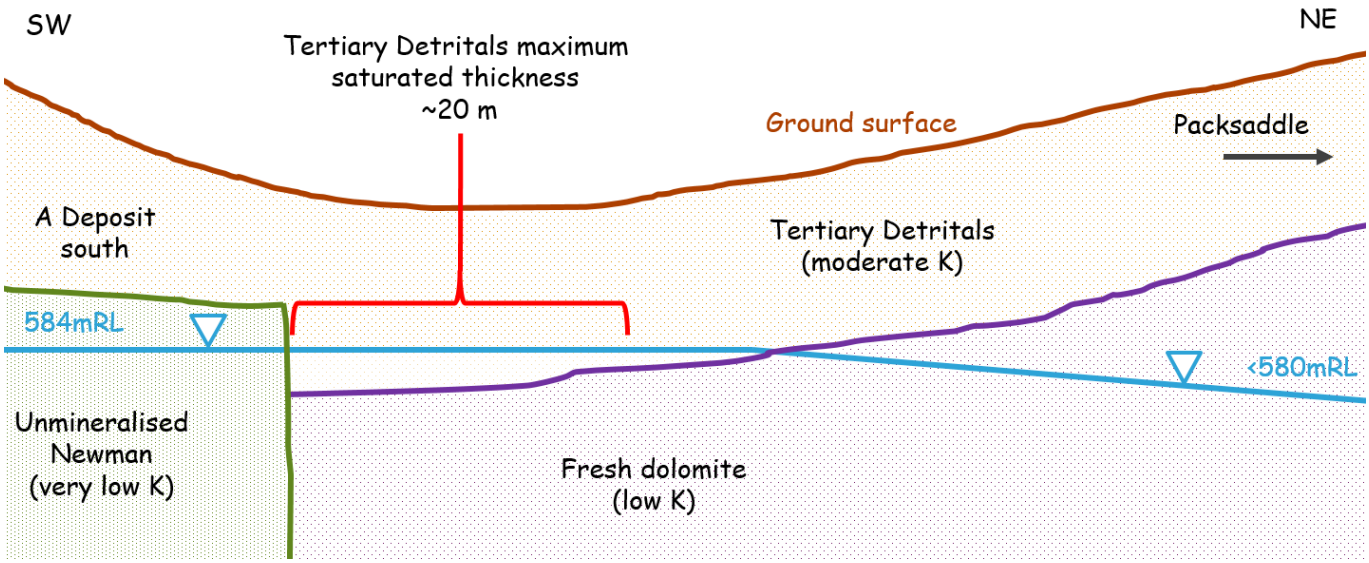
- GA1309M and 1380M return the same responses as A Deposit, but:
    - the heads are clearly lower (~5 m by 2018)
    - the difference between these two and the main A Deposit heads has been increasing with time (most likely due to the influence of Hope Downs drawdown)
- GA1487M and HGA0068M to the south are clearly in the Hope Downs aquifer system. This shows that the transition between the two aquifer systems occurs over a small distance in this area.
- The observed heads in HEPS0124M and 126M (to the east) are more complicated. The heads are much higher than those in the Hope Downs aquifer (i.e. much closer to the A Deposit heads) but they do not show any of the response behaviour of the A Deposit bores (although the observation record is very short). They show a steady fall throughout the monitoring period. Unfortunately, the pre-development water level is not known.

Geological information is limited in the transition zone to the bores shown above. However, an analysis of this data, combined with the greater amount of data in each of the flow systems, and the water level responses has led to the development of the conceptual model shown in **Figure K.2**. It seems likely that the transition is formed by:

- a distinct zone of unmineralised Marra Mamba Formation present through the southern part of the A Deposit orebody, and
- a limited thickness of high permeability material to the northeast (probably Tertiary Detritals rather than weathered dolomite) underlain by fresh (unweathered) dolomite.

The presence of a low permeability dyke in this location also remains a possibility, even though evidence is lacking from drilling or surface observations.

Figure K.2. Conceptual model of flow barrier between A Deposit and Hope Downs aquifer systems



Key uncertainty: The exact hydrostratigraphic nature of the transition zone and its behaviour as dewatering commences at A Deposit.

5.12 Hope Downs aquifer system (L)

The Hope Downs aquifer system has been the location of the greatest abstraction to date in the Central Pilbara groundwater catchment and the response to this has been captured sufficiently to determine the extent of the flow compartment (shown in **Figures L.1** and **L.2**). Unfortunately, the abstraction is not accurately recorded as it has been for the purposes of dewatering the Hope Downs North mine which is operated by Rio Tinto.

Figure L.1. Hope Downs aquifer system hydrographs (coloured by groups shown in Figure L.2)

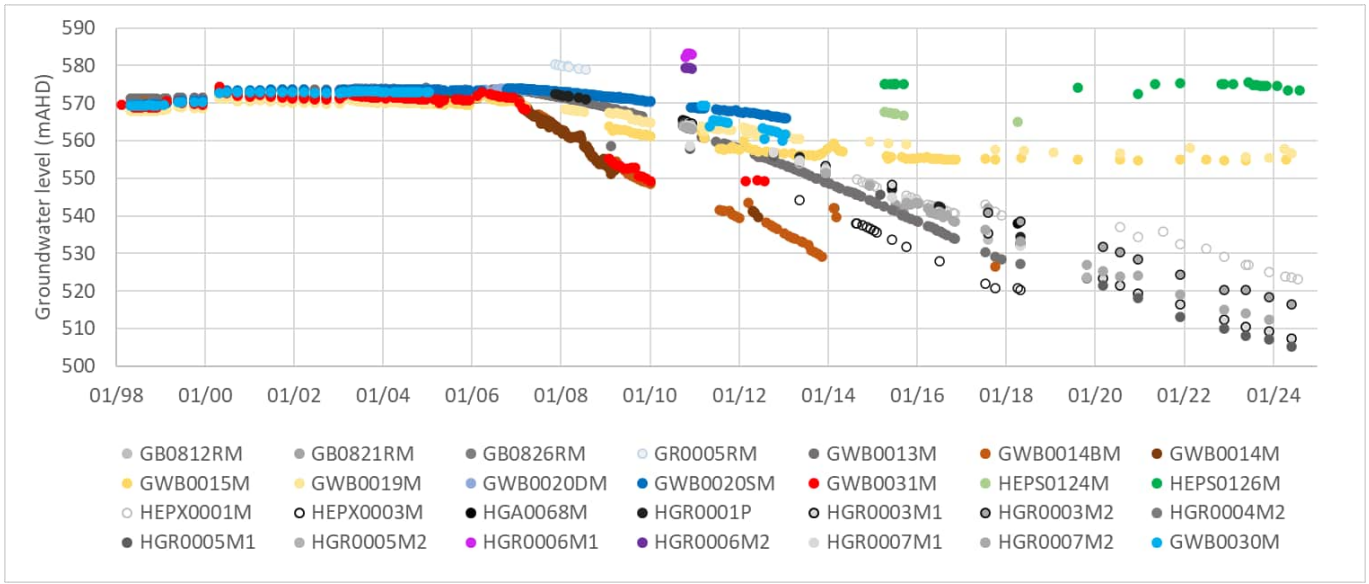
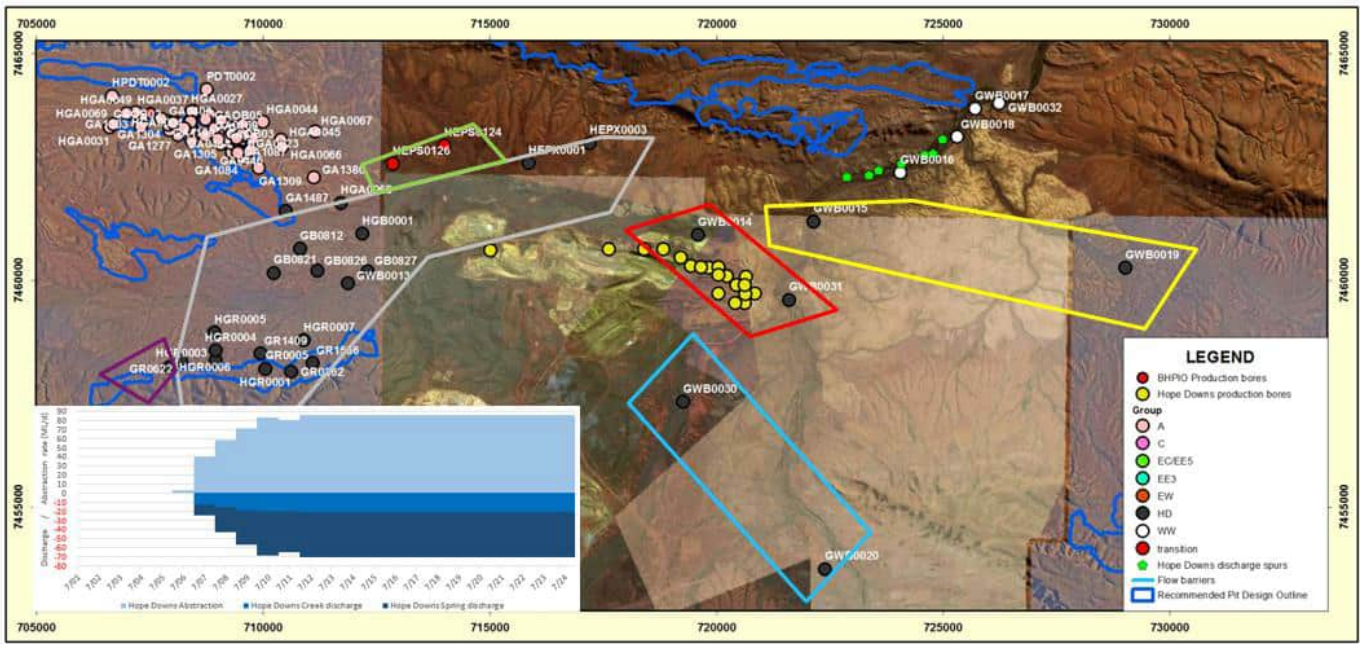


Figure L.2. Hope Downs aquifer system monitoring and estimated abstraction



The dataset within this compartment show several different type responses. All show drawdown, but to varying degrees. The key points are:

- The greatest response is directly north of Hope Downs dewatering (red group). BHPB have limited contemporary data, but it is assumed that heads would be less than 480 mAHD by 2024, indicating a total drawdown in excess of 90 in the regional dolomite here. The drawdown in the Hope Downs orebody is assumed to be greater than this.
- To the northwest and west (including MAC R Deposit) drawdown has been linear (white group), with heads reaching as low as 505 mAHD (65 m drawdown) by 2024. The only exception to this is HGR0006M which has higher heads than the rest and is probably situated on the western side of the R Deposit dyke (so therefore has higher heads and is buffered from the drawdown) and not in this compartment.
- Bores close to, or just in the calcrete, but distant from the Weeli Wolli aquifer system, (yellow group) show similar drawdown early on compared to the northwest and western area, but this levels off from about 2010 at 555 to 560 mAHD (drawdown of 10 to 15 m).
- To the south of Hope Downs (GWB0030M and 20M) data is only available up to 2013 (blue group). Both locations experience a linear drawdown up to that time. The last observations are in January 2013, by which time, the levels have reduced to 561 mAHD in GWB0030M and 566 mAHD in GWB0020M (both from around 573 mAHD prior to dewatering). Whether this drawdown has continued is not known but is fundamental to understanding the system response to the maturing Hope Downs drawdown expression south towards Bens Oasis and to the dyke east of South Flank.
- Interestingly both HEPS0124M and HEPX0001M have observed recharge events in early 2017, which exceed 1 m in 3 m respectively and hint at a large area of recharge beyond the main aquifer system (i.e. HEPS0124 is considered part of the transition zone between the A Deposit and Hope Downs aquifer systems, not in aquifer material in its own right).

It is also known that drawdown is occurring up to the western boundary of the BHPB Jinidi Deposit located to the east of Hope Downs (see following sections for details). This data shows that the area impacted from Hope Downs dewatering is very large, roughly 115 km^2. This, combined with what has been referred to (Pers. Comms Rio Tinto) as very high dolomite specific yield in that system, explains the high dewatering rates required at Hope Downs.

Key uncertainty. Lack of data recently and significant uncertainty with Hope Downs abstraction and discharge rates, locations etc. result in some uncertainty. The regional extent of affected area could be better known (if the

Rio data were available) including south to the South Flank dyke. All of this, especially the Hope Downs dewatering and discharge rates makes meaningful predictions at Weeli Wolli Spring problematic.

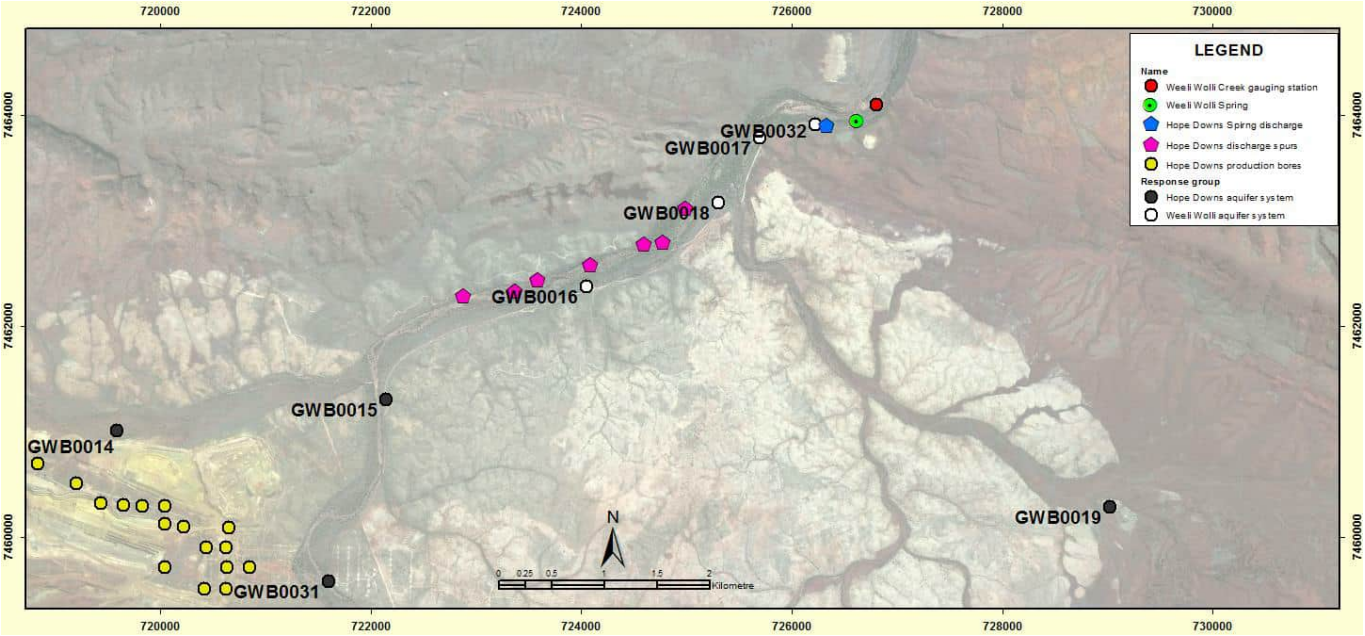
5.13 Weeli Wolli aquifer system (M)

5.13.1 Introduction

Data on which to base the conceptualisation of the Spring is derived from two main sources (**Figure M.1**):

- Monitoring bores along the Weeli Wolli Creek towards the Spring
- The (now destroyed) BoM Weeli Wolli gauging station (708016) on Weeli Wolli Creek approximately 250 m downstream of Weeli Wolli Spring

Figure M.1. Monitoring in the area of Weeli Wolli Spring



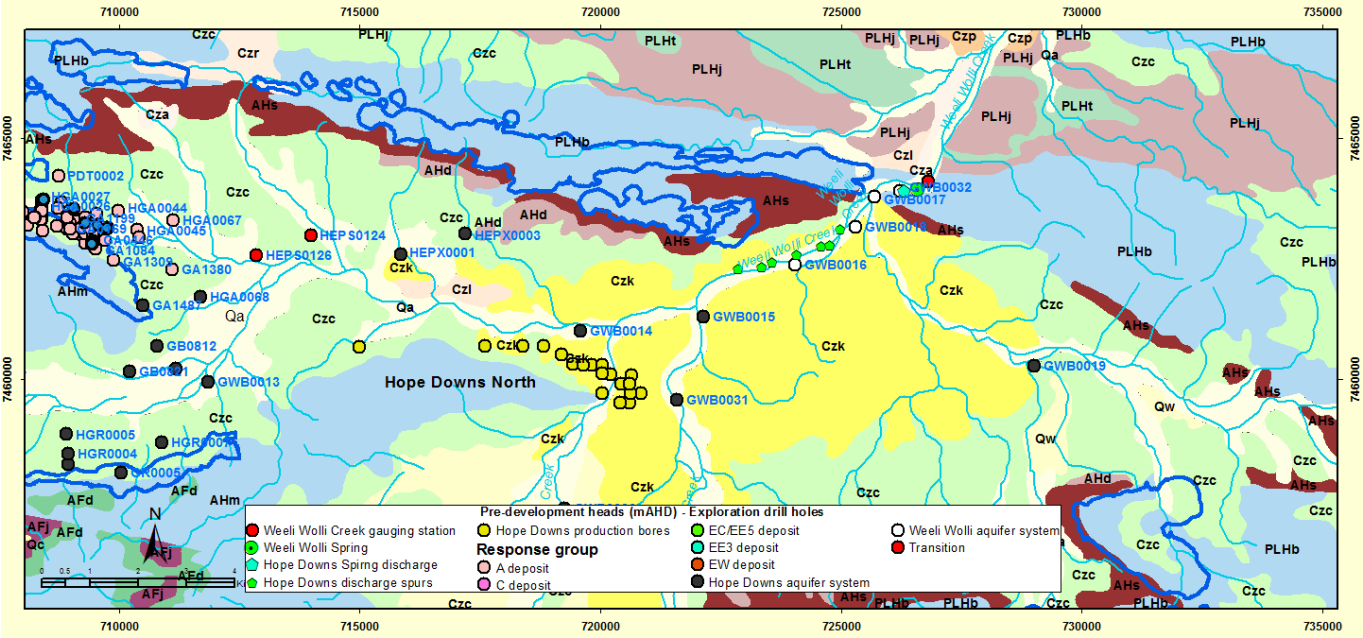
Seven groundwater monitoring bores were installed around the spring by BHPB and Hope Downs (in collaboration) during the environmental impact assessments (EIAs) for Mining Area C and Hope Downs (BHP 1997, Woodward Clyde 1997 and Hope Downs 2000). Four of these are within the main Weeli Wolli system and all are dual piezometers with discrete monitoring intervals in the detrital and basement aquifers. GWB00015M, a standard piezometer installation, is included in this analysis, but is probably in an area of transition between the Hope Downs and Weeli Wolli aquifer systems. All of these bores have been monitored since installation by Hope Downs and the data shared with BHPB. This information has provided an insight into groundwater between the alluvial and basement aquifers, on the response of the groundwater system to flood events and on the effects of dewatering and discharge since 2007 associated with Hope Downs.

The gauging station was active between 1997 and 2008, which includes the initial period of creek discharge from Hope Downs. The data shows that creek flows are ephemeral but there was a constant baseflow contribution from the Spring in the order of between 4 and 6 ML/d. This gauging station records streamflow from the Weeli Wolli catchment for the area above Weeli Wolli Spring (approximately 1,450 km^2), in effect measuring surface water outflow from the entire conceptual model domain.

5.13.2 Geology and hydrostratigraphy

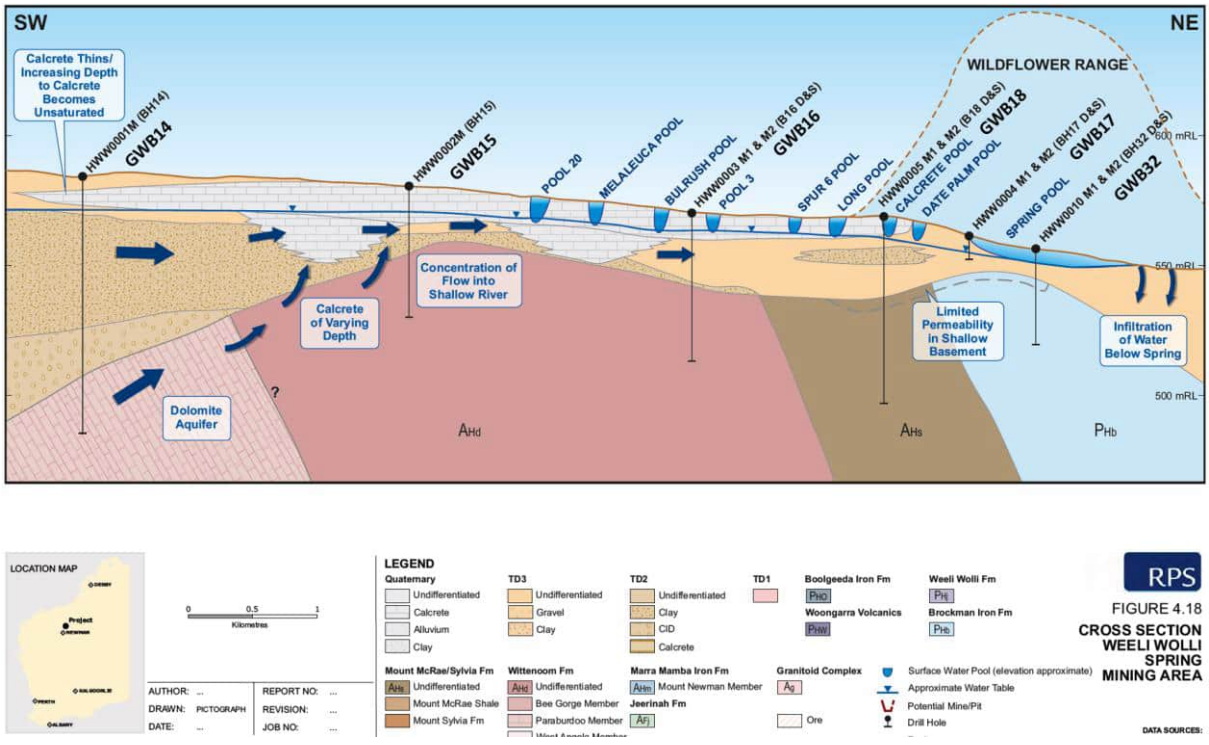
The Spring occurs where Weeli Wolli Creek passes through a gorge eroded through the Wildflower Range (**Figures M.2** and **M.3**). Groundwater flows are concentrated into the spring by low permeability basement rocks. A shallow groundwater system occurs up-gradient form the spring and is associated with an extensive zone of calcrete. Downstream of the gorge, the creek flows through a narrow channel past the confluence with Marillana Creek and ultimately into the Fortescue River Valley.

Figure M.2. Weeli Wolli aquifer system outcrop geology



Nb. Geological codes: Qa = Quaternary, Czk = Calcrete, Cza, Qw and Czc = Alluvium / Colluvium, AHm = Mount Newman, AHs = McRae Shale / Mount Sylvia, AHd = Wittenoom Formation, PLHj = Weeli Wolli Formation, PLHb = Brockman Iron Formation.

Figure M.3. Weeli Wolli aquifer system cross section



In places where groundwater levels are shallow and calcrete occurs as extensive outcrops it is possible that calcrete is still actively forming (based on the morphology of groundwater calcrete in Australia (Horwitz and Mann 1979). In such settings, calcrete formation occurs just below the groundwater table and occurs typically over a wide area where groundwater is at shallow depth. Active calcrete formation at the watertable pushes the overlying calcrete upwards. Ultimately, a plateau or dome of calcrete emerges, with the youngest units at its base (around the watertable). The plateau is dissected by streams flowing across it, as is the case upstream of Weeli Wolli Spring. In such environments, there will be a saturated zone (of approximately 5 to 10 m) of high permeability calcrete at the watertable.

The calcrete deposit varies between 0 and 40 m thick and the top of the calcrete occurs from outcrop to depths of up to 25 mbgl. The area of outcrop is concentrated in an inverse fan over an area up to 7 km upstream (south) of the spring. Calcrete extends over an even wider area, occurring in the Tertiary sequence of both the North and South Flank valleys. However, from the upstream edge of the "inverse" fan, the calcrete is covered by increasing amounts of Tertiary Detritals. The surface of the calcrete occurs at increasing depths below ground level and it progressively thins and eventually becomes unsaturated approximately 10 km upstream of the spring. The calcrete aquifer is considered likely to support a high abundance of stygofauna; although stygofauna have been discovered over a much wider area around Weeli Wolli Spring and in other (non-calcrete) Tertiary Detritals (Hope Downs, 2000).

The calcrete is underlain by poorly sorted alluvium of clay, sands and gravels with minor pisolite to depths between 10 mbgl and 75 mbgl. All of this constitutes the Tertiary Detritals (TD2 sequence) which then overlies the basement rocks. Given the diverse nature of Tertiary sediments and on their clay content and degree of cementation, their permeability is likely quite varied.

In the area of Weeli Wolli Spring and the calcrete aquifer immediately upstream, the bedrock comprises:

- Paraburdoo (weathered and high permeability) and Bee Gorge members (low permeability) of the Wittenoom Formation, with the latter stratigraphically higher and closer to the Spring than the former (**Figure M.3**). These deposits occur at depths of between 40 to 70 mbgl, shallower towards the spring as the more weathering resistant Bee Gorge Member subcrops.
- Mount Sylvia Formation (low permeability).
- Mount McRae Shale (low permeability).
- Brockman Iron Formation (unmineralised - low permeability).

The Brockman and Mt McRae are particularly resistant to erosion and form a prominent ridge (Wildflower Range) along the northern extent of the catchment. Weeli Wolli Creek flows through this ridge (across the regional geological strike) along a narrow fault-controlled valley. Under the creek, the erosion-resistant Brockman and Mt McRae rise to shallow subcrop.

Weeli Wolli Creek downstream of the spring also follows the fault-controlled valley with a NE orientation. However, there is no evidence in available drilling records that the fault has resulted in enhanced permeability in the basement. Even where drill-cuttings have indicated a possible fault zone (e.g. GWB0018), it is noted that fracturing is weak, infilled with carbonate and well-healed. This is consistent with Kepert (2001) who notes that faults in the North Flank Valley are characteristically less than 30 cm in width with little brecciation, and Solid Geology (2013) who found no evidence of permeability in NE orientated faults in the North Flank Valley.

As noted above, the basement formations north of the Paraburdoo Member are low permeability. Thus the main aquifer in proximity to the spring is the Tertiary Detritals, particularly the calcrete and most groundwater flow occurs within this alluvial sequence.

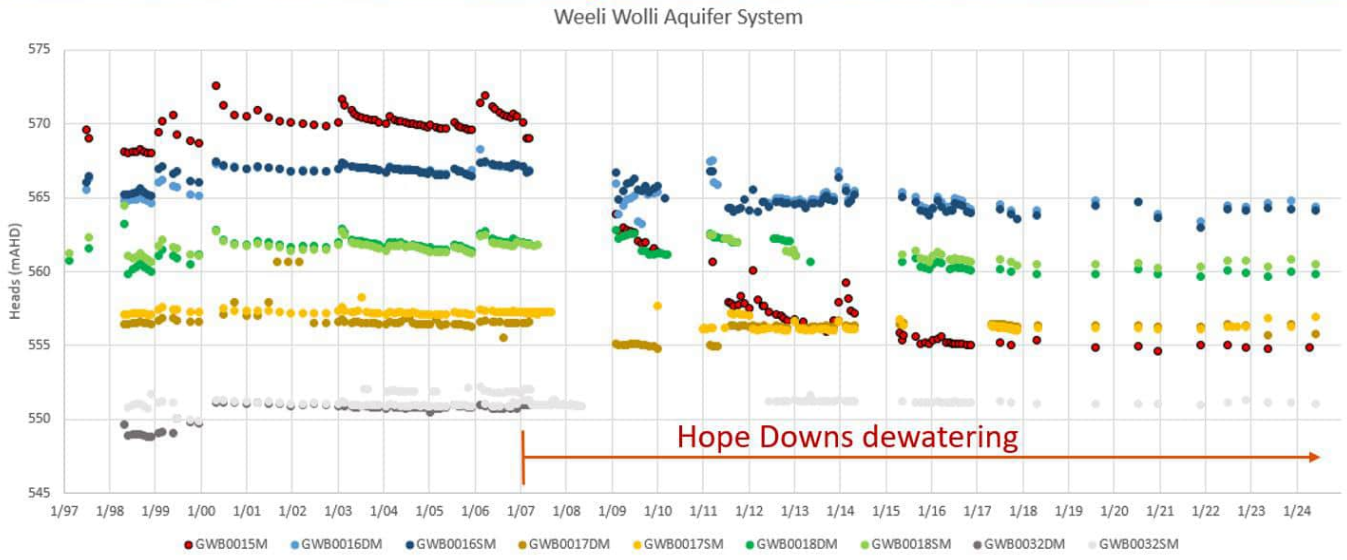
Where the calcrete occurs as outcrop, it is incised by Weeli Wolli Creek. The incised channel is infilled with Quaternary alluvium that comprises an active creek channel, terraces and flood-plains of gravel, silt and clay. The main vegetation stands occur in these alluvial channels where the silt and sand provides better soil conditions than the calcrete, and where the incision of the channel brings the root zone into close proximity to the watertable.

5.13.3 Groundwater levels

Observed groundwater levels are shown in **Figure M.4** and discussed below.

Figure M.4. Weeli Wolli aquifer system monitoring and hydrographs





Pre-development (pre 2007)

The data shows that prior to dewatering at Hope Downs:

- There was a steep gradient towards the Spring. From GWB0016M to GWB0032M (a distance of 2,800 m the head falls 10 m) the gradient is 0.0036.
- There was a much lower gradient immediately to the southwest in the Hope Downs aquifer system. From GWB0014M to GWB0015M (a distance of 2,000 m the head falls about 1.5 m) the gradient is 0.0008.
- There are vertical gradients in all of the dual piezometer bores (i.e. between the alluvium and bedrock). Upgradient of the Spring the gradient is from the lower piezometer to the higher (i.e. towards the surface). Downgradient of the Spring (i.e. at GWB0032) the gradient is from the higher piezometer to the lower (i.e. downwards) and is significant (5 m).
- Several recharge events occur and the heads vary by 1 or 2 metres between 1998 and 2007.

- Groundwater level recession from larger recharge events occurs over periods of several months to a year in the bores upstream of the spring (GWB0014M and GWB0016M). Water levels in the bores close to the spring fall much more quickly probably because the spring itself facilitates more rapid groundwater dissipation. The elevated groundwater levels upstream of the spring are likely to contribute to increased spring baseflow throughout the period of recession.
- The greater frequency of recharge events at, and immediately upstream of the spring (than elsewhere in the catchment) and the rapid rise in groundwater levels suggests much of the recharge occurs locally as infiltration from creek flows as floods cross the calcrete outcrop. This is consistent with the results of isotope studies in the area (Dogramaci and Dodson 2009).

Post-development (post 2007)

The groundwater conditions near Weeli Wolli Spring have changed significantly due to the impacts of mining (primarily dewatering at Hope Downs North). There is now a groundwater divide which has developed in the vicinity of GWB0015 and GWB0016 (around halfway between Hope Downs North and the Spring). Northeast of the divide flow has remained towards the spring. The hydraulic gradient close to the spring remains about the same as that of pre-mining conditions.

The time variant head observations show that the response to Hope Downs dewatering decreases with proximity to the spring, estimates of which are provided below up to the end of 2024 (complicated somewhat however by spurious data and a gap in monitoring between 2007 and 2009 during which natural recession as well as drawdown may have occurred):

- GWB0015M (Hope Downs aquifer system): 15 m
- GWB0016M: Between 2 and 4 m
- GWB0018M: Between 0.5 and 2 m
- GWB0017M: Less than 0.5 m
- GWB0032M: Undiscernible.

5.13.4 Flow estimates

Discharge

It is thought that there are three main discharge mechanism at play within the Weeli Wolli Creek / Spring system:

- Spring flow
- Evapotranspiration
- Throughflow to the groundwater catchment downstream

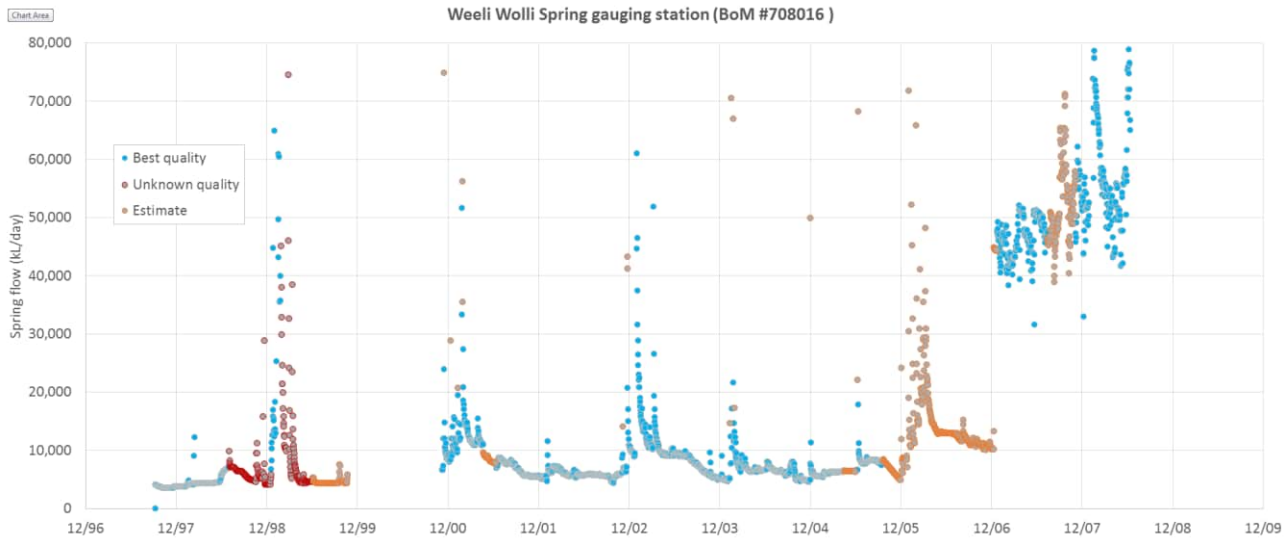
Spring flow can be estimated from the gauging station downstream of the Spring, which registered a constant flow of between 4 and 6 ML/d prior to surplus water discharge (**Figure M.5**), as opposed to the ephemeral, short term, nature of the large flows recorded after rainfall events.

Vegetation mapping and an assessment of vegetative water use around the spring was undertaken during the Hope Downs EIA using tree sapflow measurements (Hope Downs 2000). This work confirmed the presence and distribution of phreatophytic species over some 750 ha and estimated that evapotranspiration was in the order of 3 ML/d.

Throughflow within the groundwater system beneath the Spring is harder to define, but will make up the difference between catchment wide recharge and discharge via Spring flow and EVT.

Numerical modelling provides some indications, but over the many iterations of modeling these numbers and ratios, particularly throughflow and EVT, have varied.

Figure M.5 Weeli Wolli Spring gauging station data



Recharge

Mechanisms of recharge to Weeli Wolli Spring and the calcrete aquifer upstream of the spring include groundwater throughflow from the upstream catchment and infiltration of surface water runoff events. The frequency of recharge events recorded in the groundwater level monitoring suggests the calcrete is likely to be an area of enhanced groundwater recharge. This is due to a higher frequency of runoff events in the lower catchment, high permeability calcrete at outcrop and the proximity of the watertable to the surface. Analysis of hydrographs and application of a simple storage accretion model suggests that up to 2.5 ML/d of recharge (on average) occurs locally in the vicinity of the spring and calcrete (RPS, 2014). The post-flood peak and recession in baseflow represent the drainage of this local recharge.

The latest numerical modelling (both in the 2014 and 2016 studies) employed a recharge of 2.6 ML/d to the Weeli Wolli aquifer system. However, this value was set to match analytical estimates, rather than being adjusted as part of the calibration.

5.13.5 Conclusion

The Weeli Wolli aquifer system seems to be quite well buffered from the significant drawdown observed in the Hope Downs aquifer system. The data analysis above suggests that this is due to a combination of factors:

- Lower transmissivity and lateral extent of Weeli Wolli aquifer system compared to the Hope Downs system.
- High localised recharge directly into the Weeli Wolli aquifer system (at what is likely the highest rate of all the recharge zones in the Central Pilbara groundwater catchment).
- A very high rate of discharge of Hope Downs surplus water to the Weeli Wolli Creek, a significant proportion of which will recharge the Weeli Wolli aquifer system.

Schematics of the Weeli Wolli aquifer system conceptual model, both pre and post Hope Downs dewatering and discharge, are shown in **Figures M.6** and **M.7**.

Figure M.6. Weeli Wolli aquifer system conceptual cross section – pre-development

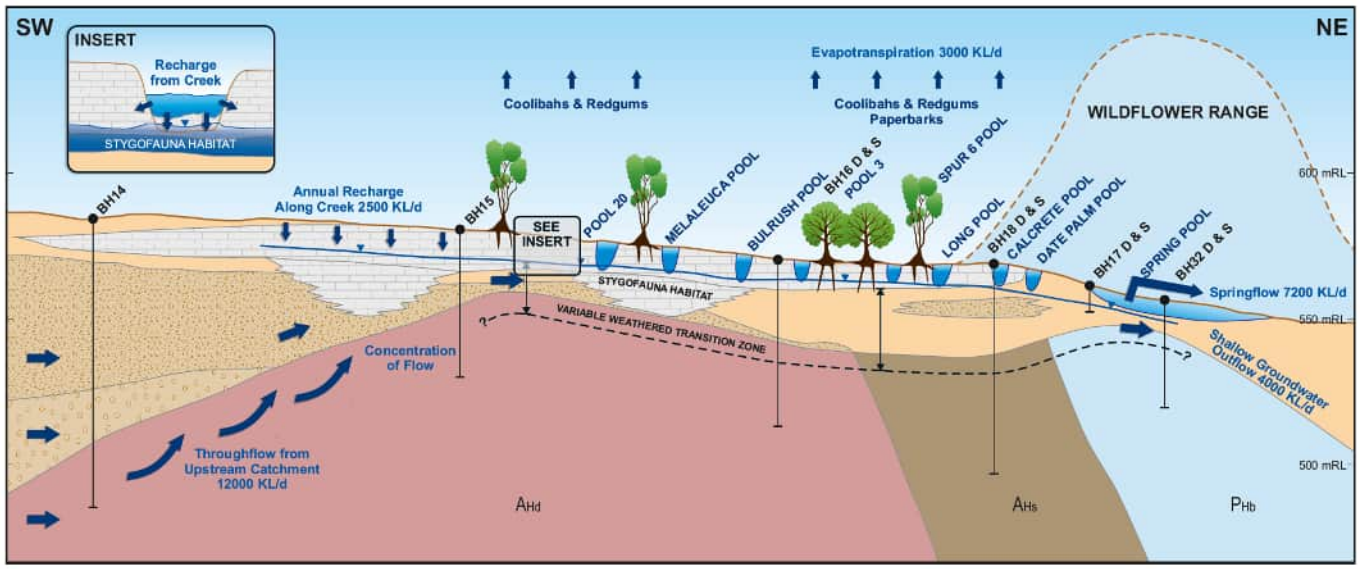
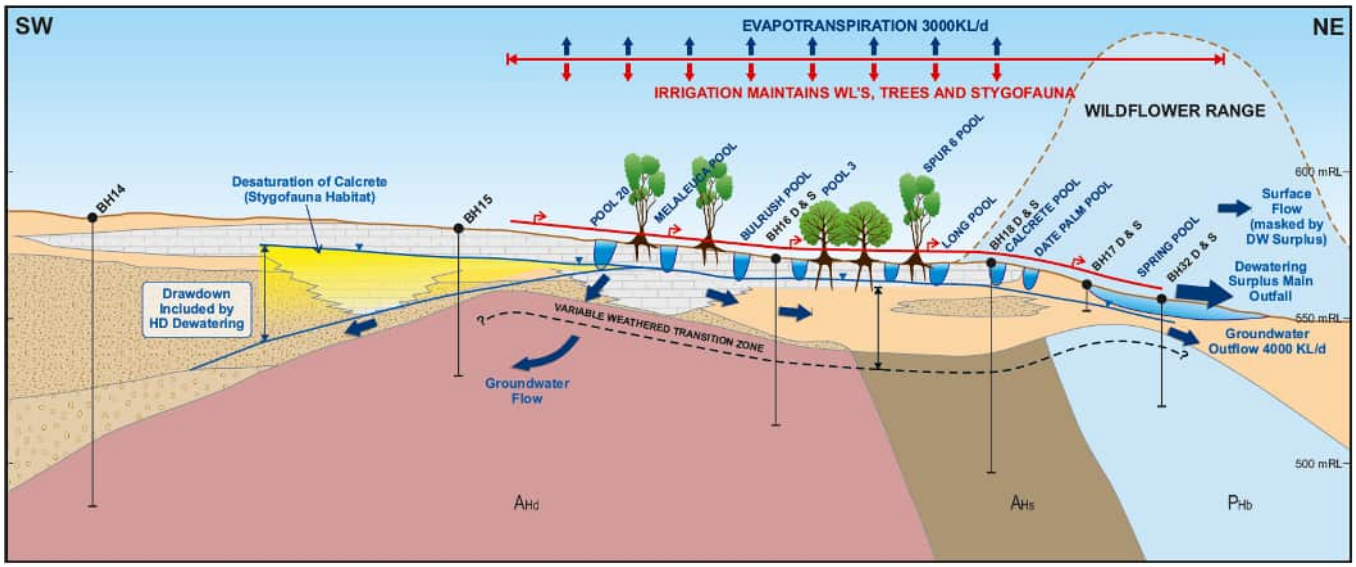


Figure M.7. Weeli Wolli aquifer system conceptual cross section – post-development



Key uncertainty. There are three main uncertainties:

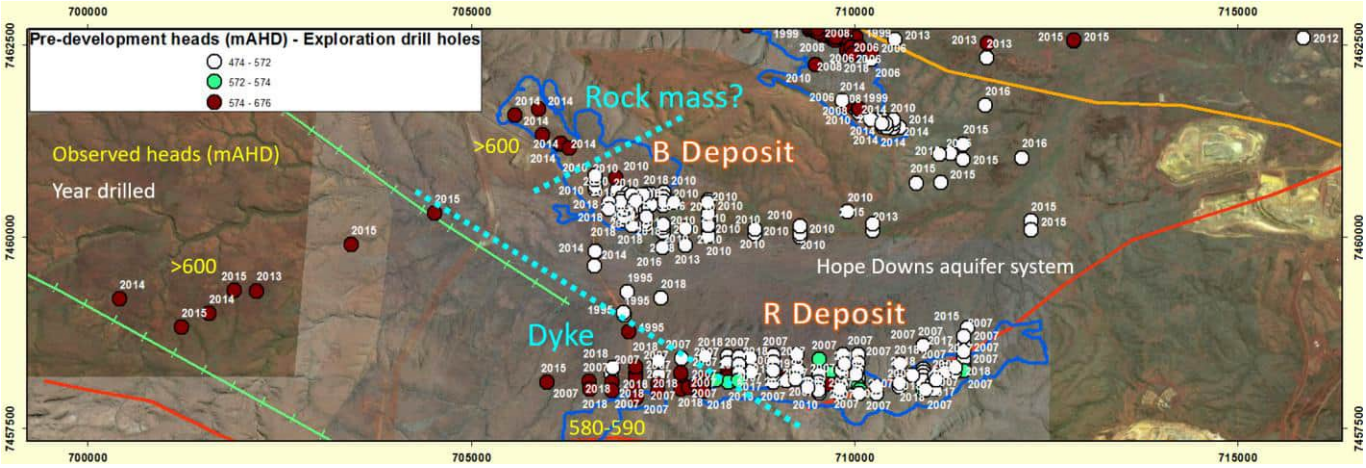
- Geology is relatively well known along the creek, but away from that, in the main zone of calcrete there is very little data. The understanding is therefore extrapolated from the creek.
- The various discharge and recharge components are hard to measure and probably present non-unique solutions in numerical modelling.
- The rate and location of Hope Downs discharge to the creek.

5.14 North Flank – R and B Deposits (N)

Groundwater level observations around R and B Deposits confirm that these orebodies lie, at least in part, within the Hope Downs aquifer system.

Exploration drilling has occurred during a few periods at around the time Hope Downs dewatering commenced and since. This data is shown in **Figure N.1** and reveals something of the flow barriers in this part of the catchment.

Figure N.1. R and B Deposit exploration water levels



This suggests that both R and B Deposits are transacted by flow barriers. The one through B Deposit appears to align with the one through the eastern part of A Deposit (so may be rock mass related), whereas the one through R Deposit matches the location of a mapped dyke, which is aligned with the dyke that passes between EE3 and C Deposits and just east of Ben's Oasis.

There are 53 monitoring / production bores installed at R Deposit. Of these 17 have groundwater level observations (**Figures N.2 and N.3**). Additionally, bore GWB0013M is located approximately 1 km north of the eastern part of the R Deposit pit and provides a longer-term record of the water levels (observations since 1997). There are no vibrating wire piezometers (VWPs) at R Deposit.

The data shows that:

- The water levels can be split into eastern and western groups, separated by the major NW/SE trending dyke.
- Monitoring is not available prior to Hope Downs dewatering. It is therefore uncertain what the pre-development water level on the western side was. The water levels on the eastern side match those at GWB0013M. So, it is most likely that pre-development water levels on the eastern side were between 571 and 574 mAHD between 1997 and 2006.
- The exploration bores are ambiguous when it comes to the pre-development water levels (**Figure N.4**). However, when only those recorded in 2007 (these are already being impacted by Hope Downs dewatering) are displayed (**Figure N.5**), they suggest that the groundwater system may be divided by two dykes (not one), and the pre-development water levels are:
    - 570 – 575 mAHD on the eastern side of the main dyke
    - 582 – 587 mAHD immediately west of the main dyke (i.e. between the dykes), then
    - 594 – 597 mAHD west of a smaller dyke further to the west.
- The water levels on both sides of the eastern dyke are falling. The decline is more rapid on the eastern side (the Hope Downs groundwater compartment side). In 2024 the decline had reached approximately:
    - 60 to 70 m on the eastern side of the main dyke (now between 505 and 516 mAHD)

- 20 to 30 mAHD (the higher value is extrapolated from earlier data) between the dykes
- An unknown value to the west of the westernmost dyke.

- GR0005RM presents an elevated water level (580 mAHD) compared to what is expected given its location (eastern side). However, its screened lithology is unknown and data is available for less than one year. It is adjacent to HGR0001P which returns water levels in the expected range (571 mAHD). There is no way of telling whether this data is erroneous or represents elevated water levels in this area.
- There are no observations in the south wall. At some point however the R Deposit water levels (571 to 574 mAHD (pre-development)) transition into the South Flank Vista Oriental water levels (>640 mAHD). The South Flank VOVI pit is approximately 3 km southwest of R Deposit.
- Exploration bores hint at these higher heads in the south wall.
- There are no observations around Hope Downs South. It is not known whether dewatering here is also impacting R Deposit.

Figure N.2. R Deposit monitoring bores (with / without data)

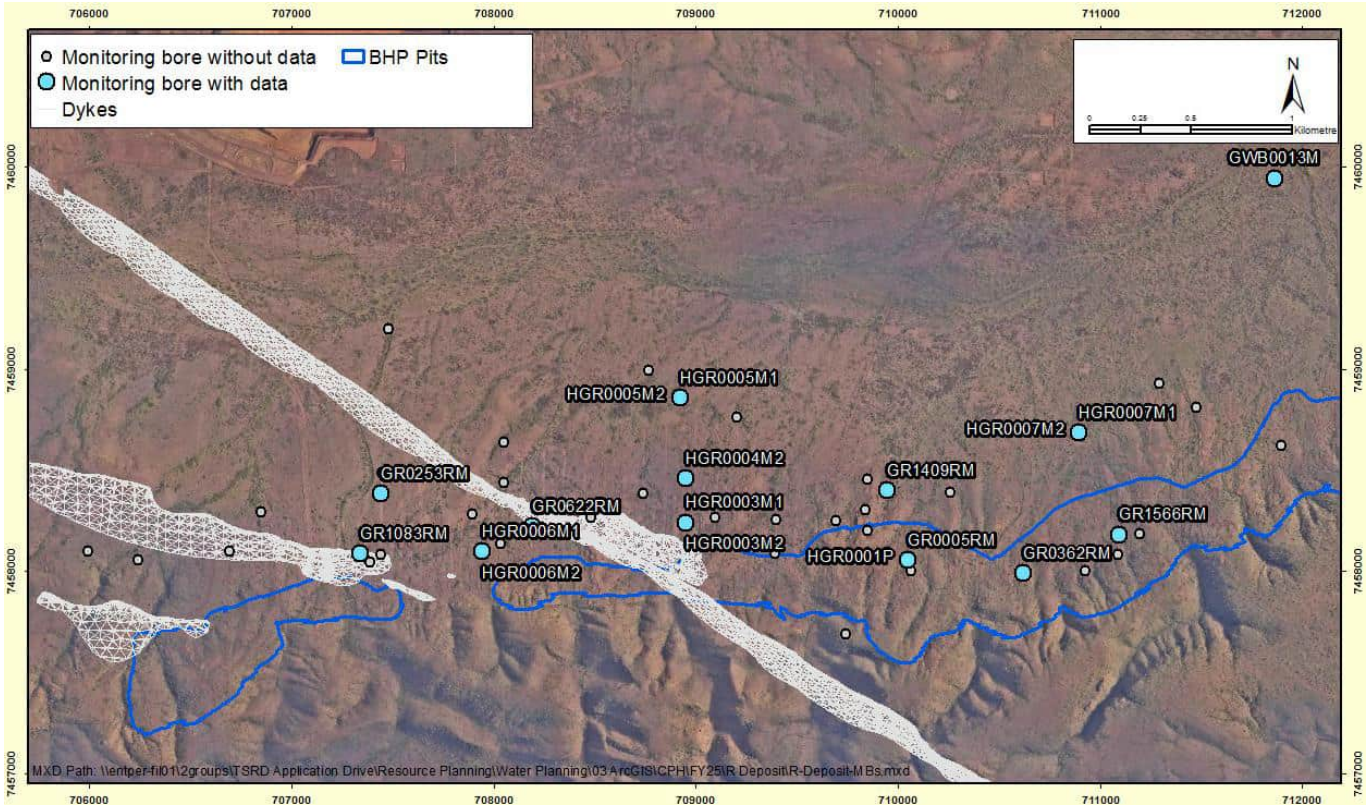


Figure N.3. R Deposit groundwater levels

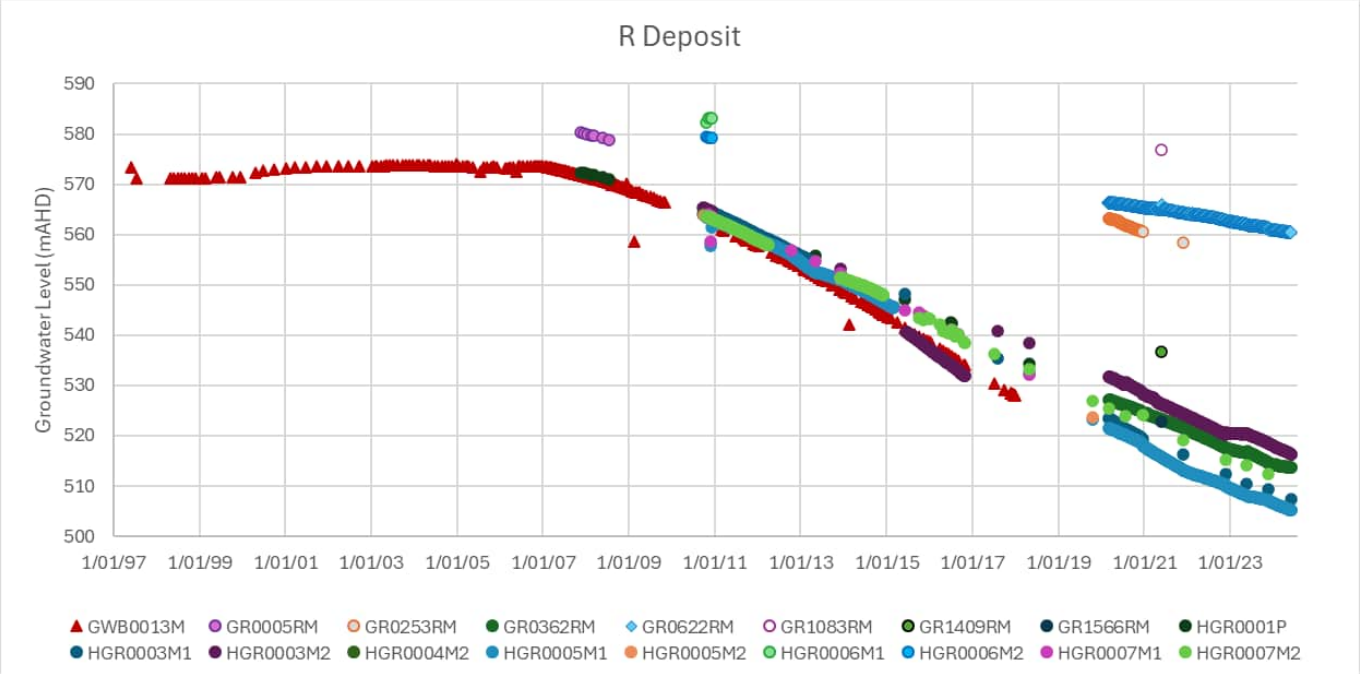


Figure N.4. R Deposit exploration groundwater levels and transient bore groups

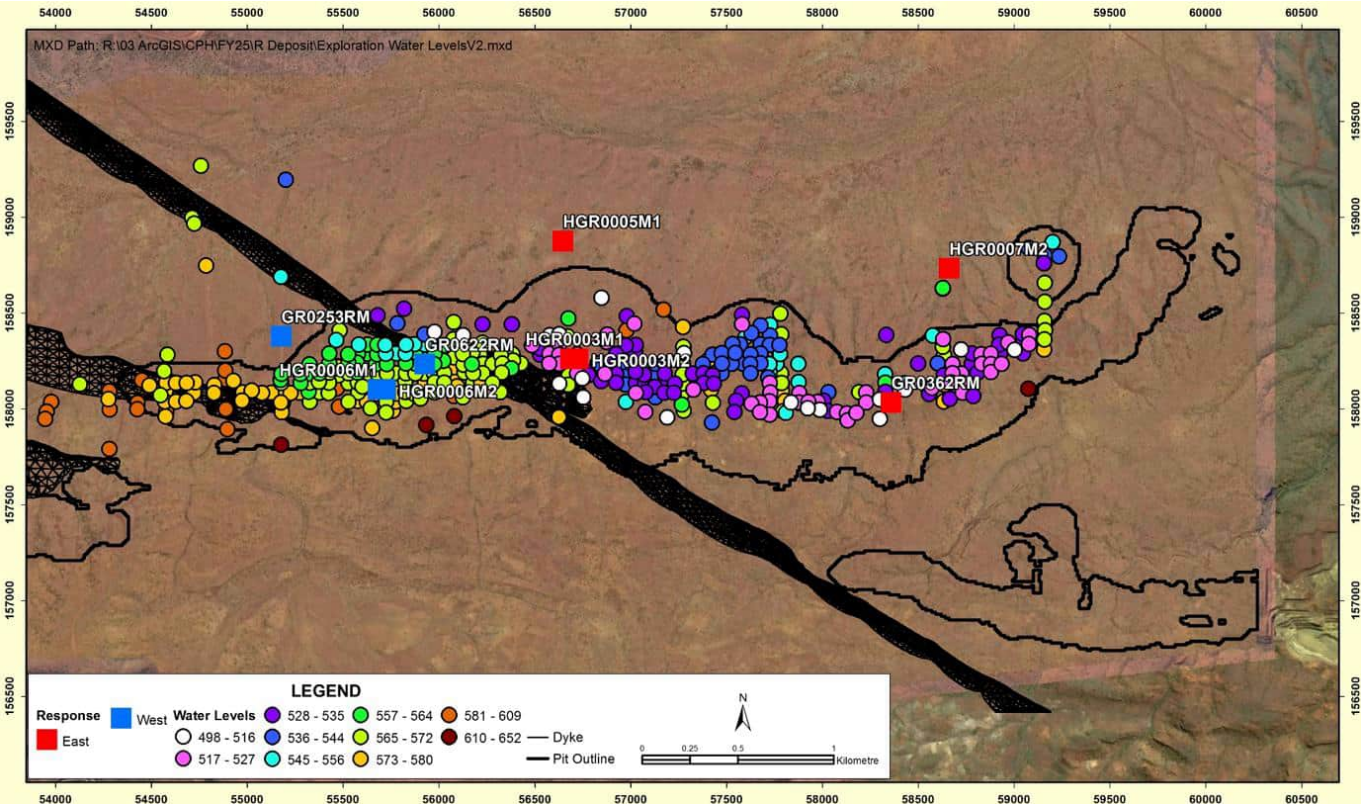
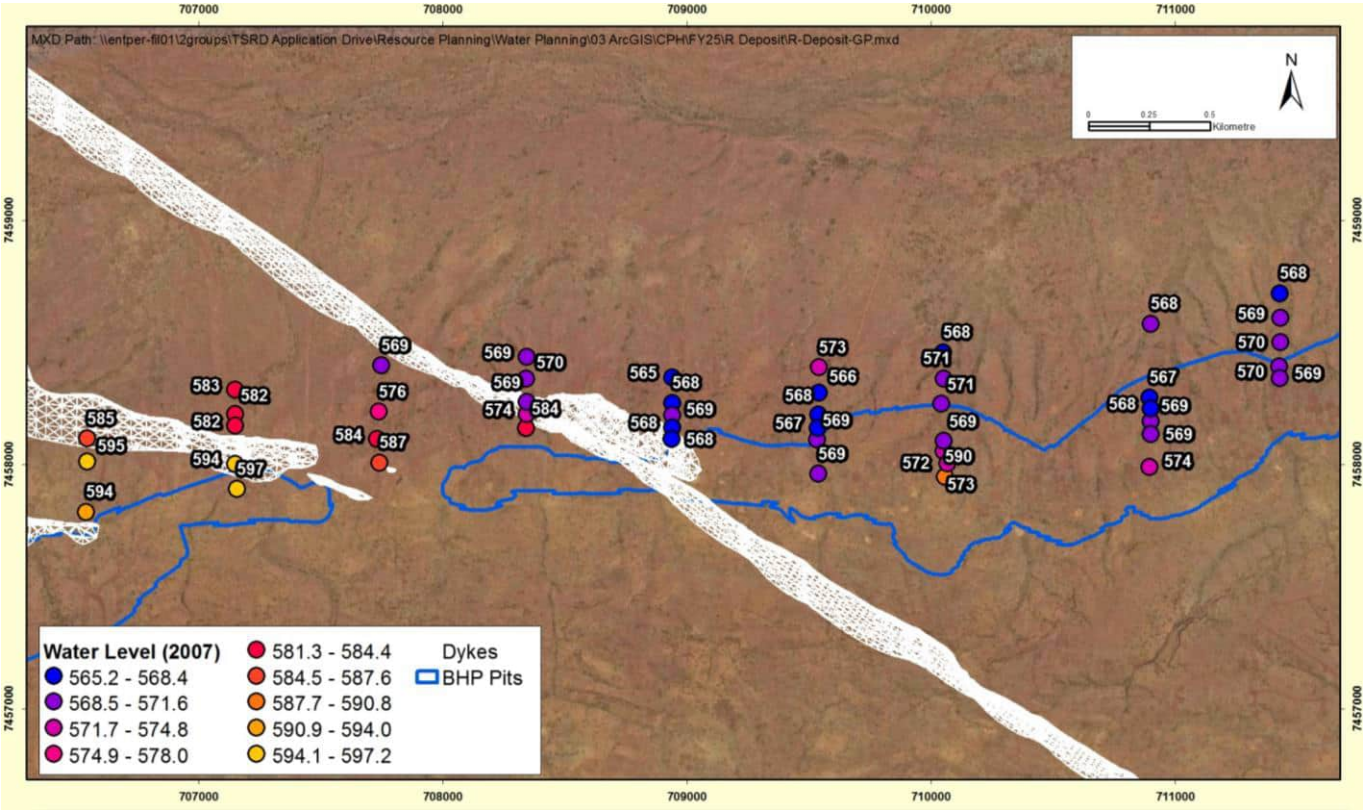


Figure N.5. R Deposit exploration groundwater levels – 2007 only



There are six monitoring bores installed in B Deposit that have at least one water level observation (**Figure N.6**). Only one of these has more than one observation (**Figure N.7**). These data show that:

- There is no monitoring west of the flow barrier identified by the exploration data
- The groundwater levels east of the flow barrier have fallen significantly and are only a few metres higher than the levels at GWB0013M (over 4.5 km to the east). In 2024 the water level in the eastern part of B Deposit is 510 mAHD, which equates to a drawdown of just over 60 m due to Hope Downs dewatering.

Figure N.6. B Deposit monitoring bores

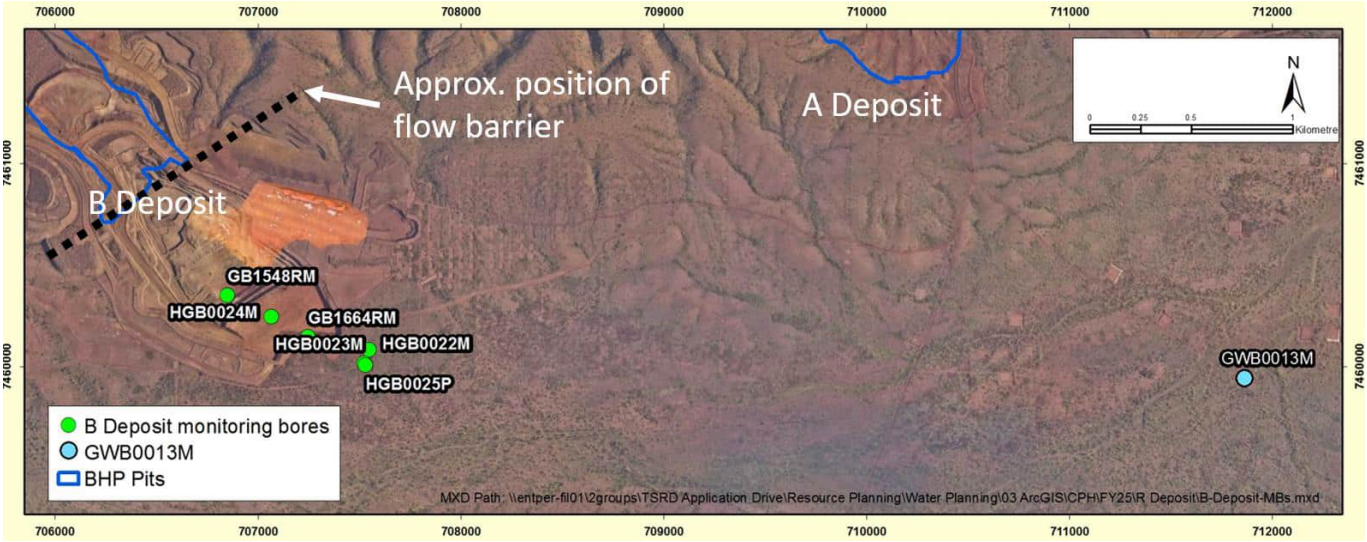
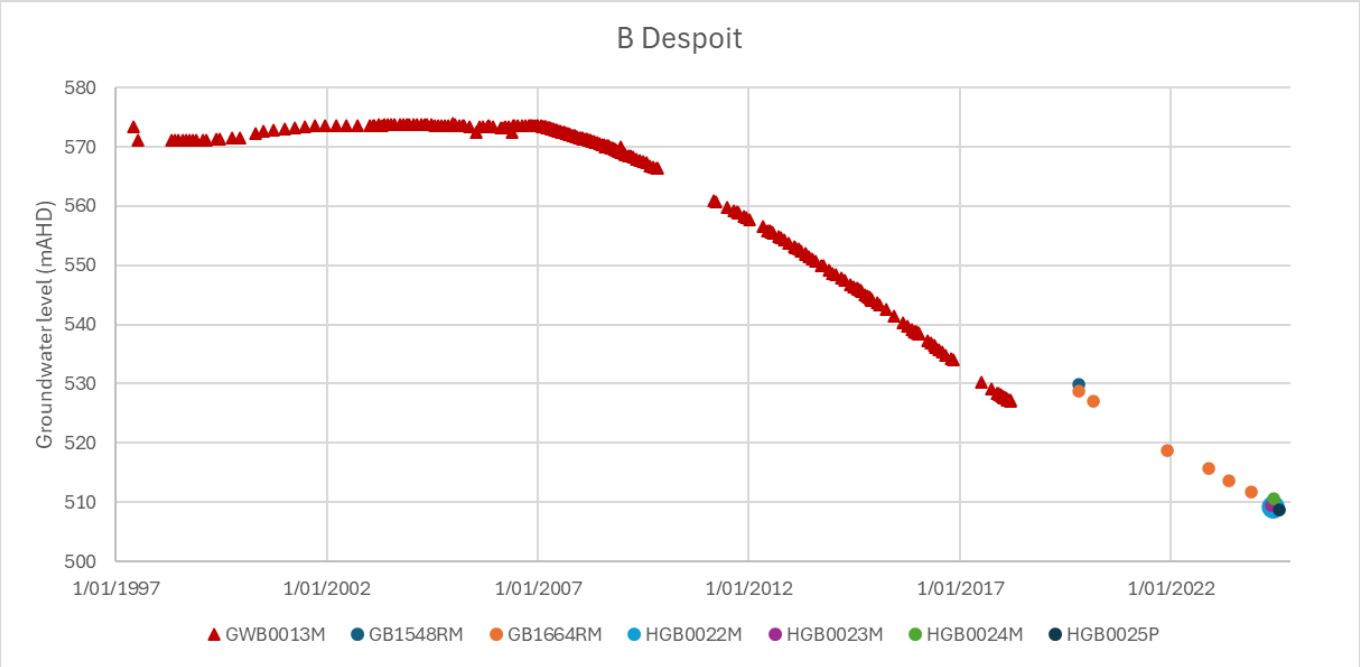


Figure N.7. B Deposit groundwater levels



At R Deposit, the data show then that:

- The orebody is transacted by two dykes.
- The eastern side of R Deposit (east of the easternmost dyke) is in the Hope Downs aquifer compartment, and water levels here are being drawn down significantly. The orebody and adjacent regional aquifer therefore present high transmissivity. This area comprises approximately two thirds of the deposit.
- The easternmost dyke behaves as a leaky flow barrier. Water levels are being drawn down in this area (i.e. between the two dykes) but at a lesser rate than to the east.
- There is no transient water level monitoring west of the westernmost dyke. It is therefore not known how well this area is hydraulically connected to the eastern areas (and Hope Downs).

And at B Deposit:

- The orebody is divided in two (roughly 50/50) by a flow barrier.
- The southeastern side is hydraulically part of the Hope Downs aquifer compartment and presents high transmissivity (as does the surrounding regional aquifer).
- It is not known to what extent the northwestern side is hydraulically connected to the Hope Downs aquifer compartment.

5.15 Jinidi Deposits (O)

The groundwater system around the Jinidi mining area appears to be controlled by several flow barriers. Analysis is complicated somewhat by having no groundwater monitoring in the area prior to Hope Downs dewatering. The first groundwater level collection occurred in 2011, at which time drawdown is likely to have reached the area. However utilising both exploration drilling data (some of which pre-dates dewatering) and the time variant data **(Figures O.1, O.2** and **O.3**) an analysis is possible.

Figure O.1. Jinidi exploration drilling water levels

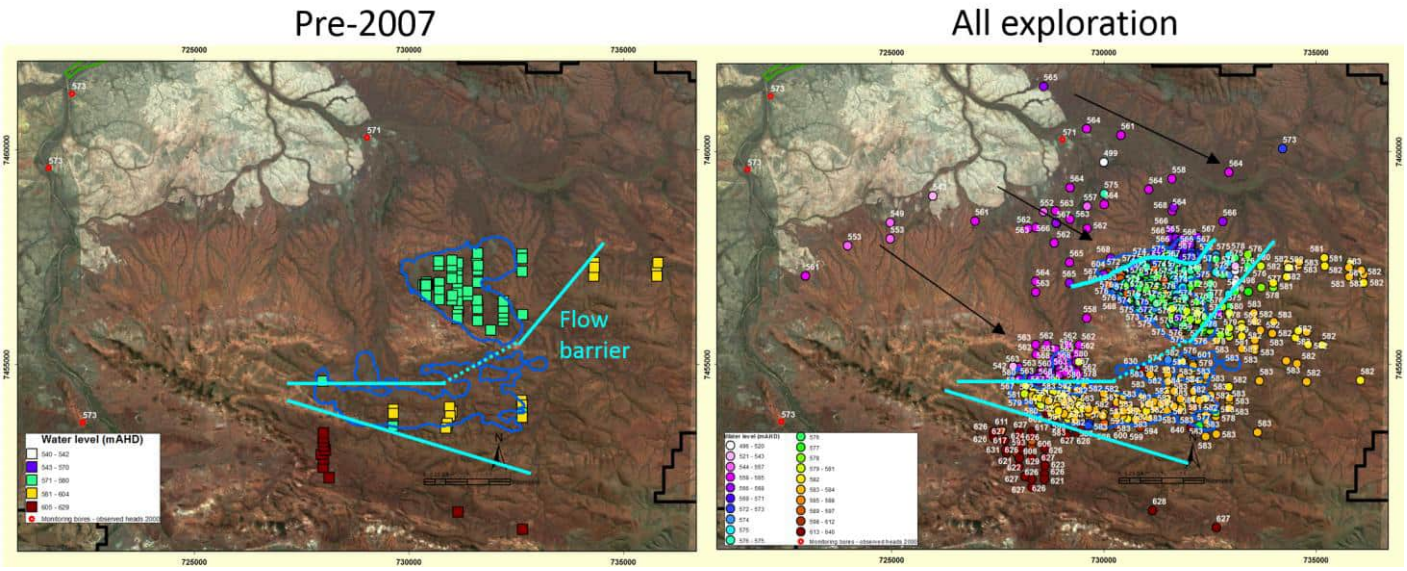


Figure O.2. Jinidi time variant monitoring

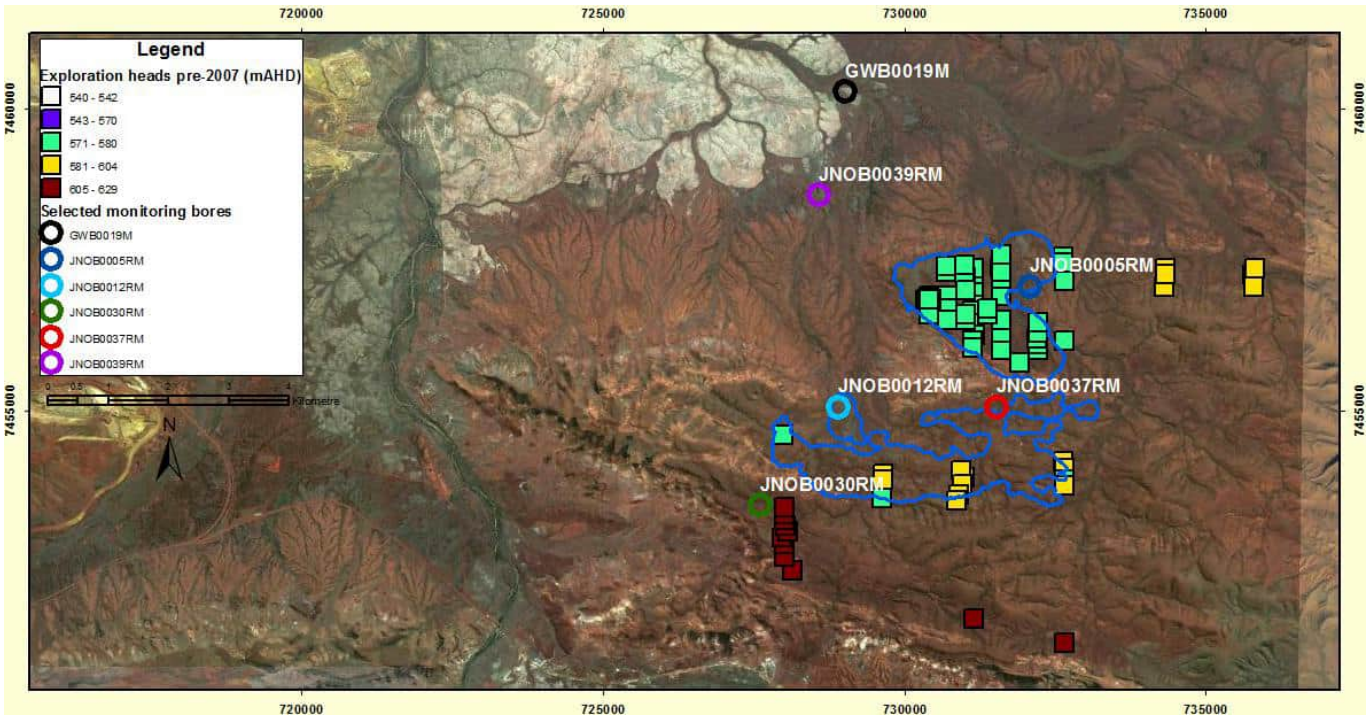
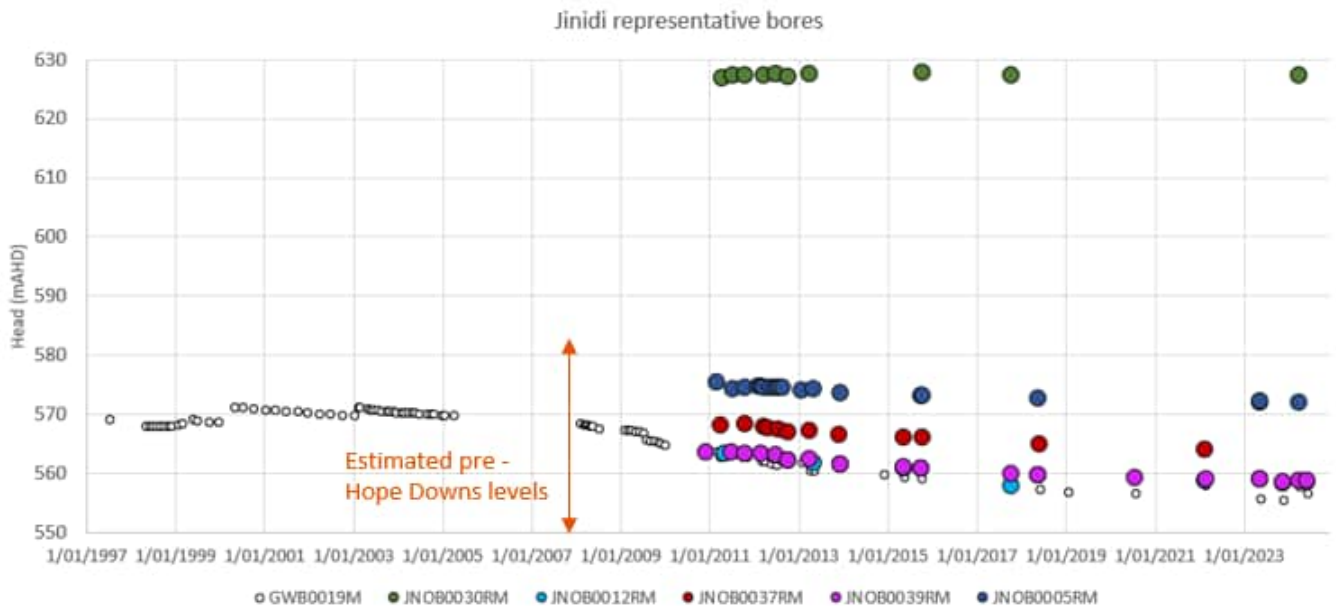


Figure O.3. Jinidi hydrographs



The data suggest that:

- There are several distinct head levels within the Jinidi area. These may be due to:
    - flow barriers and/or
    - rock mass hydraulic property differences.
- Drawdown has migrated into the northern part of Jinidi (JNOB0005RM) and the area between the orebodies (JNOB0012RM and 37RM) from Hope Downs dewatering
- Drawdown has not migrated south of Jinidi (JNOB0030RM)

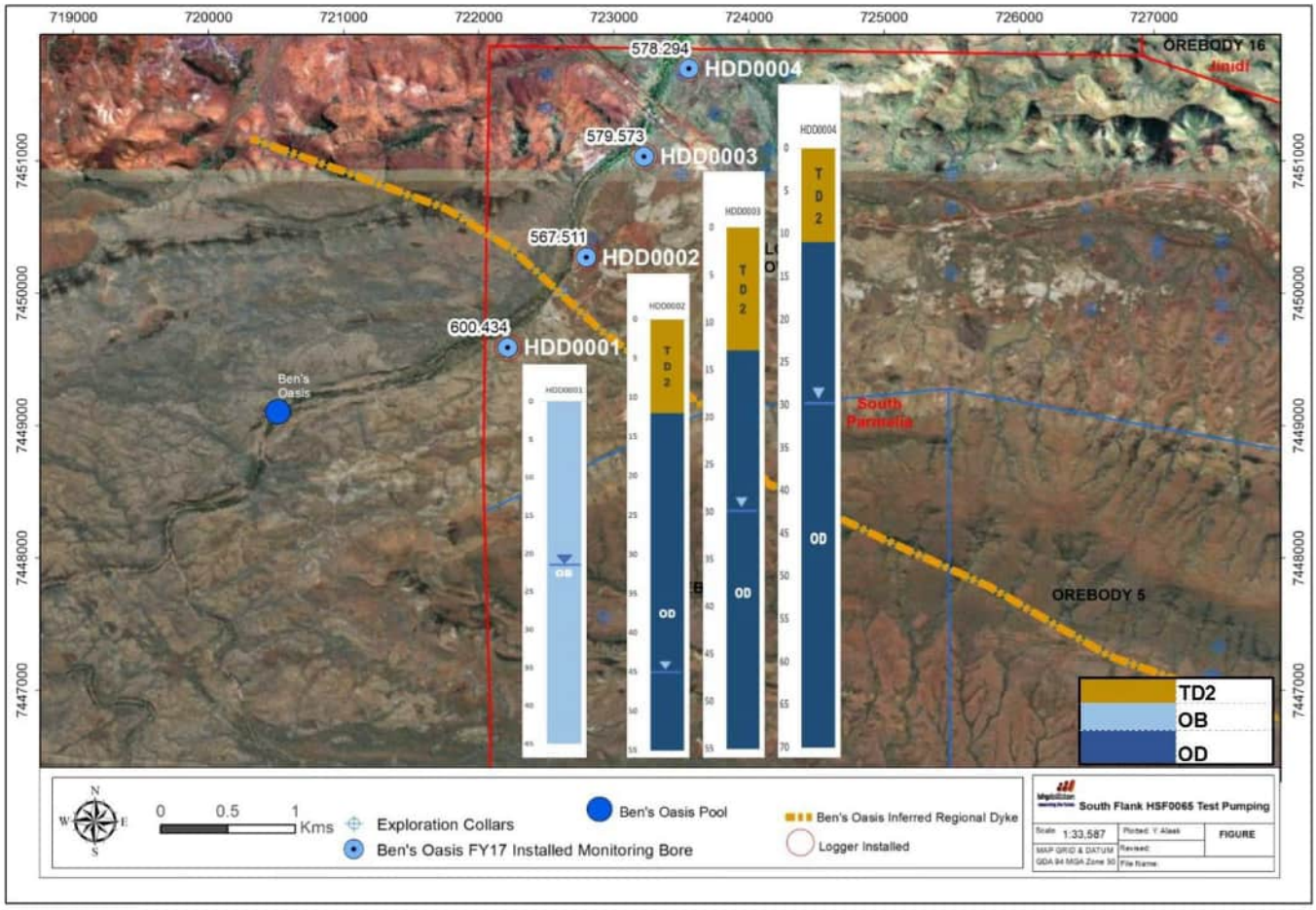
As mentioned above, the exact magnitude of drawdown at the Jinidi bores is uncertain due to the lack of reliable baseline data, however, the behaviour of the heads in the orebody bores (seemingly on the other side of flow barriers) from 2011 is almost identical to the head at bore GWB0019M (just on the edge of the calcrete outcrop). This suggests that since Hope Downs commenced dewatering the drawdown at these orebody bores has probably matched that at GWB0019M. It is likely then, even though the data shows such marked differences in head around Jinidi, that drawdown has been relatively even throughout the system. The only area where drawdown has not penetrated seems to be the area south of Jinidi, where the high pre-2007 heads have not changed significantly.

Key uncertainty. Jinidi orebodies seem to be part of a separate groundwater compartment from the Hope Downs system. The data suggests this although there is significant uncertainty in the exact nature of the mechanism behind the separation and the orebody characteristics. This is unlikely to have a major bearing on the dewatering rates or impacts from the other mines in eth catchment.

5.16 Ben's Oasis (P)

Ben's Oasis is a named water hole (spring) along Weeli Wolli Creek which has significant environment and heritage values. A groundwater investigation was undertaken in 2016 in the area, with the aim of better understanding the flow mechanisms and to install monitoring bores. The geological and head data (2016) is shown in **Figure P.1**.

Figure P.1. Ben's Oasis monitoring and hydrographs

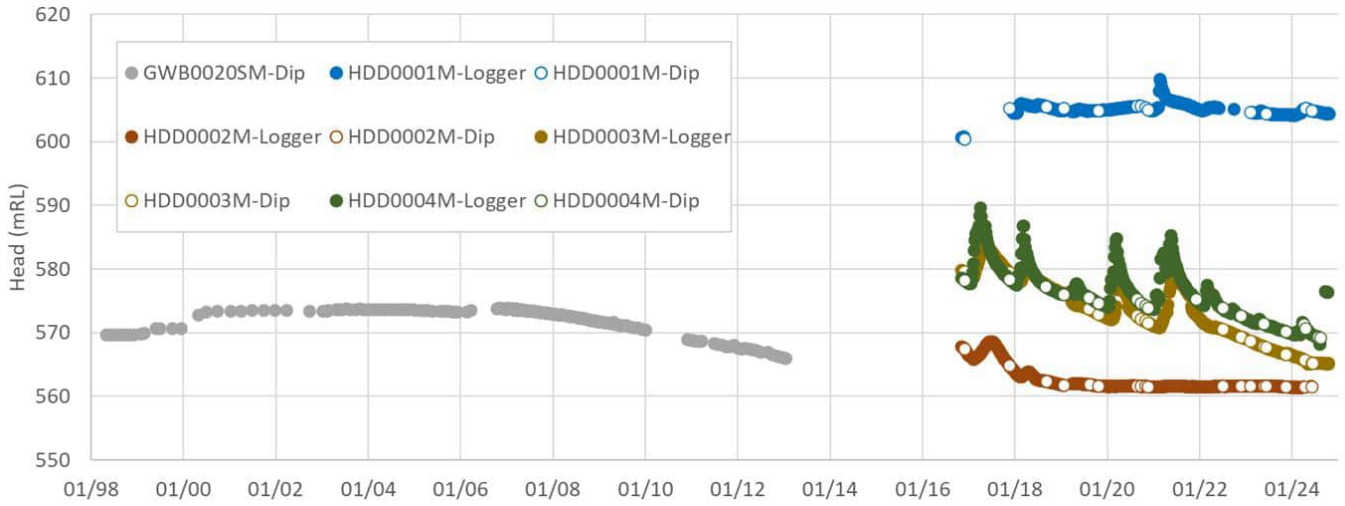


Local geology comprises Wittenoom Formation bedrock beneath Ben's Oasis and Dolomite Downs. This is bounded to the north by Brockman Iron Formation which forms a prominent ridge to the south of the South Flank Valley. Ben's Oasis occurs along the upper reaches of Weeli Wolli Creek, where the bedrock is overlain by thin detrital and alluvial cover. Previous structural mapping indicates a NW-SE striking regional dyke also extends through the area, to the northeast of Ben's Oasis.

Tertiary Detritals (TD) overlie the Wittenoom Formation downstream of the inferred dyke with a thickness ranging between 13 and 27 m. On the upstream side of the dyke, the Wittenoom Formation was found to extend to ground surface with no TD cover e.g. HDD0001 encountered Paraburdoo Dolomite (OB) over its total length. All 3 piezometers downstream of the dyke encountered low permeability Shaley Bee Gorge Member (OD) below the TD, with no OB identified.

Time variant groundwater levels at these holes and at GWB0020SM (2.3 km to the north west of HDD004M) are shown in **Figure P.2**.

Figure P.2. Ben's Oasis hydrographs



In terms of groundwater levels and flows, the following observations can be made:

- Groundwater flows in a north-easterly direction through the drilled monitoring bores. The observed head in HDD0002 is anomalous and is not considered representative of the regional system.
- A steep piezometric surface is interpreted between HDD0001 and the bores east of the dyke (HDD0003 and HDD0004). This steepness suggests that the dyke is acting as a low permeability boundary.
- The levels and responses at HDD0003 and HDD0004 are very similar. This suggests that the Paraburdoo Dolomite in and between these locations presents a high transmissivity:
    - Both respond very strongly to rainfall (rising between 5 and 10 m) and have a rapid recession. This may indicate low aquifer storage at this location, or very high recharge rates.
    - Both show a consistent long term fall in groundwater level. For example the base of recession in HDD0004 has fallen from 578 mRL in January 2017 to 569 mRL in August 2024.
- The long term reduction in levels is similar to the gradient observed in GWB0020SM, which is due to drawdown from Hope Downs dewatering.

Key uncertainty. Whether the long term downward trend in water levels is due to Hope Downs dewatering or something else.

5.17 South Flank aquifer system – East of Bruce Almighty dyke (Q)

5.17.1 Introduction

The South Flank mine covers a distance of about 26 km (east-west) with an east-west trending set of northern and southern orebodies separated by as much as 3 km. At its western end, the mine footprint extends into the Coondewanna Flats groundwater compartment. The South Flank project area is divided into three deposits, which are further divided into pushbacks based on the mining schedule. The original names of the deposits are shown in **Figure Q.1 and the updated names in Figure Q2**) are:

- Highway Deposit
- Grand Central Deposit
- Vista Oriental Deposit

Figure Q.1.South Flank project area and original mining nomenclature

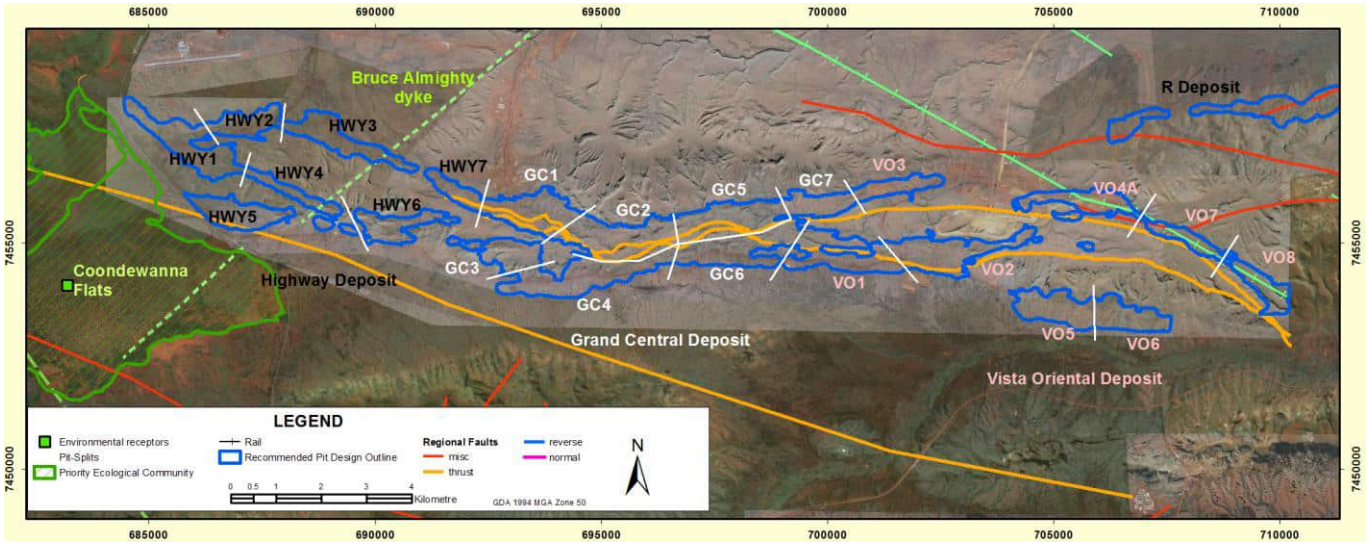
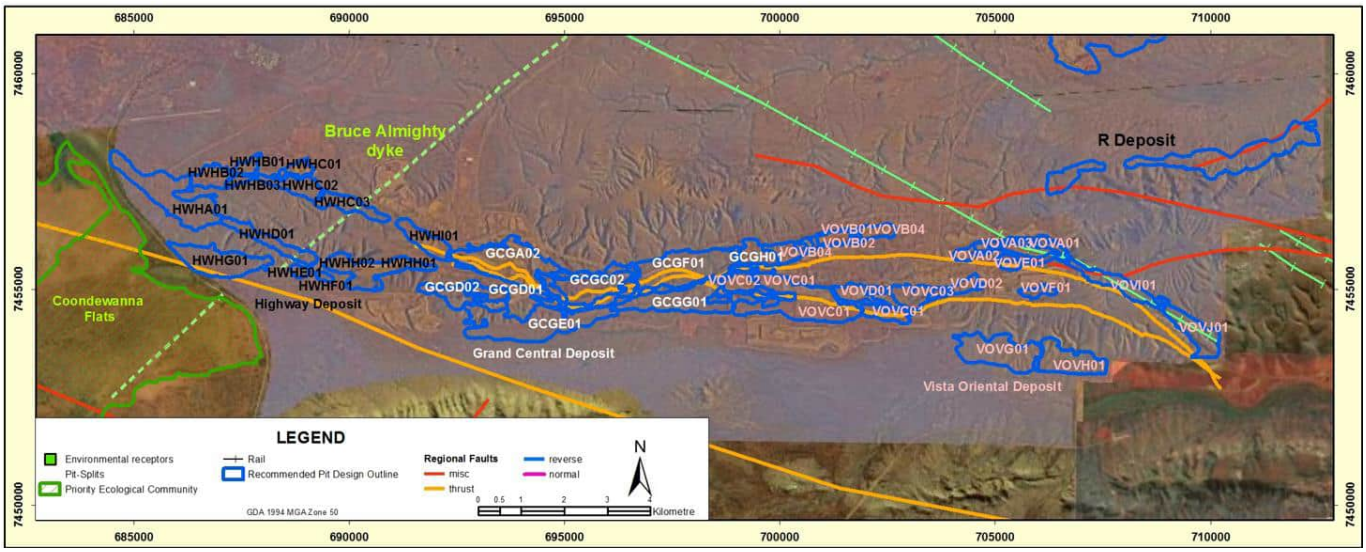


Figure Q.2.South Flank project area and current mining nomenclature



The data available over this area and used for developing the groundwater flow conceptual model are:

- Exploration drilling providing geological data and single time water levels. These are generally focussed on orebodies.
- Time variant groundwater levels from dedicated monitoring bores.
- Abstraction and injection rates from the water supply, Managed Aquifer Recharge (MAR) and dewatering operations.
- Geological modelling.
- Geophysical surveys:
    - 2012 South Flank gravity survey
    - 2010 Ground magnetic surveys, South Flank and Area C
    - 2009 Helicopter gravity gradiometer
    - 2000 Airborne gravity
    - 1992 Aeromagnetic survey
- Test pumping

5.17.2 Hydrostratigraphy

The main aquifers in the South Flank mining area are the mineralised Marra Mamba orebodies, the regional Paraburdoo Member dolomite (which forms part of the Wittenoom Formation), and the overlying Tertiary sequence.

Both the north and south walls of the northern pits and the north walls of the southern pits are generally composed of low permeability unmineralised Marra Mamba Formation.

The south walls of the southern pits variably intersect West Angela Shale (generally, but not always, low permeability) and Paraburdoo dolomite / Tertiary Detritals (moderate to high permeability).

Due to the large scale synclines, which are bounded by lower permeability unmineralised Marra Mamba some orebody aquifers (primarily the northern series) are inferred to be partially compartmentalised and isolated from the larger regional system within the South Flank Valley proper. Areas of the southern orebody may however be connected through the mineralised horizons in contact with the karstic regional dolomite aquifer or saturated detritals. The connectivity between the aquifers and the degree of compartmentalisation provided by the lower permeability unmineralised units is uncertain and only tested in local areas. Additionally, inferred SW-NE trending structures that cut across the bedrock beneath the valley and orebodies may provide some hydraulic connection.

5.17.3 Groundwater data

Groundwater level data is available from two sources:

- Exploration drill holes, with water levels taken at time of drilling. Most of the exploration drilling that is available prior to abstraction and MAR was undertaken between 2006 and 2018 but there was also some drilling between 1993 and 2003.
- Dedicated monitoring bores which are sampled manually or have loggers installed. Observations are available from 2011, but the greatest number of bores have been monitored since 2021.

5.17.4 Exploration data

The exploration data is compared against initial observations at monitoring bores in **Figure Q.3.** The plot shows that there is a good match between the exploration and monitoring bore datasets, suggesting that the exploration data can be viewed with relatively high confidence in areas where there is no dedicated water level monitoring.

These data show that there are five distinct groundwater levels:

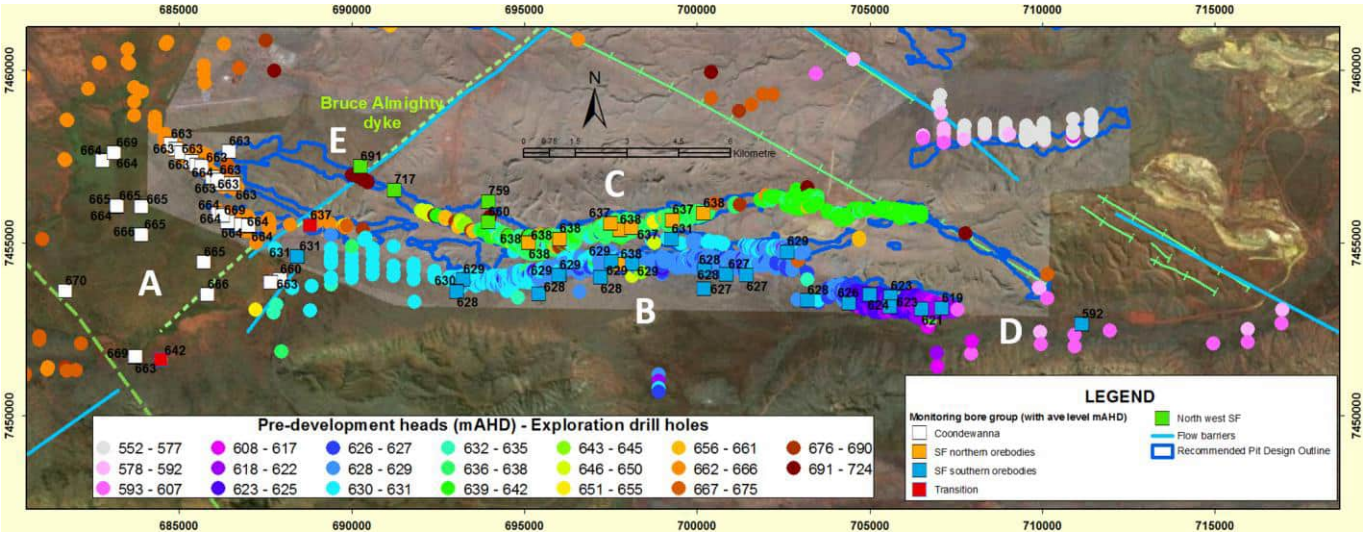
- West of the Bruce Almighty dyke (~662 to 668 mAHD) in the Coondewanna Flats compartment **(A)**.
- The eastern most southern orebodies and regional aquifers in the South Flank Valley (627 to 631 mAHD) between Bruce Almighty and Vista Oriental Pushback 5 (VO5) **(B)**.
- The northern orebodies (638 mAHD) between Grand Central Pushback 1 (GC1) up to Vista Oriental Pushback 7 (VO7) **(C)**.
- The southern orebodies (and possibly portion of Vista Oriental Pushback 8 (VO8)) and the regional aquifer from Vista Oriental Pushback 5 (VO5) to the dyke in the east **(D)**.
- Highway Pushbacks 3 and 7 (northern orebodies) where values above 660 mAHD are consistently observed **(E)**.

From the point of view of aquifer connectivity this suggests that:

- The Bruce Almighty dyke behaves as a flow barrier (with a change in heads of about 30 m across it). The water levels suggest that the dyke (or the effect of the dyke) is offset where it comes off the South Flank ridge and transitions into the Flats. This is also roughly the position that the dyke is no longer visible on the satellite image.
- There is some disconnection between the northern and southern orebody aquifer systems (i.e. as shown by the 10 m difference in heads between them).
- The southern orebodies and regional aquifers are in hydraulic connection to each other and along strike (although separated into two distinct systems by the Bruce Almighty dyke).
    - There is very little difference between heads in the southern orebodies and regional aquifers directly to the south.
    - There is a small gradient from west to east (from 631 mAHD in the west to 627 mAHD in the east).
- The (central) northern orebodies are well connected along strike (the heads vary very little).
- From the start of VO5 east to the dyke immediately east, the are several changes in head (**Figure Q4**):
    - There is a steepening of the southern orebody / regional aquifer water level gradient in the area of VO5 and VO6 (from 628 to 619 mAHD). The gradual change in heads suggests a reduction in transmissivity or aquifer width, rather than structural control.
    - Then (although based only on exploration data) an abrupt change just to the east of VO6 where the level falls to about 595 mAHD. This could be either structural or rock mass controlled.
    - From here to the dyke in the east the level remains at about 595 mAHD. This suggests that the aquifers are in good hydraulic connection through this area.

The levels at the dyke in the east are understood to be much lower on the eastern side than the western. To the west levels are about 595 mAHD whereas to the east they are likely to be similar to the general Hope Downs compartment (573 mAHD, predevelopment), and may be lower due to ongoing drawdown from Hope Downs dewatering.

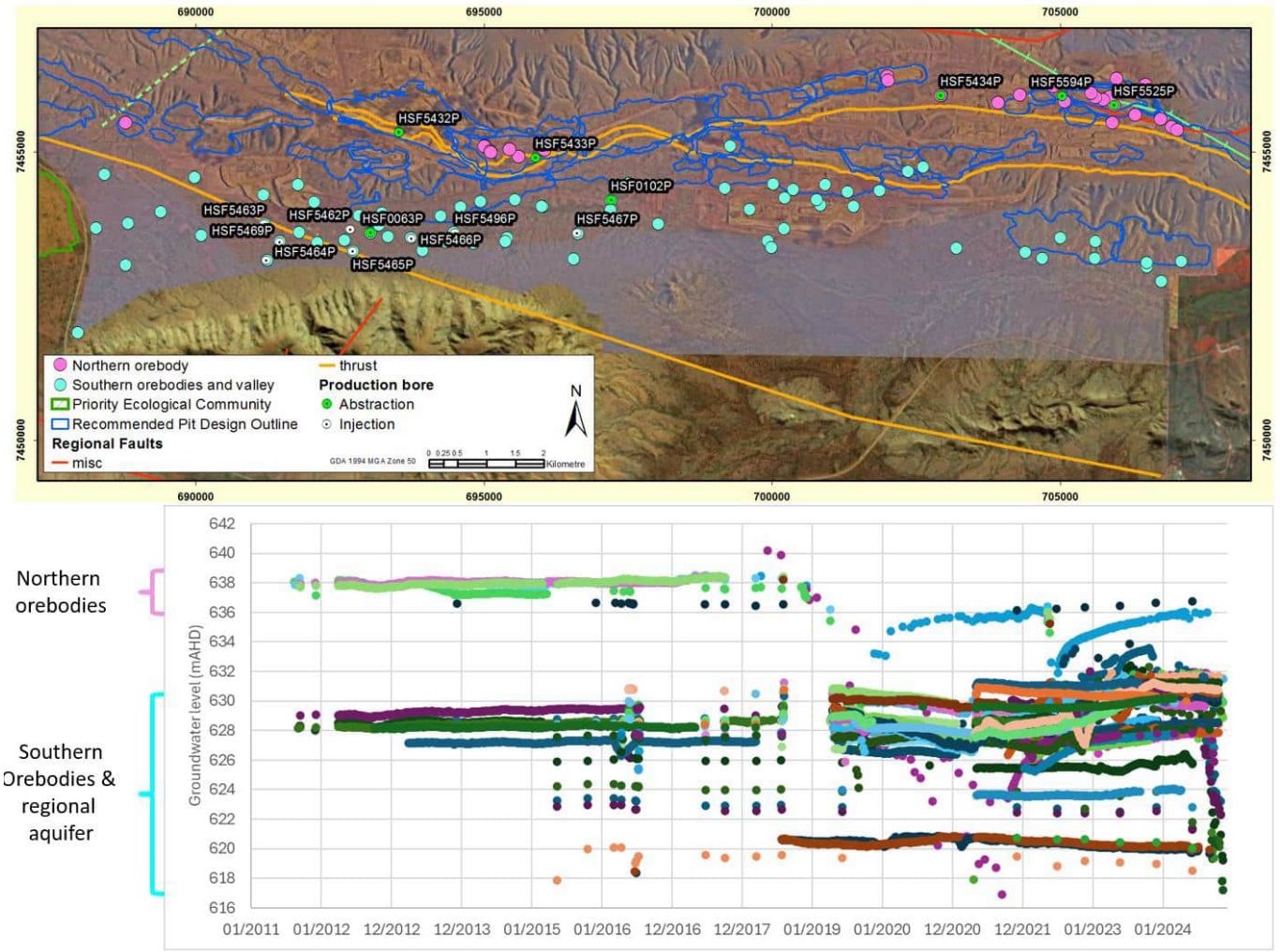
Figure Q.3. Exploration drill hole water levels and average time variant levels from monitoring bores



5.17.5 Transient data and stresses

The full transient dataset is shown in **Figure Q.4.**

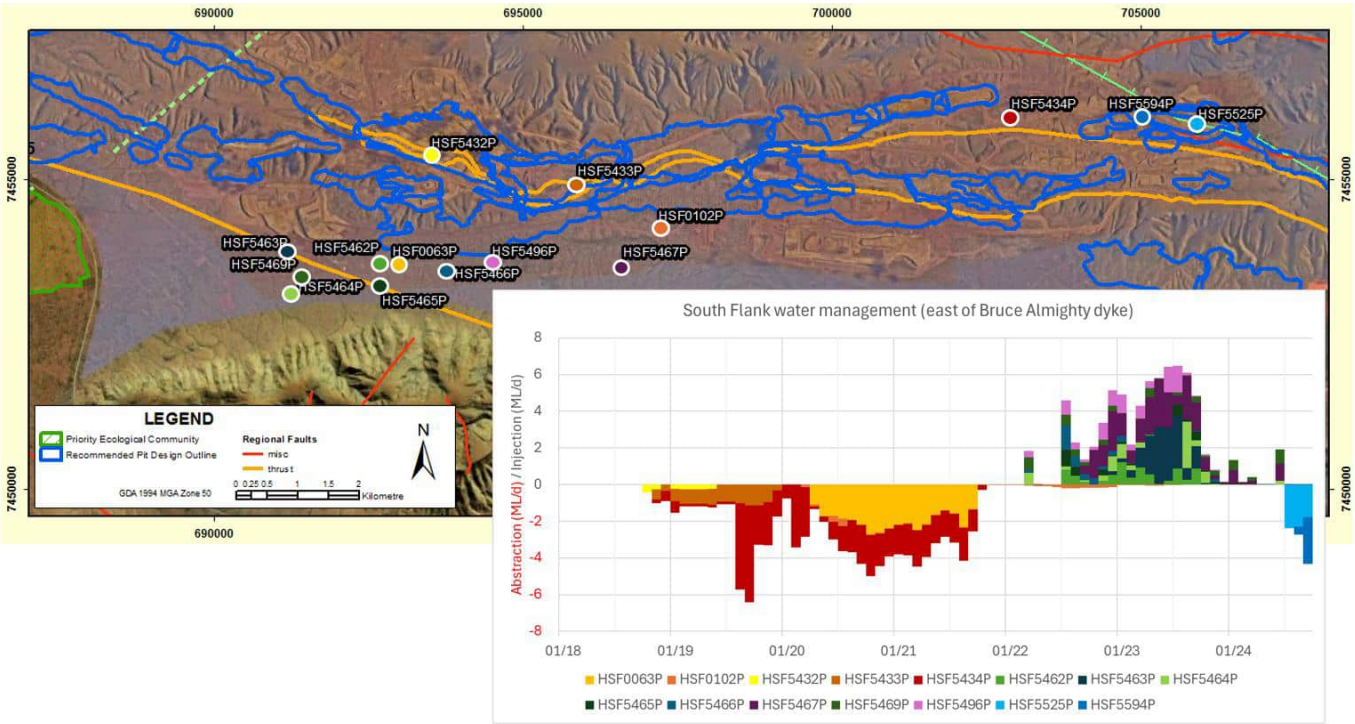
Figure Q.4. Monitoring bores in South Flank with transient data



Anthropogenic groundwater stresses in the South Flank Valley area (**Figure Q.5**) have taken the form of:

- Water supply abstraction from the end of 2018 to the middle of 2021. The production bores were spread widely but abstraction has been mostly from HSF5434P and HSF0063P. Abstraction:
    - Peaked at 6.4 ML/d in September 2019
    - Averages 2.8 ML/d between October 2018 and October 2021
- Managed aquifer recharge from March 2022 onwards, although the scheme has been used sporadically outside the period between July 2022 and September 2023 (during which the average injection rate was 4.2 ML/d).
- Dewatering from July 2024 onwards. This has averaged 3.1 ML/d up to and including September 2024. This abstraction has been from the VOVA orebody (located in the northern limb of orebodies) only.

Figure Q.5. South Flank injection and abstraction



5.17.6 Transient data – South Flank Valley

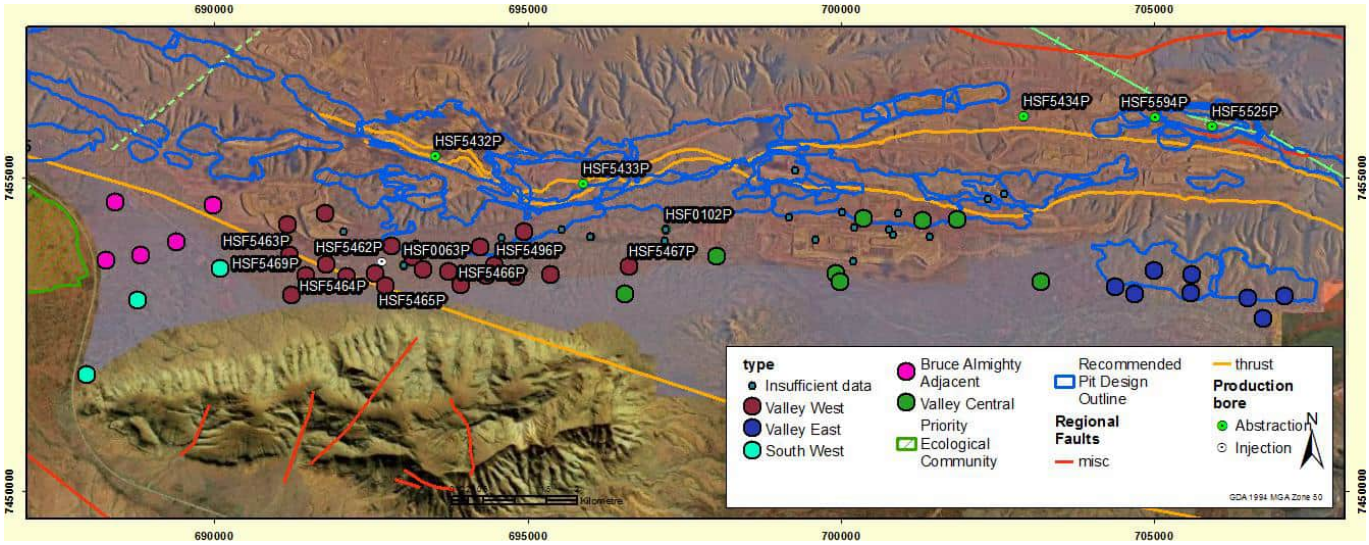
Monitoring in the South Flank Valley (**Figures Q.6 to Q.9**) during the water supply, MAR and dewatering has shown that there are five main responses, delineated by monitoring bore location. They are:

1. An area to the south west of the Highway Deposit, north east of Mount Robinson, that presents high groundwater levels and a subdued response to the stresses.
2. An area adjacent to the Bruce Almighty Dyke that responds well to both water supply abstraction and MAR injection, although at a slightly lower magnitude compared to the bores immediately east (where the abstraction and injection bores are located). This area is also unique as the water levels have not receded since the last time MAR was used consistently and with high volumes (i.e. in October 2023).
3. The Valley West area, location of one of the main water supply production bores and the MAR borefield. This area responds the most to MAR, and in a uniform manner, even though the bores in this area cover an east/west distance of approximately 8 km. The water levels here decline prior to the recorded abstraction, suggesting that there is some abstraction missing from the database. The recovery (decline) since MAR was last used consistently has been relatively slow.

4. The Valley Central area, extending approximately 6 km east/west where again, the response (both decline in response to abstraction and mounding in response to MAR) is uniform between the different bores, but is less than the Valley West area.

5. The Valley East area, from the start of VOVG to approximately 4 km east, where the groundwater levels are significantly lower than the areas to the west and also show less uniformity (i.e. there is a significant gradient (approximately 8 m) from east to west). Furthermore, the response to MAR, which is noticeable in the most westerly of these bores, disappears around the middle of the area. In the most easterly bores, a decline in water levels is observed at the same time as the western bores are increasing.

Figure Q.6. Transient data set, South Flank Valley



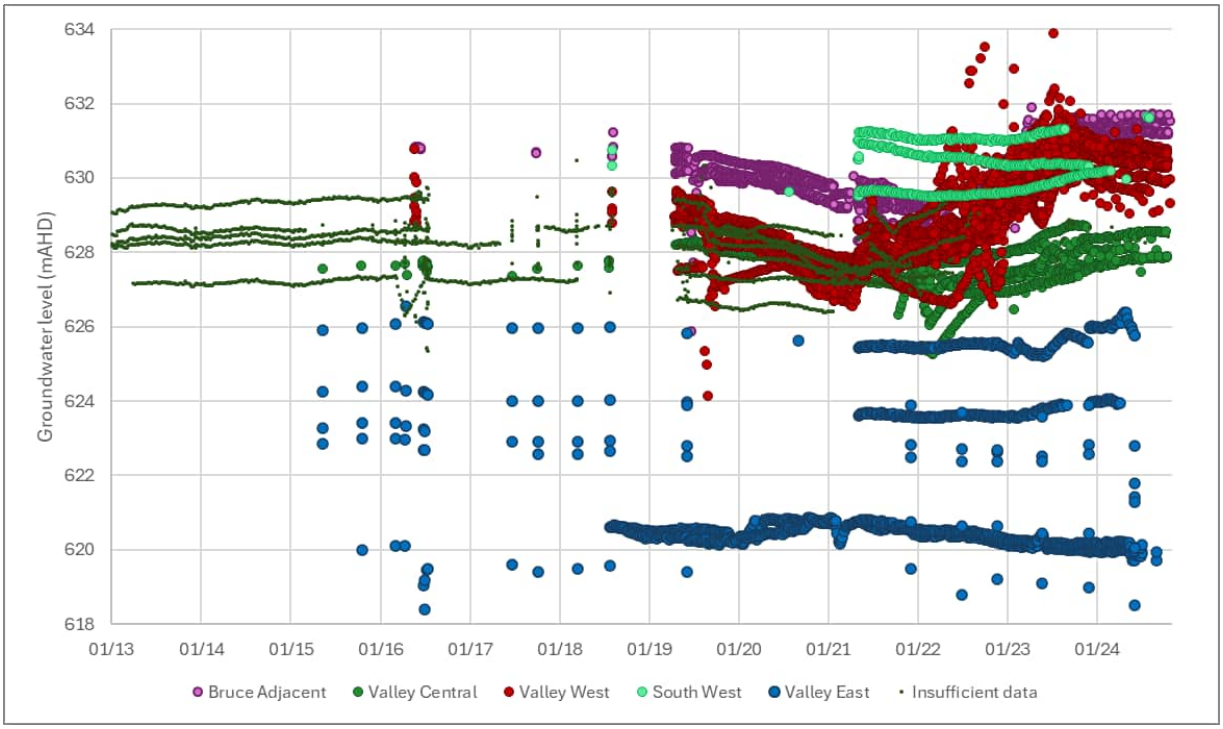


Figure Q.7. Abstraction / injection from/into the South Flank Valley aquifers

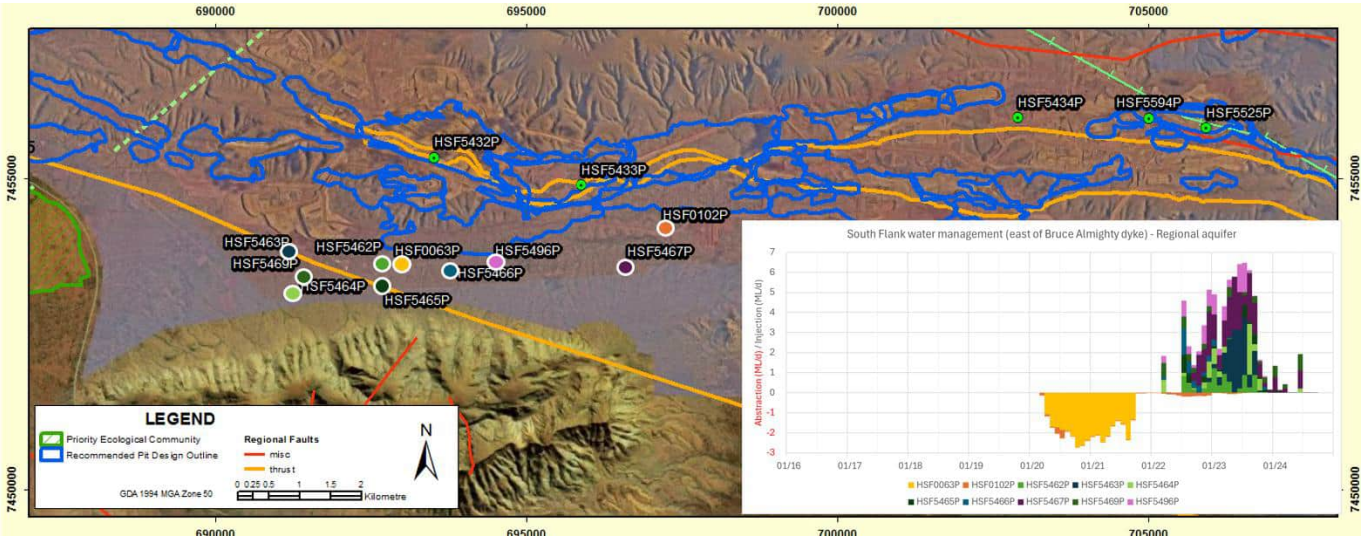


Figure Q.8. South Flank Valley transient data, by group

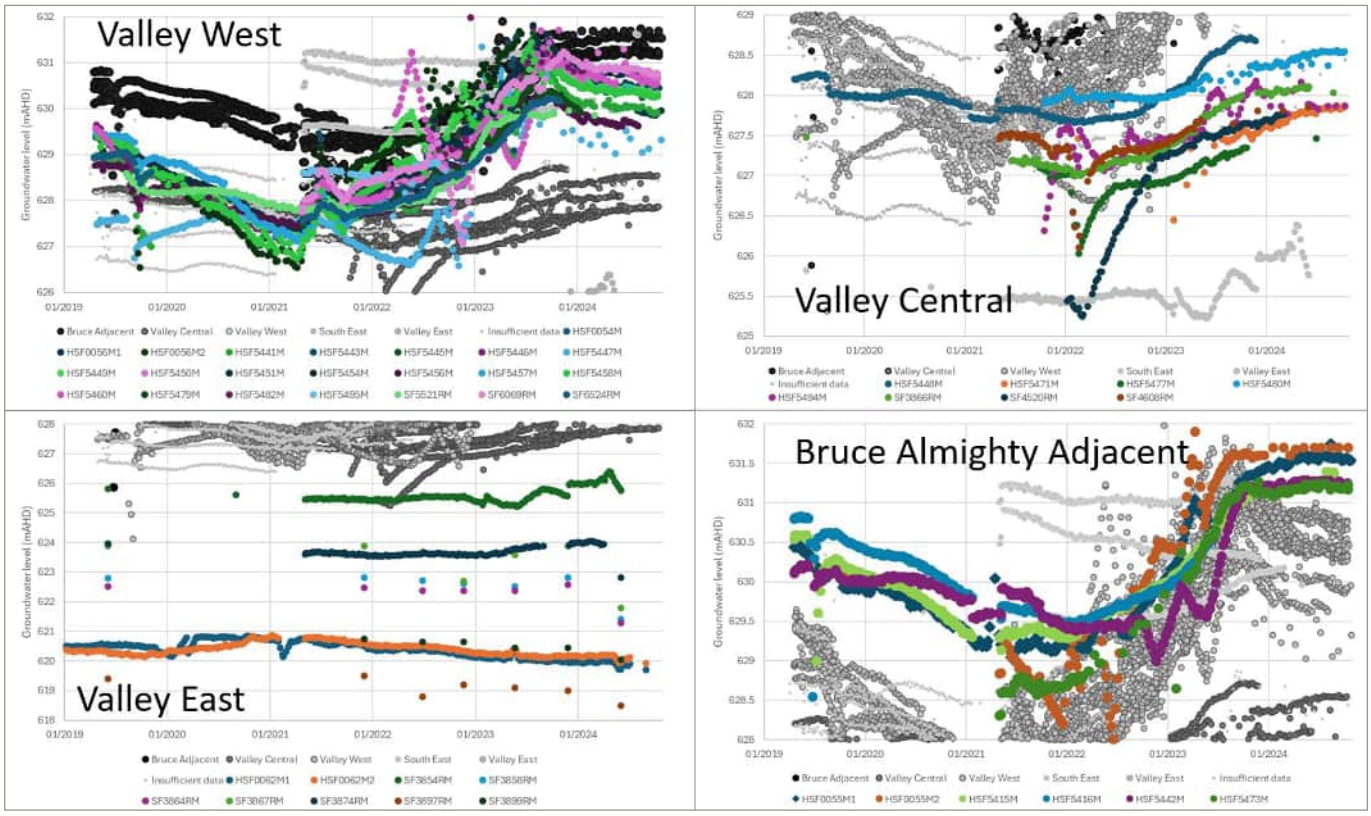
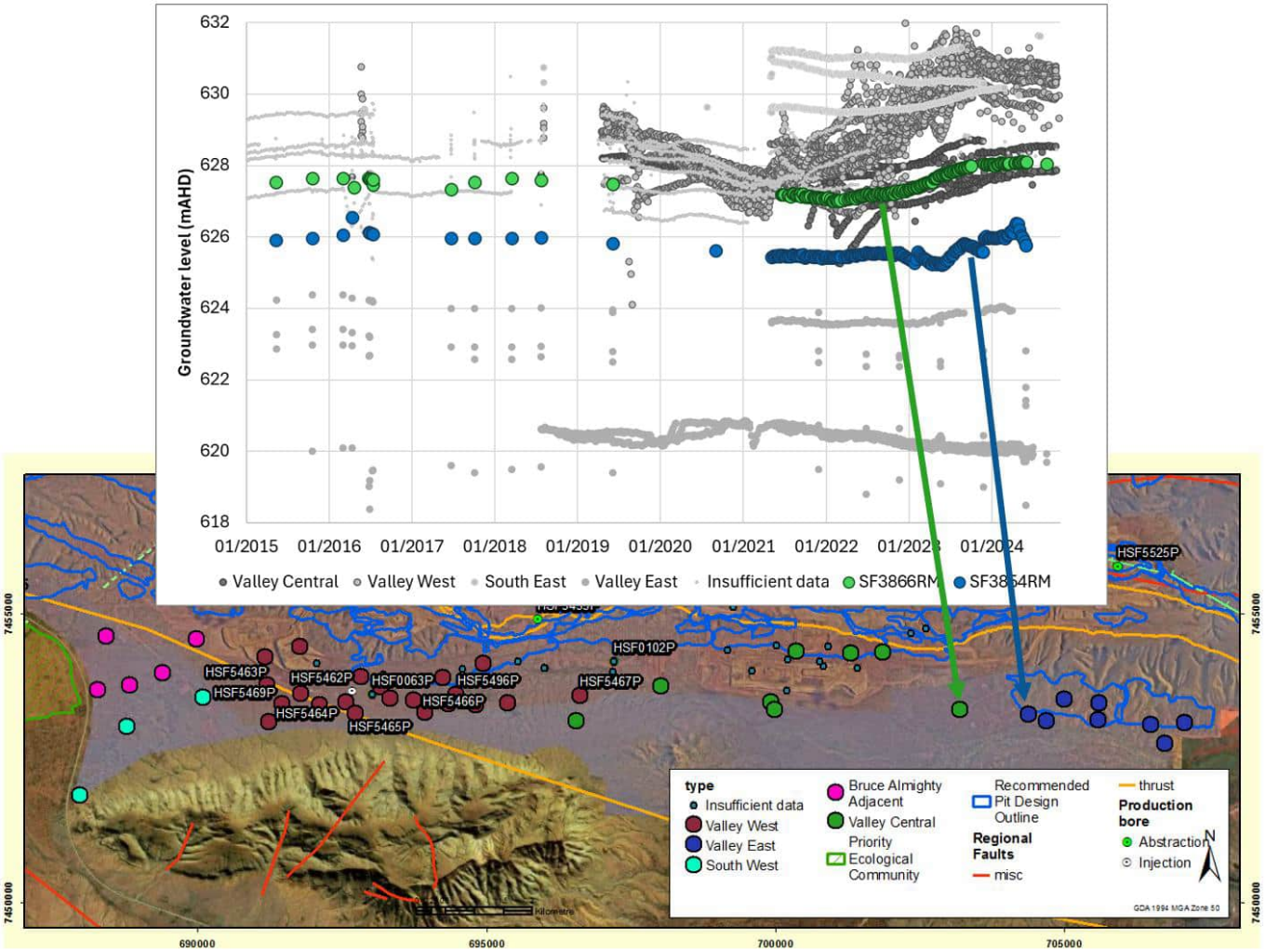


Figure Q.9. Difference in response between Valley Central and Valley East area



5.17.7 Transient data – Northern orebodies

Groundwater levels in the Northern orebodies have been unaffected by MAR or water supply abstraction in the regional aquifer to the south. They have however been impacted by water supply and dewatering abstraction in the Northern orebodies themselves. Whilst the spatial distribution of the data is limited, they do show that the responses fall into three distinct groups (**Figures Q.10 and Q.11**):

1. The bores in the east, around the eastern side of VOVB and the western side of VOVA (orange group) are drawndown significantly by water supply abstraction from HSF5434P. Once abstraction ceases, recovery is rapid, and it appears that the majority of recovery (which does not approach pre-abstraction levels) has occurred before it is impacted by the next abstraction. This final recovery level is approximately 6 m lower than the pre-abstraction value. In late 2024 these bores are drawdown by dewatering abstraction immediately to the east.

2. The bores further to the east, in the main VOVA orebody (yellow group) are impacted by water supply abstraction from HSF5434P directly to the west. About 8 m of drawdown is observed and only a metre or two of recovery. This means that at the start of 2024 the water levels here are the same as the group directly to the west and have stabilised. This suggests that the groundwater removed via HSF5434P has not been replaced and that after approximately one year, the two areas have equilibrated. Dewatering abstraction from within this area results in significant drawdown (over 10 m from two months of abstraction at an average of 3.1 ML/d).

3. The bores in the west, all but one are centred around production bore HSF5433P (green group), in the GCGC orebody and do not appear to be impacted by water supply abstraction in the east, or water supply abstraction / MAR in the south. They are however impacted by the relatively minor abstraction from HSF5433P in 2019. The recorded rate was 1 ML/d for 1 year and, after a rapid recovery, this resulted in 2 to 3 m of semi-permanent drawdown (i.e. with a very slow recovery). The one bore in this group which is not close to HSF5433P is SF3516RM, which is located adjacent to Bruce Almighty Dyke in the west. Whilst the water levels are similar to the rest of this group, there is no evidence to suggest that they have been impacted by HSF5433P and that they are hydraulically connected along strike.

Figure Q.10. Abstraction from the Northern orebodies

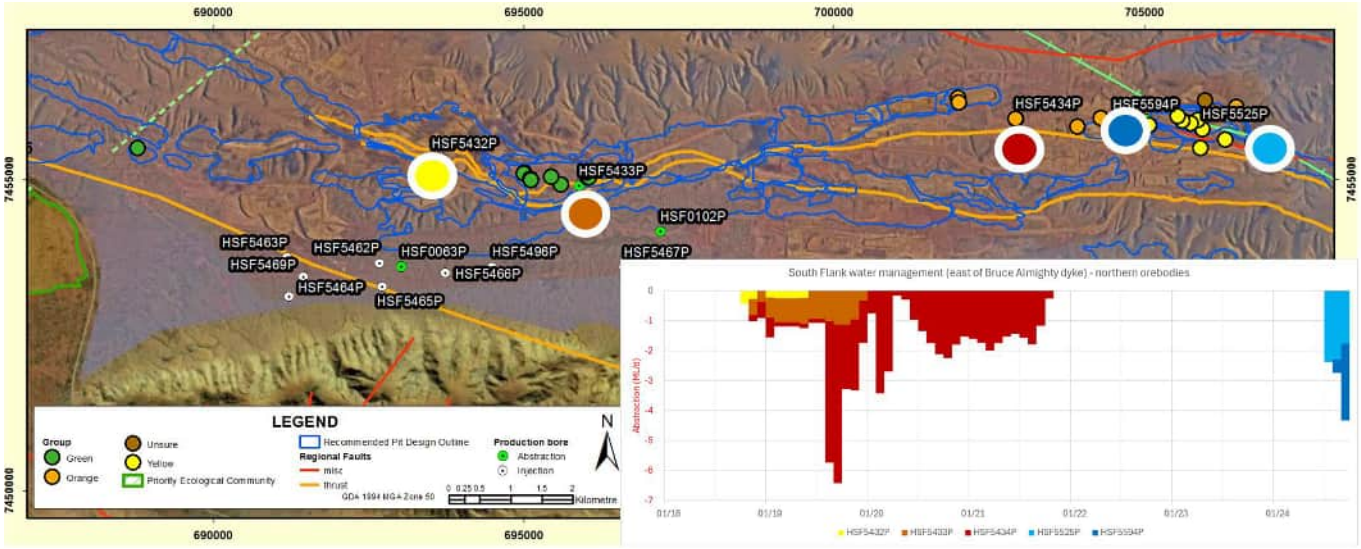
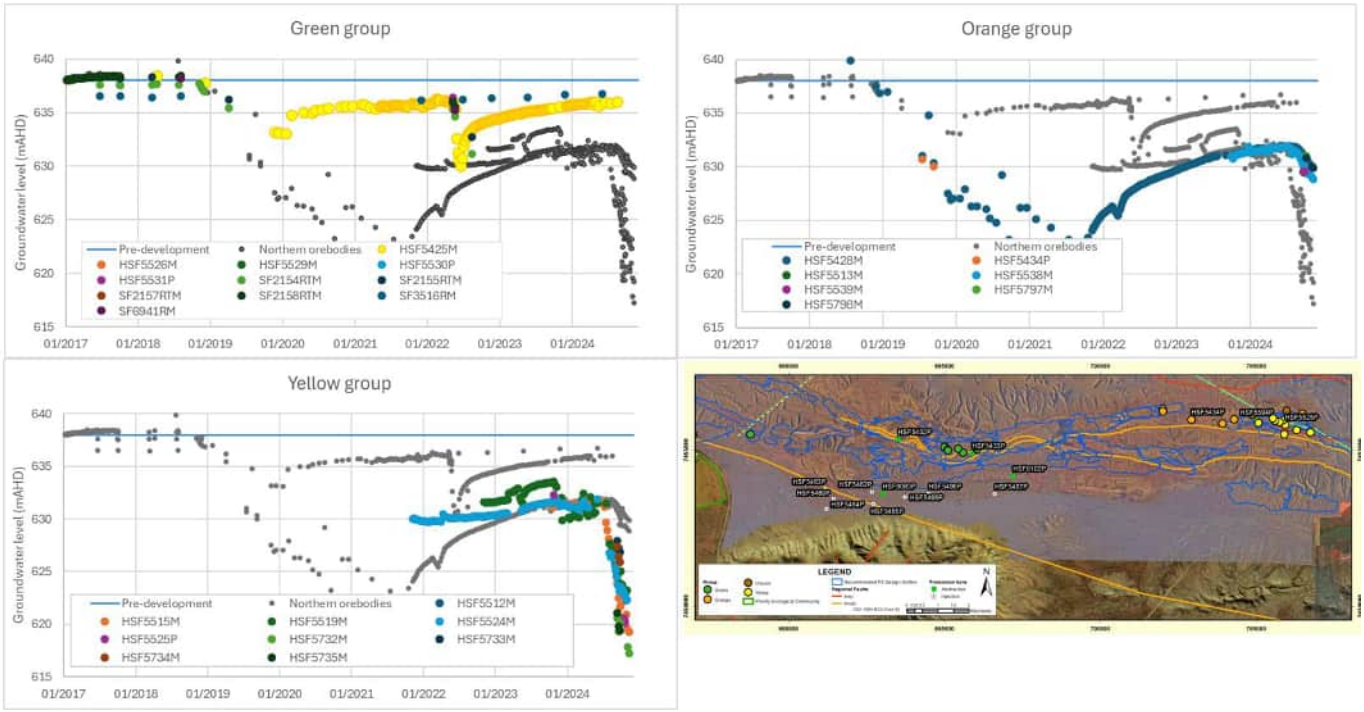


Figure Q.11. Transient groundwater levels in the northern South Flank orebodies



5.17.8 Test pumping results

Test pumping of the 4 production bores (all dolomite) in 2016 provided the following interpreted bulk hydraulic properties (for more detail see BHP, 2016):

- T ranges from 85 to 660 m^2/d (average 250 m^2/d).
- K ranges from 1.7 to 5.9 m/d (average 4.4 m/d).
- S ranges from $1.1x10^{-3}$ to $5.5x10^{-3}$.

These tests provide a very limited insight into the hydraulic characteristics of the South Flank aquifer systems given their extent (26 km x 3 km).

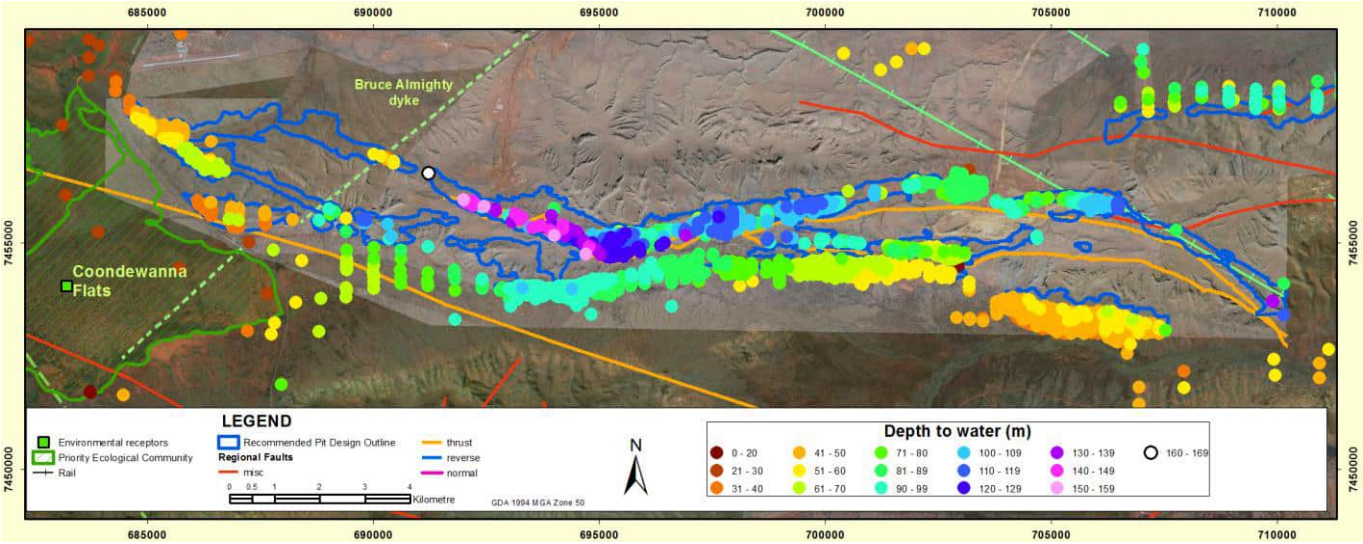
5.17.9 Groundwater / surface water interaction and discharge

Depth to groundwater in the South Flank area is shown in **Figure Q.12**. This shows that groundwater is greater than 50 m beneath the ground surface over most of the South Flank Valley and orebody areas. The exceptions to this are:

- Coondewanna Flats and Highway 5 (20 to 30 mbgl)
- Vista Oriental 5 and 6 and the regional aquifers in that area (40 to 60 m)

Additionally to this, the data show that the depth to groundwater is greater in the northern orebodies than the southern and regional aquifers and that the depth reduces in the regional aquifers to the east of Vista Oriental 1.

Figure Q.12. Depth to water in South Flank area



The only natural discharge in this area is likely to be in the form of throughflow to the west. There is very little potential for evaporation or evapotranspiration anywhere within the South Flank area other than Coondewanna Flats. However even here the depth to water (>20 m) means that vegetation communities are more likely to be dependent on the surface water regime of the Flats rather than groundwater.

The saturation of the various aquifers are as follows:

- The Tertiary Detritals has a saturated thickness of up to 100 m in some places (corresponding to the deepest parts of the palaeovalley).
- Most of the southern orebodies have at least 50 m of saturation. The greatest is HWY5 with about 150 m.
- Some of the northern orebodies are unsaturated. However, GC5 has about 130 m of saturated ore.

5.17.10 Conclusion

South Flank is comprised of two main aquifer systems, separated by the Bruce Almighty Dyke. The western part is considered in Section A. The eastern part is considered here, and incudes the area as far as the dyke east of the Vista Oriental orebodies which separates South Flank from the Hope Downs Aquifer Compartment.

Within the eastern part of South Flank there is the following complexity:

- The northern orebody aquifers (Marra Mamba) are hydraulically separated from the southern orebodies and regional aquifer. Dewatering these orebodies will require storage depletion only. Recovery will be extremely slow. The northern orebodies present roughly the same pre-development water level (between 638 and 640 mAHD), but they are likely compartmentalised to varying degrees.
- The southern orebody aquifers (Marra Mamba) are variably connected to the regional aquifer (Paraburdoo Dolomite and Tertiary Detritals). Once dewatering commences in the southern orebodies, more will be known about these connections and it is anticipated that some orebodies will be well connected, others less so.
- The southern orebodies / regional aquifer system is dissected by several leaky flow barriers. The behaviour of these are not known beyond what the limited water supply abstraction and MAR that has occurred up to November 2024 has revealed, but they have the potential to compartmentalise (to a degree) the southern area and therefore reduce the dewatering requirements of individual orebodies.
- There is a significant groundwater gradient in the eastern part of the southern orebodies / regional aquifer system that includes the area of both VOVG and VOVH. This suggests that the transmissivity and therefore dewatering burden of these two deposits and the surrounding regional aquifer will be less than the deposits to the west.
- The northerly extension of the Ben's Oasis dyke separates the Hope Downs aquifer system from the South Flank Valley aquifer system. Prior to dewatering, there was a groundwater level difference across this feature of approximately 20 m (570 mAHD on the Hope Downs side, 590 mAHD on the South Flank side).

Furthermore:

- Both the north and south walls of the northern pits and the north walls of the southern pits are generally composed of low permeability rock (unmineralised Marra Mamba Formation).
- The south walls of the southern pits variably intersect West Angela Shale (generally low permeability) and Paraburdoo dolomite / Tertiary Detritals (moderate to high permeability).
- The hydraulic conductivity of the different aquifer units appear to be quite variable, with values in the orebody aquifers potentially an order of magnitude lower than in the Paraburdoo dolomite.
- Depth to groundwater generally ranges from 60 m in the lower lying areas to over 100 m along the ridge-line.
- The hydraulic gradient from west to the east within this portion of the South Flank project area, and within the southern orebodies / regional aquifer is from 630.5 mAHD adjacent to the Bruce Almighty Dyke, to 620 mAHD at the eastern most orebody (VOVH) and approximately 590 mAHD approaching the (Ben's Oasis) dyke in the far east.
- Water levels in the South Flank Valley do not appear to be affected by dewatering at MAC or Hope Downs at the present time. However, the observed decline in the eastern most monitoring bores should be considered with the observed water levels at the RTIO bores further east once that data becomes available.
- A small amount of flow is probably occurring across the Bruce Almighty Dyke into this area. This may explain why the South Flank Valley water levels just east of the dyke have not returned to their original levels following MAR.
- Diffuse recharge into the valley detritals and orebody aquifers is likely to be limited by the significant depth to groundwater (which is generally greater than 60 m) but hydrographs show that some recharge is

occurring. Direct recharge from flows in the Pebble Mouse Creek is also likely to occur but at relatively low rates.

Key uncertainties: Due to the size of the area and the relatively limited dewatering to date, uncertainty in the South Flank area is still high. The most relevant uncertainties to future dewatering rates and drawdown migration are:

- The nature and behaviour of the potential flow barriers described above.
- Hydraulic parameters and geometry of the regional aquifers (the dolomite and Tertiary Detritals)
- Hydraulic connection (particularly with depth) between the regional aquifers and the southern South Flank orebodies
- The potential flow under increasing water level gradients across the key regional structures:
    - The Bruce Almighty dyke (in the west)
    - The dyke and potentially lower transmissivity area to the east

5.18 Packsaddle aquifer system (R)

5.18.1 Introduction

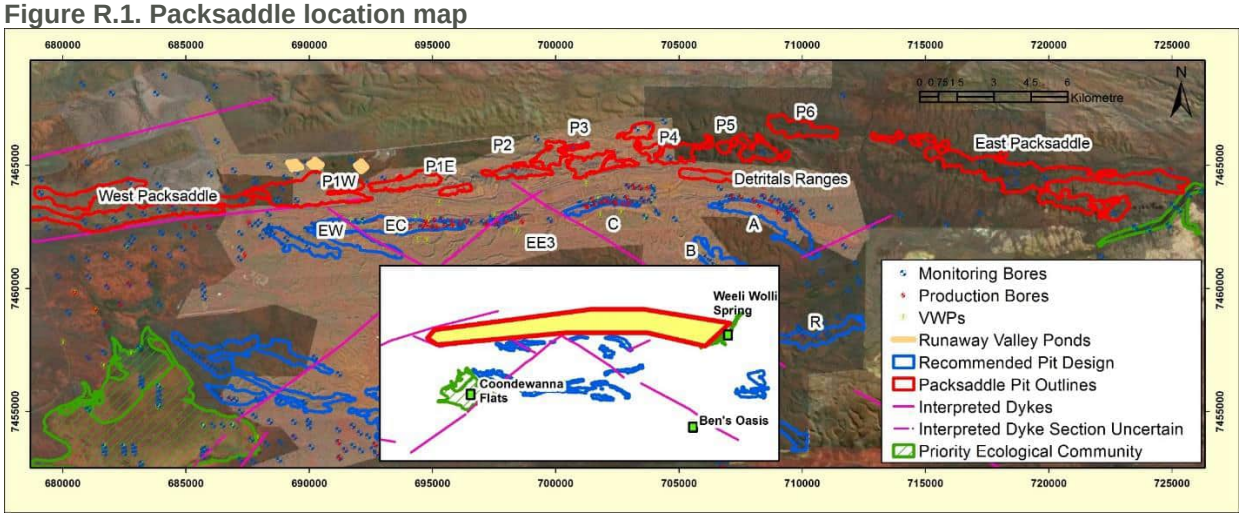
The Packsaddle ranges ('Packsaddle') are located north of MAC and span 47 km from Tandanya in the west to Weeli Wolli Spring in the east (**Figure R.1**). For the purposes of mining, Packsaddle has been divided into the following pits/orebodies:

- West Packsaddle
- P1 (including west and east – P1W and P1E)
- P2, P3, P4, P5 and P6
- The Packsaddle Detritals Ranges
- East Packsaddle

Currently, only AWT mining is occurring within Packsaddle. The FY22 LoA mine plan indicates BWT mining at West Packsaddle, P1W and P3. As such, hydrogeological conceptualisation will focus primarily on these areas.

The only anthropogenic stress within Packsaddle is surplus water discharge to the Runaway Valley (RAV) Ponds. The RAV ponds are located to the north/northwest of P1 and commenced operation in 2018.

Figure R.1. Packsaddle location map

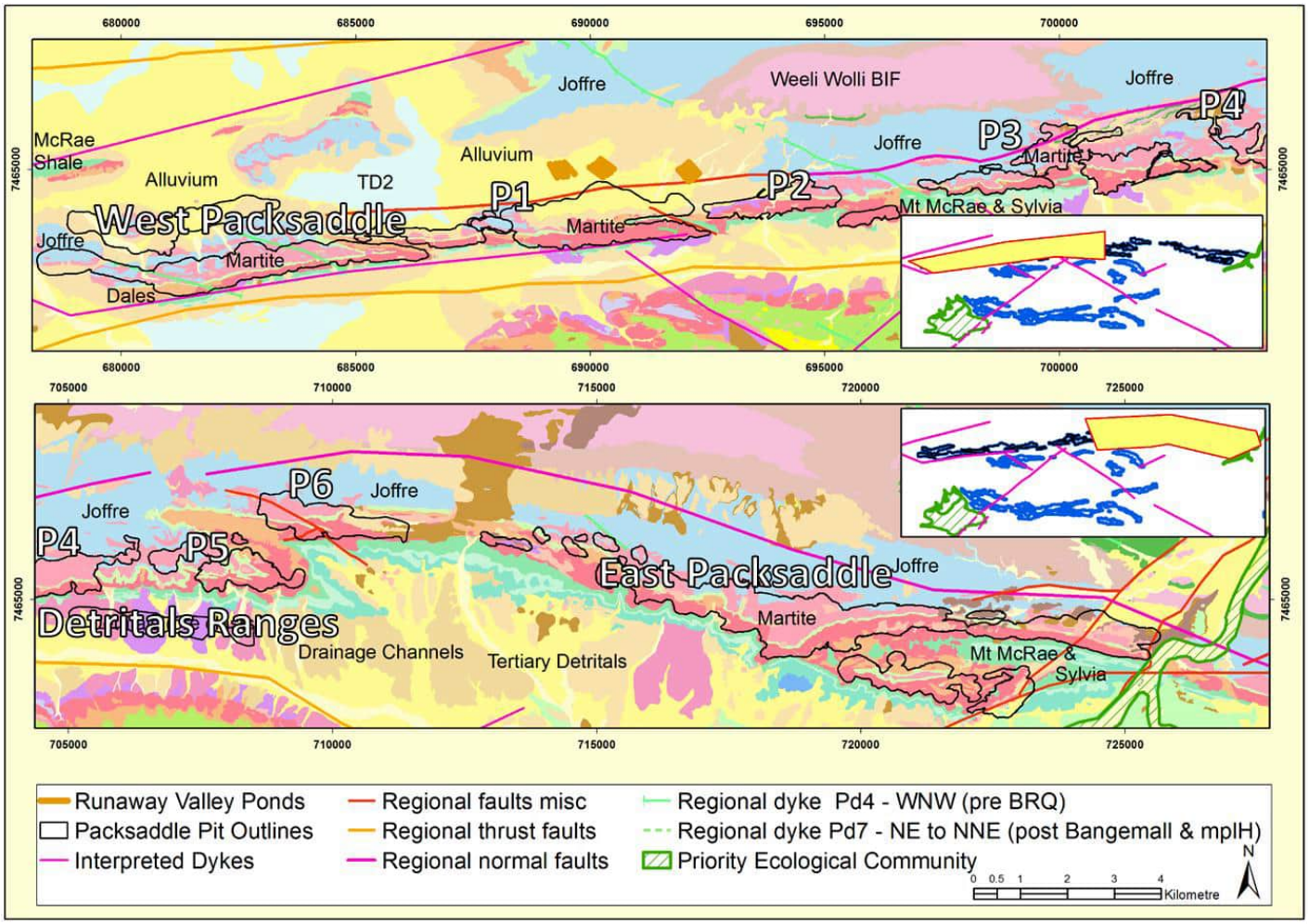


5.18.2 Geology

Outcropping geology and mapped/inferred structures for Packsaddle are shown in **Figure R.2**. This figure, as well as geological modelling and exploration drilling reports for this area indicate the following:

- The Packsaddle deposits sit on the northern limb of the Weeli Wolli anticline and are E-W striking.
- The outcropping geology represents the Hamersley Group, with the oldest outcropping unit being the Wittenoom Formation in the south, and the youngest being the Weeli Wolli Formation in the north.
- Tertiary Detritals cover the majority of the geology in the south and east of the project area.
- Drainage lines have developed through the alluvium/detritals which overlay the weathered and fractured basement rock (primarily Brockman Iron Formation and possibly Wittenoom Formation in the northwest as indicated in Tandanya).
- Low permeability Mt McRae and Mt Sylvia Formations separate a large portion of the Packsaddle orebodies from the regional system/MAC in the south.
- East Packsaddle shows structural complexity and tighter folding in the central and eastern pits.

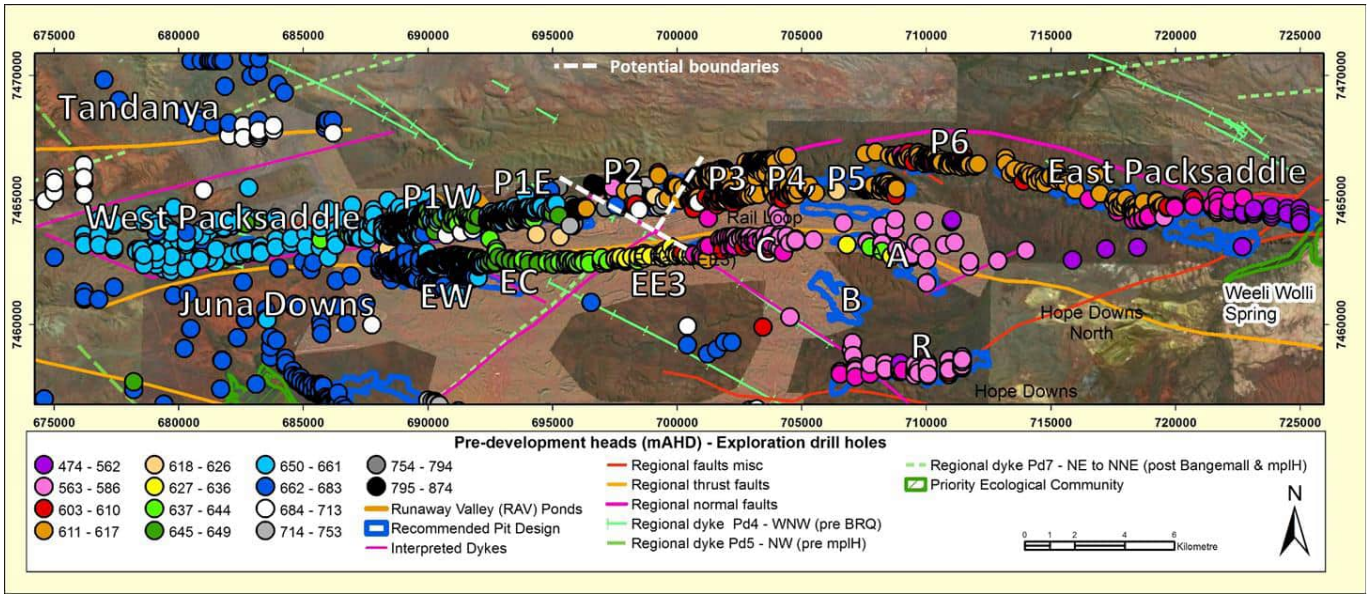
Figure R.2. Surface geology and structural map



5.18.3 Pre-development heads

The observed heads from exploration and hydrogeology drill holes are shown in **Figure R.3.**

Figure R.3. Pre-development heads



Holes drilled prior to 2019 have been included in the analysis, with the exception of the area around P1 (restricted to holes drilled pre-2018 i.e. prior to operation of RAV). A brief analysis of the pre-development heads show that:

- Heads in Packsaddle are higher than in the MAC deposits to the south, with the exception of P1 where heads are similar to the regional system/EC deposit (see below).
- Heads in West Packsaddle are ~30 m lower than heads in Tandanya (to the north) and ~10 m lower than heads in Juna Downs (to the south).
- There is a head gradient along the Packsaddle range with higher heads in West Packsaddle (650 – 661 mRL) and lower heads in East Packsaddle (474 – 562 mRL).
- Heads are relatively uniform across West Packsaddle and P1W.
- Heads in P2 are variable and range between 583 mRL and 874 mRL, suggesting erroneous data and/or structural or geological influence potentially isolating this ‘wedge’ from the rest of Packsaddle range.
- Heads are relatively uniform across P3 – P6 (611 – 617 mRL) and are up to 50 m higher than the regional system and C/A deposits to the south.
- There is a head gradient within East Packsaddle towards Weeli Wolli Spring.

The data therefore suggest the following about the Packsaddle aquifer system:

- Hydraulic boundaries exist to the west, northwest and southwest (bound by structures/low permeability rock masses).
- It is constrained to the south by low permeability Mt McRae and Mt Sylvia Formations (which are significantly thicker to the east).
- It is possibly connected to the regional system/EC deposit near P1E. If so, flows west of P2 are likely converging towards P1E and potentially flowing south into EC Deposit and moving east through MAC.
- It is likely connected along strike in West Packsaddle and P1W.
- It is likely disconnected midway through the Packsaddle Range (by structures/rock masses around P2).
- It is likely connected along strike from P3 to East Packsaddle.
- East Packsaddle is well connected to Weeli Wolli Spring.

5.18.4 Groundwater Stresses

The only anthropogenic stress within the Packsaddle ranges is the RAV ponds which commenced operation in 2018, receiving surplus discharge from MAC. Other anthropogenic stresses have occurred south of Packsaddle within the regional aquifer/North Flank orebodies.

Summary of the RAV infiltration scheme:

- Surplus scheme consisting of three infiltration ponds – Western (FMAC0061), Central (FMAC0062) and Eastern (FMAC0063) ponds.
- Commenced operation in 2018, and can receive up to 30 ML/d (license limit) surplus water from MAC to enable infiltration to the underlying groundwater system.
- Drill and blasting activities in FY20 enabled increase in infiltration capacity, and a recent (Nov 2019) amendment to license now includes additional ability to overtop the ponds and allow water to discharge to nearby creek lines (which eventually converge at Coondewanna Flats).

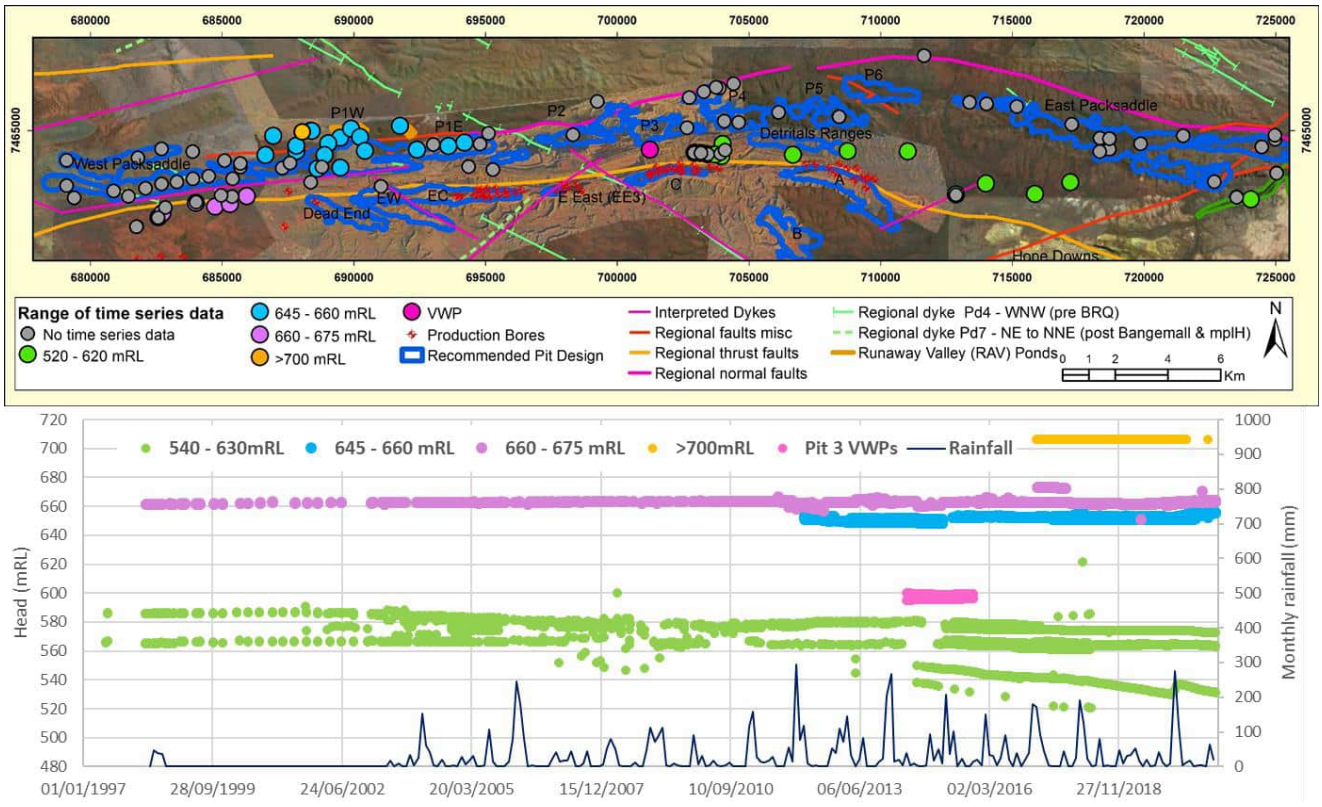
5.18.5 Groundwater level monitoring

Monitoring in the Packsaddle and East Packsaddle project areas commenced in 1997. While there are numerous monitoring installations (114) within this area, less than half have collected data (≥1 data point) and thus there is opportunity to improve temporal and spatial monitoring. The monitoring dataset consists of:

- 55 monitoring installations containing at least 1 manual dip (providing a total of 2,225 manual dips)
- 31 monitoring installations with loggers installed and data available (>1 head observation)
- 18 monitoring installations containing time series (≥2 head observations) data relevant to Packsaddle orebody (i.e. excluding pumping water levels and monitoring in the regional aquifer system)
- 1 vibrating wire piezometer (with 2 vibrating wires installed) south of P3 screened in the regional dolomite

The time series data and geographic extent of the monitoring dataset is shown in **Figure R.4**.

Figure R.4. Time series heads and spatial distribution of monitoring dataset.



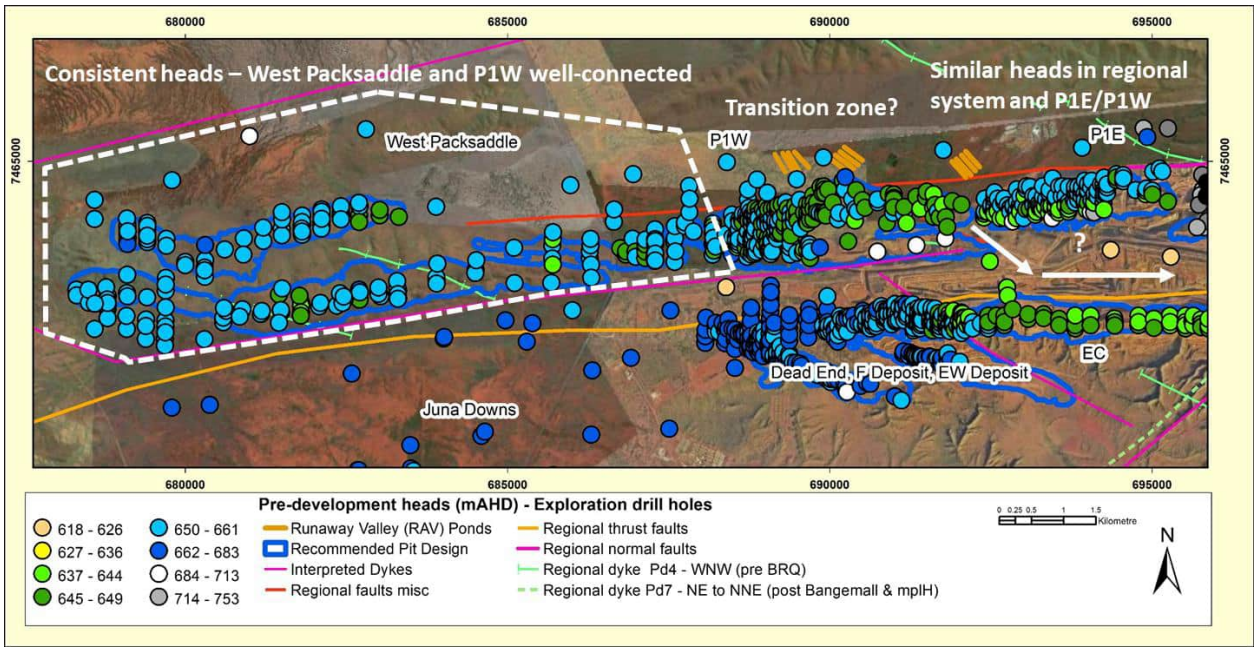
The figure shows:

- All time series monitoring within the Packsaddle orebody occurs within the P1W and P1E deposits.
- There is some time series monitoring within the regional system south of Packsaddle (analysed in greater detail in the A deposit, Hope Downs and Weeli Wolli sections of the Conceptual Model report)
- There are a significant number of monitoring locations not actively being monitored (grey bores).
- There is a monitoring bore (HPSA1637M) located near the RAV ponds which is screened in the Yandicoogina shales and shows higher heads at ~706 mRL. This data may also be erroneous.
- The VWP in the dolomite south of P3 has a limited data set (from 2014 to 2015).

5.18.6 Data analysis

Time series head data in the Packsaddle orebody occurs only in the western pits, and thus further conceptualisation will focus on these areas. These western pits can be analysed by looking more closely at the pre-development (**Figure R.5**) and time series heads (**Figure R.6**).

Figure R.5. Pre-development heads in western region of Packsaddle.



The pre-development head data in **Figure R.5** suggests the following:

- Heads are uniform across West Packsaddle and the western portion of P1W (primarily 650 – 661 mRL).
- Heads decrease from P1W towards P1E, with a 'transition zone' in the region south of the RAV ponds (primarily mix of heads 645 – 661 mRL).
- P1E shows a clear gradient from higher heads in the north (650 – 661 mRL) to lower heads in the south (637 – 644 mRL). This is not seen in other areas of Packsaddle.
- Heads in West Packsaddle and P1W are 5 – 10 m lower than in the regional system/Juna Downs/Dead End/ F Deposit to the south.
- P1E (and the eastern portion of P1W) heads are consistent with heads in the regional system/EC deposit immediately to the south. This may indicate a potential hydraulic connection to the south.

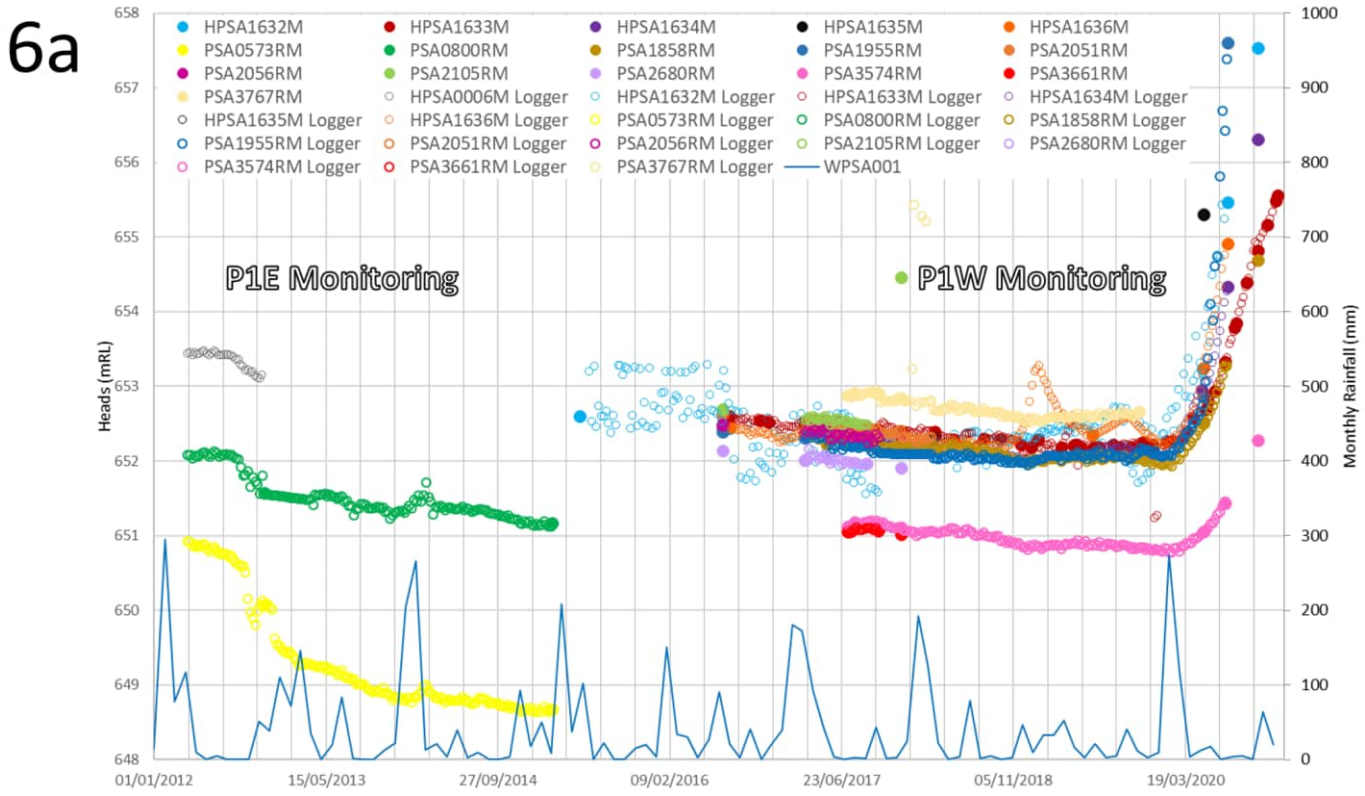
There is no time series data in the West Packsaddle pits. Time series heads in P1W and P1E are plotted in **Figure R.6a** (with corresponding locations in **Figure R.6c**).

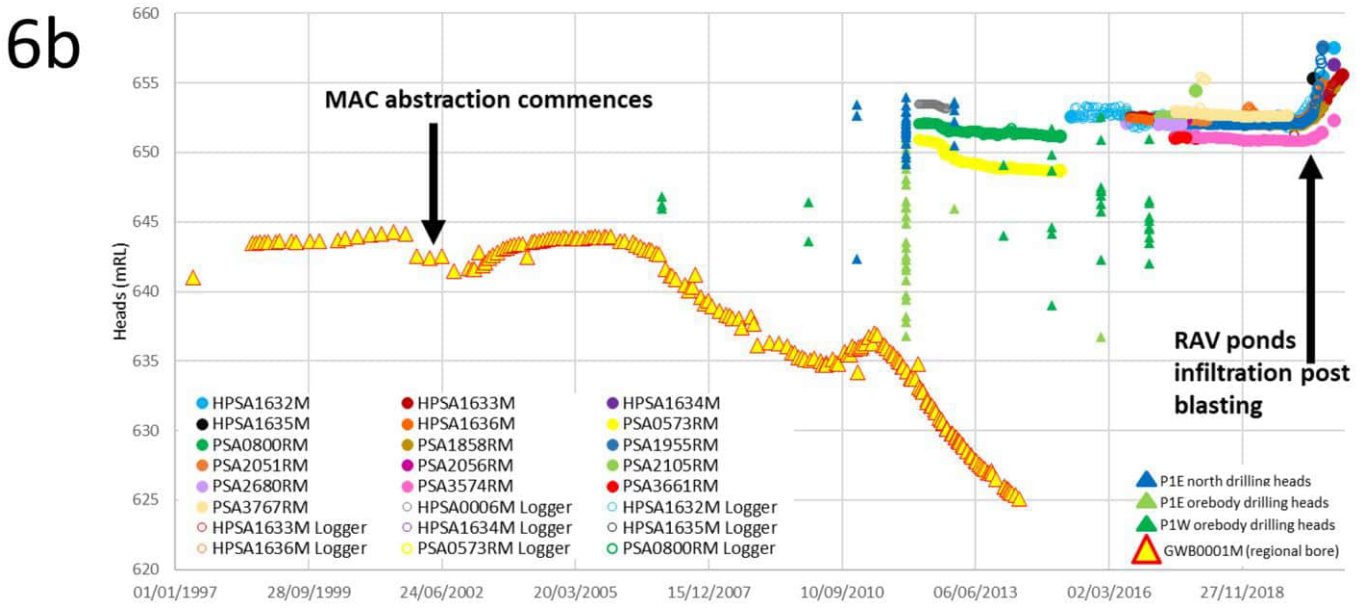
The data show:

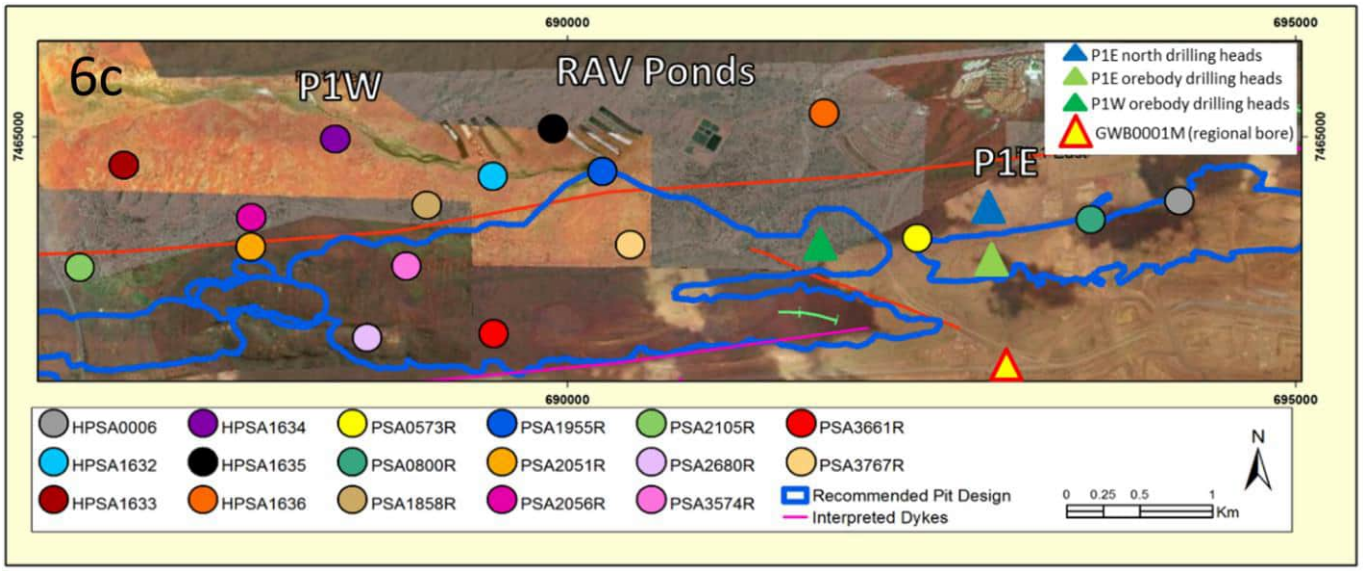
- All heads prior to 2018 show a long-term drawdown trend. It is difficult to ascertain whether this drawdown is due to a natural decline in heads, or affected by abstraction in MAC, however the steepening gradients in some bores (e.g. PSA0573RM - yellow) may indicate the impact of anthropogenic stresses.
- There is a head gradient in P1E with levels increasing towards the east (reversal of overall trend in Packsaddle of increasing towards the west).
- Most of the monitoring in P1W occurs within the 'transition zone' south of the RAV ponds.
- While heads are relatively consistent around P1W, there is a head gradient in the P1W orebody with higher heads in the east (similar to head gradient in P1E).
- All P1W monitoring bores show a rise in heads following the commencement to RAV pond discharge, including monitoring within the P1W orebody (PSA3574RM - pink).

To investigate the potential connection between P1E/P1W and the regional aquifer to the south, these heads are also plotted against a regional monitoring bore north of EC deposit (GWB0001M), as well as the exploration drilling ('pre-development') heads from the P1W orebody, P1E orebody and P1E north (**Figure R.6b - c**).

Figure R.6. Time series heads for P1W, P1E and GWB0001M, drilling heads and corresponding locations.







Thus, the existing pre-development and time series head data shows:

- P1E may be connected to the regional system/EC deposit to the south. Existing evidence for this potential connection includes:
  - Similarities between exploration drilling heads in P1E orebody and the regional aquifer (**Figure R.5**)
  - The P1E head gradient showing heads increasing towards the east (reversal of overall trend in Packsaddle of increasing towards the west) (**Figure R.6a**)
  - Similarities between exploration drilling heads in P1E orebody and GWB0001M time series heads post MAC drawdown (2012) (**Figure R.6b**)

  This aligns with geological outcrop maps showing a small mineralised martite ‘channel’ which may act as a conduit for flow between the low permeability Mt McRae/Sylvia shales. Additional monitoring is required to confirm the extent of this connection.
- It is likely that the West Packsaddle pits and the western portion of P1W are connected along strike, and disconnected from the regional system to the south. Mapped structures (Neale’s fault) and low permeability Mt McRae and Sylvia shales likely act to restrict flow north/south.

- The mix of heads in the P1W 'transition zone' may indicate variable connection along strike between P1W and P1E. This is possibly (but not limited to) explained by the EW/EC structure extending north into P1W or other structural/geological features in the vicinity.
- It is likely that the P1W orebody is disconnected from the regional aquifer to the south, although the long-term drawdown trend within these pits may suggest a potential (if muted) impact from MAC dewatering, potentially along strike from P1E.
- The P1W orebody and the region directly north are hydraulically connected (shown in head responses following RAV infiltration). This will have implications on recirculation once P1W dewatering commences.

5.18.7 Conclusions

- Outcropping low permeability Mt McRae and Sylvia Formations separate most of the Packsaddle orebody from the regional system/MAC in the south.
- There is limited time series data available in Packsaddle. Most data exists in P1W and P1E. Additional monitoring is required in the orebodies to better elucidate the hydraulic properties of this system.
- Hydraulic boundaries likely exist:
  - To the west and northwest
  - To the south, separating the Packsaddle deposits and the regional system (with the exception of P1E)
  - Midway through Packsaddle range, isolating P2 from the east, west and south
- Hydraulic connections in the system likely/may exist between:
  - West Packsaddle and P1W (along-strike)
  - P1E and the regional system to the south
  - P3, P4, P5, P6 and the eastern portion of East Packsaddle pit (along-strike)
  - East Packsaddle orebody and Weeli Wolli Spring
- Due to limited available data, a number of hypotheses require additional testing, including:
  - Along-strike connection in P1W (focus on 'transition zone' south of RAV Ponds)
  - Extent of connection between P1E and regional system
  - Extent of boundaries surrounding P2
  - Extent of connection between P3 – P6/East Packsaddle and the regional system/MAC, and implications on future BWT mining and Weeli Wolli Spring

5.18.8 Uncertainty

- In the west of Packsaddle, there is uncertainty as to the long term drawdown trends seen in time series data. This could be a natural long-term drawdown trend and/or due to influence from abstraction in MAC (e.g. at EC deposit). There is no time series data pre-MAC abstraction to confirm.
- The extent of connection between P1E (and P1W) and the southern regional system is unknown. While pre-development heads show similarities and potential connection, this is not confirmed by time series data.
- While consistent pre-development heads within West Packsaddle and a portion of P1W potentially indicate hydraulic connection along-strike, this may also have occurred due to water levels 'settling out' over long periods of time, uninfluenced by anthropogenic stressors.
- Connection between Packsaddle East and the regional system is uncertain. Pre-development heads show up to ~50 m difference in water levels. However, while the southern regional bores (HEPX) are impacted by Hope Downs dewatering, the extent of hydraulic disconnection (through the low permeability McRae/Sylvia shales south of East Packsaddle) from the East Packsaddle pits has not been quantified.
- Characteristics / quality of the orebody aquifers.

6 Chemistry

Piper and Expanded Durov diagrams for the Mining Area C groundwaters collected during FY2018 are presented in **Figures 6.1 and 6.2** and all electrical conductivity (EC) observations (BHPB) are shown in **Figure 6.3**.

6.1.1 Water Type

Piper and expanded Durov-diagram representations (**Figures 6.1 and 6.2**) suggest generally coincident water types (dissolution/mixing) for detritals and detritals-proximal aquifers (A, C and E deposits), with a gradual shifting of carbonate dominant signatures to more mixed and sulphate dominant (bores HSF0055M2 and HSF0061P) both well within historical ranges for South Flank. Juna Downs, Coondewanna Flats and Packsaddle bores suggest generally carbonate dominant signatures

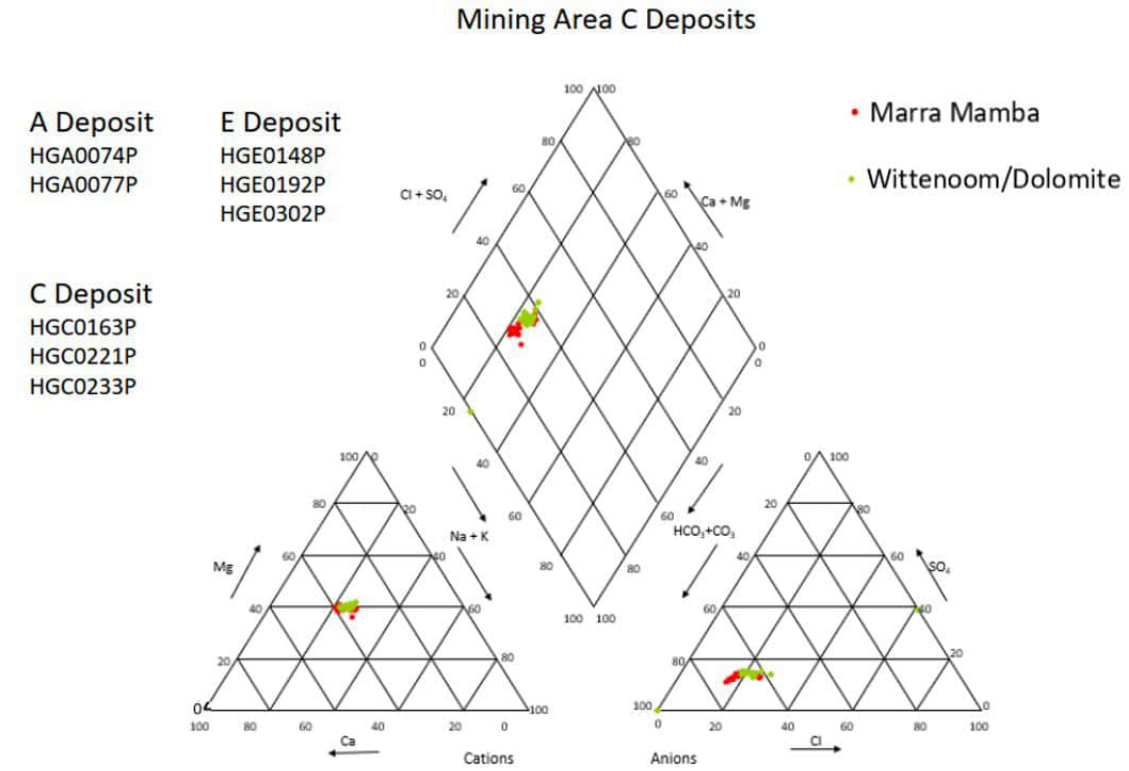
6.1.2 Electrical Conductivity

Electrical Conductivity (EC) observations are shown in **Figure 6.3**. They show the following:

- The North Flank orebody and dolomite EC values are similar, generally ranging between 400 and 800 µS/cm (indicating relatively fresh water).
- There could be a slight increasing EC trend in some of the locations (dolomite north of C Deposit and the A and C Deposit orebodies) although this may be a consequence of variations in the monitoring network with time.
- The Coondewanna Flats aquifer system water has a similar EC to the North Flank orebody and dolomite (averaging about 650 µS/cm). All the way from Coondewanna Flats to A Deposit then, the water EC is similar and relatively fresh.
- Groundwater in the Hope Downs system appears to have a significantly higher EC. There are only 4 EC measurements, between 1,000 and 1,600 µS/cm. They are therefore roughly double the North Flank orebody and dolomite values.
- The variation in observed EC values is greater in the orebody aquifers than either the regional dolomite north of C Deposit or the Coondewanna aquifer system. This is either due to the fact that there are considerably more bores monitored in the orebodies or a signature of greater variability in the orebody groundwater.
- The South Flank Valley and Southern orebody waters present a similar EC to the Coondewanna Flats and North Flank waters. The South Flank Northern orebody waters however present a much more variable EC, ranging from approximately 200 µS/cm to 1400 µS/cm.

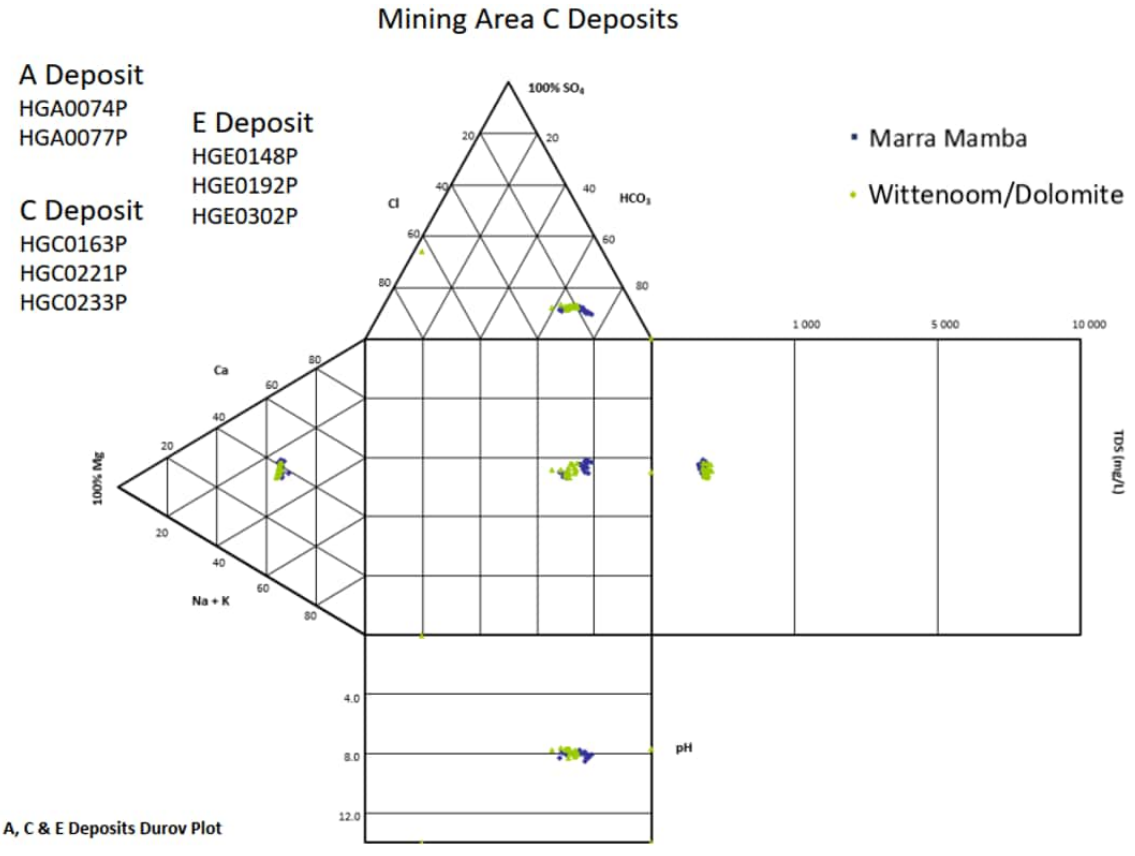
These data indicate then that the Coondewanna, North Flank and South Flank Valley and Southern orebody aquifers are quite fresh, most likely due to the depth to water (and therefore lack of evapotranspiration) and rainfall recharge, and are seemingly relatively well connected. The Hope Downs aquifer system by contrast seems to have a higher salinity groundwater due, not to lower recharge rates, but evaporative concentration of salts at the Weeli Wolli aquifer system.

Figure 6.1. Hydrochemistry typing and compatibility – North Flank



A, C & E Deposit Piper Plot

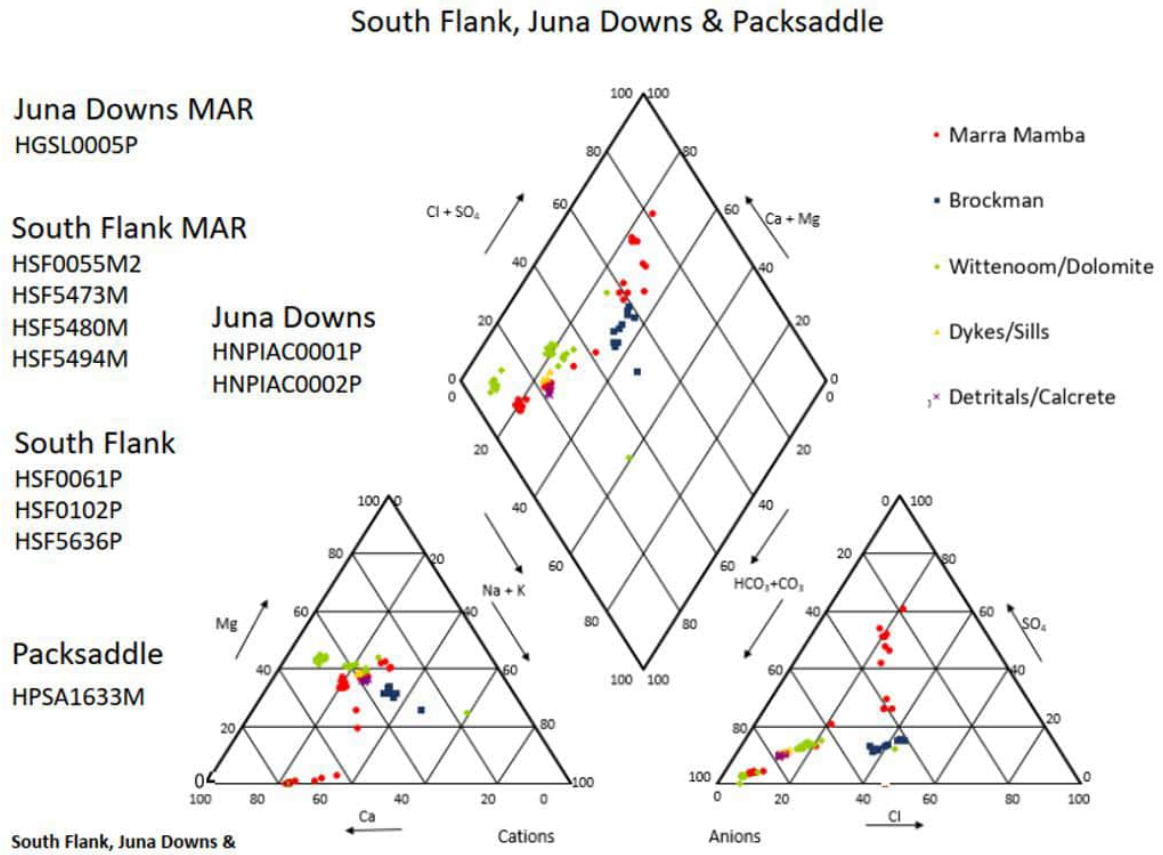
Annual Aquifer Review 2024



A, C & E Deposits Durov Plot

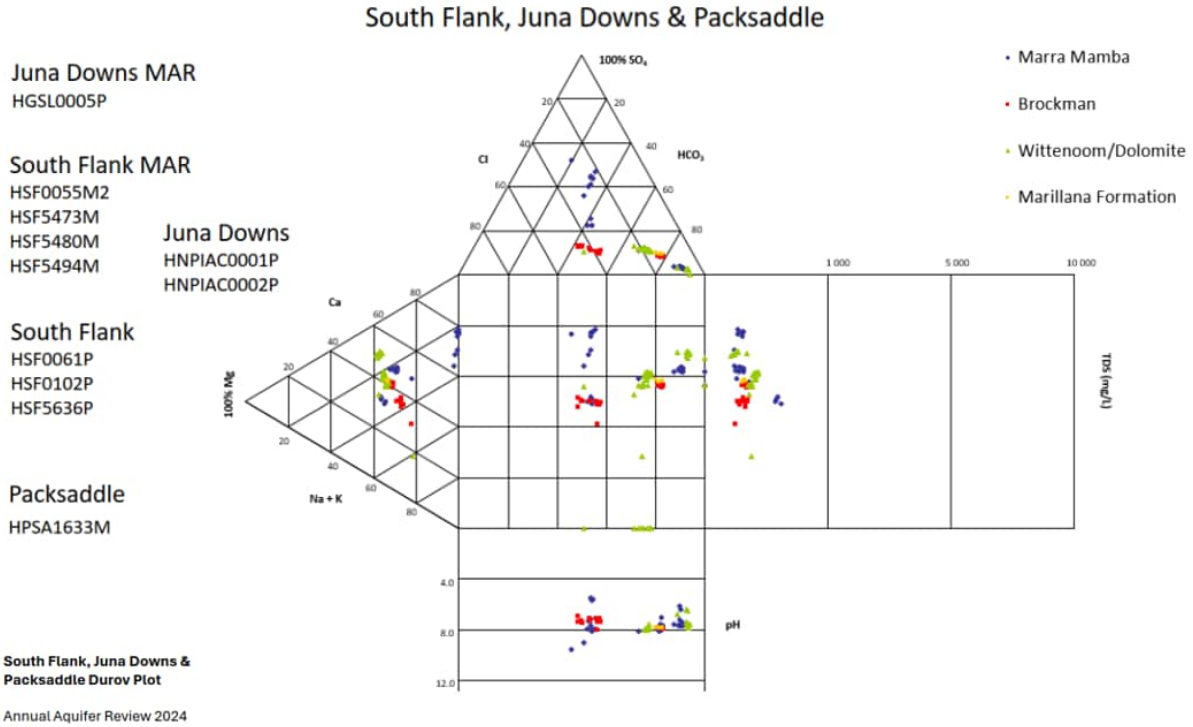
Annual Aquifer Review 2024

Figure 6.2 Hydrochemistry typing and compatibility – South Flank, Juna Downs and Packsaddle



South Flank, Juna Downs & Packsaddle Piper Plot

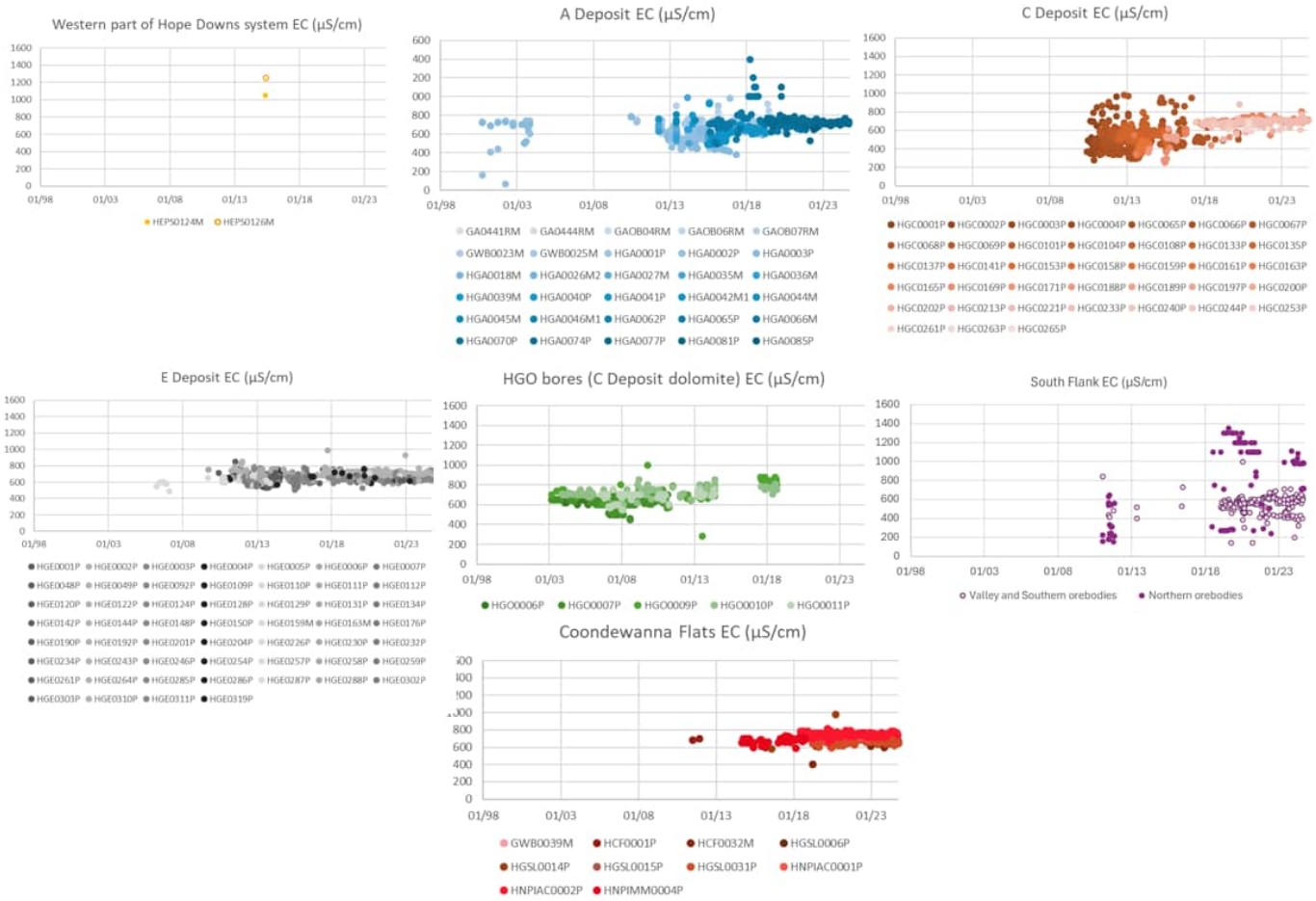
Annual Aquifer Review 2024



South Flank, Juna Downs & Packsaddle Durov Plot

Annual Aquifer Review 2024

Figure 6.3. EC time series data



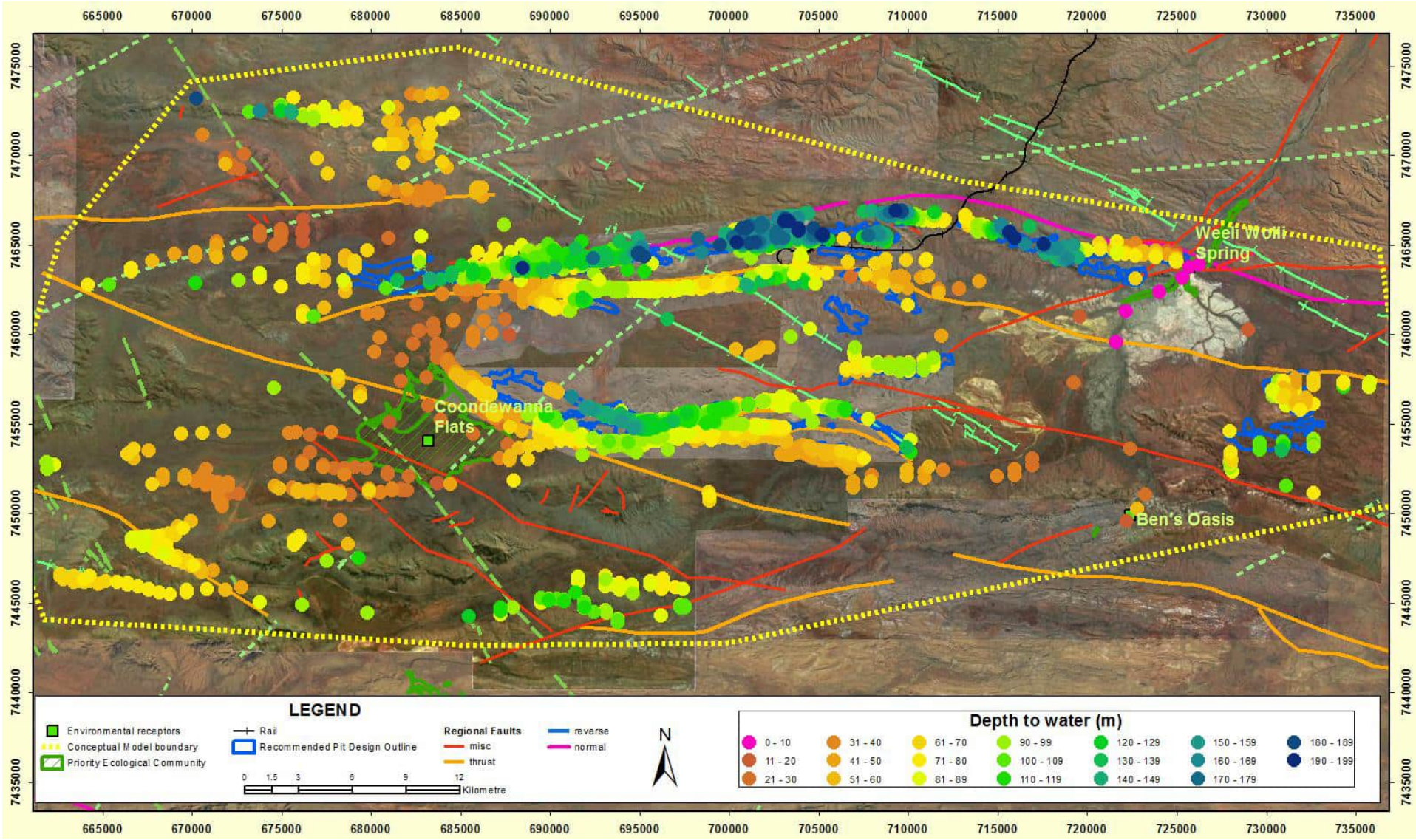
7 Depth to groundwater

Observed pre-development depth to groundwater is shown in **Figure 7.1**. This shows that:

- The greatest depth to water in the observed data is within the Packsaddle Ranges (generally more than 100 m). Depth to groundwater reduces within about 4 km of Weeli Wolli Spring however (i.e. in the eastern most part of this area).
- Within the central part of the conceptual model domain (i.e. the BHPB North Flank and South Flank mining areas) depth to water is between 50 and 100 m, apart from the two southern Vista Oriental orebodies, where groundwater is between 30 to 40 m below surface.
- Depth to water is generally between 30 and 50 m in the Coondewanna aquifer system and in the Hope Downs system between 10 and 40. In the R Deposit part of the Hope Downs system however, depth to water is greater (between 60 to 80 m).
- Groundwater is less than 10 m from the ground surface only in the area of the Weeli Wolli aquifer system.
- Depth to groundwater is greater than 50 m over all of the Jinidi aquifer system, with a clear distinction between the northern orebody (50 to 70 m) and the southern (mostly 80 to 110 m).

This data confirms that the only area within the Central Pilbara catchment where groundwater / surface water interaction (other than rainfall recharge) can occur is in the area of Weeli Wolli Spring and the calcrete surrounding it. Everywhere else groundwater is greater than 30 m below (pre-mining) ground surface.

Figure 7.1. Depth to groundwater (pre-development)



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Appendix D – Hydrogeological Bore Logs

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GA1380R	Hole Length:	144.00

Easting: 711124.76
Northing: 7462274.97
Surface RL: 621.69
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 144.0	JNDRIG7	RHF	140	AIR/WATER/FOAM	JND	CW1

TOC RL: 621.69 - (drilled) SWL: 40.24 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 621.69 - (current) Is Live: N (14 Apr 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZYG	JCX			Surface scree, brown soils					BLANK PVC: (0.00-104.00)
		VB2	JG1	C			Hardcap bif, marginal					
			JG	F			Marginal, some yellow cherts					
10			J	C			White cherts					
			J	C			White cherty q					
			J	C			Red cherts					
			JK	L								
20			J	LK			Yellow clays					
			JK	LS			Clays					
			JK	LS			Clays					
			J1	N								
30			N	GWK			Maanganese and g ore?, trace yellow clay					
			N	GW			Hardish mang-crete hardcap over dolomite, (not sure what its called)					
			N	G1C			Marginal grading manganocrete? (something like that, spelling not right)					
40			DN				Hardcap mang-crete over dolomite trans zone					
			D				Fresher looking d					
			D				Fresher looking d					
			D									
50			D									
			D									
			D									
			D									LEVELTROLL(59.30) ID: 1177
60		OB	D				No pyrites					
			D									
			D	4								
70			D									
			D									
			D									
80			D				No vissible pyrites					
			D									
			D									
90			D									
			D	PB			Pyrites					
			D				Trace p					
100			D				Green shales?not asbestos					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GA1380R	Hole Length:	144.00

Easting: 711124.76
Northing: 7462274.97
Surface RL: 621.69
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 144.0	JNDRIG7	RHF	140	AIR/WATER/FOAM	JND	CW1

TOC RL: 621.69 - (drilled) SWL: 40.24 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 621.69 - (current) Is Live: N (14 Apr 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	D				Green shales?not asbestos					BLANK PVC: (0.00-104.00)
			D				Trace p					
			D									
110			D									
			D									
			D									
			D	4								
120			D									
			D									
			D									
			D4									
130			D4									
			D									
			D									
140			D									
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB01R	Hole Length:	120.00

Easting: 707314.29
Northing: 7463574.66
Surface RL: 644.02
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: PLANNED WB_01, AQT OBSERVATION BORE 1

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	JNDRIG7	RHF	140		JND	CRW

TOC RL: 644.39 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 644.73 - (current) Is Live: N (15 Nov 17) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	ZXJ	SW			Quite a lot of shale					
			ZXJ	WS			..					
			ZJX	GSW								
10			ZJG	X								
			ZXJ	LG			Enough x for td3					
			ZX	JG			Still some j and g					
			ZXS									
20			ZX									
			ZXS									
			ZX	SL			Transitional?					
30			ZX	GSL								
		TD2	ZX	GSL								
			ZSK	GL								
			ZS	KLG								
40			ZKS	L								
			ZS	KLF								
			ZSK	L								
50			ZHG	S			Td1?					
			ZHG	BS								
			ZG				Probably td2 with heaps of g, interesting i twent red and then back to yellow					
60			ZG									
			ZG				Very small chips, very little liquid					
			ZGJ	SL			Bit biffy as well					
			ZG	JS			Hardcapped g, more variable sized and angular chips, wa1					LEVELAPP-TEK(63.68) ID: 1542
70			ZG									
			ZG	SL								
			ZGS	JW								
80			ZGW	JS								
			ZSF	WG								
			ZWF	SG			Possibly transitional between det and wa1					
90			ZWF	SG								
			GJ	SL			Part min.					
			SJ	LG								
		WA1 WA2	SJ	LG								
			J	S								
			J	G			Trying to mineralise					
100			J	G			Trying to mineralise					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB01R	Hole Length:	120.00

Easting: 707314.29
Northing: 7463574.66
Surface RL: 644.02
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: PLANNED WB_01, AQT OBSERVATION BORE 1

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	JNDRIG7	RHF	140		JND	CRW

TOC RL: 644.39 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 644.73 - (current) Is Live: N (15 Nov 17) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		WA1	J	G			Trying to mineralise					
			J	G			..					
			J				..					
110			JS									
		N3	J	S								
			J				Oxidised bif					
120			J				.. Eoh					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB05R	Hole Length:	180.00

Easting: 708935.71
Northing: 7463355.50
Surface RL: 631.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 180.0	JNDRIG7	RHF	140		JND	ADT

Comments: No open hole geophysical survery was carried out in fear of getting tool stuck in 50mm poly-pipe

TOC RL: 631.47 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 632.10 - (current) Is Live: N (31 May 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZYX	JLG			Quite angular					
			ZYX	JGF			Cherty bif					
			ZXY	FGJ								
10			ZYX	FGL			Traces vit g					
			ZY	XGC			Still very much a mixture					
			ZXY	GS								
20		ST3	ZXY	SKG								
			ZXY	SKG			Very poor sample					
			ZX	YGH								
			ZX	SKY								
30			ZX	SKY								
			ZSK	CJ			X dropped out, become much more shaley					
			ZSC	KJ								
40			ZSC	KG			Trace of vit g					
			ZSG	FC								
			SK	GF								
50		VB2	SK	G								
			SK	GF								
			SK	G								
			SK				Very very shaley					
60		CY2	SK									
			SK									
			SK									
			SK									
70			SK				Beginning of dolomite					
			SK	DQ			Dolomite, slightly weathered					
			D	S								
			D	S								
80			D				Becoming much fresher dolomite now					
		OB	D									
			D									
			D									
90			D									
			D									
			D									
			D									
100			D				Fractured and weathered					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB05R	Hole Length:	180.00

Easting: 708935.71
Northing: 7463355.50
Surface RL: 631.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 180.0	JNDRIG7	RHF	140		JND	ADT

Comments: No open hole geophysical survery was carried out in fear of getting tool stuck in 50mm poly-pipe

TOC RL: 631.47 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 632.10 - (current) Is Live: N (31 May 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	D				Fractured and weathered					
			D									
			D									
110			D									LEVELAPP-TEK(107.97) ID: 1541
			D									
			D									
			D									
120			D									
			D	SK								
			D				Still has some yellow, weathering					
130			D				Relatively weathered					
			D	K			Becoming more clay rich					
			D	S								
140			D	S			Slightly fresher looking dolomite					
			D									
			D									
150		WA2	G	DL			Potentially top of wa or newman					
			G	DL			Potentially top of wa or newman					
			SG	L			Weathered goethite					
		WA1	J	GL			The gl is quite weathered and soft					
			J	GL								
			J	G			The gl is quite weathered and soft					
160			J	G								
			J	G								
			J	C			Very biffy					
170			JC	Q			Looks like a beach, good on ya lindsay					
			JQ	C								
		N3	JQ	C			Fresh bif					
			J	M								
180			J	G			Eoh - fresh bif					
190												
200												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 6

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB07R	Hole Length:	153.00

Easting:	709729.31
Northing:	7462883.98
Surface RL:	626.90
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	-
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 153.0	JNDRIG7	RHF	140		JND	ADT

TOC RL:	626.90	-	(drilled)	SWL:		Dev:	N	Final pH:	-
TOC RL:	627.75	-	(current)	Is Live:	N	(01 Dec 22)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZYX	GF			Please note this hole has not been sampled due to a twin hole being on the same pad					
			ZYX	GH								
			ZYX	GL								
10		TD3	ZX	YGF								
			ZX	GY								
			ZX	G								
20			ZX	G								
			ZX	G								
			ZX3	G			Quite a bit of calcrete coming through now					
		TD2	3				Almost purely calcrete with a little q as well, not sure if this is weathered dolomite above the parabadoo					
30			3									
			3				Same					
			S3	K			Trace of g coming through					
			3	SG			Very shaley calcrete					
40			S3				Some quite good ore amongst the calcrete					
			S3	Q			Quite shaley now					
			S3	K			Same					
50			3	SG			Quite clayey shale					
			3	SG								
			G	S								
60			G	S								LEVELAPP-TEK(60.91) ID: 1567
			S	GK			Very shaley					
			S	KG								
70			S	GK								
			SK									
			SK	D			Potentially the bottom of td2 here as now coming into dolomite, possibly parabadoo					
80		OB	D	S			Beginning of dolomite, quite shaley and weathered					
			D									
			D				Weathered - quite yellowish in colour					
			D	Q								
90			D				Still quite yellow in appearance					
			D				Dolomite become quite fresh now, typical light greyish in colour					
			D									
100			D									LEVELTROLL(97.00) ID: 461
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 7

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GAOB07R	Hole Length:	153.00

Easting: 709729.31
Northing: 7462883.98
Surface RL: 626.90
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 153.0	JNDRIG7	RHF	140		JND	ADT

TOC RL: 626.90 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 627.75 - (current) Is Live: N (01 Dec 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	D									
			D									
			D									
110			D									
			D									
			D									
			D									
120			D									
			D									
			D	S			Coming into what looks to be weathered dolomite and limonitic mineralisation					
		WA2	L	G			Very limonitic material, not quite sure if grade though					
130			GL				Again					
			GL	S			Again					
			D	SK			Small amount of dolomitic material back agai n					
			GJ	DL			Limonitic mineralisation with quite alot of impurities, perhaps just grade??					
140			J	C			Come into what looks like freshing bif now					
		N3	J	C								
			J	C								
			J	CQ			Eoh - hole finished in bif					
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GF0914R	Hole Length:	75.00

Easting: 689888.10
Northing: 7462409.93
Surface RL: 713.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: test newman min. piezo installation. No openhole (piezo)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 75.0	GD10	RHF	140		BLY	EG

TOC RL: 713.55 (Stickup 0.55m) (drilled) SWL: 52.77 MBGL (11 Sep 14) Dev: N Final pH: -
TOC RL: 714.50 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZGY	XCW			Angular chips scree.					BLANK PVC: 50mm (0.00-56.00)
		ST3	ZGX	YCW			Mag pesos present, still angular blocks though. Yellow cherts.					
			ZGX	YCW			Mag pesos present, still angular blocks though. Yellow cherts.					
10			ZGX	YCW			Angular chips. Mag present.					
			ZGX	WCY			Increased mag pesos. Trace q					
			ZGX	W			Mag pesos some yellow cherts.					
		GS3	ZGX	W			Mag pesos.					
20												
30												
40		WP3	ZGX	W			Mag pesos dominant. Some subangular slightly bedrocky looking chips, still magnetic.					
			ZGX	W								
		VB2	ZG	L			Mag pesos dominant. Some subangular slightly bedrocky looking chips, still magnetic.					
50			ZG	L								
			ZG	LS			Some vit g. L fines					
			ZG	LKS			Some vit g. L fines					
		N2	G	LCS			Clumps of yellow s. Some vit g.					
60			GJ	CLQ			K lumps. Some vit g.					SLOTTED PVC: 50mm , Slots 3mm (56.00-74.00)
			GC	JS			Bedrock. Mo, just grade.					
			JC	G			Mo, just grade					
		N1	JC	G			Leached yellow cherts, soft. Mo, unlikely to grade. Shaley fines - bright yellow					
70			JC				Oxy bif. Visible banding					LEVELAPP-TEK(70.31) ID: 1577
							Oxy bif. Visible banding					END CAP (74.00)
							Oxy bif					
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: YEJ15 E Deposit RC Drilling Planned Hole: GF_2015_0002 Page: 9

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** GF0939R **Hole Length:** 63.00

Easting: 687181.80
Northing: 7461212.01
Surface RL: 703.96
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Oct 15 - 10 Oct 15
Comments: Sucessfull, Pezio, below water table.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 63.0	MCYRC09	RHF	146		MCKAY	CW1

TOC RL: 704.94 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 704.94 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZJ	CX								BLANK PVC: Size 50 - Class 18 (0.00-33.00)
		ST3	ZJ	CX								
10			JC1	S			VIT G, PITTED					
		N1	JC1	S			VIT G, PITTED					
20			JCS				YELLOW SHALES, CHERTY, MM					
		MM	JCS				YELLOW SHALES, CHERTY, MM					SLOTTED PVC: Size 50 - Class 18, Slots 3mm (33.00-59.00)
30												
40												
												LEVELTROLL(44.85) ID: 1548
50												
			JMC	B			GETTING FRESH, BLUE GREEN SAHLES, CARB HALE, STIP, PYRTIE, NO ASBESTOS					END CAP (59.00)
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK Hole Name: GWB0005 Hole Length: 166.00

Easting: 703638.38
Northing: 7462908.42
Surface RL: 732.40
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 06 Jun 97 - 09 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	BD	DR	190		BD	EJL
80.0 - 166.0	BD	CH	146		BD	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH5. UNABLE TO MEASURE WATER LEVEL DUE TO DRILLING OIL CONTAMINAT IN BORE...

TOC RL: 732.41 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 732.66 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0-100		UN				0 100 200	LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO	0-5000	0-14	0-50		STEEL CASING: 152mm (0.00-80.00) BLANK PVC: 50mm : CL9 (0.00-153.00)

Program: Planned Hole: Page: 11

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: GWB0005 | Hole Length: 166.00

Easting: 703638.38
Northing: 7462908.42
Surface RL: 732.40
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 06 Jun 97 - 09 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	BD	DR	190		BD	EJL
80.0 - 166.0	BD	CH	146		BD	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH5. UNABLE TO MEASURE WATER LEVEL DUE TO DRILLING OIL CONTAMINAT IN BORE...

TOC RL: 732.41 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 732.66 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 400mm | Notes

100 110 120 130 140 150 160 170 180 190 200

Strat: UN

Hydrogeological Description: LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO

Gamma CPS API: 0 100 200

EC us/cm: 0-5000 | pH: 0-14 | Yield L/s: 0-50

Diagram Scaled to 400mm

Notes:
- BLANK PVC: 50mm : CL9 (0.00-153.00)
- GRAVEL PACK (140.00-166.00)
- SLOTTED PVC: 50mm : CL9 (153.00-165.00)
- BLANK PVC: 50mm (165.00-166.00)
- LEVELAPP-TEK(169.15) ID: 1375

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: GWB0010 Hole Length: 100.00

Easting: 704007.44
Northing: 7464478.42
Surface RL: 665.74
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 May 97 - 24 May 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 26.0	BD	DR	180		BD	EJL
26.0 - 100.0	BD	CH	146		BD	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH10 Minign Area C/Northern Side of North Flank Vallley; WOODWARD CLYDE B...

TOC RL: 665.74 - (drilled) SWL: 79.31 MBGL (14 Jul 97) Dev: N Final pH: -
TOC RL: 665.81 - (current) Is Live: N (01 Dec 17) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		UN					LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO					BACKFILL (0.00-48.00) BLANK PVC: 50mm : CL9 (0.00-88.00)
10												
20												
30												
40												
50												GRAVEL PACK (48.00-100.00)
60												
70												
80												
90												SLOTTED PVC: 50mm : CL9 (88.00-100.00)
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 13

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	GWB0010	Hole Length:	100.00

Easting: 704007.44
Northing: 7464478.42
Surface RL: 665.74
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 May 97 - 24 May 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 26.0	BD	DR	180		BD	EJL
26.0 - 100.0	BD	CH	146		BD	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH10 Minign Area C/Northern Side of North Flank Vallley; WOODWARD CLYDE B...

TOC RL: 665.74 - (drilled) SWL: 79.31 MBGL (14 Jul 97) Dev: N Final pH: -
TOC RL: 665.81 - (current) Is Live: N (01 Dec 17) Date: - Final EC: -

Depth mgbl	Cond	UN Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100												LEVELAPP-TEK(102.20) ID: 1045
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 14

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GWB0013	Hole Length:	94.00

Easting: 711867.00
Northing: 7459943.00
Surface RL: 621.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 26 May 97 - 31 May 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 94.0	BD	DR	180		BD	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH13 Mining Area C/ Mouth of R&B Valley; R/B valley mouth. Stopped in all...

TOC RL: 621.22 - (drilled) SWL: 93.30 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 621.22 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		UN					LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO					BACKFILL (0.00-72.00) BLANK PVC: 50mm : CL9 (0.00-77.00)
10												
20												
30												
40												
50												
60												
70												GRAVEL PACK (72.00-94.00)
80												SLOTTED PVC: 50mm : CL9 (77.00-94.00)
90												LEVELTROLL(87.00) ID: 2081
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 15

BHPIO - Hydrogeology Log

BHP

Project:	WAIO EXPL	Hole Name:	GWB0014B	Hole Length:	0.00

Easting: 719590.84
Northing: 7461005.51
Surface RL: 583.76
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 01 Jan 70 - 01 Jan 70
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 0.0	UNKN	UNKN	300		UNKN	

TOC RL: 584.02 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 583.76 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0												
10												
20												
30												
40												
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	WAIO EXPL	Hole Name:	GWB0015	Hole Length:	46.00

Easting: 722144.62
Northing: 7461302.39
Surface RL: 578.55
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Jun 97 - 24 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 22.0	BD	DR	180		BD	DWEST
22.0 - 46.0	BD	CH	146		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH15 Mining Are C/Hope Downs/ Weeli Wolli Creek; WOODWARD CLYDE BOREHOLE ...

TOC RL: 578.55 - (drilled) SWL: 9.48 MBGL (13 Jul 97) Dev: N Final pH: -
TOC RL: 578.55 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 400mm | Notes

0
10
20
30
40
50
60
70
80
90
100

Strat: UN

Hydrogeological Description: LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO

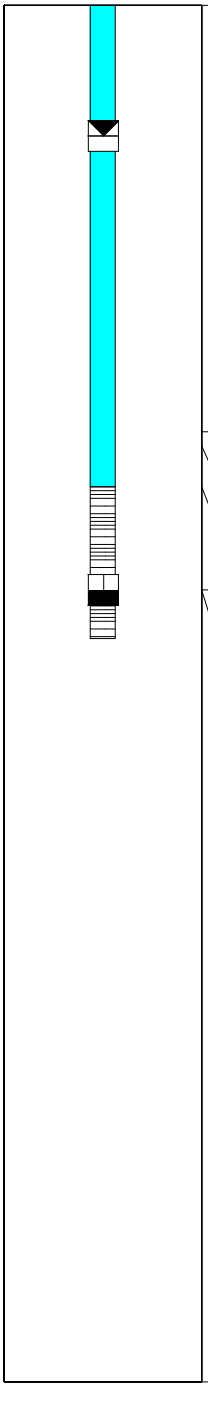
Gamma CPS API: 0 100 200

EC us/cm: 0-5000

pH: 0-14

Yield L/s: 0-50

Diagram Scaled to 400mm



Notes:
- BACKFILL (0.00-31.00)
- BLANK PVC: 50mm : CL9 (0.00-35.00)
- BENTONITE (31.00-32.00)
- GRAVEL PACK: (1.6-3.2mm) (32.00-46.00)
- SLOTTED PVC: 50mm : CL9 (35.00-46.00)
- LEVELTROLL(42.48) ID: 2326

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

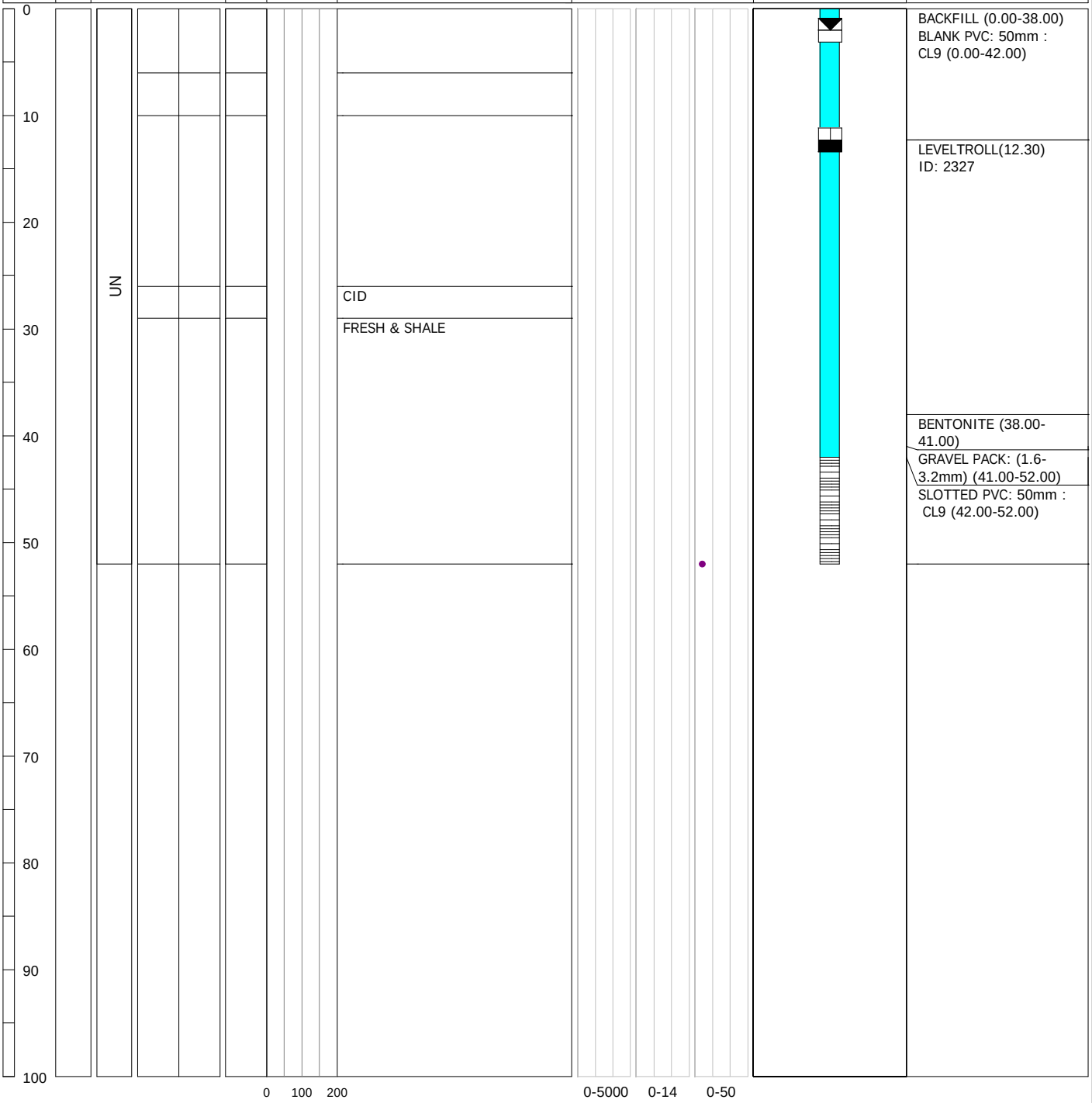
Project:	EAST PACKSADDLE	Hole Name:	GWB0016D	Hole Length:	52.00

Easting: 724054.48
Northing: 7462379.92
Surface RL: 568.31
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 25 Jun 97 - 30 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 30.0	BD	DR	180		BD	DWEST
30.0 - 52.0	BD	CH	146		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH16D Mining Area C/ Hope Downs/Weeli Wolli Creek; WOODWARD CLYDE BOREHOL...

TOC RL: 568.31 - (drilled) SWL: 1.99 MBGL (13 Jul 97) Dev: N Final pH: -
TOC RL: 569.24 - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole: Page: 18

BHPIO - Hydrogeology Log

BHP

Project:	EAST PACKSADDLE	Hole Name:	GWB0016S	Hole Length:	28.00

Easting: 724056.98
Northing: 7462380.68
Surface RL: 568.52
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 25 Jun 97 - 30 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 28.0	BD	DR	180		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH16S Mining Area C/ Hpe Downs/Weeli Wolli Creek; WOODWARD CLYDE BOREHOLE...

TOC RL:	568.52	-	(drilled)	SWL:	2.15 MBGL	(13 Jul 97)	Dev:	N	Final pH: -
TOC RL:	568.92	-	(current)	Is Live:	Y	(-)	Date:	-	Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		UN					LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO					BACKFILL (0.00-14.00) BLANK PVC: 50mm : CL9 (0.00-16.00)
10												LEVELTROLL(10.00) ID: 2079
20												GRAVEL PACK (14.00-28.00) SLOTTED PVC: 50mm : CL9 (16.00-28.00)
30												
40												
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

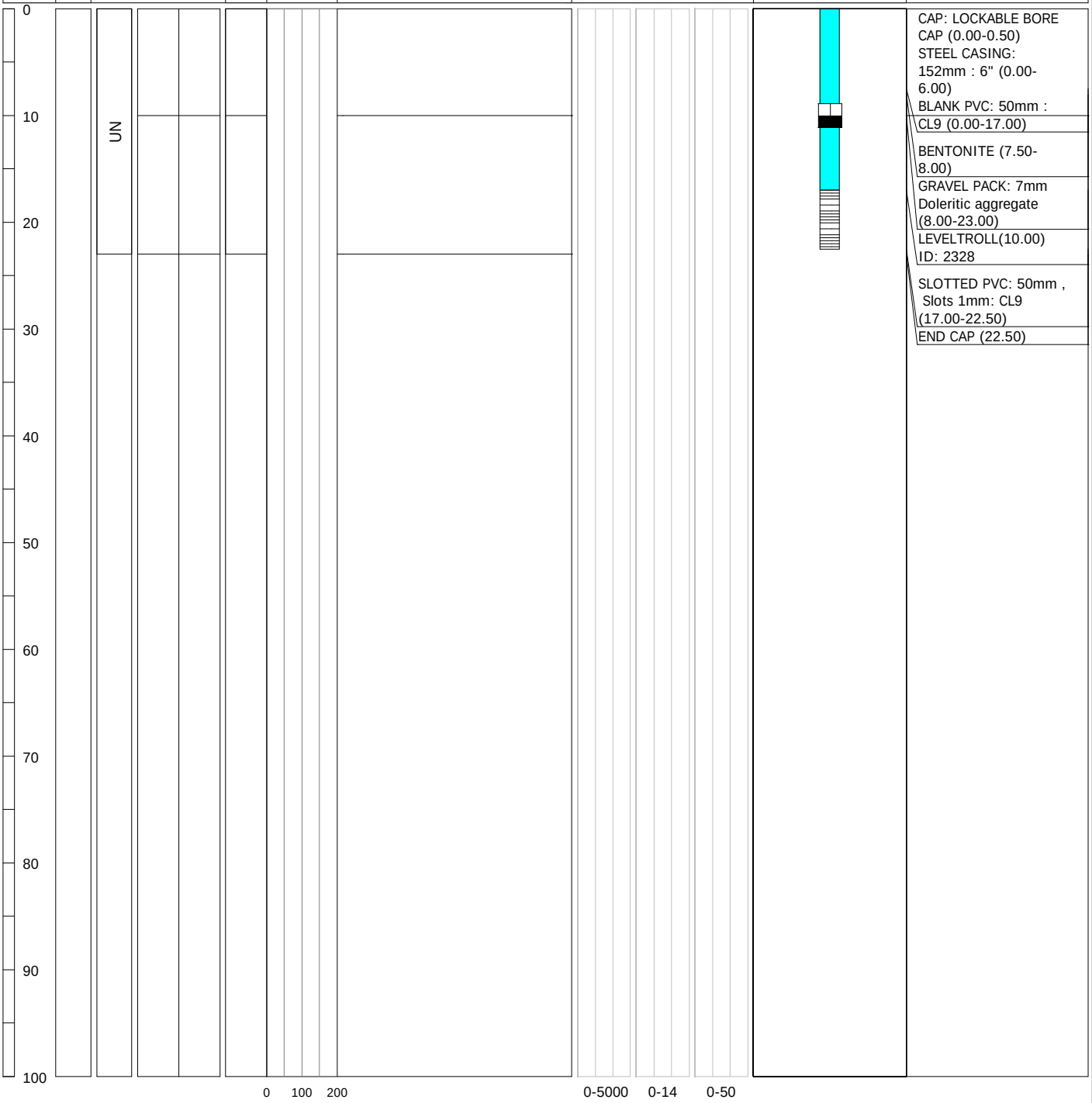
Project:	NORTHEAST CORNER	Hole Name:	GWB0017D	Hole Length:	23.00

Easting: 725698.07
Northing: 7463790.82
Surface RL: 558.98
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 06 Apr 98 - 06 Apr 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 10.0	BD	DR	180		BD	DWEST
10.0 - 23.0	BD	CH	146		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH17D - HOPE DOWNS PROJECT Hope Downs/Welli Wolli Spring; WOODWARD CLYDE ...

TOC RL: 560.70 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 559.30 - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTHEAST CORNER	Hole Name:	GWB0017S	Hole Length:	11.00

Easting: 725698.79
Northing: 7463790.53
Surface RL: 558.96
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 06 Apr 98 - 06 Apr 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 11.0	BD	DR	180		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH17D - HOPE DOWNS PROJECT Hope Downs/ WeeliWolli Spring; WOODWARD CLYDE ...

TOC RL: 560.70 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 559.74 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		UN					LOGGED BY WATER CONTRACTOR INTO FIELD LOG - NOT LOGGED BY BHPBIO					CAP: LOCAKABLE BORE CAP (0.00-0.50) STEEL CASING: 152mm : 6" (0.00-3.00) BLANK PVC: 50mm : CL9 (0.00-4.00) SLOTTED PVC: 50mm : CL9 (4.00-9.50) END CAP (9.50) LEVELTROLL(10.00) ID: 2329 FALLBACK (10.00-11.00)
10												
20												
30												
40												
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 21

BHPIO - Hydrogeology Log

BHP

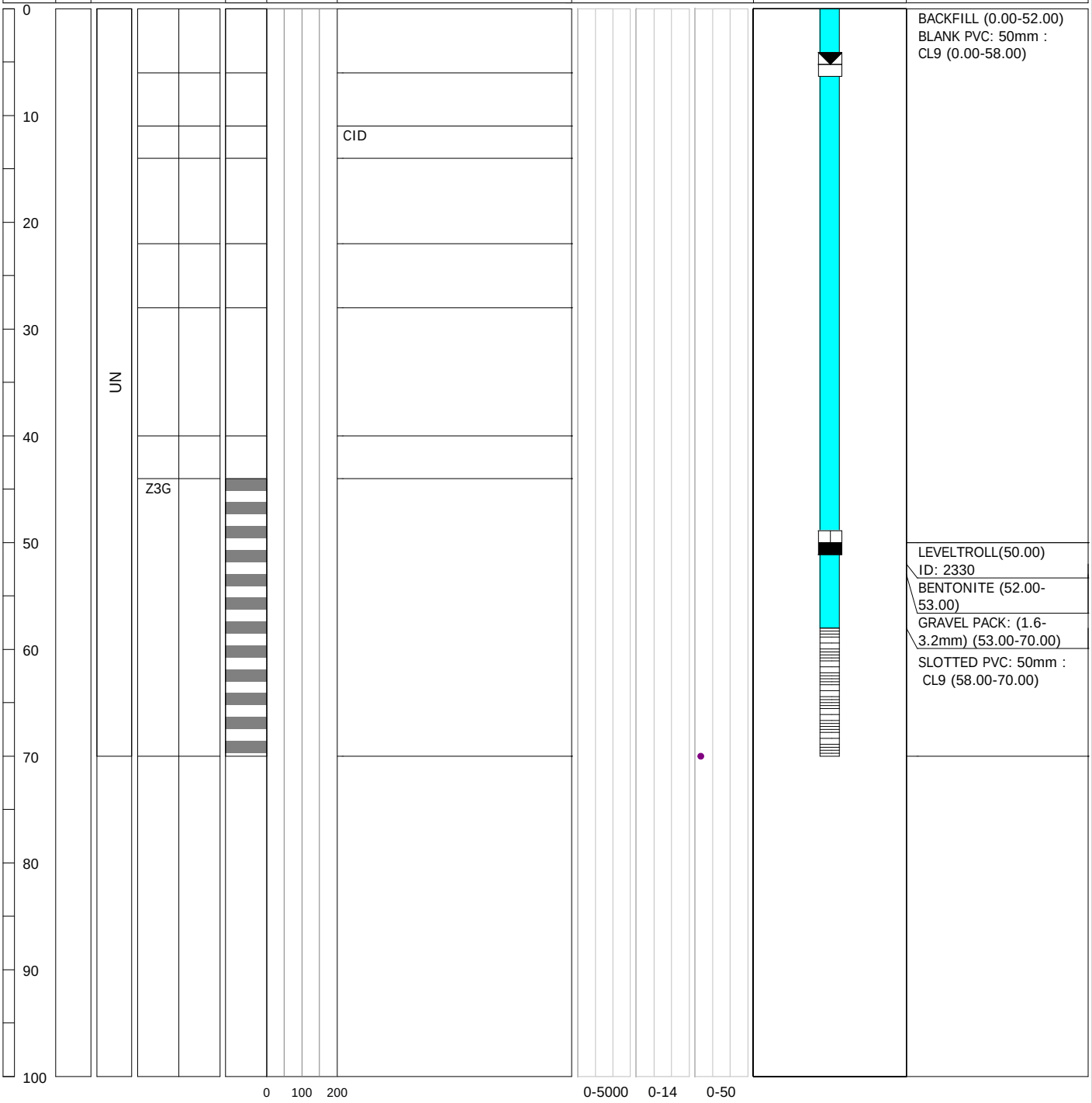
Project:	NORTHEAST CORNER	Hole Name:	GWB0018D	Hole Length:	70.00

Easting: 725307.50
Northing: 7463171.26
Surface RL: 566.78
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Jun 97 - 07 Jul 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 34.0	BD	DR	180		BD	DWEST
34.0 - 70.0	BD	CH	146		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH18D Mining Area C/ Weeli Wolli Creek/ Hope Downs; WOODWARD CLYDE BOREHO...

TOC RL:	566.78	-	(drilled)	SWL:	5.19 MBGL	(13 Jul 97)	Dev:	N	Final pH: -
TOC RL:	567.48	-	(current)	Is Live:	Y	(-)	Date:	-	Final EC: -



Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

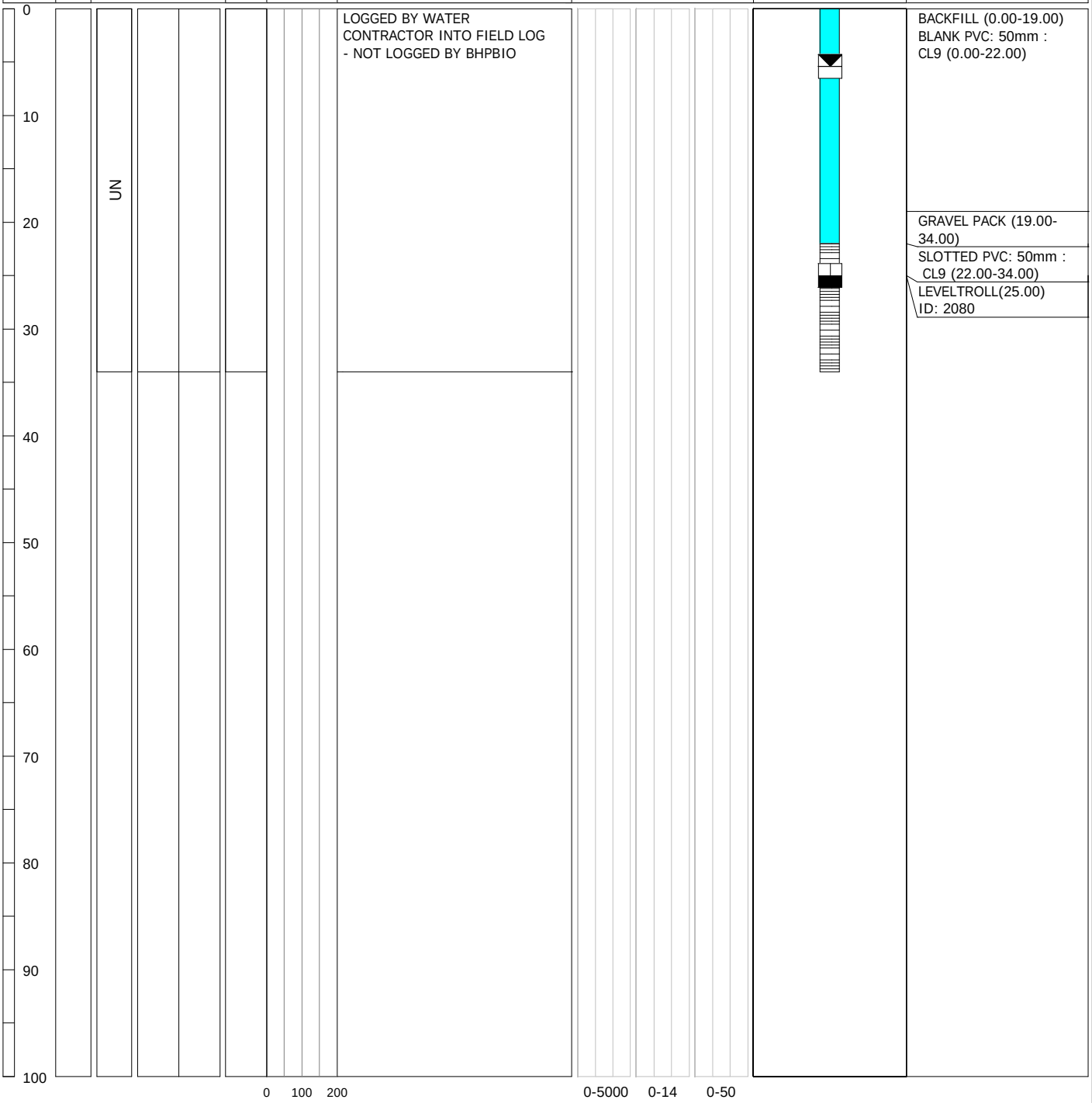
Project:	NORTHEAST CORNER	Hole Name:	GWB0018S	Hole Length:	34.00

Easting: 725308.00
Northing: 7463169.61
Surface RL: 566.92
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Jun 97 - 07 Jul 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 34.0	BD	DR	180		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH18S Mining Area C/Hope Downs/ Weeli Wolli Creek; WOODWARD CLYDE BOREHOL...

TOC RL:	566.92	-	(drilled)	SWL:	5.40 MBGL	(13 Jul 97)	Dev:	N	Final pH: -
TOC RL:	568.02	-	(current)	Is Live:	Y	(-)	Date:	-	Final EC: -



Program: Planned Hole: Page: 23

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GWB0025	Hole Length:	99.00

Easting: 709546.90
Northing: 7463440.42
Surface RL: 631.30
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Oct 97 - 02 Oct 97
Comments: STOPPED IN WIT DOLOMITE; STOPPED IN WIT DOLOMITE;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 99.0	RCD8	UNKN	UNKN		DRLX	MAP

TOC RL: 632.16 (Stickup 0.86m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 632.35 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		T	ZYJ	HXG								UNKN: No construction details available (0.00-99.00)
10			ZYJ	GHX								
20			ZY	XGJ								
30			ZY	X								
40			ZY	X								
50			ZY	X								
60			ZY	X								
70			ZG	X								
80			3									
90			3									
100		OB	3									
			D									
			D									
			D

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	GWB0025	Hole Length:	99.00

Easting: 709546.90
Northing: 7463440.42
Surface RL: 631.30
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Oct 97 - 02 Oct 97
Comments: STOPPED IN WIT DOLOMITE; STOPPED IN WIT DOLOMITE;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 99.0	RCD8	UNKN	UNKN		DRLX	MAP

TOC RL: 632.16 (Stickup 0.86m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 632.35 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100												LEVELAPP-TEK(102.70) ID: 1540
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 25

BHPIO - Hydrogeology Log

BHP

Project:	NORTHEAST CORNER	Hole Name:	GWB0032D	Hole Length:	34.00

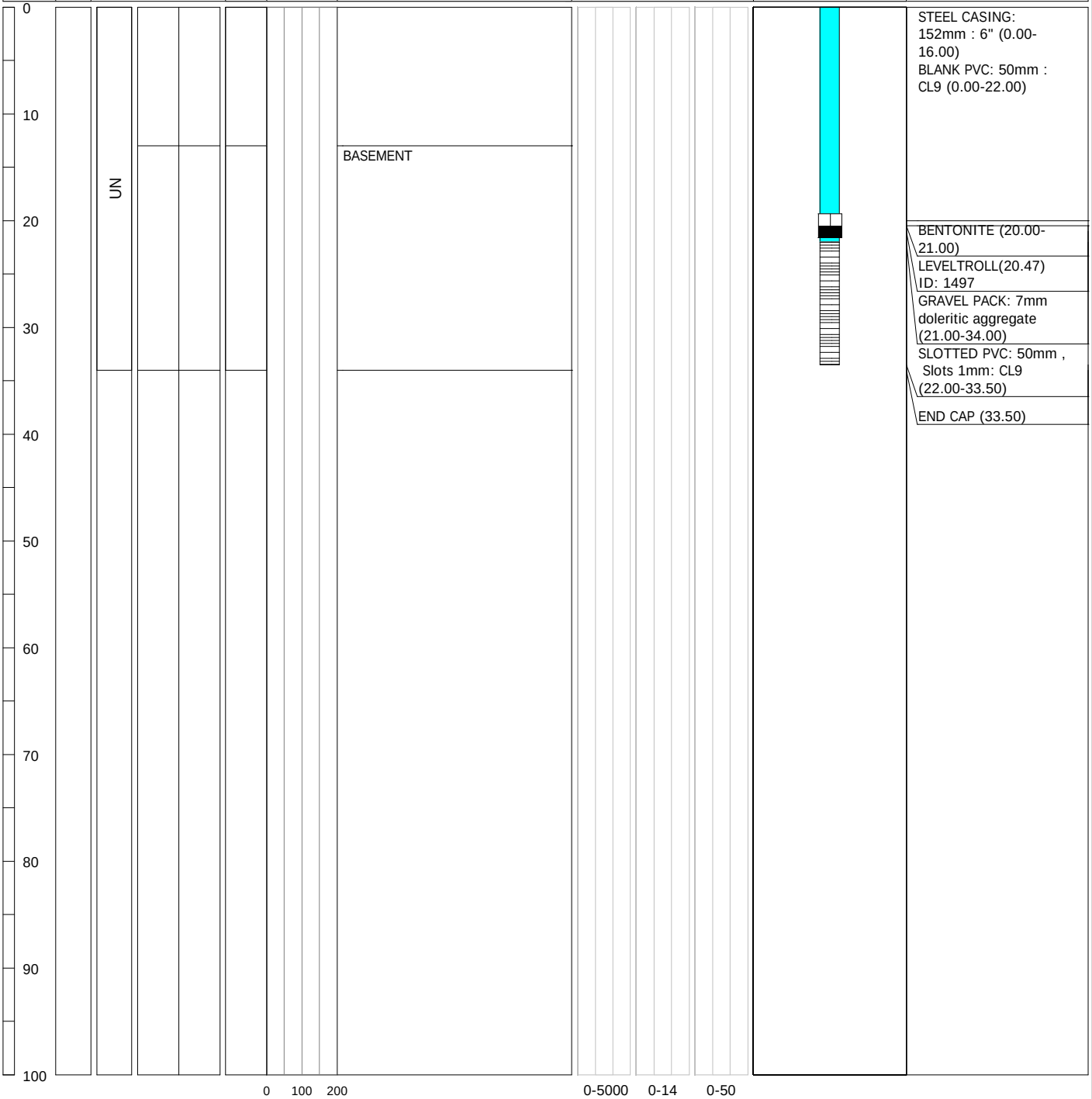
Easting: 726229.15
Northing: 7463911.63
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Apr 98 - 07 Apr 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 16.0	BD	DR	180		BD	DWEST
16.0 - 34.0	BD	CH	146		BD	DWEST

Comments: WOODWARD CLYDE BOREHOLE NO BH32D. HOPE DOWNS - WEELI WOLLI AREA Hope Downs/Weeli Wolli Spring; WOODW...

TOC RL: 555.21 - (drilled) SWL: Dev: N Final pH: -
TOC RL: - - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 400mm | Notes



STEEL CASING: 152mm : 6" (0.00-16.00)
BLANK PVC: 50mm : CL9 (0.00-22.00)
BENTONITE (20.00-21.00)
LEVELTROLL(20.47) ID: 1497
GRAVEL PACK: 7mm doleritic aggregate (21.00-34.00)
SLOTTED PVC: 50mm , Slots 1mm: CL9 (22.00-33.50)
END CAP (33.50)

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: NORTHEAST CORNER Hole Name: GWB0032S Hole Length: 15.00

Easting: 726229.15
Northing: 7463911.63
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Feb 98 - 15 Feb 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 15.0	UNKN	CH	165		NUDRILL	EJL

Comments: WOODWARD CLYDE BOREHOLE NO BH32S. HOPE DOWNS - WEELI WOLLI AREA Hope Downs/ Weeli Wolli Spring; WOOD...

TOC RL: 559.80 - (drilled) SWL: 4.93 MBGL (16 Feb 98) Dev: N Final pH: -
TOC RL: 555.30 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		UN										CAP: Lockable Steel Cap (0.00-0.50)
10												BLANK PVC: 300mm : Default size used (0.00-3.00)
												STEEL CASING: 203mm : 8" (0.00-6.00)
												GRAVEL PACK: (1.6 - 3.2mm) (0.00-7.90)
20												SLOTTED CASING: 300mm : Default size used (3.00-7.00)
												LEVELTROLL(7.73) ID: 2331
												BENTONITE (7.90-8.20)
30												FALLBACK (8.20-15.00)
40												LEVELTROLL(40.00) ID: 1207
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 27

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	GWB0037	Hole Length:	54.00

Easting: 680025.04
Northing: 7457828.33
Surface RL: 701.69
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 Mar 04 - 18 Mar 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	NUDUNKN	CH	254	AIR/FOAM	NUDRILL	SJW
6.0 - 54.0	NUDUNKN	CH	152	AIR/FOAM	NUDRILL	SJW

TOC RL: 701.69 (Stickup 0.75m) (drilled) SWL: 37.95 MBTOC (03 Jul 04) Dev: N Final pH: -
TOC RL: 701.69 (Stickup 0.75m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Angular to subangular BIF (mineralised), scree with red-brown clay/silt, unconsolidated matrix.					BLANK STEEL: 203mm (0.00-6.00)
10												BLANK PVC: 50mm (0.00-46.00)
20							Pisolitic gravels, sub rounded to rounded pisolitic gravel plus minor clay.					
30												LEVELTROLL(28.00) ID: 446
40							Blue/grey fresh crystalline dolomite with calcite veining (10-20%), moderately fractured.					
							Yellow brown to pale green and off white, some weathering to clay.					
50							Grey, crystalline dolomite, moderate fracturing but not weathered.					GRAVEL UNKN (45.00-52.00)
												SLOTTED PVC: 50mm (46.00-52.00)
												VWPPANDO(48.33) ID: 861
												LEVELTROLL(51.00) ID: 2332
60												FALLBACK (52.00-54.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	GWB0039	Hole Length:	56.00

Easting: 682783.35
Northing: 7457379.72
Surface RL: 688.61
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 25 Jun 04 - 25 Jun 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	G&C	CH	254	AIR/FOAM	G&C	JRG
6.0 - 56.0	G&C	CH	152	AIR/FOAM	G&C	JRG

TOC RL: 688.61 (Stickup 0.75m) (drilled) SWL: 25.05 MBTOC (28 Jun 04) Dev: N Final pH: -
TOC RL: 688.61 (Stickup 0.43m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Alluvial scree, red-brown, sub angular to sub rounded BIF and cherty material.				BLANK STEEL: 203mm (0.00-6.00) BLANK PVC: 50mm (0.00-44.00)	
10												
20												
30							Yellow/brown calcrete, very fresh large pieces (2-3cm), surfaces pitted and rounded, 30-36: Calcrete and BIF pisolitic gravel (sub angular to sub rounded).					
40							Blue/grey fresh crystalline dolomite with calcite veining (10-20%), moderately fractured.					LEVELTROLL(39.22) ID: 1685
50												GRAVEL UNKN (42.00-56.00) SLOTTED PVC: 50mm (44.00-56.00) VWPPANDO(47.50) ID: 857
60												
70												
80												
90												
100												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 29

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	GWB0041	Hole Length:	60.00

Easting: 687915.85
Northing: 7453939.55
Surface RL: 687.56
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 01 Jul 04 - 01 Jul 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	G&C	CH	203	AIR/FOAM	G&C	JRG
6.0 - 60.0	G&C	CH	152	AIR/FOAM	G&C	JRG

TOC RL: 688.38 (Stickup 0.75m) (drilled) SWL: 28.90 MBTOC (04 Jul 04) Dev: N Final pH: -
TOC RL: 687.87 (Stickup 0.37m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Gravels red/brown to 1cm rare, BIF material with minor chert, sub angular to sub rounded fragments. 60% gravels with sand.					BLANK STEEL: 152mm (0.00-6.00)
10												BLANK PVC: 50mm (0.00-48.00)
20							Pisolitic gravels red/brown, fragments to 0.5cm sub angular to sub rounded weathered BIF material.					
30							White/yellow to white/pink calcrete, sub angular mostly 0.5cm fragments.					
40							Dolomitic shale, blue/grey to black, sub angular flat chips to 0.5cm. 30-34m: very contaminated sample of shales, calcrete and calcite.					LEVELTROLL(35.00) ID: 449
50							Fresh blue/grey to weathered light brown dolomite, weathered between 38-44m, abundant calcite and calcite veining.					LEVELTROLL(40.00) ID: 1685
60												GRAVEL UNKN (46.00-60.00)
70												SLOTTED PVC: 50mm (48.00-60.00)
80												PRESSUREPANDO(56.00) ID: 1519
90												
100												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 30

BHPIO - Hydrogeology Log

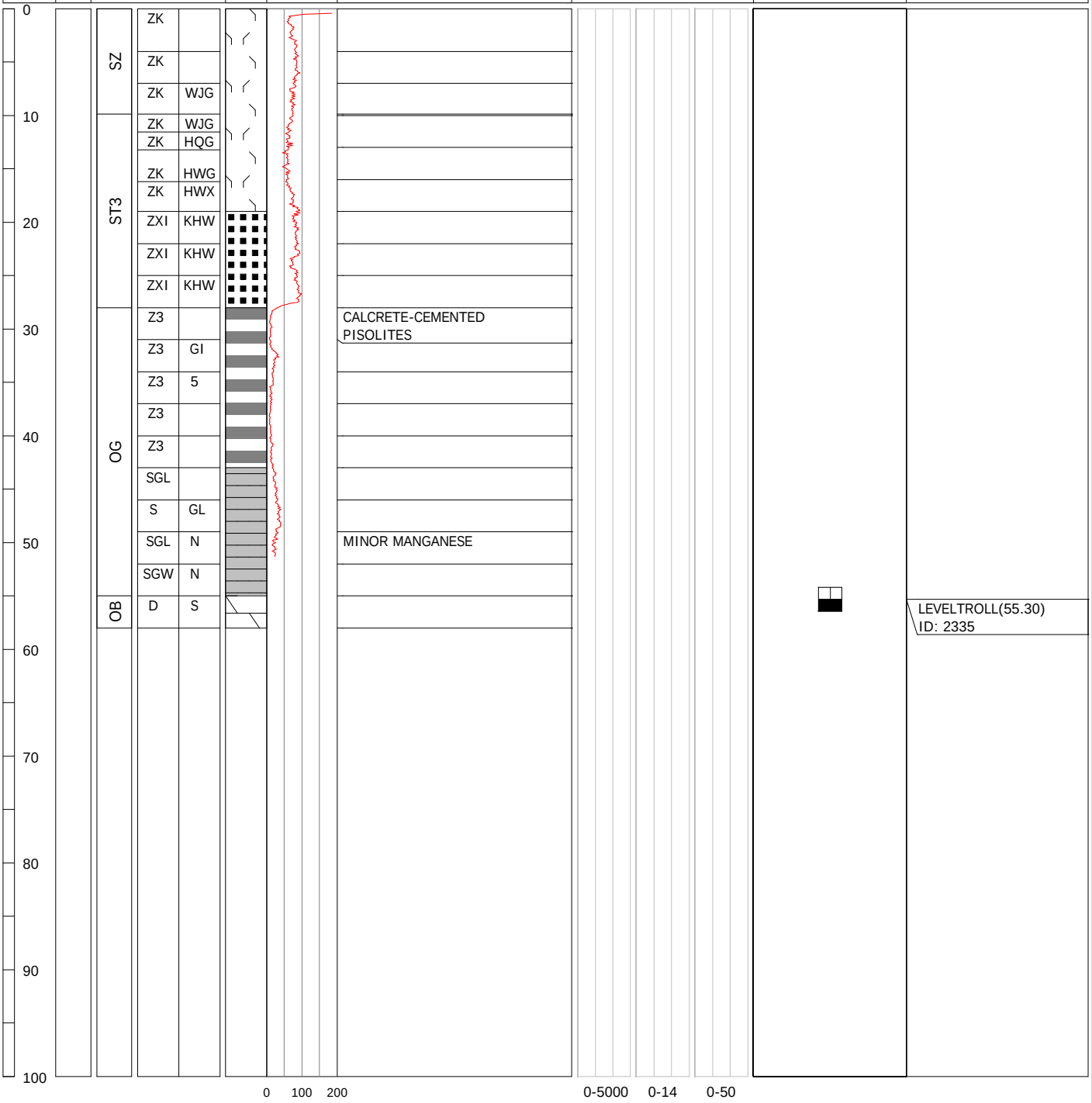
BHP

Project:	PACKSADDLE	Hole Name:	GWRS0014	Hole Length:	58.00

Easting: 685938.19
Northing: 7462494.90
Surface RL: 693.89
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Oct 96 - 08 Oct 96
Comments: FINISHED IN PHD DOLOMITE;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 58.0	T685	RHF	146		DRLX	PH

TOC RL: 694.15 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 694.15 - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole: Page: 31

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HCF0018	Hole Length:	47.00

Easting: 683189.00
Northing: 7456051.00
Surface RL: 686.64
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Oct 13 - 30 Oct 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 47.0	BLYSR170	SONIC	152	NA	BLY	MW7

TOC RL: 687.14 (Stickup 0.50m) (drilled) SWL: 23.02 MBTOC (07 Nov 13) Dev: N Final pH: -
TOC RL: 688.37 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	Z	Y			Sandy gravel, minor silt, unconsolidated, dark red, rounded to sub angular, visible organics					CEMENT: 150mm (0.00-1.00)
10			Z	K			Gravel, minor sand, silt/clay, unconsolidated, dark red, sub rounded to sub angular, visible organics					BLANK PVC: 50MM (0.00-35.00)
20			Z	K			Clayey sand,minor gravel and silt, unconsolidated to moderately consolidated, dark red, low plasticity, sub rounded to angular					BENTONITE: 150mm (1.00-2.00)
			Z	Y			Silty sand, minor gravel, dark red, sub rounded to angular					GRAVEL MED: 150mm (2.00-31.00)
			Z	Y			Sandy gravel, minor silt brown/ grey, sub rounded to angular					
		TO	3	Z			Calcrete and silcrette, highly consolidatted layers interbedded with cemented gravels and sandy gravels					
30		TD2	K	Z			Gravelly and silty clays interbedded with clays (some lamination in clays and silts), minor sand and silt brown, beige/yellow,					LEVELTROLL(30.00) ID: 303
							Sandy silt and clayey silt with minor gravel (dolomite),					LEVELTROLL(30.50) ID: 2333
40			Y	K			Dolomite, blue grey, quartz and calcite veins, highly fractured					BENTONITE: 150mm (31.00-34.00)
			D									GRAVEL MED: 150mm (34.00-47.00)
50												SLOTTED PVC: 50MM, Slots 3mm (35.00-47.00)
60												END CAP: (46.90)
70												
80												
90												
100												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: 16A

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HCF0023	Hole Length:	87.00

Easting: 683720.00
Northing: 7451697.00
Surface RL: 682.00
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Nov 13 - 08 Nov 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 87.0	BLYSR170	SONIC	152	NA	BLY	MW7

TOC RL: 688.28 (Stickup 0.57m) (drilled) SWL: 18.85 MBTOC (25 Nov 13) Dev: N Final pH: -
TOC RL: 688.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		A	Z	Y			Gravel silt sand and clay, dark red grey and white, very fine to very coarse, loose, poorly graded, subrounded to angular, highly weathered, unconsolidated.					GRAVEL MED: 152mm : (0.00-64.00)
10		TD3	Z	K			Clay pisolitic gravel, hematite, goethite, dark red grey brown trace white, poorly graded, very fine to coarse, subangular to rounded, some stiff clay, highly weathered, trace calcium carbonate in pisolites and increase with depth.					BLANK PVC: 50MM (0.00-68.00)
20		TO	C	I			Calcrete silcrete pisolites, white light brown grey, hard, conglomerate silcrete 17 to 20 mbgl, slighly weathered, some porosity, fractures or small cavity.					
30		TD2	K	Z			Clay sand gravel, orange white to dark brown, stiff, poorly graded, very fine to coarse, hematite, trace limonite, moderate weathering,					LEVELTROLL(29.60) ID: 300
40			K	Y			Clay with silt and trace gravel, brown orange white and red, stiff, very fine to medium, angular to subrounded, moderate weathering,					
50			K	Z			Clay with sand and gravel, dark red orange white, mottled, very fine to coarse, moderate to high weathered.					
60		TD1	K	Z			As above, stiff, consolidated					
70			S				As above, weathered, unconsolidated					BENTONITE: 152mm : (64.00-67.00)
80			K	Z			As above, stiff, manganese gravel, subrounded					GRAVEL MED: 152mm : (67.00-86.00)
90			Z	K			As above, red brown, increase mottled					SLOTTED PVC: 50MM (68.00-86.00)
100							As above, dark red brown					
							As above, dark red brown white, hematite gravel					
							Shale, dark red purple white, stiff, high plasticity,					
							Clay with sand and trace dolomite gravel, white light brown, stiff, fine to coarse, subrounded to angular, highly weathered, several dolomite gravels.					
							Clay with trace gravel, light brown white red, stiff, mottled,					END CAP: (85.90)
							Gravel with clay, dark red brown trace white, fine to cobble, loose, high weathering, subrounded to angular, gravel hematite ang geothite, clay is soft					
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: 12A_1 Page: 33

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HCF0032	Hole Length:	62.00

Easting: 683103.00
Northing: 7457610.00
Surface RL: 688.20
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Nov 13 - 19 Nov 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	BLYSR170	SONIC	152	NA	BLY	JH8

TOC RL: 693.28 (Stickup 0.68m) (drilled) SWL: 24.35 MBTOC (23 Nov 13) Dev: N Final pH: -
TOC RL: 689.15 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	Z	K			Clayey sand, red brown, loosely consolidated, sub rounded to sub angular,minor gravel and coarse sand, med - high plasticity clay, poorly sorted					CEMENT: 152mm (0.00-0.20)
			K	Z								BLANK PVC: 50MM (0.00-50.00)
			K	Z								FALLBACK: 152mm (0.20-1.50)
10			Z	K								BENTONITE: 152mm (1.50-2.50)
			K	Z			Sandy clay,red brown, minor gravels, loosely consolidated, sub rounded - sub angular, clay med- high plasticity, some clay laminar					GRAVEL MED: 152mm (2.50-46.00)
			K									
20			K				Gravelly clay, red brown, gravels upto 4 cm, loosely consolidated, sub rounded - sub angular, poorly sorted, clay med-high plasticity					
			K				Clayey gravel, as above with 70% gravel and coarse sands and 30% clay					
			K	Z								
30			Z	K			Gravelly clay, red brown, loosely consolidated, sub rounded - sub angular, poorly sorted, becoming more sandy with depth					
			3Z									
			3									
40							Clay, red brown, trace of sands and gravels,sub rounded - sub angular, loosely to well consolidated clays, med - high plasticity					
		TD2	K	Z								LEVELTROLL(43.31) ID: 2270
							Clay, red brown, trace sand and gravel, sub rounded - sub angular, well consolidated, dense, med - high plasticity					BENTONITE: 152mm (46.00-49.00)
50			K	Z								GRAVEL MED: 152mm (49.00-62.00)
							Clay, trace of sands and gravels, sub rounded - sub angular, mod - well consolidated, med - high plasticity, trace of white clays (non calcereous)					SLOTTED PVC: 50MM, Slots 3mm (50.00-62.00)
		OB	D									
60							As above (with trace of calcrete in a block of cemented detritals) rounded - sub angular					END CAP: (61.90)
							Gravelly clay, red brown, rounded - sub angualr, mod - well consolidated, poorly sorted, med - high plasticity					
70							Clayey gravel, 70-80% rounded - sub anguar gravels, loosely consolidated, poorly - moderately sorted, med - high plasticity clay					
							Core loss					
80							Gravels and calcrete/silcrete, chert pebbles, mottled, moderately weathered, vuggy calcrete					
							Calcrete silcrete cemented with detritals, white brown grey, hard, massive, cavities vuggs and fractures, some trace hematite and goethite gravels,					
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: 15A_1 Page: 34

BHPIO - Hydrogeology Log

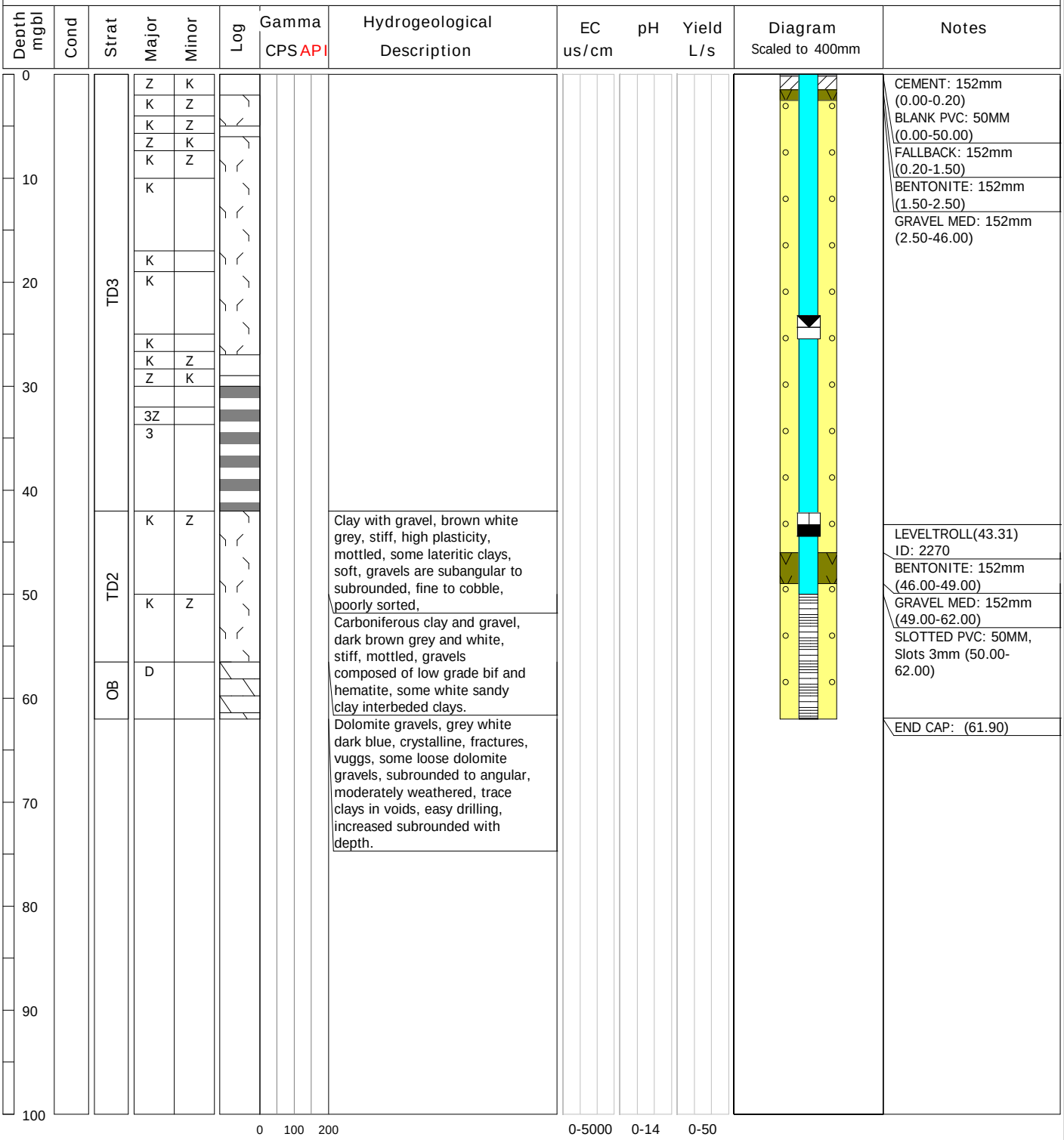
BHP

Project:	SOUTH FLANK	Hole Name:	HCF0032	Hole Length:	62.00

Easting: 683103.00
Northing: 7457610.00
Surface RL: 688.20
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Nov 13 - 19 Nov 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	BLYSR170	SONIC	152	NA	BLY	JH8

TOC RL: 693.28 (Stickup 0.68m) (drilled) SWL: 24.35 MBTOC (23 Nov 13) Dev: N Final pH: -
TOC RL: 689.15 - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole: 15A_1 Page: 35

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HCF0042	Hole Length:	30.00

Easting: 687645.00
Northing: 7453869.12
Surface RL: 687.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 May 14 - 06 May 14
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 30.0	BLYSR170	SONIC	121	NA	BLY	JH8

TOC RL: 687.96 (Stickup 0.77m) (drilled) SWL: 23.93 MBTOC (29 May 14) Dev: N Final pH: -
TOC RL: 687.96 (Stickup 0.77m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	Z	K			Gravel sand and clay, red brown gray, poorly sorted, subrounded to angular, roots, highly weathered, hematite gravels					CEMENT & BENTONITE: 140mm (0.00-2.00)
			K	Z								BLANK PVC: 50mm (0.00-21.00)
10			K	Z			Clay with gravel, dark red brown gray, stiff, highly weathered, roots, gravels with hematite					GRAVEL MED: 140mm (2.00-18.00)
			K	Z								
			IZ	K			As above, roots greater than 2 mm observed					
20							Clay with gravel, dark red brown gray, stiff, highly weathered, roots, gravels with hematite					BENTONITE: 140mm (18.00-20.00)
			IZ	K								GRAVEL MED: 140mm (20.00-30.00)
		TO	3	Z			Pisolite gravel and clay, red brown, poorly sorted, fine to gravel, well rounded to subangular, highly weathered, gravels composed of hematite and goethite					SLOTTED PVC: 50mm (21.00-30.00)
30							As above, brown and white, some calcrete cemented gravels in clay, wet					LEVELTROLL(27.26) ID: 305
							Calcrete cemented with hematite goethite and some clays, white gray brown, hard, massive, fractured and some porosity					END CAP: (29.90)
40												
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 36

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HCF0045	Hole Length:	22.00

Easting: 681032.16
Northing: 7455102.59
Surface RL: 687.17
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 25 May 14 - 26 May 14
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 22.0	BLYSR170	SONIC	121	NA	BLY	JH8

TOC RL: 687.86 (Stickup 0.67m) (drilled) SWL: 18.75 MBTOC (29 May 14) Dev: N Final pH: -
TOC RL: 688.26 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		A	A	K			Detritals, red brown, rounded to subrouned, roots greater than 2 mm, organic matter, clay and silt 50%, gravel 40%, sand 10%, poorly sorted, some hematite and goethite gravels.					CEMENT & BENTONITE: 50MM (0.00-2.00)
			Z	K								BLANK PVC: 50mm (0.00-16.00)
10		TD3	Z	K			Detritals, red to brown, rounded to subangular, some roots, 70% gravel 30% clay and silt, poorly graded.					GRAVEL MED: 50MM (2.00-10.00)
			K				Detritals, brown, subrounded to angular, loose, poorly sorted.					BENTONITE: 50MM (10.00-12.00)
20		TO	K				Detritals, clay with sand, red and brown, consolidated, stiff, high plasticity.					GRAVEL MED: 50MM (12.00-22.00)
			3	K			Detritals, clay and gravel, dark brown, rounded to subrounded, poorly graded, 60% gravel 40% clay, increasing clay with depth.					SLOTTED PVC: 50mm (16.00-22.00)
30			K	Z			Calcrete with some clay, white and some pink, hard, interbeded with some pink clays, clay content increases with depth.					LEVELTROLL(19.38) ID: 301
40							Clay with calcrete, pink and white, calcrte gravel, clay 70% calcrete 30%, consolidated, angular.					END CAP: (21.90)
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 37

BHPIO - Hydrogeology Log

BHP

Project:	TANDANYA	Hole Name:	HCH0003	Hole Length:	120.00

Easting: 676206.51
Northing: 7465670.60
Surface RL: 711.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Apr 04 - 08 Apr 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	G&C	CH	318	AIR	G&C	SJW
6.0 - 120.0	G&C	CH	203	AIR	G&C	SJW

TOC RL: 711.36 - (drilled) SWL: 19.03 MBTOC (09 Apr 04) Dev: N Final pH: -
TOC RL: 711.36 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Red-brown, clayey (10 to 70%), unconsolidated sub angular gravel.					BLANK STEEL: 203mm (0.00-6.00)
10												BLANK PVC: 50mm (0.00-114.00)
20							Red-brown, sub angular to rounded, moderately well sorted pisolitic gravel (1-10mm) with minor sand and clay.					
30							Yellow-brown, moderately weathered to fresh calcrete and vitreous goethite.					
40							Very dark red-brown to black vitreous goethite with minor (5-10%) calcrete.					
50			Z3G				Yellow-brown calcrete with minor vitreous goethite (1-5%).					LEVELAPP-TEK(40.12) ID: 1667
60							Off-white to pink clay after dolomite, minor weathered dolomite.					
70							Light blue-grey, fresh to moderately weathered, crystalline, moderately fractured dolomite and minor dolomitic shale. Increased weathering at 56-60m and 64-66m (light grey-brown mod weathered dolomite).					
80							Dark red-purple-brown (manganiferous?) extremely weathered BIF. Iron formation/ hematite weathered to orchreous, manganiferous? clay (dark red-brown). Minor dark red-brown chert.					
90							Light blue-grey, fresh to moderately weathered, well to moderately fractured, crystalline dolomite and dolomitic shale. Increased fracturing/ weathering at 84-88m and 92-98m with yellow-brown staining on fracture planes. Overall increased weathering from 9					
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 38

BHPIO - Hydrogeology Log

BHP

Project:	TANDANYA	Hole Name:	HCH0003	Hole Length:	120.00

Easting: 676206.51
Northing: 7465670.60
Surface RL: 711.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Apr 04 - 08 Apr 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	G&C	CH	318	AIR	G&C	SJW
6.0 - 120.0	G&C	CH	203	AIR	G&C	SJW

TOC RL: 711.36 - (drilled) SWL: 19.03 MBTOC (09 Apr 04) Dev: N Final pH: -
TOC RL: 711.36 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200						0 100 200	Light blue-grey, fresh to moderately weathered, well to moderately fractured, crystalline dolomite and dolomitic shale. Increased fracturing/ weathering at 84-88m and 92-98m with yellow-brown staining on fracture planes. Overall increased weathering from 9	0-5000	0-14	0-50		BLANK PVC: 50mm (0.00-114.00) LEVELAPP-TEK(40.12) ID: 1667 BENTONITE (109.00-110.00) GRAVEL UNKN (110.00-120.00) SLOTTED PVC: 50mm (114.00-120.00)

BHPIO - Hydrogeology Log

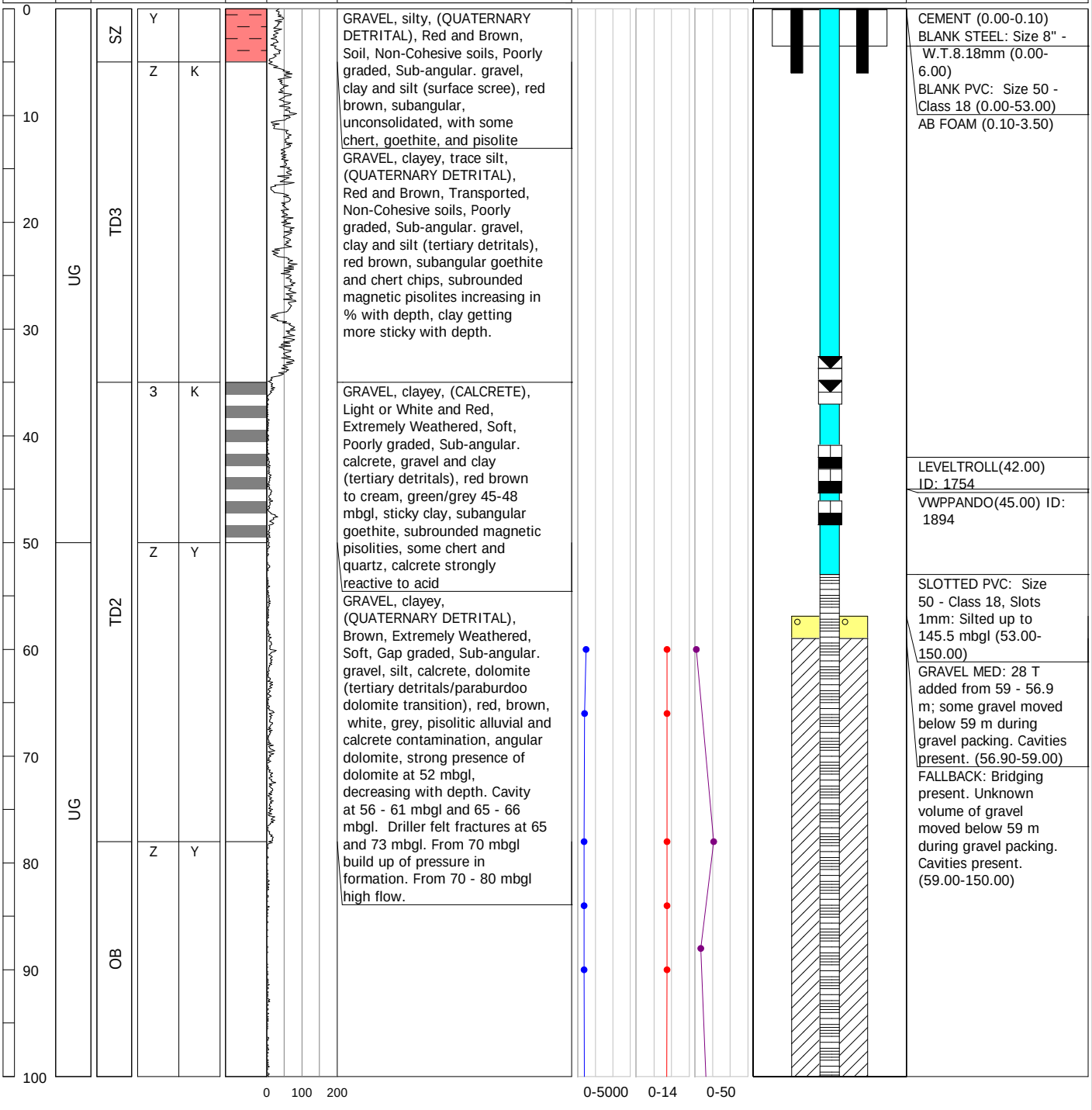
BHP

Project:	MUDLARK WELL	Hole Name:	HCL0008	Hole Length:	156.00

Easting:	680487.21
Northing:	7459827.55
Surface RL:	698.21
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	03 Sep 15 - 05 Sep 15
Comments:	Juna Downs FY16 MAR Program MB4 (JDH3)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	MCYWW06	CH	300		MCKAY	HOB
6.0 - 156.0	MCYWW06	CH	200		MCKAY	HOB

TOC RL:	-	(Stickup 0.68m)	(drilled)	SWL:	33.66 MBGL	(03 Sep 15)	Dev:	N	Final pH:	-
TOC RL:	699.50	(Stickup 1.29m)	(current)	Is Live:	Y	(-)	Date:	04 Sep 2015	Final EC:	-



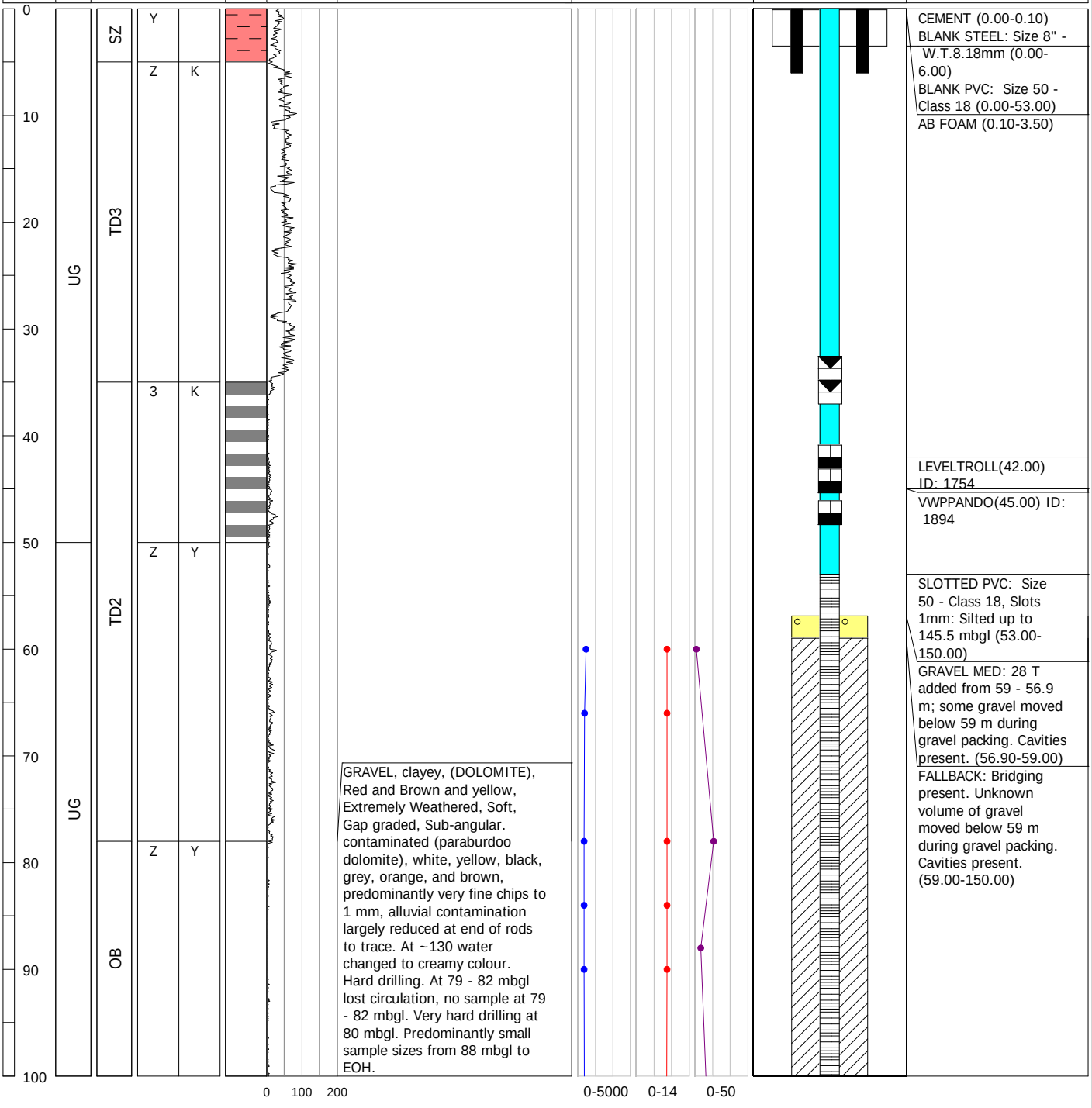
BHPIO - Hydrogeology Log

Project: MUDLARK WELL **Hole Name:** HCL0008 **Hole Length:** 156.00

Easting: 680487.21
Northing: 7459827.55
Surface RL: 698.21
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Sep 15 - 05 Sep 15
Comments: Juna Downs FY16 MAR Program MB4 (JDH3)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	MCYWW06	CH	300		MCKAY	HOB
6.0 - 156.0	MCYWW06	CH	200		MCKAY	HOB

TOC RL: - (Stickup 0.68m) (drilled) SWL: 33.66 MBGL (03 Sep 15) Dev: N Final pH: -
TOC RL: 699.50 (Stickup 1.29m) (current) Is Live: Y (-) Date: 04 Sep 2015 Final EC: -



BHPIO - Hydrogeology Log

BHP

Project: MUDLARK WELL **Hole Name:** HCL0008 **Hole Length:** 156.00

Easting: 680487.21
Northing: 7459827.55
Surface RL: 698.21
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Sep 15 - 05 Sep 15
Comments: Juna Downs FY16 MAR Program MB4 (JDH3)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	MCYWW06	CH	300		MCKAY	HOB
6.0 - 156.0	MCYWW06	CH	200		MCKAY	HOB

TOC RL: - (Stickup 0.68m) (drilled) SWL: 33.66 MBGL (03 Sep 15) Dev: N Final pH: -
TOC RL: 699.50 (Stickup 1.29m) (current) Is Live: Y (-) Date: 04 Sep 2015 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	UG	OB	Z	Y			GRAVEL, clayey, (DOLOMITE), Red and Brown and yellow, Extremely Weathered, Soft, Gap graded, Sub-angular. contaminated (paraburdoo dolomite), white, yellow, black, grey, orange, and brown, predominantly very fine chips to 1 mm, alluvial contamination largely reduced at end of rods to trace. At ~130 water changed to creamy colour. Hard drilling. At 79 - 82 mbgl lost circulation, no sample at 79 - 82 mbgl. Very hard drilling at 80 mbgl. Predominantly small sample sizes from 88 mbgl to EOH.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm: Silted up to 145.5 mbgl (53.00-150.00)
110												
120												
130												
140												
150												GRAVEL MED: 28 T added from 59 - 56.9 m; some gravel moved below 59 m during gravel packing. Cavities present. (56.90-59.00) FALLBACK: Bridging present. Unknown volume of gravel moved below 59 m during gravel packing. Cavities present. (59.00-150.00)
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		END CAP (150.00) FALLBACK (150.00-156.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH PARMELIA	Hole Name:	HDD0001	Hole Length:	45.00

Easting: 722215.92
Northing: 7449592.87
Surface RL: 622.08
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Oct 16 - 14 Oct 16
Comments: FY17 Ben's Oasis Monitoring Progam

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 45.0	MCYRC18	RHF	140		MCKAY	YA

TOC RL: 623.17 (Stickup 1.10m) (drilled) SWL: 37.88 MBTOC (14 Oct 16) Dev: N Final pH: -
TOC RL: 623.42 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	OB	D				DOLOMITE, (OB), Blue, Slightly Weathered, Strong Rock. Large crystalline dolomite boulders from surface to approximately 3 mbgl, making collaring difficult					CEMENT (0.00-2.00)
			D				DOLOMITE, (OB), Blue, Slightly Weathered, Strong Rock. Slightly weathered dolomite but still largely crystalline, no evidence of water inflows					BLANK PVC: 140mm (0.00-6.00)
												BLANK PVC: 61mm (0.00-15.00)
												GRAVEL MED (2.00-45.00)
												SLOTTED PVC: 61mm , Slots 1mm (15.00-45.00)
			D				DOLOMITE, (OB), Blue, Fresh, Strong Rock. Dolomite slightly more weathered, shaley and fractured, insignificant inflows, crystalline from 36 – 45 mbgl, insignificant yields. Hole terminated at 45 mbgl					LEVELTROLL(32.00) ID: 2194
												LEVELTROLL(42.00) ID: 1682
100												END CAP (45.00)

0 100 200 0-5000 0-14 0-50

Program: South Parmelia FY17 Eco Hydro monitoring (Bens Oasis) Planned Hole: HBO_FY17_MB1

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH PARMELIA	Hole Name:	HDD0002	Hole Length:	51.00

Easting: 722796.49
Northing: 7450274.28
Surface RL: 612.46
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Oct 16 - 13 Oct 16
Comments: FY17 Ben's Oasis Monitoring Progam

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 51.0	MCYRC18	RHF	140		MCKAY	YA

TOC RL: 613.42 (Stickup 0.97m) (drilled) SWL: 45.68 MBTOC (13 Oct 16) Dev: N Final pH: -
TOC RL: 613.67 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	BG	TD2	Z	K			CLAY, silty, (CLAY), Light or White and Red, Extremely Weathered, Soft, Well graded, Sub-rounded. Highly weathered tertiary clays with chert and calcrete interbeds. Low sample return from 10 – 12m, samples wash through the sieve almost completely, unsaturated				CEMENT (0.00-2.00) BLANK PVC: 140mm (0.00-6.00) BLANK PVC: 61mm (0.00-9.00)	
10			Z	K							GRAVEL MED (2.00-51.00)	
20		OD	4	3			CLAY, silty, (CLAY), Light or White and Red, Extremely Weathered, Soft, Well graded, Sub-rounded. Highly weathered tertiary clays with chert and calcrete interbeds. Low sample return from 10 – 12m, samples wash through the sieve almost completely, unsaturated				SLOTTED PVC: 61mm , Slots 1mm (9.00-51.00)	
30			S	3			, (), Dark or Black and Blue, Extremely Weathered, Stiff.					
40							CLAY, silty, (), Dark or Black, Extremely Weathered, Firm, Well graded, Sub-angular. Highly weathered shales and calcareous shales. Black sample piles resembling black shale, sample piles turn blue once dry and exposed to air, insignificant yields of 0.2 l/s					
50											END CAP (51.00)	
60												LEVELTROLL(59.19) ID: 1681
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH PARMELIA	Hole Name:	HDD0003	Hole Length:	51.00

Easting: 723224.76
Northing: 7451036.97
Surface RL: 607.78
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Oct 16 - 11 Oct 16
Comments: FY17 Ben's Oasis Monitoring Progam

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 51.0	MCYRC18	RHF	140		MCKAY	YA

TOC RL: 608.65 (Stickup 0.87m) (drilled) SWL: 28.70 MBTOC (11 Oct 16) Dev: N Final pH: -
TOC RL: 608.94 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	BG	TD2	Z	Y			CLAY, silty, (CLAY), Light or White, Extremely Weathered, Very Soft, Well graded, Sub-rounded. Highly weathered tertiary clays, high plasticity, calcrete overprinting. Unsaturated, loose broken ground, fast drilling, boundary with OD hard to distinguish. Most samples wash through the sieve					CEMENT (0.00-2.00) BLANK PVC: 140mm (0.00-6.00) BLANK PVC: 61mm (0.00-33.00)
10												GRAVEL MED (2.00-25.00)
20		OD	Z	Y			CLAY, silty, (CLAY), Light or White, Extremely Weathered, Very Soft, Well graded, Sub-rounded. Highly weathered tertiary clays, high plasticity, calcrete overprinting. Unsaturated, loose broken ground, fast drilling, boundary with OD hard to distinguish. Most samples wash through the sieve					BENTONITE (25.00-29.00)
30			4	C								GRAVEL MED (29.00-51.00)
40							CLAY, silty, (SHALE), Dark or Black, Extremely Weathered, Firm, Well graded, Sub-angular. Highly weathered calcareous shales with minor cherts, resembling black shale towards end of hole, samples turn blue once dry and exposed to air, max yields of 1 l/s (30 -36m), loose broken ground, fast drilling.					SLOTTED PVC: 61mm , Slots 3mm (33.00-51.00)
50												LEVELTROLL(45.14) ID: 1561
60												END CAP (51.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH PARMELIA	Hole Name:	HDD0004	Hole Length:	69.00

Easting: 723555.11
Northing: 7451700.25
Surface RL: 606.92
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Oct 16 - 16 Oct 16
Comments: FY17 Ben's Oasis Monitoring Progam

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 69.0	MCYRC18	RHF	140		MCKAY	YA

TOC RL: 607.89 (Stickup 0.98m) (drilled) SWL: 29.28 MBGL (14 Oct 16) Dev: N Final pH: -
TOC RL: 608.19 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	BG	TD2	Z	Y			CLAY, silty, (QUATERNARY DETRITAL), Red and Light or White, Extremely Weathered, Firm, Well graded, Sub-angular. Weathered tertiary clays, high plasticity, unsaturated. White cemented layers resemble calcrete but do not fizz with hydrochloric acid, slower drilling due to the 'cemented' nature of the clays					CEMENT (0.00-2.00) BLANK PVC: 140mm (0.00-6.00) BLANK PVC: 61mm (0.00-9.00) GRAVEL MED (2.00-57.00)
10			Z	Y			CLAY, silty, (QUATERNARY DETRITAL), Red and Light or White, Extremely Weathered, Firm, Well graded, Sub-angular. Weathered tertiary clays, high plasticity, unsaturated. White cemented layers resemble calcrete but do not fizz with hydrochloric acid, slower drilling due to the 'cemented' nature of the clays					SLOTTED PVC: 61mm , Slots 1mm (9.00-57.00)
20		OD	4	S			CLAY, sandy, (CONGLOMERATE), Dark or Black, Extremely Weathered, Soft, Well graded, Sub-angular.					
30							CLAY, silty, (QUATERNARY DETRITAL), Red and Dark or Black, Extremely Weathered, Firm, Well graded, Sub-angular. Highly weathered Bee Gorge shales with minor cherts, samples resemble black shale, significant yields of 4.5 l/s (63 – 69m) encountered, hammer blocked, significant fallback, no gamma survey conducted due to malfunction of tool					LEVELTROLL(44.04) ID: 1689
40			4	S								END CAP (57.00) FALLBACK (57.00-69.00)
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: South Parmelia FY17 Eco Hydro monitoring (Bens Oasis) Planned Hole: HBO_FY17_MB6

BHPIO - Hydrogeology Log

BHP

Project:	EAST PACKSADDLE	Hole Name:	HEPS0126	Hole Length:	120.00

Easting: 712864.35
Northing: 7462564.58
Surface RL: 610.57
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Mar 15 - 31 Mar 15
Comments: East Packsaddle Regional Monitoring Bore Program - BCR. Re-drill of HEPS0125;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	MCYWW06	CH	200		MCKAY	MW5

TOC RL: 611.32 (Stickup 0.75m) (drilled) SWL: 37.14 MBTOC (19 Apr 18) Dev: Y: 0.3 hour(s) Final pH: -
TOC RL: 611.59 - (current) Is Live: Y (-) Date: 02 Apr 2015 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZYX	FCJ			Gravel and silt, sandy, trace clay and slight trace cobbles (surface scree); reddish brown; angular; loose; some organic matter; mixed bag of mostly hard to moderately hard chips of varying size (maghemite, ferruginous shale, chert, bif, goethised chert).					CEMENT: (0.00-0.60) BLANK STEEL: 203mm (0.00-6.00) BLANK PVC: 50mm (0.00-48.00)
10		TD2	ZYX	FCJ								AB FOAM: AB Foam. (0.60-2.00)
			ZSF	CH3			Gravel and silt, sandy, trace clay and slight trace cobbles (surface scree); reddish brown; angular; loose; some organic matter; mixed bag of mostly hard to moderately hard chips of varying size (maghemite, ferruginous shale, chert, bif, goethised chert).					OPEN HOLE: (2.00-34.00)
20			ZSC	1G								
			DS				Silt and gravel, some clay, trace sand (st3 - siltstone); reddish brown; angular; mixed bag of mostly small moderately soft chips.					
			DS									
30			D				Gravel and clay, some silt, trace sand (td2??); yellowy brown; sub-angular; moderately soft; shaley; lots of soft sub-rounded white chert? (not calcrete - no reaction with hcl, maybe shale?), angular goethite increasing from 16-18m, angular dolomite fragments appearing from 19m.					GRAVEL MED: On 3 April (after airlifting on 2 April), to pof gravel was tagged at 34mbgl, approximately 14m above slots. No more gravel was added due to potential to damage PVC casing (additional weight). (34.00-120.00)
40												
50												
60		OB					Dolomite and weathered shale (paraburdoo member), brownish grey, angular, mostly moderately hard small dolomite fragments with a lot of shale from 22-24m.					SLOTTED PVC: 50mm , Slots 1mm: On 3 April (after airlifting on 2 April), PVC casing bottom was tagged at 118.5mbgl. (48.00-120.00)
							Dolomite and weathered shale (paraburdoo member), brownish grey, angular, mostly moderately hard small dolomite fragments with a lot of shale from 22-24m.					
70												
80							Dolomite (paraburdoo member), light brownish grey, angular, hard fresh dolomite chips, trace chert. Driller noted drop from 29-30m, drilled from 30-31m, then dropped again from 31-33m. No sample return from 30m onwards. Inferred fresh dolomite with trace shale (from geophysics).					LEVELTROLL(40.00) ID: 1190
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: EAST PACKSADDLE **Hole Name:** HEPS0126 **Hole Length:** 120.00

Easting: 712864.35
Northing: 7462564.58
Surface RL: 610.57
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Mar 15 - 31 Mar 15
Comments: East Packsaddle Regional Monitoring Bore Program - BCR. Re-drill of HEPS0125;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	MCYWW06	CH	200		MCKAY	MW5

TOC RL: 611.32 (Stickup 0.75m) (drilled) SWL: 37.14 MBTOC (19 Apr 18) Dev: Y: 0.3 hour(s) Final pH: -
TOC RL: 611.59 - (current) Is Live: Y (-) Date: 02 Apr 2015 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		OB	D			0 100 200	Dolomite (paraburdoo member), light brownish grey, angular, hard fresh dolomite chips, trace chert. Driller noted drop from 29-30m, drilled from 30-31m, then dropped again from 31-33m. No sample return from 30m onwards. Inferred fresh dolomite with trace shale (from geophysics).	0-5000	0-14	0-50		GRAVEL MED: On 3 April (after airlifting on 2 April), to pof gravel was tagged at 34mbgl, approximately 14m above slots. No more gravel was added due to potential to damage PVC casing (additional weight). (34.00-120.00) LEVELTROLL(40.00) ID: 1190 SLOTTED PVC: 50mm , Slots 1mm: On 3 April (after airlifting on 2 April), PVC casing bottom was tagged at 118.5mbgl. (48.00-120.00) END CAP (120.00)

BHPIO - Hydrogeology Log

BHP

Project:	EAST PACKSADDLE	Hole Name:	HEPX0001	Hole Length:	192.00

Easting: 715860.41
Northing: 7462587.71
Surface RL: 609.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Jun 12 - 11 Jun 12
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	BLYWW01	CH	301	AIR	BLY	CL1
6.0 - 192.0	BLYWW01	CH	150	AIR/FOAM	BLY	CL1

TOC RL: 610.41 - (drilled) SWL: 68.80 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 610.58 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	ZXY	K			Light brown colour, rounded to angular chips, lithology clays, silt, maghemite pisolites and some goethitic clay, 20% fines. Unit 0-2 mbgl					CEMENT (0.00-1.50) BLANK STEEL: 200mm (0.00-6.00) BLANK PVC: 50MM (0.00-100.00)
			ZXY	D								
			ZXD				Light brown grey, about 20% fines, angular to sub angular chips, 30% rounded maghemite pisolites. Same lithology as above withy some broken blocky dolomites chips (dark grey colour). Unit 2-4 mbgl.					
10			D									
			D									
			D									
			D									
			D									
			D									
20			D									
			D									
			D				20% fines, light grey brown colour, angular chips, chips are more blocky and harder. 60% dolomite, 20% shale. End of detritals, start of paraburdoo dolomite. Strong reaction to hcl. Unit 4-6 mbgl					
			D									
			D									
			D									
			D									
			D									
30			D									
			D									
			D									
			D									
			D									
			D									
40			D									
			D									
			D									
			Z3G				Light grey colour, sample is dolomite, blocky angular chips, crystalline with a vitreous lustre, some pieces have been weathered and feel moist. Reacts with hcl when broken down to a powder, some pieces show recrystallised quartz in small fractures.					
			D									
			D									
			D									
50			D									
			D									
			D									
			D									
			D									
			D									
60			D									
			D									
			D									
			D									
			D									
			D									
70			D									
			D									
			D									
			D									
			D									
			D									
80			D									
			D									
			D									
			D									
			D									
			D									
90			D									
			D									
			D									
			D									
			D									
100			D									
							Sample is very wet. Could be a small fracture as water disappeared the next 4 m. Moderately weathered. Chips are sharp, broken and angular. Variation in chip size from 4mm to 2cm. Some recrystallised quartz in fractures on the chips, unit (14-18 mbgl).					
							Sample is not wet. Moderate weathering, lots of fines around chips. Unit 18-20 mbgl.					GRAVEL MED (85.00-192.00)
							Moist sample, high percentage of fines, quartz veins running through dolomite chips. Unit 20-22 mbgl.					LEVELTROLL(90.00) ID: 3137
		OB										SLOTTED PVC: 50MM, Slots 1mm: PVC broke down the hole (100.00-172.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	EAST PACKSADDLE	Hole Name:	HEPX0001	Hole Length:	192.00

Easting: 715860.41
Northing: 7462587.71
Surface RL: 609.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Jun 12 - 11 Jun 12
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	BLYWW01	CH	301	AIR	BLY	CL1
6.0 - 192.0	BLYWW01	CH	150	AIR/FOAM	BLY	CL1

TOC RL: 610.41 - (drilled) SWL: 68.80 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 610.58 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	ZXY	K								CEMENT (0.00-1.50)
			ZXY	D								BLANK STEEL: 200mm (0.00-6.00)
			ZXD									BLANK PVC: 50MM (0.00-100.00)
10			D									
20			D				Dry, mainly dolomitic fines, moderately weathered. Seem to be hitting tiny fractures. Unit 22-28 mbgl.					
30			D				Moist, mostly fines (40%). Dolomite frags are very broken and evidence of in filled fractures on the chips. Quartz content can be variable. Unit 28-42 mbgl.					
40			D									
50		OB	Z3G				Moist to wet sample, less fines, moderately weathered. Chips are angular. Unit 42-46 mbgl.					
			D				Chips size about 2mm to 2cm, angular, hard. Some quartz veins.					
60			D				Some chips have small amounts of iron staining.					
			D				Dolomite, hard, crystalline, fresh, fine material appearing in sample, moist sample, unit 48-56mbgl.					
70			D				Less fines 10%, sample wet. Chips are smaller and more broken about 2-5mm in size. Some fe staining on some frags from 58-60 mbgl. Unit 58-66 mbgl.					
80			D				Fines 30%, moist, chips larger about 1-2cm. Dolomite chips are fresh.					
			D				Some small chips having fe staining.					
90			D				Sample was more wet.					GRAVEL MED (85.00-192.00)
			D				Chip size is smaller 2-5mm, some fe staining on some chips. Unit 74-78 mbgl.					LEVELTROLL(90.00) ID: 3137
100			D									SLOTTED PVC: 50MM, Slots 1mm: PVC broke down the hole (100.00-172.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

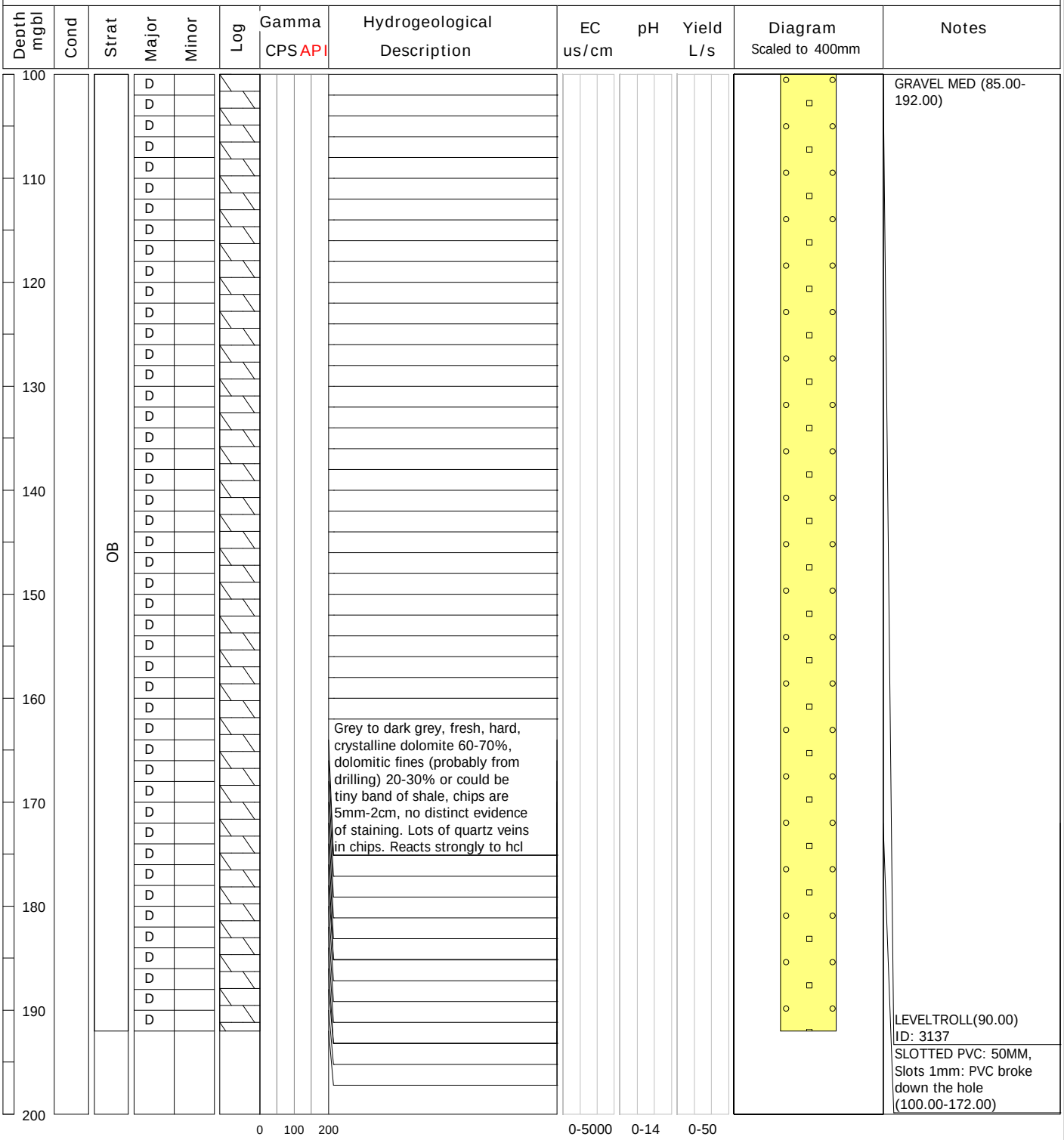
BHP

Project:	EAST PACKSADDLE	Hole Name:	HEPX0001	Hole Length:	192.00

Easting: 715860.41
Northing: 7462587.71
Surface RL: 609.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Jun 12 - 11 Jun 12
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	BLYWW01	CH	301	AIR	BLY	CL1
6.0 - 192.0	BLYWW01	CH	150	AIR/FOAM	BLY	CL1

TOC RL: 610.41 - (drilled) SWL: 68.80 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 610.58 - (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

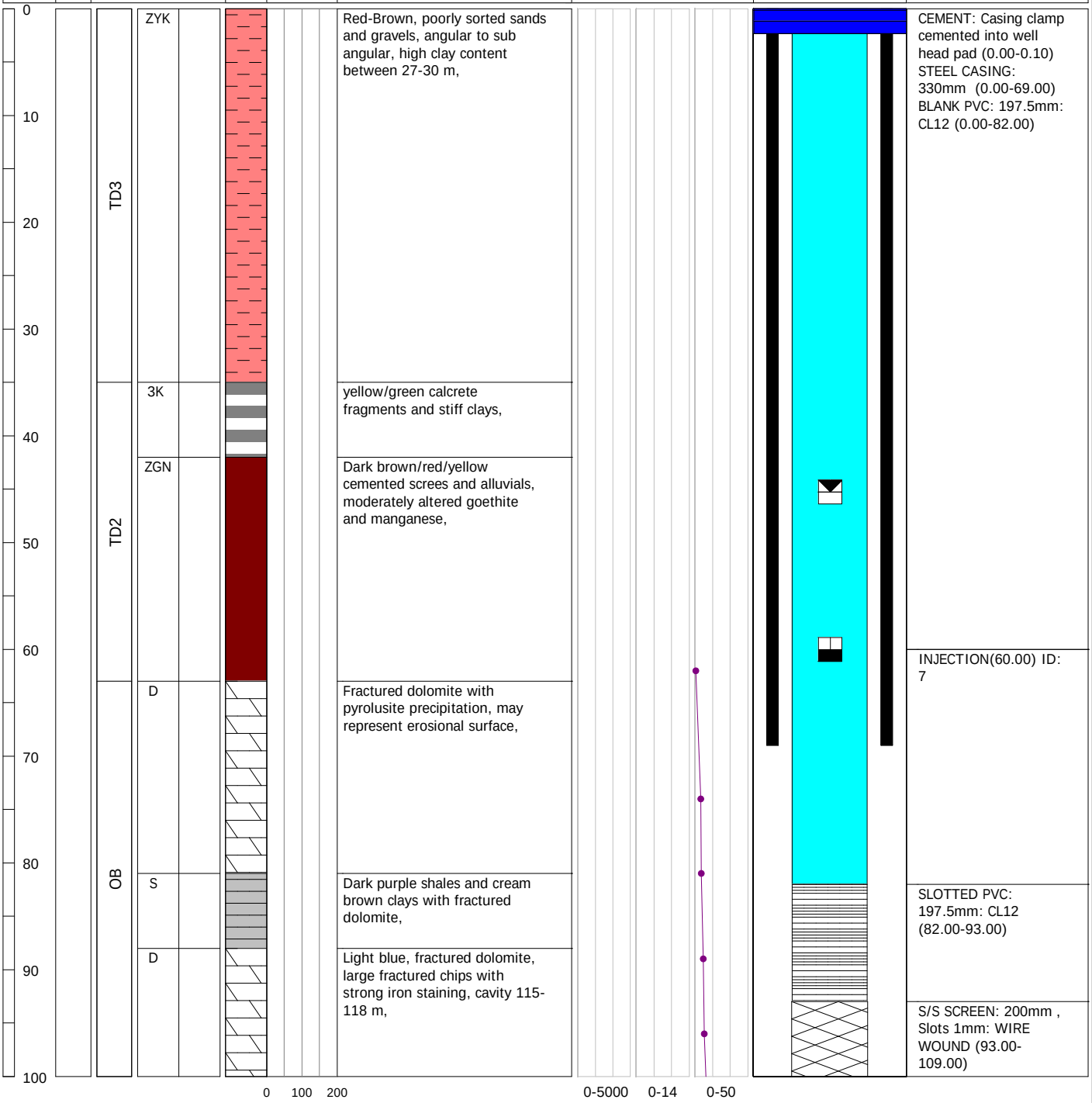
Project:	NORTH FLANK	Hole Name:	HGA0001	Hole Length:	118.00

Easting: 709317.00
Northing: 7463243.00
Surface RL: 630.12
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 Mar 98 - 30 Mar 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 69.0	UNKN	DR	330	Air/Foam	BARBER	EJL
69.0 - 118.0	UNKN	CH	298		BARBER	EJL

Comments: Hole not logged, geology from pilot hole GWB0026. Details have been updated from 1998 Woodward_Clye ...

TOC RL: 630.00 - (drilled) SWL: 45.27 MBGL (18 Apr 98) Dev: N Final pH: -
TOC RL: 630.12 - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0001 **Hole Length:** 118.00

Easting: 709317.00
Northing: 7463243.00
Surface RL: 630.12
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 Mar 98 - 30 Mar 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 69.0	UNKN	DR	330	Air/Foam	BARBER	EJL
69.0 - 118.0	UNKN	CH	298		BARBER	EJL

Comments: Hole not logged, geology from pilot hole GWB0026. Details have been updated from 1998 Woodward_Clye ...

TOC RL: 630.00 - (drilled) SWL: 45.27 MBGL (18 Apr 98) Dev: N Final pH: -
TOC RL: 630.12 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		OB	D				Light blue, fractured dolomite, large fractured chips with strong iron staining, cavity 115-118 m,					S/S SCREEN: 200mm , Slots 1mm: WIRE WOUND (93.00-109.00) SLOTTED PVC: 200mm : ? (109.00-115.00) VOID: CAVITY (115.00-118.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 53

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0002	Hole Length:	136.00

Easting: 709562.30
Northing: 7463202.95
Surface RL: 626.36
Grid Name: MGA94_50
Incl / Azm: -89-->113
Construct: 31 Mar 98 - 05 Apr 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 99.0	UNKN	DR	330	Air/Foam	BARBER	EJL
99.0 - 136.0	UNKN	CH	298		BARBER	EJL

Comments: Hole not logged, geology from pilot hole GWB0028. Details have been updated from 1998 Woodward_Clye ...

TOC RL: 626.36 - (drilled) SWL: 42.63 MBGL (19 Apr 98) Dev: N Final pH: -
TOC RL: 627.68 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	ZYK				Red-brown, clay and sub angular to rounded alluvials/ gravels,					CEMENT: PAD (0.00-0.10) BLANK PVC: 197.5mm: CL12 (0.00-77.50) STEEL CASING: 330mm (0.00-90.00) GRAVEL PACK: 10mm aggregate (0.00-136.00)
40		TD2	3KZ				yellow brown clay, gravels and clacrete fragments,					
50			ZGK				Dark brown/yellow cemented scree alluvials, highly soluted altered chips, geothite alteration, mustard/yellow clays,					
60												~~VWP(58.87) ID: 150~~ INJECTION(60.00) ID: 7
80												SLOTTED PVC: 195mm: C12 (77.50-113.50)
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 54

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK Hole Name: HGA0002 Hole Length: 136.00

Easting: 709562.30
Northing: 7463202.95
Surface RL: 626.36
Grid Name: MGA94_50
Incl / Azm: -89-->113
Construct: 31 Mar 98 - 05 Apr 98

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 99.0	UNKN	DR	330	Air/Foam	BARBER	EJL
99.0 - 136.0	UNKN	CH	298		BARBER	EJL

Comments: Hole not logged, geology from pilot hole GWB0028. Details have been updated from 1998 Woodward_Clye ...

TOC RL: 626.36 - (drilled) SWL: 42.63 MBGL (19 Apr 98) Dev: N Final pH: -
TOC RL: 627.68 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		TD2	ZGK				Dark brown/yellow cemented scree alluvials, highly soluted altered chips, geothite alteration, mustard/yellow clays,					GRAVEL PACK: 10mm aggregate (0.00-136.00)
110		OB	DK				Brown, strongly weathered dolomite, with high clay content,					
120												
130												
140												
150												
160												VWP(58.87) ID: 150
170												INJECTION(60.00) ID: 7
180												SLOTTED PVC: 195mm: C12 (77.50-113.50)
190												S/S SCREEN: 200mm , Slots 1mm: WIRE WOUND (113.50-125.50)
200						0 100 200		0-5000	0-14	0-50		BLANK PVC: 197.5mm: CL12 (125.50-133.00)

Program: Planned Hole: Page: 55

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0003	Hole Length:	115.00

Easting: 709769.78
Northing: 7463143.19
Surface RL: 626.55
Grid Name: MGA94_50
Incl / Azm: -89-->159
Construct: 26 Jun 97 - 30 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 64.0	UNKN	DR	330	Air/Foam	BARBER	EJL
64.0 - 115.0	UNKN	P	298		BARBER	EJL

Comments: Hole not logged, geology based on GWB0012. Details have been updated from 1997 Woodward_Clye MAC Hyd...

TOC RL: 627.00 - (drilled) SWL: 42.66 MBGL (05 Oct 97) Dev: N Final pH: -
TOC RL: 627.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		TD3	ZYK				Red-brown, sub -angular to rounded chips comprimising of BIF, quarts, chert,					BLANK PVC: 200mm : CL12 (0.00-46.00) GRAVEL PACK: (1.6 - 3.2) (0.00-64.00) STEEL CASING: 330mm (0.00-64.00)
30		TD2	K3Z				yellow/brown clay, angular to sub-rounded calcrete,					
40			ZGK				Brown/yellow clay with 10-30% sub-angular to sub rounded grey, red brown chips, clumps of yellow blue green clay,					SLOTTED PVC: 200mm : CL12 (46.00-99.00)
60		OB	DK				Green/Brown clay with angular to sub rounded dolomite chips,					GRAVEL PACK: (3.2 - 6.4) (64.00-115.00)
100						0 100 200		0-5000	0-14	0-50		S/S SCREEN: 200mm , Slots 1mm: WIRE WOUND (99.00-106.00)

Program: Planned Hole: Page: 56

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK Hole Name: HGA0003 Hole Length: 115.00

Easting: 709769.78
Northing: 7463143.19
Surface RL: 626.55
Grid Name: MGA94_50
Incl / Azm: -89-->159
Construct: 26 Jun 97 - 30 Jun 97

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 64.0	UNKN	DR	330	Air/Foam	BARBER	EJL
64.0 - 115.0	UNKN	P	298		BARBER	EJL

Comments: Hole not logged, geology based on GWB0012. Details have been updated from 1997 Woodward_Clye MAC Hyd...

TOC RL: 627.00 - (drilled) SWL: 42.66 MBGL (05 Oct 97) Dev: N Final pH: -
TOC RL: 627.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	DK				Green/Brown clay with angular to sub rounded dolomite chips,					GRAVEL PACK: (3.2 - 6.4) (64.00-115.00) S/S SCREEN: 200mm , Slots 1mm: WIRE WOUND (99.00-106.00) BLANK PVC: 200mm : SUMP (106.00-112.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0038	Hole Length:	126.00

Easting: 708825.84
Northing: 7463675.16
Surface RL: 634.85
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: PLANNED PBA1P

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 126.0	CNDWW17	DR	203	WATER	CONNECTOR	BD4

TOC RL: 634.85 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 636.12 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		T	ZK	XJ			Surface scree, rounded piolites ofx. Plus larger subangular to angular clasts of bif.					
10			ZX	K			Rounded pisolites of x in a reddy clay silt matrix.					
20			ZX				Same as above.					
30			ZK				Red ilty clay, few j and g fairly rounded clasts.					
40			ZK	C			Light brown red clay, with small to med chips of subangular to subrounded, fine to med lasts of chert.					
50			ZK				Similar to above but beoimg yellow with some greeny looking lays.					
60			ZK				Similar to above, but inrease in clasts, possible start of a harap surfae, n rih.					
70			ZKN				Yellow brown clay detrtial with last sof hardappedd n rih.					
80		OB	DN	GW			Hardapped ob dolomite, possible some g and w.					
			DN	GW			Hardapped ob dolomite, possible some g and w.					
			D	S			Looks to be shaley ddolomite / weathered dolomite, frature surfaes look stained with brown orange. Laste are anglar and large when drilled so guessing fairly strong rok.					
90			D				Light grey dolomite, homogenous.Eoh.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0038 **Hole Length:** 126.00

Easting: 708825.84
Northing: 7463675.16
Surface RL: 634.85
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: PLANNED PBA1P

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 126.0	CNDWW17	DR	203	WATER	CONNECTOR	BD4

TOC RL: 634.85 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 636.12 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	D				Light grey dolomite, homogenous.Eoh.					LEVELAPP-TEK(111.24) ID: 1539
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0040 **Hole Length:** 157.00

Easting: 709080.65
Northing: 7463555.56
Surface RL: 633.88
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Sep 12 - 04 Oct 12
Comments: Waiting for HGA0040 to be deleted from database, change hole name to this and add construction detai...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 82.0	CNDWW17	DR	450		CONNECTOR	PM2
82.0 - 157.0	CNDWW17	DR	406		CONNECTOR	PM2

TOC RL: 634.31 (Stickup 0.43m) (drilled) SWL: 52.70 MBTOC (11 Jan 13) Dev: N Final pH: -
TOC RL: 634.31 (Stickup 0.43m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		T					Not logged from 0 to 112m - refer to hga0039					GRAVEL AGG (0.00-1.00)
												BLANK STEEL: Size 14" - 350 (0.00-117.30)
												CEMENT (1.00-8.00)
10												GRAVEL AGG: 30 tonnes used (8.00-155.80)
20												
30												
40												
50												
60		OB					Not logged from 0 to 112m - refer to hga0039					INJECTION(60.00) ID: 7
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 60

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0040	Hole Length:	157.00

Easting: 709080.65
Northing: 7463555.56
Surface RL: 633.88
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Sep 12 - 04 Oct 12
Comments: Waiting for HGA0040 to be deleted from database, change hole name to this and add construction detai...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 82.0	CNDWW17	DR	450		CONNECTOR	PM2
82.0 - 157.0	CNDWW17	DR	406		CONNECTOR	PM2

TOC RL: 634.31 (Stickup 0.43m) (drilled) SWL: 52.70 MBTOC (11 Jan 13) Dev: N Final pH: -
TOC RL: 634.31 (Stickup 0.43m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100												BLANK STEEL: Size 14" - 350 (0.00-117.30)
110			D	K			Dolomitic hardcap. Some clay at top					CEMENT (1.00-8.00) GRAVEL AGG: 30 tonnes used (8.00-155.80)
120			D				Cavernous dolomite hardcap					
130		OB										
140			D				Slightly fractured fresh dolomite					
150			D				Fractured, weathered and carvernous dolomite					
160												INJECTION(60.00) ID: 7
170												S/S SCREEN: Size 14" - 350, Slots 1.6mm (117.30-153.80)
180												
190												SUMP: Size 14" - 350 (153.80-155.80)
200												END CAP (155.80) FALLBACK (155.80-157.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0041 **Hole Length:** 138.30

Easting: 708440.28
Northing: 7463729.79
Surface RL: 636.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Oct 12 - 20 Nov 12
Comments: Waiting for HGA0041 to be deleted from database. include information from this hole

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 42.0	CNDWW17	DR	450	AIR/WATER/FOAM	CONNECTOR	PM2
42.0 - 84.0	CNDWW17	CH	445	AIR/WATER/FOAM	CONNECTOR	PM2
84.0 - 88.0	CNDWW17	DR	406	AIR/WATER/FOAM	CONNECTOR	PM2
88.0 - 138.3	CNDWW17	CH	381	AIR/WATER/FOAM	CONNECTOR	PM2

TOC RL: 637.07 (Stickup 0.36m) (drilled) SWL: 55.56 MBTOC (11 Jan 13) Dev: N Final pH: -
TOC RL: 637.07 (Stickup 0.36m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		TD3	ZX	JGK			Loose detrital material dominated by maghemite pisolites less than 0.5cm					OPEN HOLE (0.00-32.50) BLANK STEEL: 457mm (0.00-34.00) BLANK STEEL: 300mm (0.00-65.10)
30		TD2	ZK	3GJ			Not typical td2 material. Composed of carboneous material, calcrete and weathered dolomite, clay is limonitic, fines up to 70%					GRAVEL AGG: Hole bridged (32.50-44.00) OPEN HOLE (44.00-100.00) INJECTION(60.00) ID: 7 S/S SCREEN: 300mm , Slots 1mm (65.10-77.30)
70		OB	ZD				First 6m of interval is slightly weathered dolomite with an increase in fines. Below this depth is hard fresh dolomite, calcite crystals throughout. Up to 3mm clays in the dolomite, could be contamination					SLOTTED STEEL: 300mm , Slots 1mm (77.30-113.40) GRAVEL AGG: 15 Tonne gravel installed (100.00-134.60)
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 62

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0041 **Hole Length:** 138.30

Easting: 708440.28
Northing: 7463729.79
Surface RL: 636.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Oct 12 - 20 Nov 12
Comments: Waiting for HGA0041 to be deleted from database. include information from this hole

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 42.0	CNDWW17	DR	450	AIR/WATER/FOAM	CONNECTOR	PM2
42.0 - 84.0	CNDWW17	CH	445	AIR/WATER/FOAM	CONNECTOR	PM2
84.0 - 88.0	CNDWW17	DR	406	AIR/WATER/FOAM	CONNECTOR	PM2
88.0 - 138.3	CNDWW17	CH	381	AIR/WATER/FOAM	CONNECTOR	PM2

TOC RL: 637.07 (Stickup 0.36m) (drilled) SWL: 55.56 MBTOC (11 Jan 13) Dev: N Final pH: -
TOC RL: 637.07 (Stickup 0.36m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OB	ZD				First 6m of interval is slightly weathered dolomite with an increase in fines. Below this depth is hard fresh dolomite, calcite crystals throughout. Up to 3mm clays in the dolomite, could be contamination					SLOTTED STEEL: 300mm , Slots 1mm (77.30-113.40) GRAVEL AGG: 15 Tonne gravel installed (100.00-134.60)
110												S/S SCREEN: 300mm , Slots 1mm (113.40-131.60)
120												
130												SUMP: 300mm (131.60-134.60)
140		O	SD	G			Dolomite, medium to fine particle size, very high strength with moderate weathering, massive,faulting. Large fractures throughout					END CAP (134.60) FALLBACK (134.60-138.30)
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 63

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0061 **Hole Length:** 124.00

Easting: 709006.09
Northing: 7463115.30
Surface RL: 634.54
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 29 Nov 14 - 06 Dec 14
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 34.0	CNDWW16	DR	500	AIR/WATER	CONNECTOR	LS2
34.0 - 124.0	CNDWW16	CH	500	AIR/WATER/FOAM	CONNECTOR	LS2

TOC RL: 635.14 (Stickup 0.60m) (drilled) SWL: 54.33 MBGL (06 Dec 14) Dev: Y: 9.0 hour(s) Final pH: 8.3
TOC RL: 635.14 (Stickup 0.60m) (current) Is Live: N (31 Aug 21) Date: 06 Dec 2014 Final EC: 701.00

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0			ZYX	CG		Silt and gravel, some sand, slight trace clay (surface scree); red brown; angular; loose; polymictic conglomerate with maghemite, chert and bif.					CEMENT (0.00-2.00)
10			ZX	Y		Gravel, silty, trace sand and clay (gravelly siltstone); red brown; very well rounded to sub-angular; loose; pisolites from 14-24m, 1-3mm diameter.					BLANK STEEL: 300mm (0.00-62.00)
20			ZG	K		Vuggy, vitreous geothite with some pisolites, slight trace clay and silt (vuggy breccia); light brown; very well rounded to sub-angular; some yellow brown clay from 27-28m					GRAVEL AGG (2.00-115.00)
30		T	ZH	W		Gravel clasts, in matrix of some sand and silt, trace clay (hematite conglomerate); red brown; sub-angular to angular; mineralised with hematite and martite; hard ground, very slow penetration rates with 500mm dr casing; some clay from 38-62m					
40											
50											
60			ZH	W		Gravel clasts, in matrix of some sand and silt, trace clay (hematite conglomerate); red brown; sub-angular to angular; mineralised with hematite and martite; hard ground, very slow penetration rates with 500mm dr casing; some clay from 38-62m					LEVELTROLL(61.00) ID: 1196
70		WA2	S	GJ		Shale with minor bif (west angela member); grey brown; moderately soft; moderately weathered; mineralised with geothite and limonite, marginal grade; white and pink shales, trace quarzt throughout.					SLOTTED STEEL: 300mm , Slots 2mm (62.00-97.00)
80		WA1	JS	G		Bif and shale (west angela member); brown; hard; slightly weathered; unmineralised bif fragments with brown cherts; trace quartz and white and pink shales from 88m.					
90											
100		N3	G	LJ		Bif (mount newman member); yellow brown; moderately hard; weathered; mineralised with geothite and limonitic shales, low grade; fractured zone 98-100m resulting in increased yields; low sample return and trace white shales 100-102m.					S/S SCREEN: 300mm , Slots 2mm (97.00-109.00)
					0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

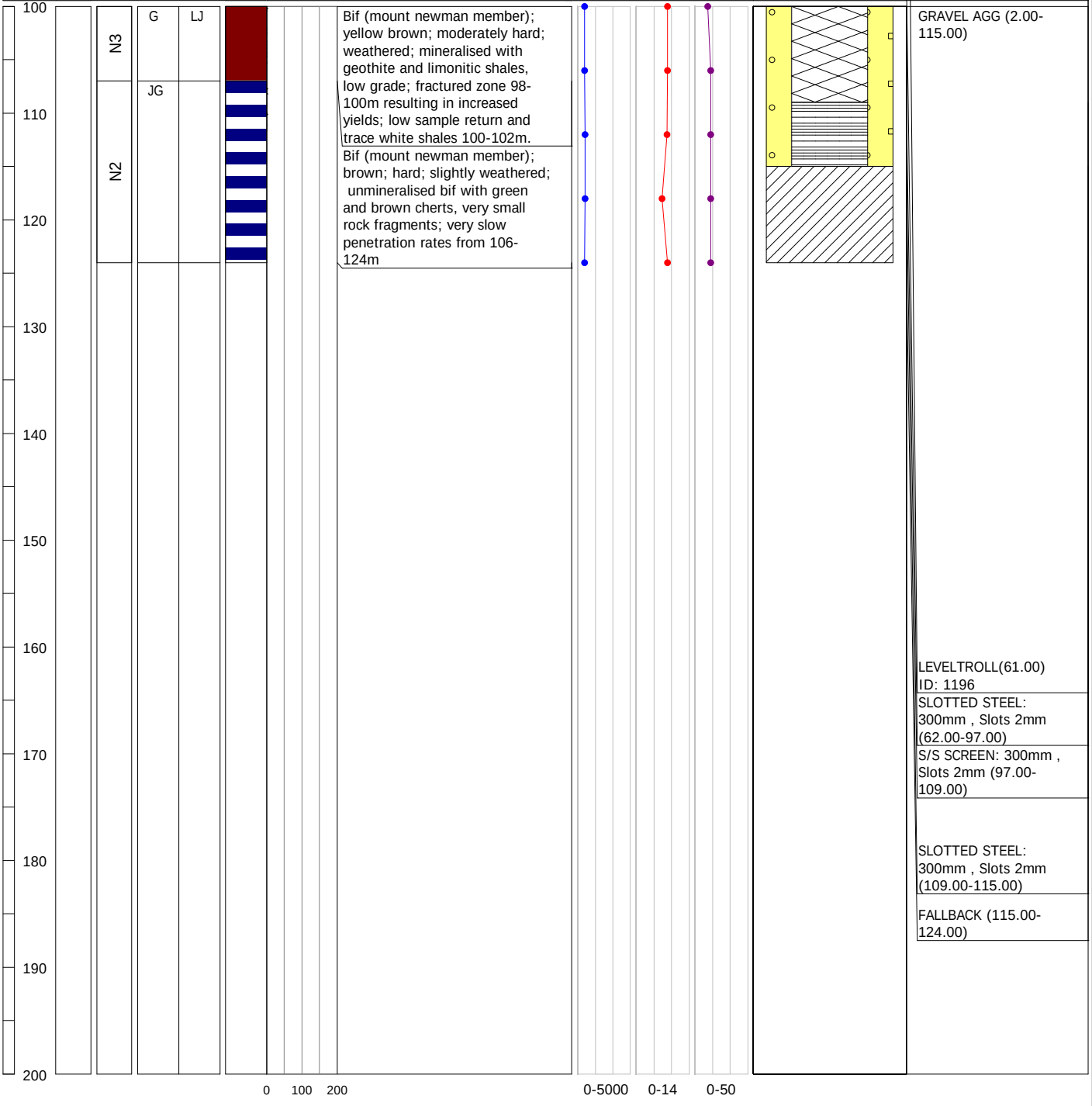
BHP

Project:	NORTH FLANK	Hole Name:	HGA0061	Hole Length:	124.00

Easting: 709006.09
Northing: 7463115.30
Surface RL: 634.54
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 29 Nov 14 - 06 Dec 14
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 34.0	CNDWW16	DR	500	AIR/WATER	CONNECTOR	LS2
34.0 - 124.0	CNDWW16	CH	500	AIR/WATER/FOAM	CONNECTOR	LS2

TOC RL: 635.14 (Stickup 0.60m) (drilled) SWL: 54.33 MBGL (06 Dec 14) Dev: Y: 9.0 hour(s) Final pH: 8.3
TOC RL: 635.14 (Stickup 0.60m) (current) Is Live: N (31 Aug 21) Date: 06 Dec 2014 Final EC: 701.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0062	Hole Length:	190.00

Easting: 708732.68
Northing: 7463553.51
Surface RL: 632.45
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Feb 15 - 25 Feb 15
License: CAW177516
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 40.0	CNDWW16	DR	500		CONNECTOR	YA
40.0 - 172.0	CNDWW16	DR	450		CONNECTOR	KM3
172.0 - 190.0	CNDWW16	CH	450		CONNECTOR	KM3

TOC RL: 633.01 (Stickup 0.56m) (drilled) SWL: 52.37 MBTOC (08 Mar 15) Dev: Y: 14.0 hour(s) Final pH: 8.2
TOC RL: 633.01 (Stickup 0.56m) (current) Is Live: Y (-) Date: 05 Mar 2015 Final EC: 788.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		T	ZY	JC			Silt and sand, gravelly, slight trace clay (quaternary detritals); red brown; angular; polymictic conglomerate; trace roots and organic matter					CEMENT (0.00-2.00)
			ZYX	JC								BLANK STEEL: 300mm (0.00-56.00)
10							Gravel, silty, some sand, slight trace clay (gravelly siltstone); red brown; very well rounded to angular; loose; clayey (red) 16-24m and 38-40.5m; some pisolites 18-24 and predominately pisolites 24-38m					GRAVEL MED (2.00-188.00)
20												
30												
40			ZK	CS			Clay, trace gravel, slight trace sand and silt (tertiary clay); yellow brown; medium plasticity clay; mottled					
50			ZG	LKJ			Vuggy, vitreous geothite with limonite, some trace clay and silt infill (vuggy breccia) yellow brown; some yellow clay 72-80; compact/cemented goethite					SLOTTED STEEL: 300mm , Slots 1mm (56.00-140.00)
60												
70												
80							Vuggy, vitreous geothite with limonite, some trace clay and silt infill (vuggy breccia) yellow brown; some yellow clay 72-80; compact/cemented goethite					
90		OB	ZG	LKJ								
			ZKH	G			Gravel, clayey and sandy, slight trave silt (hematite conglomerate); red brown; predominately rounded with some angular chips; moderately compact; red clay thoughout the entire interval					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0062	Hole Length:	190.00

Easting:	708732.68
Northing:	7463553.51
Surface RL:	632.45
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	21 Feb 15 - 25 Feb 15
Comments:	A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 40.0	CNDWW16	DR	500		CONNECTOR	YA
40.0 - 172.0	CNDWW16	DR	450		CONNECTOR	KM3
172.0 - 190.0	CNDWW16	CH	450		CONNECTOR	KM3

License: CAW177516

TOC RL:	633.01	(Stickup 0.56m)	(drilled)	SWL:	52.37 MBTOC	(08 Mar 15)	Dev:	Y: 14.0 hour(s)	Final pH:	8.2
TOC RL:	633.01	(Stickup 0.56m)	(current)	Is Live:	Y	(-)	Date:	05 Mar 2015	Final EC:	788.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100			ZKH	G			Gravel, clayey and sandy, slight trave silt (hematite conglomerate); red brown; predominately rounded with some angular chips; moderately compact; red clay thoughout the entire interval					GRAVEL MED (2.00-188.00)
			DK	G								SLOTTED STEEL: 300mm , Slots 1mm (56.00-140.00)
110							Laterised dolomite (paraburdoo member); yellow and white clays with clasts of geothite up to 0.5cm; dolomite has undergone decalcification and devolatisation resulting in a magnifireous-geothitic clay resdiue					LEVELTROLL(110.00) ID: 1196
			D	N								
120												
							Dolomite with vuggs and fractures filled with manganese minerals (paraburdoo member); blue grey 116-120 and 146 to 185, yellow brown 112-116 and120-146, black blue 185-190; highly weathered 112-116 and 120-146, slightly weathered 116-120 and 146-999; very hard; driller commented fast penetration 144-148m and very slow penetration 168-172m, 176-178m; large chips up to 5cm 114-116m, 141-147m and 158-172m, possibly fractured zones?; 185-190 carbonaceous black shale; black discharge to the sump 182-190m					
130												
		OB										
140												W/W STEEL: 300mm , Slots 1mm (140.00-146.00)
												SLOTTED STEEL: 300mm , Slots 1mm (146.00-158.00)
150												
												W/W STEEL: 300mm , Slots 1mm (158.00-170.00)
160												
												SLOTTED STEEL: 300mm , Slots 1mm (170.00-182.00)
170			D	N			Dolomite with vuggs and fractures filled with manganese minerals (paraburdoo member); blue grey 116-120 and 146 to 185, yellow brown 112-116 and120-146, black blue 185-190; highly weathered 112-116 and 120-146, slightly weathered 116-120 and 146-999; very hard; driller commented fast penetration 144-148m and very slow penetration 168-172m, 176-178m; large chips up to 5cm 114-116m, 141-147m and 158-172m, possibly fractured zones?; 185-190 carbonaceous black shale; black discharge to the sump 182-190m					
180		WA2										SUMP: 300mm (182.00-188.00)
		WA1	D	N								FALLBACK (188.00-190.00)
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

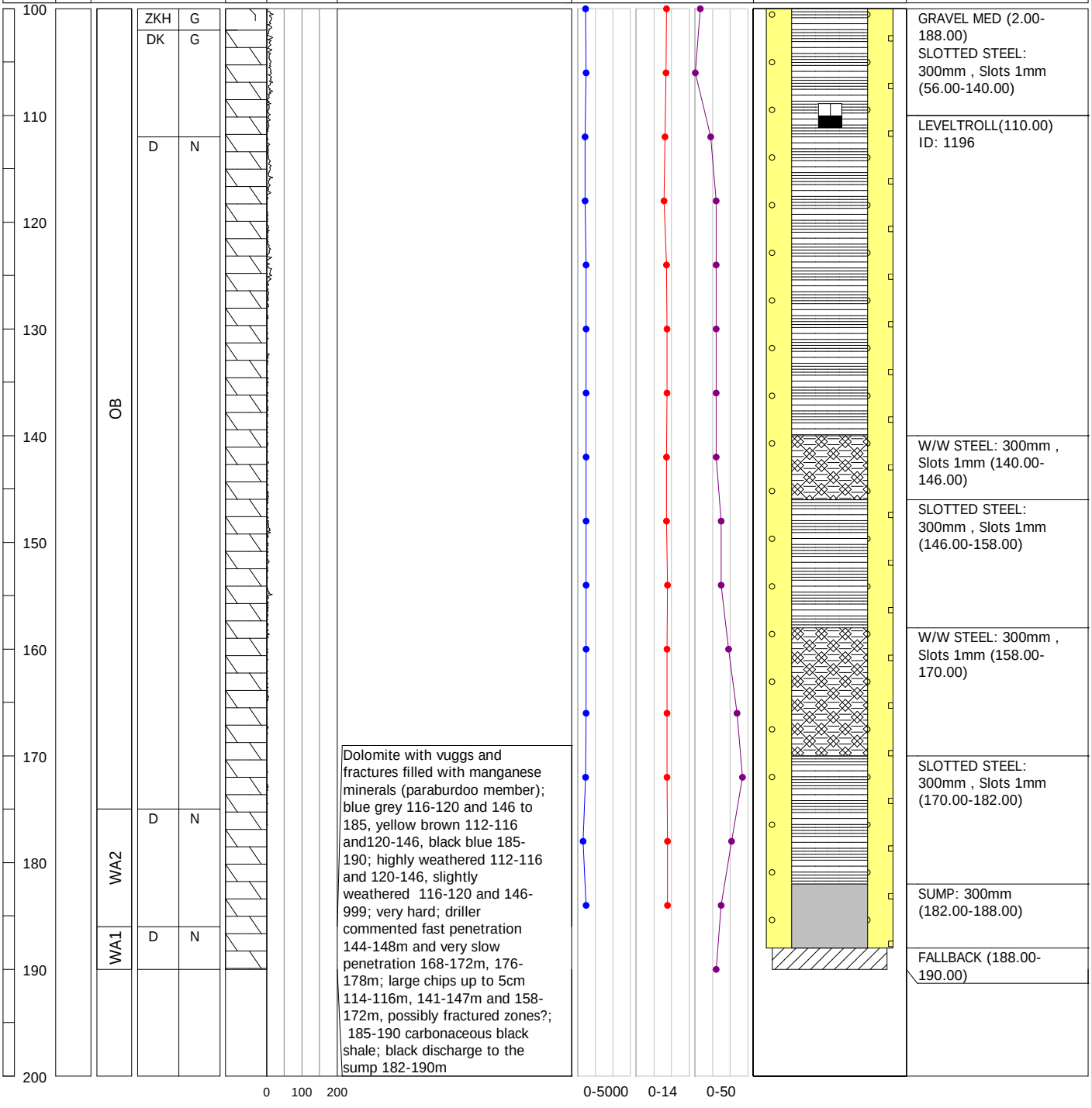
BHP

Project:	NORTH FLANK	Hole Name:	HGA0062	Hole Length:	190.00

Easting: 708732.68
Northing: 7463553.51
Surface RL: 632.45
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Feb 15 - 25 Feb 15
License: CAW177516
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 40.0	CNDWW16	DR	500		CONNECTOR	YA
40.0 - 172.0	CNDWW16	DR	450		CONNECTOR	KM3
172.0 - 190.0	CNDWW16	CH	450		CONNECTOR	KM3

TOC RL: 633.01 (Stickup 0.56m) (drilled) SWL: 52.37 MBTOC (08 Mar 15) Dev: Y: 14.0 hour(s) Final pH: 8.2
TOC RL: 633.01 (Stickup 0.56m) (current) Is Live: Y (-) Date: 05 Mar 2015 Final EC: 788.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0064	Hole Length:	130.00

Easting: 709450.01
Northing: 7462814.97
Surface RL: 633.45
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Mar 15 - 26 Mar 15
License: CAW177516
Comments: A Central Pilot Borefiled Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 122.0	CNDWW16	DR	500		CONNECTOR	KM3
122.0 - 130.0	CNDWW16	CH	500		CONNECTOR	KM3

TOC RL: 634.03 (Stickup 0.58m) (drilled) SWL: Dev: Y: 15.0 hour(s) Final pH: 8.2
TOC RL: 630.34 - (current) Is Live: N (01 Apr 23) Date: 25 Mar 2015 Final EC: 723.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0			ZYJ				Gravel, silty, slight trace sand and clay (surface scree); red brown; angular; moderately weathered chips; polymictic conglomerate					BLANK STEEL: 508mm (0.00-6.00)
10			ZYX				Gravel, silty, trace clay and slight trace sand (gravelly siltstone); red brown; angular to well rounded (pisolites); moderately compacted 2-6m, loose through pisolitic zone 6-19m; gravel up to 3cm; some red clay 2-6m; driller commented that the ground was very "tight" and it was difficult to advance the casing					BLANK STEEL: 300mm (0.00-63.00)
20		T	ZGL	K								GRAVEL MED (2.00-126.00)
30							Vuggy geothite with infill of some limonite, trace clay and sand, and slight trace silt (vuggy breccia); yellow brown; compacted; weathered; vitreous goethite 19-22m; denatured geothite 22m onwards, with increaing amounts of limonitic infill down the unit; trace red clay 30-34m, some yellow clay 38-46m and some brown clay 46-52m, transition zone 46-52m, colour changes from yellow brown to brown and chips become more denatured					
40												
50			S	J			Shale (west angela member); dark brown; moderately weathered; soft to moderately soft; unmineralised; mangnese rich shales 56-70m; white shales present from 60m					LEVELTROLL(50.00) ID: 1196
60		WA2										
70							Shale (west angela member); dark brown; moderately weathered; soft to moderately soft; unmineralised; mangnese rich shales 56-70m; white shales present from 60m					SLOTTED STEEL: 300mm , Slots 2mm (63.00-93.00)
80		WA1	S	J			Shale and bif (west angela member); yellow brown; moderately weathered; soft to moderately hard; unmineralised; trace pink shales 83-86 marking strat boundary; increasing yellow shale content from 72m					
			SG	K								
90			G	S			Bif (mount newman member); brown; moderately weathered, giving chips pitted texture; moderately soft to hard; mineralised 86-92m with martite present, mineralisation decreases down unit; increasing amounts limonite and shales down unit; chips appear massive					S/S SCREEN: 300mm , Slots 2mm (93.00-99.00)
100		N3	G	S								SLOTTED STEEL: 300mm , Slots 2mm (99.00-111.00)
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

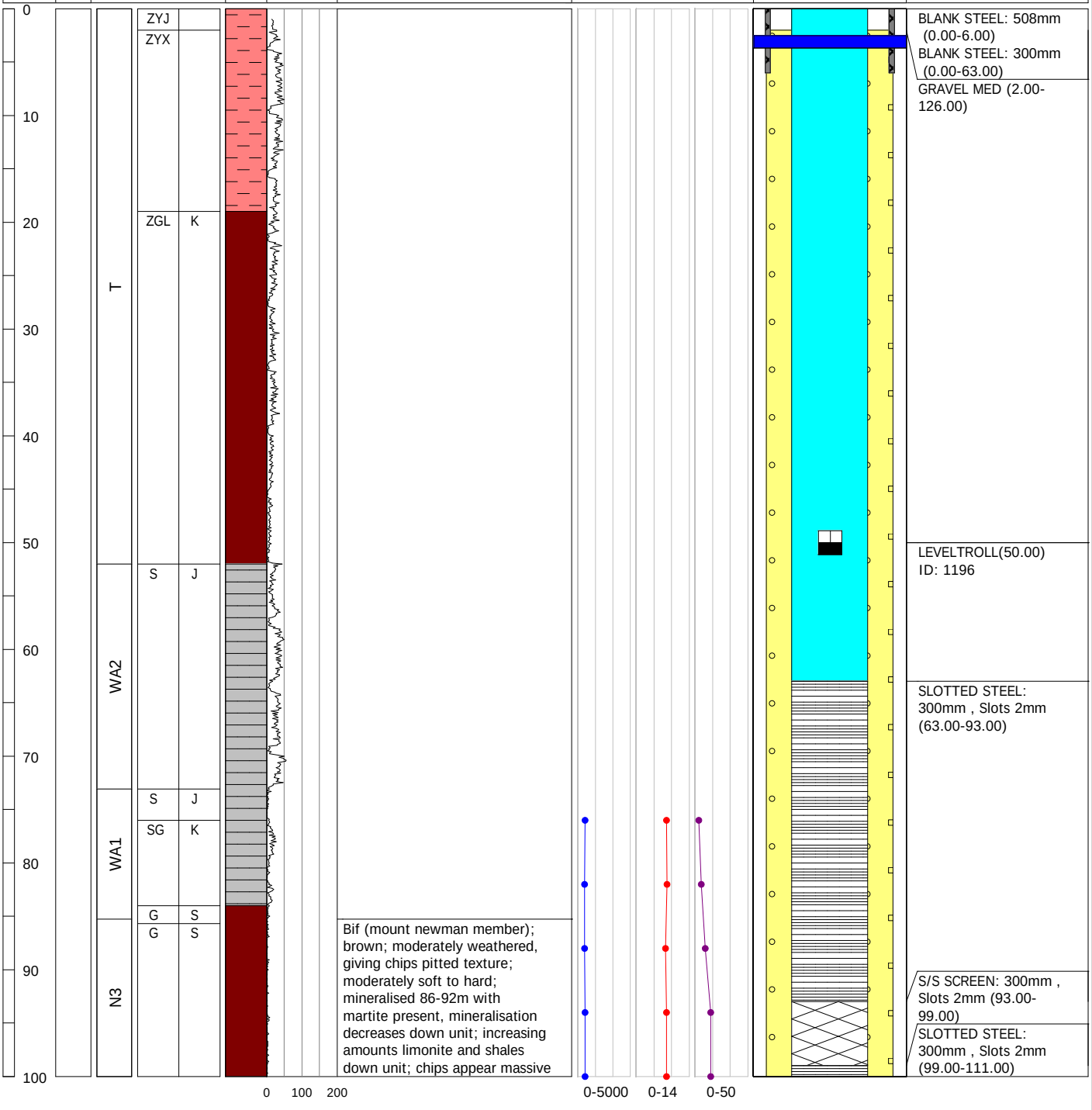
BHP

Project:	NORTH FLANK	Hole Name:	HGA0064	Hole Length:	130.00

Easting: 709450.01
Northing: 7462814.97
Surface RL: 633.45
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Mar 15 - 26 Mar 15
License: CAW177516
Comments: A Central Pilot Borefiled Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 122.0	CNDWW16	DR	500		CONNECTOR	KM3
122.0 - 130.0	CNDWW16	CH	500		CONNECTOR	KM3

TOC RL: 634.03 (Stickup 0.58m) (drilled) SWL: Dev: Y: 15.0 hour(s) Final pH: 8.2
TOC RL: 630.34 - (current) Is Live: N (01 Apr 23) Date: 25 Mar 2015 Final EC: 723.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0064	Hole Length:	130.00

Easting: 709450.01
Northing: 7462814.97
Surface RL: 633.45
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Mar 15 - 26 Mar 15
Comments: A Central Pilot Borefiled Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 122.0	CNDWW16	DR	500		CONNECTOR	KM3
122.0 - 130.0	CNDWW16	CH	500		CONNECTOR	KM3

License: CAW177516

TOC RL: 634.03 (Stickup 0.58m) (drilled) SWL: Dev: Y: 15.0 hour(s) Final pH: 8.2
TOC RL: 630.34 - (current) Is Live: N (01 Apr 23) Date: 25 Mar 2015 Final EC: 723.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		N3	G	S			Bif (mount newman member); brown; moderately weathered, giving chips pitted texture; moderately soft to hard; mineralised 86-92m with martite present, mineralisation decreases down unit; increasing amounts limonite and shales down unit; chips appear massive					GRAVEL MED (2.00-126.00)
110		N2	G	S								
			JC	GS								
120		N1	JC	GS			Bif (mount newman member); brown; moderately weathered, giving chips pitted texture; moderately soft to hard; mineralised 86-92m with martite present, mineralisation decreases down unit; increasing amounts limonite and shales down unit; chips appear massive					
130							Bif (mount newman member); yellowish brown; moderately weathered 106-118m; fresh 118-130m; hard; unmineralised; visible banding from 118m, sligthly magnetic 118-122, moderately magnetic 122-130; very slow penetration rate					
140												
150							Bif (mount newman member); yellowish brown; moderately weathered 106-118m; fresh 118-130m; hard; unmineralised; visible banding from 118m, sligthly magnetic 118-122, moderately magnetic 122-130; very slow penetration rate					LEVELTROLL(50.00) ID: 1196
160												SLOTTED STEEL: 300mm , Slots 2mm (63.00-93.00)
170												S/S SCREEN: 300mm , Slots 2mm (93.00-99.00)
180												SLOTTED STEEL: 300mm , Slots 2mm (99.00-111.00)
190												S/S SCREEN: 300mm , Slots 2mm (111.00-117.00)
200						0 100 200		0-5000	0-14	0-50		SLOTTED STEEL: 300mm , Slots 2mm (117.00-123.00)
												SUMP: 300mm (123.00-126.00)
												FALLBACK (126.00-130.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0065	Hole Length:	180.00

Easting: 709418.56
Northing: 7463144.86
Surface RL: 628.84
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 May 15 - 06 Jun 15
License: CAW177516
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 46.0	CNDWW16	DR	600		CONNECTOR	YA
46.0 - 106.0	CNDWW16	DR	500		CONNECTOR	YA
106.0 - 180.0	CNDWW16	CH	500		CONNECTOR	YA

TOC RL: 629.41 (Stickup 0.57m) (drilled) SWL: 48.56 MBTOC (07 Jun 15) Dev: Y: 11.0 hour(s) Final pH: 8.2
TOC RL: 629.41 (Stickup 0.57m) (current) Is Live: N (18 Jan 23) Date: 05 Jun 2015 Final EC: 628.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	ZY	JX			Silt and sand, trace gravel, slight trace clay (quaternary detritals); red brown; angular; low sample return; some roots and organic matter; polymictic conglomerate					CEMENT (0.00-2.00)
10		TD3	ZX	JC			Silt and gravel, sandy (gravelly siltstone) red brown; angular to sub-angular, conglomerate maghemite and bif, rounded to very well rounded 20 - 30cm, fractured ground at 30m					BLANK STEEL: Size 20" - W.T.12.7mm: 0-42m (0.00-42.00) BLANK STEEL: Size 24" - W.T.12.7mm: Ground too tight to remove casing (0.00-46.00) BLANK STEEL: Size 14" - W.T.9.53mm (0.00-58.00)
20												GRAVEL AGG (2.00-175.00)
30		TD2	ZG	KY			Clay, some silt; trace tertiary clay (Vuggy Breccia) yellow to light brown, medium plasticity, rounded to sub-angular, moderately weathered, very hard drilling from 46m. 24" DR reached refusal at 46m, first wate strike ~55m					
40												
50												
60		OB	D	N			Dolomite (Paraburdoo Dolomite) weathered and oxidised dolomite 50-126m, orange brown colour, some chips greater than 5cm indicating that there might be fracturing, some interbedded manganese layers; fresh to moderately weathered dolomite with clastic content (silt & very fine sand) 126-178m, darkish grey to bluish, moderate hardness, weathered with interbedded layers of fresh dolomite. High yields of 50 l/s (138-180m) from karstic dolomite, good steady drilling conditions					SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 2mm (58.00-124.00) LEVELTROLL(60.00) ID: 1196
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

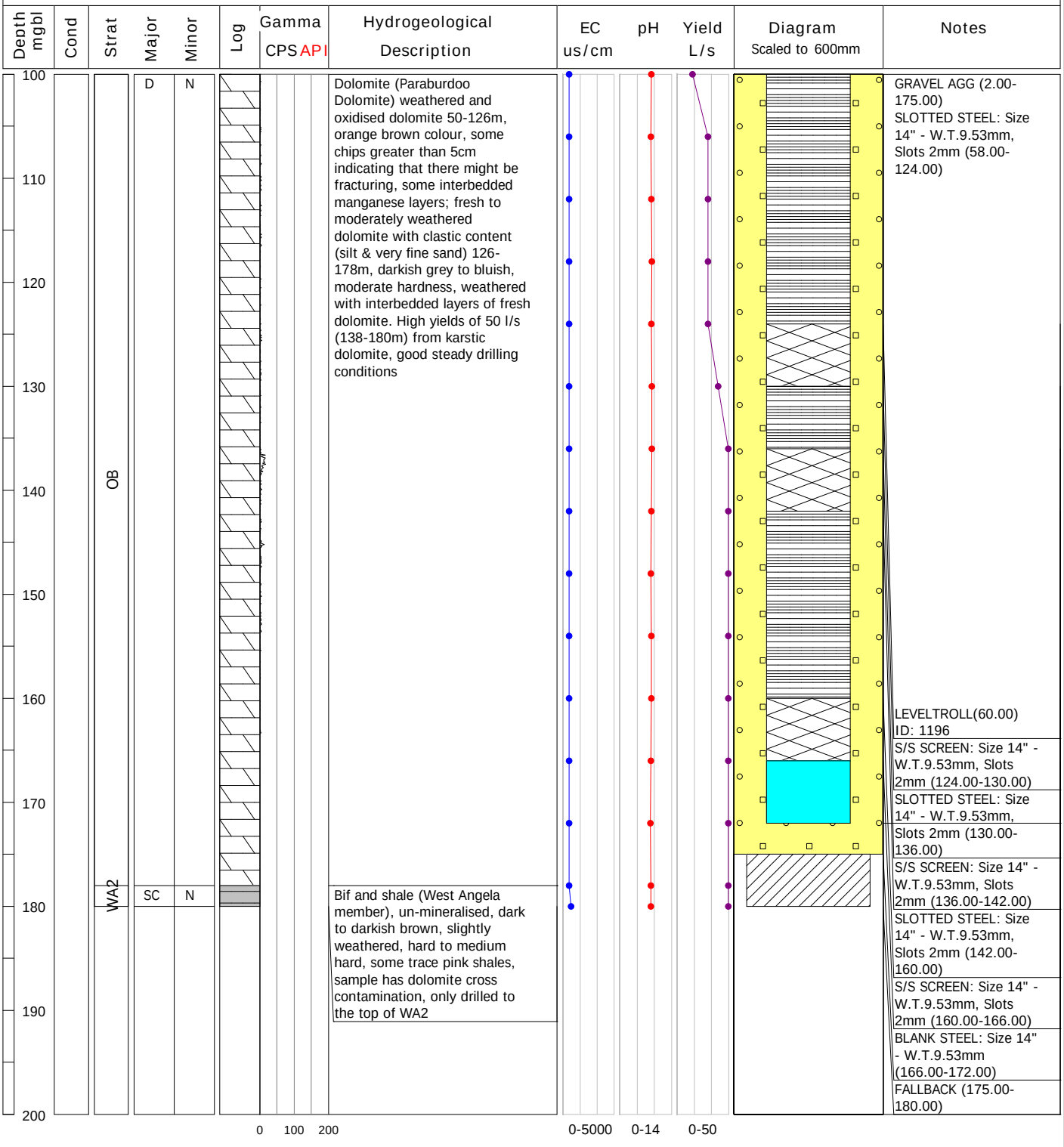
BHP

Project:	NORTH FLANK	Hole Name:	HGA0065	Hole Length:	180.00

Easting: 709418.56
Northing: 7463144.86
Surface RL: 628.84
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 May 15 - 06 Jun 15
License: CAW177516
Comments: A Central Pilot Borefield Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 46.0	CNDWW16	DR	600		CONNECTOR	YA
46.0 - 106.0	CNDWW16	DR	500		CONNECTOR	YA
106.0 - 180.0	CNDWW16	CH	500		CONNECTOR	YA

TOC RL: 629.41 (Stickup 0.57m) (drilled) SWL: 48.56 MBTOC (07 Jun 15) Dev: Y: 11.0 hour(s) Final pH: 8.2
TOC RL: 629.41 (Stickup 0.57m) (current) Is Live: N (18 Jan 23) Date: 05 Jun 2015 Final EC: 628.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0066	Hole Length:	142.00

Easting: 710423.92
Northing: 7462948.37
Surface RL: 622.04
Grid Name: MGA94_50
Incl / Azm: -89-->29
Construct: 22 Jun 15 - 24 Jun 15
Comments: Monitoring bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 142.0	MCYWW06	CH	200		MCKAY	CVM

TOC RL: 622.94 (Stickup 0.90m) (drilled) SWL: 42.00 MBGL (24 Jun 15) Dev: N Final pH: -
TOC RL: 623.38 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							GRAVEL, clayey, (QUATERNARY DETRITAL), , Extremely Weathered, Non-Cohesive soils, Gap graded, Angular.					CEMENT (0.00-2.00) BLANK STEEL: Size 8" - W.T.8.18mm (0.00-6.00) BLANK PVC: Size 50 - Class 18 (0.00-78.00) GRAVEL FINE (2.00-96.00)
10												
20												
30												
40							DOLOMITE, (A), , Slightly Weathered, Very Strong Rock.					
50		A										
60												
70												LEVELAPP-TEK(70.34) ID: 2043
80												SLOTTED PVC: Size 50 - Class 18, Slots 2mm (78.00-96.00)
90												
100						0 100 200		0-5000	0-14	0-50		FALLBACK (96.00-142.00)

BHPIO - Hydrogeology Log

Project: NORTH FLANK **Hole Name:** HGA0066 **Hole Length:** 142.00

Easting: 710423.92
Northing: 7462948.37
Surface RL: 622.04
Grid Name: MGA94_50
Incl / Azm: -89-->29
Construct: 22 Jun 15 - 24 Jun 15
Comments: Monitoring bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 142.0	MCYWW06	CH	200		MCKAY	CVM

TOC RL: 622.94 (Stickup 0.90m) (drilled) SWL: 42.00 MBGL (24 Jun 15) Dev: N Final pH: -
TOC RL: 623.38 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		A				0 100 200	DOLOMITE, (A), , Slightly Weathered, Very Strong Rock.	0-5000	0-14	0-50		FALLBACK (96.00-142.00)

Program: FY15 MAC DEWATERING DRILLING Planned Hole: HGA0066M

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGA0069 | Hole Length: 199.00

Easting: 706703.56
Northing: 7463451.87
Surface RL: 650.42
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Apr 18 - 04 Apr 18
Comments: pilot hole for potential PB. Yields not great 1-4 L/s.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 40.0	EWMWW04	DR	200		EASTERNWELL	MRC1
40.0 - 199.0	EWMWW04	CH	200		EASTERNWELL	MRC1, RF2

TOC RL: 650.96 - (drilled) SWL: 80.00 MBGL (04 Apr 18) Dev: N Final pH: -
TOC RL: 650.96 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	SZ	ZG	J			QUATERNARY DETRITAL, (SZ), Red and Yellow, Highly Weathered, Strong Rock.					AB FOAM (0.00-2.00)
10		TD3	ZJ	G			QUATERNARY DETRITAL, (TD3), Red and Yellow and grey, Moderately Weathered, Strong Rock.					BLANK PVC: 48mm (0.00-109.00)
			ZJ	CX			QUATERNARY DETRITAL, (TD3), Red and Yellow and grey, Highly Weathered, Strong Rock. Pisolite present 14m - 28m. Drilling well					GRAVEL MED (2.00-199.00)
20		WA1	ZG	J			GRAVEL, (QUATERNARY DETRITAL), Yellow and Grey, Extremely Weathered, Very Stiff, Gap graded, Rounded. High goethitic content. Drilling well					
30		N3	ZJ	XG			QUATERNARY DETRITAL, (N3), Grey and Brown, Highly Weathered, Strong Rock.					
40			ZJ	G			QUATERNARY DETRITAL, (N3), Grey and Yellow, Moderately Weathered, Strong Rock.					
50			ZGJ				GRAVEL, (QUATERNARY DETRITAL), Yellow and Grey, Extremely Weathered, Very Stiff, Gap graded, Angular.					
60		N2	ZCG	J			QUATERNARY DETRITAL, (N2), Yellow and Grey, Moderately Weathered, Strong Rock.					
			ZG	J			GRAVEL, (QUATERNARY DETRITAL), Yellow, Extremely Weathered, Very Stiff, Poorly graded, Angular.					
70			ZG	JC			QUATERNARY DETRITAL, (N2), Yellow and Brown and grey, Moderately Weathered, Strong Rock.					
			ZG	JC			QUATERNARY DETRITAL, (N2), Yellow and Grey, Moderately Weathered, Strong Rock.					
80		N1	J	C			PARTIALLY MINERALISED, (N1), Grey and Yellow, Fresh, Strong Rock. Magnetism increase from 86m (masks on, 1m samples)					
90			JC	G			MINERALISED BIF, (N1), Grey and Yellow and brown, Fresh, Strong Rock. Fresh mineralised BIF. Trace pyrite.					
			JC	S			MINERALISED BIF, (N1), Grey and Yellow, Fresh, Strong Rock.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0069	Hole Length:	199.00

Easting: 706703.56
Northing: 7463451.87
Surface RL: 650.42
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Apr 18 - 04 Apr 18
Comments: pilot hole for potential PB. Yields not great 1-4 L/s.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 40.0	EWMWW04	DR	200		EASTERNWELL	MRC1
40.0 - 199.0	EWMWW04	CH	200		EASTERNWELL	MRC1, RF2

TOC RL: 650.96 - (drilled) SWL: 80.00 MBGL (04 Apr 18) Dev: N Final pH: -
TOC RL: 650.96 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	N1	JC	S			MINERALISED BIF, (N1), Grey and Yellow, Fresh, Strong Rock.					BLANK PVC: 48mm (0.00-109.00) GRAVEL MED (2.00-199.00)
110			JC				MINERALISED BIF, (N1), Grey and Yellow and brown, Fresh, Strong Rock. 106-108m Fibrous material (follow procedure)					SLOTTED PVC: 48mm , Slots 1mm (109.00-199.00)
120		MM	J	4D			MINERALISED BIF, (MM), Grey and Red, Fresh, Strong Rock. 110m Dolomite/Dolomitic shale					LEVELTROLL(120.00) ID: 2046
130			J4	DS			MINERALISED BIF, (MM), Grey and Dark or Black, Fresh, Strong Rock.					
140			4	D			DOLOMITE, (MM), Dark or Black and Grey, Fresh, Strong Rock.					
150		MU	4D	S			DOLOMITE, (MU), Grey and Green, Fresh, Strong Rock. From 152m magnetic increase (1m samples)					
160			D	J			DOLOMITE, (MU), Grey and Green, Fresh, Strong Rock.					
170			4	DJ			DOLOMITE, (MU), Grey and Green, Fresh, Strong Rock.					
180			D	J4			DOLOMITE, (MU), Grey and Green and blue, Fresh, Strong Rock. slow penetration. magnetic portion					
190			MD	J4			DOLOMITE, (MU), Grey and Green and red, Fresh, Strong Rock. rounded red/yellow chips 2-15mm (90-91m & 94-95m, geothite?shale?). Trace pyrite and Q (190-192m).					
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0070	Hole Length:	190.00

Easting: 708044.22
Northing: 7463572.19
Surface RL: 635.65
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 Apr 18 - 29 Apr 18
Comments: Production bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	450		EASTERNWELL	MRC1
110.0 - 190.0	EWMWW04	CH	425		EASTERNWELL	MRC1, RF2

License: CAW183161

TOC RL: 636.19 - (drilled) SWL: 50.00 MBGL (18 Apr 18) Dev: Y: 25.0 hour(s) Final pH: 8.2
TOC RL: 617.63 - (current) Is Live: Y (-) Date: 27 Apr 2018 Final EC: 706.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	SZ	Z	JS			COBBLE, gravelly, (QUATERNARY DETRITAL), Red, Extremely Weathered, Very Stiff, Gap graded, Sub-angular.					GROUT (0.00-2.00)
10		TD3	HX	JG			QUATERNARY DETRITAL, (TD3), Red, Moderately Weathered, Strong Rock.					BLANK STEEL: 356mm (0.00-79.00)
20												GRAVEL MED (2.00-189.00)
30												
40							CLAY, gravelly, (QUATERNARY DETRITAL), Yellow and Light or White, Extremely Weathered, Very Stiff, Poorly graded, Angular.					
50	UG	TD2	GK	X			CLAY, trace gravel, (QUATERNARY DETRITAL), Yellow and Light or White, Extremely Weathered, Very Stiff, Poorly graded, Angular.					
60			K	G			CLAY, gravelly, (QUATERNARY DETRITAL), Light or White and Dark or Black, Extremely Weathered, Very Stiff, Gap graded, Angular. driller tried conventional hammer without DR but little to no progress. Continued DR - Slow penetration					
70			K	GS			SHALE, (WA2), Dark or Black and Brown and yellow, Highly Weathered, Strong Rock. Slow penetration rate					
80	MG	WA2	N	S			SHALE, (WA2), Dark or Black and Grey and yellow, Highly Weathered, Strong Rock.					S/S SCREEN: 356mm , Slots 1mm: 18 lengths (79.00-187.00)
90			N	SG			SHALE, (WA2), Dark or Black and Yellow and brown, Highly Weathered, Strong Rock.					
100							GRAVEL, (SHALE), Yellow and Grey and brown, Extremely Weathered, Very Stiff, Gap graded, Angular.					
			N	G			SHALE, (WA2), Brown and Yellow and grey, Highly Weathered, Strong Rock.					
	MG		G	SN			SHALE, (WA2), Brown and Yellow and light or white, Highly Weathered, Strong Rock.					
			D	G								
			S	GN								

0 100 200 | 0-5000 | 0-14 | 0-50

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0070	Hole Length:	190.00

Easting: 708044.22
Northing: 7463572.19
Surface RL: 635.65
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 Apr 18 - 29 Apr 18
Comments: Production bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	450		EASTERNWELL	MRC1
110.0 - 190.0	EWMWW04	CH	425		EASTERNWELL	MRC1, RF2

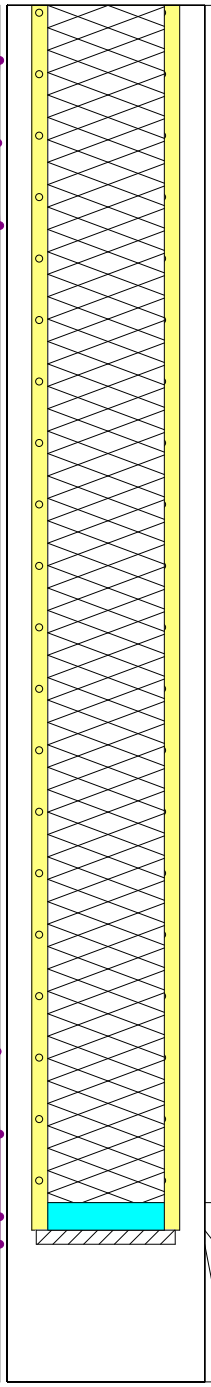
License: CAW183161

TOC RL: 636.19 - (drilled) SWL: 50.00 MBGL (18 Apr 18) Dev: Y: 25.0 hour(s) Final pH: 8.2
TOC RL: 617.63 - (current) Is Live: Y (-) Date: 27 Apr 2018 Final EC: 706.00

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description
100	MG	WA2	S	GN		SHALE, (WA2), Brown and Yellow and light or white, Highly Weathered, Strong Rock.
	MG		G	SN		SHALE, (WA2), Yellow and Brown and light or white, Extremely Weathered, Strong Rock. Slow penetration rate.
110	MG	WA1	SG	J		GRAVEL, (SHALE), Yellow and Brown and red, Extremely Weathered, Very Stiff, Gap graded, Angular.
	MG		G	SJ		PARTIALLY MINERALISED, (WA1), Yellow and Dark or Black, Slightly Weathered, Strong Rock.
120	MG	N3	G	JC		PARTIALLY MINERALISED, (N3), Yellow and Dark or Black, Slightly Weathered, Strong Rock.
130	MG					
140	MG					
150	MG					
160	MG	N2	GL	CJ		PARTIALLY MINERALISED, (N2), Brown and Yellow, Slightly Weathered, Strong Rock. Progressively getting harder, slower drilling from 170m and more magnetic towards end. Red shale band @ 176m
170	MG					
180	MG	N1	JC	G		UNMINERALISED BIF, (N1), Brown, Slightly Weathered, Strong Rock. Magnetic, clear banded BIF pieces, opaque cherts
190			JC			UNMINERALISED BIF, (N1), Grey and Blue, Fresh, Strong Rock. Very fresh and magnetic, didn"t intersect fibrous but would have been close.
200						

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Diagram Scaled to 600mm



Notes:
GRAVEL MED (2.00-189.00)
S/S SCREEN: 356mm , Slots 1mm: 18 lengths (79.00-187.00)
BLANK STEEL: 356mm (187.00-189.00)
END CAP (189.00)
FALLBACK (189.00-190.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0071	Hole Length:	190.00

Easting: 706982.74
Northing: 7463694.09
Surface RL: 643.89
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 May 18 - 15 May 18
Comments: Pilot bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 118.0	EWMWW04	DR	250		EASTERNWELL	MM9
118.0 - 190.0	EWMWW04	DR	200		EASTERNWELL	MM9

TOC RL: 644.61 - (drilled) SWL: 60.00 MBGL (15 May 18) Dev: N Final pH: -
TOC RL: 644.96 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	SZ	ZC	K			GRAVEL, clayey, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Stiff, Poorly graded, Sub-rounded.					AB FOAM (0.00-2.00)
10		TD3	Z	K			GRAVEL, clayey, (QUATERNARY DETRITAL), Red and Grey, Transported, Very Stiff, Poorly graded, Sub-rounded. Contains a lot of pisolite, magnetic.					BLANK PVC: Size 50 - Class 25 (0.00-109.00)
20												GRAVEL AGG (2.00-189.00)
30												
40			Z3	K			CLAY, gravelly, (QUATERNARY DETRITAL), Light or White and Yellow, Transported, Very Stiff, Poorly graded, Sub-angular. Calcrete. White and yellow clays.					
50												
60		TD2	L	G			MINERALISED BIF, (TD2), Yellow, Highly Weathered, Extremely Weak Rock. Limonite clays with goethite fragments. Dark yellow sample.					
70		WA2	J	C			LEACHED BIF, (WA2), Light or White and Yellow and grey, Highly Weathered, Extremely Weak Rock. Highly weathered BIF. Clays at 82-84m.					
80												
90							PARTIALLY MINERALISED, (WA2), Grey and Yellow, Moderately Weathered, Medium Strong Rock. Moderately weathered BIF and shales.					
100			JC	S								LEVELTROLL(100.00) ID: 1505
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0071	Hole Length:	190.00

Easting: 706982.74
Northing: 7463694.09
Surface RL: 643.89
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 May 18 - 15 May 18
Comments: Pilot bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 118.0	EWMWW04	DR	250		EASTERNWELL	MM9
118.0 - 190.0	EWMWW04	DR	200		EASTERNWELL	MM9

TOC RL: 644.61 - (drilled) SWL: 60.00 MBGL (15 May 18) Dev: N Final pH: -
TOC RL: 644.96 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	WA2	JC	S			PARTIALLY MINERALISED, (WA2), Grey and Yellow, Moderately Weathered, Medium Strong Rock. Moderately weathered BIF and shales.					BLANK PVC: Size 50 - Class 25 (0.00-109.00)
110		N3	SK	J			SHALE, (N3), Light or White and Yellow, Highly Weathered, Very Weak Rock. Base shale unit of WA2					GRAVEL AGG (2.00-189.00)
120			JC	D			DOLOMITE, (N3), Grey and Red and light or white, Moderately Weathered, Medium Strong Rock. Dolomite.					
130		N2	JC				PARTIALLY MINERALISED, (N2), Grey and Brown and red, Moderately Weathered, Medium Strong Rock. BIF weakly magnetic. Soft zone with red clay at 170-171m approximately. Shale band?					
140												
150												
160												
170												
180		N1	JC				UNMINERALISED BIF, (N1), Dark or Black and Green, Slightly Weathered, Strong Rock. Strongly magnetic BIF / chert with some pyrite.					
190												LEVELTROLL(100.00) ID: 1505
200						0 100 200		0-5000	0-14	0-50		SLOTTED PVC: Size 50 - Class 25, Slots 1mm (109.00-189.00) FALLBACK (189.00-190.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0074	Hole Length:	202.00

Easting: 707142.19
Northing: 7463717.33
Surface RL: 642.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Jul 18 - 30 Jul 18
Comments: Ex Pit Production bore.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	KKR
80.0 - 134.0	EWMWW04	DR	450		EASTERNWELL	KS6
134.0 - 202.0	EWMWW04	CH	450		EASTERNWELL	KKR

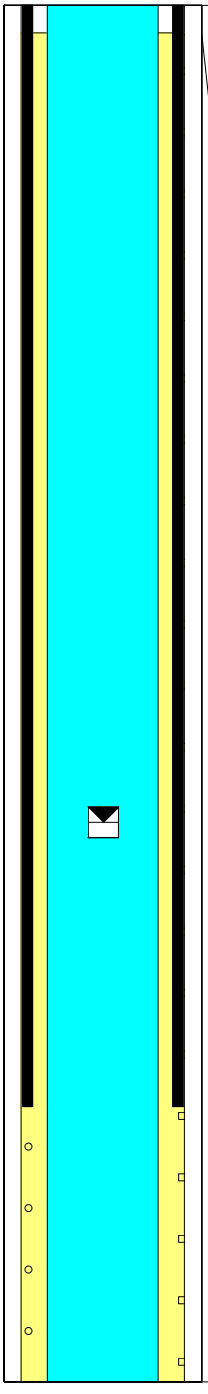
License: CAW183161

TOC RL: 642.54 (Stickup 0.33m) (drilled) SWL: 59.34 MBTOC (30 Jul 18) Dev: N Final pH: -
TOC RL: 642.54 (Stickup 0.33m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Hydrogeological Description
0	MG	TD1	Z		GRAVEL, cobbled, (CONGLOMERATE), Red and Brown, Extremely Weathered, Stiff, Gap graded, Sub-angular. Pisolitic
10		TD3	Z	X	SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Poorly graded, Sub-angular. Pisolitic
20			ZX	I	GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Uniform, Rounded. Pisolitic
30					
40			Z	XI	GRAVEL, clayey, trace silt, (QUATERNARY DETRITAL), Red and Brown and light or white, Transported, Stiff, Poorly graded, Sub-rounded. Calcrete rich
50		TD2	Z3		GRAVEL, silty, trace clay, (CALCRETE), Light or White and Yellow, Soil, Stiff, Uniform, Sub-angular. Calcrete rich
60			ZK	3	CLAY, gravelly, trace silt, (CLAY), Yellow and Grey, Soil, Soft, Poorly graded, Sub-rounded. Calcrete rich
70			Z	KW	GRAVEL AND CLAY, trace silt, (QUATERNARY DETRITAL), Yellow and Dark or Black, Transported, Very Stiff, Poorly graded, Sub-angular.
80	BG	WA2	D		GRAVEL, trace clay, (DOLOMITE), Grey and Yellow and red, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. 92-96m Fracture zone, high watere discharge rate (+30 l/s)
90					
100					

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Diagram Scaled to 600mm



Notes:
AB FOAM (0.00-2.00)
BLANK STEEL: Size 20" - W.T.9.53mm (0.00-80.00)
BLANK STEEL: Size 14" - W.T.9.53mm (0.00-118.00)
GRAVEL MED: Medium grade (2.00-202.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0074	Hole Length:	202.00

Easting: 707142.19
Northing: 7463717.33
Surface RL: 642.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Jul 18 - 30 Jul 18
Comments: Ex Pit Production bore.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	KKR
80.0 - 134.0	EWMWW04	DR	450		EASTERNWELL	KS6
134.0 - 202.0	EWMWW04	CH	450		EASTERNWELL	KKR

License: CAW183161

TOC RL: 642.54 (Stickup 0.33m) (drilled) SWL: 59.34 MBTOC (30 Jul 18) Dev: N Final pH: -
TOC RL: 642.54 (Stickup 0.33m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Hydrogeological Description	Notes
100	BG	WA2	D		GRAVEL, trace clay, (DOLOMITE), Grey and Yellow and red, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. 92-96m Fracture zone, high watere discharge rate (+30 l/s)	BLANK STEEL: Size 14" - W.T.9.53mm (0.00-118.00) GRAVEL MED: Medium grade (2.00-202.00)
110			D	S	GRAVEL, sandy, (DOLOMITE), Yellow and Grey and brown, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. 106-112m fracture zone, high water discharge rate(+30 l/s)	
120	MG	WA1	S		GRAVEL, trace sand, (SHALE), Dark or Black and Brown and red, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. Shaley, dark, red, brown. 50 L/s flow rate.	W/W STEEL: Size 14" - W.T.9.53mm, Slots 1mm (118.00-202.00)
			S	K	GRAVEL AND COBBLE, clayey, (SHALE), Yellow and Red and brown, Extremely Weathered, Stiff, Poorly graded, Sub-rounded. 122m-128m fractured - cobble size. Yellow, Red, Brown. 80+ L/s flow rate.	
130	BG	N3	J	GK	GRAVEL, cobbled, (UNMINERALISED BIF), Yellow and Brown, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. 128M Fractured. Yellow, brown. 90 L/s flow rate	
			J	GCK	GRAVEL, cobbled, (UNMINERALISED BIF), Yellow and Dark or Black, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. 136m fractured - Cobbles, Water flow 75 L/s. Yellow, brown, dark. Intermitent clay, chert/ geothised chert percentage varies from 5 to 20%.	
140			J	CG1	UNMINERALISED BIF, (N3), Yellow and Dark or Black, Moderately Weathered, Strong Rock. Water flow 75 L/s, Yellow, Brown. 142-144m chert/geothised chert 15-20%. Clay intermitent. minor magnetic.	
150						
160	MG	N2	J	GK	UNMINERALISED BIF, (N2), Yellow and Dark or Black, Moderately Weathered, Strong Rock. Water flow >80 L/s. Yellow, Dark. Trace amounts of chert. Minor fractured 158 to 162m.	
170						
180						
190						
200						

Log: Gamma CPS API (0 100 200)
EC us/cm (0-5000) pH (0-14) Yield L/s (0-50)
Diagram Scaled to 600mm

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0074	Hole Length:	202.00

Easting: 707142.19
Northing: 7463717.33
Surface RL: 642.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Jul 18 - 30 Jul 18
Comments: Ex Pit Production bore.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	KKR
80.0 - 134.0	EWMWW04	DR	450		EASTERNWELL	KS6
134.0 - 202.0	EWMWW04	CH	450		EASTERNWELL	KKR

License: CAW183161

TOC RL: 642.54 (Stickup 0.33m) (drilled) SWL: 59.34 MBTOC (30 Jul 18) Dev: N Final pH: -
TOC RL: 642.54 (Stickup 0.33m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200	MG	N2	J	GK			UNMINERALISED BIF, (N2), Yellow and Dark or Black, Moderately Weathered, Strong Rock. Water flow >80 L/s. Yellow, Dark. Trace amounts of chert. Minor fractured 158 to 162m.					GRAVEL MED: Medium grade (2.00-202.00) W/W STEEL: Size 14" - W.T.9.53mm, Slots 1mm (118.00-202.00)
210												
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

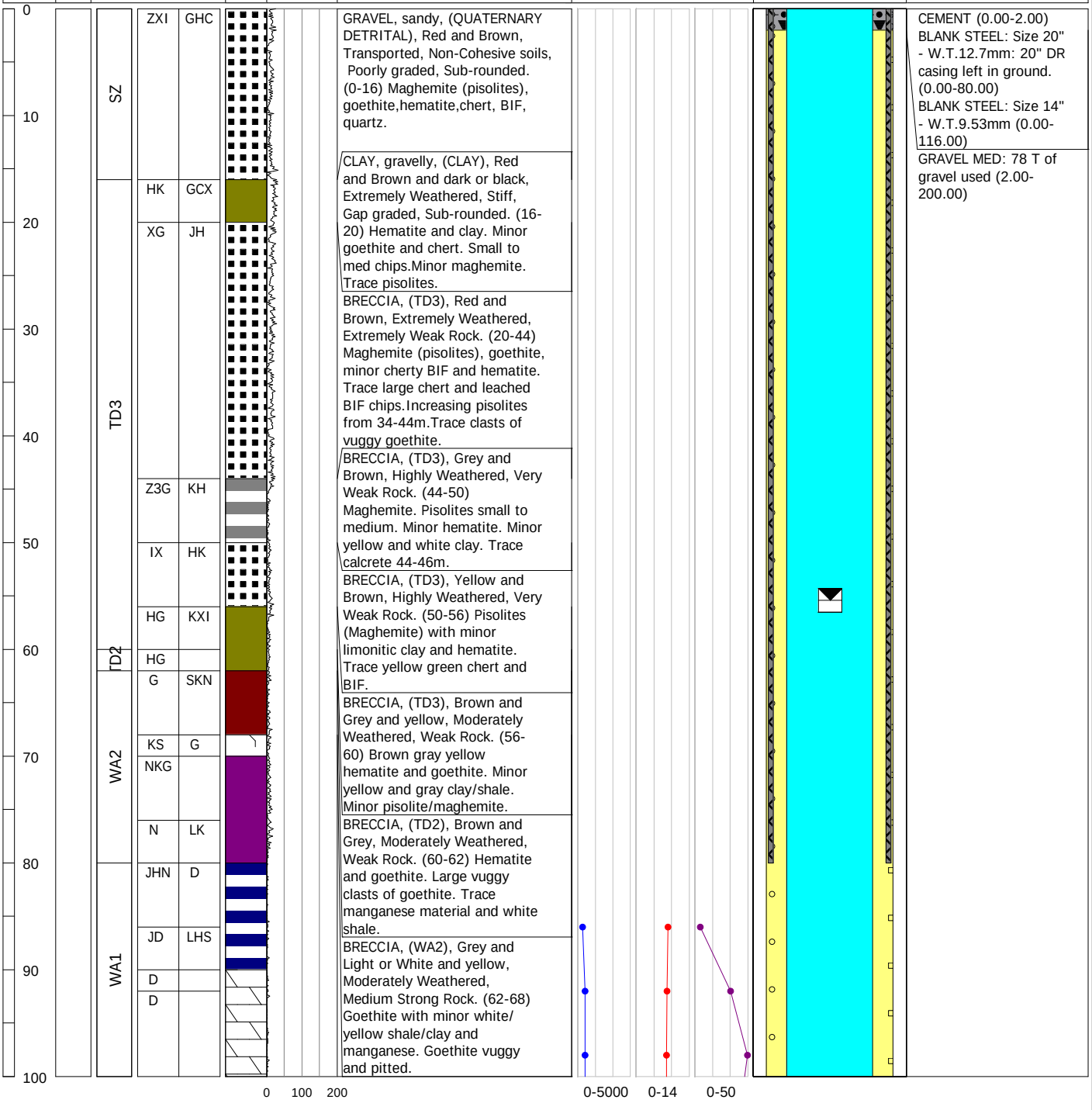
Project: NORTH FLANK | Hole Name: HGA0077 | Hole Length: 200.00

Easting: 707511.19
Northing: 7463704.92
Surface RL: 640.10
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Jun 18 - 27 Jun 18
License: CAW183161

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	MRC1
80.0 - 150.0	EWMWW04	DR	450		EASTERNWELL	KKR
150.0 - 200.0	EWMWW04	CH	450		EASTERNWELL	KKR

Comments: Production bore drilled as replacement due to failure of HGA0072. Drilled to 200m, 196 to 200m very ...

TOC RL: 640.59 - (drilled) SWL: 55.40 MBGL (27 Jun 18) Dev: N Final pH: 8.3
TOC RL: 640.59 - (current) Is Live: Y (-) Date: 27 Jun 2018 Final EC: 655.00



BHPIO - Hydrogeology Log

BHP

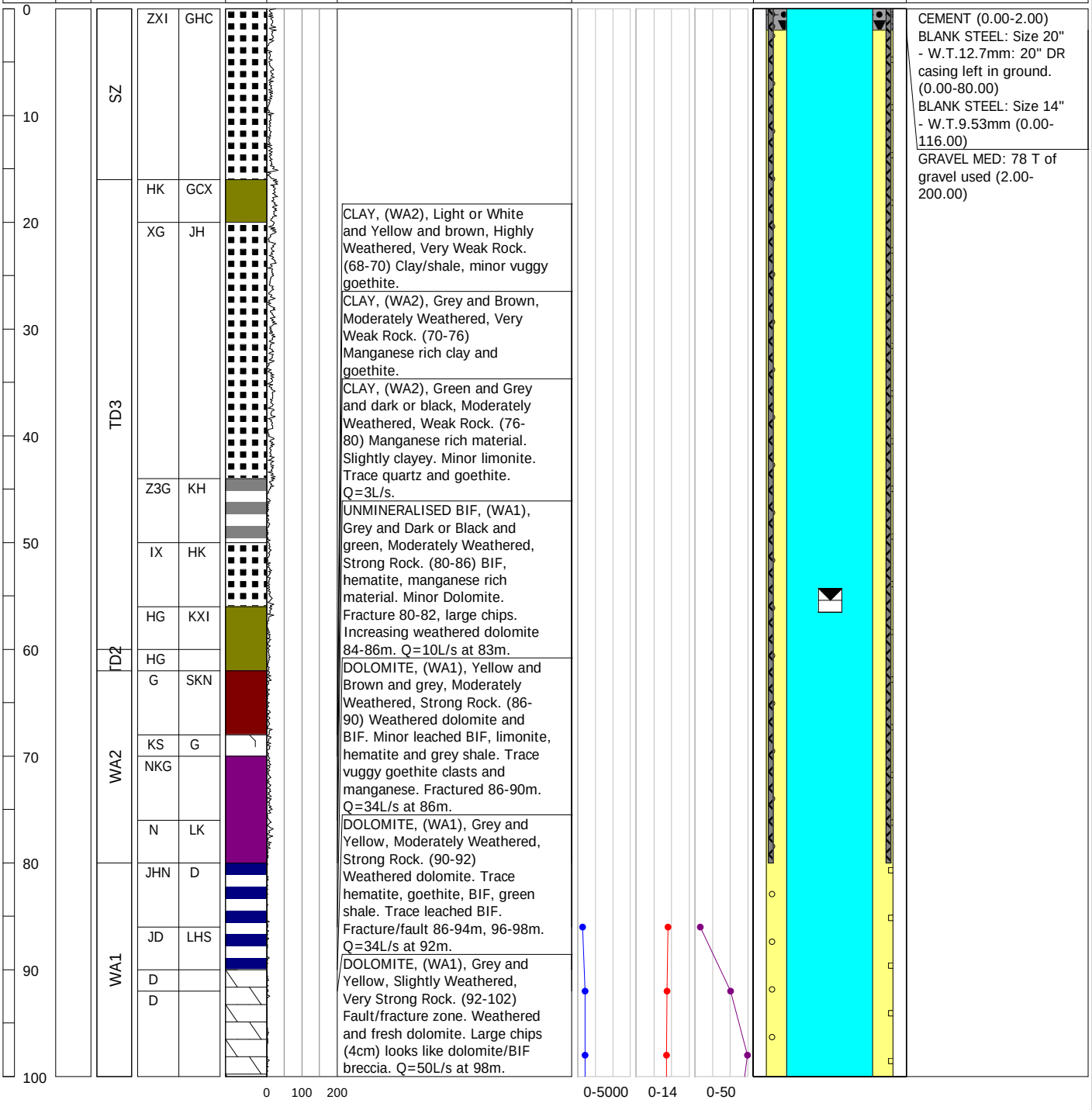
Project:	NORTH FLANK	Hole Name:	HGA0077	Hole Length:	200.00

Easting: 707511.19
Northing: 7463704.92
Surface RL: 640.10
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Jun 18 - 27 Jun 18
License: CAW183161

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	MRC1
80.0 - 150.0	EWMWW04	DR	450		EASTERNWELL	KKR
150.0 - 200.0	EWMWW04	CH	450		EASTERNWELL	KKR

Comments: Production bore drilled as replacement due to failure of HGA0072. Drilled to 200m, 196 to 200m very ...

TOC RL: 640.59 - (drilled) SWL: 55.40 MBGL (27 Jun 18) Dev: N Final pH: 8.3
TOC RL: 640.59 - (current) Is Live: Y (-) Date: 27 Jun 2018 Final EC: 655.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0077	Hole Length:	200.00

Easting: 707511.19
Northing: 7463704.92
Surface RL: 640.10
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Jun 18 - 27 Jun 18
License: CAW183161

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	MRC1
80.0 - 150.0	EWMWW04	DR	450		EASTERNWELL	KKR
150.0 - 200.0	EWMWW04	CH	450		EASTERNWELL	KKR

Comments: Production bore drilled as replacement due to failure of HGA0072. Drilled to 200m, 196 to 200m very ...

TOC RL:	640.59	-	(drilled)	SWL:	55.40 MBGL	(27 Jun 18)	Dev:	N	Final pH: 8.3
TOC RL:	640.59	-	(current)	Is Live:	Y	(-)	Date:	27 Jun 2018	Final EC: 655.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		WA1	D				DOLOMITE, (WA1), Grey and Yellow, Slightly Weathered, Very Strong Rock. (92-102) Fault/fracture zone. Weathered and fresh dolomite. Large chips (4cm) looks like dolomite/BIF breccia. Q=50L/s at 98m.					BLANK STEEL: Size 14" - W.T.9.53mm (0.00-116.00)
110			D	JS			DOLOMITE, (WA1), Grey and Light or White, Slightly Weathered, Very Strong Rock. (102-104) Fractured. Fresh dolomite. Minor leached BIF, white shale/clay. Trace vuggy limonite. Q=60L/s).					GRAVEL MED: 78 T of gravel used (2.00-200.00)
120			D	J			DOLOMITE, (WA1), Yellow and Grey, Slightly Weathered, Very Strong Rock. (104-122) Dolomite and leached BIF. Minor limonite and quartz. Limonitic staining on surfaces. Some vuggy and brecciated chips. Possibple fracture.					S/S SCREEN: Size 14" - W.T.9.53mm, Slots 2mm (116.00-200.00)
130		N3	D				DOLOMITE, (WA1), Brown and Dark or Black, Fresh, Very Strong Rock. (122-126) Weathered dolomite. Grainy texture. Yield increased to 70L/s.					
140			J	LKC			UNMINERALISED BIF, (N3), Light or White and Brown, Slightly Weathered, Strong Rock. (126-128) Leached BIF. Minor limonite, red shale, black chert. Vuggy texture. Possible fracture. Q=60L/s.					
150			JC	L			UNMINERALISED BIF, (N3), Yellow and Brown and grey, Slightly Weathered, Very Strong Rock. (128-150) Weathered BIF and chert. Minor red chert. Minor red/purple shale, limonite, trace goethite . Fractured 132-134m, 136-138m, chips up to 5cm. Q=73L/s at 134m.					
160			JC	GL			UNMINERALISED BIF, (N2), Grey and Yellow and brown, Fresh, Very Strong Rock. (150-170) Unmineralised cherty BIF. Minor leached BIF and goethite. Increasing chert and limonite with depth. Fracture 168-170m. Minor to trace red/purple/white shale and quartz. Q @164m = 58L/s, 170m = 58L/s.					
170		N2	J	C								
180												
190												
200			JC									END CAP (200.00)
						0 100 200		0-5000		0-14	0-50	

BHPIO - Hydrogeology Log

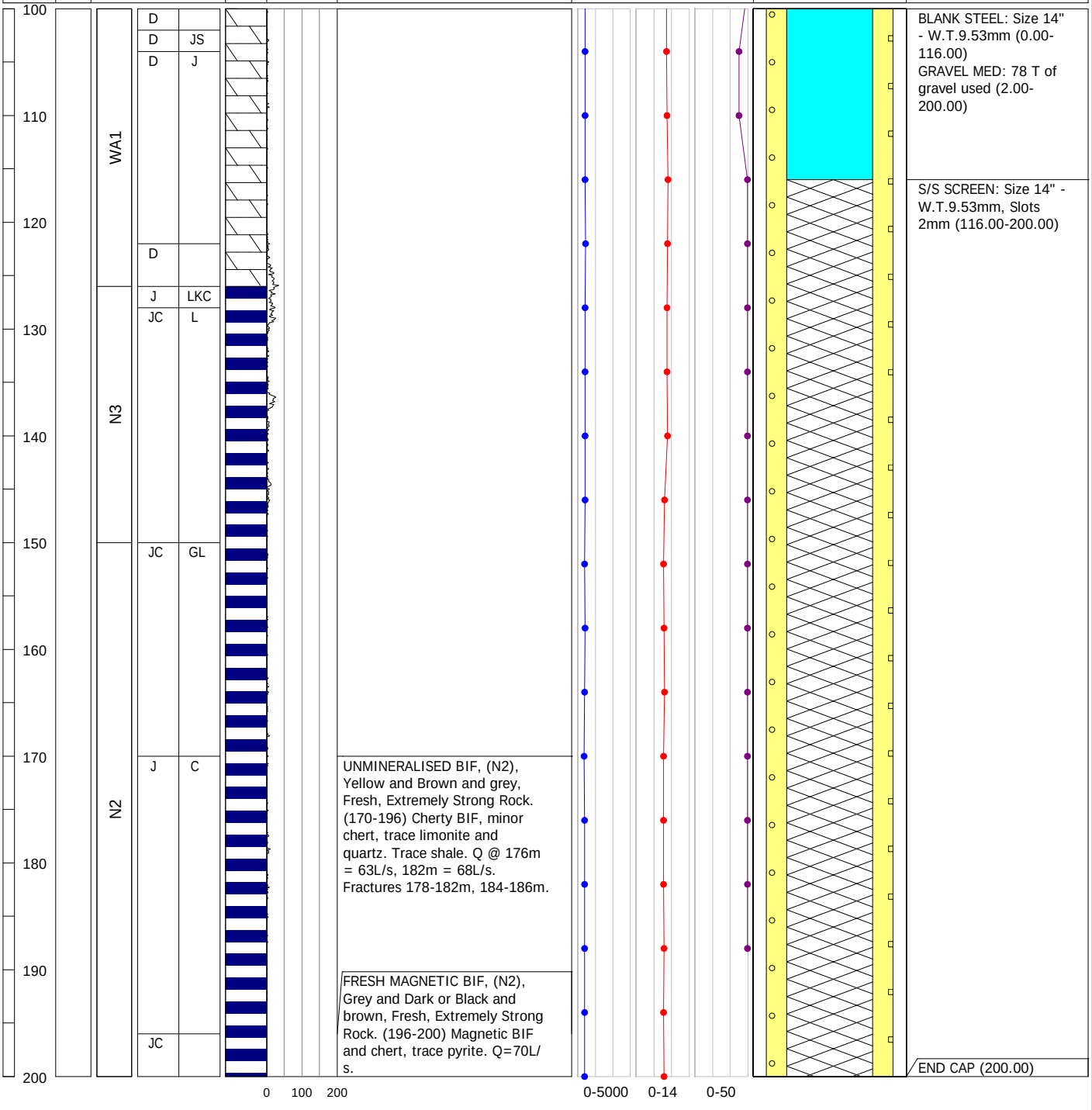
BHP

Project:	NORTH FLANK	Hole Name:	HGA0077	Hole Length:	200.00

Easting: 707511.19
Northing: 7463704.92
Surface RL: 640.10
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Jun 18 - 27 Jun 18
License: CAW183161
Comments: Production bore drilled as replacement due to failure of HGA0072. Drilled to 200m, 196 to 200m very ...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	EWMWW04	DR	500		EASTERNWELL	MRC1
80.0 - 150.0	EWMWW04	DR	450		EASTERNWELL	KKR
150.0 - 200.0	EWMWW04	CH	450		EASTERNWELL	KKR

TOC RL: 640.59 - (drilled) SWL: 55.40 MBGL (27 Jun 18) Dev: N Final pH: 8.3
TOC RL: 640.59 - (current) Is Live: Y (-) Date: 27 Jun 2018 Final EC: 655.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0079	Hole Length:	132.00

Easting: 708110.46
Northing: 7463331.32
Surface RL: 580.96
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 26 Aug 21 - 26 Aug 21
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 12.0	WLDRIG6	CH	300		WELLDRILL	MC9
12.0 - 132.0	WLDRIG6	CH	200		WELLDRILL	MC9

TOC RL: 581.80 (Stickup 0.83m) (drilled) SWL: 60.01 MBTOC (29 Aug 21) Dev: N Final pH: -
TOC RL: 581.80 (Stickup 0.83m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	WA2	T	HG			MINERALISED BIF, (WA2), Red and Brown, Highly Weathered, Very Weak Rock. No Water. 2-15mm subrounded to rounded chips, smooth clay texture, very shaley.Driller reports soft ground					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-94.00)
20		WA1	S				SHALE, (WA1), Pink, Extremely Weathered, Extremely Weak Rock. Shale band					
			JG	S			MINERALISED BIF, (WA1), Brown, Moderately Weathered, Medium Strong Rock. No Water. 2-20mm angular chips, evidence of laminations, gritty texture, shaley. Driller reports soft ground					
30		N3	JG	HS			MINERALISED BIF, (N3), Dark or Black and Brown, Slightly Weathered, Strong Rock. No Water. 1-5mm sub angular chips, pitted surfaces, gritty texture. Driller reports soft ground					
60		N2	JG	LS			MINERALISED BIF, (N2), Yellow and Brown, Slightly Weathered, Strong Rock. No Water. 2-10mm angular to subangular chips,evidence of laminations. Driller reports soft ground					
70		N1	JC	G			UNMINERALISED BIF, (N1), Grey, Slightly Weathered, Very Strong Rock. No Water. 2-10mm angular chips high chert content. Some (limited) reactivity with HCl. Driller reports hard ground					
90		MM	JC				UNMINERALISED BIF, (MM), Light or White and Grey, Slightly Weathered, Very Strong Rock. No Water. 2-10mm angular chips high chert content. Driller reports hard ground					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (94.00-130.00)
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0079	Hole Length:	132.00

Easting: 708110.46
Northing: 7463331.32
Surface RL: 580.96
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 26 Aug 21 - 26 Aug 21
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 12.0	WLDRIG6	CH	300		WELLDRILL	MC9
12.0 - 132.0	WLDRIG6	CH	200		WELLDRILL	MC9

TOC RL: 581.80 (Stickup 0.83m) (drilled) SWL: 60.01 MBTOC (29 Aug 21) Dev: N Final pH: -
TOC RL: 581.80 (Stickup 0.83m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	MM	JC				UNMINERALISED BIF, (MM), Light or White and Grey, Slightly Weathered, Very Strong Rock. No Water. 2-10mm angular chips high chert content. Driller reports hard ground					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (94.00-130.00)
110												
120			JC	P			UNMINERALISED BIF, (MM), Dark or Black and Grey, Slightly Weathered, Very Strong Rock. No Water. 2-10mm angular chips high chert content. Pyrite nodules, concentration increasing with depth. Driller reports hard ground					
130												END CAP (130.00)
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0084	Hole Length:	116.00

Easting: 708983.96
Northing: 7463099.28
Surface RL: 605.18
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Dec 21 - 16 Dec 21
Comments: Bore canned early due to fibrous material.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	EWMWW04	DR	250		EASTERNWELL	KS6
86.0 - 116.0	EWMWW04	CH	250		EASTERNWELL	KS6

TOC RL: 605.86 (Stickup 0.59m) (drilled) SWL: 76.32 MBTOC (18 Dec 21) Dev: N Final pH: -
TOC RL: 605.86 (Stickup 0.59m) (current) Is Live: N (01 Apr 23) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	TD1	ZY				GRAVEL AND SAND, (SCREE), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Sub-rounded. Detritals					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 25 (0.00-62.00)
30	BG	WA2	GS				MINERALISED BIF, (WA2), Brown and Yellow, Moderately Weathered, Medium Strong Rock. Geothite with shale, some of the shale has been weathered down to clay. Small chips from 2-5mm and large chips from 10-20mm intermixed. Fracture at 36 to 38 mbgl.					
50	SF	WA1	G	C			MINERALISED BIF, (WA1), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Geothite with some minor chert. chip size 8-18mm.					
60		N3	J				MINERALISED BIF, (N3), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Mineralised BIF. chip size 4-8mm with some large chips 15-20mm randomly throughout. small fractures intersected from 79 mbgl.					SLOTTED PVC: Size 50 - Class 25, Slots 1mm (62.00-116.00)
80	HG	N2	J	C			MINERALISED BIF, (N2), Yellow and Brown, Slightly Weathered, Strong Rock. Mineralised BiF with chert. chip size 2-8mm, large fracture at 83-84 mbgl, large chips 84-86 mbgl of 20-25mm. Small fractures throughout sequence. No yield observed.					
90		N1	J				UNMINERALISED BIF, (N1), Dark or Black and Grey, Fresh, Strong Rock. Fresh Magnetic BiF. Angular to sub angular foliated/platey chips sized from 2 to 15mm randomly. Pyrite material observed at ~114 mbgl. Fibrous material intersected at 116 mbgl, hole canned.					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGA0084 | Hole Length: 116.00

Easting: 708983.96
Northing: 7463099.28
Surface RL: 605.18
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Dec 21 - 16 Dec 21
Comments: Bore canned early due to fibrous material.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	EWMWW04	DR	250		EASTERNWELL	KS6
86.0 - 116.0	EWMWW04	CH	250		EASTERNWELL	KS6

TOC RL: 605.86 (Stickup 0.59m) (drilled) SWL: 76.32 MBTOC (18 Dec 21) Dev: N Final pH: -
TOC RL: 605.86 (Stickup 0.59m) (current) Is Live: N (01 Apr 23) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	HG	N1	J				UNMINERALISED BIF, (N1), Dark or Black and Grey, Fresh, Strong Rock. Fresh Magnetic BiF. Angular to sub angular foliated/platey chips sized from 2 to 15mm randomly. Pyrite material observed at ~114 mbgl. Fibrous material intersected at 116 mbgl, hole canned.					SLOTTED PVC: Size 50 - Class 25, Slots 1mm (62.00-116.00)
110												
116												END CAP (116.00)
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGA0087	Hole Length:	206.00

Easting: 708467.44
Northing: 7463763.05
Surface RL: 637.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Dec 21 - 11 Dec 21
License: CAW205346
Comments: Bore could not be developed. Air venting to surface reducing volume and not being able to dispalce w...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 104.0	EWMWW04	DR	500		EASTERNWELL	KS6
104.0 - 206.0	EWMWW04	CH	500		EASTERNWELL	KS6

TOC RL: 637.44 (Stickup 0.30m) (drilled) SWL: 122.31 MBTOC (12 Dec 21) Dev: N Final pH: -
TOC RL: 637.44 (Stickup 0.30m) (current) Is Live: Y (-) Date: 11 Dec 2021 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	SF	TD3	ZH				GRAVEL, (SCREE), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Detritals.					GROUT: Surface Seal (0.00-2.00)
30	HG	CA2	Z3				GRAVEL, (CALCRETE), Light or White, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Calcrete, sub-angular to angular chips. 8 to 25mm in size.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-128.00)
40	SF	TD2	Z3				GRAVEL, (CALCRETE), Light or White, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Calcrete, sub-angular to angular chips. 8 to 25mm in size.					GRAVEL MED (2.00-206.00)
50			Z3G	H			GRAVEL, (VUGHY BRECCIA), Brown and Dark or Black, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Detritals, chips size 1-5mm.					
80	HG	OB	D				DOLOMITE, (OB), Grey and Light or White, Slightly Weathered, Strong Rock. Dolomite, slightly weathered to fresh. chip size 5 to 18mm. some chips show signs of leaching. No sample return from 142mbgl, logging via model.					
100	CV											

0 100 200 (Gamma CPS API) 0-5000 (EC us/cm) 0-14 (pH) 0-50 (Yield L/s)

BHPIO - Hydrogeology Log

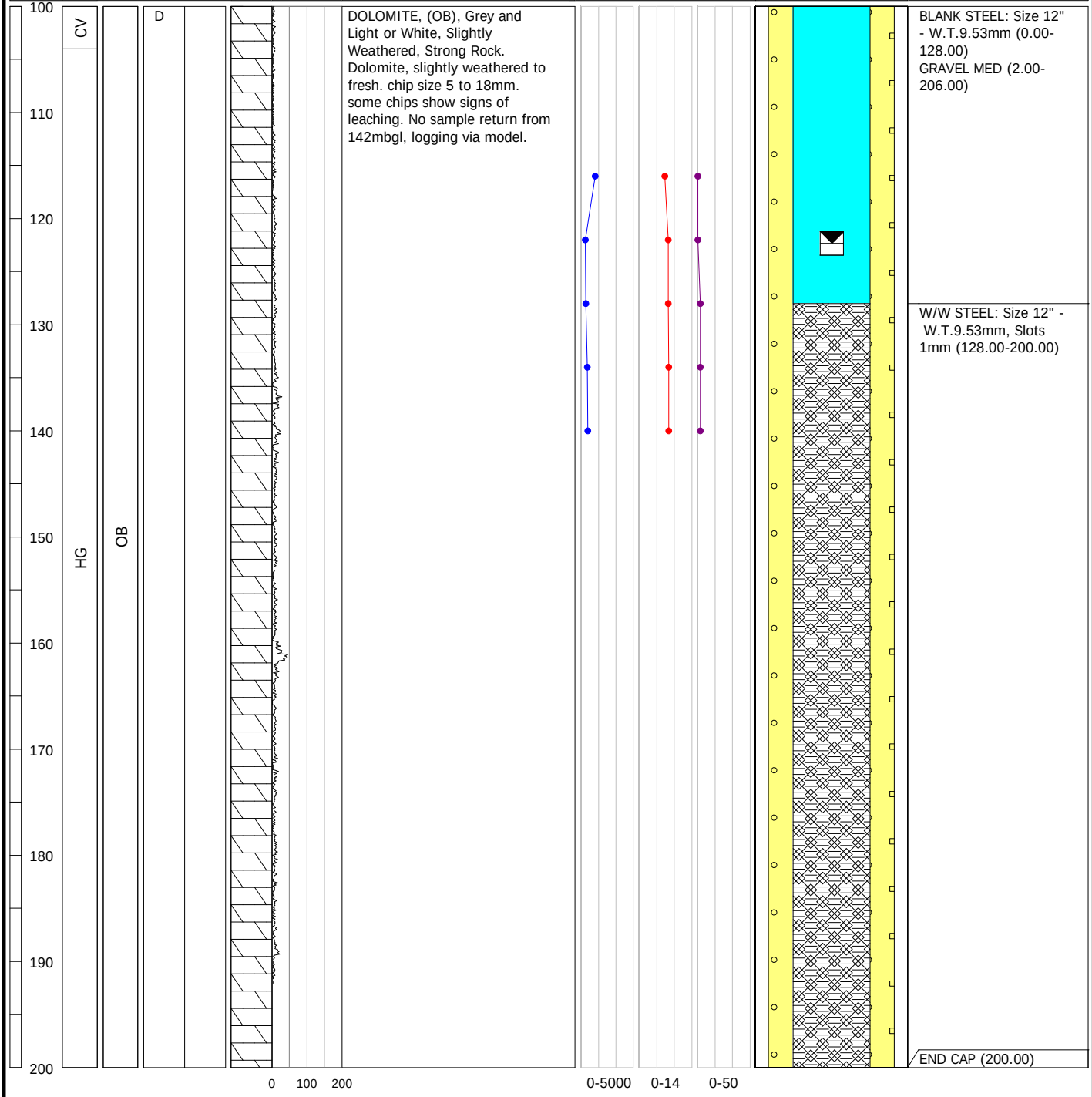
Project: NORTH FLANK **Hole Name:** HGA0087 **Hole Length:** 206.00

Easting: 708467.44
Northing: 7463763.05
Surface RL: 637.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Dec 21 - 11 Dec 21
License: CAW205346
Comments: Bore could not be developed. Air venting to surface reducing volume and not being able to dispalce w...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 104.0	EWMWW04	DR	500		EASTERNWELL	KS6
104.0 - 206.0	EWMWW04	CH	500		EASTERNWELL	KS6

TOC RL: 637.44 (Stickup 0.30m) (drilled) SWL: 122.31 MBTOC (12 Dec 21) Dev: N Final pH: -
TOC RL: 637.44 (Stickup 0.30m) (current) Is Live: Y (-) Date: 11 Dec 2021 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100–200	CV / HG	OB	D			0 100 200	DOLOMITE, (OB), Grey and Light or White, Slightly Weathered, Strong Rock. Dolomite, slightly weathered to fresh. chip size 5 to 18mm. some chips show signs of leaching. No sample return from 142mbgl, logging via model.	0-5000	0-14	0-50		BLANK STEEL: Size 12" - W.T.9.53mm (0.00-128.00) GRAVEL MED (2.00-206.00) W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (128.00-200.00) END CAP (200.00)



BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGA0087 **Hole Length:** 206.00

Easting: 708467.44
Northing: 7463763.05
Surface RL: 637.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Dec 21 - 11 Dec 21
License: CAW205346
Comments: Bore could not be developed. Air venting to surface reducing volume and not being able to dispalce w...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 104.0	EWMWW04	DR	500		EASTERNWELL	KS6
104.0 - 206.0	EWMWW04	CH	500		EASTERNWELL	KS6

TOC RL: 637.44 (Stickup 0.30m) (drilled) SWL: 122.31 MBTOC (12 Dec 21) Dev: N Final pH: -
TOC RL: 637.44 (Stickup 0.30m) (current) Is Live: Y (-) Date: 11 Dec 2021 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200	HG	OB	D				DOLOMITE, (OB), Grey and Light or White, Slightly Weathered, Strong Rock. Dolomite, slightly weathered to fresh. chip size 5 to 18mm. some chips show signs of leaching. No sample return from 142mbgl, logging via model.					GRAVEL MED (2.00-206.00)
210												
220												
230												W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (128.00-200.00) END CAP (200.00)
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGB0001	Hole Length:	180.00

Easting: 712188.12
Northing: 7461028.27
Surface RL: 617.04
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 16 - 03 Jun 16
Comments: FY16 MAC Regional

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 180.0	MCYWW06	RHF	140		MCKAY	BM2

TOC RL: 618.11 (Stickup 1.06m) (drilled) SWL: 87.72 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 618.21 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZYX	J			SILT, gravelly and sandy, (QUATERNARY DETRITAL), Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular.					CEMENT (0.00-1.50)
		GS3	ZYX	C								BLANK PVC: 161mm (0.00-3.00)
10			ZYX	K			SILT, gravelly and sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-rounded.					BLANK PVC: Size 50 - Class 18 (0.00-96.00)
		CA2	Z3	XG			SILT, clayey and gravelly, (QUATERNARY DETRITAL), Brown and Red, Transported, Soft, Poorly graded, Sub-rounded.					OPEN HOLE (1.50-57.00)
20							SILT, gravelly and sandy, (CALCRETE), Light or White and Dark or Black, Transported, Stiff, Well graded, Sub-rounded.					
			ZKY	XG								
30		VB2	ZKY	XG			CLAY AND SILT, gravelly, trace sand, (CLAY), Yellow, Extremely Weathered, Firm, Poorly graded, Sub-rounded. Yellow clays.					
			ZG	XN								
			ZYK	XG			CLAY AND SILT, gravelly, trace sand, (CLAY), Yellow, Extremely Weathered, Firm, Poorly graded, Sub-rounded. Yellow clays.					
40			ZG	XN								
			ZG	XN			SILT, gravelly and sandy, (QUATERNARY DETRITAL), Dark or Black and Brown, Transported, Stiff, Well graded, Sub-angular.					
50	CV		ZG	XN								
		OB	D				SILT AND CLAY, gravelly, trace sand, (CLAY), Yellow and Dark or Black, Extremely Weathered, Stiff, Poorly graded, Sub-rounded. Yellow and white clays both present.					GRAVEL MED: Gravel intended to 65 mBGL. Agreed with drillers to use 1 more full bag when gravel was short at 70 MGBL. (57.00-180.00)
60							SAND, silty and gravelly, (QUATERNARY DETRITAL), Dark or Black and Brown, Transported, Stiff, Well graded, Sub-rounded. Steadily increasing manganese colour (purples) and vit. goethite with depth.					
70												
80							SAND, silty and gravelly, (QUATERNARY DETRITAL), Dark or Black and Brown, Transported, Stiff, Well graded, Sub-rounded. Steadily increasing manganese colour (purples) and vit. goethite with depth.					
90												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (96.00-180.00)
100						0 100 200		0-5000	0-14	0-50		LEVELTROLL(97.25) ID: 2143

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGB0001	Hole Length:	180.00

Easting: 712188.12
Northing: 7461028.27
Surface RL: 617.04
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 16 - 03 Jun 16
Comments: FY16 MAC Regional

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 180.0	MCYWW06	RHF	140		MCKAY	BM2

TOC RL: 618.11 (Stickup 1.06m) (drilled) SWL: 87.72 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 618.21 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZYX	J								CEMENT (0.00-1.50)
		GS3	ZYX	C								BLANK PVC: 161mm (0.00-3.00)
			ZYX	K								BLANK PVC: Size 50 - Class 18 (0.00-96.00)
10		CA2	Z3	XG								OPEN HOLE (1.50-57.00)
20												
30		VB2	ZKY	XG								
			ZKY	XG								
			ZG	XN								
			ZYK	XG								
40			ZG	XN								
			ZG	XN								
50	CV		ZG	XN			GRAVEL, trace sand, (QUATERNARY DETRITAL), Dark or Black and Brown, Transported, Stiff, Uniform, Sub-rounded. Very little return at top and bottom otherwise complete loss of return, no water so above WT.					
			D				DOLOMITE, (OB), Grey, Fresh, Medium Strong Rock. Fresh dolomite. Uniform chip size less than 1 cm. Sample bags from 104 to120 look a bit light but appears to be due to drilling rather than ground conditions.					GRAVEL MED: Gravel intended to 65 mBGL. Agreed with drillers to use 1 more full bag when gravel was short at 70 MGBL. (57.00-180.00)
60		OB										
70												
80												
90												
100												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (96.00-180.00)
												LEVELTROLL(97.25) ID: 2143
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGB0001	Hole Length:	180.00

Easting: 712188.12
Northing: 7461028.27
Surface RL: 617.04
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 16 - 03 Jun 16
Comments: FY16 MAC Regional

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 180.0	MCYWW06	RHF	140		MCKAY	BM2

TOC RL: 618.11 (Stickup 1.06m) (drilled) SWL: 87.72 MBTOC (19 Apr 18) Dev: N Final pH: -
TOC RL: 618.21 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		OB	D			0 100 200	DOLOMITE, (OB), Grey, Fresh, Medium Strong Rock. Fresh dolomite. Uniform chip size less than 1 cm. Sample bags from 104 to120 look a bit light but appears to be due to drilling rather than ground conditions.	0-5000	0-14	0-50		GRAVEL MED: Gravel intended to 65 mBGL. Agreed with drillers to use 1 more full bag when gravel was short at 70 MGBL. (57.00-180.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (96.00-180.00) LEVELTROLL(97.25) ID: 2143 END CAP (180.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0011	Hole Length:	168.00

Easting: 703825.61
Northing: 7463552.89
Surface RL: 667.56
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Oct 09 - 17 Oct 09
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 168.0	UNKN				UNKN	UNKN

TOC RL: 668.30 - (drilled) SWL: 88.32 MBTOC (18 Oct 09) Dev: N Final pH: -
TOC RL: 668.48 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes

0 10 20 30 40 50 60 70 80 90 100

0 100 200

0-5000 0-14 0-50

Program: Planned Hole: Page: 99

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0011	Hole Length:	168.00

Easting: 703825.61
Northing: 7463552.89
Surface RL: 667.56
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Oct 09 - 17 Oct 09
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 168.0	UNKN				UNKN	UNKN

TOC RL: 668.30 - (drilled) SWL: 88.32 MBTOC (18 Oct 09) Dev: N Final pH: -
TOC RL: 668.48 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100												LEVELAPP-TEK(122.51) ID: 1574
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

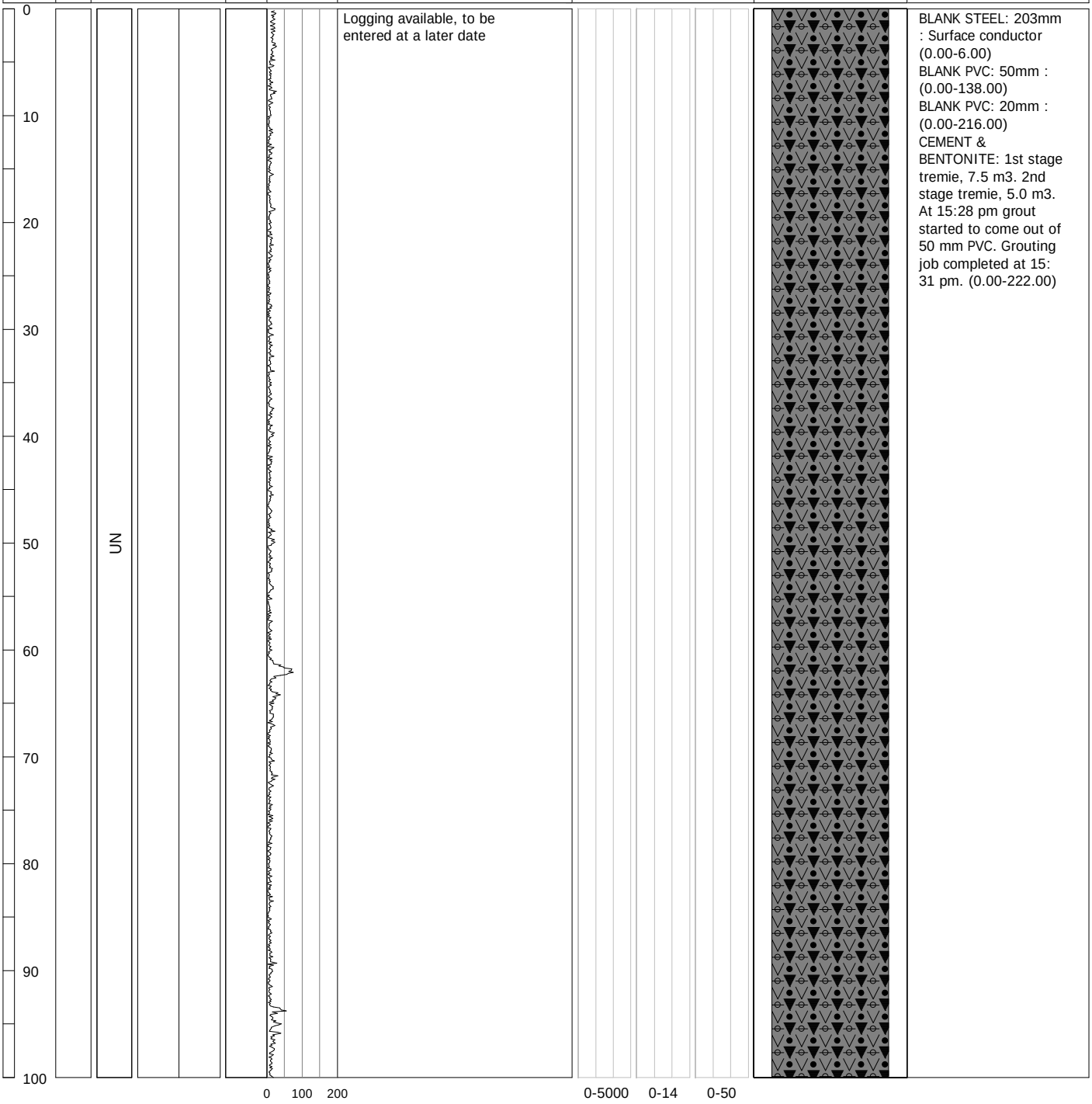
BHP

Project: NORTH FLANK **Hole Name:** HGC0053 **Hole Length:** 222.00

Easting: 703644.94
Northing: 7462882.90
Surface RL: 735.03
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Sep 10 - 29 Sep 10
Comments: Site 1 in original proposal.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	HYD1	CH	305		EASTERNWELL	UNKN
6.0 - 222.0	HYD1	CH	165		EASTERNWELL	UNKN

TOC RL: - - (drilled) SWL: 129.55 MBGL (22 Oct 10) Dev: N Final pH: -
TOC RL: - - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole:

BHPIO - Hydrogeology Log

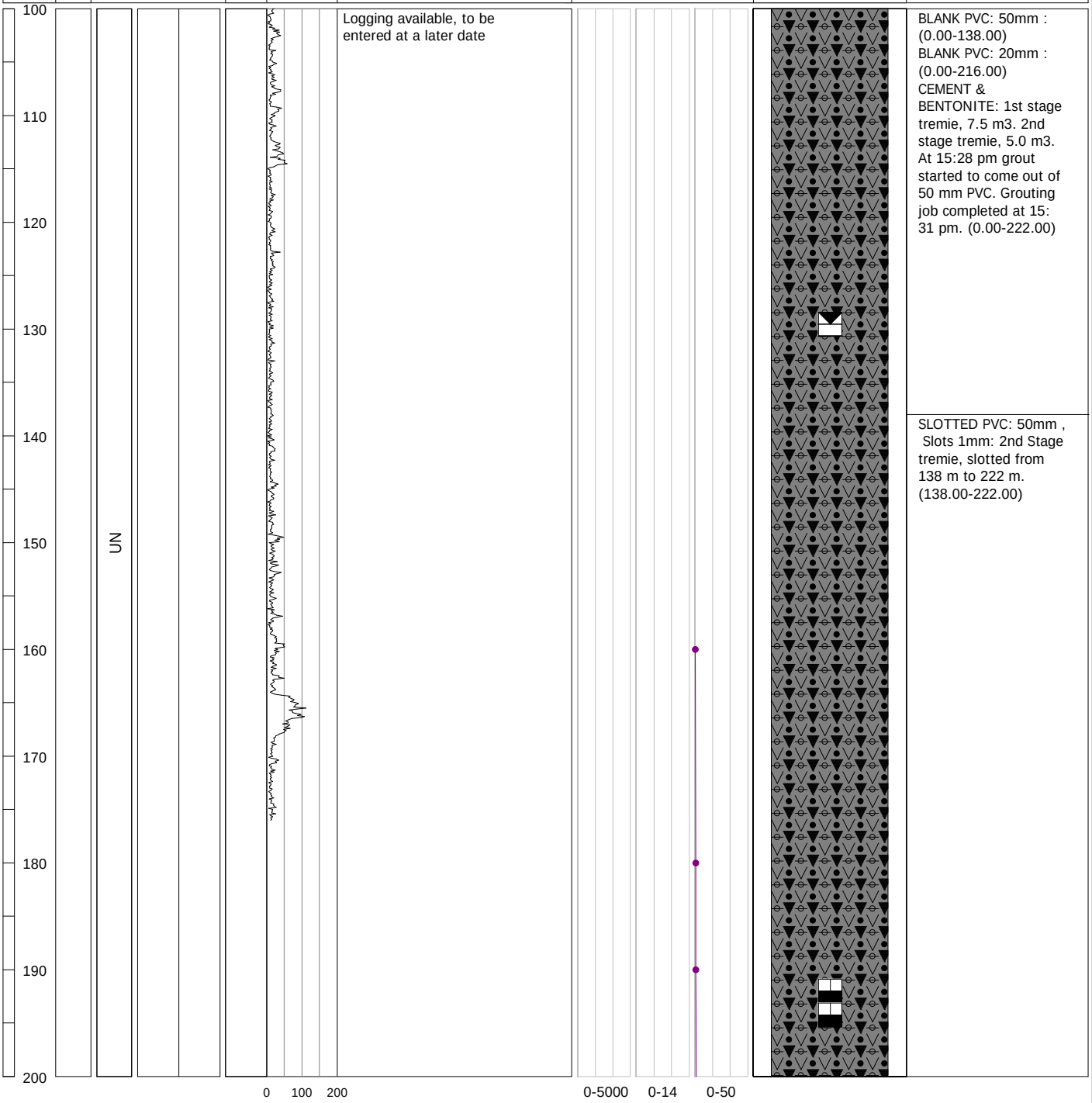
BHP

Project: NORTH FLANK **Hole Name:** HGC0053 **Hole Length:** 222.00

Easting: 703644.94
Northing: 7462882.90
Surface RL: 735.03
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Sep 10 - 29 Sep 10
Comments: Site 1 in original proposal.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	HYD1	CH	305		EASTERNWELL	UNKN
6.0 - 222.0	HYD1	CH	165		EASTERNWELL	UNKN

TOC RL: - - (drilled) SWL: 129.55 MBGL (22 Oct 10) Dev: N Final pH: -
TOC RL: - - (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole: Page: 102

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGC0053 | Hole Length: 222.00

Easting: 703644.94
Northing: 7462882.90
Surface RL: 735.03
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Sep 10 - 29 Sep 10
Comments: Site 1 in original proposal.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	HYD1	CH	305		EASTERNWELL	UNKN
6.0 - 222.0	HYD1	CH	165		EASTERNWELL	UNKN

TOC RL: - - (drilled) SWL: 129.55 MBGL (22 Oct 10) Dev: N Final pH: -
TOC RL: - - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 400mm | Notes

200
210
220
230
240
250
260
270
280
290
300

Strat: UN

Hydrogeological Description: Logging available, to be entered at a later date

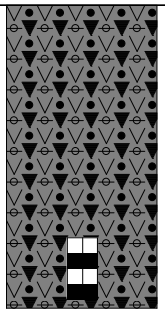
Gamma CPS API: 0 100 200

EC us/cm: 0-5000

pH: 0-14

Yield L/s: 0-50

Diagram Scaled to 400mm



Notes:

BLANK PVC: 20mm : (0.00-216.00) CEMENT & BENTONITE: 1st stage tremie, 7.5 m3. 2nd stage tremie, 5.0 m3. At 15:28 pm grout started to come out of 50 mm PVC. Grouting job completed at 15: 31 pm. (0.00-222.00)

SLOTTED PVC: 50mm , Slots 1mm: 2nd Stage tremie, slotted from 138 m to 222 m. (138.00-222.00)

SLOTTED PVC: 20mm , Slots 2mm: 1st Stage tremie, slotted from 216 m to 222 m. (216.00-222.00)

VWP(218.00) ID: 62

Program: Planned Hole: Page: 103

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0067	Hole Length:	178.00

Easting: 703845.31
Northing: 7463548.47
Surface RL: 688.27
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Apr 11 - 01 May 11
Comments: E.51490 N.163425 Mine;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 5.0	NUDRIG8	CH	508	Air/foam	NUDRILL	BDW
5.0 - 114.0	NUDRIG8	DR	406	Air/foam	NUDRILL	BDW
114.0 - 178.0	NUDRIG8	CH	340	Air/foam	NUDRILL	BDW

TOC RL: 668.79 - (drilled) SWL: 96.48 (02 May 11) Dev: N Final pH: -
TOC RL: 669.21 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0							Fine to coarse gravel of Hematite, Goethite, Chert, Shale, BIF & Maghemite. Slightly clayey, silty matrix.					BLANK STEEL: 450mm (0.00-5.00) BLANK STEEL: Size 10" - 250 (0.00-108.00) BLANK STEEL: 406mm (0.00-114.00) GRAVEL MED (0.00-178.00)
30							Fine to medium gravel of Maghemite Pisolite, Hematite & Goethite.					
							Fine to coarse gravel of Vitreous Goethite, Maghemite Pisolite, rare Siltstone, Shale & Chert.					
40							Clayey gravel of Hematite; Martite; Maghemite Pisolite; Vitreous Goethite; Shale; Siltstone & rare Chert.					
50							Clayey gravel of Martite; semi mineralised BIF; Limonite; Goethetic Clay nodules & brown Calcrete.					
60							High plasticity Clay; clay decreasing after 68m, some fine & medium gravel consisting of Calcrete, Hematite & Goethite.					
70							Fine to medium gravel of mainly hardcap with some Goethetic Hematite.					
80												
90							Limonitic Clay; soft Shale & Clay; rare Goethite; band of brown/ grey to ochreous yellow ore of Martite, Goethite & Limonite.					
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGC0067 **Hole Length:** 178.00

Easting: 703845.31
Northing: 7463548.47
Surface RL: 688.27
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Apr 11 - 01 May 11
Comments: E.51490 N.163425 Mine;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 5.0	NUDRIG8	CH	508	Air/foam	NUDRILL	BDW
5.0 - 114.0	NUDRIG8	DR	406	Air/foam	NUDRILL	BDW
114.0 - 178.0	NUDRIG8	CH	340	Air/foam	NUDRILL	BDW

TOC RL: 668.79 - (drilled) SWL: 96.48 (02 May 11) Dev: N Final pH: -
TOC RL: 669.21 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100							Limonitic Clay; soft Shale & Clay; rare Goethite; band of brown/ grey to ochreous yellow ore of Martite, Goethite & Limonite.					BLANK STEEL: Size 10" - 250 (0.00-108.00) BLANK STEEL: 406mm (0.00-114.00) GRAVEL MED (0.00-178.00)
110							Laminated Shale, some Limonite; Limonitic Clay; mineralised bands of Goethite; rare Martite & Quartz.					SLOTTED STEEL: Size 10" - 250, Slots 0.125mm (108.00-172.00)
120							Slightly mineralised Limonite & Goethite; rare Martite & Quartz.					
130							Black to dark grey Martite; unconsolidated material; unmineralised BIF.					
140							Unmineralised BIF & Chert; black to dark grey Martite & Goethite; Quartz. Large rounded chips present at 154m-160m. Very broken & weathered, magnetic at 176m-178m.;					
150												
160												
170												BLANK STEEL: Size 10" - 250 (172.00-178.00)
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 105

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0133	Hole Length:	95.00

Easting: 703409.81
Northing: 7463298.70
Surface RL: 554.40
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 May 12 - 28 May 12
Comments: PLANNED HOLE PBC7, logged by Aaron Noakes

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 95.0	CNDWW17	RHF	300		CONNECTOR	AN3

TOC RL: 554.68 (Stickup 0.28m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 538.00 - (current) Is Live: N (01 Mar 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N2	J	G			Not logged by geo until 75m, log taken from hgc0132. Semi oxidised bif, check gamma for stat, cntamination is making it hard to pick shales.Mainly goethitic cherts and magnetite.					BLANK STEEL: 400mm (0.00-6.00) BLANK STEEL: Size 14" - 350 (0.00-30.00) GRAVEL MED (0.00-93.00) GRAVEL MED (0.00-95.00)
30		N1	JC				Could pos be mm, due to high amount of yellw chert will have to check gamma, very low water yields, drilling down strike?					SLOTTED STEEL: Size 14" - 350, Slots 2mm (30.00-92.00)
70		MM	JC				Could pos be mm, due to high amount of yellw chert will have to check gamma, very low water yields, drilling down strike?					
			JC				Yellow to brown grey chert, xidise bif, limited amunt of shale recovered due to drilling method. Eoh. Looks like mm as said above due to rich yellowy chert.					BLANK STEEL: Size 14" - 350: FALL BACK OF 2M. (92.00-93.00)
100												

0 100 200 0-5000 0-14 0-50

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0163	Hole Length:	162.00

Easting: 702383.85
Northing: 7463529.07
Surface RL: 605.43
Grid Name: MGA94_50
Incl / Azm: -89-->111
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CRR	559	AIR/WATER	CONNECTOR	ND1
6.0 - 162.0	CNDWW17	CH	445	AIR/WATER/FOAM	CONNECTOR	ND1

TOC RL: 605.68 (Stickup 0.25m) (drilled) SWL: 34.85 MBTOC (10 Jun 13) Dev: N Final pH: -
TOC RL: 569.50 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		TD3	ZK	H			Dark red clay and silt with hard, dark blue-grey haematite					BLANK STEEL: 508mm (0.00-6.00) BLANK STEEL: 304mm: 323mm 9.5 WT (0.00-50.00) GRAVEL AGG: 35.5 t gravel used (23.5 m3) (0.00-158.00)
10			ZK				Dark red clay with minor silt and haematite. Possibly west ange					
20		WA1	G	HM			Brown to yellow-brown, hard, goethite with some haematite. Clasts sub-rouded to rounded					
30		N3	G	HM			Brown to yellow-brown, hard, goethite with some haematite. Clasts sub-rouded to rounded					
40			H	GK			Dark red-brown, haematite plus goethite. Clayey					
		WA2	H	GK			Dark red-brown, haematite plus goethite. Clayey					
			Z3G	S			Yellow-brown, thinly laminated chert with bif and shale. Distinctly weathered. Rounded in places.					
50		WA1	Z3G	S			Yellow-brown, thinly laminated chert with bif and shale. Distinctly weathered. Rounded in places.					SLOTTED STEEL: 304mm, Slots 2mm: 323mm 9.5 WT (50.00-158.00)
60			C	JS								
			J	C			Yellow-brown, thinly laminated chert with bif and shale. Distinctly weathered. Rounded in places. Fractured zone - large clasts					
			J	C								
70		N3	J	C			Yellow-brown speckled blue-grey. Bif with chert. Hard					
							Blue-grey bif with yellow-brown chert, hard					
80			J	CH			Blue-grey bif with yellow-brown chert, hard					
							Bif with chert and minor soft red shale. Bif is partially mineralised and magnetic					
90												
			J	CH			Bif with chert and minor soft red shale. Bif is partially mineralised and magnetic					
		N2	JC				Blue-grey bif with yellow-brown chert. Hard, some rounded clasts. Magnetic bif					
100												
						0 100 200		0-5000		0-14 0-50		

Program: Planned Hole: Page: 107

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0163	Hole Length:	162.00

Easting: 702383.85
Northing: 7463529.07
Surface RL: 605.43
Grid Name: MGA94_50
Incl / Azm: -89-->111
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CRR	559	AIR/WATER	CONNECTOR	ND1
6.0 - 162.0	CNDWW17	CH	445	AIR/WATER/FOAM	CONNECTOR	ND1

TOC RL: 605.68 (Stickup 0.25m) (drilled) SWL: 34.85 MBTOC (10 Jun 13) Dev: N Final pH: -
TOC RL: 569.50 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		N2	JC				Blue-grey bif with yellow-brown chert. Hard, some rounded clasts. Magnetic bif					GRAVEL AGG: 35.5 t gravel used (23.5 m3) (0.00-158.00)
110			CJ				Yellow-brown, thinly laminated chert with partially mieralised bif. Rounded clasts throughout. Trace angular quartz. Magnetic bif					SLOTTED STEEL: 304mm, Slots 2mm: 323mm 9.5 WT (50.00-158.00)
			S				Shale, pale red, soft, greasy					
120			CJ	S			Cherty bif with minor shale. Yellow-brown chert with thin laminations. Blue-grey partially mineralised bif.Distinctly weathered. Fractured zones throughout with rounded clasts. Magnetic bif					
130												
140		N1	CJ	S			Cherty bif with minor shale. Yellow-brown chert with thin laminations. Blue-grey partially mineralised bif.Distinctly weathered. Fractured zones throughout with rounded clasts. Magnetic bif					
			JC	S			Blue-grey bif with yellow-brown chert. Hard. Moderately weathered. Minor shale. Some green chert					
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 108

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0165	Hole Length:	156.00

Easting: 702165.83
Northing: 7463503.66
Surface RL: 605.15
Grid Name: MGA94_50
Incl / Azm: -89-->96
Construct: 16 Jun 13 - 23 Jun 13
Comments: Development completed on 3-4/8/13

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CH	559	AIR/WATER/FOAM	CONNECTOR	RS2
6.0 - 156.0	CNDWW17	CH	508	AIR/WATER/FOAM	CONNECTOR	RS2

TOC RL: 605.41 (Stickup 0.26m) (drilled) SWL: 32.53 MBTOC (23 Jun 13) Dev: N Final pH: -
TOC RL: 557.00 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		WA2	KZ	X			Dark red, clay rich, calcareous 8-10m					BLANK STEEL (0.00-6.00)
			KZ	X			Dark red, clay rich, calcareous 8-10m					BLANK STEEL: 300mm (0.00-57.00)
10		WA1	GLJ	S			Very weathered, shaley at 17m					GRAVEL MED (0.00-153.00)
20		N3	GHJ	L			Weathered, sugary texture					
30												
40												
50		MN	GHJ	S			Weathered, small chips. Ls.					
60			GHM	S			Weathered, possible faulted zone					SLOTTED STEEL: 300mm , Slots 2mm (57.00-153.00)
		N3	GHL	JS			Medium chips, weathered. Poorly sorted, fracturing. Trace black shale					
70												
80			S	GHL			Weathered, laminated, med chips size, fracturing					
			GHJ	L			Hard, weathered, med chip sizes					
90												
100		N2	GHJ	LC			Hard, weathered, laminated, very small chips					

0 100 200 0-5000 0-14 0-50

Program: Planned Hole: Page: 109

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGC0165 **Hole Length:** 156.00

Easting: 702165.83
Northing: 7463503.66
Surface RL: 605.15
Grid Name: MGA94_50
Incl / Azm: -89-->96
Construct: 16 Jun 13 - 23 Jun 13
Comments: Development completed on 3-4/8/13

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CH	559	AIR/WATER/FOAM	CONNECTOR	RS2
6.0 - 156.0	CNDWW17	CH	508	AIR/WATER/FOAM	CONNECTOR	RS2

TOC RL: 605.41 (Stickup 0.26m) (drilled) SWL: 32.53 MBTOC (23 Jun 13) Dev: N Final pH: -
TOC RL: 557.00 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		N2	GHJ	LC			Hard, weathered, laminated, very small chips					GRAVEL MED (0.00-153.00)
110												SLOTTED STEEL: 300mm , Slots 2mm (57.00-153.00)
120												
130		N1	GC	HS			Hard, slightly weathered, small chips.					
140			SF				Hard, weathered, small chips. Shale dominated					
150			GC	LS			Hard, slightly weathered, slightly magnetic					FALLBACK (153.00-154.00)
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0169	Hole Length:	150.00

Easting: 702723.18
Northing: 7463425.81
Surface RL: 605.08
Grid Name: MGA94_50
Incl / Azm: -89-->172
Construct: 17 Aug 13 - 25 Aug 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CRR	550	AIR/WATER/FOAM	CONNECTOR	ND1
6.0 - 24.0	CNDWW17	DR	450	NA	CONNECTOR	ND1
24.0 - 150.0	CNDWW17	CH	500	AIR/WATER/FOAM	CONNECTOR	ND1

TOC RL: 605.30 (Stickup 0.22m) (drilled) SWL: 40.14 MBTOC (02 Sep 13) Dev: N Final pH: -
TOC RL: 533.55 - (current) Is Live: N (01 Jun 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		UN	GL				Very weathered, sugary, highly mineralised					BLANK STEEL: 508mm (0.00-6.00)
10			LS				Very soft/weathered, orange/ buff shales					BLANK STEEL: 304mm (0.00-66.00)
20			S				Dark brown weathered shales, no chips, pulverised					GRAVEL AGG (0.00-144.00)
30			LGW	S			Very weathered, small g/w chips, very soft, minor dark brown shale, heavy l staining throughout					
40			L				Extremely weathered, ittle/no chips.					
50			GWL				Very weathered/limonite throughout					
60			GWF	S			Very small weathered chips, soft					
70			GW	L			Porous texture, highly weathered, very vuggy heavy limonite staining on fractures, large chips.					SLOTTED STEEL: 304mm, Slots 2mm (66.00-144.00)
80												
90			GW	SL			Very weathered, minor l stained fractures, minor silicified fibrous					
100			G1W	CLS			Moderately weathered, porous/ sugary texture, minor fractures with limonite staining, leached white cherts.					

0 100 200 0-5000 0-14 0-50

Program: Planned Hole: Page: 111

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0169	Hole Length:	150.00

Easting:	702723.18
Northing:	7463425.81
Surface RL:	605.08
Grid Name:	MGA94_50
Incl / Azm:	-89-->172
Construct:	17 Aug 13 - 25 Aug 13
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW17	CRR	550	AIR/WATER/FOAM	CONNECTOR	ND1
6.0 - 24.0	CNDWW17	DR	450	NA	CONNECTOR	ND1
24.0 - 150.0	CNDWW17	CH	500	AIR/WATER/FOAM	CONNECTOR	ND1

TOC RL:	605.30	(Stickup 0.22m)	(drilled)	SWL:	40.14 MBTOC	(02 Sep 13)	Dev:	N	Final pH:	-
TOC RL:	533.55	-	(current)	Is Live:	N	(01 Jun 20)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		UN	G1W	CLS			Moderately weathered, porous/ sugary texture, minor fractures with limonite staining, leached white cherts.					GRAVEL AGG (0.00-144.00)
110			GW1	SCJ			Slightly weathered, minor fractures, yellow/brown goethetised cherts, minor red shales					SLOTTED STEEL: 304mm, Slots 2mm (66.00-144.00)
120												
130												
140			G1J	S			Large red shale band, some very soft chips					
			J1C	SQ			Hard, slightly weathered, minor limonite staining, magnetic bif from 148 m					FALLBACK (144.00-150.00)
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0189	Hole Length:	172.00

Easting: 701275.71
Northing: 7463293.29
Surface RL: 630.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 May 14 - 06 Jun 14

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW21	CH	550	AIR/WATER/FOAM	CONNECTOR	FF1
6.0 - 172.0	CNDWW21	CH	425	AIR/WATER/FOAM	CONNECTOR	FF1

Comments: Pilot hole drilling before reaming. 18/5/14: 0-3m 300mm precollar. 19/5/14: 3-78m 8.5" CH. 21-24/5/1...

TOC RL: 630.07 - (drilled) SWL: 52.30 MBGL (25 May 14) Dev: N Final pH: -
TOC RL: 593.29 - (current) Is Live: N (01 Aug 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	Z	YH			Sand, gravelly, some silt, some hematite, angular, red-brown					BLANK STEEL: 508mm (0.00-6.00)
		TD3	Y	ZH			Silt, sandy, some gravel, angular, some hematite, red-brown					CEMENT (0.00-6.00)
10												BLANK STEEL: 300mm (0.00-56.50)
		WA2	KY	HG			Clay and siilt, some sand, trace gravel, some hematite/ goethite/ limonite, high plasticity, darker brown at 28m, brown					GRAVEL MED: 3.2-6.4 mm (0.00-167.50)
20												
30												
40			KS				Clay/shale, medium plasticity, some wihite shale, black					
		WA1	JK				Bif, clayey/shaley, trace pink shale at 44m, med. Magnetic, mainly goethite at 42-48, dark brown					
50		N3	J				Bif, mineralised, hematite, some shale/clay, heavy sample, trace pink shale at 60-64, light brown sloppy piles at 60-66, yellowish brown					SLOTTED STEEL: 300mm , Slots 2mm (56.50-122.50)
60												
70		N2	J				Bif, mineralised, bigger chips, angular to subangular, porous, slightly magnetic, dark grey (slightly yellowish brown in piles)					
80			S				Shale, very fine chips, intermed magnetic, whitish grey					
			J	C			Bif, chert, fine and laminated, some goethite, magnetic, sharp edges, grey/ ochreous					
90												
		N1	J				Bif, less chert and goethite, trace quartz, 126-128 more chert, grey					LEVELTROLL(100.00) ID: 1727
100												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

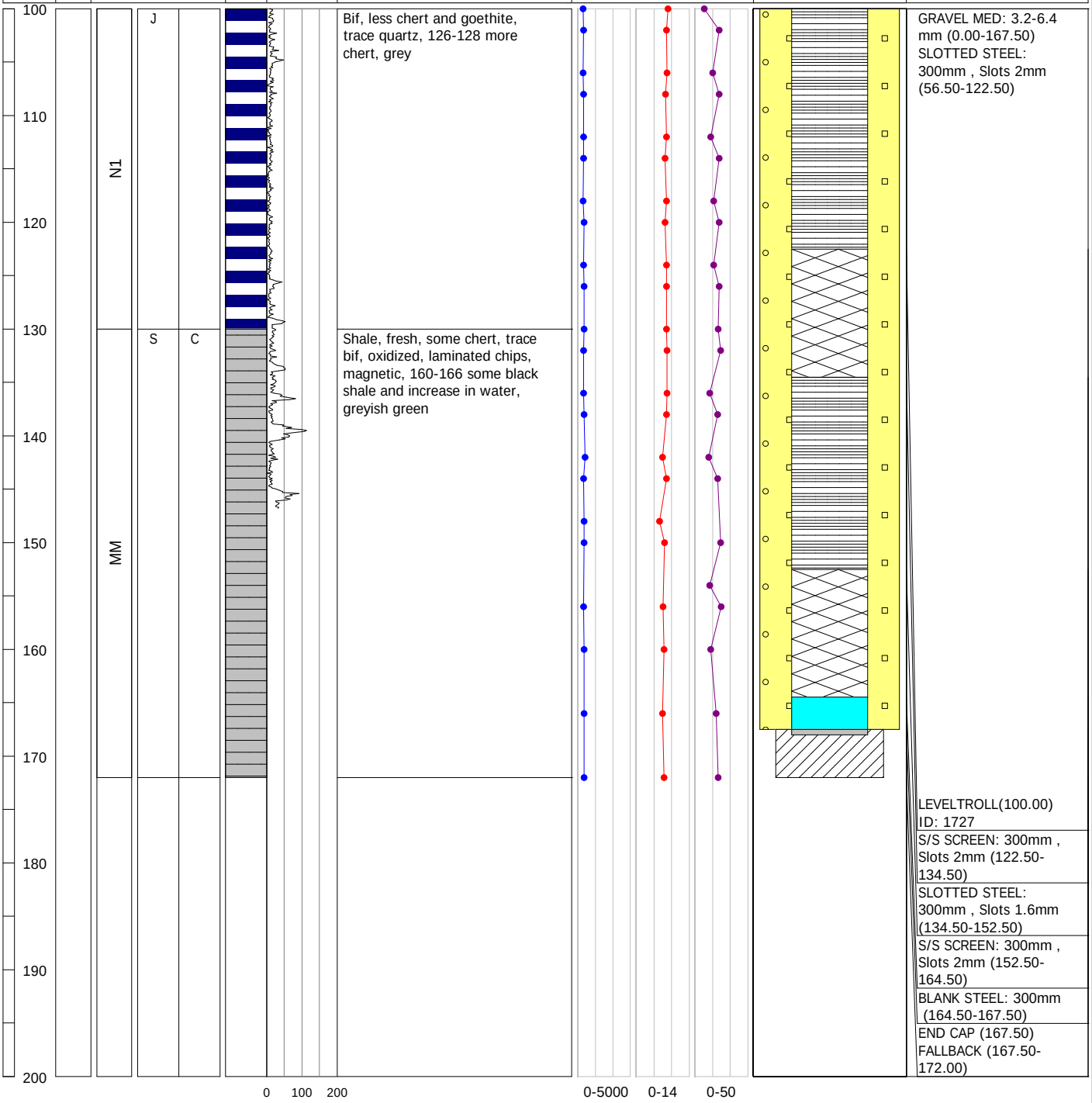
Project: NORTH FLANK **Hole Name:** HGC0189 **Hole Length:** 172.00

Easting: 701275.71
Northing: 7463293.29
Surface RL: 630.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 May 14 - 06 Jun 14

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW21	CH	550	AIR/WATER/FOAM	CONNECTOR	FF1
6.0 - 172.0	CNDWW21	CH	425	AIR/WATER/FOAM	CONNECTOR	FF1

Comments: Pilot hole drilling before reaming. 18/5/14: 0-3m 300mm precollar. 19/5/14: 3-78m 8.5" CH. 21-24/5/1...

TOC RL: 630.07 - (drilled) SWL: 52.30 MBGL (25 May 14) Dev: N Final pH: -
TOC RL: 593.29 - (current) Is Live: N (01 Aug 22) Date: - Final EC: -



Program: Planned Hole: Page: 114

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0197	Hole Length:	100.00

Easting: 702911.99
Northing: 7463416.02
Surface RL: 557.59
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Jun 15 - 25 Jun 15
Comments: Production bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 100.0	WLDRIG5	CH	425		WELLDRILL	CVM

License: CAW181097

TOC RL: 558.09 (Stickup 0.90m) (drilled) SWL: 16.00 mbtoc (20 Jun 19) Dev: N Final pH: -
TOC RL: 532.65 - (current) Is Live: N (01 Aug 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		N3	GL	H			MINERALISED BIF, (N3), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Orange brown weathered/leached BIF. Goethite/limonite minor hematite. Large fragments.					BLANK STEEL: 324mm : BLANK STEEL (0.00-70.00) GRAVEL MED (0.00-100.00)
50		N2	HG	C			PARTIALLY MINERALISED, (N2), Brown and Grey, Slightly Weathered, Strong Rock. Brown grey yellow BIF. Hematite and Goethite. Minor shale and chert. Medium fragments					SLOTTED STEEL: 324mm , Slots 1.25mm: BRIDESLOTTED STEEL >15% OPEN AREA (70.00-100.00)
90		N1	J				FRESH MAGNETIC BIF, (N1), Blue and Grey, Fresh, Very Strong Rock. Black grey fresh magnetic BIF. Small to medium chips. Minor pink shale.					END CAP (100.00)
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0200	Hole Length:	283.00

Easting: 702390.87
Northing: 7463718.90
Surface RL: 672.33
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Nov 15 - 28 Nov 15
Comments: Production bore north wall C Deposit

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 283.0	WLDRIG5	ROT	425		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.77 (Stickup 0.63m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 672.77 (Stickup 0.63m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	I	X			, (), Red and Brown, Transported, Non-Cohesive soils. Red brown surface scree. Angular fragments. Magnetic pisolites. Maghemite and hematite.					CEMENT: Cement/ Bentonite Grout (0.00-2.00)
10			H	J			, (), Red and Brown, Extremely Weathered, Non-Cohesive soils. Red brown detrital. Hematite and BIF gravel. Smaal magnetic pisolites.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-184.20)
20												GRAVEL MED (2.00-280.00)
30			X	K			, (), Red and Brown, Extremely Weathered, Non-Cohesive soils. Red brown detrital. Maghemite. Very clayey. Magnetic pisolites.					
40												
50		TD3	K	I			, (), Yellow and Brown, Extremely Weathered, Non-Cohesive soils. Yellow brown detrital. Very clayey. Medium sized magnetic pisolites. Maghemite, hematite and goethite.					
60												
70			K	I			, (), Red and Brown, Extremely Weathered, Non-Cohesive soils. Red brown very clayey detrital. Large magnetic pisolites. Maghemite and hematite. Minor chert fragments.					
80												
90												
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0200	Hole Length:	283.00

Easting: 702390.87
Northing: 7463718.90
Surface RL: 672.33
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Nov 15 - 28 Nov 15
Comments: Production bore north wall C Deposit

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 283.0	WLDRIG5	ROT	425		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.77 (Stickup 0.63m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 672.77 (Stickup 0.63m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		TD3	K	I			, (), Red and Brown, Extremely Weathered, Non-Cohesive soils. Red brown very clayey detrital. Large magnetic pisolites. Maghemite and hematite. Minor chert fragments.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-184.20)
110												GRAVEL MED (2.00-280.00)
120												
130		WA2	K	I			, (), Red and Brown, Extremely Weathered, Non-Cohesive soils. Red brown very clayey detrital. Large magnetic pisolites. Maghemite and hematite. Minor chert fragments.					
140												
150		WA2	N	K			, (WA2), Dark or Black and Grey, Soil, Very Weak Rock. Black gray manganese clay. Magnetic pisolites. Maghemite and hematite.					
160			N	K			, (WA2), Grey and Yellow, Soil, Very Weak Rock. Gray yellow manganese clay and yellow clay.Minor maghemite.					
170			N	K			, (WA2), Dark or Black and Grey, Slightly Weathered, Very Weak Rock. Black gray manganese clay.					
180		MN	J	C			, (MN), Red and Brown, Moderately Weathered, Strong Rock. Red brown weathered BIF. Minor chert and hematite. Yellow clay 182-194m.					
190							, (WA2), Dark or Black, Slightly Weathered, Very Weak Rock. Black manganese clay.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (184.20-277.00)
		WA2	N	K			, (MN), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown weathered BIF and yellow clay. Minor chert.					
200		MN	J	K								
					0	100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0200	Hole Length:	283.00

Easting: 702390.87
Northing: 7463718.90
Surface RL: 672.33
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 Nov 15 - 28 Nov 15
Comments: Production bore north wall C Deposit

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 283.0	WLDRIG5	ROT	425		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.77 (Stickup 0.63m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 672.77 (Stickup 0.63m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200		MN	J	K			, (MN), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown weathered BIF and yellow clay. Minor chert.					GRAVEL MED (2.00-280.00)
210			J	K			, (MN), Red and Brown, Fresh, Very Strong Rock. Red brown BIF, clayey. Minor hematite (magnetic BIF)					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (184.20-277.00)
220		WA2	N	K			, (WA2), Dark or Black and Grey, Moderately Weathered, Strong Rock. Black grey manganese clay.					
230		MN	J				, (MN), Red and Brown, Fresh, Very Strong Rock. Red brown BIF with yellow clay layers.					
240		MM	J	N			, (MM), Dark or Black and Grey, Moderately Weathered, Strong Rock. Black and grey BIF and manganese clay.					
250			J	C			, (MM), Red and Brown, Fresh, Very Strong Rock. Red brown BIF and chert, minor hematite.					
260			J	C			, (MM), Yellow and Brown, Fresh, Very Strong Rock. Yellow brown BIF and yellow clay. Very cherty.					
270			J	C			, (MM), Grey and Blue, Fresh, Very Strong Rock. Grey blue BIF and chert. Minor magnetic BIF. Small white clay fragments from 264-282m.					BLANK STEEL: Size 12" - W.T.9.53mm (277.00-280.00)
280												END CAP (280.00)
290												FALLBACK (280.00-283.00)
300												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0202	Hole Length:	247.00

Easting: 702897.51
Northing: 7463666.60
Surface RL: 670.43
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Sep 16 - 11 Sep 16
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 247.0	WLDRIG5	ROT	450		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.00 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 670.95 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		TD3	XC	HQJ			GRAVEL, (QUATERNARY DETRITAL), Brown and Red, Transported, Non-Cohesive soils, Gap graded, Angular. Brown red surface scree. Medium to large angular fragments.Maghemite, chert, quartz, hematite and BIF					BLANK STEEL: Size 20" - W.T.9.53mm: Actual casing size is 22" (0.00-54.00)
10			KI	H			GRAVEL, (CLAY), Red and Brown, Transported, Very Soft, Well graded, Rounded. Red brown clay and pisolites. 50% clay. Some angular fragments. Maghemite, minor hematite.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-175.50)
20			I	H			GRAVEL, (CID), Red and Brown, Transported, Very Soft, Poorly graded, Rounded. Red brown pisolites. Maghemite with minor hematite.					GRAVEL MED (2.00-242.50)
30												
40			KI	HG			GRAVEL, (CLAY), Red and Brown, Transported, Very Soft, Gap graded, Sub-rounded. Red brown clay, pisolites, hematite and goethite. 50% clay. Minor leached ore. Major mud loss between 50 and 60m. Rounded and angular fragments.Possible cavities 50-60m					
50												
60			X				CID, (TD3), Red and Brown, Moderately Weathered, Medium Strong Rock. Red brown small angular fragments. Maghemite.					
70			K				CLAY, (CLAY), Red and Brown, Extremely Weathered, Very Soft, Uniform, Rounded. Red brown clay.					
80												
90			XK				CID, (TD3), Red and Brown, Moderately Weathered, Weak Rock. Red brown small angular fragments. Clayey maghemite, minor hematite. Almost no sample return.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0202	Hole Length:	247.00

Easting: 702897.51
Northing: 7463666.60
Surface RL: 670.43
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Sep 16 - 11 Sep 16
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 247.0	WLDRIG5	ROT	450		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.00 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 670.95 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		TD3	XK				CID, (TD3), Red and Brown, Moderately Weathered, Weak Rock. Red brown small angular fragments. Clayey maghemite, minor hematite. Almost no sample return.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-175.50)
110			XI	H			CID, (TD3), Red and Brown, Moderately Weathered, Medium Strong Rock. Red brown small to medium sized rounded pisolite fragments. Minor hematite. Trace goethite and quartz.					GRAVEL MED (2.00-242.50)
120			KX	G			CLAY, (TD3), Red and Brown, Moderately Weathered, Medium Strong Rock. Red brown very clayey maghemite. 50% clay. Minor goethite. Major mud loss 136-137m.					
130												
140		OA	V				SILT, (UNMINERALISED BIF), Missing, Extremely Weathered, Very Soft, Uniform, Angular. No Sample Return					
150												
160												
170												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens. Sump 12" from 236.5 to 242.5m. (175.50-236.50)
180												
190												
200		MN	V				SILT, (UNMINERALISED BIF), Missing, Extremely Weathered, Very Soft, Uniform, Angular. No Sample Return					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0202	Hole Length:	247.00

Easting: 702897.51
Northing: 7463666.60
Surface RL: 670.43
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Sep 16 - 11 Sep 16
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 247.0	WLDRIG5	ROT	450		WELLDRILL	KKR

License: CAW181097

TOC RL: 672.00 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 670.95 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200		MN	V				SILT, (UNMINERALISED BIF), Missing, Extremely Weathered, Very Soft, Uniform, Angular. No Sample Return					GRAVEL MED (2.00-242.50)
210												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens. Sump 12" from 236.5 to 242.5m. (175.50-236.50)
220												
230												
240												CEMENT: Cement plug instead of end cap inside 12" sump from 236.5 to 242.5m (239.50-242.50)
250												FALLBACK (242.50-247.00)
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0205	Hole Length:	60.00

Easting: 702525.03
Northing: 7463440.38
Surface RL: 557.26
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Jun 17 - 08 Jun 17
Comments: STAB hole.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 60.0	WLDRIG5	CH	200		WELLDRILL	SS7

TOC RL: 558.39 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 558.39 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N1	LSG				PARTIALLY MINERALISED, (N1), Yellow, Slightly Weathered, Weak Rock. sample piles run over. could not log accurately.					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-42.00)
10												
20												
30												
40												
50												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (42.00-60.00) LEVELTROLL(53.00) ID: 2045
60												END CAP (60.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0206	Hole Length:	60.00

Easting: 701843.31
Northing: 7463503.57
Surface RL: 569.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Jun 17 - 11 Jun 17
Comments: STAB hole.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 60.0	WLDRIG5	CH	200		WELLDRILL	SS7

TOC RL: 570.45 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 570.15 - (current) Is Live: N (01 Jan 23) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N2	HFG				MINERALISED BIF, (N2), Dark or Black and Red and brown, Slightly Weathered, Weak Rock. check model for strat					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-42.00)
10		N1	FGS				PARTIALLY MINERALISED, (N1), Dark or Black and Red and brown, Slightly Weathered, Weak Rock. shaley mineralisation.					
20												
30		MM	S	FC			SHALE, (MM), Yellow and Dark or Black and brown, Slightly Weathered, Weak Rock. likely to be in Macleod. Check model					
40												
50												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (42.00-60.00)
60			S	L			SHALE, (MM), Yellow, Slightly Weathered, Weak Rock. EOH. target reached.					LEVELTROLL(60.00) ID: 2113 END CAP (60.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0213	Hole Length:	160.00

Easting:	701539.10
Northing:	7463406.30
Surface RL:	593.32
Grid Name:	MGA94_50
Incl / Azm:	-89-->113
Construct:	22 Jul 16 - 24 Jul 16
Comments:	Production bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 160.0	WLDRIG5	CH	450		WELLDRILL	KKR

License: CAW181097

TOC RL:	593.32	(Stickup 0.10m)	(drilled)	SWL:		Dev: N	Final pH: -
TOC RL:	557.43	-	(current)	Is Live: Y	(-)	Date: -	Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		WA2	GHS				PARTIALLY MINERALISED, (WA2), Brown and Red, Moderately Weathered, Medium Strong Rock. Brown/ red goethite, hematite and red/ pink shale. Slightly clayey. Small to mediium fragments					BLANK STEEL: Size 20" - W.T.9.53mm (0.00-6.00)
10			S				SHALE, (WA2), Grey and Brown and light or white, Moderately Weathered, Weak Rock. Grey/brown/white shale. Minor yellow shale.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-102.00)
20		WA1	HG	S			LEACHED BIF, (WA1), Brown and Green, Moderately Weathered, Weak Rock. Brown/ green weathered hematite and goethite. Leached vuggy ore. Minor manganese rich shale.					GRAVEL MED: 42 Tonnes (4.00-156.00)
30			SHG				LEACHED BIF, (N3), Brown and Yellow, Highly Weathered, Very Weak Rock. Brown/yellow shale and weathered leached/vuggy ore. Hematite and goethite. Fractured 44-48m.					
40		N3										
50			HG	C			MINERALISED BIF, (N3), Brown and Dark or Black and yellow, Slightly Weathered, Strong Rock. Brown/black/yellow BIF. Hematite and goethite. Minor chert. Fracture: 64-68m. Minor pink shale 78-84m.					
60												
70												
80												
90		N2	HG				LEACHED BIF, (N2), Dark or Black and Brown and grey, Slightly Weathered, Medium Strong Rock. Dark/grey/brown weathered leached BIF. Hematite and goethite. Large fracture 84-98m.					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0213	Hole Length:	160.00

Easting:	701539.10
Northing:	7463406.30
Surface RL:	593.32
Grid Name:	MGA94_50
Incl / Azm:	-89-->113
Construct:	22 Jul 16 - 24 Jul 16
Comments:	Production bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 160.0	WLDRIG5	CH	450		WELLDRILL	KKR

License: CAW181097

TOC RL:	593.32	(Stickup 0.10m)	(drilled)	SWL:		Dev: N	Final pH: -
TOC RL:	557.43	-	(current)	Is Live: Y	(-)	Date: -	Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
100		N2	HG				LEACHED BIF, (N2), Dark or Black and Brown and grey, Slightly Weathered, Medium Strong Rock. Dark/grey/brown weathered leached BIF. Hematite and goethite. Large fracture 84-98m.
110			J	SHG			UNMINERALISED BIF, (N2), Brown and Light or White and yellow, Slightly Weathered, Strong Rock. Brown/white/ yellow BIF. Shale, quartz, hematite, goethite, chert. Fractured.
120		N1	J	HG			UNMINERALISED BIF, (N1), Brown and Red and yellow, Fresh, Very Strong Rock. Brown/red/yellow/grey fresh BIF. Aternating hard and soft bands. Shale bands: 120-122m, 124-128m, 140-146m, 150-154m. Intermittent fractures.120-122m, 126-128m, 132-134m, 140-144m, 146-150m.
130							
140							
150							
160							
170							
180							
190							
200						0 100 200	

EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
				BLANK STEEL: Size 12" - W.T.9.53mm (0.00-102.00)
				GRAVEL MED: 42 Tonnes (4.00-156.00)
				SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (102.00-150.00)
				BLANK STEEL: Size 12" - W.T.9.53mm (150.00-156.00)
				END CAP (156.00)
				FALLBACK (156.00-160.00)
0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0221	Hole Length:	273.00

Easting: 701494.76
Northing: 7463601.15
Surface RL: 678.52
Grid Name: MGA94_50
Incl / Azm: -89-->251
Construct: 25 Jul 16 - 05 Aug 16
License: CAW181097
Comments: Mud Rotary. Production casing became stuck. Installed approximately 148m.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 273.0	WLDRIG5	ROT	450		WELLDRILL	KKR

TOC RL: 678.52 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 678.52 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	XG				GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Angular. Red brown scree. Maghemite and goethite.Subrounded to angular chips, medium sized.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-26.60) BLANK STEEL: Size 10" - W.T.9.27mm (0.00-204.00) GRAVEL MED: 17 tonnes; used hopper to install (0.00-268.00)
10												
20		TD3	IX	H			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Soft, Well graded, Rounded. Red brown pisolites (maghemite), hematite and minor goethite. Medium to small chips.					
30												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (26.60-44.00)
40			X				GRAVEL, (QUATERNARY DETRITAL), Dark or Black and Red, Transported, Very Soft, Well graded, Sub-rounded. Black red fine magnetic angular chips. Maghemite.					
50			IX				GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Soft, Well graded, Rounded. Red brown small pisolites. Maghemite.					BLANK STEEL: Size 12" - W.T.9.53mm (44.00-104.00)
60			IX	G			GRAVEL, (QUATERNARY DETRITAL), Red and Yellow, Transported, Hard, Well graded, Rounded. Brown Yellow pisolites (maghemite), goethite and yellow clay.					
70												
80							GRAVEL, (QUATERNARY DETRITAL), Brown and Red, Transported, Hard, Well graded, Rounded. Brown red large pisolites (maghemite), hematite, goethite. Minor leached (vuggy) ore.					
90			IX	HG								
100			K	X			CLAY, (CLAY), Red and Yellow, Extremely Weathered, Hard, Uniform, Rounded. Brown yellow very clayey maghemite.					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0221	Hole Length:	273.00

Easting: 701494.76
Northing: 7463601.15
Surface RL: 678.52
Grid Name: MGA94_50
Incl / Azm: -89-->251
Construct: 25 Jul 16 - 05 Aug 16
License: CAW181097
Comments: Mud Rotary. Production casing became stuck. Installed approximately 148m.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 273.0	WLDRIG5	ROT	450		WELLDRILL	KKR

TOC RL: 678.52 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 678.52 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		TD3	K	X			CLAY, (CLAY), Red and Yellow, Extremely Weathered, Hard, Uniform, Rounded. Brown yellow very clayey maghemite.					BLANK STEEL: Size 10" - W.T.9.27mm (0.00-204.00)
110			SK	H			SHALE, (WA2), Red and Yellow, Moderately Weathered, Very Weak Rock. Brown yellow shale/ clay, hematite.					GRAVEL MED: 17 tonnes; used hopper to install (0.00-268.00)
120												
130			NS	H			SHALE, (WA2), Dark or Black and Light or White, Moderately Weathered, Medium Strong Rock. Black and white manganese rich shale (clayey) with hematite fragments.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (26.60-44.00)
140												BLANK STEEL: Size 12" - W.T.9.53mm (44.00-104.00)
150		WA2	D				DOLOMITE, (WA2), Grey and Light or White, Highly Weathered, Medium Strong Rock. Grey white weathered dolomite.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (104.00-145.00)
160												
170			NS				SHALE, (WA2), Dark or Black and Light or White, Moderately Weathered, Medium Strong Rock. Black grey manganese rich shale (clayey).					
180												BLANK STEEL: Size 12" - W.T.9.53mm: Sump (145.00-148.00)
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0221	Hole Length:	273.00

Easting: 701494.76
Northing: 7463601.15
Surface RL: 678.52
Grid Name: MGA94_50
Incl / Azm: -89-->251
Construct: 25 Jul 16 - 05 Aug 16
License: CAW181097
Comments: Mud Rotary. Production casing became stuck. Installed approximately 148m.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 273.0	WLDRIG5	ROT	450		WELLDRILL	KKR

TOC RL: 678.52 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 678.52 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200			NS				SHALE, (WA2), Dark or Black and Light or White, Moderately Weathered, Medium Strong Rock. Black grey manganese rich shale (clayey).					BLANK STEEL: Size 10" - W.T.9.27mm (0.00-204.00)
210		WA2	S	G			SHALE, (WA2), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Yellow brown weathered shale and goethite					GRAVEL MED: 17 tonnes; used hopper to install (0.00-268.00)
220			NS				SHALE, (WA2), Dark or Black and Brown, Slightly Weathered, Medium Strong Rock. Black and brown manganese rich shale . Minor white shale.					
230		WA1	D				DOLOMITE, (WA1), Grey and Yellow, Slightly Weathered, Medium Strong Rock. Grey yellow weathered dolomite.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (26.60-44.00)
240												BLANK STEEL: Size 12" - W.T.9.53mm (44.00-104.00)
250		N3	J	D			UNMINERALISED BIF, (N3), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black fresh BIF and minor dolomite. Large fracture 254 - 256m.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (104.00-145.00)
260												
270												BLANK STEEL: Size 12" - W.T.9.53mm: Sump (145.00-148.00)
280												SLOTTED STEEL: Size 10" - W.T.9.27mm, Slots 2mm (204.00-264.00)
290												BLANK STEEL: Size 10" - W.T.9.27mm: Sump (264.00-270.00)
300						0 100 200		0-5000	0-14	0-50		GROUT: Used tremmie to install (268.00-270.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0233	Hole Length:	120.00

Easting: 703061.57
Northing: 7463474.93
Surface RL: 569.20
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 May 17 - 29 May 17
Comments: C Deposit Production Bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	550		WELLDRILL	ME1
6.0 - 120.0	WLDRIG5	CH	425		WELLDRILL	YA

License: CAW183161

TOC RL:	569.51	-	(drilled)	SWL:	24.72 MBTOC	(01 Jun 17)	Dev:	Y: 10.8 hour(s)	Final pH:	8.3
TOC RL:	569.51	-	(current)	Is Live:	N	(01 Oct 22)	Date:	22 May 2017	Final EC:	605.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	MN	G1	H			PARTIALLY MINERALISED, (MN), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Brown yellow goethite, chert, minor hematite and trace shale.					CEMENT (0.00-2.00)
10												BLANK STEEL: 457mm (0.00-6.00)
20			HG1				PARTIALLY MINERALISED, (MN), Brown and Red, Slightly Weathered, Medium Strong Rock. Brown red hematite, goethite and chert. FWS = 34m. Fractures at 28-34m, 34-38m. Large fracture at 44m. Yield 3L/s at 38m, 5L/s at 42m, 6L/s at 44m.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-38.00)
30							UNMINERALISED BIF, (MN), Brown, Slightly Weathered, Strong Rock. Brown hematite and chert. Fractures at 46-47m, 49-51m, 54m. Yield 7.5L/s at 48m, 10.9L/s at 54m, 8.3L/s at 60m.					GRAVEL MED (2.00-120.00)
40												
50			Z3G	1			FRESH MAGNETIC BIF, (MU), Grey and Brown, Fresh, Very Strong Rock. Grey brown magnetic BIF, chert and quartz (30%). Yield 10L/s.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (38.00-110.00)
60		MU	J	CQ			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black, fresh magnetic BIF. Minor Dolomite, trace chert and quartz. Fractures 70, 77, 80m. Yield 9L/s at 78m.					
70			J	D			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black, fresh magnetic BIF. Minor quartz. Fractures 84m. Yield 10L/s at 84m.					
80			J	Q			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black, fresh magnetic BIF (60%) and Dolomite (40%), minor quartz. Fractures 87, 88, 97m. Yield 11L/s at 90m.					
90			JD	Q			UNMINERALISED BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black fresh BIF, dolomite (alternating BIF and dolomite bands), black shale, chert and quartz. Traces of pyrite. 109 to 110m 90% quartz/fracture. 98-99, 102-106m Dolomite. Brown BIF bands. Yield 14L/s at102m, 14L/s 108, >14L/s at 120m.					
100			JDC	Q								
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGC0233 | Hole Length: 120.00

Easting: 703061.57
Northing: 7463474.93
Surface RL: 569.20
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 May 17 - 29 May 17
Comments: C Deposit Production Bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	550		WELLDRILL	ME1
6.0 - 120.0	WLDRIG5	CH	425		WELLDRILL	YA

License: CAW183161

TOC RL: 569.51 - (drilled) SWL: 24.72 MBTOC (01 Jun 17) Dev: Y: 10.8 hour(s) Final pH: 8.3
TOC RL: 569.51 - (current) Is Live: N (01 Oct 22) Date: 22 May 2017 Final EC: 605.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	MU	JDC	Q			UNMINERALISED BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black fresh BIF, dolomite (alternating BIF and dolomite bands), black shale, chert and quartz. Traces of pyrite. 109 to 110m 90% quartz/fracture. 98-99, 102-106m Dolomite. Brown BIF bands. Yield 14L/s at102m, 14L/s 108, >14L/s at 120m.					GRAVEL MED (2.00-120.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (38.00-110.00) END CAP (110.00) FALLBACK (110.00-120.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0237	Hole Length:	120.00

Easting: 703174.27
Northing: 7463454.78
Surface RL: 568.81
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 May 17 - 29 May 17
Comments: C Deposit pilot hole with no production installation. pvc installed down hole as mointoring point. f...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	WLDRIG5	CH	200		WELLDRILL	YA

TOC RL: 569.41 - (drilled) SWL: 22.56 MBGL (18 May 17) Dev: N Final pH: -
TOC RL: 569.41 - (current) Is Live: N (17 Aug 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	MN	G	HS			PARTIALLY MINERALISED, (MN), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Brown yellow goethite, hematite, minor chert and shale.					BLANK PVC: Size 40 - Class 12 (0.00-108.00)
10												
20			HG1				PARTIALLY MINERALISED, (MN), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Brown yellow hematite, goethite and minor chert. FWS = 30m.					
30			HC	1			UNMINERALISED BIF, (MN), Brown and Red, Slightly Weathered, Strong Rock. Brown red hematite (50%) and chert (50%). Fractures 32-34m.					
40			GC				UNMINERALISED BIF, (MN), Brown and Yellow, Slightly Weathered, Very Strong Rock. Brown Yellow goethite and chert. Fracture at 38m.					
50			HG				UNMINERALISED BIF, (MN), Yellow and Brown, Slightly Weathered, Very Strong Rock. Yellow brown hematite and goethite. Fractures at 47-48m, Yield 1L/s.					
		MU	JC	Q			FRESH MAGNETIC BIF, (MU), Grey and Brown, Fresh, Very Strong Rock. Grey brown magnetic BIF, chert and minor quartz. Yield 3L/s.					LEVELTROLL(55.00) ID: 1732
60			JC	Q								
			J	DQ			FRESH MAGNETIC BIF, (MU), Grey, Fresh, Very Strong Rock. Grey fresh magnetic BIF, chert and quartz. Fractures 56 - 57m. Fibrous material 58-59m. Yield 3L/s.					
70							FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black, fresh magnetic BIF. Minor Dolomite and quartz. Fractures 64m. Fibrous material 71-79m. Yield 3L/s.					
80			DJ	QC			FRESH MAGNETIC BIF, (MU), Grey and Green, Fresh, Very Strong Rock. Grey green fresh dolomite, magnetic BIF, quartz and chert. Fracture at 83m.					
			JDQ	C								
90			JDQ	C			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black/ green, fresh magnetic BIF, Dolomite and white quartz, minor chert. Fibrous material 86-87m.					
100			JD	Q								
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

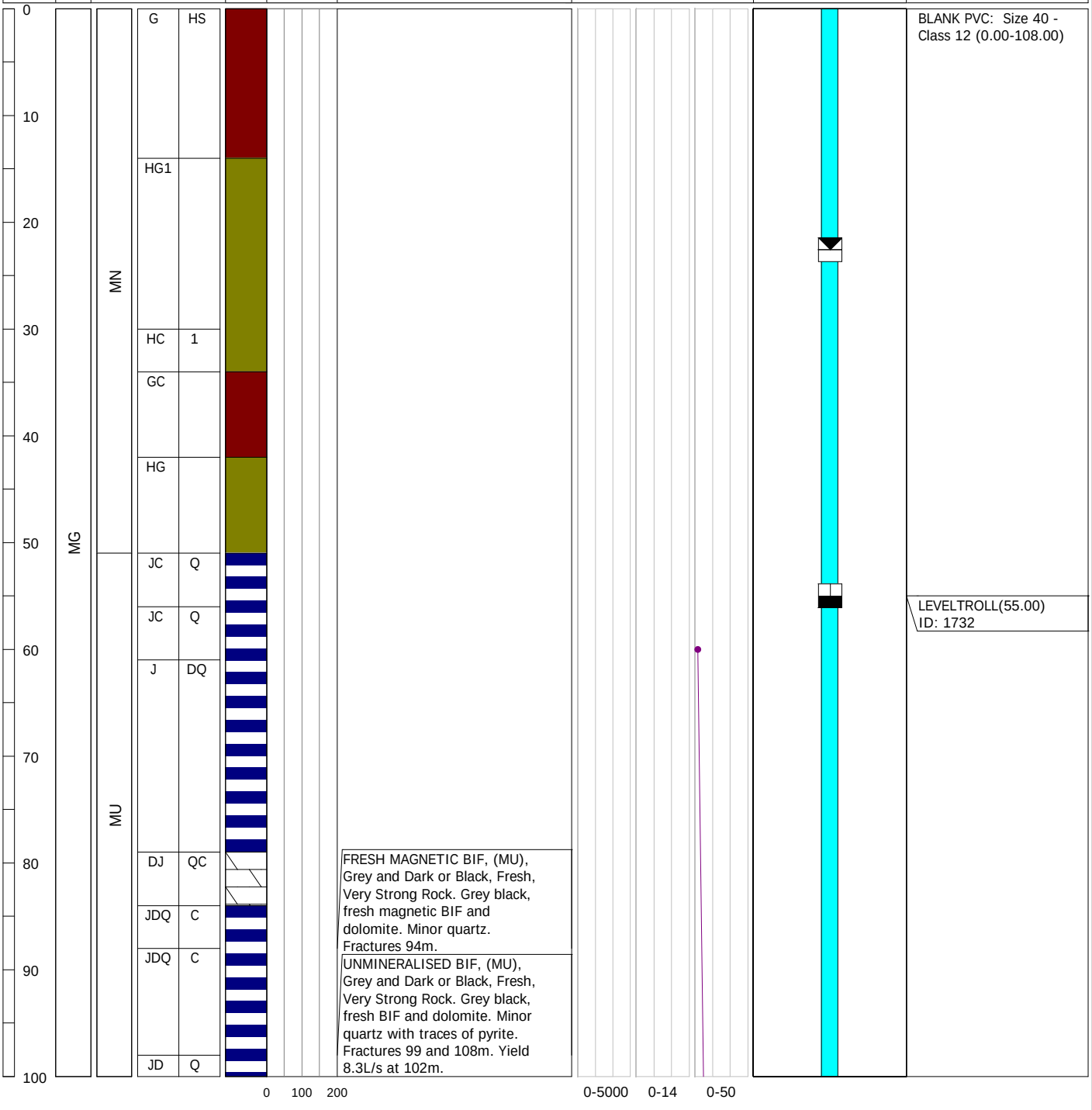
BHP

Project:	NORTH FLANK	Hole Name:	HGC0237	Hole Length:	120.00

Easting: 703174.27
Northing: 7463454.78
Surface RL: 568.81
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 May 17 - 29 May 17
Comments: C Deposit pilot hole with no production installation. pvc installed down hole as mointoring point. f...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	WLDRIG5	CH	200		WELLDRILL	YA

TOC RL: 569.41 - (drilled) SWL: 22.56 MBGL (18 May 17) Dev: N Final pH: -
TOC RL: 569.41 - (current) Is Live: N (17 Aug 22) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0237	Hole Length:	120.00

Easting: 703174.27
Northing: 7463454.78
Surface RL: 568.81
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 17 May 17 - 29 May 17
Comments: C Deposit pilot hole with no production installation. pvc installed down hole as mointoring point. f...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	WLDRIG5	CH	200		WELLDRILL	YA

TOC RL: 569.41 - (drilled) SWL: 22.56 MBGL (18 May 17) Dev: N Final pH: -
TOC RL: 569.41 - (current) Is Live: N (17 Aug 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	MU	JD	Q			UNMINERALISED BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black, fresh BIF and dolomite. Minor quartz with traces of pyrite. Fractures 99 and 108m. Yield 8.3L/s at 102m.					BLANK PVC: Size 40 - Class 12 (0.00-108.00)
110			KSC	DQ			UNMINERALISED BIF, (MU), Grey and Dark or Black, Fresh, Very Strong Rock. Grey black and white fresh BIF, shale, chert, quartz and minor dolomite. Quartz 113 to 114m. Yield 10L/s at120m.					
120												LEVELTROLL(55.00) ID: 1732
130												SLOTTED PVC: Size 40 - Class 12, Slots 1mm (108.00-120.00)
140												
150												
160												
170												END CAP (120.00)
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0240		Hole Length:	118.00
Easting:	701247.79					
Northing:	7463350.59					
Surface RL:	605.36					
Grid Name:	MGA94_50					
Incl / Azm:	-89-->150					
Construct:	04 Jul 16 - 06 Jul 16				License:	CAW181097
Comments:	Mud Rotary					

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 118.0	WLDRIG5	ROT	450		WELLDRILL	KKR

TOC RL:	605.76	-	(drilled)	SWL:		Dev:	N
TOC RL:	605.76	-	(current)	Is Live:	N	(01 Sep 21)	Date:

Final pH:	-
Final EC:	-

Depth mgbl	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description
0	TD3	HG			QUATERNARY DETRITAL, (TD3), Red and Brown, Highly Weathered, Very Weak Rock. Brown, small angular and subrounded fragments. Hematite and goethite.
10		K	HG		CLAY, (TD3), Yellow and Red, Highly Weathered, Very Weak Rock. Yellow and red clay, minor hematite and goethite.
	TD2	G			CID, (TD2), Dark or Black and Grey, Slightly Weathered, Strong Rock. Black grey goethite, Large fragments. frature/fault.
20		K			CLAY, (CLAY), Yellow and Red, Transported, Hard, Uniform, Rounded. Yellow and brown clay
		G	K		
30	MN	J	GH		PARTIALLY MINERALISED, (MN), Dark or Black and Red, Slightly Weathered, Strong Rock. Black red goethite, marthite and yellow and red clay.
		J	G		PARTIALLY MINERALISED, (MN), Yellow and Brown, Slightly Weathered, Medium Strong Rock. Yellow brown BIF, Goetite, hematite trace magnetite and chert.
40					
		SG			MINERALISED BIF, (MN), Grey and Dark or Black and red, Fresh, Strong Rock. Grey, black and red mineralised BIF. Goethite and trace marthite. Iron staining (red). Fuggy/ leached ore in places. Medium sized chips.
50					
		HG			MINERALISED BIF, (MN), Yellow and Brown and dark or black, Fresh, Strong Rock. Yellow, brown and black shale/clay and goethite (mineralised)
60					LEACHED BIF, (MN), Grey and Dark or Black and brown, Slightly Weathered, Strong Rock. Grey, black and brown hematite and goethite. Large fragments. Leached /fuggy ore fragments.
	MM	J	GM		PARTIALLY MINERALISED, (MM), Brown and Yellow and grey, Fresh, Extremely Strong Rock. Brown, yellow and grey BIF. Slightly mineralised. Goethite, minor magnetite and hematite, quartz and chert. Fine to medium gragments. 106-110m fracture.
70					
80					
90					
100					

0 100 200

EC us/cm: 0-5000 | pH: 0-14 | Yield L/s: 0-50

Diagram Scaled to 600mm

Notes:

- BLANK STEEL: Size 12" - W.T.9.53mm (0.00-45.00)
- GRAVEL MED (0.00-117.00)
- SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (45.00-51.00)
- BLANK STEEL: Size 12" - W.T.9.53mm (51.00-63.00)
- SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (63.00-81.00)
- BLANK STEEL: Size 12" - W.T.9.53mm (81.00-99.00)
- SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (99.00-105.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0240	Hole Length:	118.00

Easting: 701247.79
Northing: 7463350.59
Surface RL: 605.36
Grid Name: MGA94_50
Incl / Azm: -89-->150
Construct: 04 Jul 16 - 06 Jul 16
Comments: Mud Rotary

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 118.0	WLDRIG5	ROT	450		WELLDRILL	KKR

License: CAW181097

TOC RL: 605.76 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 605.76 - (current) Is Live: N (01 Sep 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		MM	J	GM			PARTIALLY MINERALISED, (MM), Brown and Yellow and grey, Fresh, Extremely Strong Rock. Brown, yellow and grey BIF. Slightly mineralised. Goethite, minor magnetite and hematite, quartz and chert. Fine to medium gragments. 106-110m fracture.					GRAVEL MED (0.00-117.00)
110												
120												
130												
140												
150												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (45.00-51.00) BLANK STEEL: Size 12" - W.T.9.53mm (51.00-63.00)
160												
170												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (63.00-81.00) BLANK STEEL: Size 12" - W.T.9.53mm (81.00-99.00) SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (99.00-105.00)
180												BLANK STEEL: Size 12" - W.T.9.53mm (105.00-111.00)
190												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm: Bridge slot screens (111.00-117.00)
200						0 100 200		0-5000	0-14	0-50		END CAP (117.00) FALLBACK (117.00-118.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0241	Hole Length:	60.00

Easting: 701940.13
Northing: 7463498.68
Surface RL: 569.00
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Jun 17 - 09 Jun 17
Comments: STAB hole.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 60.0	WLDRIG5	CH	200		WELLDRILL	SS7

TOC RL: 569.96 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 569.96 - (current) Is Live: N (01 Nov 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N3	GL	S			MINERALISED BIF, (N3), , Slightly Weathered, Medium Strong Rock.					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-42.00)
10			G	L			MINERALISED BIF, (N3), , Slightly Weathered, Medium Strong Rock.					
20			G	LS			MINERALISED BIF, (N3), , Slightly Weathered, Weak Rock. shalier.					
30												
40												
50			Z3G				MINERALISED BIF, (N3), , Slightly Weathered, Weak Rock.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (42.00-60.00)
60												LEVELTROLL(57.98) ID: 1731 END CAP (60.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0242	Hole Length:	60.00

Easting: 702686.41
Northing: 7463458.74
Surface RL: 557.06
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Jun 17 - 11 Jun 17
Comments: STAB hole.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 60.0	WLDRIG5	CH	200		WELLDRILL	SS7

TOC RL: 557.89 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 557.89 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N2	LG	1			PARTIALLY MINERALISED, (N2), Yellow, Slightly Weathered, Weak Rock.					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-42.00)
10			GL	H			MINERALISED BIF, (N2), Red, Slightly Weathered, Strong Rock.					
		N1	G				MINERALISED BIF, (N1), Brown, Slightly Weathered, Weak Rock.					
20												
30			1G	S			PARTIALLY MINERALISED, (N1), Brown, Slightly Weathered, Strong Rock.					
40												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (42.00-60.00)
			1L				PARTIALLY MINERALISED, (N1), Red and Brown and yellow, Slightly Weathered, Strong Rock.					
50		MM	J				PARTIALLY MINERALISED, (MM), , Moderately Weathered, Strong Rock. eoh.					
60												LEVELTROLL(59.57) ID: 2046 END CAP (60.00)
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0243	Hole Length:	126.00

Easting: 702442.13
Northing: 7463440.61
Surface RL: 557.63
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Jun 17 - 04 Jun 17
License: CAW183161
Comments: C deposit replacement production bore for CD27

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	550		WELLDRILL	SS7
6.0 - 126.0	WLDRIG5	CH	425		WELLDRILL	SS7

TOC RL: 557.00 - (drilled) SWL: Dev: Y: 9.8 hour(s) Final pH: 8.3
TOC RL: 545.50 - (current) Is Live: N (01 Aug 22) Date: 04 Jun 2017 Final EC: 404.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	WA1	G	S			PARTIALLY MINERALISED, (WA1), Blue and Brown and pink, Highly Weathered, Medium Strong Rock. driller noted fractured ground 0 - 6m					BLANK STEEL: Size 18" - W.T.9.53mm (0.00-6.00)
			SH	C								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-42.00)
			J	C			SHALE, (WA1), Pink and Dark or Black, Highly Weathered, Weak Rock.					GRAVEL MED (0.00-126.00)
10			C	HS								
			H	G			LEACHED BIF, (WA1), Light or White and Red and grey, Highly Weathered, Medium Strong Rock.					BLANK STEEL: Size 12" - 300: a patch has been installed between 2.4m and 3.5m depth with an ID of 296mm. Material is gGade 316 stainless steel (no vulcanised rubber). (2.40-3.50)
20			B	N			PARTIALLY MINERALISED, (WA1), Grey and Pink, Highly Weathered, Medium Strong Rock.					
			H	C			MINERALISED BIF, (WA1), Grey and Dark or Black, Highly Weathered, Medium Strong Rock.					
30			GC				SHALE, (WA1), Dark or Black, Highly Weathered, Very Weak Rock. fractured ground					
			CS				MINERALISED BIF, (WA1), Grey, Moderately Weathered, Medium Strong Rock.					
			H				PARTIALLY MINERALISED, (WA1), Brown, Moderately Weathered, Medium Strong Rock.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (42.00-66.00)
40			HS				SHALE, (WA1), Brown and Yellow and pink, Moderately Weathered, Very Weak Rock.					
			H				PARTIALLY MINERALISED, (N3), Blue and Grey, Moderately Weathered, Medium Strong Rock. LARGE CHUNKS IN PILES					SLOTTED STEEL: Size 12" - 300, Slots 1mm: A 6.25m long Grade 316 stainless steel 10" vulcanised rubber swage patch was installed between 54.8m and 60.8m depth. Between 54.8m and 55.9m the patched screen ID is 290mm. Below this, the patched screen ID is 296mm. (54.80-55.90)
50			HC	G			PARTIALLY MINERALISED, (N3), Red and Blue, Moderately Weathered, Medium Strong Rock.					
							PARTIALLY MINERALISED, (N3), Blue, Highly Weathered, Medium Strong Rock.					
60							MINERALISED BIF, (N3), Brown and Blue, Moderately Weathered, Medium Strong Rock. LARGE CHUNKS IN PILES from 42 - 56					
							MINERALISED BIF, (N2), Brown and Blue, Moderately Weathered, Medium Strong Rock.					SLOTTED STEEL: 304mm, Slots 1mm (55.90-60.80)
70							PARTIALLY MINERALISED, (N2), Grey and Yellow, Moderately Weathered, Medium Strong Rock.					
		N3										
80			HCS	G								
			HC	GJ								
90		N2										S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (66.00-120.00)
			HCS	GJ								
100			HC	GJ								
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGC0243 | Hole Length: 126.00

Easting: 702442.13
Northing: 7463440.61
Surface RL: 557.63
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Jun 17 - 04 Jun 17
License: CAW183161
Comments: C deposit replacement production bore for CD27

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	550		WELLDRILL	SS7
6.0 - 126.0	WLDRIG5	CH	425		WELLDRILL	SS7

TOC RL: 557.00 - (drilled) SWL: Dev: Y: 9.8 hour(s) Final pH: 8.3
TOC RL: 545.50 - (current) Is Live: N (01 Aug 22) Date: 04 Jun 2017 Final EC: 404.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	WA1	G	S								BLANK STEEL: Size 18" - W.T.9.53mm (0.00-6.00)
10			SH	C								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-42.00)
			J	C								GRAVEL MED (0.00-126.00)
			C	HS								
20			H	G								BLANK STEEL: Size 12" - 300: a patch has been installed between 2.4m and 3.5m depth with an ID of 296mm. Material is gGade 316 stainless steel (no vulcanised rubber). (2.40-3.50)
			B	N								
			H	C								
30			GC									
			CS									
		N3	H									
40			HS									
			H									
			HC	G								SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (42.00-66.00)
50												
												SLOTTED STEEL: Size 12" - 300, Slots 1mm: A 6.25m long Grade 316 stainless steel 10" vulcanised rubber swage patch was installed between 54.8m and 60.8m depth. Between 54.8m and 55.9m the patched screen ID is 290mm. Below this, the patched screen ID is 296mm. (54.80-55.90)
60												
70												
80		N2	HCS	G								SLOTTED STEEL: 304mm, Slots 1mm (55.90-60.80)
			HC	GJ								
							PARTIALLY MINERALISED, (N2), Grey and Yellow, Moderately Weathered, Medium Strong Rock.					
90												
			HCS	GJ			PARTIALLY MINERALISED, (N2), Grey and Yellow, Moderately Weathered, Medium Strong Rock.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (66.00-120.00)
			HC	GJ								
100						0 100 200		0-5000	0-14	0-50		

Program: MAC FY17 DEWATERING DRILLING | Planned Hole: HGC0243 | Page: 139

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0243	Hole Length:	126.00

Easting: 702442.13
Northing: 7463440.61
Surface RL: 557.63
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Jun 17 - 04 Jun 17
Comments: C deposit replacement production bore for CD27

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	550		WELLDRILL	SS7
6.0 - 126.0	WLDRIG5	CH	425		WELLDRILL	SS7

License: CAW183161

TOC RL: 557.00 - (drilled) SWL: Dev: Y: 9.8 hour(s) Final pH: 8.3
TOC RL: 545.50 - (current) Is Live: N (01 Aug 22) Date: 04 Jun 2017 Final EC: 404.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N2	HC	GJ			PARTIALLY MINERALISED, (N2), Grey and Yellow, Moderately Weathered, Medium Strong Rock.					GRAVEL MED (0.00-126.00)
110												BLANK STEEL: Size 12" - 300: a patch has been installed between 2.4m and 3.5m depth with an ID of 296mm. Material is gGade 316 stainless steel (no vulcanised rubber). (2.40-3.50)
120			S	H			SHALE, (N2), Pink and Grey, Moderately Weathered, Weak Rock. POSSIBLY NS4 SHALE BAND					
			HC	S			PARTIALLY MINERALISED, (N2), Grey, Moderately Weathered, Medium Strong Rock. POSSBLY BASED OF n2 UNIT WITH WHITE SHALES OBSERVED= ns3					
130												
140												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (42.00-66.00)
150												
160												SLOTTED STEEL: Size 12" - 300, Slots 1mm: A 6.25m long Grade 316 stainless steel 10" vulcanised rubber swage patch was installed between 54.8m and 60.8m depth. Between 54.8m and 55.9m the patched screen ID is 290mm. Below this, the patched screen ID is 296mm. (54.80-55.90)
170												
180												SLOTTED STEEL: 304mm, Slots 1mm (55.90-60.80)
												S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (66.00-120.00)
190												
200						0 100 200		0-5000	0-14	0-50		END CAP (120.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0244	Hole Length:	126.00

Easting: 702425.37
Northing: 7463468.93
Surface RL: 556.52
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Aug 18 - 12 Aug 18
License: CAW201628
Comments: Was to be drilled to 130m but stopped short at 126m due to fibrous intercept at 130m

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	450		WELLDRILL	MRC1
6.0 - 126.0	WLDRIG5	CH	425		WELLDRILL	MRC1

TOC RL: 557.72 - (drilled) SWL: 39.09 MBGL (13 Aug 18) Dev: N Final pH: -
TOC RL: 557.72 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	WA2	K	J			CLAY, (WA2), Yellow and Brown and dark or black, Extremely Weathered, Medium Strong Rock.					AB FOAM (0.00-2.00)
10			J	K			UNMINERALISED BIF, (WA2), Yellow and Brown and dark or black, Moderately Weathered, Strong Rock.					BLANK STEEL: Size 18" - W.T.9.53mm (0.00-12.00)
20			J	K			UNMINERALISED BIF, (WA2), Red and Yellow and dark or black, Highly Weathered, Strong Rock.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-66.00)
30		WA1	J	C			UNMINERALISED BIF, (WA1), Dark or Black and Yellow, Moderately Weathered, Strong Rock.					GRAVEL MED: 17 tonnes (2.00-126.00)
40	MG	N3	C	J			CHERT, (N3), Yellow and Dark or Black and brown, Moderately Weathered, Strong Rock.					
50												
60			K	JC			CLAY, (N3), Dark or Black and Yellow and brown, Extremely Weathered, Medium Strong Rock.					
70		N2	J	C			UNMINERALISED BIF, (N2), Grey and Blue and yellow, Moderately Weathered, Strong Rock.					W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (66.00-126.00)
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0244	Hole Length:	126.00

Easting: 702425.37
Northing: 7463468.93
Surface RL: 556.52
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Aug 18 - 12 Aug 18
License: CAW201628
Comments: Was to be drilled to 130m but stopped short at 126m due to fibrous intercept at 130m

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	450		WELLDRILL	MRC1
6.0 - 126.0	WLDRIG5	CH	425		WELLDRILL	MRC1

TOC RL: 557.72 - (drilled) SWL: 39.09 MBGL (13 Aug 18) Dev: N Final pH: -
TOC RL: 557.72 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N2	J	C			UNMINERALISED BIF, (N2), Grey and Blue and yellow, Moderately Weathered, Strong Rock.					GRAVEL MED: 17 tonnes (2.00-126.00)
110		N1	C	J			CHERT, (N1), Yellow and Grey and blue, Moderately Weathered, Strong Rock.					W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (66.00-126.00)
120		MM	J	C			UNMINERALISED BIF, (MM), Grey and Yellow and blue, Moderately Weathered, Strong Rock.					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0246	Hole Length:	60.00

Easting: 702272.72
Northing: 7463499.72
Surface RL: 557.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Aug 18 - 05 Aug 18
Comments: Monitoring hole at C Deposit

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	MRC1
6.0 - 60.0	WLDRIG5	CH	200		WELLDRILL	MRC1

TOC RL: 558.24 - (drilled) SWL: 32.99 MBTOC (13 Aug 18) Dev: N Final pH: -
TOC RL: 558.24 - (current) Is Live: N (08 Aug 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	WA2	J				CONGLOMERATE, (WA2), Light or White and Dark or Black and red, Highly Weathered, Strong Rock.					AB FOAM: No gravel used (0.00-2.00)
			J	G								BLANK PVC: Size 50 - Class 18 (0.00-42.00)
10			K	J			UNMINERALISED BIF, (WA2), Brown and Yellow, Moderately Weathered, Strong Rock.					
		N3					CLAY, (N3), Red and Brown, Extremely Weathered, Medium Strong Rock.					
20			J	C			UNMINERALISED BIF, (N3), Yellow and Brown and red, Moderately Weathered, Strong Rock.					
			J	G			UNMINERALISED BIF, (N3), Brown and Yellow and dark or black, Moderately Weathered, Strong Rock.					
30												
40												
50		N2	K	J			CLAY, (N2), Yellow and Brown, Extremely Weathered, Medium Strong Rock.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (42.00-60.00)
60												LEVELTROLL(60.00) ID: 1419
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: FY19 C Deposit Hydro Drilling Planned Hole: HGC00246 Page: 143

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0252	Hole Length:	132.00

Easting: 701994.65
Northing: 7463559.76
Surface RL: 569.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jul 19 - 03 Jul 19

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 132.0	DR5	DR	200		EASTERNWELL	MRC1

Comments: Drilled to assist in determining and identify location of production bore and/or allow for ground wa...

TOC RL: 569.68 - (drilled) SWL: 36.36 MBTOC (04 Jul 19) Dev: N Final pH: -
TOC RL: 569.68 - (current) Is Live: N (15 May 23) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	UG	WA2	KJ	S			PARTIALLY MINERALISED, (WA2), Red and Brown, Highly Weathered, Strong Rock. Clay/ shale and BIF with some mineralisation, highly wethered, hard gravel to soft clay clumps.					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 12 (0.00-36.00)
50	MG	WA2	J	GK			UNMINERALISED BIF, (WA2), Grey and Yellow, Moderately Weathered, Strong Rock. Unmineralised BIF with minoe goethite and clay, moderately weathered angular gravels.					
60		WA1	J	G			UNMINERALISED BIF, (WA1), Grey and Brown, Highly Weathered, Strong Rock. Fault zone between 58 - 62m					SLOTTED PVC: Size 50 - Class 12, Slots 1mm (36.00-132.00)
90		N3	G	HC			UNMINERALISED BIF, (N3), Yellow and Grey and dark or black, Moderately Weathered, Strong Rock. Goethite yellowish to brown, hematite and chert hard very angular, trace quartz. Moderately weathered gravel. Competent ground.					
100												

0 100 200 0-5000 0-14 0-50

Program: MAC C West DEW FY19 Stage 2 Planned Hole: MAC_CW_HYD_FY19_MB02 Page: 144

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0252	Hole Length:	132.00

Easting: 701994.65
Northing: 7463559.76
Surface RL: 569.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jul 19 - 03 Jul 19

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 132.0	DR5	DR	200		EASTERNWELL	MRC1

Comments: Drilled to assist in determining and identify location of production bore and/or allow for ground wa...

TOC RL: 569.68 - (drilled) SWL: 36.36 MBTOC (04 Jul 19) Dev: N Final pH: -
TOC RL: 569.68 - (current) Is Live: N (15 May 23) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	N3	G	HC			UNMINERALISED BIF, (N3), Yellow and Grey and dark or black, Moderately Weathered, Strong Rock. Goethite yellowish to brown, hematite and chert hard very angular, trace quartz. Moderately weathered gravel. Competent ground.					SLOTTED PVC: Size 50 - Class 12, Slots 1mm (36.00-132.00)
110			H	GC			PARTIALLY MINERALISED, (N3), Grey and Yellow, Moderately Weathered, Strong Rock. Hematite dark grey with goethite and chert yellowish brown, hard and moderately weathered angular cuttings.					
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0253	Hole Length:	120.00

Easting: 701700.06
Northing: 7463477.32
Surface RL: 569.15
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Jul 19 - 14 Jul 19
License: CAW201628
Comments: Production bore to increase dewatering at C deposit.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 104.0	DR5	DR	500		EASTERNWELL	KS6
104.0 - 120.0	DR5	CH	500		EASTERNWELL	KS6

TOC RL:	569.73	-	(drilled)	SWL:	37.10 MBTOC	(21 Jul 19)	Dev:	N	Final pH:	8.9
TOC RL:	557.36	-	(current)	Is Live:	Y	(-)	Date:	16 Jul 2019	Final EC:	675.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	WA2	H	S			PARTIALLY MINERALISED, (WA2), Red and Brown and dark or black, Moderately Weathered, Medium Strong Rock. Redish brown coated hematite and goethite with minor pinkish shale. Moderately weathered and hard gravel to cobble.					BLANK STEEL: Size 14" - W.T.9.53mm (0.00-84.00)
10			S	H			SHALE, (WA2), Red and Brown, Moderately Weathered, Weak Rock. Grey and red shale and hematite. Fairly well sorted, partly weathered hard cuttings.					GRAVEL MED (0.00-120.00)
20		WA1	G	HS			LEACHED BIF, (WA1), Yellow and Brown, Highly Weathered, Weak Rock. Yellowish brown and goethitic soft fine material. Greyish hematite, partly leached and moderately weathered. Poorly sorted cuttings but competent ground.					
30												
40		N3	HG	S			LEACHED BIF, (N3), Yellow and Brown, Highly Weathered, Very Weak Rock. Weathered leahed and dark hematite and vuggy ore. Yellowish goethite, relatively soft. Poorly sorted and hard cuttings					
50			HG				MINERALISED BIF, (N3), Grey and Yellow and dark or black, Highly Weathered, Strong Rock. Broken grouns zone between 60 - 80m. Weathered and leached.					
60												
70												
80												
90		N2	H	G			LEACHED BIF, (N2), Yellow and Dark or Black and red, Moderately Weathered, Medium Strong Rock. Grey dark weathered/leached hematite/ BIF. Some yellow goethite and traces of pinkish shale. Relatively hard and moderately weathered with minor mineralisation. Broken ground 89 - 91m					W/W STEEL: Size 14" - W.T.9.53mm, Slots 1mm (84.00-120.00)
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0253	Hole Length:	120.00

Easting: 701700.06
Northing: 7463477.32
Surface RL: 569.15
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Jul 19 - 14 Jul 19
License: CAW201628
Comments: Production bore to increase dewatering at C deposit.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 104.0	DR5	DR	500		EASTERNWELL	KS6
104.0 - 120.0	DR5	CH	500		EASTERNWELL	KS6

TOC RL:	569.73	-	(drilled)	SWL:	37.10 MBTOC	(21 Jul 19)	Dev:	N	Final pH:	8.9
TOC RL:	557.36	-	(current)	Is Live:	Y	(-)	Date:	16 Jul 2019	Final EC:	675.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N2	H	G			LEACHED BIF, (N2), Yellow and Dark or Black and red, Moderately Weathered, Medium Strong Rock. Grey dark weathered/leached hematite/ BIF. Some yellow goethite and traces of pinkish shale. Relatively hard and moderately weathered with minor mineralisation. Broken ground 89 - 91m					GRAVEL MED (0.00-120.00)
110			J	HCG								W/W STEEL: Size 14" - W.T.9.53mm, Slots 1mm (84.00-120.00)
120							UNMINERALISED BIF, (N2), Grey and Dark or Black and yellow, Slightly Weathered, Strong Rock. Unmineralised dark and moderately weathered BIF. Angular and hard chert with softer goethite. Traces of redish shale. Broken ground at 120m					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000		0-14 0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0261	Hole Length:	162.00

Easting:	701859.08
Northing:	7463499.13
Surface RL:	569.19
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	10 Sep 20 - 13 Sep 20
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	550		WELLDRILL	KS6
6.0 - 162.0	WLDRIG6	CH	425		WELLDRILL	KS6

License: CAW202447

TOC RL:	569.75	(Stickup 0.37m)	(drilled)	SWL:	52.05 MBTOC	(17 Sep 20)	Dev:	Y: 22.0 hour(s)	Final pH:	8.3
TOC RL:	557.60	-	(current)	Is Live:	Y	(-)	Date:	15 Sep 2020	Final EC:	660.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
0	MG	WA1	G	W			MINERALISED BIF, (WA1), Brown, Slightly Weathered, Strong Rock. Geothite with minor geothitic hematite.
10			G	K			MINERALISED BIF, (WA1), Red, Moderately Weathered, Strong Rock. Geothite with minor clay (possible due to water injection)
20		N3	GK	L			MINERALISED BIF, (N3), Yellow and Brown, Moderately Weathered, Strong Rock. Geothite and Geothitic rich clays with some minor lemonite.
30							
40							
50			Z3G	K			MINERALISED BIF, (N3), Yellow and Brown, Moderately Weathered, Strong Rock. Geothite with minor geothitic clay. FWS at 66 metres. Yield of 1 l/sec at 72 metres.
60							
70		N2	JGS	C			MINERALISED BIF, (N2), Dark or Black and Brown and yellow, Slightly Weathered, Strong Rock. Geothite with Shale, BIf with some minor leeching observed. Minor chert observed at 144 to 146 metres. Fractures/Broken ground at 134 to 138 metres. Yield of 10 l/sec visually observed at 144 metres.
80							
90							
100						0 100 200	

EC us/cm: 0-5000 | pH: 0-14 | Yield L/s: 0-50

Diagram Scaled to 600mm

Notes:
- BLANK STEEL: Size 18" - W.T.9.53mm (0.00-18.00)
- BLANK STEEL: Size 12" - W.T.9.53mm (0.00-96.00)
- GRAVEL MED (0.00-158.00)
- GROUT: Grout for surface casing (9.00-18.00)
- W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (96.00-156.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0261	Hole Length:	162.00

Easting: 701859.08
Northing: 7463499.13
Surface RL: 569.19
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Sep 20 - 13 Sep 20
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	550		WELLDRILL	KS6
6.0 - 162.0	WLDRIG6	CH	425		WELLDRILL	KS6

License: CAW202447

TOC RL:	569.75	(Stickup 0.37m)	(drilled)	SWL:	52.05 MBTOC	(17 Sep 20)	Dev:	Y: 22.0 hour(s)	Final pH:	8.3
TOC RL:	557.60	-	(current)	Is Live:	Y	(-)	Date:	15 Sep 2020	Final EC:	660.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
100	MG	N2	JGS	C			MINERALISED BIF, (N2), Dark or Black and Brown and yellow, Slightly Weathered, Strong Rock. Geothite with Shale, BIf with some minor leeching observed. Minor chert observed at 144 to 146 metres. Fractures/Broken ground at 134 to 138 metres. Yield of 10 l/sec visually observed at 144 metres.
110							
120							
130							
140							
150		N1	JSC				UNMINERALISED BIF, (N1), Dark or Black and Grey and light or white, Slightly Weathered, Strong Rock. Shale and strongly magnetic BIF with Chert bands. Final yield of 17 l/sec observed at 156 metres.
160							
170							
180							
190							
200							

0 100 200

EC us/cm	pH	Yield L/s
0-5000	0-14	0-50

Diagram Scaled to 600mm

Notes:
- GRAVEL MED (0.00-158.00)
- GROUT: Grout for surface casing (9.00-18.00)
- W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (96.00-156.00)
- END CAP (156.00)
- END CAP (156.00)
- FALLBACK (158.00-162.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0263	Hole Length:	165.00

Easting: 702032.98
Northing: 7463572.00
Surface RL: 569.27
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Oct 20 - 12 Oct 20
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 165.0	WLDRIG6	ROT	450	MUD	WELLDRILL	KS6

License: CAW202447

TOC RL: 569.80 (Stickup 0.55m) (drilled) SWL: 50.09 MBTOC (20 Oct 20) Dev: Y: 25.0 hour(s) Final pH: 8.5
TOC RL: 569.80 (Stickup 0.55m) (current) Is Live: Y (-) Date: 15 Oct 2020 Final EC: 683.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	TD1	Z				HAEMATITE CONGLOMERATE, (TD1), Red, Slightly Weathered, Extremely Strong Rock.					CEMENT (0.00-2.00)
10			XZ	I			HAEMATITE CONGLOMERATE, (TD1), Red and Brown, Slightly Weathered, Very Strong Rock. Detritals/Maghemite with some minor pisolites.					BLANK STEEL: Size 18" - W.T.9.53mm (0.00-6.00)
20			XZ	Y			HAEMATITE CONGLOMERATE, (TD1), Brown and Red, Slightly Weathered, Very Strong Rock. Detritals/Maghemite with some minor silt.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-105.00)
30												
40												
50			XI	K			HAEMATITE CONGLOMERATE, (TD1), Red and Brown, Slightly Weathered, Strong Rock. Maghemite/pisolites with minor clay.					GRAVEL MED (2.00-165.00)
60		WA2	GJ	K			MINERALISED BIF, (WA2), Brown, Slightly Weathered, Strong Rock. Geothite with minor clay, FWS at 66m. Yield of 3 l/sec at 90 metres. Possible fracture or fault at 84 to 88 metres, no increase in water flow observed.					
70												
80							MINERALISED BIF, (WA1), Brown, Slightly Weathered, Strong Rock. BIF/Geothite with evidence of some minor leeching.					
90		WA1	JG				MINERALISED BIF, (N3), Brown and Yellow, Slightly Weathered, Strong Rock. Geothite and Shale with minor Lemonite. yield of 5 l/sec at 120m, no broken ground or fractures observed.					
100		N3	SG	L								
					0	100 200		0-5000	0-14	0-50		

Program: North Flank C West DEW Phase 3 Planned Hole: FY21_HGC0263 Page: 150

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGC0263	Hole Length:	165.00

Easting:	702032.98
Northing:	7463572.00
Surface RL:	569.27
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	08 Oct 20 - 12 Oct 20
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 165.0	WLDRIG6	ROT	450	MUD	WELLDRILL	KS6

License: CAW202447

TOC RL:	569.80	(Stickup 0.55m) (drilled)	SWL:	50.09 MBTOC	(20 Oct 20)	Dev:	Y: 25.0 hour(s)	Final pH:	8.5
TOC RL:	569.80	(Stickup 0.55m) (current)	Is Live:	Y	(-)	Date:	15 Oct 2020	Final EC:	683.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N3	SG	L			MINERALISED BIF, (N3), Brown and Yellow, Slightly Weathered, Strong Rock. Geothite and Shale with minor Lemonite. yield of 5 l/sec at 120m, no broken ground or fractures observed.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-105.00)
110												GRAVEL MED (2.00-165.00)
120			SJ				MINERALISED BIF, (N3), Yellow and Brown, Slightly Weathered, Strong Rock. Shale and BIF, possible contact between N3 and N2 at 126-128m.					W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (105.00-165.00)
130		N2	SJG	K			MINERALISED BIF, (N2), Yellow and Brown, Slightly Weathered, Strong Rock. Shale, BIF and Geothite with a minor clay band at 143 metres. Soft broken ground at 148 to 150 metres, increase in yield from 17 to 20 l/ sec (visual estimate)					
140												
150		N1	SJ	C			UNMINERALISED BIF, (N1), Dark or Black and Grey and light or white, Fresh, Strong Rock. Shale and magnetic fresh to slightly weathered BIF, hard ground, no observed broken ground or fractures. Yield of 20 l/sec observed at 169 metres.					
160												END CAP (165.00)
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

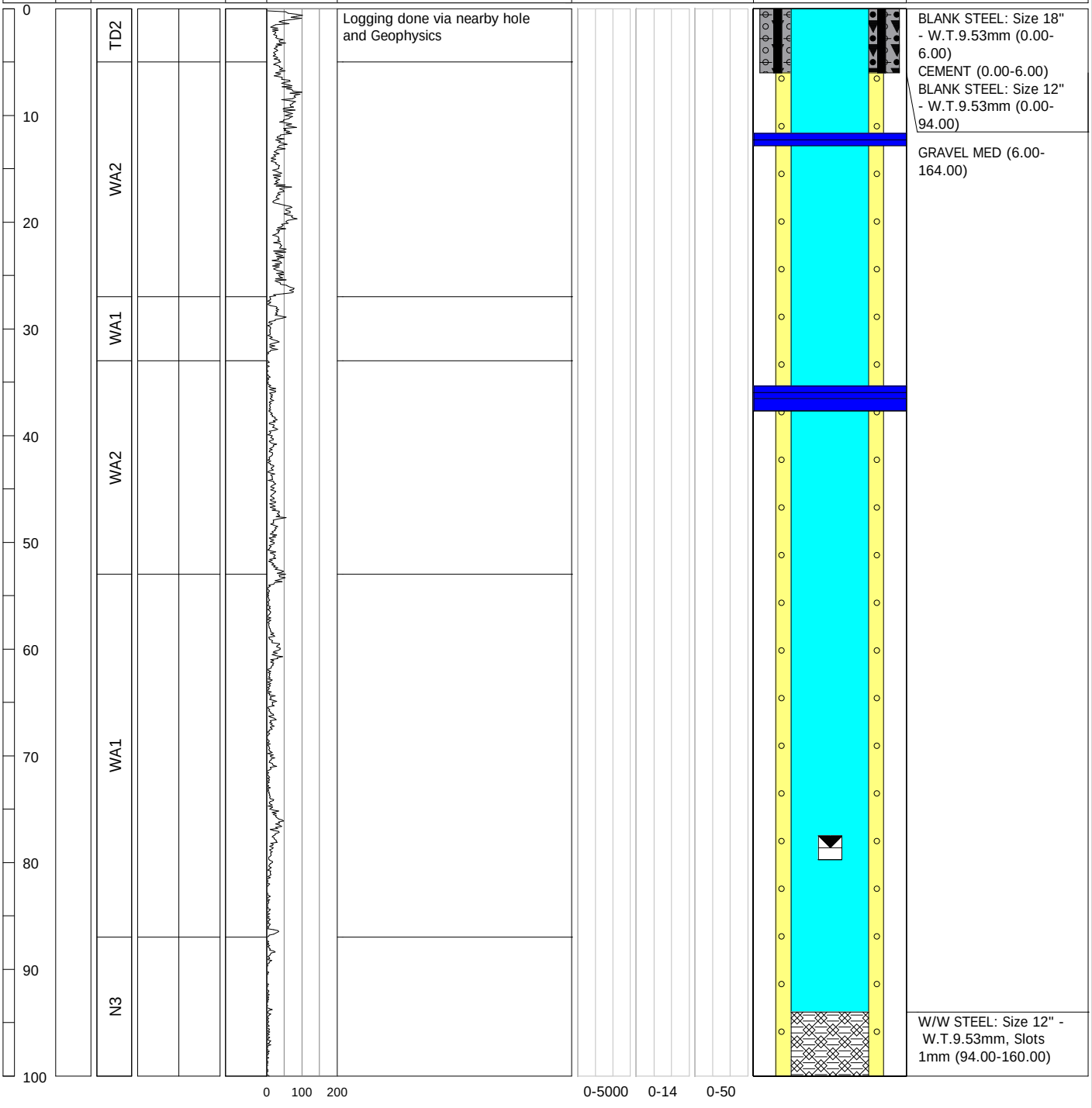
BHP

Project:	NORTH FLANK	Hole Name:	HGC0265	Hole Length:	164.00

Easting: 701250.98
Northing: 7463359.39
Surface RL: 605.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Nov 20 - 16 Nov 20
License: CAW202447
Comments: Logging done via nearby hole and Geophysics

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	ROT	550		WELLDRILL	KS6
6.0 - 164.0	WLDRIG6	ROT	425		WELLDRILL	KS6

TOC RL: 605.80 (Stickup 0.40m) (drilled) SWL: 78.61 MBTOC (19 Nov 20) Dev: Y: 13.5 hour(s) Final pH: 8.6
TOC RL: 569.52 - (current) Is Live: Y (-) Date: 17 Nov 2020 Final EC: 740.00



BHPIO - Hydrogeology Log

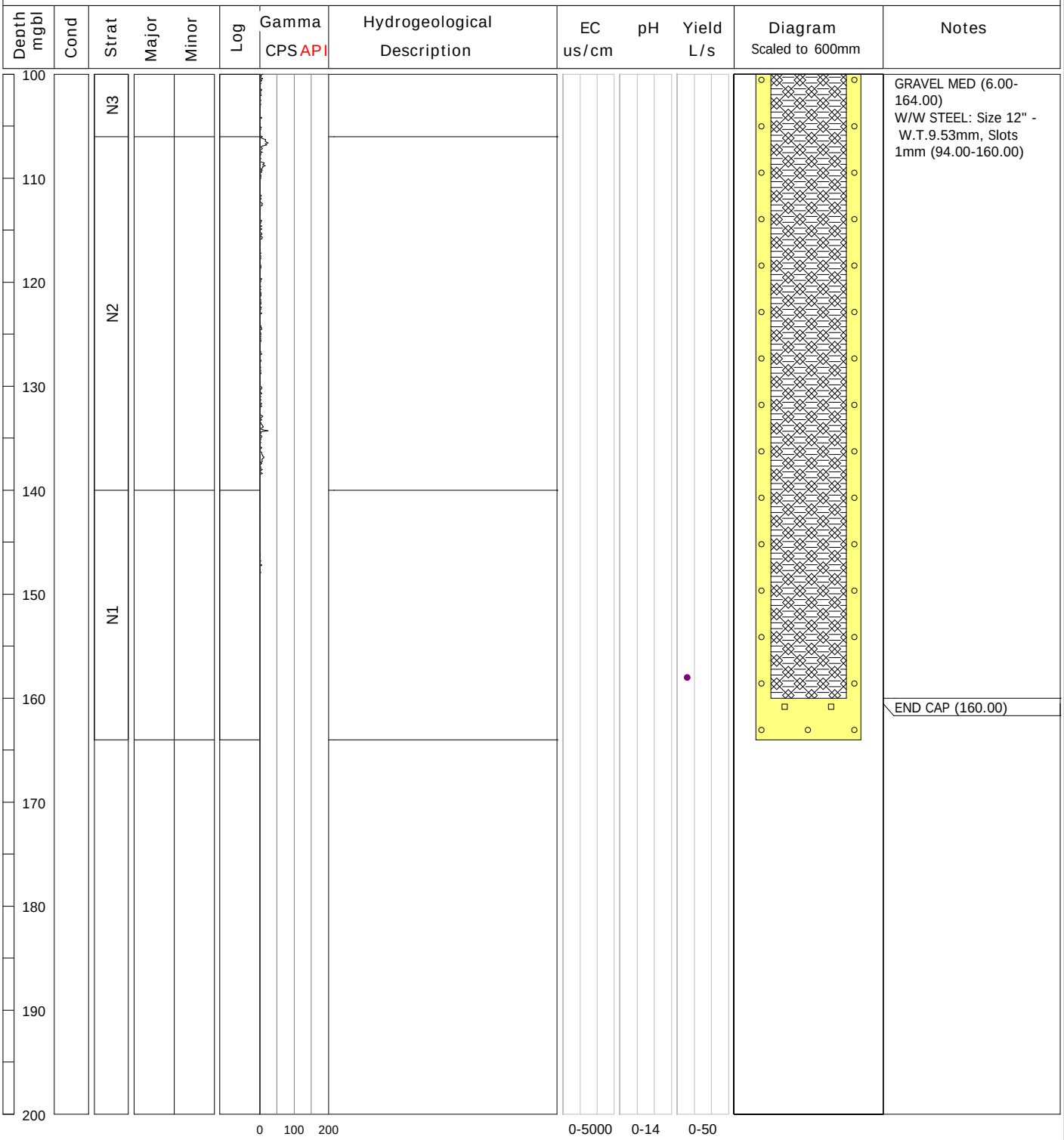
BHP

Project:	NORTH FLANK	Hole Name:	HGC0265	Hole Length:	164.00

Easting: 701250.98
Northing: 7463359.39
Surface RL: 605.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 10 Nov 20 - 16 Nov 20
License: CAW202447
Comments: Logging done via nearby hole and Geophysics

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	ROT	550		WELLDRILL	KS6
6.0 - 164.0	WLDRIG6	ROT	425		WELLDRILL	KS6

TOC RL: 605.80 (Stickup 0.40m) (drilled) SWL: 78.61 MBTOC (19 Nov 20) Dev: Y: 13.5 hour(s) Final pH: 8.6
TOC RL: 569.52 - (current) Is Live: Y (-) Date: 17 Nov 2020 Final EC: 740.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0002	Hole Length:	102.00

Easting: 697447.38
Northing: 7462570.21
Surface RL: 617.99
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 12 Sep 09 - 19 Sep 09
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 2.4	NUDRIG8	CRR	300	Air/Water	NUDRILL	BDW
2.4 - 102.0	NUDRIG8	CH	381	Air/Water/Foam	NUDRILL	BDW

TOC RL: 644.88 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 635.50 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Brown/grey small angular gravels and large weathered gravels, minor brown shale and hematite					BLANK STEEL: 250mm (0.00-18.00) GRAVEL AGG (0.00-102.00)
20							Brown/grey angular gravels with minor shales. Martite goethite content last 4m with increasing orange chert					SLOTTED STEEL: 250mm (18.00-96.00)
40							Orange grey biffy chert, partially weathered, brown shales present.					
							Grey 70% hematite, minor brown shale, cream and ferruginous chert, trace quartz					
50							Brown grey chert in silt matrix, red and brown shale					
							Grey 60% hematite 40% orange and cream chert. Increasing quartz content. Occasional red stained hematite with pyrite present on joint surfaces. Trace shales					
70							Same as above:					
80							Same as above:					
90							Same as above					
100												BLANK STEEL: 250mm (96.00-102.00)
						0 100 200			0-5000	0-14	0-50	

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0002	Hole Length:	102.00

Easting: 697447.38
Northing: 7462570.21
Surface RL: 617.99
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 12 Sep 09 - 19 Sep 09
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 2.4	NUDRIG8	CRR	300	Air/Water	NUDRILL	BDW
2.4 - 102.0	NUDRIG8	CH	381	Air/Water/Foam	NUDRILL	BDW

TOC RL: 644.88 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 635.50 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100							Same as above					GRAVEL AGG (0.00-102.00)
110												
120												SLOTTED STEEL: 250mm (18.00-96.00) BLANK STEEL: 250mm (96.00-102.00)
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 155

BHPIO - Hydrogeology Log

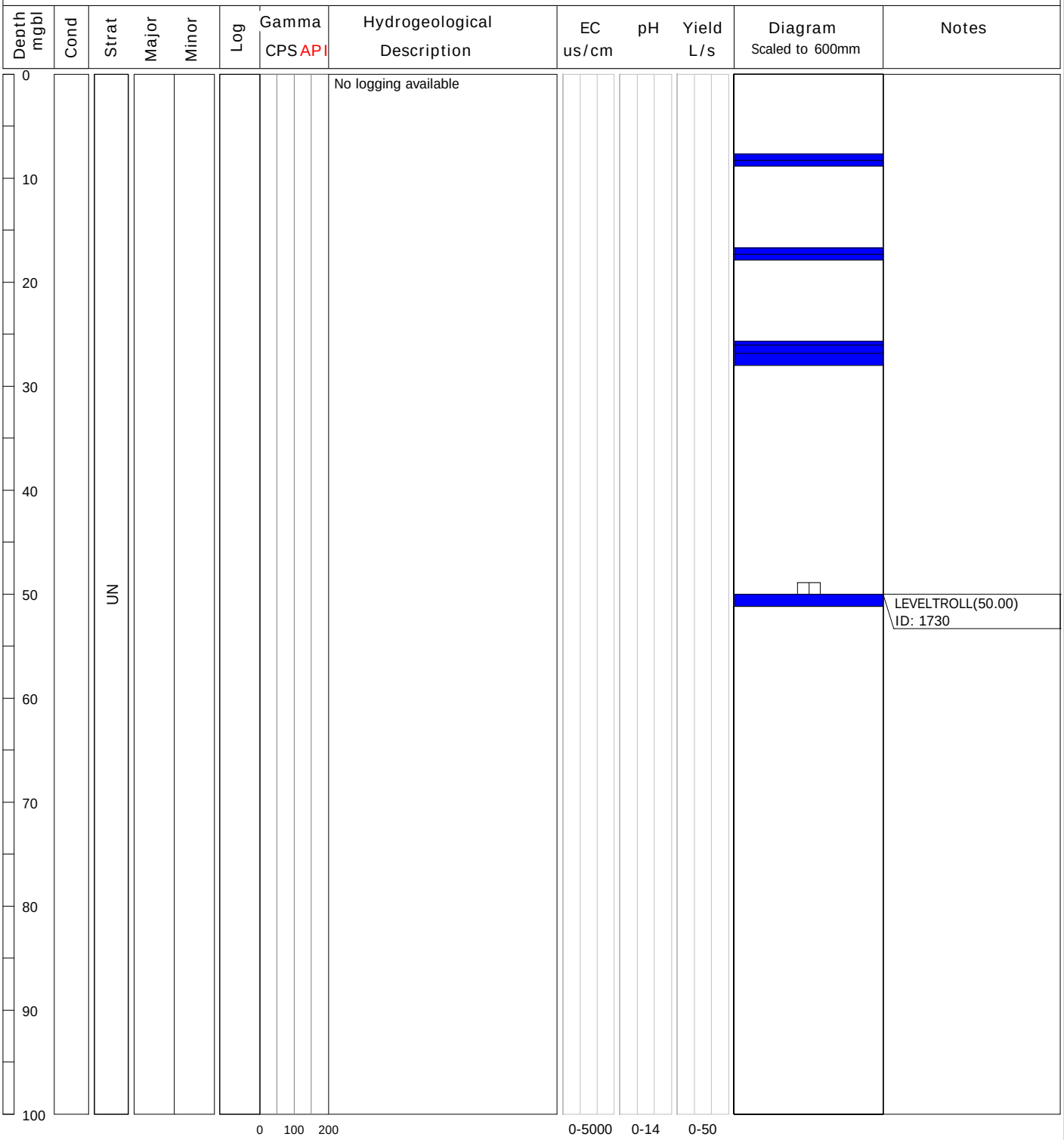
BHP

Project:	NORTH FLANK	Hole Name:	HGE0004	Hole Length:	118.00

Easting: 697658.71
Northing: 7462602.13
Surface RL: 634.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 2.0	UNKN	CH	559		UNKN	UNKN
2.0 - 118.0	UNKN	CH	432		UNKN	UNKN

TOC RL: 635.11 (Stickup 0.51m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 584.00 - (current) Is Live: N (01 Jun 21) Date: - Final EC: -



Program: Planned Hole: Page: 156

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK Hole Name: HGE0004 Hole Length: 118.00

Easting: 697658.71
Northing: 7462602.13
Surface RL: 634.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 2.0	UNKN	CH	559		UNKN	UNKN
2.0 - 118.0	UNKN	CH	432		UNKN	UNKN

TOC RL: 635.11 (Stickup 0.51m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 584.00 - (current) Is Live: N (01 Jun 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		UN					No logging available					
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 157

BHPIO - Hydrogeology Log

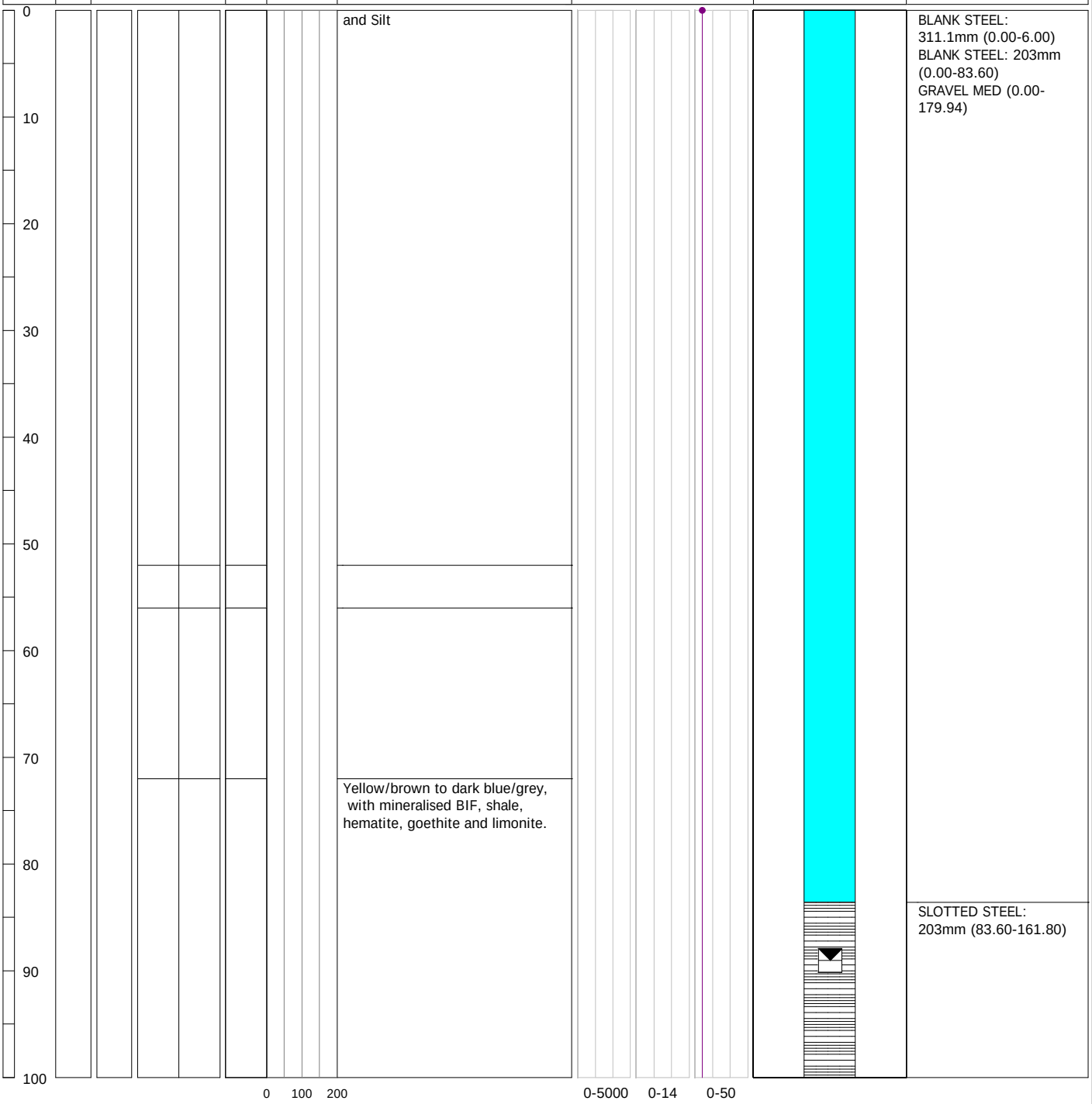
BHP

Project:	NORTH FLANK	Hole Name:	HGE0005	Hole Length:	184.00

Easting: 694047.53
Northing: 7462491.78
Surface RL: 734.11
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jul 05 - 19 Jul 05
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	NUDRIG1	CH	444	Air/foam	NUDRILL	DTG
6.0 - 184.0	NUDRIG1	CH	311	Air/foam	NUDRILL	DTG

TOC RL: 734.35 - (drilled) SWL: 89.03 MBGL (22 Jul 05) Dev: N Final pH: -
TOC RL: 734.35 - (current) Is Live: N (30 Jan 23) Date: - Final EC: -



Program: Planned Hole: Page: 158

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0005	Hole Length:	184.00

Easting: 694047.53
Northing: 7462491.78
Surface RL: 734.11
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jul 05 - 19 Jul 05
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	NUDRIG1	CH	444	Air/foam	NUDRILL	DTG
6.0 - 184.0	NUDRIG1	CH	311	Air/foam	NUDRILL	DTG

TOC RL: 734.35 - (drilled) SWL: 89.03 MBGL (22 Jul 05) Dev: N Final pH: -
TOC RL: 734.35 - (current) Is Live: N (30 Jan 23) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 600mm | Notes

100 110 120 130 140 150 160 170 180 190 200

Yellow/brown to dark blue/grey, with mineralised BIF, shale, hematite, goethite and limonite.

0 100 200

0-5000 0-14 0-50

GRAVEL MED (0.00-179.94)
SLOTTED STEEL: 203mm (83.60-161.80)
LEVELTROLL(140.00) ID: 2142
S/S SCREEN: 203mm (161.80-173.81)
SLOTTED STEEL: 203mm (173.81-179.94)
FALLBACK (179.94-184.00)

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0007	Hole Length:	190.50

Easting: 698429.79
Northing: 7462950.48
Surface RL: 696.57
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Nov 10 - 16 Dec 10
Comments: Logged by AQT;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	NUDRIG8	DR	406	Air/foam	NUDRILL	SB2
120.0 - 160.0	NUDRIG8	DR	330	Air/foam	NUDRILL	SB2
160.0 - 190.5	NUDRIG8	CH	305	Air/Water/Foam	NUDRILL	SB2

TOC RL: 690.00 - (drilled) SWL: 73.36 MBTOC (22 Dec 10) Dev: N Final pH: -
TOC RL: 690.00 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 600mm | Notes

0 – 10: Red-brown, poorly sorted, rounded to sub-rounded, silty gravel with some clay. Gravel clasts include maghemite, magnetite, goethite and limonite

10 – 46: Red-brown, poorly sorted, rounded to sub-rounded, silty gravel with some clay. Gravel clasts include maghemite, magnetite, goethite and limonite

46 – 78: Red-brown, poorly sorted, rounded to sub-rounded, silty gravel with some clay. Gravel clasts include vitreous goethite and limonite Redish brown clay 62-64m calcrete 64-78m

78 – 100: Yellow-white calcrete, shale band at 102m

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Notes:
BLANK STEEL: 250mm (0.00-70.50)
BLANK STEEL: 405mm (0.00-120.00)
GRAVEL MED: (0.00-191.00)
SLOTTED STEEL: 250mm , Slots 1mm (70.50-190.50)

Program: Planned Hole: Page: 160

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0007	Hole Length:	190.50

Easting: 698429.79
Northing: 7462950.48
Surface RL: 696.57
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Nov 10 - 16 Dec 10
Comments: Logged by AQT;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 120.0	NUDRIG8	DR	406	Air/foam	NUDRILL	SB2
120.0 - 160.0	NUDRIG8	DR	330	Air/foam	NUDRILL	SB2
160.0 - 190.5	NUDRIG8	CH	305	Air/Water/Foam	NUDRILL	SB2

TOC RL: 690.00 - (drilled) SWL: 73.36 MBTOC (22 Dec 10) Dev: N Final pH: -
TOC RL: 690.00 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 600mm | Notes

100
110
120
130
140
150
160
170
180
190
200

Yellow-white calcrete, shale band at 102m

Dolmite fractured, precipitaction evident on fracture surfaces, varying grades of weathering

0 100 200

0-5000 0-14 0-50

BLANK STEEL: 405mm (0.00-120.00)
GRAVEL MED: (0.00-191.00)
SLOTTED STEEL: 250mm , Slots 1mm (70.50-190.50)

END CAP (190.50)

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0120	Hole Length:	112.00

Easting: 697534.17
Northing: 7462610.39
Surface RL: 625.83
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Apr 12 - 02 May 12
Comments: logged by Aaron Noakes, PBE6P

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 112.0	CNDWW17	DR	432	AIR/WATER/FOAM	CONNECTOR	AN3

TOC RL: 626.16 (Stickup 0.33m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 572.38 - (current) Is Live: N (01 Jun 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		N3					Check hole hge0119.					BLANK STEEL: 400mm (0.00-6.00)
10												BLANK STEEL: Size 14" - 350 (0.00-36.00)
20												GRAVEL UNKN (0.00-112.00)
30												
40		N2					Check hole hge0119.					SLOTTED STEEL: Size 14" - 350, Slots 1mm (36.00-109.00)
50												
60												LEVELTROLL(57.44) ID: 1496
70												
80												
90			GW				Good looking ore, chips are 70% w 30% g. Strat n2?? quite shaley - shales of variable colous. Quick penetration rate.					
			GW				Same as above.					
100		N3	GW	S			Lots of yellow green bwn shale chips. Single peice of quartz.					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGE0120 **Hole Length:** 112.00

Easting: 697534.17
Northing: 7462610.39
Surface RL: 625.83
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Apr 12 - 02 May 12
Comments: logged by Aaron Noakes, PBE6P

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 112.0	CNDWW17	DR	432	AIR/WATER/FOAM	CONNECTOR	AN3

TOC RL: 626.16 (Stickup 0.33m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 572.38 - (current) Is Live: N (01 Jun 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		N3	GW	S			Lots of yellow green bwn shale chips. Single peice of quartz.					GRAVEL UNKN (0.00-112.00)
			GW				Hg ore, chips are very fine compaed to above,					SLOTTED STEEL: Size 14" - 350, Slots 1mm (36.00-109.00)
			GW				Same as above, pentration rate slower than above, maybe less fratured.					
110			GW				Same as above,					
			GW	S			Possibly ns4?? brown to yellow shale.					
120												
130												
140												
150												
160												LEVELTROLL(57.44) ID: 1496
170												BLANK STEEL: Size 14" - 350 (109.00-111.00)
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 163

BHPIO - Hydrogeology Log

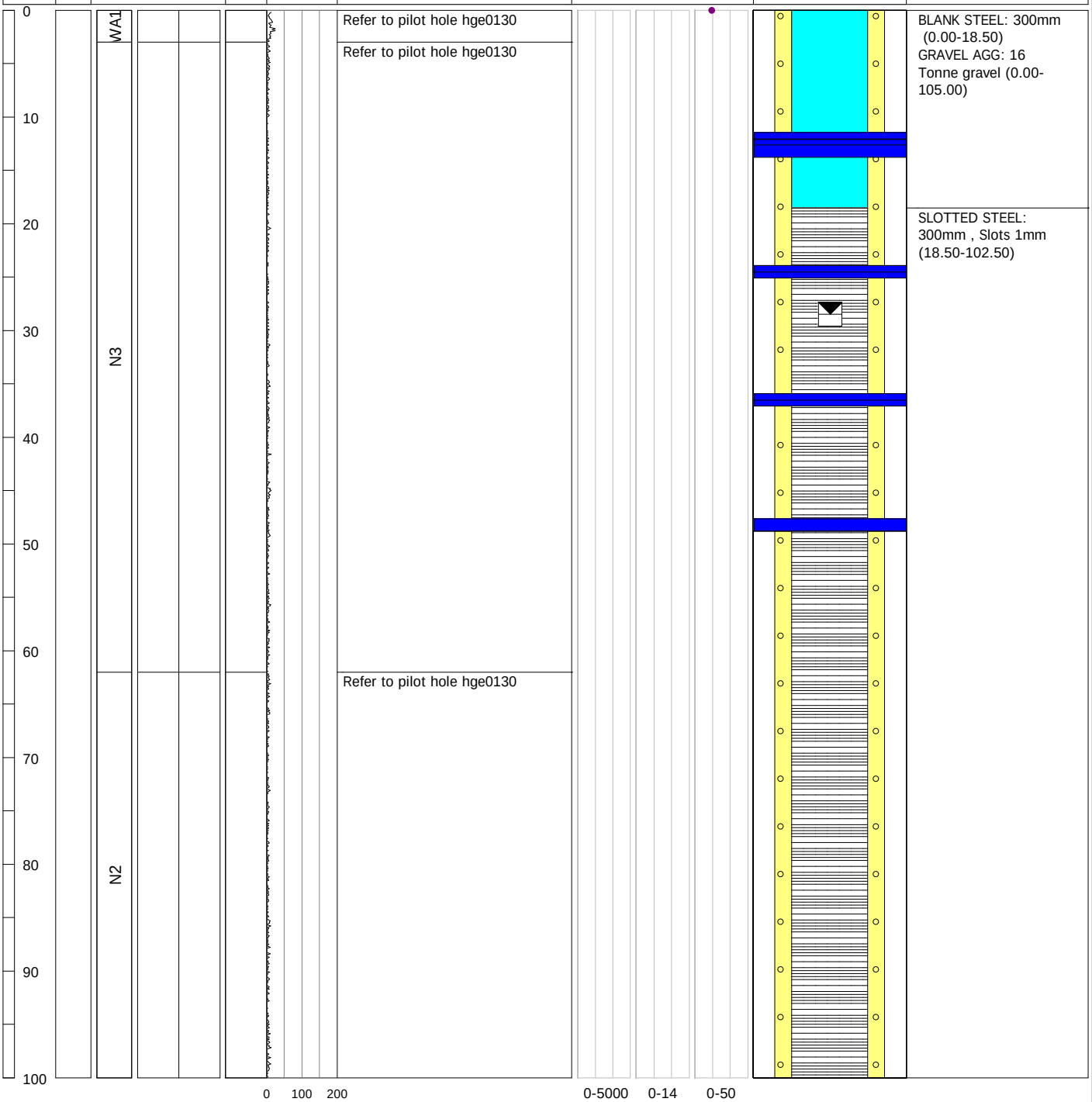
BHP

Project:	NORTH FLANK	Hole Name:	HGE0131	Hole Length:	108.00

Easting: 698358.25
Northing: 7462644.54
Surface RL: 608.52
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 Aug 12 - 25 Aug 12
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	CNDWW17	DR	432	AIR/WATER/FOAM	CONNECTOR	PM2
62.0 - 108.0	CNDWW17	CH	432	AIR/WATER/FOAM	CONNECTOR	PM2

TOC RL: 608.52 (Stickup 0.30m) (drilled) SWL: 28.48 MBTOC (31 Aug 12) Dev: N Final pH: -
TOC RL: 560.30 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -



Program: Planned Hole: Page: 164

BHPIO - Hydrogeology Log

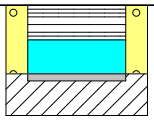
BHP

Project:	NORTH FLANK	Hole Name:	HGE0131	Hole Length:	108.00

Easting: 698358.25
Northing: 7462644.54
Surface RL: 608.52
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 18 Aug 12 - 25 Aug 12
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	CNDWW17	DR	432	AIR/WATER/FOAM	CONNECTOR	PM2
62.0 - 108.0	CNDWW17	CH	432	AIR/WATER/FOAM	CONNECTOR	PM2

TOC RL: 608.52 (Stickup 0.30m) (drilled) SWL: 28.48 MBTOC (31 Aug 12) Dev: N Final pH: -
TOC RL: 560.30 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		N2					Refer to pilot hole hge0130					GRAVEL AGG: 16 Tonne gravel (0.00-105.00) SLOTTED STEEL: 300mm , Slots 1mm (18.50-102.50) BLANK STEEL: 300mm (102.50-105.00) END CAP (105.00) FALLBACK (105.00-108.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0174	Hole Length:	168.00

Easting: 691024.57
Northing: 7462635.93
Surface RL: 721.48
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Apr 15 - 13 Apr 15
Comments: E-West Monitoring Bores (EWM2)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 168.0	MCYWW06	CH	200		MCKAY	ME

TOC RL: - (Stickup 0.65m) (drilled) SWL: 64.70 MBGL (24 Apr 15) Dev: Y: 0.3 hour(s) Final pH: -
TOC RL: 724.46 - (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZGW	X			gravel and silt (surface scree) reddish brown, sub angular, trace roots,moderately weathered. some vitreous goethite.					CEMENT: (0.00-1.00) BLANK STEEL: 234mm : (0.00-6.00) BLANK PVC: Size 50 - Class 18 (0.00-71.36) GRAVEL MED: (0.00-167.40)
			ZGW	X								
			ZWH	GXT								
10		TD3					CLAY, gravelly, (CLAY), Red and Brown, Extremely Weathered, Very Soft, Poorly graded, Sub-rounded. gravel and silt (surface scree) reddish brown, sub angular, trace roots, moderately weathered. some vitreous goethite.					
20							CLAY, gravelly, (CLAY), Red and Brown, Extremely Weathered, Very Soft, Poorly graded, Sub-rounded. gravel and silt (gravelly siltstone), reddish brown, sub angular to sub rounded, magnetic pisolites, reddish clay increasing from8m , increased drilling foam at 8m, sample mainly hematitic shale and clay dominated with trace chips, trace qtz, decrease in clay content from18-22m, chips size increasing at 28m to ~ 0.5mm with less shale, increase in chips, vitreous goethite and shales decreasing but becoming more sticky from 42m,					
30												
40												
50			ZWH	GXT								
60		WA2	SG	KJ			GRAVEL, silty, (SILTSTONE), Red and Brown, Extremely Weathered, Soft, Poorly graded, Sub-angular. gravel and silt (gravelly siltstone), reddish brown, sub angular to sub rounded, magnetic pisolites, reddish clay increasing from8m , increased drilling foam at 8m, sample mainly hematitic shale and clay dominated with trace chips, trace qtz, decrease in clay content from18-22m, chips size increasing at 28m to ~ 0.5mm with less shale, increase in chips, vitreous goethite and shales decreasing but becoming more sticky from 42m,					
70												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (71.36-167.36)
80		WA1	S	JG								
90		N3	GJ	KS			UNMINERALISED BIF, (WA2), Brown and Yellow, Extremely Weathered, Very Weak Rock. unmineralised bif (west angela member), light yellow brown, sub angular chips, mostly yellow shale, trace vitreous goethite, some kaolinite chips, increase in drilling foam in sample					
100												LEVELTROLL(98.00) ID: 2184
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

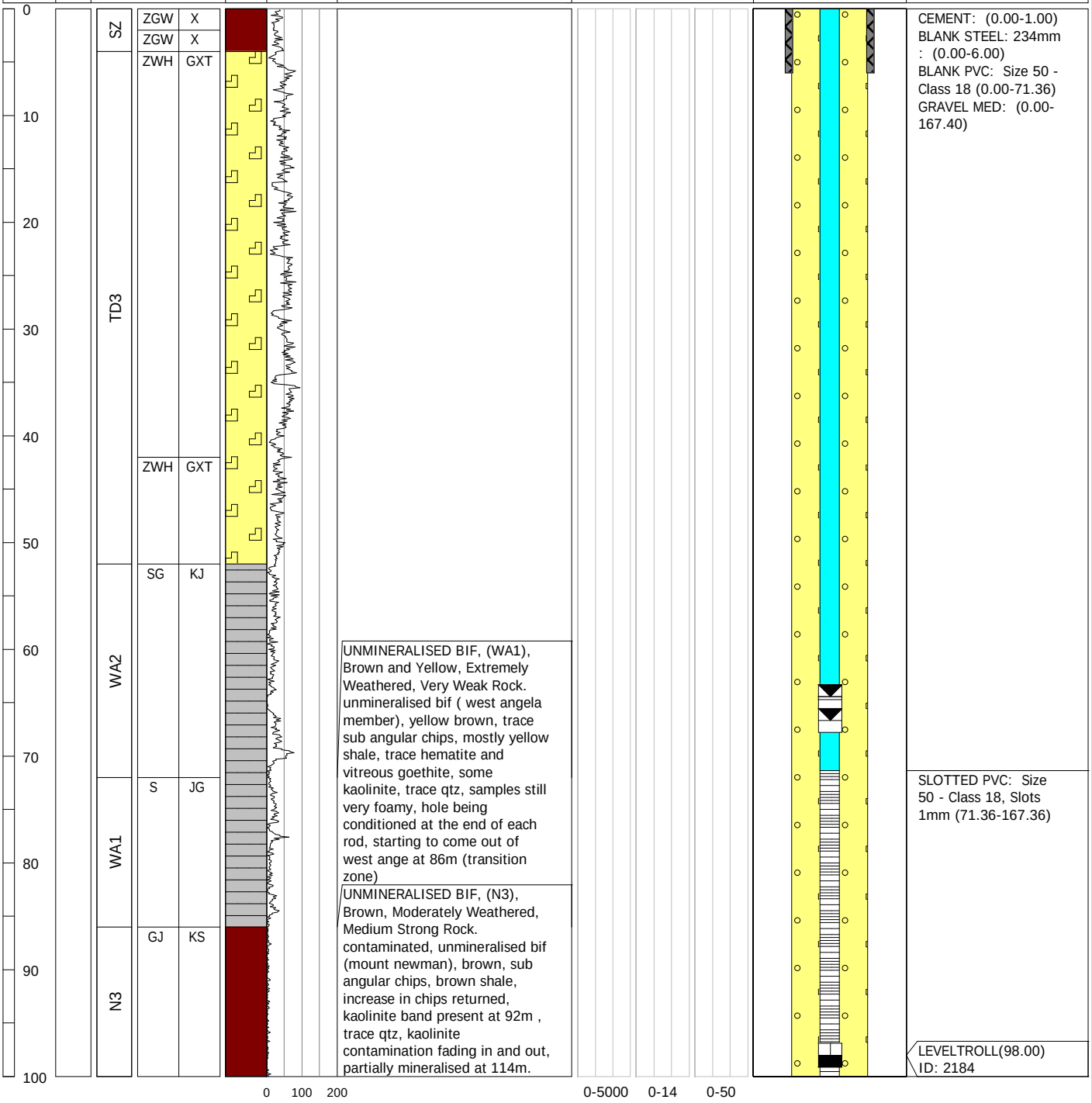
BHP

Project:	NORTH FLANK	Hole Name:	HGE0174	Hole Length:	168.00

Easting: 691024.57
Northing: 7462635.93
Surface RL: 721.48
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Apr 15 - 13 Apr 15
Comments: E-West Monitoring Bores (EWM2)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 168.0	MCYWW06	CH	200		MCKAY	ME

TOC RL: - (Stickup 0.65m) (drilled) SWL: 64.70 MBGL (24 Apr 15) Dev: Y: 0.3 hour(s) Final pH: -
TOC RL: 724.46 - (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0174	Hole Length:	168.00

Easting: 691024.57
Northing: 7462635.93
Surface RL: 721.48
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Apr 15 - 13 Apr 15
Comments: E-West Monitoring Bores (EWM2)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 168.0	MCYWW06	CH	200		MCKAY	ME

TOC RL: - (Stickup 0.65m) (drilled) SWL: 64.70 MBGL (24 Apr 15) Dev: Y: 0.3 hour(s) Final pH: -
TOC RL: 724.46 - (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		N3	GJ	KS		0 100 200	UNMINERALISED BIF, (N3), Brown, Moderately Weathered, Medium Strong Rock. contaminated, unmineralised bif (mount newman), brown, sub angular chips, brown shale, increase in chips returned, kaolinite band present at 92m , trace qtz, kaolinite contamination fading in and out, partially mineralised at 114m.	0-5000	0-14	0-50		GRAVEL MED: (0.00-167.40) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (71.36-167.36)
		N2	GJK	H			UNMINERALISED BIF, (N2), Light or White and Brown and red, Moderately Weathered, Medium Strong Rock. contaminated, unmineralised bif, (mount newman) mottled colour, kaolinite contamination in and out of samples, increase in rounded magnetic maghemite from 122m, hematitic weathering on rounded goethite chips, hematite increasing at 122m-130m, increase in magnetic maghemite at 134m with trace kaolinite, kaolinite increasing at 136m, large silicous goethite chips with internal vitreous goethite weathering.					
		N1	K	GJ			UNMINERALISED BIF, (N1), Light or White and Yellow, Moderately Weathered, Medium Strong Rock. contaminated, unmineralised bif, (mount newman) large kaolinite and bif chips ~ 3cm in length, trace red staining on kaolinite, some qtz up to 1cm at 142m, some well rounded goethite and subangular silicous goethite and large bif chips at 156m sample still very contaminated, sample mainly kaolinite at 160m, extremely hard bif at 164m, 4cm in length and visible silica crystals within the silica bands of the bif on fresh surfaces at 156m.					LEVELTROLL(98.00) ID: 2184 END CAP: (167.36) FALLBACK: (167.40-168.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0175	Hole Length:	132.00

Easting: 690563.14
Northing: 7462577.87
Surface RL: 717.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Apr 15 - 24 Apr 15
Comments: E-West Monitoring Bores (EWM1)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 132.0	MCYWW06	CH	200		MCKAY	ME, RK2

TOC RL: 718.22 (Stickup 0.83m) (drilled) SWL: 57.82 MBGL (24 Apr 15) Dev: Y: 0.2 hour(s) Final pH: 8.0
TOC RL: 718.49 (Stickup 1.10m) (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: 652.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZG	WX			GRAVEL, silty, (SILTSTONE), Red and Brown, Extremely Weathered, Stiff, Poorly graded, Sub-angular. gravel and silt, (surface scree) reddish brown, sub angular to sub rounded chips, moderatley weathered, some rounded magnetic pusolites					CEMENT (0.00-0.60) BLANK STEEL: 234mm : Actually 8" (0.00-6.00) BLANK PVC: Size 50 - Class 18 (0.00-86.00) AB FOAM: (0.60-2.00) OPEN HOLE (2.00-25.00)
10		TD3	ZGW	KXJ								
20							GRAVEL, silty, (SILTSTONE), Red and Brown, Extremely Weathered, Stiff, Poorly graded, Sub-angular. gravel and silt (gravelly siltstone) reddish brown, sub angular to sub rounded, some brown shale material at 6m, some magnetic rounded pisolites, clays increasing from 8m can be moulded under light pressure, some hemaitite pisolites at 14m, drill foam increase at 14m, trace chert at 18m, bif increasing from 22m, sample mostly clay at 26m, martite increasing at 28m to 32m with sticky clays					GRAVEL MED: The gravel pack during airlift did not drop. Massive void around 25mbgl in the detritals, 8 tonne of gravel was used and it did not come up. (25.00-69.00)
30												
40		TD2	ZW	GX								
50							GRAVEL, silty, (SILTSTONE), Red and Brown, Extremely Weathered, Firm, Poorly graded, Sub-rounded. gravel and some silt (gravelly siltstone), hardcapped, reddish brown, subrounded , chips up to 1cm, less clays, rounded martitic pisolites,becoming sub angular from 42m, brecciated texture at44m, broken ground at 44m, some brown clay at 48m, increase in limonite at 56m					
60		WA2	SWL									
70		WA1	SG	C			PARTIALLY MINERALISED, (WA2), Yellow, Moderately Weathered, Medium Strong Rock. sub mineralised bif (west angela member) yellow, yellow shales with mineralised martite, some hematite and hematitc cherts, moderatley hard, increased drilling foam at 60m,					FALLBACK (69.00-132.00)
80		N3	G	WC								
90			G	W			UNMINERALISED BIF, (WA1), Brown and Yellow, Moderately Weathered, Medium Strong Rock. unmineralised bif (west angela member) yellowish brown, sub angular, yellow shale, some brown and yellow chert, trace kaolinite at 68m, increase in white shales at 72m					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (86.00-132.00)
100			G	W								LEVELTROLL(99.50) ID: 2185

0 100 200 0-5000 0-14 0-50

Program: FY15 E Deposit Hydro Planned Hole: HGE_FY15_EWM1 Page: 169

BHPIO - Hydrogeology Log

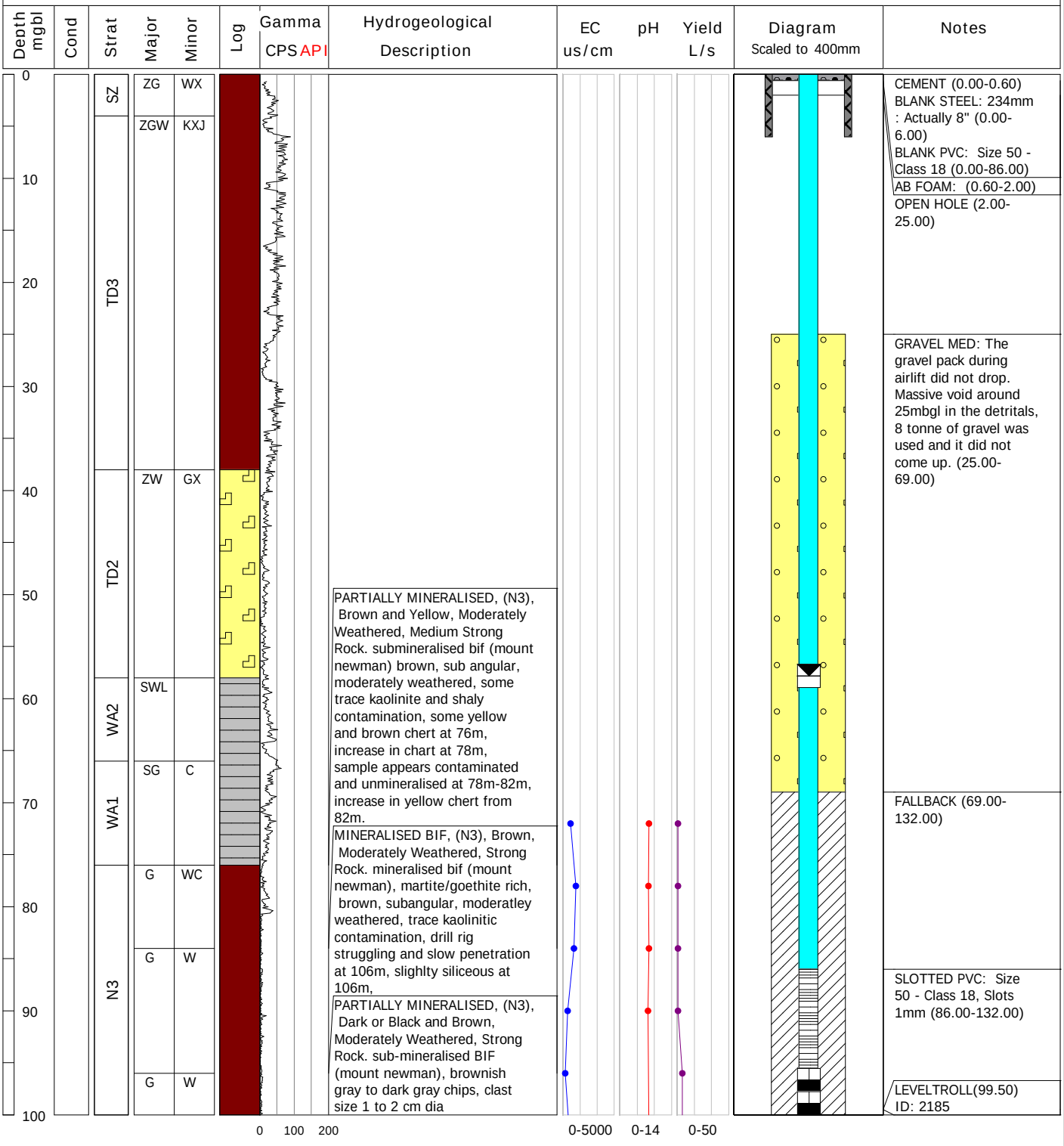
BHP

Project:	NORTH FLANK	Hole Name:	HGE0175	Hole Length:	132.00

Easting: 690563.14
Northing: 7462577.87
Surface RL: 717.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Apr 15 - 24 Apr 15
Comments: E-West Monitoring Bores (EWM1)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 132.0	MCYWW06	CH	200		MCKAY	ME, RK2

TOC RL: 718.22 (Stickup 0.83m) (drilled) SWL: 57.82 MBGL (24 Apr 15) Dev: Y: 0.2 hour(s) Final pH: 8.0
TOC RL: 718.49 (Stickup 1.10m) (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: 652.00



BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0175	Hole Length:	132.00

Easting: 690563.14
Northing: 7462577.87
Surface RL: 717.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Apr 15 - 24 Apr 15
Comments: E-West Monitoring Bores (EWM1)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 132.0	MCYWW06	CH	200		MCKAY	ME, RK2

TOC RL: 718.22 (Stickup 0.83m) (drilled) SWL: 57.82 MBGL (24 Apr 15) Dev: Y: 0.2 hour(s) Final pH: 8.0
TOC RL: 718.49 (Stickup 1.10m) (current) Is Live: Y (-) Date: 24 Apr 2015 Final EC: 652.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		N3	G	W			PARTIALLY MINERALISED, (N3), Dark or Black and Brown, Moderately Weathered, Strong Rock. sub-mineralised BIF (mount newman), brownish gray to dark gray chips, clast size 1 to 2 cm dia					FALLBACK (69.00-132.00)
110		N2	G	H			PARTIALLY MINERALISED, (N2), Yellow and Brown, Moderately Weathered, Medium Strong Rock. sub-mineralised BIF, becoming more limonitic, slightly larger clast size (up to 3 cm dia), sub-angular to angular, some sample contaminated from higher intervals, driller indicated broken ground, increase in yield					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (86.00-132.00)
120		N1	J	L			UNMINERALISED BIF, (N1), Red and Brown, Highly Weathered, Medium Strong Rock. unmineralized BIF, appears highly weathered, broken ground, reddish brown well rounded clasts mixed with limonitic clasts					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		LEVELTROLL(99.50) ID: 2185 END CAP (132.00)

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0190	Hole Length:	230.00

Easting: 698452.13
Northing: 7462936.54
Surface RL: 697.59
Grid Name: MGA94_50
Incl / Azm: -89-->69
Construct: 15 Jun 16 - 29 Jun 16
Comments: Dual Rotary

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	450		EASTERNWELL	KKR

License: CAW181097

TOC RL: 697.59 (Stickup 0.00m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 697.59 (Stickup 0.00m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	X	HG			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Extremely Weathered, Non-Cohesive soils, Well graded, Angular. Red brown surface scree. Large angular fragments. Maghemite, hematite and goethite.					CEMENT (0.00-1.00)
10			IX	H			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Soft, Well graded, Rounded. Red brown and purple pisolites. Maghemite and hematite. 40-42m and 60-62m larger pisolites.					BLANK STEEL: Size 20" - W.T.9.53mm (0.00-116.00)
20												BLANK STEEL: Size 12" - W.T.9.53mm (0.00-167.70)
30												GRAVEL MED: Used 32.5 Tonnes (0.00-222.70)
40												
50		TD3										
60												
70			3	I			CALCRETE, (TD3), Yellow and Light or White and brown, Slightly Weathered, Strong Rock. Yellow white brown calcrete and pisolites (possible contamination). Medium sized fragments					
80			3				CALCRETE, (TD3), Yellow, Slightly Weathered, Strong Rock. Yellow calcrete					
90			K3				CALCRETE, (TD3), Yellow and Brown, Slightly Weathered, Strong Rock. Yellow brown clay/ shale and calcrete.					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0190	Hole Length:	230.00

Easting:	698452.13
Northing:	7462936.54
Surface RL:	697.59
Grid Name:	MGA94_50
Incl / Azm:	-89-->69
Construct:	15 Jun 16 - 29 Jun 16
Comments:	Dual Rotary

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	450		EASTERNWELL	KKR

License: CAW181097

TOC RL: 697.59 (Stickup 0.00m) (drilled) SWL: Dev: N Final pH: -

TOC RL: 697.59 (Stickup 0.00m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		TD3	K3				CALCRETE, (TD3), Yellow and Brown, Slightly Weathered, Strong Rock. Yellow brown clay/ shale and calcrete.					BLANK STEEL: Size 20" - W.T.9.53mm (0.00-116.00)
110			IX	G			QUATERNARY DETRITAL, (TD3), Yellow and Dark or Black, Slightly Weathered, Strong Rock. Yellow black pisolites (maghemite) and goethite					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-167.70)
120		TD2	G				MINERALISED BIF, (TD2), Yellow, Slightly Weathered, Strong Rock. Yellow goethite, small to medium chips.					GRAVEL MED: Used 32.5 Tonnes (0.00-222.70)
			S				SHALE, (TD2), Yellow, Extremely Weathered, Very Weak Rock. Yellow clay/shale					
130		OB	J	GQ			PARTIALLY MINERALISED, (OB), Yellow and Brown and red, Slightly Weathered, Strong Rock. Yellow brown red BIF. Goethite with minor hematite. Large quartz fragments. Fracture/fault with large fragments 130-132m, 134-138m, 140-142m.					
140												
150			DC	S			DOLOMITE, (OB), Grey and Light or White and red, Slightly Weathered, Medium Strong Rock. Grey white red dolomite and chert with minor manganese rich shale. Fractured. Large chips 1-2cm. Large quartz fragments.					
160												
170			D	NS			DOLOMITE, (OA), Brown and Yellow and grey, Slightly Weathered, Medium Strong Rock. Brown yellow grey dolomite, manganese rich shale. fuggy/leached ore. Fractured with large fragments 1-2cm.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (167.70-227.70)
180		OA					DOLOMITE, (OA), Grey, Fresh, Very Strong Rock. Grey dolomite and manganese rich shale. Large fragments (1-2cm) 192-196m.					
			D	NS			FRESH MAGNETIC BIF, (MN), Brown and Dark or Black, Slightly Weathered, Very Strong Rock. Brown black weathered BIF. Slightly magnetic. Minor dolomite.					
190												
		MN	J	D			DOLOMITE, (MN), Grey and Dark or Black, Fresh, Extremely Strong Rock. Grey black fresh dolomite. Fracture 200-204m.					
200			D									
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0190	Hole Length:	230.00

Easting: 698452.13
Northing: 7462936.54
Surface RL: 697.59
Grid Name: MGA94_50
Incl / Azm: -89-->69
Construct: 15 Jun 16 - 29 Jun 16
Comments: Dual Rotary

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	450		EASTERNWELL	KKR

License: CAW181097

TOC RL: 697.59 (Stickup 0.00m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 697.59 (Stickup 0.00m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200		MN	D				DOLOMITE, (MN), Grey and Dark or Black, Fresh, Extremely Strong Rock. Grey black fresh dolomite. Fracture 200-204m.					GRAVEL MED: Used 32.5 Tonnes (0.00-222.70)
210			J				FRESH MAGNETIC BIF, (MN), Dark or Black and Brown, Fresh, Extremely Strong Rock. Black brown fresh magnetic BIF. Minor quartz and chert.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (167.70-227.70)
220												
230												END CAP (227.70) FALLBACK (227.70-230.00)
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

Program: MAC FY16 DEWATERING DRILLING
Planned Hole: HGE0190

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0228	Hole Length:	58.00

Easting: 696130.07
Northing: 7462469.67
Surface RL: 644.15
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Feb 17 - 09 Feb 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 58.0	WLDRIG5	CH	200		WELLDRILL	YA

TOC RL: 644.83 (Stickup 0.68m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 644.83 (Stickup 0.68m) (current) Is Live: N (04 Apr 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		MN	J				UNMINERALISED BIF, (MN), Brown and Yellow, Fresh, Medium Strong Rock.					BLANK PVC: Size 50 - Class 18 (0.00-52.00)
30		MM	J				UNMINERALISED BIF, (MM), Brown and Yellow, Fresh, Medium Strong Rock.					LEVELTROLL(50.00) ID: 2530; SLOTTED PVC: Size 50 - Class 18, Slots 1mm (52.00-58.00)
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0236	Hole Length:	87.00

Easting: 694561.71
Northing: 7462488.54
Surface RL: 644.18
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Nov 18 - 09 Nov 18
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 87.0	ED1524	RHF	140		ANW	RM7

TOC RL: 645.40 - (drilled) SWL: 51.00 MBGL (09 Nov 18) Dev: N Final pH: -
TOC RL: 645.40 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N2					ochgoetite, goetite, trace fine-grained shale, low grade					BLANK PVC: Size 50 - Class 18 (0.00-60.00) OPEN HOLE (0.00-84.00)
10							goetite, martite, trace fine-grained shale					
20							ochgoetite, goetite, trace fine-grained shale					
30		N1					goetite, martite, trace ochgoetite, trace shale					
40												
50												
60												SLOTTED PVC: Size 50 - Class 18, Slots 2mm (60.00-84.00)
70												
80												
90												LEVELTROLL(84.00) ID: 1499
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0237	Hole Length:	87.00

Easting: 695063.75
Northing: 7462446.67
Surface RL: 644.11
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Nov 18 - 09 Nov 18
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 87.0	ED1524	RHF	140		ANW	RM7

TOC RL: 645.28 - (drilled) SWL: 57.00 MBGL (09 Nov 18) Dev: N Final pH: -
TOC RL: 645.28 - (current) Is Live: N (09 Nov 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		N3					goetite, ochgoetite, trace shale, low grade					BLANK PVC: Size 50 - Class 18 (0.00-63.00) OPEN HOLE (0.00-87.00)
10												
20												
25		N2					goetite, trace shale					
30							goetite, martite, trace fine-grained shale					
40												
50												
55												LEVELTROLL(53.00) ID: 2077
60												
70												SLOTTED PVC: Size 50 - Class 18, Slots 2mm (63.00-87.00)
72		N3					goetite, ochgoetite, trace shale, low grade					
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK | Hole Name: HGE0238 | Hole Length: 105.00

Easting: 695562.91
Northing: 7462607.75
Surface RL: 644.43
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Nov 18 - 08 Nov 18
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 105.0	ED1524	RHF	140		ANW	RM7

TOC RL: 645.73 - (drilled) SWL: 69.00 MBGL (08 Nov 18) Dev: N Final pH: -
TOC RL: 645.73 - (current) Is Live: N (01 Oct 21) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		WA2					clay (shale, ochematite)					BLANK PVC: Size 50 - Class 18 (0.00-78.00) OPEN HOLE (0.00-102.00)
10												
20							ochgoetite, shale, trace chert					
30		WA1					bif, goetite, trace shale					
40							shale, goetite					
50		N3					goetite, ochgoetite, shale, low grade if ore					
60												
70							bif, goetite, shale, trace chert, possibly waste					LEVELTROLL(66.00) ID: 2232
80		N2					goetite, minor fine-grained shale, goetite, waste?					SLOTTED PVC: Size 50 - Class 18, Slots 2mm (78.00-102.00)
90												
100						0 100 200		0-5000	0-14	0-50		

Program: MAC Hydro Monitoring Infill_Part 1 EC Deposit | Planned Hole: HGE0238 | Page: 178

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0238	Hole Length:	105.00

Easting: 695562.91
Northing: 7462607.75
Surface RL: 644.43
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 08 Nov 18 - 08 Nov 18
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 105.0	ED1524	RHF	140		ANW	RM7

TOC RL: 645.73 - (drilled) SWL: 69.00 MBGL (08 Nov 18) Dev: N
TOC RL: 645.73 - (current) Is Live: N (01 Oct 21) Date: -
Final pH: -
Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		N2					goetite, minor fine-grained shale, goetite, waste?					OPEN HOLE (0.00-102.00)
110												
120												
130												
140												
150												
160												
170												LEVELTROLL(66.00) ID: 2232
180												SLOTTED PVC: Size 50 - Class 18, Slots 2mm (78.00-102.00)
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0242	Hole Length:	144.00

Easting: 696118.19
Northing: 7462561.33
Surface RL: 644.14
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Nov 19 - 19 Nov 19
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 144.0	WLDRIG5	CH	200		WELLDRILL	KS6

TOC RL: 645.05 - (drilled) SWL: 52.20 MBTOC (21 Nov 19) Dev: N Final pH: -
TOC RL: 645.05 - (current) Is Live: N (04 Apr 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	N3	JG	K			MINERALISED BIF, (N3), Brown and Yellow, Slightly Weathered, Strong Rock. Bif and geothite with minor clay.					AB FOAM (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-48.00)
10												
20												
30		N2	J	GK			MINERALISED BIF, (N2), Brown and Dark or Black, Slightly Weathered, Strong Rock. Brown and black BIF chips with minor geothite and clay. FWS at 80 metres.					
40												
50												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (48.00-144.00)
60												
70												
80							MINERALISED BIF, (N1), Yellow and Brown, Slightly Weathered, Strong Rock. Yellow and brown geothite with minor BIF and clay.					
		N1	G	JK								
90	BG		J	GQC			PARTIALLY MINERALISED, (N1), Dark or Black and Brown, Slightly Weathered, Strong Rock. BIF with minor geothite/ quartz/chertz. Fracture at 113 metres, corresponding increase in yield. Fibrous materials intersection at 127 to 130m. yield of 5 l/sec at 114 metres.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0242	Hole Length:	144.00

Easting: 696118.19
Northing: 7462561.33
Surface RL: 644.14
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 19 Nov 19 - 19 Nov 19
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 144.0	WLDRIG5	CH	200		WELLDRILL	KS6

TOC RL: 645.05 - (drilled) SWL: 52.20 MBTOC (21 Nov 19) Dev: N Final pH: -
TOC RL: 645.05 - (current) Is Live: N (04 Apr 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	BG	N1	J	GQC			PARTIALLY MINERALISED, (N1), Dark or Black and Brown, Slightly Weathered, Strong Rock. BIF with minor geothite/ quartz/chertz. Fracture at 113 metres, corresponding increase in yield. Fibrous materials intersection at 127 to 130m. yield of 5 l/sec at 114 metres.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (48.00-144.00)
110												
120			JSC				UNMINERALISED BIF, (N1), Dark or Black and Grey, Fresh, Strong Rock. Fresh unmineralised BIF with minor shale and chertz. Maximum yield of 8.6 l/sec recorded at 132 metres.					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0243	Hole Length:	156.00

Easting: 696132.35
Northing: 7462628.48
Surface RL: 644.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Nov 19 - 19 Nov 19
License: CAW201628
Comments: This hole is to be reamed out into a production bore.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 156.0	WLDRIG5	CH	450		WELLDRILL	KS6

TOC RL: 644.98 - (drilled) SWL: 53.63 MBTOC (21 Nov 19) Dev: N Final pH: -
TOC RL: 632.81 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	VA1	H	K			MINERALISED BIF, (WA1), Dark or Black and Brown, Slightly Weathered, Strong Rock. Dark brown hematite with minor clay.					AB FOAM (0.00-2.00)
		N3	K	H			CLAY, (N3), Yellow and Brown, Extremely Weathered, Strong Rock. Brown and yellow clay with minor clay.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-78.00)
10		WA2	K	H			CLAY, (WA2), Brown, Extremely Weathered, Strong Rock. Brown clay with minor hematite.					GRAVEL MED (2.00-156.00)
20												
		WA1	J	K			MINERALISED BIF, (WA1), Brown, Moderately Weathered, Strong Rock. BIF with minor clay					
30												
40												
50												
		N3	J				PARTIALLY MINERALISED, (N3), Brown, Slightly Weathered, Strong Rock. FWS at 80 metres.					
60												
70												
80												S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (78.00-156.00)
90												
		N2	J	GS			UNMINERALISED BIF, (N2), Dark or Black and Yellow, Slightly Weathered, Medium Strong Rock. Fracture at 105 metres. Maximum yield of > 15 l/sec at 150 metres.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0243	Hole Length:	156.00

Easting: 696132.35
Northing: 7462628.48
Surface RL: 644.36
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Nov 19 - 19 Nov 19
License: CAW201628
Comments: This hole is to be reamed out into a production bore.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 156.0	WLDRIG5	CH	450		WELLDRILL	KS6

TOC RL: 644.98 - (drilled) SWL: 53.63 MBTOC (21 Nov 19) Dev: N Final pH: -
TOC RL: 632.81 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N2	J	GS			UNMINERALISED BIF, (N2), Dark or Black and Yellow, Slightly Weathered, Medium Strong Rock. Fracture at 105 metres. Maximum yield of > 15 l/sec at 150 metres.					GRAVEL MED (2.00-156.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (78.00-156.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGE0252 **Hole Length:** 198.00

Easting: 692874.44
Northing: 7462702.27
Surface RL: 716.04
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Aug 21 - 20 Aug 21
Comments: Logging assisted by Gamma

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 32.0	WLDRIG6	CH	300		WELLDRILL	MC9
32.0 - 198.0	WLDRIG6	CH	200		WELLDRILL	MC9

TOC RL: 716.68 (Stickup 0.72m) (drilled) SWL: 100.70 MBTOC (21 Aug 21) Dev: N Final pH: -
TOC RL: 716.68 (Stickup 0.72m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0 - 40	UG	TD2	ZH	KI			GRAVEL, silty, (SCREE), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. No ground water. 2-15mm clasts with gritty silt not cemented. driller reports broken ground					AB FOAM (0.00-2.00) BLANK STEEL: Size 12" - W.T.9.53mm (0.00-18.00) BLANK STEEL: Size 8" - W.T.8.18mm (0.00-40.00) BLANK PVC: Size 50 - Class 18 (0.00-112.00)
30 - 40		UN	V				Void no sample returned					
40 - 50	BG	TD2	ZI	H			GRAVEL, silty, (SCREE), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Rounded. No ground water. 1-10mm piezoliths some gritty silt. driller repots broken ground					
50 - 90	MG	WA2	JG				UNMINERALISED BIF, (WA2), Brown, Moderately Weathered, Medium Strong Rock. No ground water. 2-18mm chips smooth clay feel. potentially some hardcap 84-90. Driller reports hard ground					
90 - 100		N3	JGH	S			MINERALISED BIF, (N3), Brown and Red, Moderately Weathered, Strong Rock. FWS at 138 mbgl. 2-5mm angular to subangular chips with conchoidal fractureand massive fabric. Some martite sparkle. Driller reports competent ground easy drilling					

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0252	Hole Length:	198.00

Easting: 692874.44
Northing: 7462702.27
Surface RL: 716.04
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Aug 21 - 20 Aug 21
Comments: Logging assisted by Gamma

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 32.0	WLDRIG6	CH	300		WELLDRILL	MC9
32.0 - 198.0	WLDRIG6	CH	200		WELLDRILL	MC9

TOC RL: 716.68 (Stickup 0.72m) (drilled) SWL: 100.70 MBTOC (21 Aug 21) Dev: N Final pH: -
TOC RL: 716.68 (Stickup 0.72m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200	MG	N3	JGH	S		0 100 200	MINERALISED BIF, (N3), Brown and Red, Moderately Weathered, Strong Rock. FWS at 138 mbgl. 2-5mm angular to subangular chips with conchoidal fractureand massive fabric. Some martite sparkle. Driller reports competent ground easy drilling	0-5000	0-14	0-50		BLANK PVC: Size 50 - Class 18 (0.00-112.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (112.00-124.00) BLANK PVC: Size 50 - Class 18 (124.00-136.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (136.00-148.00) BLANK PVC: Size 50 - Class 18 (148.00-160.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (160.00-172.00) BLANK PVC: Size 50 - Class 18 (172.00-184.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (184.00-196.00) FALLBACK (196.00-198.00)
		N2	JGS	C			MINERALISED BIF, (N2), Yellow and Grey, Moderately Weathered, Strong Rock. Yield increases. 2-5mm subangular chips evidence of bedding. Driller reports competent ground easy drilling					
	MG	N1	JCH	SG			UNMINERALISED BIF, (N1), Grey and Brown, Moderately Weathered, Strong Rock. Yield increases. 2-5mm subangular chips some martite sparkle. High chert content. Driller reports hard drilling					

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0261	Hole Length:	196.00

Easting: 693917.39
Northing: 7462522.90
Surface RL: 668.05
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 25 Feb 22 - 04 Mar 22
License: CAW205346
Comments: Hole canned 4 m short due to hardground and slow progression

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	550		WELLDRILL	MC9
6.0 - 196.0	WLDRIG6	CH	200		WELLDRILL	MC9

TOC RL:	668.49	(Stickup 0.41m)	(drilled)	SWL:	65.49 MBTOC	(06 Mar 22)	Dev:	Y: 21.3 hour(s)	Final pH:	8.6
TOC RL:	660.52	-	(current)	Is Live:	Y	(-)	Date:	04 Mar 2022	Final EC:	626.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	WA2	JS	GH			MINERALISED BIF, (WA2), Brown and Red, Slightly Weathered, Medium Strong Rock. Fine shaley material that sives out, sub rounded chips 1-10mm					GROUT: Surface Seal (0.00-2.00)
10		WA1	JS	GH			MINERALISED BIF, (WA1), Brown and Red, Slightly Weathered, Medium Strong Rock. Fine shaley material that sives out, sub rounded chips 1-10mm					BLANK STEEL: Size 18" - W.T.9.53mm (0.00-6.00)
20												BLANK STEEL: Size 12" - W.T.9.53mm (0.00-91.00)
30		N3	JG	HL			MINERALISED BIF, (N3), Brown, Moderately Weathered, Medium Strong Rock. Limonite staining throughout, 26-34m sub angular chips 1-10mm, 34-54m angular chips 1-10mm with some rounded chips expressing pitted surfaces					GRAVEL MED: 16 tonne (2.00-196.00)
40												
50												
60		N2	JLS	GH			MINERALISED BIF, (N2), Yellow and Brown, Highly Weathered, Medium Strong Rock. Significantlimonite staining to the extent the samples are Khaki, fine limonite shale that sives out, 54-78m angular to sub angular chips 1-10m, 78-96m angular chips 2-10mm.pitted surfaces throughout. Potential fault zone					
70												
80												
90												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (91.00-145.00)
100		N3	JG	LH			MINERALISED BIF, (N3), Brown and Yellow, Moderately Weathered, Strong Rock. Some limonite staining, evidence of bedding sub angular to sub rounded chips					
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	NORTH FLANK	Hole Name:	HGE0261	Hole Length:	196.00

Easting:	693917.39
Northing:	7462522.90
Surface RL:	668.05
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	25 Feb 22 - 04 Mar 22
Comments:	Hole canned 4 m short due to hardground and slow progression

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	550		WELLDRILL	MC9
6.0 - 196.0	WLDRIG6	CH	200		WELLDRILL	MC9

License: CAW205346

TOC RL:	668.49	(Stickup 0.41m)	(drilled)	SWL:	65.49 MBTOC	(06 Mar 22)	Dev:	Y: 21.3 hour(s)	Final pH:	8.6
TOC RL:	660.52	-	(current)	Is Live:	Y	(-)	Date:	04 Mar 2022	Final EC:	626.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	N3	JG	LH			MINERALISED BIF, (N3), Brown and Yellow, Moderately Weathered, Strong Rock. Some limonite staining, evidence of bedding sub angular to sub rounded chips					GRAVEL MED: 16 tonne (2.00-196.00) SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (91.00-145.00)
110												
120		N2	JC	SG			UNMINERALISED BIF, (N2), Dark or Black and Grey, Slightly Weathered, Very Strong Rock. Some extremly weathered chips that are highly friable and crumble from finger pressure, evidence of water flow. Angular chips 2-10mm some free Qtz					
130												
140												
150	HG											W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (145.00-193.00)
160												
170												
180		N1	JC	S			UNMINERALISED BIF, (N1), Light or White and Grey, Fresh, Very Strong Rock. Fresh waste, very cherty, samples become highly magnetic, free Qtz, angular chips 2-8mm					
190												
200						0 100 200		0-5000	0-14	0-50		END CAP (193.00)

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGF0018 **Hole Length:** 106.00

Easting: 691234.86
Northing: 7462003.76
Surface RL: 703.89
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 Feb 15 - 26 Feb 15
Comments: Method: DR 18" 0-36m, Open hole 18" 36-95m, DR 16" 95-104m.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 36.0	CNDWW17	DR	450		CONNECTOR	KKR
36.0 - 106.0	CNDWW17	DR	400		CONNECTOR	KKR

TOC RL: 704.00 (Stickup 0.11m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 668.00 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		N3	H	GC		Surface scree; brown/orange, iron ore material, minor chert fragments					GRAVEL MED (0.00-36.00)
			H	G		Iron ore material; orange/black, fine and large fragments (2-3cm), martite and minor goethite					BLANK STEEL: 300mm (0.00-68.00)
10											
20		N2	H	S		Iron ore material and shale; black/red, martite dominant, minor shale, medium to fine fragments, 32-34m - chert band					
30											
40											GRAVEL MED (36.00-104.00)
50		N1	H	G		Iron ore material; orange/black, martite with minor goethite, leached ore fragments, medium to large fragments, fws @ 50m					
60											
70											S/S SCREEN: 300mm , Slots 2mm (68.00-104.00)
80		MM	J	HS		Orange/brown to black, sub mineralised martite. Leached ore fragments. Micro banding. Bif, minor shale bands (82-86) weathered bif; black/dark brown, minor quartz and chert fragments, very large fragments (2-4cm), fault/fracture zone, increase in water, leached ore					
						Bif; black/brown, reduced weathering, quartz fragments, leached ore, slow drilling					
90			J	Q		Fresh bif; brown/white, green and brown chert, quartz, slow drilling					
			J	C							
100			C	J		Cherty fresh bif; brown/white/ green, chert rich, minor quartz and pink shale, slow drilling					
					0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: NORTH FLANK **Hole Name:** HGF0018 **Hole Length:** 106.00

Easting: 691234.86
Northing: 7462003.76
Surface RL: 703.89
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 22 Feb 15 - 26 Feb 15
Comments: Method: DR 18" 0-36m, Open hole 18" 36-95m, DR 16" 95-104m.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 36.0	CNDWW17	DR	450		CONNECTOR	KKR
36.0 - 106.0	CNDWW17	DR	400		CONNECTOR	KKR

TOC RL: 704.00 (Stickup 0.11m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 668.00 - (current) Is Live: N (01 Nov 18) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		MM	C	J			Cherty fresh bif; brown/white/ green, chert rich, minor quartz and pink shale, slow drilling					GRAVEL MED (36.00-104.00)
110												S/S SCREEN: 300mm , Slots 2mm (68.00-104.00)
120												END CAP (104.00)
130												FALLBACK (104.00-106.00)
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

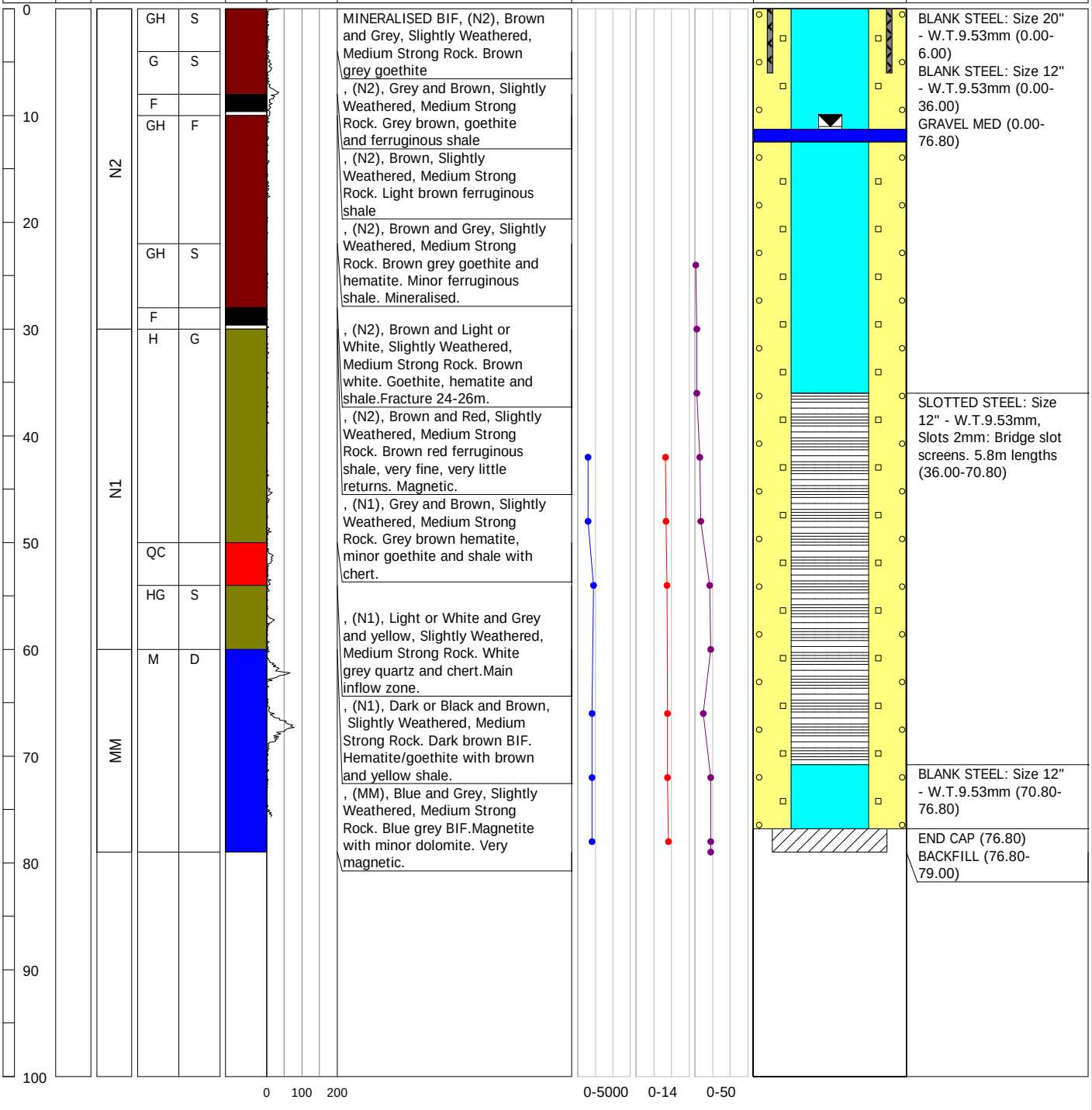
Project:	NORTH FLANK	Hole Name:	HGF0026	Hole Length:	79.00

Easting:	691549.10
Northing:	7461972.39
Surface RL:	667.90
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	14 Mar 16 - 21 Mar 16
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	600		WELLDRILL	RS4
6.0 - 79.0	WLDRIG5	CH	450		WELLDRILL	RS4

License: CAW181097

TOC RL:	668.37	-	(drilled)	SWL:	11.04 MBTOC	(22 Mar 16)	Dev:	Y: 3.0 hour(s)	Final pH:	-
TOC RL:	656.00	-	(current)	Is Live:	N	(30 Nov 17)	Date:	20 Mar 2016	Final EC:	-



BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: HGO0008 Hole Length: 200.00

Easting: 703433.00
Northing: 7464091.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Sep 01 - 13 Sep 01
Comments: Mine_Process_Supply/AQUATERRA BOREHOLE TP8. MINE PROCESS SUPPLY.;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 3.0	UNKN	P	508	Foam	NUDRILL	JE
3.0 - 154.0	UNKN	P	444	Foam	NUDRILL	JE
154.0 - 200.0	UNKN	P	311		NUDRILL	JE

TOC RL: 663.49 - (drilled) SWL: 75.96 MBGL (13 Sep 01) Dev: N Final pH: -
TOC RL: 663.49 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0							WITH GRAVEL Red-brown Silt; with fine to medium, angular to subrounded, BIF Gravel. Rounded pisoliths from 22 m to 66 m. Some Clay from 20 m to 66 m.					SURFACE CASING: 444mm: 18" Steel Collar (0.00-3.00) CONDUCTOR CASING: 310mm: 12.75" Steel (0.00-154.00) GRAVEL PACK: 3.2 to 6.4 mm Slimeline packer (0.00-154.00) BLANK PVC: 195mm: Class 12 (0.00-155.00)
10												
20												
30												
40												
50												
60												
70							Brown to orange-brown Clay. Minor Gravel, quartz and BIF, fine to medium, subangular to subrounded. Yellow brown, soft and sticky Clay. Minor calcrete, cream to light brown.					
80							Dark greenish-brown Clay. Brown Clay. Greenish brown soft and sticky Clay. No evidence of goethitic gravel in samples.					
90												
100							WITH GRAVEL. Brown Clay. Some Gravel, predominantly goethite, fine to medium, subangular to subrounded.					
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE **Hole Name:** HGO0008 **Hole Length:** 200.00

Easting: 703433.00
Northing: 7464091.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Sep 01 - 13 Sep 01

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 3.0	UNKN	P	508	Foam	NUDRILL	JE
3.0 - 154.0	UNKN	P	444	Foam	NUDRILL	JE
154.0 - 200.0	UNKN	P	311		NUDRILL	JE

Comments: Mine_Process_Supply/AQUATERRA BOREHOLE TP8. MINE PROCESS SUPPLY.;

TOC RL: 663.49 - (drilled) SWL: 75.96 MBGL (13 Sep 01) Dev: N Final pH: -
TOC RL: 663.49 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100							WITH GRAVEL. Brown Clay. Some Gravel, predominantly goethite, fine to medium, subangular to subrounded.					CONDUCTOR CASING: 310mm: 12.75" Steel (0.00-154.00) GRAVEL PACK: 3.2 to 6.4 mm Slimeline packer (0.00-154.00) BLANK PVC: 195mm: Class 12 (0.00-155.00)
110							WITH GRAVEL. Dark brown to black Clay, Manganiferous. Predominantly fine to medium goethite and quartz gravel. Minor sulphide (pyrite) throughout.					
120												
130							WITH CLAY Goethite Gravel, brown to yellow-brown, subangular to angular, variably cemented in parts, minor magnetite (?). Minor brown Clay in bands.					
140												
150												
160							Brown, to greenish-brown to grey, extremely weathered Dolomite. From 154 to 162 m pale grey to dark grey Dolomite with weathered surfaces, minor broken ground/fractures at 162 to 164 m. Yellow- brown weathered Dolomite from 164 to 174 m. Clayey in z					PACKER: 152mm (154.00-155.00) GRAVEL PACK: 210 micron polyester mesh wrapping 155 mm screen and casing. (154.00-176.00) SLOTTED PVC: 152mm (155.00-161.00) S/S SCREEN: 0mm (155.00-170.00) SCREEN: 152mm (161.00-173.00) SLOTTED STEEL: 0mm (170.00-176.00) SLOTTED PVC: 152mm (173.00-176.00) FALLBACK (176.00-200.00)
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: HGO0009 Hole Length: 162.00

Easting: 702946.00
Northing: 7464148.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Sep 01 - 20 Sep 01
Comments: AQUATERRA BOREHOLE TP9. MINE PROCESS SUPPLY.;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 162.0	UNKN	UNKN	300		NUDRILL	JE

TOC RL: 666.56 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 666.56 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0							Paraburdoo Dolomite/TD2					UNKN: No construction details available (0.00-162.00)
10												
20												
30												
40												
50												
60												
70												
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 193

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: HGO0009 Hole Length: 162.00

Easting: 702946.00
Northing: 7464148.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Sep 01 - 20 Sep 01
Comments: AQUATERRA BOREHOLE TP9. MINE PROCESS SUPPLY.;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 162.0	UNKN	UNKN	300		NUDRILL	JE

TOC RL: 666.56 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 666.56 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200						0 100 200	Paraburdoo Dolomite/TD2	0-5000	0-14	0-50		UNKN: No construction details available (0.00-162.00)

Program: Planned Hole: Page: 194

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: HGO0010 Hole Length: 164.00

Easting: 703727.00
Northing: 7464083.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Aug 03 - 06 Sep 03
Comments: Mine_Process_Supply/Mining_Area_C;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	UNKN	P	508	Air/Foam	NUDRILL	SJW
6.0 - 155.0	UNKN	P	444	Air/Foam	NUDRILL	SJW
155.0 - 164.0	UNKN	P	330	Air/Foam	NUDRILL	SJW

TOC RL: 661.11 - (drilled) SWL: 76.32 MBGL (04 Sep 03) Dev: N Final pH: -
TOC RL: 661.11 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0												SURFACE CASING: 444mm: 18" Steel Collar (0.00-6.00) CONDUCTOR CASING: 310mm: 14" ID Steel Conductor Casing (0.00-104.50)
10												
20							Red-brown clay (70%) with coarse subangular to subrounded gravel, poorly sorted.					
30												
40												
50							Red-brown, clayey pisolitic sand / fine gravel. Moderatelly to well sorted.					
60												
70							Pale grey-green, sticky clay with minor hematitic and cherty gravels.					
80												
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE | Hole Name: HGO0010 | Hole Length: 164.00

Easting: 703727.00
Northing: 7464083.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Aug 03 - 06 Sep 03
Comments: Mine_Process_Supply/Mining_Area_C;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	UNKN	P	508	Air/Foam	NUDRILL	SJW
6.0 - 155.0	UNKN	P	444	Air/Foam	NUDRILL	SJW
155.0 - 164.0	UNKN	P	330	Air/Foam	NUDRILL	SJW

TOC RL: 661.11 - (drilled) SWL: 76.32 MBGL (04 Sep 03) Dev: N Final pH: -
TOC RL: 661.11 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 600mm | Notes

100
110
120
130
140
150
160
170
180
190
200

Pale grey-green, sticky clay with minor hematitic and cherty gravels.

Dark to light Red-brown poorly sorted, hematite, BIF and weathered geothite well rounded to subangular gravel. Vitreous geothite (20-40%).

WITH CLAY Mauve to dark red-brown, poorly sorted, well rounded to subangular hematitic gravel.

139-144 m: Light brown to grey-green, moderately fresh to weathered, well fractured;
144-164 m: Light pale greeny brown, highly weathered dolomite.



CONDUCTOR CASING: 310mm: 14" ID Steel Conductor Casing (0.00-104.50)
GRAVEL PACK: 3.2 to 6.4 mm (104.50-146.00)
S/S SCREEN: 0mm: 10" (104.50-146.50)
FALLBACK (146.00-164.00)

0 100 200 | 0-5000 | 0-14 | 0-50

Program: Planned Hole: Page: 196

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE Hole Name: HGO0011 Hole Length: 180.00

Easting: 703163.00
Northing: 7464139.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Aug 04 - 03 Sep 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	NUDRIG1	ROT	457	Mud	NUDRILL	KAG
4.0 - 6.0	UNKN				UNKN	UNKN
6.0 - 180.0	NUDRIG1	ROT	381	Mud	NUDRILL	KAG

TOC RL: 665.37 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 665.37 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0							Brown angular gravel of BIF, chert and shale in a soft silty matrix. Minor organic matter.					SURFACE CASING: 457mm (0.00-4.00) STEEL CASING: 250mm (0.00-100.00)
10							Brown sub angular to sub rounded BIF, chert, enriched BIF and shale gravel in soft red brown silt. Predominantly enriched BIF from 6m. Clayey at 12m, becoming cherty. Clayey at 24m. Predominantly ferruginous shale from 34m. 38m back to cherty BIF.					
20												
30												
40												
50												
60							Hard white crystalline calcrete.					
70							Yellow brown soft clayey ochrous goethite gravel. Trace vitrous goethite and soft white clay. 92-94m minor mottled clays.					
80												
90												
100							Brown angular BIF and shale gravel.					SLOTTED STEEL: 250mm (100.00-130.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 197

BHPIO - Hydrogeology Log

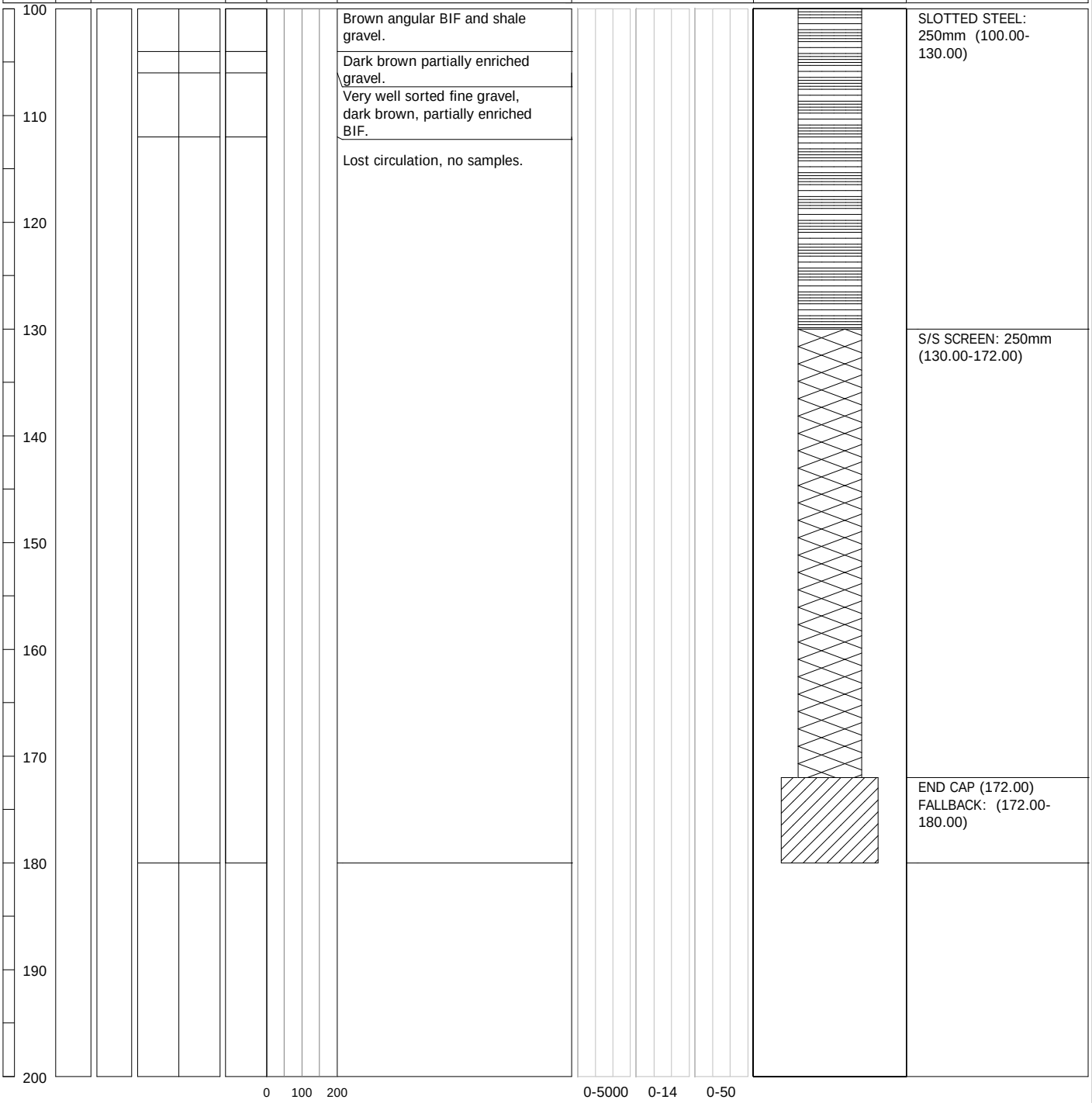
BHP

Project: PACKSADDLE Hole Name: HGO0011 Hole Length: 180.00

Easting: 703163.00
Northing: 7464139.00
Surface RL:
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Aug 04 - 03 Sep 04
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	NUDRIG1	ROT	457	Mud	NUDRILL	KAG
4.0 - 6.0	UNKN				UNKN	UNKN
6.0 - 180.0	NUDRIG1	ROT	381	Mud	NUDRILL	KAG

TOC RL: 665.37 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 665.37 - (current) Is Live: N (01 Jan 20) Date: - Final EC: -



Program: Planned Hole: Page: 198

BHPIO - Hydrogeology Log

BHP

Project: MUDLARK WELL **Hole Name:** HGSL0002 **Hole Length:** 110.00

Easting: 681322.04
Northing: 7459144.63
Surface RL: 693.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Oct 15 - 13 Oct 15
Comments: Juna Downs FY16 MAR Program MB9 (JDH_0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	DR3	DR	300		EASTERNWELL	HOB
4.0 - 68.0	DR3	DR	200		EASTERNWELL	HOB
68.0 - 110.0	DR3	CH	200		EASTERNWELL	YA

TOC RL: - (Stickup 0.66m) (drilled) SWL: 29.11 MBGL (14 Oct 15) Dev: Y: 1.3 hour(s) Final pH: 8.3
TOC RL: 694.53 (Stickup 0.93m) (current) Is Live: Y (-) Date: 08 Oct 2015 Final EC: 612.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	UG	TD3	Y	Z			SILT, gravelly, trace clay, (QUATERNARY DETRITAL), Red, Soil, Non-Cohesive soils, Poorly graded, Sub-rounded. Silt, gravel and clay (surface scree), red brown, subrounded to subangular, unconsolidated, with some chert, hematite, goethite, vitreous goethite to 20 mm. Some calcrete cementation.					CEMENT (0.00-2.00)
10			Z									BLANK STEEL: 324mm (0.00-4.00)
20			Z	K			GRAVEL, silty, (QUATERNARY DETRITAL), Red, Transported, Very Soft, Poorly graded, Sub-rounded. Coarse sand to coarse gravel and silt (tertiary detritals), red brown, chips 2 to 100 mm (cemented detritals), some chips magnetic, some with flakey planar break, with fine calcrete veins (reactive to acid), chert, soft goethite, ocherous goethite, trace vitreous goethite, hematite, solution channels? Some chips of cemented bedding (red/pale red grey).				BLANK PVC: Size 50 - Class 18 (0.00-25.34)
30			Z									GRAVEL MED (2.00-110.00)
40	MG	TD2	3	K								SLOTTED PVC: Size 50 - Class 18, Slots 1mm (25.34-109.74)
50	UG	TD1	O				GRAVEL, silty, (QUATERNARY DETRITAL), Dark or Black and Red, Transported, Firm, Poorly graded, Sub-angular. Coarse sand to fine gravel and silt (tertiary detritals), dark red brown, chips 2 to 15 mm (cemented detritals), some chips magnetic, some areas with flakey planar bedding; friable, pisolites, chert, rounded mudrock, soft goethite, ocherous goethite, trace vitreous goethite, hematite; predominantly magnetic. Clayey silt matrix sample at 14 m, red brown. Some chips of cemented bedding (red/pale red grey). Trace clay 18 - 20 mbgl.				LEVELTROLL(34.31) ID: 1736
60												VWPPANDO(35.30) ID: 1898
70												
80	MG	OB	D									
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0002	Hole Length:	110.00

Easting: 681322.04
Northing: 7459144.63
Surface RL: 693.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Oct 15 - 13 Oct 15
Comments: Juna Downs FY16 MAR Program MB9 (JDH_0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	DR3	DR	300		EASTERNWELL	HOB
4.0 - 68.0	DR3	DR	200		EASTERNWELL	HOB
68.0 - 110.0	DR3	CH	200		EASTERNWELL	YA

TOC RL: - (Stickup 0.66m) (drilled) SWL: 29.11 MBGL (14 Oct 15) Dev: Y: 1.3 hour(s) Final pH: 8.3
TOC RL: 694.53 (Stickup 0.93m) (current) Is Live: Y (-) Date: 08 Oct 2015 Final EC: 612.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	UG	TD3	Y	Z								CEMENT (0.00-2.00)
10			Z									BLANK STEEL: 324mm (0.00-4.00)
20			Z									BLANK PVC: Size 50 - Class 18 (0.00-25.34)
30			Z	K			GRAVEL, clayey, (QUATERNARY DETRITAL), Dark or Black and Red, Transported, Firm, Poorly graded, Sub-angular. clay and silt (tertiary detritals), dark red brown, chips 2 to 10 mm (cemented detritals), some chips magnetic, clay content decreasing with depth, pisolites, chert, rounded mudrock, soft goethite, ocherous goethite, high % hematite; predominantly magnetic (Laterite?).					GRAVEL MED (2.00-110.00)
40	MG	TD2	Z									
50	UG	TD1	3	K								SLOTTED PVC: Size 50 - Class 18, Slots 1mm (25.34-109.74)
60			O				GRAVEL, (QUATERNARY DETRITAL), Dark or Black and Red, Transported, Firm, Poorly graded, Sub-angular. coarse sand/fine gravel and silt (tertiary detritals), dark red brown, chips 2 to 20 mm (cemented detritals), some chips magnetic, hematitic pisolites to 10 mm, trace chert, goethite, ocherous goethite, hematite; some magnetic (Laterite?). Alluvial gravel % increase and size to 30 mm at 30 mbgl, large chips of goethite and cemented detritals with large pisolites 32 - 38 mbgl, some vugs and solute channels in cemented detritals and goethite chips. Fine calcrete veining common 28 - 32 mbgl, very reactive to acid. Soft drilling 32 - 40 mbgl; trace clay content. Some silcrete and calcrete cementing (fine viens) 40 m, highly reactive to acid. Some ocherous clay nodules at 40 mbgl.					LEVELTROLL(34.31) ID: 1736
70												VWPPANDO(35.30) ID: 1898
80	MG	OB	D									
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

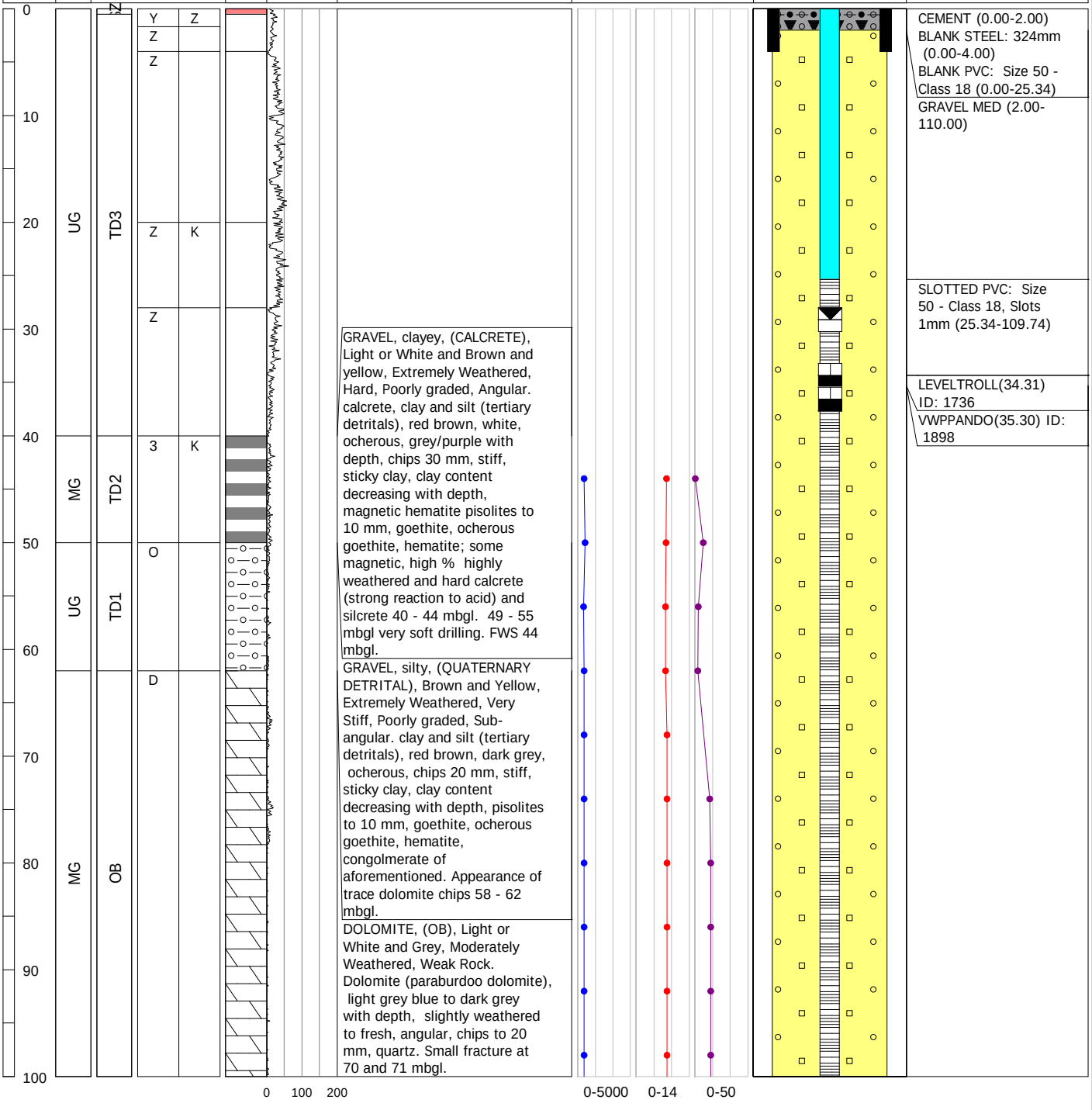
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0002	Hole Length:	110.00

Easting: 681322.04
Northing: 7459144.63
Surface RL: 693.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Oct 15 - 13 Oct 15
Comments: Juna Downs FY16 MAR Program MB9 (JDH_0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	DR3	DR	300		EASTERNWELL	HOB
4.0 - 68.0	DR3	DR	200		EASTERNWELL	HOB
68.0 - 110.0	DR3	CH	200		EASTERNWELL	YA

TOC RL: - (Stickup 0.66m) (drilled) SWL: 29.11 MBGL (14 Oct 15) Dev: Y: 1.3 hour(s) Final pH: 8.3
TOC RL: 694.53 (Stickup 0.93m) (current) Is Live: Y (-) Date: 08 Oct 2015 Final EC: 612.00



BHPIO - Hydrogeology Log

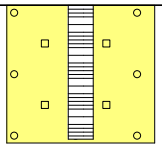
BHP

Project: MUDLARK WELL **Hole Name:** HGSL0002 **Hole Length:** 110.00

Easting: 681322.04
Northing: 7459144.63
Surface RL: 693.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Oct 15 - 13 Oct 15
Comments: Juna Downs FY16 MAR Program MB9 (JDH_0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 4.0	DR3	DR	300		EASTERNWELL	HOB
4.0 - 68.0	DR3	DR	200		EASTERNWELL	HOB
68.0 - 110.0	DR3	CH	200		EASTERNWELL	YA

TOC RL: - (Stickup 0.66m) (drilled) SWL: 29.11 MBGL (14 Oct 15) Dev: Y: 1.3 hour(s) Final pH: 8.3
TOC RL: 694.53 (Stickup 0.93m) (current) Is Live: Y (-) Date: 08 Oct 2015 Final EC: 612.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	OB	D				DOLOMITE, (OB), Light or White and Grey, Moderately Weathered, Weak Rock. Dolomite (paraburdoo dolomite), light grey blue to dark grey with depth, slightly weathered to fresh, angular, chips to 20 mm, quartz. Small fracture at 70 and 71 mbgl.					GRAVEL MED (2.00-110.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (25.34-109.74) LEVELTROLL(34.31) ID: 1736 VWPPANDO(35.30) ID: 1898 END CAP (109.74)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0005	Hole Length:	101.00

Easting: 680478.29
Northing: 7459821.75
Surface RL: 698.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 23 Nov 15 - 27 Nov 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB4 (MB7; JDH0006)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	DR3	DR	450		EASTERNWELL	ROD
62.0 - 101.0	DR3	DR	425		EASTERNWELL	ROD

TOC RL:	-	(Stickup 0.60m)	(drilled)	SWL:	33.90 MBGL	(28 Nov 15)	Dev:	Y: 10.0 hour(s)	Final pH:	8.2
TOC RL:	699.53	-	(current)	Is Live:	Y	(-)	Date:	27 Nov 2015	Final EC:	624.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	BG	SZ	Z	Y			GRAVEL, sandy, (QUATERNARY DETRITAL), Brown and Red and light or white, Transported, Non-Cohesive soils, Well graded, Sub-angular. Surface scree, gravels 10-20mmD					CEMENT (0.00-2.00)
10		TD3	Z	Y			GRAVEL, sandy, (QUATERNARY DETRITAL), Brown and Light or White, Transported, Non-Cohesive soils, Well graded, Sub-rounded. (Tertiary Detritals) Some subangular 10-20mmD gravel and sand, haemitite and geothite, increasing silt, increasing % pisolitic maghemetite, decreasing % chert with depth					BLANK STEEL: Size 16" - W.T.9.53mm: 16 5/8" casing (423 mm) (0.00-5.00)
20												BLANK STEEL: Size 12" - W.T.9.53mm (0.00-38.00)
30												GRAVEL MED (2.00-98.00)
40		TD2	M3	G			QUATERNARY DETRITAL, (TD2), Red and Light or White and green, Highly Weathered, Medium Strong Rock. (Tertiary Detritals) Green clay and green staining on faces, calcrete very reactive to acid; goethite goethitc clay, ochre/lime green/ grey clay (Tertiary Detritals); drilling slow from 37m, taking lots of added water; pitted faces on the gravel					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (38.00-74.00)
50		OB	D	G			DOLOMITE, (OB), Blue and Red, Fresh, Strong Rock. Crystallline (?) Dolomite larger chips up to 20mm showing fracture faces (not from hammer). Calcrete very acid reactive. Residual green clay, minor pisolite, trace quartz (Weathered dolomite); drilling water loss and slow penetration.					
60			D				DOLOMITE, (OB), Blue, Fresh, Strong Rock. Crystallline dolomite, dark to pale blue frags to 20mm showing solute stains on faces. Trace calcrete chips, contam goethite pisolites and frags from cyclone? at 76m. FWS est 35L/s					INJECTION(60.00) ID: 7
70												W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (74.00-80.00)
80			GX	D			DOLOMITE, (OB), Red and Brown and blue, Fresh, Strong Rock. 88m dominated by infill sub-round goethite/ maghemitite, increasing yellow clay from 92m, trace siltstone and quartz, water staining on faces					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (80.00-92.00)
90	CV		DK	O			DOLOMITE, (OB), Blue and Yellow, Fresh, Strong Rock. Even mix of dolomite and orange clay, up to 20mm frags, occassional larger siltstone frag					W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (92.00-98.00)
100			DK	B								END CAP (98.00) GROUT (98.00-101.00)
						0 100 200		0-5000	0-14	0-50		

Program: Juna Downs Hydrogeological Drilling FY16
Planned Hole: HJD_FY16_PB4

BHPIO - Hydrogeology Log

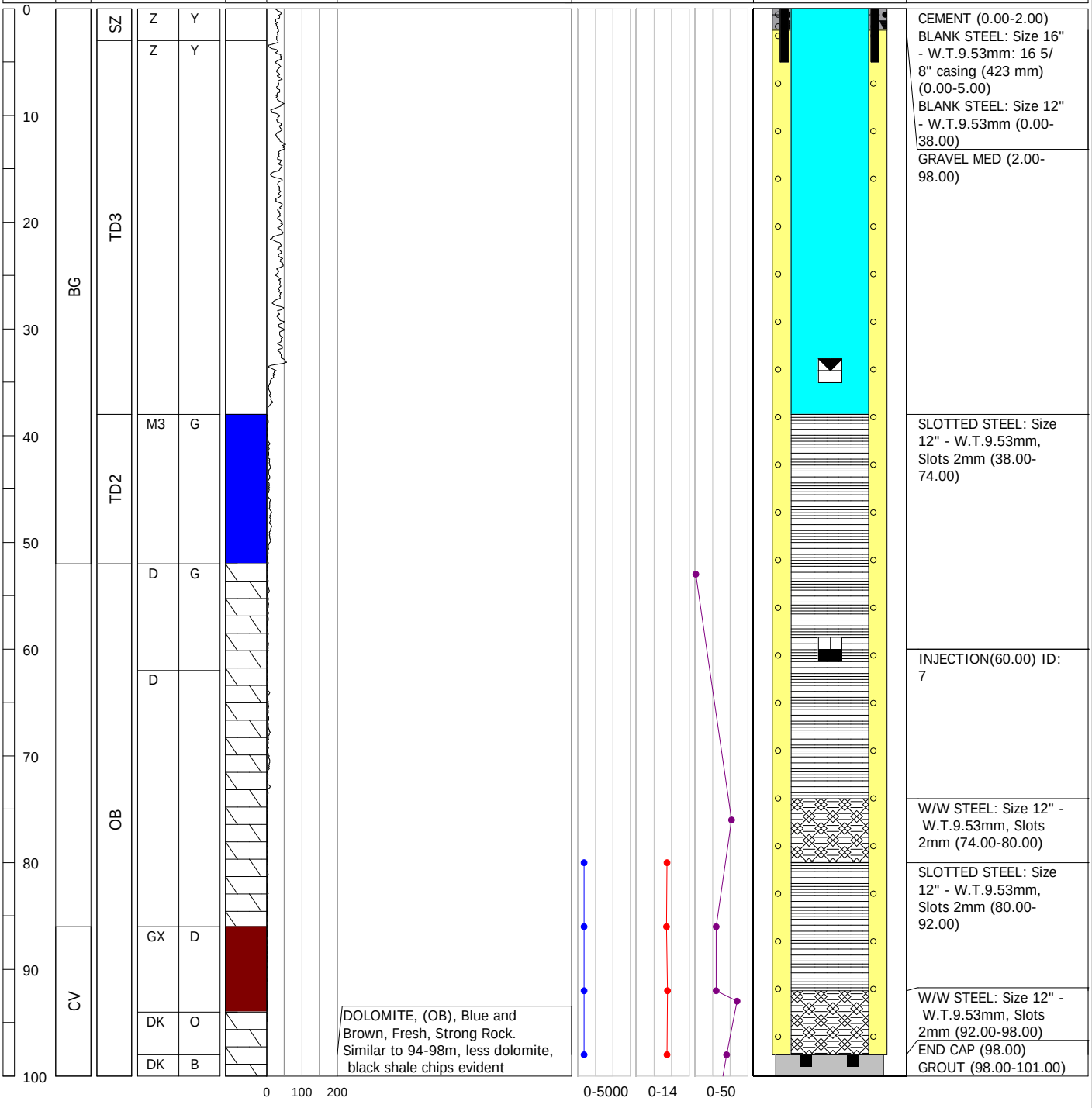
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0005	Hole Length:	101.00

Easting: 680478.29
Northing: 7459821.75
Surface RL: 698.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 23 Nov 15 - 27 Nov 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB4 (MB7; JDH0006)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	DR3	DR	450		EASTERNWELL	ROD
62.0 - 101.0	DR3	DR	425		EASTERNWELL	ROD

TOC RL:	-	(Stickup 0.60m)	(drilled)	SWL:	33.90 MBGL	(28 Nov 15)	Dev:	Y: 10.0 hour(s)	Final pH:	8.2
TOC RL:	699.53	-	(current)	Is Live:	Y	(-)	Date:	27 Nov 2015	Final EC:	624.00



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0005	Hole Length:	101.00

Easting: 680478.29
Northing: 7459821.75
Surface RL: 698.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 23 Nov 15 - 27 Nov 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB4 (MB7; JDH0006)

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 62.0	DR3	DR	450		EASTERNWELL	ROD
62.0 - 101.0	DR3	DR	425		EASTERNWELL	ROD

TOC RL: - (Stickup 0.60m) (drilled) SWL: 33.90 MBGL (28 Nov 15) Dev: Y: 10.0 hour(s) Final pH: 8.2
TOC RL: 699.53 - (current) Is Live: Y (-) Date: 27 Nov 2015 Final EC: 624.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	CV	OB	DK	B			DOLOMITE, (OB), Blue and Brown, Fresh, Strong Rock. Similar to 94-98m, less dolomite, black shale chips evident					GROUT (98.00-101.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0006	Hole Length:	98.10

Easting: 681312.30
Northing: 7459149.61
Surface RL: 693.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Dec 15 - 04 Dec 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB3 (MB9; JDH0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 56.0	DR3	DR	450		EASTERNWELL	HOB
56.0 - 98.1	DR3	DR	425		EASTERNWELL	HOB

TOC RL: - (Stickup 0.60m) (drilled) SWL: 29.00 MBGL (05 Dec 15) Dev: N Final pH: -
TOC RL: 694.89 (Stickup 1.22m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	SZ	K	Y			CLAY, silty, trace gravel, (QUATERNARY DETRITAL), Red and Brown, Soil, Non-Cohesive soils, Poorly graded, Sub-rounded. Clay, silt and gravel (Surface Scree), red brown, subrounded to subangular, unconsolidated, with some chert, hematite, goethite, mudrock, quartz, pisolites, chips to to 10 mm.					CEMENT: Surface annulus seal (0.00-2.00)
			Y	Z								BLANK STEEL: Size 12" - W.T.6.35mm (0.00-38.10)
10		TD3	Z	Y								
			Y	Z								GRAVEL MED: -1.6 to 3.2mm grade (2.00-98.10)
20							SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Soil, Non-Cohesive soils, Poorly graded, Sub-rounded. Silt and gravel (Surface Scree), red brown, subrounded to subangular, unconsolidated, with some chert, hematite, goethite, vitreous goethite, magnetic pisolites, chert, quartz, cemented detritals, chips to 4 mm.					
			K	Z								
30		TD2	K	Z								
40							GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-angular. Gravel and silt (Tertiary Detritals), red brown, subrounded to angular, unconsolidated, with some chert, BIF, magnetic pisolites, mudrock, quartz, goethite, hematite, cemented detritals, chips to 60 mm, predominantly 15 mm.					SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (38.10-50.10)
		TD1	Z3G	Y								
50												S/S SCREEN: Size 12" - W.T.6.35mm, Slots 1mm (50.10-56.10)
			D									SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (56.10-74.10)
60	MG											
							SILT, gravelly, trace clay, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-rounded. Silt and gravel (Tertiary Detritals), red brown, subrounded to subangular, unconsolidated, with some chert, BIF, magnetic pisolites, mudrock, quartz, goethite, hematite, cemented detritals, chips to 15 mm. Clay content increasing in % to trace with depth.					INJECTION(60.00) ID: 7
70		OB										
												S/S SCREEN: Size 12" - W.T.6.35mm, Slots 1mm (74.10-80.10)
80												SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (80.10-98.10)
90												
												END CAP: 12" steel. Approx 300mm deep (97.8-98.1 mbgl) (98.10)
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0006	Hole Length:	98.10

Easting: 681312.30
Northing: 7459149.61
Surface RL: 693.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Dec 15 - 04 Dec 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB3 (MB9; JDH0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 56.0	DR3	DR	450		EASTERNWELL	HOB
56.0 - 98.1	DR3	DR	425		EASTERNWELL	HOB

TOC RL: - (Stickup 0.60m) (drilled) SWL: 29.00 MBGL (05 Dec 15) Dev: N Final pH: -
TOC RL: 694.89 (Stickup 1.22m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 600mm | Notes

Strat: SZ, TD3, TD2, TD1, OB
Cond: UG, MG
Major / Minor: K Y; Y Z; Z Y; Y Z; K Z; K Z; Z3G Y; D

Hydrogeological Description:

CLAY, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-rounded.

Clay, silt and gravel (Tertiary Detritals), red brown, subrounded to subangular, unconsolidated, sticky silty clay matrix, with some chert, BIF, magnetic pisolites, mudrock, quartz, goethite, hematite, cemented detritals, chips to 10 mm, increasing to 20 mm from 30 mbgl. From 30 mbgl, clear calcrete cementing beginning, highly reactive to acid.

CLAY, gravelly, (QUATERNARY DETRITAL), Light or White and Brown and yellow, Transported, Very Stiff, Well graded, Sub-angular. Clay, silt and gravel (Tertiary Detritals), red brown to pale ocherous brown with depth, subrounded to subangular, semi consolidated to consolidated with depth, sticky silty clay matrix, with quartz, goethite, hematite, ocherous goethite, vitreous goethite, all alluvial gravel decreasing in % with depth, cemented detritals (calcrete cement) and calcrete increasing in % with depth, trace magnetic pisolites and magnetic BIF, trace silcrete increasing in % with depth to with some, white clay nodues, highly reactive to acid, overprint (?) 30-32 m (trace gravel, mostly cemented clay/silt). Chips to 20 mm. Solute channels and vuggy surfaces present and increasing with depth. FWS at 40 mbgl.

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Notes:
- CEMENT: Surface annulus seal (0.00-2.00)
- BLANK STEEL: Size 12" - W.T.6.35mm (0.00-38.10)
- GRAVEL MED: -1.6 to 3.2mm grade (2.00-98.10)
- SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (38.10-50.10)
- S/S SCREEN: Size 12" - W.T.6.35mm, Slots 1mm (50.10-56.10)
- SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (56.10-74.10)
- INJECTION(60.00) ID: 7
- S/S SCREEN: Size 12" - W.T.6.35mm, Slots 1mm (74.10-80.10)
- SLOTTED STEEL: Size 12" - W.T.6.35mm, Slots 1mm (80.10-98.10)
- END CAP: 12" steel. Approx 300mm deep (97.8-98.1 mbgl) (98.10)

BHPIO - Hydrogeology Log

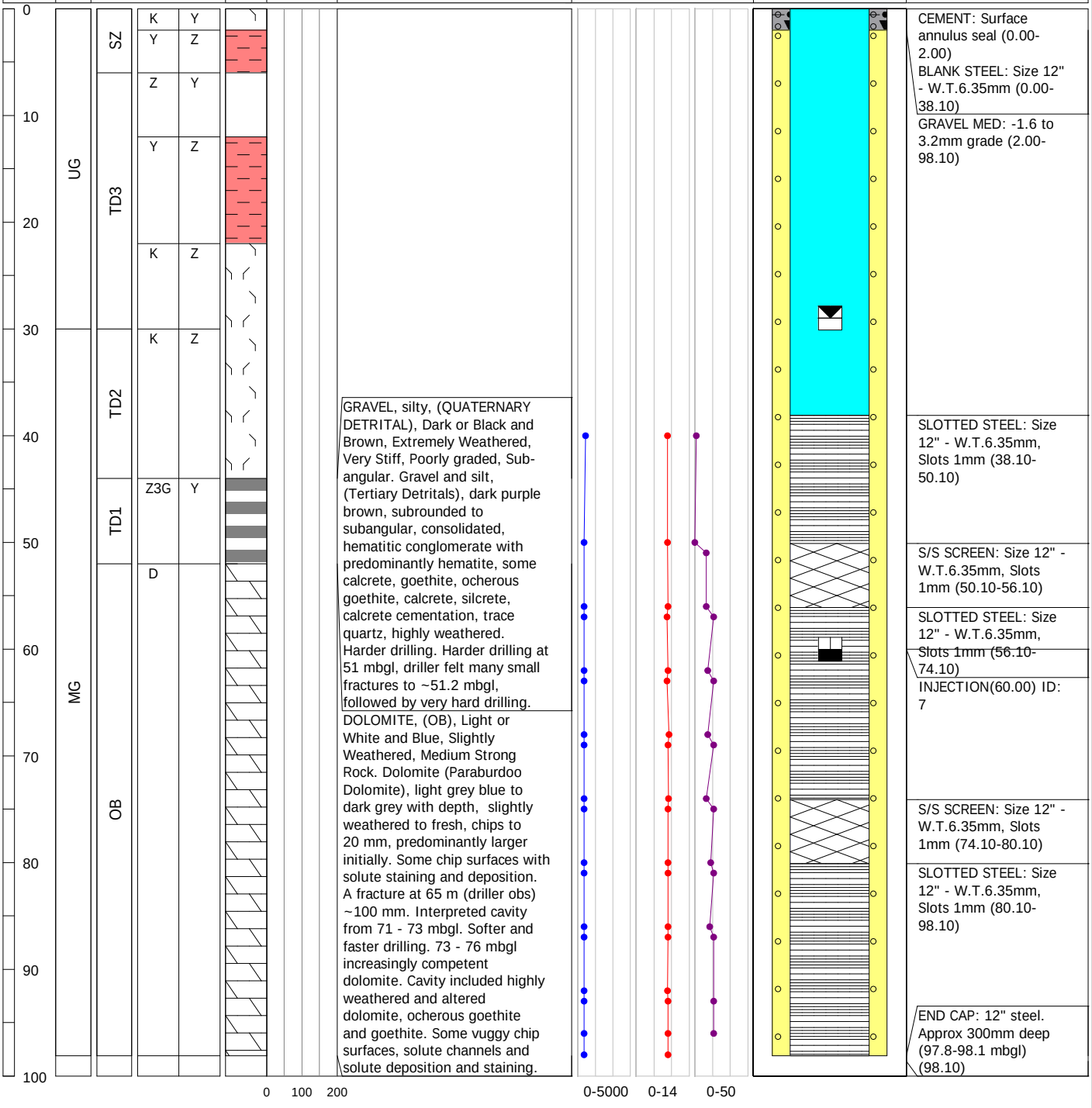
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0006	Hole Length:	98.10

Easting: 681312.30
Northing: 7459149.61
Surface RL: 693.67
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Dec 15 - 04 Dec 15
License: CAW181126
Comments: Juna Downs FY16 MAR Program PB3 (MB9; JDH0010);

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 56.0	DR3	DR	450		EASTERNWELL	HOB
56.0 - 98.1	DR3	DR	425		EASTERNWELL	HOB

TOC RL: - (Stickup 0.60m) (drilled) SWL: 29.00 MBGL (05 Dec 15) Dev: N Final pH: -
TOC RL: 694.89 (Stickup 1.22m) (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0010	Hole Length:	98.00

Easting: 681038.51
Northing: 7457195.17
Surface RL: 693.73
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 06 Jun 16 - 08 Jun 16

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 68.0	EWMWW02	DR	250		EASTERNWELL	CCN
68.0 - 98.0	EWMWW02	CH	200		EASTERNWELL	CCN

Comments: Juna Downs Phase 2 FY16 Hydro Program. Hole termiated hortof planned 120m due to drilling into shale...

TOC RL: 694.20 (Stickup 0.46m) (drilled) SWL: 28.86 MBGL (10 Jun 16) Dev: N Final pH: -
TOC RL: 694.45 (Stickup 0.72m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	UG	TD3	Z	Y			GRAVEL, clayey, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Well graded, Sub-rounded. Reddish-brown, sub rounded to sub angular detritals. Some maghemite pisolites throughout.					CEMENT (0.00-2.00) BLANK PVC: Size 50 - Class 18 (0.00-28.00) GRAVEL MED (2.00-68.00)
30	MG	TD2	3				CALCRETE, (TD2), Light or White, Fresh, Strong Rock. White to cream crystalline calcrete, fresh at top becoming slightly weathered with depth. HCL+ve.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (28.00-75.00)
40	BG		3	Z			QUATERNARY DETRITAL, (TD2), Light or White and Brown, Moderately Weathered, Medium Strong Rock. Cream to light brown, weathered calcrete (chalky) with detrirals. HCL+ve.					LEVELTROLL(35.00) ID: 1687
50	MG	OB	D	Q			DOLOMITE, (OB), Blue and Grey, Moderately Weathered, Strong Rock. Blue-grey crystalline to cream coloured weathered dolomite. Highest weathering from 50-52m and 56-64m. Cavity from 61-63m with some manganese deposits.					
70	MG	OA	S	K			SHALE, (OA), Brown and Grey, Extremely Weathered, Very Weak Rock. Shale and clay, brown / grey. Possibly WA but could be extremely weathered OB. No magnetism, not HCL+ve. Upper margin quartz dominant, some quartz throughout interval. Manganiferous minerals present throughout. Shale looks like remnant dolomite. Some white clasts of kaolinite.					GRAVEL MED (68.00-75.00) END CAP (75.00) BENTONITE (75.00-77.00) GRAVEL MED (77.00-98.00)
100												

0 100 200 0-5000 0-14 0-50

Program: Juna Downs Hydrogeological Investigation Phase 2 FY16 Planned Hole: JDH_2016_0014 Page: 209

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0014	Hole Length:	85.00

Easting: 681027.98
Northing: 7457201.04
Surface RL: 693.76
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Jun 16 - 25 Jun 16
License: CAW181126
Comments: Juna Downs Phase 2 FY16 Hydro Program;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR3	DR	450		EASTERNWELL	AW10
44.0 - 85.0	DR3	CH	425		EASTERNWELL	AW10

TOC RL: 694.47 - (drilled) SWL: 29.36 MBTOC (25 Jun 16) Dev: Y: 8.0 hour(s) Final pH: 8.3
TOC RL: 695.06 (Stickup 1.30m) (current) Is Live: Y (-) Date: 24 Jun 2016 Final EC: 633.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	Z	YCX			GRAVEL, silty, (QUATERNARY DETRITAL), Brown and Red, Transported, Non-Cohesive soils, Well graded, Sub-angular. Sub-rounded to rounded maghemite (X) pisolites; cloudy cherts					CEMENT (0.00-2.00)
			Z	Y								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-30.00)
			Z	YC								GRAVEL MED (2.00-79.20)
10		TD3	Z	Y			GRAVEL, silty, (QUATERNARY DETRITAL), Brown and Red, Transported, Stiff, Well graded, Sub-rounded. Detritals sub-rounded to sub-angular, small (<1cm); some X pisolites, rounded, <0.5cm					
			Z	YX								
			Z	YXC								
20			ZX	Y								
			ZX	Y3C			GRAVEL, silty, (QUATERNARY DETRITAL), Light or White and Red and brown, Transported, Stiff, Well graded, Sub-angular. Detritals sub-angular to sub-rounded, most <1cm; some rounded X pisos, <0.5cm; cloudy and banded cherts					
			3	CZ								
30		TD2	3	CZ								SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (30.00-42.00)
			K3	Z								
			K	3Z			GRAVEL, silty, (QUATERNARY DETRITAL), Light or White and Red and brown, Transported, Stiff, Well graded, Sub-rounded. Detritals sub-rounded, most <1cm; some rounded X pisos, <0.5cm					
			Z3	S								
40			D	3ZS								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (42.00-48.00)
			D									
			D				SAND AND GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Well graded, Sub-rounded. Detritals sub-rounded to sub-angular, mostly <0.5cm with few occasional large >2cm chips; rounded X pisos, <0.5cm; trace sub-angular chert					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (48.00-54.00)
50			D3S	F								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (54.00-72.00)
			DS	QK								
	CV		DS				SAND AND GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Well graded, Sub-rounded. As above; minor sub-angular chert					INJECTION(60.00) ID: 7
60		OB	S	D								
			S				GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Hard, Well graded, Rounded. Detritals sub-rounded, mostly <1cm; rounded X pisos, <1cm					BLANK STEEL: Size 12" - W.T.9.53mm: Sump (72.00-74.00)
70												END CAP (74.00)
			S									FALLBACK (79.20-85.00)
80			S				GRAVEL, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Hard, Poorly graded, Sub-rounded. Transition into TD2. Rounded X pisos; crystalline calcrete, strong fizz; large chert fragments with black spotting/ veining, unreactive HCl; brown silt					
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Juna Downs Hydrogeological Investigation Phase 2 FY16 Planned Hole: JDH_2016_0014A

BHPIO - Hydrogeology Log

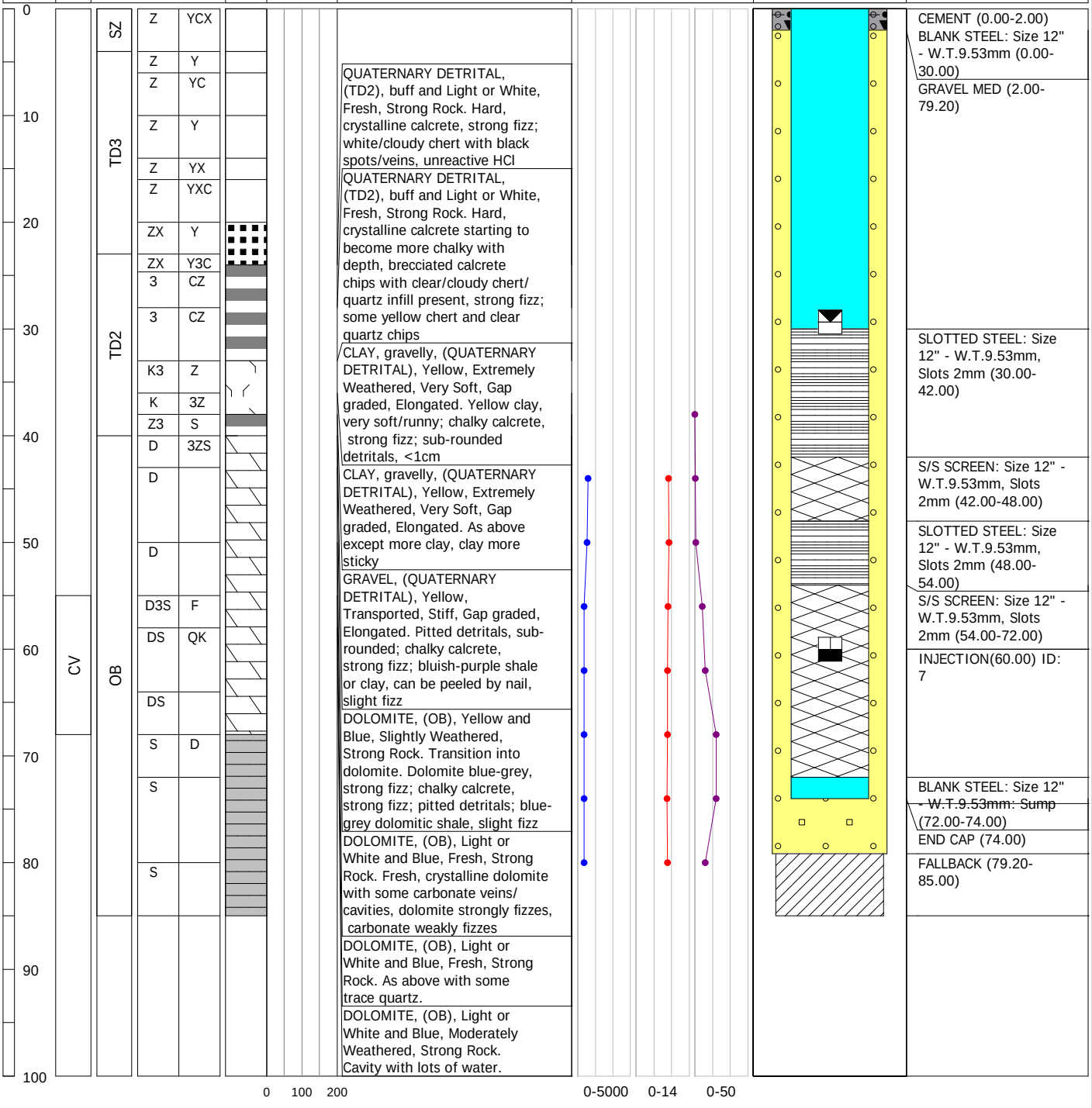
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0014	Hole Length:	85.00

Easting: 681027.98
Northing: 7457201.04
Surface RL: 693.76
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Jun 16 - 25 Jun 16
License: CAW181126
Comments: Juna Downs Phase 2 FY16 Hydro Program;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR3	DR	450		EASTERNWELL	AW10
44.0 - 85.0	DR3	CH	425		EASTERNWELL	AW10

TOC RL: 694.47 - (drilled) SWL: 29.36 MBTOC (25 Jun 16) Dev: Y: 8.0 hour(s) Final pH: 8.3
TOC RL: 695.06 (Stickup 1.30m) (current) Is Live: Y (-) Date: 24 Jun 2016 Final EC: 633.00



BHPIO - Hydrogeology Log

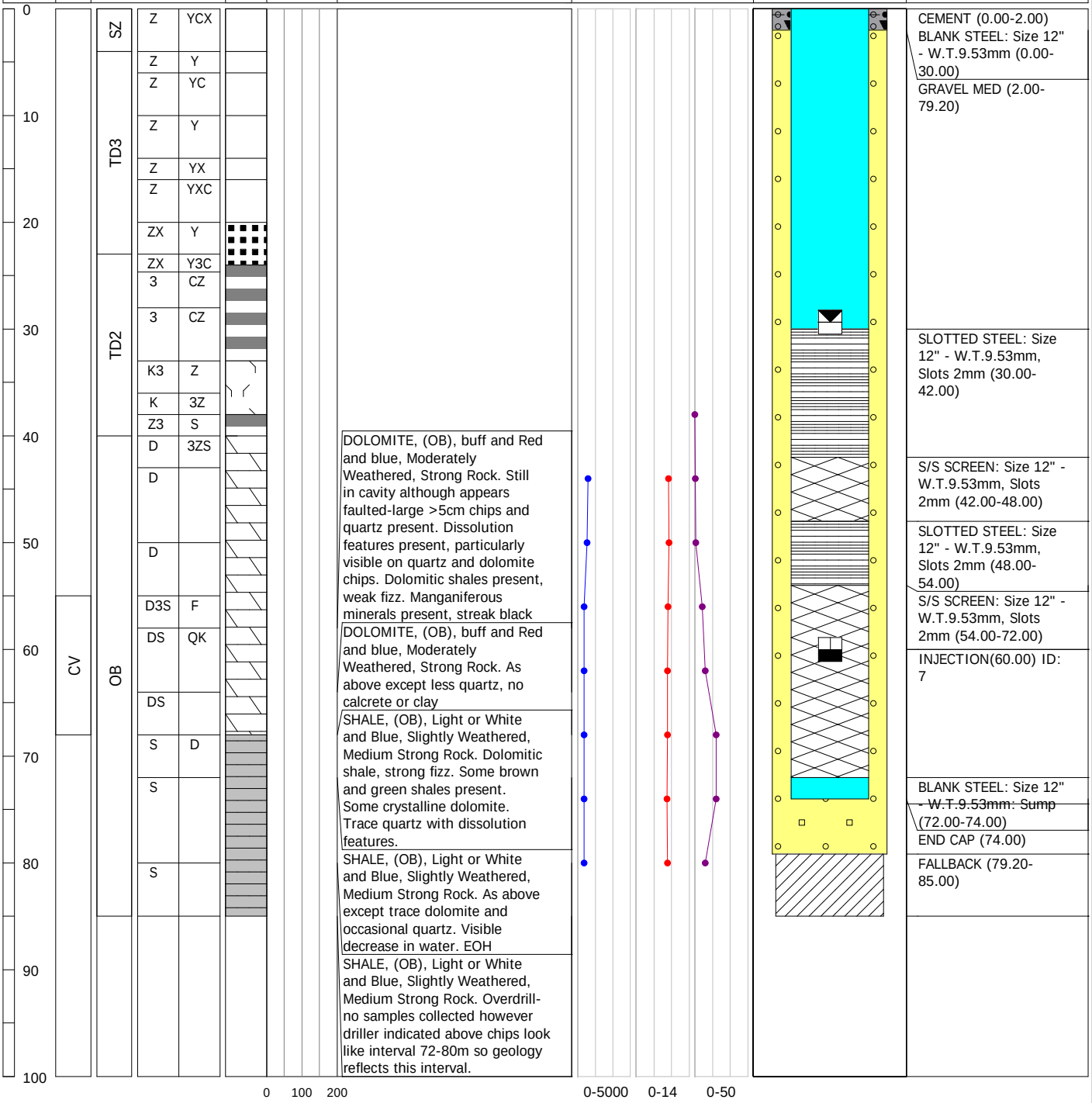
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0014	Hole Length:	85.00

Easting: 681027.98
Northing: 7457201.04
Surface RL: 693.76
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Jun 16 - 25 Jun 16
License: CAW181126
Comments: Juna Downs Phase 2 FY16 Hydro Program;

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR3	DR	450		EASTERNWELL	AW10
44.0 - 85.0	DR3	CH	425		EASTERNWELL	AW10

TOC RL: 694.47 - (drilled) SWL: 29.36 MBTOC (25 Jun 16) Dev: Y: 8.0 hour(s) Final pH: 8.3
TOC RL: 695.06 (Stickup 1.30m) (current) Is Live: Y (-) Date: 24 Jun 2016 Final EC: 633.00



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0015	Hole Length:	136.00

Easting: 681805.00
Northing: 7460074.32
Surface RL: 694.93
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Jul 16 - 01 Aug 16
License: CAW181126
Comments: Juna Downs Phase 2 FY16 Hydro Program Production Bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 10.0	DR3	DR	500		EASTERNWELL	BM2
10.0 - 124.0	DR3	DR	450		EASTERNWELL	BM2, YA
124.0 - 136.0	DR3	CH	425		EASTERNWELL	YA

TOC RL: 695.67 - (drilled) SWL: 31.51 MBGL (23 Jul 16) Dev: Y: 19.0 hour(s) Final pH: 8.2
TOC RL: 696.35 (Stickup 1.42m) (current) Is Live: Y (-) Date: 30 Jul 2016 Final EC: 560.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	SZ	ZY	JD			SILT AND GRAVEL, (QUATERNARY DETRITAL), Brown, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Detritals with very poor sorting, mostly silt but large angular fragments (0 - 4 cm) throughout.					CEMENT (0.00-2.00) BLANK STEEL: Size 12" - W.T.9.53mm (0.00-35.00)
10		TD3	ZX	YJ			SILT, gravelly and sandy, trace clay, (QUATERNARY DETRITAL), Brown, Transported, Stiff, Poorly graded, Sub-rounded. Into T detritals, well rounded with less, smaller gravel (up to 1 cm).Samples only coming up with heavy foam. Appears to have a clay content from 26 mbgl down, but probably due to foam.					GRAVEL MED (2.00-133.00)
30			ZX	Y								
40	MG	TD2	3ZJ	X			SILT, gravelly and sandy, (QUATERNARY DETRITAL), Missing, Transported, Hard, Poorly graded, Sub-rounded. Change of ground conditions noted. Expected TD2, but low returns with mostly piezolites and silt from above. Cyclone cleaned out as end of day.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (35.00-83.00)
50							CALCRETE, (TD2), Light or White and Brown, Slightly Weathered, Medium Strong Rock. Cemented silicious calcretes with some larger fragments (up to 5 cm long/3 wide) in 34 - 38 m.					
60			ZJ	GL3								INJECTION(60.00) ID: 7
70	BG	OB	D				SAND, gravelly and silty, (QUATERNARY DETRITAL), Yellow and Brown, Transported, Hard, Poorly graded, Sub-rounded. Much softer with clays noted. Still calcrete coming up.					
80							DOLOMITE, (OB), Blue and Yellow, Slightly Weathered, Medium Strong Rock. Broken ground with large fragments of dolomite (3 - 5 cm). Very broken and caving in on the hammer as soon as lifted.					
90							DOLOMITE, (OB), Blue and Yellow, Slightly Weathered, Medium Strong Rock. Fractured dolomite with infill cavities. Weathered cherts and clays. Quartz particle					W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (83.00-119.00)
100			D	C								
					0	100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0015	Hole Length:	136.00

Easting: 681805.00
Northing: 7460074.32
Surface RL: 694.93
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Jul 16 - 01 Aug 16
License: CAW181126
Comments: Juna Downs Phase 2 FY16 Hydro Program Production Bore

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 10.0	DR3	DR	500		EASTERNWELL	BM2
10.0 - 124.0	DR3	DR	450		EASTERNWELL	BM2, YA
124.0 - 136.0	DR3	CH	425		EASTERNWELL	YA

TOC RL: 695.67 - (drilled) SWL: 31.51 MBGL (23 Jul 16) Dev: Y: 19.0 hour(s) Final pH: 8.2
TOC RL: 696.35 (Stickup 1.42m) (current) Is Live: Y (-) Date: 30 Jul 2016 Final EC: 560.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	BG	OB	D	C			DOLOMITE, (OB), Blue and Yellow, Slightly Weathered, Medium Strong Rock. Fractured dolomite with infill cavities. Weathered cherts and clays. Quartz particle					GRAVEL MED (2.00-133.00)
120	MG		D				DOLOMITE, (OB), Blue and Grey, Slightly Weathered, Medium Strong Rock. competent crystalline dolomite, very slow penetration					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (35.00-83.00)
140												INJECTION(60.00) ID: 7
150												W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (83.00-119.00)
160												
170												
180												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (119.00-131.00)
190												BLANK STEEL: Size 12" - W.T.9.53mm (131.00-133.00)
200						0 100 200		0-5000	0-14	0-50		END CAP (133.00) FALLBACK (133.00-136.00)

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0019	Hole Length:	150.00

Easting: 682680.96
Northing: 7460154.83
Surface RL: 692.56
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Sep 17 - 11 Sep 17
Comments: NO WIRELINE REQUESTED

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 693.41 (Stickup 0.68m) (drilled) SWL: 29.87 MBTOC (13 Sep 17) Dev: N Final pH: -
TOC RL: 693.71 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	YXG	C			SILT, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Soil, Maghemite,Goethite and minor Chert.					BLANK PVC: Size 40 - Class 9 (0.00-36.00)
10		TD3	YK	XH			SILT, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Soil, silt and clay. Minor Maghemite, Hematite and trace goethite.					GRAVEL MED (0.00-150.00)
20			I	H			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Rounded. Pisolites and minor hematite.					
30			3K	N			CALCRETE, (TD3), Grey and Light or White, Moderately Weathered, Weak Rock. Calcrete and clay with minor black manganese rich material (surfaces). Trace chert. Small to medium chips.					
40			3N	C			CALCRETE, (TD3), Dark or Black and Grey, Slightly Weathered, Medium Strong Rock. Manganese rich calcrete and minor chert.Small to medium chips.					SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)
50			DK				DOLOMITE, (OB), Grey and Brown, Moderately Weathered, Weak Rock. Weathered and fractures dolomite and clay. FWS = 42m (2L/s).					LEVELTROLL(40.00) ID: 2157
60			D									
70		OB					DOLOMITE, (OB), Dark or Black and Grey, Fresh, Strong Rock. Dolomite and trace quartz. Small fractures at 76-80m, 90-94m, 126-128m. Water increased to 4L/s at 120m.				
80												
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0019	Hole Length:	150.00

Easting: 682680.96
Northing: 7460154.83
Surface RL: 692.56
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 11 Sep 17 - 11 Sep 17
Comments: NO WIRELINE REQUESTED

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 693.41 (Stickup 0.68m) (drilled) SWL: 29.87 MBTOC (13 Sep 17) Dev: N Final pH: -
TOC RL: 693.71 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–200		OB	D			0 100 200	DOLOMITE, (OB), Dark or Black and Grey, Fresh, Strong Rock. Dolomite and trace quartz. Small fractures at 76-80m, 90-94m, 126-128m. Water increased to 4L/s at 120m.	0-5000	0-14	0-50		GRAVEL MED (0.00-150.00) SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00) LEVELTROLL(40.00) ID: 2157 END CAP (150.00)

Program: FY18 Juna Downs Phase 3 MAR Borefield Planned Hole: JDH_2018_002 Page: 216

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0022	Hole Length:	150.00

Easting:	683527.30
Northing:	7460190.35
Surface RL:	690.80
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	07 Sep 17 - 07 Sep 17
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL:	691.65	(Stickup 0.89m) (drilled)	SWL:	28.09 MBGL	(10 Sep 17)	Dev:	N	Final pH:	-
TOC RL:	691.95	(Stickup 1.15m) (current)	Is Live:	Y	(-)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
0	UG	SZ	XY	G			SAND, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Surface scree. Soil and small angular fragments of maghemite and minor goethite.
10		TD3	K	XH			CLAY, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-angular. Clay and minor fine to small fragments of maghemite and hematite, trace goethite.
20			KC				
30			IX	GK			CLAY, (QUATERNARY DETRITAL), Light or White and Brown, Transported, Hard, Poorly graded, Sub-angular. Clay and calcrete with trace maghemite and goethite.
40		TD2	G	SK			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Rounded. Small to large magnetic pisolites, maghemite and minor goethite. Very clayey. Large pisolites 34-36m.
50			KIG	X			GRAVEL, (QUATERNARY DETRITAL), Light or White and Brown, Transported, Very Stiff, Poorly graded, Angular. Small angular chips of clayey vitreous goethite and weathered yellow goethite. Minor white and yellow shale/clay.
60			XG	D			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Stiff, Poorly graded, Sub-rounded. Clay, maghemite (pisolites) and siliceous goethite. Minor white clay fragments, large white shale/clay fragments 58-60m. Fracture at 56-58m, goethite chips up to 2cm.
70							
80		OB	DSC				QUATERNARY DETRITAL, (TD2), Green and Brown, Highly Weathered, Extremely Weak Rock. Maghemite (small pisolites), vuggy goethite, minor dolomite. Trace quartz and chert. Large fracture/fault 62-64m, 66-68m, fragments 5 - 8cm of vuggy goethite. Angular and rounded chips. Vry clayey 60-64m.
90							
100							

Gamma CPS API: 0 100 200

EC us/cm: 0-5000 | pH: 0-14 | Yield L/s: 0-50

Diagram Scaled to 400mm

Notes:

- GROUT (0.00-2.00)
- BLANK PVC: Size 40 - Class 9 (0.00-36.00)
- GRAVEL MED (2.00-150.00)
- LEVELTROLL(9.54) ID: 2178
- SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)

BHPIO - Hydrogeology Log

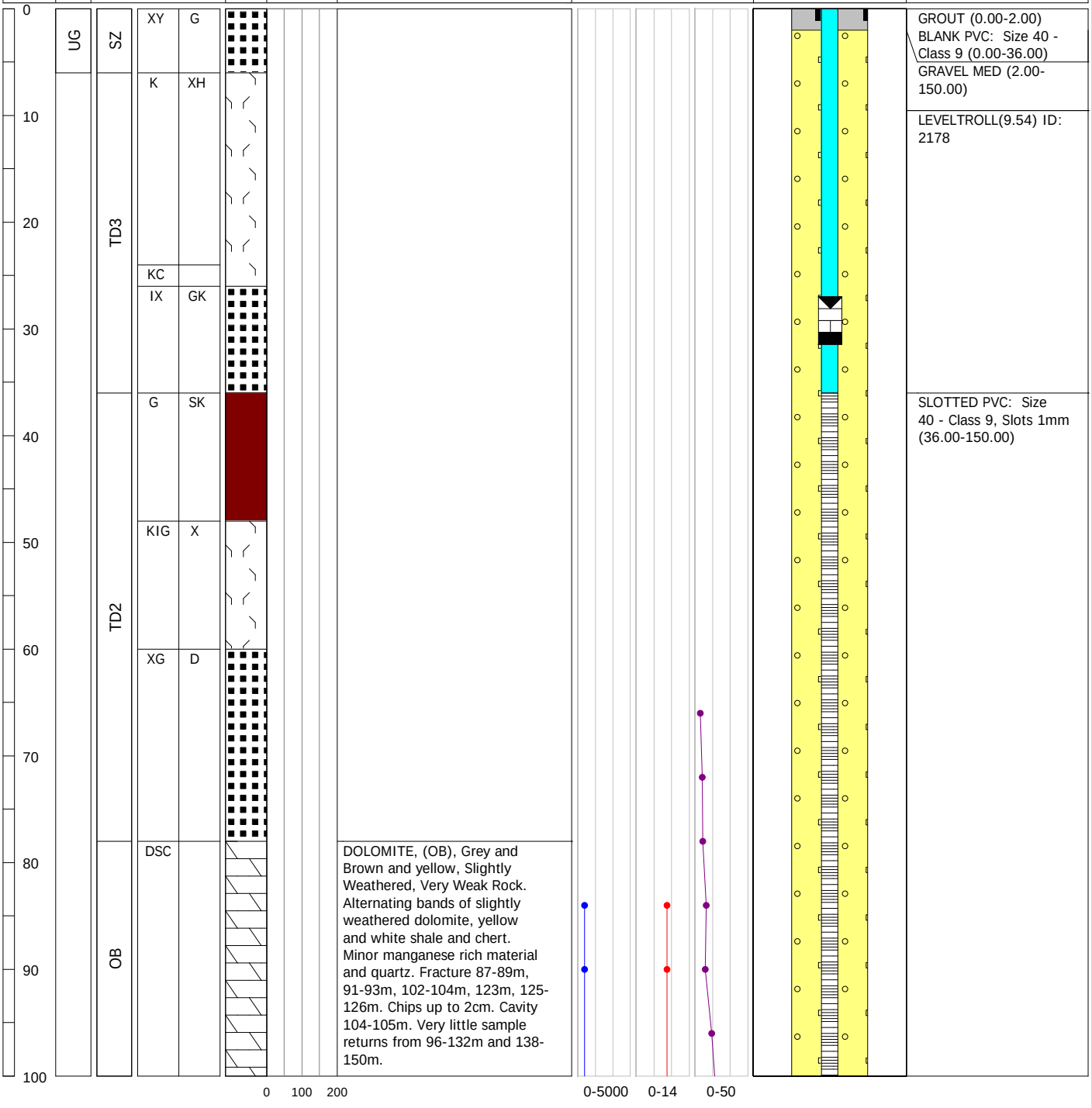
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0022	Hole Length:	150.00

Easting: 683527.30
Northing: 7460190.35
Surface RL: 690.80
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Sep 17 - 07 Sep 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 691.65 (Stickup 0.89m) (drilled) SWL: 28.09 MBGL (10 Sep 17) Dev: N Final pH: -
TOC RL: 691.95 (Stickup 1.15m) (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0022	Hole Length:	150.00

Easting: 683527.30
Northing: 7460190.35
Surface RL: 690.80
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 07 Sep 17 - 07 Sep 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 691.65 (Stickup 0.89m) (drilled) SWL: 28.09 MBGL (10 Sep 17) Dev: N Final pH: -
TOC RL: 691.95 (Stickup 1.15m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OB	DSC				DOLOMITE, (OB), Grey and Brown and yellow, Slightly Weathered, Very Weak Rock. Alternating bands of slightly weathered dolomite, yellow and white shale and chert. Minor manganese rich material and quartz. Fracture 87-89m, 91-93m, 102-104m, 123m, 125-126m. Chips up to 2cm. Cavity 104-105m. Very little sample returns from 96-132m and 138-150m.					GRAVEL MED (2.00-150.00) LEVELTROLL(9.54) ID: 2178 SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00) END CAP (150.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0025	Hole Length:	150.00

Easting:	681723.93
Northing:	7458523.90
Surface RL:	692.02
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	21 Sep 17 - 22 Sep 17
Comments:	Sump breach: TDS = 431ppm, pH = 7.72, EC = 607micrS/cm

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL:	692.63	(Stickup 0.68m)	(drilled)	SWL:	28.49 MBTOC	(23 Sep 17)	Dev:	N	Final pH:	-
TOC RL:	692.93	-	(current)	Is Live:	Y	(-)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	YXH	GQC			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Angular. Surface scree, Silty soil, maghemite, hematite, goethite, chert and quartz.					AB FOAM (0.00-2.00)
10		TD3	YK	XH			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Angular. Fine clayey silt/soil. Minor maghemite/ hematite. Trace chert and quartz.					BLANK PVC: Size 40 - Class 9 (0.00-36.00)
20												GRAVEL MED (2.00-150.00)
30		TD2	3	K			CALCRETE, (TD2), Light or White and Yellow, Slightly Weathered, Medium Strong Rock. Slightly clayey calcrete.					
40			K3	XG			CALCRETE, (TD2), Green and Yellow, Moderately Weathered, Medium Strong Rock. Clay and calcrete. Minor maghemite and goethite 46-48m.FWS 42m.					SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)
50			G3	K			CALCRETE, (TD2), Brown and Light or White, Moderately Weathered, Medium Strong Rock. Goethite and calcrete. Minor fragments of white clay.					
			GK				CLAY, (TD2), Yellow and Brown, Moderately Weathered, Very Weak Rock. Weathered goethite and yellow clay.					
60			K	G			CLAY, (TD2), Light or White, Moderately Weathered, Very Weak Rock. White clay with minor goethite (60-62m). Large goethite fragments 62-64m.					
70		OB	GK	D			CLAY, (OB), Yellow and Brown and grey, Slightly Weathered, Medium Strong Rock. Goethite, yellow clay/shale and minor dolomite.					
			D	S			DOLOMITE, (OB), Grey and Brown, Slightly Weathered, Strong Rock. Dolomite with minor yellow and white shale. Small chips. Fractures at 69m, 72-74m, 76-78m. Yield increased to 10L/s.					
80			S	D								
			D	S								
90			S	DG			SHALE, (OB), Light or White, Slightly Weathered, Weak Rock. White shale with minor dolomite and trace weathered goethite					
		OA	S	JD			DOLOMITE, (OB), Grey, Fresh, Strong Rock. Dolomite with minor white shale. Trace goethite.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

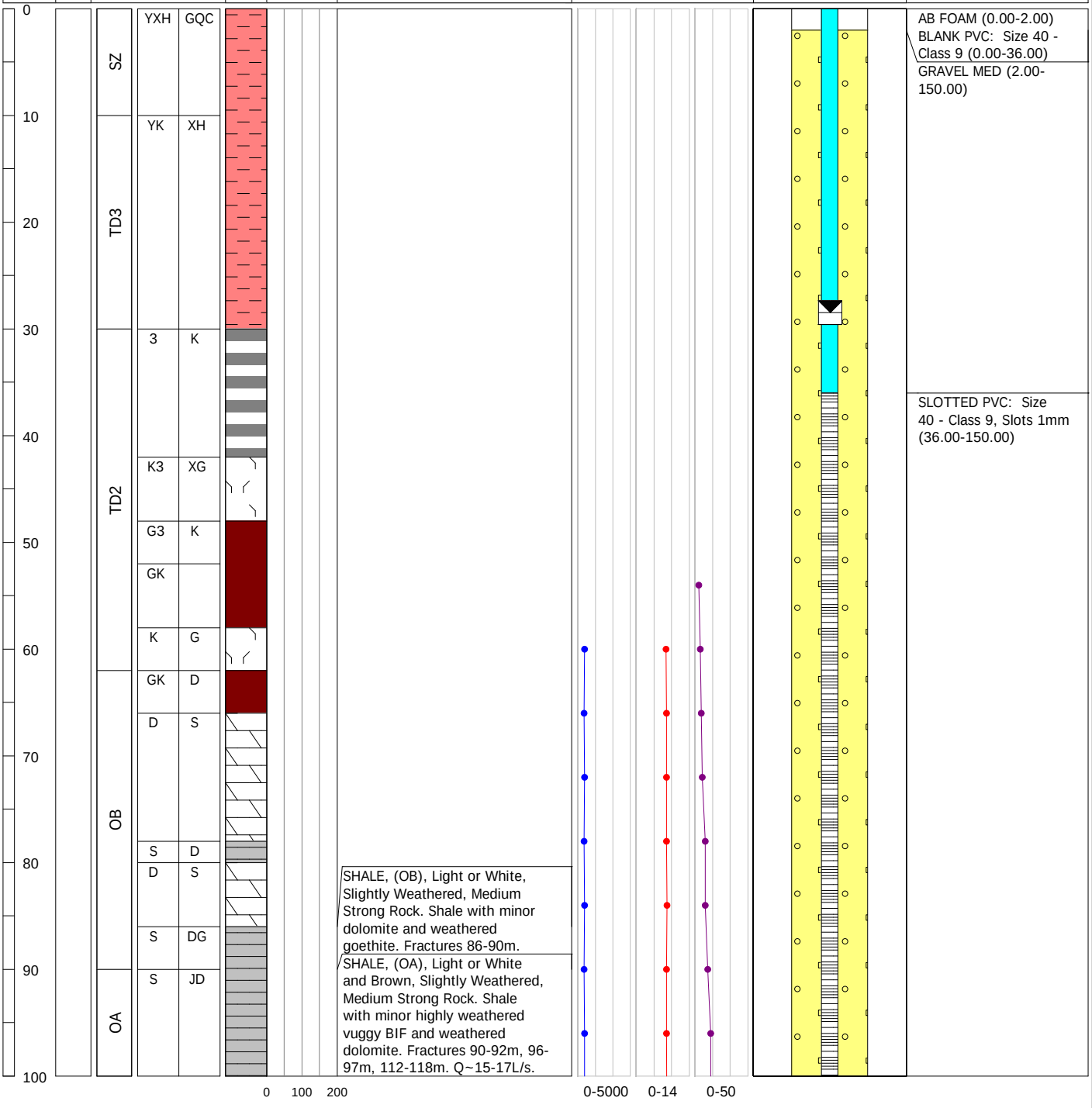
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0025	Hole Length:	150.00

Easting: 681723.93
Northing: 7458523.90
Surface RL: 692.02
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Sep 17 - 22 Sep 17
Comments: Sump breach: TDS = 431ppm, pH = 7.72, EC = 607micrS/cm

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 692.63 (Stickup 0.68m) (drilled) SWL: 28.49 MBTOC (23 Sep 17) Dev: N Final pH: -
TOC RL: 692.93 - (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0025	Hole Length:	150.00

Easting: 681723.93
Northing: 7458523.90
Surface RL: 692.02
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Sep 17 - 22 Sep 17
Comments: Sump breach: TDS = 431ppm, pH = 7.72, EC = 607micrS/cm

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 692.63 (Stickup 0.68m) (drilled) SWL: 28.49 MBTOC (23 Sep 17) Dev: N Final pH: -
TOC RL: 692.93 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		OA	S	JD			SHALE, (OA), Light or White and Brown, Slightly Weathered, Medium Strong Rock. Shale with minor highly weathered vuggy BIF and weathered dolomite. Fractures 90-92m, 96-97m, 112-118m. Q~15-17L/s.					GRAVEL MED (2.00-150.00)
110												SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)
120			SD	J			SHALE, (OA), Light or White and Brown, Fresh, Very Strong Rock. Shale and fresh dolomite. Minor weathered BIF. Q~17L/s.					
130			SDJ				LEACHED BIF, (OA), Light or White and Brown, Slightly Weathered, Weak Rock. Shale, fresh dolomite minor weathered vuggy BIF. Q~20L/s.					
140			J	S			LEACHED BIF, (OA), Brown, Slightly Weathered, Weak Rock. Weathered BIF, minor shale, trace dolomite. Q~20L/s					
150												END CAP (150.00)
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0028	Hole Length:	150.00

Easting: 682361.36
Northing: 7459405.37
Surface RL: 692.62
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Sep 17 - 17 Sep 17

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	MM10

Comments: Highly fractured ground, continuousely cleaning out fallback and flows over 20L/s high amounts of fo...

TOC RL: 693.35 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.60 (Stickup 0.98m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZXG	YC			GRAVEL AND SAND, silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Sub-rounded.					CEMENT (0.00-2.00) BLANK PVC: Size 40 - Class 9 (0.00-36.00)
10		TD3	ZY	X			SILT, sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Sub-rounded. Cavity 18-24m.					GRAVEL MED: tOOK 17 TONNES(EXPECTED WAS 7.5) (2.00-150.00)
20	CV	TD2	V				CALCRETE, (TD2), Missing, Extremely Weathered, Medium Strong Rock. Cavity, no sample return, hammer did not hit					
			3	CK			CALCRETE, (TD2), Light or White and Yellow, Extremely Weathered, Medium Strong Rock. Fractured rock and clays, extremely weathered from 24-30, then becomes more fresh, minor yellow chert, chips are craggly, significant secondary percipitation, some chips to 50mm. Damp ground at 26m.					
40			3K	CQG			CALCRETE, (TD2), Light or White and Yellow and grey, Extremely Weathered, Medium Strong Rock. Fractured rock and clays interbedded, first flow at 42m.					SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)
		OB	D3S	G								
50			D	KSC			DOLOMITE, (OB), Grey and Light or White, Moderately Weathered, Medium Strong Rock. Chips 1-15mm. Minor black sheen- maybe manganese or black shale, nothing significant in sample.					
60			QCD									
			D	CQ			DOLOMITE, (OB), Grey and Light or White, Moderately Weathered, Medium Strong Rock. Chips 1-30mm, inttermittent fractures and competent ground 46-54m, more fresh from 48-50. Then increase in chips 15-30mm, increased weathering, craggly textures, purple and yellow dolomite and secondary percipitation from 50-54 and 56-58 then becomes a very dark purple grey with minor white clay nodules from 58-60m.					
70			SN	C								
		OA	DN	SC								
80			NCS	JDK								
90			SC	GJ			DOLOMITE, (OB), Light or White and Yellow, Extremely Weathered, Weak Rock. Mostly white secondary silicification on fractured yellow chert and dolerite, some chips to 30mm, very pocked and craggly. Driller notes small fracture 60-66.					
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0028	Hole Length:	150.00

Easting: 682361.36
Northing: 7459405.37
Surface RL: 692.62
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Sep 17 - 17 Sep 17
Comments: Highly fractured ground, continuousely cleaning out fallback and flows over 20L/s high amounts of fo...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	MM10

TOC RL: 693.35 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.60 (Stickup 0.98m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZXG	YC								CEMENT (0.00-2.00)
10		TD3	ZY	X			DOLOMITE, (OB), Grey, Highly Weathered, Medium Strong Rock. Rare clasts of secondary silicification minor friable, gritty silt and silica and minor white clay nodules. Driller notes larger fractures 66-78m. appears to be interbedded fracturing- 73, 76 and larger fractures 76-78.					BLANK PVC: Size 40 - Class 9 (0.00-36.00)
20	CV	TD2	V									GRAVEL MED: tOOK 17 TONNES(EXPECTED WAS 7.5) (2.00-150.00)
			3	CK			DOLOMITE, (OA), Yellow and Dark or Black and grey, Highly Weathered, Medium Strong Rock. Yellow pocked and craggly silicified shale, dark grey to purple dolerite, minor quartz ad white silt nodules, moderately to well weathered.					
30			3K	CQG								
40			D3S	G			DOLOMITE, (OA), Dark or Black and Grey, Highly Weathered, Medium Strong Rock. Dark grey to purple dolomite and manganese, minor yellow shale and white nodules as described above. Well fractured with potential cavities 76-78m.					SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)
50		OB	D	KSC								
60			QCD				DOLOMITE, (OA), Yellow and Dark or Black and grey, Highly Weathered, Very Weak Rock. As above with highly silicified and chery grey and yellow goethite BIF looking esp at 88-90m, 92-96. Over all moderately silicified, interbedded with very craggly yellow shale, mionor pink and white clayey shale nodules, no reaction to HCl. Driller notes fractures 78-90m. Over all drilling looks to have intermittent fractures from 83-90m.					
			D	CQ								
70			SN	C								
80			DN	SC								
		OA	NCS	JDK			UNMINERALISED BIF, (OA), Yellow, Extremely Weathered, Weak Rock. Yellow weathered shale/chert and craggly white to yellow secondary silicification and friable shale and shaley silica nodules, minor dark grey silicified BIF. Driller notes loose, fallback and small fractures 96-102.					
90												
			SC	GJ								
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: MUDLARK WELL **Hole Name:** HGSL0028 **Hole Length:** 150.00

Easting: 682361.36
Northing: 7459405.37
Surface RL: 692.62
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Sep 17 - 17 Sep 17
Comments: Highly fractured ground, continuously cleaning out fallback and flows over 20L/s high amounts of fo...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	WLDRIG5	CH	200		WELLDRILL	MM10

TOC RL: 693.35 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.60 (Stickup 0.98m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Strat	Major	Minor	Hydrogeological Description
100–110	OA	SC	GJ	UNMINERALISED BIF, (OA), Yellow, Extremely Weathered, Weak Rock. Yellow weathered shale/chert and craggly white to yellow secondary silicification and friable shale and shaley silica nodules, minor dark grey silicified BIF. Driller notes loose, fallback and small fractures 96-102.
110–120	N3	JC	GS	UNMINERALISED BIF, (N3), Dark or Black and Grey and yellow, Highly Weathered, Weak Rock. Dark grey and yellow cherty goethite BIF, moderatley silicified with minor craggly white to yellow secondary silicification and friable shale and silica nodules.
120–150	N3	S	CJ	UNMINERALISED BIF, (N3), Yellow and Pink and light or white, Highly Weathered, Weak Rock. Contamination??? Craggly, friable, pink and yellown with mionr white, shale and silica nodules, secondary silicification, minor dark grey silicified BIF. Increase in pink to orange friable shale nodules from 120m. Chips are smaller from 126m, driller has a hard time lifting cuttings, contamination suspected. Driller notes small fractures 114-120, then fractured from 120-123, 125-138m.

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Diagram Scaled to 400mm

Notes:
GRAVEL MED: tOOK 17 TONNES(EXPECTED WAS 7.5) (2.00-150.00)
SLOTTED PVC: Size 40 - Class 9, Slots 1mm (36.00-150.00)

BHPIO - Hydrogeology Log

BHP

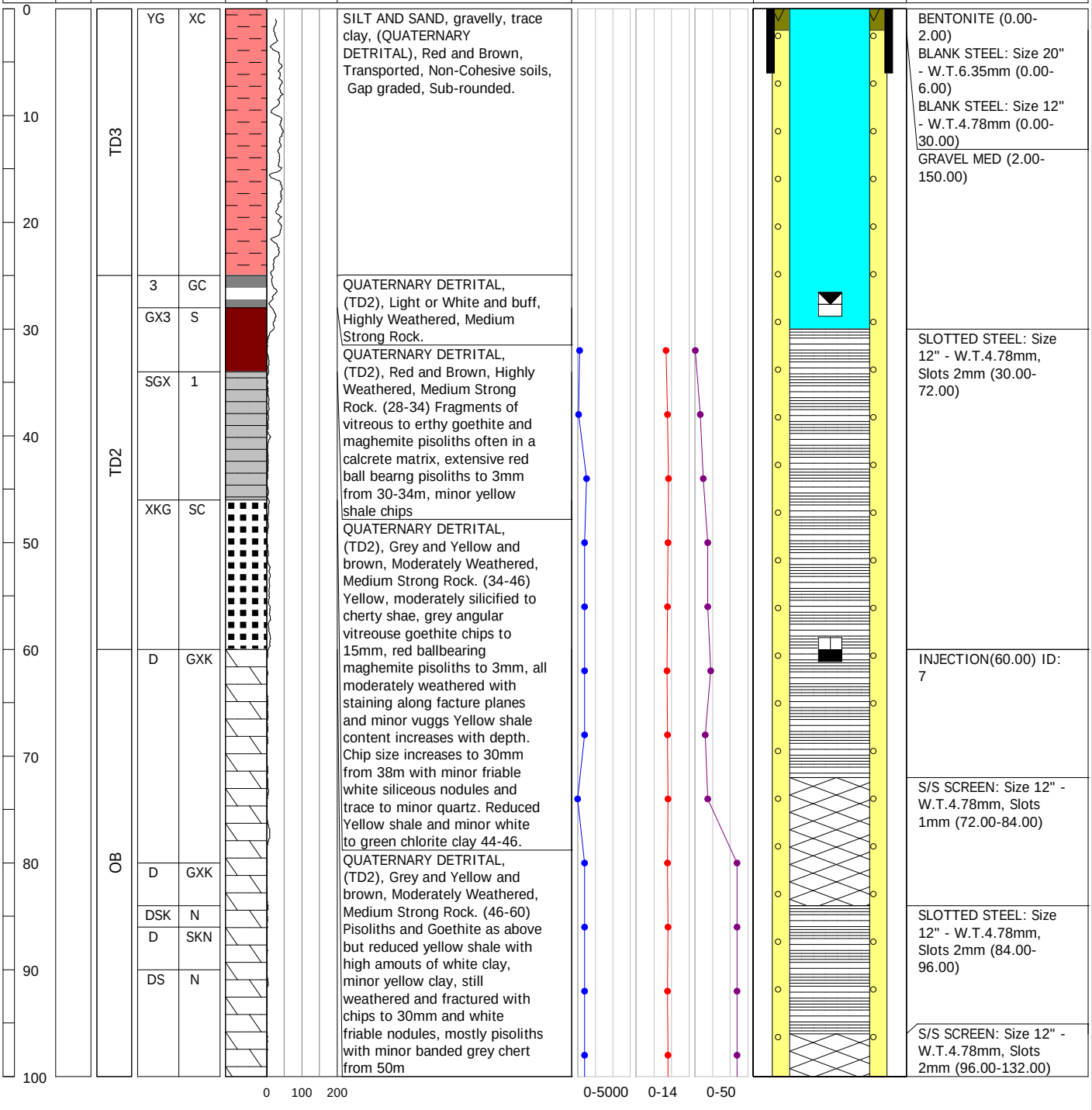
Project:	MUDLARK WELL	Hole Name:	HGSL0031	Hole Length:	168.00

Easting: 683544.94
Northing: 7460196.57
Surface RL: 690.59
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Sep 17 - 30 Sep 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 134.0	DR5	DR	450		EASTERNWELL	MM10
134.0 - 168.0	DR5	CH	450		EASTERNWELL	MM10

License: CAW200193

TOC RL: 691.19 (Stickup 0.41m) (drilled) SWL: 27.68 MBGL (04 Oct 17) Dev: Y: 13.3 hour(s) Final pH: 8.0
TOC RL: 691.81 (Stickup 1.22m) (current) Is Live: Y (-) Date: 29 Sep 2017 Final EC: 643.00



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0031	Hole Length:	168.00

Easting: 683544.94
Northing: 7460196.57
Surface RL: 690.59
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Sep 17 - 30 Sep 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 134.0	DR5	DR	450		EASTERNWELL	MM10
134.0 - 168.0	DR5	CH	450		EASTERNWELL	MM10

License: CAW200193

TOC RL: 691.19 (Stickup 0.41m) (drilled) SWL: 27.68 MBGL (04 Oct 17) Dev: Y: 13.3 hour(s) Final pH: 8.0
TOC RL: 691.81 (Stickup 1.22m) (current) Is Live: Y (-) Date: 29 Sep 2017 Final EC: 643.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
0		TD3	YG	XC			DOLOMITE, (OB), Grey and Brown, Highly Weathered, Medium Strong Rock. (60-80) Weathered fractured chips of dolomite, mostly to 20mm, some to 50mm, with more larger chips from 60-64, 70-74, 78-80m. Extensive discolouration and alteration on surfaces, minor botrioidal nodules of transported Fe and clay. Minor pisoliths- potentially contamination, but could be inplace.
10							
20							
30		TD2	3	GC			DOLOMITE, (OB), Grey and Brown, Highly Weathered, Strong Rock. (80-84) As above, driller notes very hard band 80-84, chips are still very large (to 50mm).Yield doubled from around 20 to 40L/sec. Started back up the next day at 82m and the sample returned as 80-90% pisolites- contamination. Driller reports that the ground is still hard. Dolomite is quite crystalline.
40			GX3	S			
50			SGX	1			DOLOMITE, (OB), Yellow and Grey, Highly Weathered, Medium Strong Rock. (84-86) Increase in yellow clayey shale. Driller notes broken ground 84-86 and water picking up.
60			XKG	SC			DOLOMITE, (OB), Grey and Yellow, Highly Weathered, Medium Strong Rock. (86-90) Weathered fractured chips of dolomite, mostly to 20mm, some to 50mm, slightly less discoloration and alteration on surfaces and a bit more angular, minor yellow shaley clay. Minor pisolites- likely contamination. Driller notes broken ground 86-87, hard from 87-91.
70		OB	D	GXK			
80			D	GXK			DOLOMITE, (OB), Grey and Red, Highly Weathered, Medium Strong Rock. (90-108) More weathered, driller notes 91-92 broken ground, 92-98 hard wit broken bits, 98-110 hard. High amounts of purple discoloration and shale esp. from 90-92 and 102-104. From 92m minor weathered yellowish brown shale, rounded gritty clasts of highly weathered brown dolomite some to 60mm. Slightly fresher 104-106.
			DSK	N			
			D	SKN			
90			DS	N			
100							

0 100 200

EC us/cm	pH	Yield L/s
0-5000	0-14	0-50

Diagram Scaled to 600mm

Notes:
- BENTONITE (0.00-2.00)
- BLANK STEEL: Size 20" - W.T.6.35mm (0.00-6.00)
- BLANK STEEL: Size 12" - W.T.4.78mm (0.00-30.00)
- GRAVEL MED (2.00-150.00)
- SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 2mm (30.00-72.00)
- INJECTION(60.00) ID: 7
- S/S SCREEN: Size 12" - W.T.4.78mm, Slots 1mm (72.00-84.00)
- SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 2mm (84.00-96.00)
- S/S SCREEN: Size 12" - W.T.4.78mm, Slots 2mm (96.00-132.00)

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0031	Hole Length:	168.00

Easting: 683544.94
Northing: 7460196.57
Surface RL: 690.59
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Sep 17 - 30 Sep 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 134.0	DR5	DR	450		EASTERNWELL	MM10
134.0 - 168.0	DR5	CH	450		EASTERNWELL	MM10

License: CAW200193

TOC RL: 691.19 (Stickup 0.41m) (drilled) SWL: 27.68 MBGL (04 Oct 17) Dev: Y: 13.3 hour(s) Final pH: 8.0
TOC RL: 691.81 (Stickup 1.22m) (current) Is Live: Y (-) Date: 29 Sep 2017 Final EC: 643.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OB	DS	N			DOLOMITE, (OB), Grey and Red, Highly Weathered, Medium Strong Rock. (90-108) More weathered, driller notes 91-92 broken ground, 92-98 hard wit broken bits, 98-110 hard. High amounts of purple discoloration and shale esp. from 90-92 and 102-104. From 92m minor weathered yellowish brown shale, rounded gritty clasts of highly weathered brown dolomite some to 60mm. Slightly fresher 104-106.					GRAVEL MED (2.00-150.00)
110			D	Q								
120			D	Q			DOLOMITE, (OB), Grey, Slightly Weathered, Strong Rock. (108-122) Fresher, chips are more angular, minor yellow brown discoloration, smaller (only trace over 30mm) chips overall. Slightly more weathered 110-112m. Driller notes 110-116 hard with broken bits, 116-121 hard, 121-122 broken and yield increase.					
130			D	Q								SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 2mm (30.00-72.00)
140			D	Q			DOLOMITE, (OB), Grey and Yellow, Moderately Weathered, Strong Rock. (122-134) Slightly more weathered- more oxidation/staining yellow to brown, trace larger chips to 40mm esp. 128-130. Driller notes 122-128 is very broken hole rod. From 128-139 hard with broken ground at 131-132.					
150							DOLOMITE, (OB), Grey, Slightly Weathered, Strong Rock. (134-150) Fresher, chips are more angular, minor to trace yellow brown discoloration, smaller chips 0-10mm. Driller notes very hard ground 134-140- over 2 hrs. to drill.					
160												INJECTION(60.00) ID: 7
170							DOLOMITE, (OB), Grey, Fresh, Strong Rock. (140-152) Fresh, chips to 5mm, trace yellow brown discoloration potentially contamination. Driller notes hard ground.					S/S SCREEN: Size 12" - W.T.4.78mm, Slots 1mm (72.00-84.00)
180												SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 2mm (84.00-96.00)
190												S/S SCREEN: Size 12" - W.T.4.78mm, Slots 2mm (96.00-132.00)
												SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 2mm (132.00-150.00)
200						0 100 200		0-5000	0-14	0-50		END CAP (150.00)

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0032	Hole Length:	150.00	

Easting: 682347.98
Northing: 7459356.43
Surface RL: 692.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Oct 17 - 25 Oct 17
License: CAW200193

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	500		EASTERNWELL	LG3
110.0 - 150.0	EWMWW04	CH	500		EASTERNWELL	MM10

Comments: Bore not developed via airlift due to proximity blow out hasard. Not airlifted, developed by pumptes...

TOC RL: 692.90 (Stickup 0.30m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.51 (Stickup 1.01m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Strat	Major	Minor	Hydrogeological Description	Notes
0	SZ	YXH	C	SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Silty soil. Maghemite, hematite minor chert and trace quartz.	BLANK STEEL: 457mm : Grout 8m of 18" casing to ensure it does not drop as development completed by test pump crew so gravel top up and surface completion done after. (0.00-8.00) GROUT: 1m X 1m concrete plinth 0.1m above ground surface, casing stick up0.3 above plinth. (0.00-8.00) BLANK STEEL: 324mm (0.00-52.00)
10	TD3	Y	XHG	SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Silty soil, minor maghemite, goethite and hematite.	
20					
30	TD2	3	X	CALCRETE, (TD2), Light or White and Brown, Highly Weathered, Very Weak Rock. Calcrete and minor maghemite.	GRAVEL MED (2.00-148.00)
		3		CALCRETE, (TD2), Light or White, Moderately Weathered, Medium Strong Rock. Large calcrete fragments.	
40		K3	G	CLAY, (TD2), Yellow and Light or White, Highly Weathered, Medium Strong Rock. Yellow white clay, calcrete and minor large clasts of goethite.	
		K3			
50		Z3G	G3	CLAY, (TD2), Yellow and Green, Highly Weathered, Very Weak Rock. Clay and calcrete, green clay fragments 40-44m.	
	OB	D		CLAY, (TD2), Dark or Black and Grey, Highly Weathered, Very Weak Rock. Manganese rich clay and vuggy leached goethite. Minor calcrete 48-50m. Fractured 46-50m. Q = 3L/s.	SLOTTED STEEL: 324mm , Slots 1mm (52.00-76.00)
60					INJECTION(60.00) ID: 7
70				DOLOMITE, (OB), Blue and Grey, Slightly Weathered, Strong Rock. Slightly weathered dolomite.Minor yellow discoloration 60-68m. Fractured 50-58m. Q increased from 5 to 10L/s between 56 and 62m, and 10 to 12L/s between 68 and 74m.	
		SJ			S/S SCREEN: 324mm , Slots 2mm (76.00-88.00)
80	OA	JSC	N	SHALE, (OB), Brown and Yellow and grey, Slightly Weathered, Strong Rock. Shale and weathered BIF (Hematite and goethite). Q = 12L/s.	
		J	S	UNMINERALISED BIF, (OA), Brown and Grey and light or white, Slightly Weathered, Strong Rock. Slightly weathered BIF (cherty) and shale (white, red and yellow). Minor manganese nodules. Fracture 82-86m (chips 1-2cm). Q = 24L/s.	SLOTTED STEEL: 324mm , Slots 1mm (88.00-94.00)
90		J			
	OA	J			S/S SCREEN: 324mm , Slots 2mm (94.00-118.00)
100					

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50
Diagram Scaled to 600mm

BHPIO - Hydrogeology Log

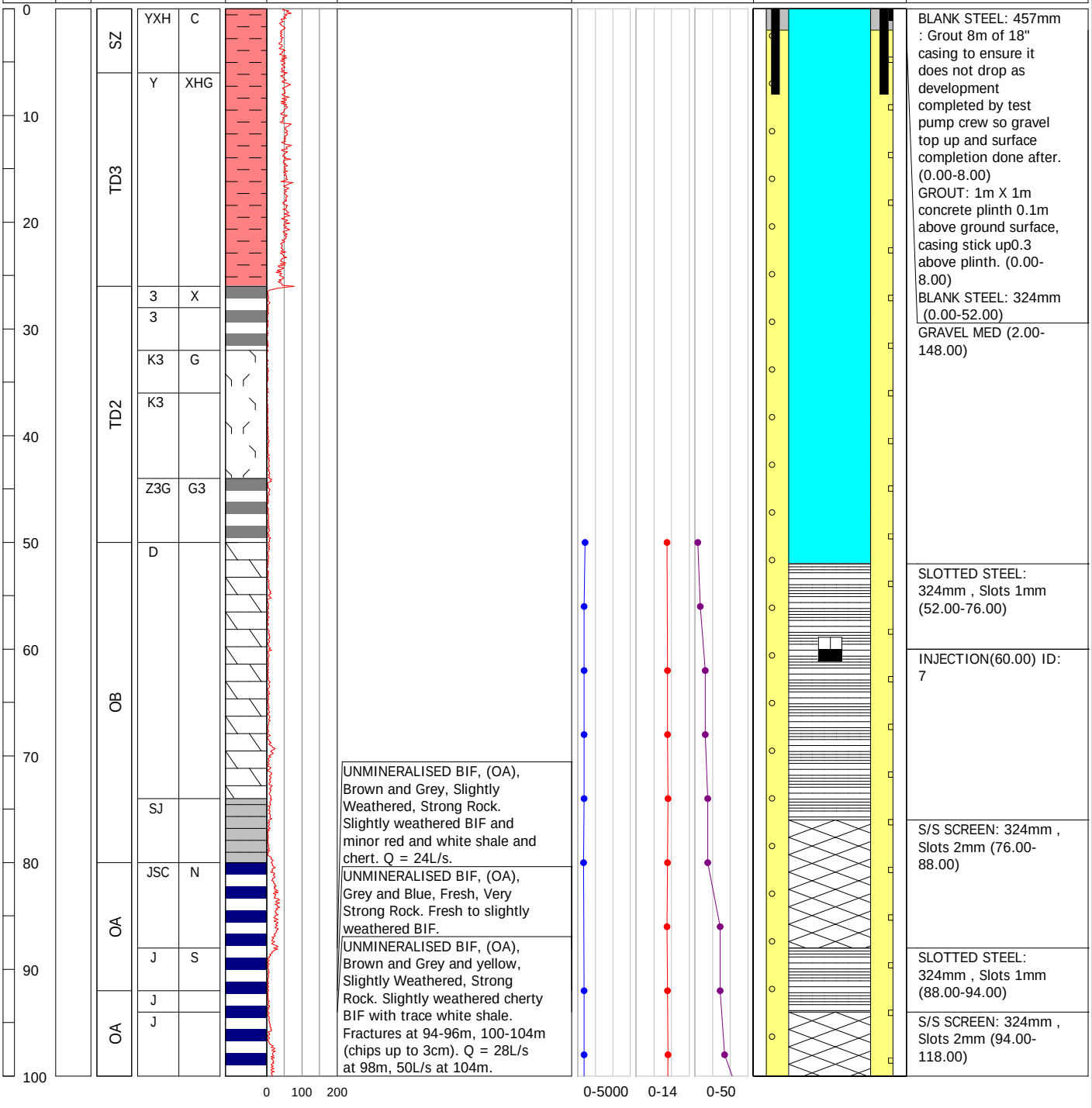
BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0032	Hole Length:	150.00

Easting: 682347.98
Northing: 7459356.43
Surface RL: 692.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Oct 17 - 25 Oct 17
License: CAW200193
Comments: Bore not developed via airlift due to proximity blow out hasard. Not airlifted, developed by pumptes...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	500		EASTERNWELL	LG3
110.0 - 150.0	EWMWW04	CH	500		EASTERNWELL	MM10

TOC RL: 692.90 (Stickup 0.30m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.51 (Stickup 1.01m) (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0032	Hole Length:	150.00

Easting: 682347.98
Northing: 7459356.43
Surface RL: 692.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Oct 17 - 25 Oct 17

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	500		EASTERNWELL	LG3
110.0 - 150.0	EWMWW04	CH	500		EASTERNWELL	MM10

License: CAW200193

Comments: Bore not developed via airlift due to proximity blow out hasard. Not airlifted, developed by pumptes...

TOC RL: 692.90 (Stickup 0.30m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.51 (Stickup 1.01m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OA	J				UNMINERALISED BIF, (OA), Brown and Grey and yellow, Slightly Weathered, Strong Rock. Slightly weathered cherty BIF with trace white shale. Fractures at 94-96m, 100-104m (chips up to 3cm). Q = 28L/s at 98m, 50L/s at 104m.					GRAVEL MED (2.00-148.00)
110			J	1S								
			J	1								
120			J	1S			UNMINERALISED BIF, (OA), Brown and Grey and yellow, Moderately Weathered, Strong Rock. As above, chips become very platey with percipitated white vuggy quartz along fracture planes. Minor pink and white shale and nodules of manganese from 108-110. Rare platey chip to 40mm. Q at 110 read as 54m, low confidence as sumps full.					
130												
140			J	1S			UNMINERALISED BIF, (OA), Brown and Grey and yellow, Slightly Weathered, Strong Rock. Slightly weathered cherty BIF, chips are more fresh, more angularminor planar chips, mostly 15mm, minor chips to 20mm.					
			J1	S								
			J1S	Q								
150			J1	SQ			UNMINERALISED BIF, (OA), Brown and Grey and yellow, Slightly Weathered, Strong Rock. As above, minor interbedded shale esp between 116-118 and 128-130. Very slight increase in yellow shale and vuggy percipitated silica along fracture planes.					SLOTTED STEEL: 324mm , Slots 1mm (52.00-76.00)
160												INJECTION(60.00) ID: 7
170							UNMINERALISED BIF, (OA), Yellow and Grey, Moderately Weathered, Strong Rock. Major fracture zone. Driller notes fractures from 137.7-138.5 and a double in yield to over 50L/ sec. Chips return more weathererd, larger (to 50mm) and some are sub rounded to rounded, minor grey shale and chips of black vuggy, friable iron. Driller notes it becoming hard again after 138.5m.					S/S SCREEN: 324mm , Slots 2mm (76.00-88.00)
180												SLOTTED STEEL: 324mm , Slots 1mm (88.00-94.00)
												S/S SCREEN: 324mm , Slots 2mm (94.00-118.00)
190							UNMINERALISED BIF, (OA), Yellow, Slightly Weathered, Strong Rock. Mostly yellow cherty BIF. Chips are smaller (to 15mm) and more angular. Minor white and grey shale, possibly from above.					SLOTTED STEEL: 324mm , Slots 1mm (118.00-136.00)
												S/S SCREEN: 324mm , Slots 2mm (136.00-148.00)
200												END CAP (148.00) FALLBACK (148.00-150.00)
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

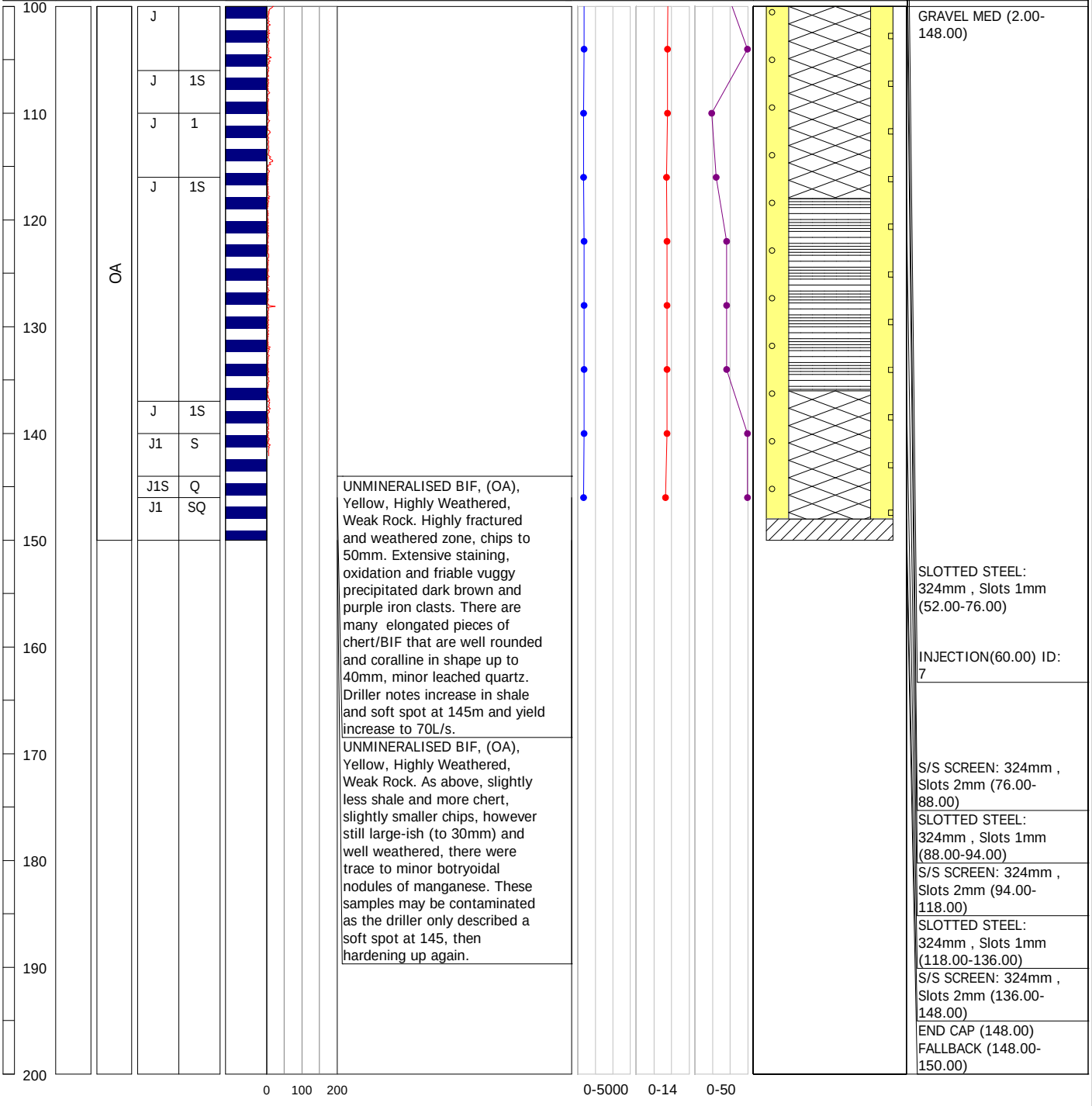
Project:	MUDLARK WELL	Hole Name:	HGSL0032	Hole Length:	150.00

Easting: 682347.98
Northing: 7459356.43
Surface RL: 692.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 20 Oct 17 - 25 Oct 17
Comments: Bore not developed via airlift due to proximity blow out hasard. Not airlifted, developed by pumptes...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	EWMWW04	DR	500		EASTERNWELL	LG3
110.0 - 150.0	EWMWW04	CH	500		EASTERNWELL	MM10

License: CAW200193

TOC RL: 692.90 (Stickup 0.30m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.51 (Stickup 1.01m) (current) Is Live: Y (-) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0037	Hole Length:	152.00

Easting: 682693.35
Northing: 7460206.11
Surface RL: 692.48
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Aug 18 - 24 Aug 18
Comments: Injection bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	EWMWW04	DR	500		EASTERNWELL	KS6
44.0 - 152.0	EWMWW04	DR	450		EASTERNWELL	KS6

License: CAW201374

TOC RL: 693.00 - (drilled) SWL: 28.40 MBTOC (14 Sep 18) Dev: N Final pH: -
TOC RL: 693.78 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	Z	J			CONGLOMERATE, (SZ), Dark or Black and Red, Highly Weathered, Medium Strong Rock. Pisolitic					CEMENT (0.00-2.00) BLANK STEEL: Size 12" - W.T.9.53mm (0.00-42.00) GRAVEL MED: Amount?? (0.00-152.00)
10		TD3	J	I			PARTIALLY MINERALISED, (TD3), Red, Highly Weathered, Medium Strong Rock.					
20			J	G			PARTIALLY MINERALISED, (TD3), Dark or Black and Red, Highly Weathered, Medium Strong Rock.					
30		TD2	J	QC								
			C	J			UNMINERALISED BIF, (TD2), Light or White and Dark or Black and brown, Highly Weathered, Medium Strong Rock. White chert and brown/ red BIF + quartz & calcrete					
40			D3	C			CHERT, (TD2), Light or White and Dark or Black, Highly Weathered, Medium Strong Rock. Chert with minor BIF + trace quartz					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (42.00-150.00)
50			D	3K			DOLOMITE, (TD2), Blue and Grey and light or white, Moderately Weathered, Strong Rock. Chert, Calcrete and dolomite, Light yellow/brown.					
60		OB					DOLOMITE, (OB), Grey and Brown and yellow, Slightly Weathered, Medium Strong Rock. Major fractures 42m, 50-62m, 66-78m.					
70												
80												
			D				DOLOMITE, (OB), Grey, Fresh, Strong Rock. Minor Fractures 82-84m, 90-94m visual estimated flow rate 25-35 l/s. without air flow ~20 l/s.				
90												
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: MUDLARK WELL | Hole Name: HGSL0037 | Hole Length: 152.00

Easting: 682693.35
Northing: 7460206.11
Surface RL: 692.48
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Aug 18 - 24 Aug 18
Comments: Injection bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	EWMWW04	DR	500		EASTERNWELL	KS6
44.0 - 152.0	EWMWW04	DR	450		EASTERNWELL	KS6

License: CAW201374

TOC RL: 693.00 - (drilled) SWL: 28.40 MBTOC (14 Sep 18) Dev: N Final pH: -
TOC RL: 693.78 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OB	D				DOLOMITE, (OB), Grey, Fresh, Strong Rock. Minor Fractures 82-84m, 90-94m visual estimated flow rate 25-35 l/s. without air flow ~20 l/s.					GRAVEL MED: Amount?? (0.00-152.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (42.00-150.00)
110												
120			D				DOLOMITE, (OB), Grey and Blue, Fresh, Strong Rock.					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Juna Downs Phase 4 MAR Borefield Expansion FY19 Planned Hole: HGSL0037 Page: 234

BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0038	Hole Length:	152.00

Easting: 681771.91
Northing: 7458488.87
Surface RL: 691.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Sep 18 - 12 Sep 18
License: CAW201374
Comments: Injection bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	EWMWW04	DR	500		EASTERNWELL	AW11
44.0 - 62.0	EWMWW04	DR	450		EASTERNWELL	MNT
62.0 - 152.0	EWMWW04	DR	400		EASTERNWELL	MNT

TOC RL:	693.02	-	(drilled)	SWL:	29.11 MBTOC	(14 Sep 18)	Dev:	N	Final pH: 8.8
TOC RL:	963.30	-	(current)	Is Live:	Y	(-)	Date:	12 Sep 2018	Final EC: 591.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	YGW	XC			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Extremely Weathered, Non-Cohesive soils, Poorly graded, Sub-angular.					CEMENT: surface seal (0.00-2.00)
10		TD3	ZX	WG			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown and grey, Transported, Non-Cohesive soils, Poorly graded, Sub-angular.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-62.00)
20							SILT, gravelly, (QUATERNARY DETRITAL), Missing, Extremely Weathered, Non-Cohesive soils, Uniform, Sub-angular. Void- no sample 29-30					GRAVEL MED (2.00-152.00)
30			V				SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown and grey, Transported, Non-Cohesive soils, Poorly graded, Sub-angular.					
			ZXI	WG								
			H3G				SILT, gravelly, (QUATERNARY DETRITAL), Grey and Light or White, Extremely Weathered, Non-Cohesive soils, Poorly graded, Sub-angular.					
40			GC	D			GRAVEL, sandy, (QUATERNARY DETRITAL), Brown and Light or White, Extremely Weathered, Non-Cohesive soils, Poorly graded, Sub-rounded.					
50		TD2	Z3G	CD			QUATERNARY DETRITAL, (TD2), Dark or Black and Brown and light or white, Highly Weathered, Medium Strong Rock. goethite- often pisolitic, V. Goethite, Hematite, Calcrete, increasing Dolomite with depth, Sometimes pisolitic. Slightly difficult loose drilling.					
60	UG	OB	DSC	3			DOLOMITE, (OB), Grey and Red and light or white, Slightly Weathered, Medium Strong Rock. increasing dolomite with depth, decreasing white weathered non reactive shl/cly, calcrete with depth, jaspilite @ 58m. potential fracture with large 3-4cm dolomite clasts @ 62-66m.					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (62.00-68.00)
70	MG		D									W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (68.00-98.00)
80	UG		D									
90			D	S			DOLOMITE, (OB), Grey, Fresh, Medium Strong Rock. Grey dolomite, gravel with minor 3-4cm chips between 64-66m. weathered rounded surfaces suggests pre-existing fractures. slower penetration with depth and associated finer chip size. trace qtz viens and brown shale from 78-82m.					W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (98.00-104.00)
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

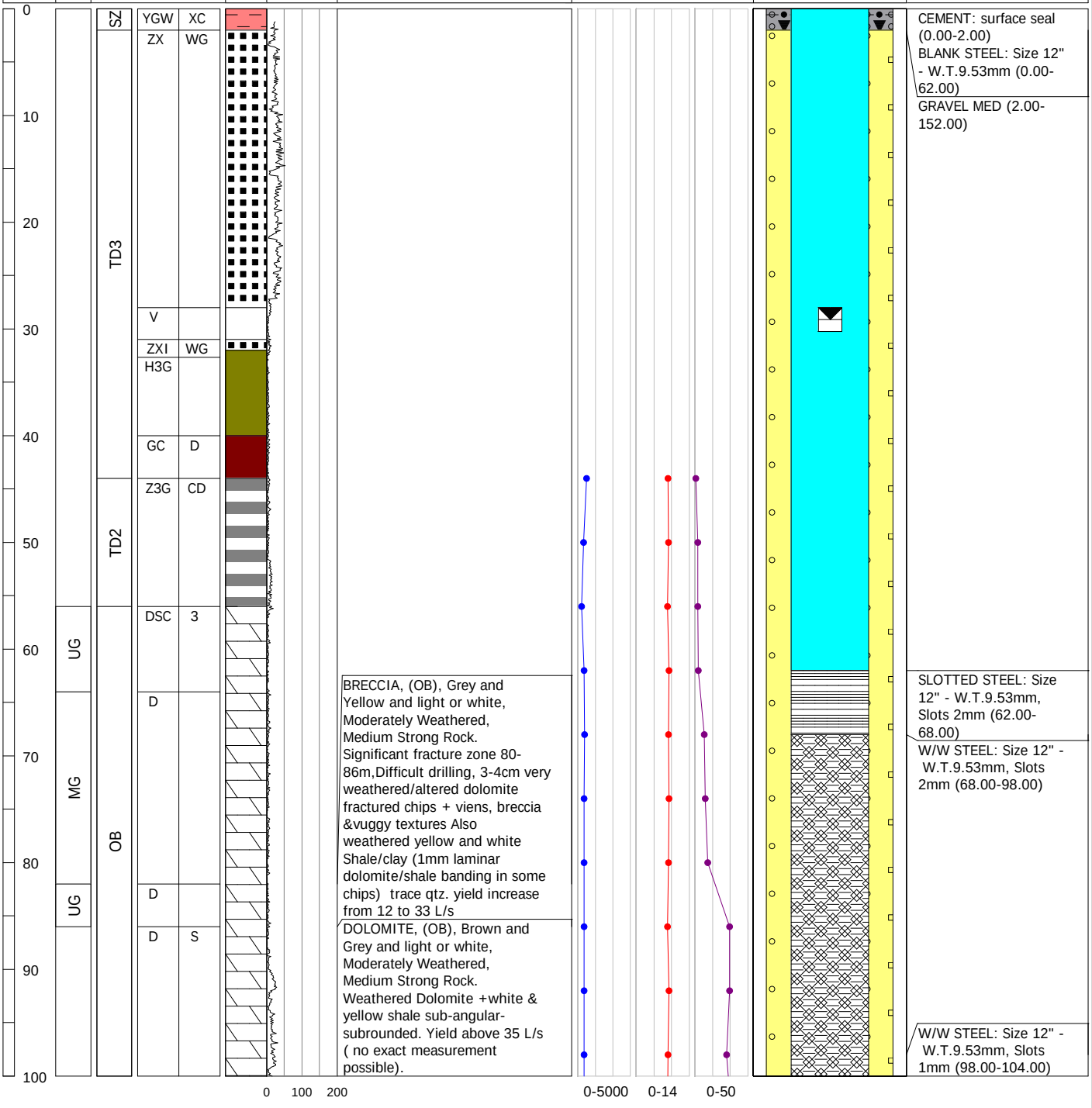
Project:	MUDLARK WELL	Hole Name:	HGSL0038	Hole Length:	152.00

Easting: 681771.91
Northing: 7458488.87
Surface RL: 691.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Sep 18 - 12 Sep 18
Comments: Injection bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	EWMWW04	DR	500		EASTERNWELL	AW11
44.0 - 62.0	EWMWW04	DR	450		EASTERNWELL	MNT
62.0 - 152.0	EWMWW04	DR	400		EASTERNWELL	MNT

License: CAW201374

TOC RL: 693.02 - (drilled) SWL: 29.11 MBTOC (14 Sep 18) Dev: N Final pH: 8.8
TOC RL: 963.30 - (current) Is Live: Y (-) Date: 12 Sep 2018 Final EC: 591.00



BHPIO - Hydrogeology Log

BHP

Project:	MUDLARK WELL	Hole Name:	HGSL0038	Hole Length:	152.00

Easting: 681771.91
Northing: 7458488.87
Surface RL: 691.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 05 Sep 18 - 12 Sep 18
License: CAW201374
Comments: Injection bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	EWMWW04	DR	500		EASTERNWELL	AW11
44.0 - 62.0	EWMWW04	DR	450		EASTERNWELL	MNT
62.0 - 152.0	EWMWW04	DR	400		EASTERNWELL	MNT

TOC RL: 693.02 - (drilled) SWL: 29.11 MBTOC (14 Sep 18) Dev: N Final pH: 8.8
TOC RL: 963.30 - (current) Is Live: Y (-) Date: 12 Sep 2018 Final EC: 591.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OB	D	S			DOLOMITE, (OB), Brown and Grey and light or white, Moderately Weathered, Medium Strong Rock. Weathered Dolomite +white & yellow shale sub-angular-subrounded. Yield above 35 L/s (no exact measurement possible).					GRAVEL MED (2.00-152.00)
110			DF				DOLOMITE, (OB), Grey and Brown, Moderately Weathered, Medium Strong Rock. mixed-weathered subanngular-subrounded dolomite, subrounded to rounded (pisolitic) Fe Shale					
120			D				DOLOMITE, (OB), Grey and Brown, Fresh, Medium Strong Rock. Fresh dolomite with some minor shale 128-130, trace otherwise.					
130												
140												
150												
160												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (62.00-68.00)
170												W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (68.00-98.00)
180												W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (98.00-104.00)
190												W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (104.00-116.00)
200												W/W STEEL: Size 12" - W.T.9.53mm, Slots 1mm (116.00-122.00)
												W/W STEEL: Size 12" - W.T.9.53mm, Slots 2mm (122.00-152.00)
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE **Hole Name:** HNPIAC0001 **Hole Length:** 90.00

Easting: 685388.41
Northing: 7462486.06
Surface RL: 695.80
Grid Name: MGA94_50
Incl / Azm: -89-->118
Construct: 11 Aug 13 - 30 Aug 13

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW21	CH	550	AIR/WATER/FOAM	CONNECTOR	NJ1
6.0 - 51.0	CNDWW21	ROT	450	MUD/WATER	CONNECTOR	NJ1, MC3, ND1
51.0 - 90.0	CNDWW21	CH	400	AIR/WATER/FOAM	CONNECTOR	ND1

Comments: Drilled through alluvials using mud rotary, drilled through dolomite using conventional hammer.

TOC RL: 696.27 (Stickup 0.47m) (drilled) SWL: 33.10 MBTOC (31 Aug 13) Dev: N Final pH: -
TOC RL: 696.27 (Stickup 0.47m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	Y	Z			Silt and clay with gravel					CEMENT (0.00-6.00)
			Z	YK			Silt and clay with gravel. Coarse, sub-rounded to sub-angular, poorly sorted, magnetic. Bif with goethite.					BLANK STEEL: 250mm (0.00-50.50)
10		ST3	Z	YK			Silt and clay with gravel. Coarse, sub-rounded to sub-angular, poorly sorted, magnetic. Bif with goethite.					BLANK STEEL: 405mm : Cased off detritals and continued drilling CH (0.00-51.00)
			ZI	Y			Gravel, fine-coarse, sub-rounded, poorly sorted, loose, magnetic.					GRAVEL AGG (6.00-89.50)
20			ZI	Y			Gravel, fine, rounded, mod sorted, hard. Bif, geothite.					
			ZI	Y			Gravel, fine, rounded, mod sorted, hard. Bif, geothite.					
		OG	Z	G3			Gravel, fine, mod sorted, hard. Bif, angular to sub-rounded, hard					
30			3	C			Calcrete, white, hard, minor yw-br clay					
			3	KC			Calcrete, white, hard, minor yw-br chert and clay					
40			ZK3	C			Clay, soft, yw-br, thin bands calcrete					
			ZKJ	C			Clay, bif, chert, minor calcrete, earthy g, bl-gy bif\mod hard					
50			ZKJ	C			Clay, bif, chert, minor calcrete, earthy g, bl-gy bif\mod hard					SLOTTED STEEL: 250mm , Slots 2mm (50.50-74.50)
			D4C	L			Dolomite, dark, v. Weath, high alt., dark cq					
			D	4			Dolomite, mod weathered, crystalline, minor fractures w/ limonite staining, minor vugs, very hard					
60			D				Dolomite, crystalline, minor fractures w/ iron staining, hard drilling 5-10 min/m.					
		OB										
70			D	Q			Dolomite, crystalline, highly fractured, strong iron staining/ weathering on fractures, large clasts, minor vugs and quartz on larger fractures, 2-4 min/m.					S/S SCREEN: 250mm , Slots 1.6mm (74.50-86.50)
80												
			D				Dolomite, crystalline, moderate fracturing, minor iron staining, marginally darker in colour than overlying dolomite, 6-7 min/m					BLANK STEEL: 250mm (86.50-89.50)
90												FALLBACK: 0.5 m fallback (89.50-90.00)
100												
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 238

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE **Hole Name:** HNPIAC0002 **Hole Length:** 101.00

Easting: 684970.78
Northing: 7462532.23
Surface RL: 697.95
Grid Name: MGA94_50
Incl / Azm: -89-->85
Construct: 31 Aug 13 - 10 Sep 13
Comments: DRILLED THROUGH ALLUVIALS USING MUD ROTART, THEN CHANGE TO CONVENTIONAL HAMMER

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 3.0	CNDWW21	ROT	550	MUD	CONNECTOR	NJ1
3.0 - 74.0	CNDWW21	ROT	450	MUD	CONNECTOR	NJ1
74.0 - 101.0	CNDWW21	CH	400	AIR/WATER/FOAM	CONNECTOR	NJ1

TOC RL: 698.52 - (drilled) SWL: 34.87 MBTOC (11 Sep 13) Dev: N Final pH: -
TOC RL: 698.52 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	Y	Z			Silt and clay with gravel					BLANK STEEL: 508mm (0.00-3.00)
			Z	YK			Silt and clay with gravel coarse sub rounded to sub angular, poorly sorted, mildly magnetic, bif and goethite					CEMENT (0.00-6.00)
10		ST3	Z	YK			Silt and clay with gravel coarse sub rounded to sub angular, poorly sorted, mildly magnetic, bif and goethite					BLANK STEEL: 250mm (0.00-65.00)
			ZI	Y			Gravel, medium-coarse, sub-rounded, loose					BLANK STEEL: 405mm (0.00-72.00)
20			ZI	YX			Gravel, fine-coarse, sub rounded-sub angular, mod sorted					GRAVEL AGG (6.00-99.50)
30			ZI	YX			Gravel, medium-coarse, sub rounded-sub angular, mod-sorted					
		OG	3	CK			Hard, minor yw-br clay (lost circulation 36m ~12000l)					
			3	CK								
40			3	BK			Hard, minor yw-br clay (lost circulation 36m ~12000l)					
			3				Hard, minor yw-br clay and chert (poor sample returns)					
50							Lost circ., no returns (calcrete assumed from hard drilling)					
			K				Lost circ., no returns (clay assumed from fast drilling)					
60												
70			D	X			Fractured and weathered.					SLOTTED STEEL: 250mm , Slots 2mm (65.00-77.00)
		OB	D	X			Fractured and weathered.					
			D	3			Highly fractured, crystalline.					
80			D	3			Highly fractured, crystalline, dark grey chert.					S/S SCREEN: 250mm , Slots 1.6mm (77.00-89.00)
			D	3			Finely fractured, crystalline.					
90												SLOTTED STEEL: 250mm , Slots 2mm (89.00-95.00)
			D	3			Finely fractured, dark staining, ore (manganese ore) and chert.					BLANK STEEL: 250mm (95.00-98.00)
			D	3								FALLBACK (98.00-101.00)
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 239

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE | Hole Name: HNPIAC0002 | Hole Length: 101.00

Easting: 684970.78
Northing: 7462532.23
Surface RL: 697.95
Grid Name: MGA94_50
Incl / Azm: -89-->85
Construct: 31 Aug 13 - 10 Sep 13
Comments: DRILLED THROUGH ALLUVIALS USING MUD ROTART, THEN CHANGE TO CONVENTIONAL HAMMER

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 3.0	CNDWW21	ROT	550	MUD	CONNECTOR	NJ1
3.0 - 74.0	CNDWW21	ROT	450	MUD	CONNECTOR	NJ1
74.0 - 101.0	CNDWW21	CH	400	AIR/WATER/FOAM	CONNECTOR	NJ1

TOC RL: 698.52 - (drilled) SWL: 34.87 MBTOC (11 Sep 13) Dev: N Final pH: -
TOC RL: 698.52 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		OB	D	3								FALLBACK (98.00-101.00)
110												
120												
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 240

BHPIO - Hydrogeology Log

BHP

Project: PACKSADDLE **Hole Name:** HNPIAC0003 **Hole Length:** 80.00

Easting: 684736.98
Northing: 7462109.22
Surface RL: 691.80
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 12 Sep 13 - 15 Sep 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 5.0	CNDWW21	CH	203	AIR/WATER	CONNECTOR	NJ1
5.0 - 9.0	CNDWW21	ROT	203	MUD	CONNECTOR	NJ1
9.0 - 80.0	CNDWW21	ROT	150	MUD	CONNECTOR	NJ1

TOC RL: 692.46 - (drilled) SWL: 29.18 MBTOC (15 Sep 13) Dev: N Final pH: -
TOC RL: 692.74 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	Y	ZK			Silt and clay with various detrital gravel					CEMENT (0.00-6.00) BLANK PVC: 50mm (0.00-67.00)
			Y	ZK			Silt and clay with various detrital gravel					
10		ST3	JW	ZKI			Angular and well sorted chips					GRAVEL AGG (6.00-79.00)
20												
30												
40		VB2	K	3			Soft white-yellow clay, small calcrete chips					LEVELTROLL(35.24) ID: 1221
			K	3			Soft white-yellow clay, small calcrete chips					
50			KJ	Z			Angular blue bif, yellow-brown clay					
							Lost circ., no sample					
60			K	JZ			Yellow-brown clay. Very small chips					
		OB	KD	Z			Yellow-brown clay, weathered dolomite					
70			D	K			Weathered brown-blue dolomite, very small chips. White-yellow clay. Minor lost circ.					SLOTTED PVC: 50mm , Slots 1mm (67.00-79.00)
80												FALLBACK (79.00-80.00)
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	HNPIAC0004	Hole Length:	82.00

Easting: 685301.36
Northing: 7462200.59
Surface RL: 692.53
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 16 Sep 13 - 19 Sep 13
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	CNDWW21	CH	305	AIR/WATER	CONNECTOR	NJ1
6.0 - 82.0	CNDWW21	ROT	150	MUD	CONNECTOR	NJ1

TOC RL: 693.14 (Stickup 0.60m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 693.29 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	Z	Y			Various ore gravel					CEMENT (0.00-6.00) BLANK PVC: 50MM (0.00-70.00)
		ST3	Z	Y			Various ore gravel					
10			Z	C			Very angular pieces, poorly sorted. Green chert.					GRAVEL AGG: 1.5 tonne (6.00-42.00)
			ZIJ	CQ			Pisolites. 1cm chips of quartz. Green chert.					
20												
30			I	Z			90% maghemite pisolites					
		VB2	K	3C			Light yellow brown clay, minor calcrete and chert.					
			K	3C								
40			3	C			Light yellow brown clay, minor calcrete and chert. Calcrete layer, yellow chert. Lost circ. At 40m.					BENTONITE: ~40 L (42.00-44.00)
			Z3G	CZ			Yellow-brown clay, small calcrete chips.					GRAVEL AGG: 1.5 tonne (44.00-82.00)
50			K	Z3			Yellow brown clay.					
							Lost circ., no sample.					
60		OB	SDK	L4			Light blue dolomite, yellow-brown clay					
			DK	L			Highly leached/weathered, competent rock					
70												SLOTTED PVC: 50MM, Slots 1mm (70.00-82.00)
			4D	K			Dark purple, highly weathered infill/alteration, very soft, lost circ.					
80			DK	L			Highly weathered, minor staining, greasy white/green talc					
90												
100						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 242

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	HPSA1633	Hole Length:	110.00

Easting: 686951.07
Northing: 7464796.20
Surface RL: 731.37
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 28 May 16
Comments: MAC Regional FY16.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	MCYWW06	RHF	140		MCKAY	AW10

TOC RL: 732.38 (Stickup 0.99m) (drilled) SWL: 78.87 MBGL (28 May 16) Dev: N Final pH: -
TOC RL: 732.56 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZY	CJ			QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Weak Rock. Detritals sub-angular to sub-rounded. X pisos sub-rounded to rounded. Watery clayey silt present.					CEMENT: Concrete plinth and lockable steel box headworks (0.00-2.00)
			XY	Z								BLANK PVC: 161mm (0.00-6.00)
			XY	Z								BLANK PVC: Size 50 - Class 18 (0.00-56.00)
10			XY				QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Very Weak Rock. X pisos sub-rounded to rounded. Watery clayey silt present.					GRAVEL MED (2.00-110.00)
			XY				QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Very Weak Rock. As above except with lots of PVC contamination					
20			XY	L			QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Very Weak Rock. Gravel to sand sized sub-rounded X pisos in watery clayey silt. Some PVC contamination.					
			X	YZK								
			Z	LG								
30			E									
			E									
			E									
			EK									
40		YE	K	E			QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Very Weak Rock. Gravel to sand sized sub-rounded to rounded X pisos					
			Z3G	Q			QUATERNARY DETRITAL, (ST3), Red and Brown, Highly Weathered, Weak Rock. X pisos sub-rounded to rounded.					
50			Z3G	Q			QUATERNARY DETRITAL, (ST3), Red and Brown and yellow, Highly Weathered, Weak Rock. X pisos, detritals sub-angular.					
			J	CL								
			C	FJS								
60			JC				QUATERNARY DETRITAL, (ST3), Yellow and Brown, Highly Weathered, Weak Rock. Hardcap. Sub-angular to angular detritals.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (56.00-110.00)
			J	CSL								
			J	CLQ			DOLERITE, (ST3), Yellow, Extremely Weathered, Very Weak Rock. Hardcap dolerite. Possibly an alteration halo.					
70		Y	JC	L			DOLERITE, (ST3), Yellow and Brown, Extremely Weathered, Weak Rock. Hardcap dolerite.					
			CS				DOLERITE, (YE), Yellow and Brown, Extremely Weathered, Weak Rock. Hardcap dolerite.					
			CS	J			DOLERITE, (YE), Brown, Extremely Weathered, Very Weak Rock. Dolerite chips extremely weathered, crumble under soft blow.					
80			S	CJ								
			J	C								
			J	C								
			J	C								
90		J6	J									
			J	C								
			J	C								
100												LEVELTROLL(98.78) ID: 1718
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	HPSA1633	Hole Length:	110.00

Easting: 686951.07
Northing: 7464796.20
Surface RL: 731.37
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 28 May 16
Comments: MAC Regional FY16.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	MCYWW06	RHF	140		MCKAY	AW10

TOC RL: 732.38 (Stickup 0.99m) (drilled) SWL: 78.87 MBGL (28 May 16) Dev: N Final pH: -
TOC RL: 732.56 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZY	CJ			CLAY, (DOLERITE), Brown, Extremely Weathered, Very Soft, Poorly graded, Elongated. Mostly watery clay with minor extremely weathered, crumbly dolerite chips					CEMENT: Concrete plinth and lockable steel box headworks (0.00-2.00)
			XY	Z								BLANK PVC: 161mm (0.00-6.00)
			XY	Z								BLANK PVC: Size 50 - Class 18 (0.00-56.00)
10			XY				CLAY, (DOLERITE), Brown and Yellow, Extremely Weathered, Very Soft, Poorly graded, Elongated. Fault zone-quartz throughout with large quartz fragments at 50-52m. Mostly a watery clay.					GRAVEL MED (2.00-110.00)
			XY									
20			XY	L			CLAY, (DOLERITE), Brown and Yellow, Extremely Weathered, Very Soft, Poorly graded, Elongated. Fault zone-quartz throughout with large quartz fragments at 50-52m. Mostly a watery clay.					
			X	YZK								
30			Z	LG			PARTIALLY MINERALISED, (Y), Brown, Moderately Weathered, Medium Strong Rock. Some chips weakly magnetic.					
			E									
		YE	E									
40			E				CHERT, (Y), Brown, Moderately Weathered, Medium Strong Rock.					
			EK									
			K	E			UNMINERALISED BIF, (Y), Brown, Moderately Weathered, Medium Strong Rock. Large fragments-fault?					
50			Z3G	Q								
			Z3G	Q			UNMINERALISED BIF, (Y), Yellow and Brown, Highly Weathered, Weak Rock. Jasperlite present					
			J	CL								
60			C	FJS			UNMINERALISED BIF, (Y), Yellow and Brown, Highly Weathered, Weak Rock. Fault-lots of quartz and some dissolution features					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (56.00-110.00)
			JC									
			J	CSL								
70		Y	J	CLQ			UNMINERALISED BIF, (Y), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Dissolution features present-still in fault					
			JC	L								
			CS				CHERT, (Y), Brown, Moderately Weathered, Medium Strong Rock. Some large (>4cm) fragments present-possibly still in fault					
80			CS	J								
			S	CJ								
			J	C			CHERT, (Y), Brown, Moderately Weathered, Medium Strong Rock. Chips have been leached and dissolution features present-in fault					
			J	C								
90			J	C								
		J6	J				UNMINERALISED BIF, (Y), Brown, Moderately Weathered, Medium Strong Rock. Samples have dissolution features and are leached. Large (>3cm) fragments-still in fault.					
			J	C								
100			J	C								LEVELTROLL(98.78) ID: 1718
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	HPSA1633	Hole Length:	110.00

Easting: 686951.07
Northing: 7464796.20
Surface RL: 731.37
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 28 May 16
Comments: MAC Regional FY16.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	MCYWW06	RHF	140		MCKAY	AW10

TOC RL: 732.38 (Stickup 0.99m) (drilled) SWL: 78.87 MBGL (28 May 16) Dev: N Final pH: -
TOC RL: 732.56 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZY	CJ								CEMENT: Concrete plinth and lockable steel box headworks (0.00-2.00)
			XY	Z								BLANK PVC: 161mm (0.00-6.00)
			XY	Z								BLANK PVC: Size 50 - Class 18 (0.00-56.00)
10			XY									GRAVEL MED (2.00-110.00)
			XY									
20			XY	L								
			X	YZK								
30			Z	LG								
			E									
		YE	E									
40			E									
			EK									
			K	E								
50			Z3G	Q			PARTIALLY MINERALISED, (Y), Brown, Slightly Weathered, Medium Strong Rock. Partially mineralised and unmineralised BIF sparkly. Many chips leached and have sugary texture.					
			Z3G	Q								SLOTTED PVC: Size 50 - Class 18, Slots 1mm (56.00-110.00)
			J	CL			PARTIALLY MINERALISED, (J6), Brown, Slightly Weathered, Medium Strong Rock. Partially mineralised and unmineralised BIF sparkly. Many chips leached and have sugary texture.					
60			C	FJS								
			JC									
			J	CSL								
		Y					PARTIALLY MINERALISED, (J6), Brown, Slightly Weathered, Medium Strong Rock. As above					
70			J	CLQ								
			JC	L			PARTIALLY MINERALISED, (J6), Brown, Slightly Weathered, Medium Strong Rock. Partially mineralised and un-mineralised BIF. Some BIF sparkly with sugary texture. Some chips slightly magnetic. Some chips leached.					
			CS									
80			CS	J								
			S	CJ								
			J	C								
			J	C			PARTIALLY MINERALISED, (J6), Yellow and Brown, Slightly Weathered, Medium Strong Rock. As above					
90		J6	J	C								
			J									
			J	C			PARTIALLY MINERALISED, (J6), Yellow and Brown, Slightly Weathered, Medium Strong Rock. As above with secondary quartz mineralisation-fault.					
100			J	C								LEVELTROLL(98.78) ID: 1718
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	PACKSADDLE	Hole Name:	HPSA1633	Hole Length:	110.00

Easting: 686951.07
Northing: 7464796.20
Surface RL: 731.37
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 28 May 16
Comments: MAC Regional FY16.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 110.0	MCYWW06	RHF	140		MCKAY	AW10

TOC RL: 732.38 (Stickup 0.99m) (drilled) SWL: 78.87 MBGL (28 May 16) Dev: N Final pH: -
TOC RL: 732.56 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		J6	J	C			PARTIALLY MINERALISED, (J6), Yellow and Brown, Slightly Weathered, Medium Strong Rock. As above with secondary quartz mineralisation-fault.					GRAVEL MED (2.00-110.00)
110			J				PARTIALLY MINERALISED, (J6), Yellow and Brown, Slightly Weathered, Medium Strong Rock. Partially mineralsed and unmineralised BIF. Occasional quartz fragment					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (56.00-110.00)
120			J				PARTIALLY MINERALISED, (J6), Brown and Grey, Slightly Weathered, Medium Strong Rock. EOH 110m.					
130												
140												
150												
160												
170												
180												
190												
200						0 100 200		0-5000	0-14	0-50		LEVELTROLL(98.78) ID: 1718 END CAP (110.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0021	Hole Length:	120.00

Easting: 697778.57
Northing: 7454373.43
Surface RL: 705.62
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 01 Aug 11 - 02 Aug 11
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	GD20	RHF	146	WATER	BLY	CL1
6.0 - 120.0	GD20	RHF	140	WATER	BLY	CL1

TOC RL: 711.20 (Stickup 0.48m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 716.18 (Stickup 0.56m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	MHJ	L			Scree; red/brown, maghemite, hematite/martite, bif, very angular, very weathered, minor limonite, trace chert, poorly sorted, conglomerate, porous. Surface scree, abundant maghemite, unconsolidated, varied grain size.					BACKFILL: 150mm (0.00-86.00)
10		TD3	MH	L			Detritals; red/brown, maghemite, limonite, hematite/ martite, sub-rounded, very weathered, minor limonite, clay, trace chert, poorly sorted, pisolitic, slightly porous. Becomes more pisolitic and weathered at about 16 m more chert and limonite, shale appears					BLANK PVC: 50mm (0.00-114.00)
20												
30												
40												
50							Detritals; white, calcrete and clay, sub-rounded, very weathered, poorly sorted, calcareous, partial cementation.					
60		TO	3K				Detritals; red/brown/white, clay, goethite, hematite/martite (also minor amounts of maghemite), sub-rounded, minor calcrete, trace quartz, poorly sorted, conglomerate. Quite weathered and rich in clay from 54 to 60 m. There is a distinct colour change from the light white/yellow colour to a light red brown colour. Chips are less frequent as we approach the west angela shale, becoming more than 70% fines. Minor pieces of fresh quartz present. Towards the end of member it becomes yellow brown which could be limonite or goethite causing the staining. Water table intersected at about 76 m. Grain size varies greatly in some samples					
70		TD2	KGH	M								
80												
90												LEVELTROLL(82.00) ID: 2272
100		WA1	F	G			Shale; yellow/brown, fe shale and minor goethite, shaley, slightly porous. Very few chips, was very friable as it was drilled through quite quickly, quite clayey					BENTONITE: 150mm (86.00-88.00)
												GRAVEL MED: 150mm (88.00-120.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK | Hole Name: HSF0021 | Hole Length: 120.00

Easting: 697778.57
Northing: 7454373.43
Surface RL: 705.62
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 01 Aug 11 - 02 Aug 11
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	GD20	RHF	146	WATER	BLY	CL1
6.0 - 120.0	GD20	RHF	140	WATER	BLY	CL1

TOC RL: 711.20 (Stickup 0.48m) (drilled) SWL: Dev: N
TOC RL: 716.18 (Stickup 0.56m) (current) Is Live: Y (-) Date: -
Final pH: -
Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		VA1	F	G			Shale; yellow/brown, fe shale and minor goethite, shaley, slightly porous. Very few chips, was very friable as it was drilled through quite quickly, quite clayey					BLANK PVC: 50mm (0.00-114.00)
110		N3	JCH	L			Ore/mineralised bif; yellow/ brown/grey, chert, bif, hematite/martite, angular, weathered, minor limonite, trace goethite, biffy, porous, heavy staining. Limonite at 114 m to 120 m. /*/*note: starts to get fresh at about 120 m with duricrust or coating					
120												
130												
140												
150												
160												
170												
180												LEVELTROLL(82.00) ID: 2272
190												BENTONITE: 150mm (86.00-88.00)
												GRAVEL MED: 150mm (88.00-120.00)
200												SLOTTED PVC: 50mm (114.00-120.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF0061 **Hole Length:** 182.00

Easting: 686801.79
Northing: 7455519.26
Surface RL: 699.65
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Apr 16 - 16 May 16
License: CAW181011
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 116.0	DR3	DR	450		EASTERNWELL	BM2, RF2
116.0 - 182.0	DR3	CH	450		EASTERNWELL	RF2, RS

TOC RL: 700.34 (Stickup 0.50m) (drilled) **SWL:** **Dev:** Y: 8.0 hour(s) **Final pH:** 8.1
TOC RL: 700.34 (Stickup 0.50m) (current) **Is Live:** Y (-) **Date:** 14 May 2016 **Final EC:** 655.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	ZXJ	CS			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Red brown silty gravel colluvium. Gravel consists of angular to subangular chert, maghemite and pisolites.					CEMENT (0.00-2.00)
10		TD3	ZXK	J			GRAVEL, clayey, (QUATERNARY DETRITAL), Missing, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. White clay matrix, bordering cohesive. Angular gravel size maghemite next to pisolites. Pink/white silty gravel.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-132.15)
20		TD2	ZXG	JL			GRAVEL AND SILT, (QUATERNARY DETRITAL), Brown and Yellow, Extremely Weathered, Very Stiff, Poorly graded, Sub-angular. Clear transitional zone with X-G-L weathering with depth.brown silty gravel					GRAVEL MED (2.00-116.50)
30			ZL	GCJ			GRAVEL AND SILT, clayey, (QUATERNARY DETRITAL), Yellow, Extremely Weathered, Very Stiff, Well graded, Sub-rounded. Yellow silty limonitic gravel, with some clay					
40			ZGX	J			QUATERNARY DETRITAL, (TD2), Brown, Slightly Weathered, Extremely Weak Rock. 36-38 m: Angular Fragments up to 5 cm.					
50		TD1	ZGX	K			QUATERNARY DETRITAL, (TD1), Brown and Red, Extremely Weathered, Extremely Weak Rock.					
60		K	ZK	GQC			GRAVEL AND SILT, clayey, (CLAY), Light or White and Brown, Extremely Weathered, Soft, Gap graded, Sub-rounded. GRAVELLY CLAY, high clay content, q/c throughout samples					
70			ZK				CLAY AND GRAVEL AND SILT, (CLAY), Light or White, Extremely Weathered, Very Soft, Gap graded, Sub-rounded. 90% clay, sloppy sample piles, some rounded magnetic pisolites (x)					
80												LEVELTROLL(78.00) ID: 1706
90			ZK	G								
100		WA1	SJK									
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF0061 **Hole Length:** 182.00

Easting: 686801.79
Northing: 7455519.26
Surface RL: 699.65
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Apr 16 - 16 May 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 116.0	DR3	DR	450		EASTERNWELL	BM2, RF2
116.0 - 182.0	DR3	CH	450		EASTERNWELL	RF2, RS

License: CAW181011

TOC RL: 700.34 (Stickup 0.50m) (drilled) SWL: Dev: Y: 8.0 hour(s) Final pH: 8.1
TOC RL: 700.34 (Stickup 0.50m) (current) Is Live: Y (-) Date: 14 May 2016 Final EC: 655.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	ZXJ	CS								CEMENT (0.00-2.00)
10		TD3	ZXK	J								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-132.15)
20		TD2	ZXG	JL								GRAVEL MED (2.00-116.50)
30			ZL	GCJ								
40			ZGX	J								
50		TD1	ZGX	K								
60		K	ZK	GQC								
70			ZK									
80							GRAVEL AND CLAY, (CLAY), Light or White, Extremely Weathered, Soft, Uniform, Sub-rounded. 70% clay, gravelly clay. Uncertainty with interval between 56 and 95 m (undifferentiated WA?); interval may be associated with geological structures (dykes, faults).					LEVELTROLL(78.00) ID: 1706
90			ZK	G								
100		WA1	SJK				, (WA1), Brown, Extremely Weathered, Medium Strong Rock. interp from gamma					
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0061	Hole Length:	182.00

Easting: 686801.79
Northing: 7455519.26
Surface RL: 699.65
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Apr 16 - 16 May 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 116.0	DR3	DR	450		EASTERNWELL	BM2, RF2
116.0 - 182.0	DR3	CH	450		EASTERNWELL	RF2, RS

License: CAW181011

TOC RL: 700.34 (Stickup 0.50m) (drilled) SWL: Dev: Y: 8.0 hour(s) Final pH: 8.1
TOC RL: 700.34 (Stickup 0.50m) (current) Is Live: Y (-) Date: 14 May 2016 Final EC: 655.00

Depth mgbl	Strat	Major	Minor	Hydrogeological Description
100–200	WA1	SJK		, (WA1), Brown, Extremely Weathered, Medium Strong Rock. interp from gamma
	N3	SJ		MINERALISED BIF, (N3), Brown and Yellow, Extremely Weathered, Extremely Weak Rock. interp from gamma -lots of contamination in chips
	N2	SJ		, (N2), Brown and Yellow, Extremely Weathered, Very Weak Rock. interp from gamma -lots of contamination with chips
	N1	JC		, (N1), Brown and Yellow and grey, Extremely Weathered, Very Weak Rock. interp from gamma- lots of contamination with chips. 174-176 highly fractured with significant water inflows
		J		FRESH MAGNETIC BIF, (N1), Blue, Slightly Weathered, Strong Rock. interp from gamma- lots of contamination with chips. Fresh hard BIF, no fracturing.

Log: Gamma CPS API (0 100 200)
EC us/cm (0-5000) pH (0-14) Yield L/s (0-50)

Diagram (Scaled to 600mm)

Notes:
- BLANK STEEL: Size 12" - W.T.9.53mm (0.00-132.15)
- GRAVEL MED (2.00-116.50)
- LEVELTROLL(78.00) ID: 1706
- GROUT (116.50-122.00)
- GRAVEL MED (122.00-182.00)
- SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (132.15-160.15)
- S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (160.15-166.15)
- SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (166.15-168.15)
- BLANK STEEL: Size 10" - W.T.9.27mm: Reducer 12" to 10" (168.15-168.55)
- SLOTTED STEEL: Size 10" - W.T.9.27mm, Slots 1mm: 10" option taken to get to depth in tight ground. Section includes 0.4 m adaptor (168-168.4) to connect 10" below 12". Slotted steel welded from 2 parts to complete lugs to screen. (168.55-172.15)
- S/S SCREEN: Size 10" - W.T.9.27mm, Slots 2mm: 10" option taken to get to depth in tight ground. (172.15-178.15)
- SLOTTED STEEL: Size 10" - W.T.9.27mm, Slots 1mm: 10" option taken to get to depth in tight ground. Minimum 0.5 m sump taken blow screens due to fallback on previous attempt sitting screens above target. (178.15-178.65)
- END CAP (178.65)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0063	Hole Length:	182.00

Easting: 693029.69
Northing: 7453597.08
Surface RL: 722.87
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 29 Apr 16 - 03 May 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 182.0	EWMWW02	DR	400		EASTERNWELL	YA

License: CAW181011

TOC RL: 723.45 - (drilled) SWL: 92.97 MBGL (29 Apr 16) Dev: Y: 5.3 hour(s) Final pH: 8.2
TOC RL: 723.45 - (current) Is Live: Y (-) Date: 03 May 2016 Final EC: 640.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	UG	ST3	Z	Y			QUATERNARY DETRITAL, (ST3), Red and Brown, Moderately Weathered, Medium Strong Rock. Angular to sub-angular tertiary clays, very well rounded magnetic pisolites 54-58m					CEMENT (0.00-2.00) BLANK STEEL: 324mm (0.00-105.00) GRAVEL MED (2.00-172.00)
60		CA2	Z	Y			QUATERNARY DETRITAL, (CA2), Red and Brown, Moderately Weathered, Medium Strong Rock. Angular to sub-angular tertiary clays, very well rounded magnetic pisolites 54-58m					
			Z	K								
70							QUATERNARY DETRITAL, (CA2), Yellow and Red and light or white, Moderately Weathered, Medium Strong Rock. Tertiary detritals with calcrete overprinting overlying soft highly weathered tertiary clays, some vuggy breccia visible					
80		VB2	Z	K			QUATERNARY DETRITAL, (VB2), Yellow and Red and light or white, Moderately Weathered, Medium Strong Rock. Tertiary detritals with calcrete overprinting overlying soft highly weathered tertiary clays, some vuggy breccia visible					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0063	Hole Length:	182.00

Easting: 693029.69
Northing: 7453597.08
Surface RL: 722.87
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 29 Apr 16 - 03 May 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 182.0	EWMWW02	DR	400		EASTERNWELL	YA

License: CAW181011

TOC RL: 723.45 - (drilled) SWL: 92.97 MBGL (29 Apr 16) Dev: Y: 5.3 hour(s) Final pH: 8.2
TOC RL: 723.45 - (current) Is Live: Y (-) Date: 03 May 2016 Final EC: 640.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100–120	UG	VB2	Z	K			QUATERNARY DETRITAL, (VB2), Yellow and Red and light or white, Moderately Weathered, Medium Strong Rock. Tertiary detritals with calcrete overprinting overlying soft highly weathered tertiary clays, some vuggy breccia visible					BLANK STEEL: 324mm (0.00-105.00) GRAVEL MED (2.00-172.00)
120–150	UG	OB	Z	K			QUATERNARY DETRITAL, (OB), Yellow and Red and light or white, Moderately Weathered, Medium Strong Rock. Tertiary detritals with calcrete overprinting overlying soft highly weathered tertiary clays, some vuggy breccia visible					SLOTTED STEEL: 324mm , Slots 1mm (105.00-159.00)
150–170	BG	OB	D	C			DOLOMITE, (OB), Blue and Grey, Moderately Weathered, Strong Rock. Weathered dolomite with cherty and shaley interbeds, significant increase in yield					LEVELTROLL(150.00) ID: 1706
170–180	BG	OB	S	C			SHALE, (OB), Blue and Yellow and red, Slightly Weathered, Strong Rock. Weathered and slightly dolomitic shale with small chert bands, reduced yields, hole terminated in shale below weathered dolomite horizon					S/S SCREEN: 324mm , Slots 1mm (159.00-171.00)
180–200												SLOTTED STEEL: 324mm , Slots 1mm (171.00-172.00)
												END CAP (172.00)
												GRAVEL MED (172.00-176.00)
												BENTONITE: some gravel added to enhance stability (176.00-177.50)
												GROUT: Base of hole sealed up due to geological uncertainty in interp and bore purpose to only stress dolomite for approvals purposes. (177.50-182.00)

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50

Program: Grand Central Hydro FY16
Planned Hole: HSF_2016_0021_1

BHPIO - Hydrogeology Log

BHP

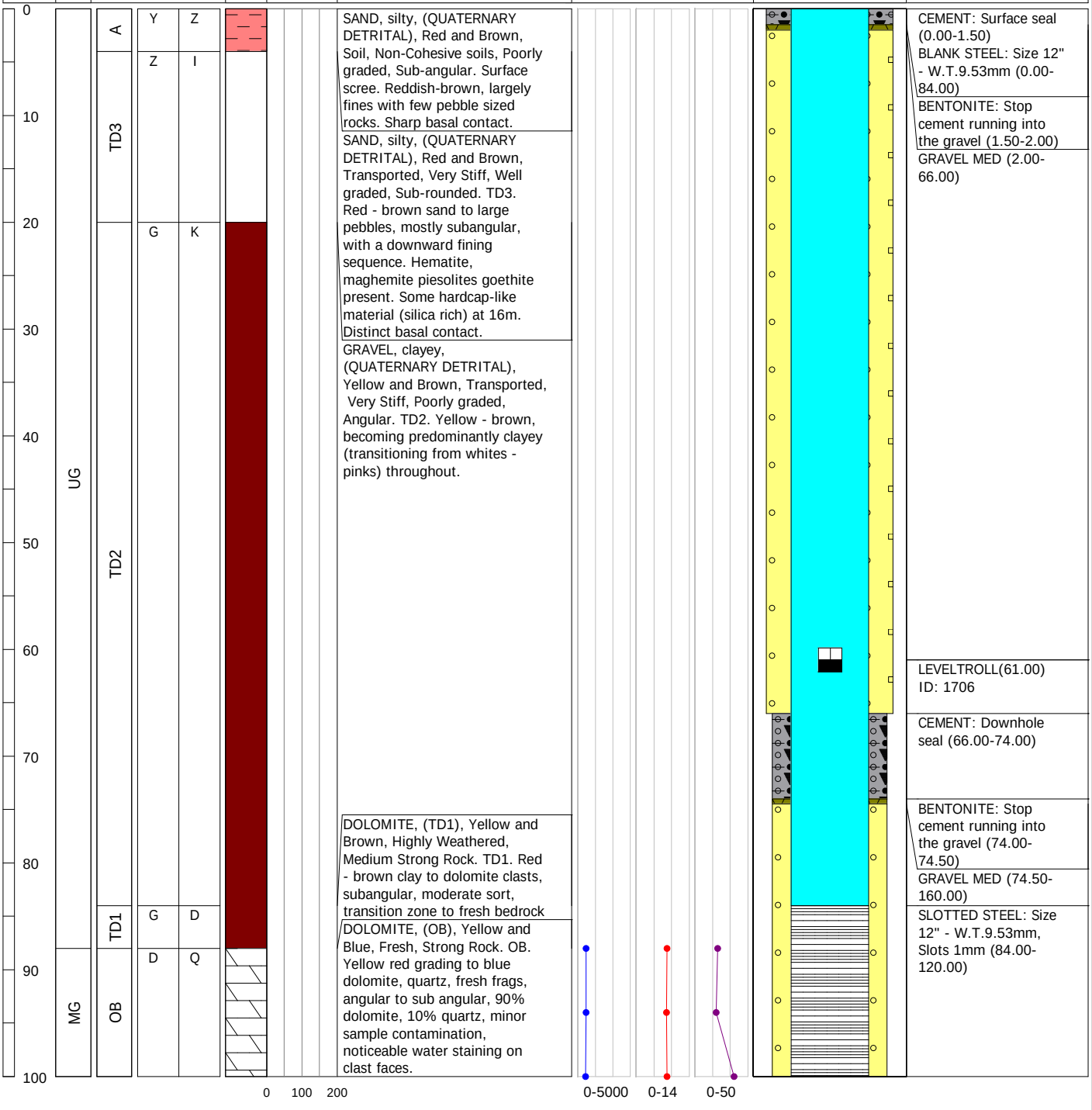
Project:	SOUTH FLANK	Hole Name:	HSF0065	Hole Length:	160.00

Easting: 706766.19
Northing: 7452756.22
Surface RL: 657.42
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 01 Jun 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 28.0	DR3	DR	500		EASTERNWELL	CCN
28.0 - 148.0	DR3	DR	450		EASTERNWELL	CCN
148.0 - 160.0	DR3	CH	450		EASTERNWELL	ROD

License: CAW181011

TOC RL: 658.17 (Stickup 0.75m) (drilled) SWL: Dev: N Final pH: 8.7
TOC RL: 658.17 (Stickup 0.75m) (current) Is Live: Y (-) Date: 01 Jun 2016 Final EC: 849.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0065	Hole Length:	160.00

Easting: 706766.19
Northing: 7452756.22
Surface RL: 657.42
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 May 16 - 01 Jun 16
Comments: South Flank FY16 Hydro Program

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 28.0	DR3	DR	500		EASTERNWELL	CCN
28.0 - 148.0	DR3	DR	450		EASTERNWELL	CCN
148.0 - 160.0	DR3	CH	450		EASTERNWELL	ROD

License: CAW181011

TOC RL: 658.17 (Stickup 0.75m) (drilled) SWL: Dev: N Final pH: 8.7
TOC RL: 658.17 (Stickup 0.75m) (current) Is Live: Y (-) Date: 01 Jun 2016 Final EC: 849.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	OB	D	Q			DOLOMITE, (OB), Yellow and Blue, Fresh, Strong Rock. OB. Yellow red grading to blue dolomite, quartz, fresh frags, angular to sub angular, 90% dolomite, 10% quartz, minor sample contamination, noticeable water staining on clast faces.					GRAVEL MED (74.50-160.00)
110												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (84.00-120.00)
120			D	Q			DOLOMITE, (OB), Red, Fresh, Very Strong Rock. OB. Blue dolomite, quartz, frags to cobble, angular, 95% dolomite, 5% quartz, trace mica, fresh rock, water staining on clast faces. Fracture zones 120-124m, 126-134m, 144-150m					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (120.00-126.00)
130												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (126.00-144.00)
140												
150												S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (144.00-150.00)
160												SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 1mm (150.00-156.00)
170												END CAP (156.00)
180												
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0100	Hole Length:	100.00

Easting: 686392.17
Northing: 7455600.37
Surface RL: 695.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Apr 11 - 27 Apr 11
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 82.0	DR4	DR	150	WATER	EASTERNWELL	AN4
82.0 - 100.0	DR4	CH	150	AIR/WATER	EASTERNWELL	AN4

TOC RL: 695.90 (Stickup 0.32m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 695.79 (Stickup 0.72m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	MFK				Maghemite, fe shale, clay; red/ brown/black,very angular, very weathered, minor goethite, trace hematite, poorly sorted, pisolitic, moderate staining					GROUT: 178mm (0.00-0.50) BLANK PVC: 50mm (0.00-94.00)
10		TD3	MK				Maghemite, clay; red, orange, brown, very weathered, minor hematite, kaolinite, pisolitic, moderate staining, high % orange clay matrix from maghemite weathering					GRAVEL MED: 178mm (0.50-82.00)
20			GHM				Goethite, hematite/martite; red, white, black, weathered, minor vit goethite, bif, limonite, trace kaolinite, vuggy weathered hardcap, bif conglomerate with many cavities and hard to drill through, pisolites present					
30			MFG				Maghemite, fe shale, goethite; red, orange, yellow, very weathered, minor limonite, trace hematite, vit goethite, soft weathered pisolites, red/ brown shales, some highly mineralised and weathered goethite					
40		TD2	GFH				Goethite, fe shale, hematite/ martite; red, yellow, white, brown, minor limonite, trace kaolinite, sugary hematite and bif, goethite in various stages of weathering. Very weathered fe shale					LEVELTROLL(37.00) ID: 1563
50			Z3G				Goethite, limonite, fe shale; brown, red, black, minor bif, trace quartz, 52-54 m higher % of limonite					
60		TD1	GHF				Goethite, hematite/martite/ fe shale; red, brown, weathered, minor limonite, trace bif, heavy staining, sugary hematite, high % limonite, very red, heavy limonite/shale band 58-62 m					
70		WA2	HGJ				Hematite/martite, goethite, bif; red, black, brown, hematite in various stages of weathering					
80			SL				Shale, limonite; white, pink, brown,elongate, laminated, very soft shales (crush with fingers), light purple, porous (sticks to tounge), platy chips					GRAVEL MED: 152mm (82.00-100.00)
90		WA1	LSG				Limonite, shale, goethite; yellow, black, brown, 2-25mm, sub-rounded, weathered, trace kaolinite, elongate, laminated, very porous, heavy staining,					
100		N3	GLH				semi-hard brown/black shales, sugary goethite, platy chips, limonite alteration prevalent. Ore grade wa1					SLOTTED PVC: 50mm (94.00-100.00)
						0 100 200		0-5000	0-14	0-50		

Program: Planned Hole: Page: 256

BHPIO - Hydrogeology Log

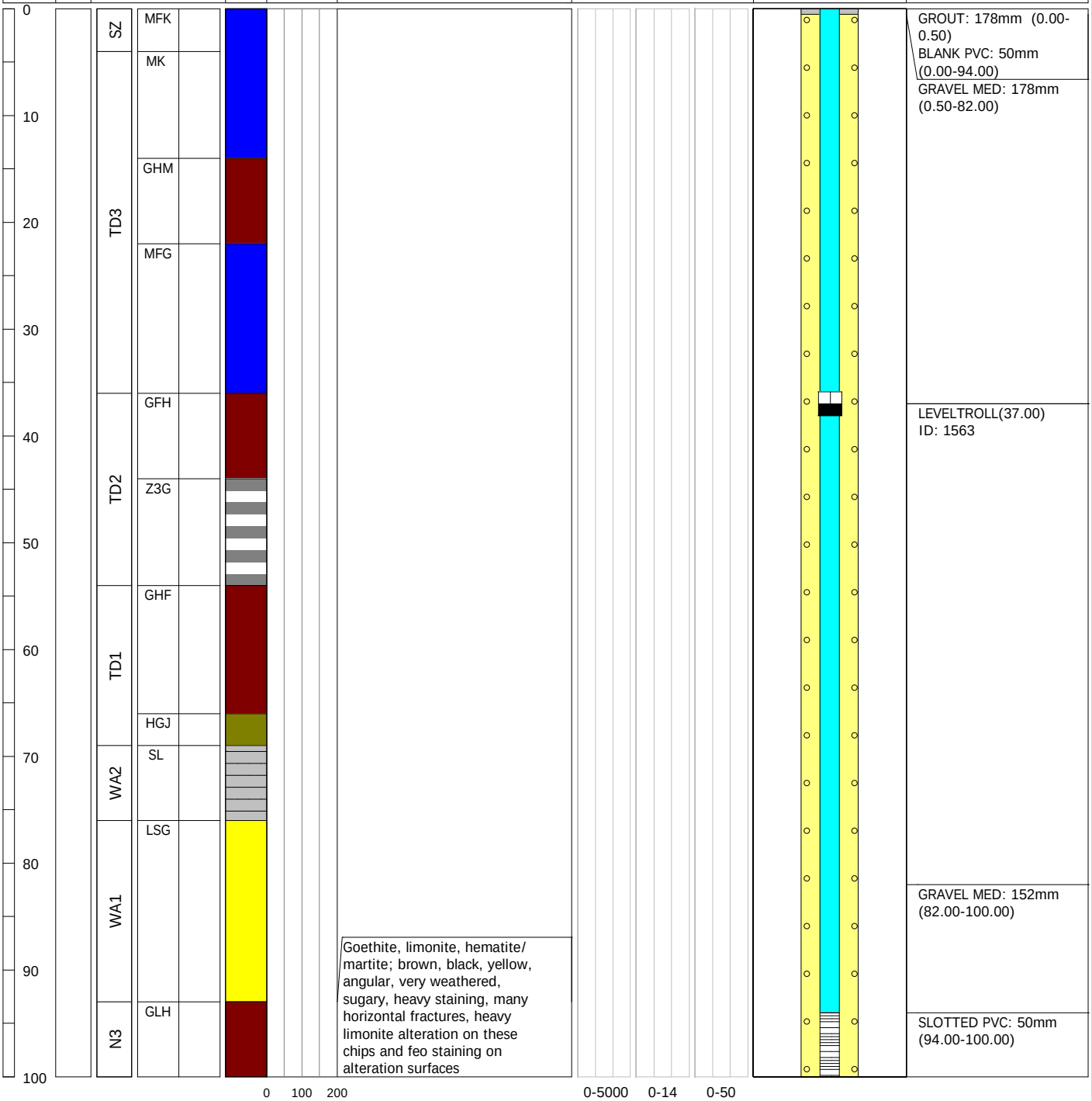
BHP

Project: SOUTH FLANK **Hole Name:** HSF0100 **Hole Length:** 100.00

Easting: 686392.17
Northing: 7455600.37
Surface RL: 695.07
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 24 Apr 11 - 27 Apr 11
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 82.0	DR4	DR	150	WATER	EASTERNWELL	AN4
82.0 - 100.0	DR4	CH	150	AIR/WATER	EASTERNWELL	AN4

TOC RL: 695.90 (Stickup 0.32m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 695.79 (Stickup 0.72m) (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole: Page: 257

BHPIO - Hydrogeology Log

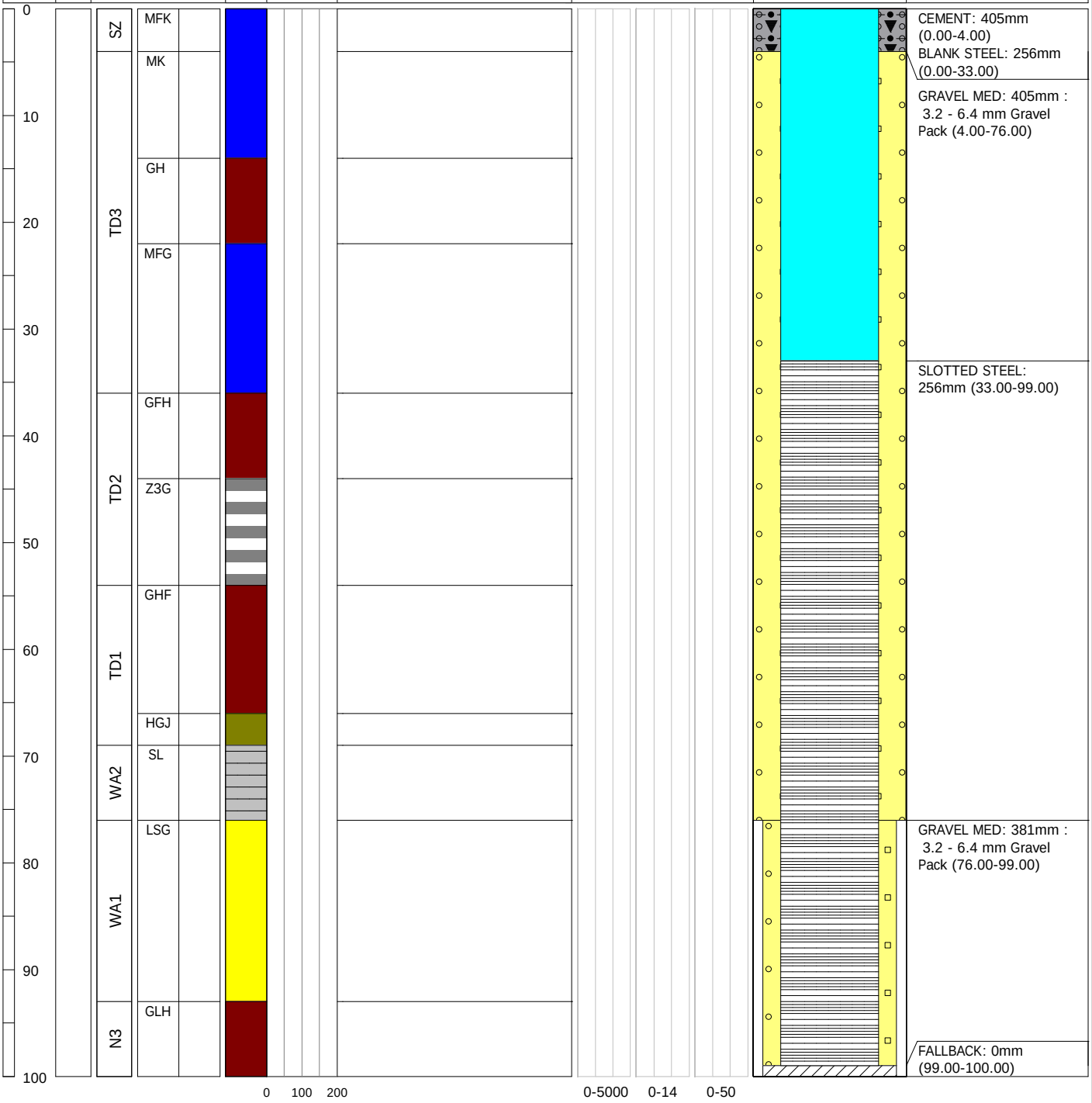
BHP

Project: SOUTH FLANK **Hole Name:** HSF0101 **Hole Length:** 100.00

Easting: 686398.00
Northing: 7455603.00
Surface RL: 695.60
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 30 Apr 11 - 07 May 11
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 76.0	DR4	DR	400	WATER	EASTERNWELL	AN4
76.0 - 100.0	DR4	CH	350	WATER	EASTERNWELL	AN4

TOC RL: 695.80 (Stickup 0.21m) (drilled) SWL: Dev: N Final pH: -
TOC RL: 695.80 (Stickup 0.21m) (current) Is Live: Y (-) Date: - Final EC: -



Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF0102	Hole Length:	0.00

Easting: 697210.61
Northing: 7454164.29
Surface RL: 707.14
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 0.0	UNKN	UNKN	UNKN		UNKN	

Comments: Site name: Central Bore. Manually loaded hole for regional monitoring. Limited data available.

TOC RL: 707.43 - (drilled) SWL: Dev: N Final pH: -
TOC RL: 707.43 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl | Cond | Strat | Major | Minor | Log | Gamma CPS API | Hydrogeological Description | EC us/cm | pH | Yield L/s | Diagram Scaled to 400mm | Notes

0 10 20 30 40 50 60 70 80 90 100

0 100 200

0-5000 0-14 0-50

Program: Planned Hole:

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5411	Hole Length:	58.00	
Easting:	687233.20					
Northing:	7455007.00					
Surface RL:	689.42					
Grid Name:	MGA94_50					
Incl / Azm:	-90-->0					
Construct:	14 Oct 17 - 14 Oct 17					
Comments:						

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 58.0	WLDRIG5	CH	200		WELLDRILL	MM10

TOC RL:	690.29	-	(drilled)	SWL:	26.01 mbtoc	(18 Apr 19)	Dev:	Y: 1.0 hour(s)	Final pH:	8.0
TOC RL:	690.42	-	(current)	Is Live:	Y	(-)	Date:	14 Oct 2017	Final EC:	606.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	ZYX	CG			SILT AND SAND, (QUATERNARY DETRITAL), Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-angular.					BLANK STEEL: 219mm (0.00-6.00)
10		TD3	XWG	CY			QUATERNARY DETRITAL, (TD3), Red and Brown, Highly Weathered, Very Weak Rock. Minor silt 2-6m, chips become larger (to 15mm) and more angular from 6m.					BLANK PVC: 61mm (0.00-40.00)
			X	WG			QUATERNARY DETRITAL, (TD3), Red and Brown, Moderately Weathered, Weak Rock. More red in colour and mostly maghemite pesoliths some large (to 25mm) rounded clasts of geothitic hematite.					
20		MN	J	1			PARTIALLY MINERALISED, (MN), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Weathered yellow cherty BIF with minor large chips to 100mm, minor white clay/shale from 24-28m.					
			K	CQ			UNMINERALISED BIF, (MN), Light or White, Moderately Weathered, Extremely Weak Rock.					
30			J	1QK			LEACHED BIF, (MN), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Minor white clay with increasing amounts at 34-36m. First Water Stike at 34m, with 1L/s flow by 36m. Minor fractures at 36m.					LEVELTROLL(30.00) ID: 2280
			J	1Q			LEACHED BIF, (MN), Yellow and Grey, Slightly Weathered, Medium Strong Rock. Slightly less weathered, chips to 10mm, chips become magnetic from 38m flow gradually increasing. Increase in weathering and quartz from 42-44 with chip size increase to 40mm. Minor to moderate weathering 48-50 with minor chips of yellow percipitated silica.					GRAVEL MED (32.00-58.00)
40												
50			J	1SQ			LEACHED BIF, (MN), Yellow and Grey, Highly Weathered, Medium Strong Rock. Fractured weathered chips to over 100mm, minor nodules of percipitated craggly quartz, vuggy surfaces, minor pink, grey and white shale from 52-54. Fractures noted 50-54m.					END CAP (40.00) SLOTTED PVC: 61mm , Slots 1mm (40.00-58.00)
			JQ									
			J	1Q								
60												
70												
80												
90												
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

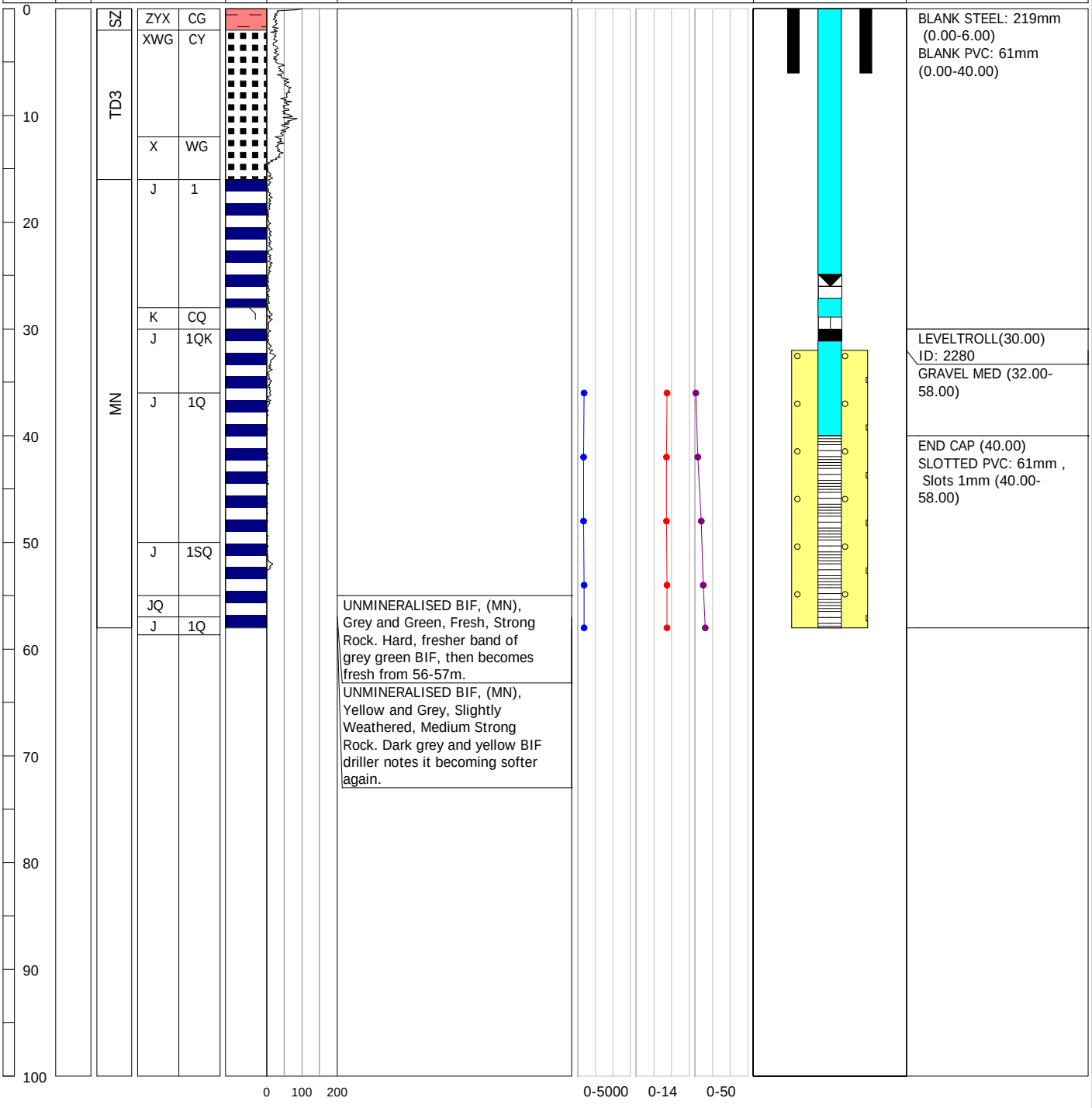
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5411	Hole Length:	58.00

Easting: 687233.20
Northing: 7455007.00
Surface RL: 689.42
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 Oct 17 - 14 Oct 17
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 58.0	WLDRIG5	CH	200		WELLDRILL	MM10

TOC RL: 690.29 - (drilled) SWL: 26.01 mbtoc (18 Apr 19) Dev: Y: 1.0 hour(s) Final pH: 8.0
TOC RL: 690.42 - (current) Is Live: Y (-) Date: 14 Oct 2017 Final EC: 606.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5413	Hole Length:	90.00

Easting: 687779.43
Northing: 7454836.97
Surface RL: 689.94
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Oct 17 - 14 Oct 17
Comments: No return 40-90m

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	250		WELLDRILL	LG3
6.0 - 90.0	WLDRIG5	CH	200		WELLDRILL	KKR

TOC RL: 690.82 - (drilled) SWL: 60.24 mbtoc (18 Apr 19) Dev: Y: 1.0 hour(s) Final pH: 8.1
TOC RL: 691.05 - (current) Is Live: Y (-) Date: 15 Oct 2017 Final EC: 476.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		SZ	YXG	CQ			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-angular. Silty soil, maghemite, goethite,trace chert and quartz.					BLANK STEEL: 219mm (0.00-6.00)
10		TD3	YXI	H			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Sub-rounded. Silty soil with small angular chips of maghemite and pisolites, minor hematite.					BLANK PVC: 61mm (0.00-78.00)
20			I				GRAVEL, (CID), Red and Yellow and brown, Transported, Non-Cohesive soils, Gap graded, Rounded. Pisolites, small to medium sized.					
30			3	GH			CALCRETE, (TD3), Light or White and Grey, Highly Weathered, Weak Rock. Calcrete and minor large clasts of hematite and small goethite chips.					
40		TD2	3SG	YK			SHALE, (TD2), Yellow and Brown, Highly Weathered, Very Weak Rock. Calcrete, yellow clay/shale, silty soil, weathered goethite.					
50		OB	3SD	H			SHALE, (OB), Brown and Light or White, Highly Weathered, Very Weak Rock. Shale/clay, calcrete, weathered dolomite, minor hematite and trace goethite.					
60		MN	G	J			PARTIALLY MINERALISED, (MN), Dark or Black and Red and brown, Slightly Weathered, Very Strong Rock. Goethite (BIF).Trace dolomite34-36m. Medium sized chips 1cm.					GRAVEL MED (61.00-90.00)
70							PARTIALLY MINERALISED, (MN), Missing, Fresh, Very Strong Rock. No sample returns from 40 to 90m.					LEVELTROLL(66.00) ID: 2281
80												SLOTTED PVC: 61mm , Slots 1mm (78.00-90.00)
90												END CAP (90.00)
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5425 **Hole Length:** 216.00

Easting: 695599.21
Northing: 7454915.70
Surface RL: 724.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 Mar 18 - 28 Mar 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	MM10
6.0 - 216.0	WLDRIG5	CH	200		WELLDRILL	MM10

Comments: Drilled to 126m when rods became a bit stuck, pulled out and became fully bogged at 84-90m. Freed up...

TOC RL: 725.40 (Stickup 0.70m) (drilled) SWL: 86.95 MBGL (28 Mar 18) Dev: N Final pH: -
TOC RL: 725.40 (Stickup 0.70m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	Notes
0	T	GXY			GRAVEL, sandy and silty, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Well graded, Rounded. Mod weath vit G and X minor pisolites, silt and river bed sediment, rounded gravels to 20mm, trace of BIF and chert, trace L.	BLANK STEEL: 219mm (0.00-6.00)
10	TD2	GS	XL		CID, (TD2), Yellow and Brown, Highly Weathered, Very Weak Rock. Well weathered earthy to vitreous goethite and shale, minor to trace H and L. Slightly more red from 8-10m, trace grey clay nodules.	BLANK PVC: Size 50 - Class 18 (0.00-72.00)
20	TD1	S	XG		CID, (TD1), Red, Highly Weathered, Very Weak Rock. Mostly red ochreous shale, slight brown, some chips of G and X, rare pisolite, trace Lim clay.	GRAVEL MED (0.00-106.00)
30		S	XW		CID, (TD1), Red, Highly Weathered, Very Weak Rock. Ochreous red to purple shale, minor chips of H/X, mildly magnetic and W. Becomes more white and pale grey with clay 24-26, very slight increase in G with depth, black manganese 59.5-60. Ore is soft and dificult to det % as most of sample is powder.	
40						
50						
60	WA2	S	GL		UNMINERALISED BIF, (WA2), Brown, Highly Weathered, Very Weak Rock. Very shalley BIF trace ore, minor weathered earthy G, very minor L. Shale is brown, grey and orange, minor pink.	
70						
80		SL			UNMINERALISED BIF, (WA2), Brown and Yellow, Highly Weathered, Very Weak Rock. Mostly shale (limonitic), fewer chips/ trace ore- weathered earthy G and L. Shale is yellow, brown, grey and orange, minor pink. No noticable drilling changes, no fractures etc, ground becomes moist from 78m- FWS?	SLOTTED PVC: Size 50 - Class 18, Slots 1mm (72.00-106.00)
90		SN			UNMINERALISED BIF, (WA2), Dark or Black and Brown, Highly Weathered, Weak Rock. As above; darker with minor manganese, soft drilling, little return.	
100						

Cond | Log: 0 100 200 | EC us/cm: 0-5000 | pH: 0-14 | Yield L/s: 0-50 | Diagram: Scaled to 400mm

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5425	Hole Length:	216.00

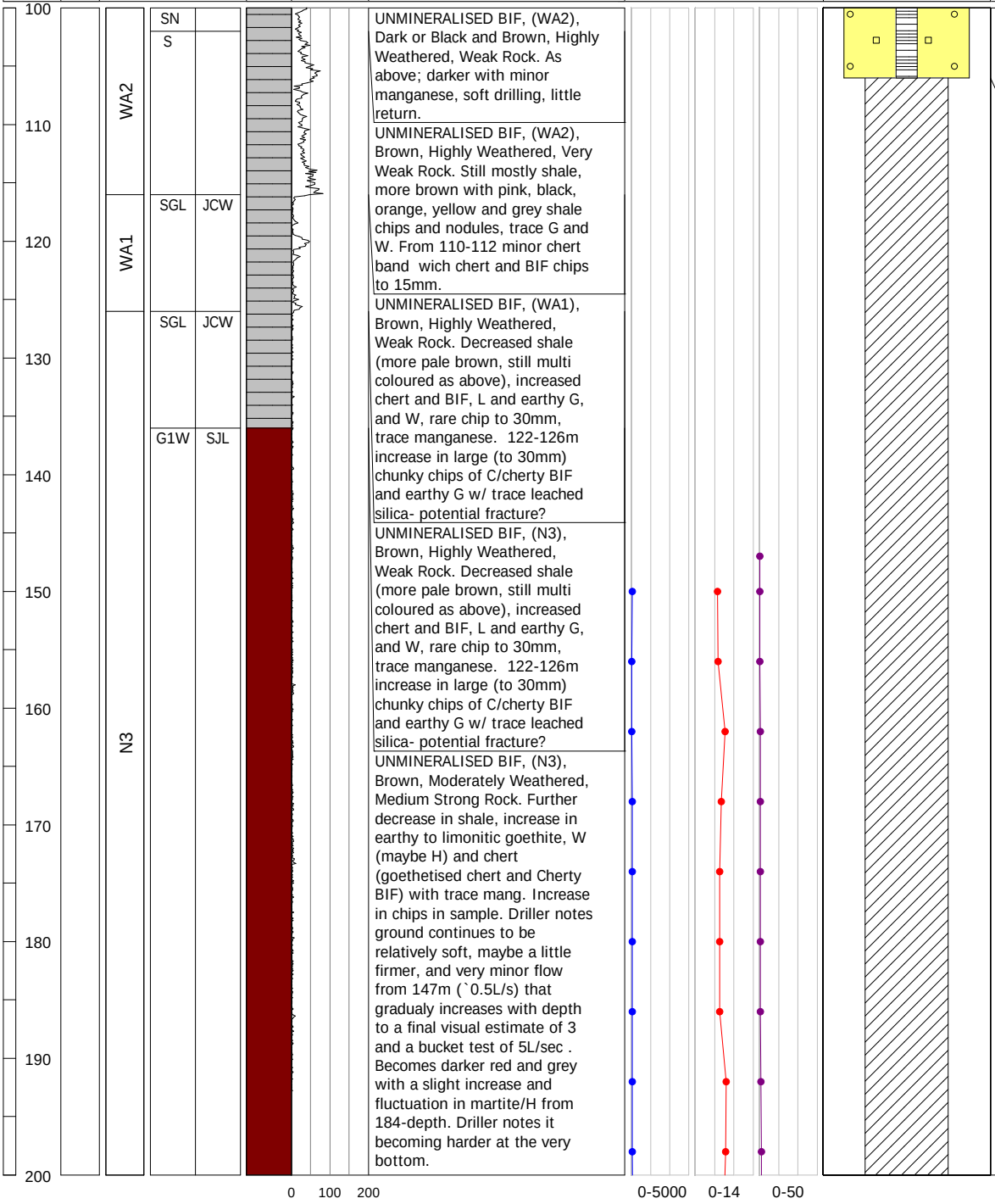
Easting: 695599.21
Northing: 7454915.70
Surface RL: 724.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 Mar 18 - 28 Mar 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	MM10
6.0 - 216.0	WLDRIG5	CH	200		WELLDRILL	MM10

Comments: Drilled to 126m when rods became a bit stuck, pulled out and became fully bogged at 84-90m. Freed up...

TOC RL: 725.40 (Stickup 0.70m) (drilled) SWL: 86.95 MBGL (28 Mar 18) Dev: N Final pH: -
TOC RL: 725.40 (Stickup 0.70m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		WA2	SN				UNMINERALISED BIF, (WA2), Dark or Black and Brown, Highly Weathered, Weak Rock. As above; darker with minor manganese, soft drilling, little return.					GRAVEL MED (0.00-106.00)
110			S				UNMINERALISED BIF, (WA2), Brown, Highly Weathered, Very Weak Rock. Still mostly shale, more brown with pink, black, orange, yellow and grey shale chips and nodules, trace G and W. From 110-112 minor chert band wich chert and BIF chips to 15mm.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (72.00-106.00)
120		WA1	SGL	JCW			UNMINERALISED BIF, (WA1), Brown, Highly Weathered, Weak Rock. Decreased shale (more pale brown, still multi coloured as above), increased chert and BIF, L and earthy G, and W, rare chip to 30mm, trace manganese. 122-126m increase in large (to 30mm) chunky chips of C/cherty BIF and earthy G w/ trace leached silica- potential fracture?					END CAP (106.00)
130			SGL	JCW			UNMINERALISED BIF, (N3), Brown, Highly Weathered, Weak Rock. Decreased shale (more pale brown, still multi coloured as above), increased chert and BIF, L and earthy G, and W, rare chip to 30mm, trace manganese. 122-126m increase in large (to 30mm) chunky chips of C/cherty BIF and earthy G w/ trace leached silica- potential fracture?					FALLBACK (106.00-216.00)
140			G1W	SJL			UNMINERALISED BIF, (N3), Brown, Moderately Weathered, Medium Strong Rock. Further decrease in shale, increase in earthy to limonitic goethite, W (maybe H) and chert (goethetised chert and Cherty BIF) with trace mang. Increase in chips in sample. Driller notes ground continues to be relatively soft, maybe a little firmer, and very minor flow from 147m (`0.5L/s) that gradualy increases with depth to a final visual estimate of 3 and a bucket test of 5L/sec . Becomes darker red and grey with a slight increase and fluctuation in martite/H from 184-depth. Driller notes it becoming harder at the very bottom.					
150												
160		N3										
170												
180												
190												
200												
						0 100 200		0-5000	0-14	0-50		



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5425	Hole Length:	216.00

Easting: 695599.21
Northing: 7454915.70
Surface RL: 724.70
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 28 Mar 18 - 28 Mar 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	MM10
6.0 - 216.0	WLDRIG5	CH	200		WELLDRILL	MM10

Comments: Drilled to 126m when rods became a bit stuck, pulled out and became fully bogged at 84-90m. Freed up...

TOC RL: 725.40 (Stickup 0.70m) (drilled) SWL: 86.95 MBGL (28 Mar 18) Dev: N Final pH: -
TOC RL: 725.40 (Stickup 0.70m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200		N3	G1W	SJL			UNMINERALISED BIF, (N3), Brown, Moderately Weathered, Medium Strong Rock. Further decrease in shale, increase in earthy to limonitic goethite, W (maybe H) and chert (goethetised chert and Cherty BIF) with trace mang. Increase in chips in sample. Driller notes ground continues to be relatively soft, maybe a little firmer, and very minor flow from 147m (`0.5L/s) that gradualy increases with depth to a final visual estimate of 3 and a bucket test of 5L/sec . Becomes darker red and grey with a slight increase and fluctuation in martite/H from 184-depth. Driller notes it becoming harder at the very bottom.					FALLBACK (106.00-216.00)
210												
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5428	Hole Length:	210.00

Easting: 702930.38
Northing: 7455974.80
Surface RL: 727.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 May 18 - 13 May 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 66.0	WLDRIG6	CH	250		WELLDRILL	KKR
66.0 - 210.0	WLDRIG6	CH	200		WELLDRILL	SS7

Comments: Assess yield for water supply PB - targeting fault zone at 171-179m. Lost circulation from 29 to 56m...

TOC RL: 728.22 (Stickup 0.97m) (drilled) SWL: 88.05 MBTOC (15 May 18) Dev: N Final pH: -
TOC RL: 728.22 (Stickup 0.97m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	XHG	I			GRAVEL, sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Surface scree. Maghemite (minor pisolites), hematite, goethite. Angular and rounded.					BLANK STEEL: Size 18" - W.T.9.53mm (0.00-5.40)
10		GS3	XHG	I			GRAVEL, sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Surface scree. Maghemite (minor pisolites), hematite, goethite. Angular and rounded.					BLANK PVC: Size 50 - Class 18 (0.00-150.00)
20			XHG	8			QUATERNARY DETRITAL, (GS3), Red and Dark or Black and brown, Extremely Weathered, Extremely Weak Rock. Maghemite, hematite and goethite. Hardcap					GRAVEL MED (0.00-210.00)
30			GL				QUATERNARY DETRITAL, (GS3), Yellow and Brown, Extremely Weathered, Extremely Weak Rock. Goethite and limonite. Trace quartz. Small to med. chips.					BLANK STEEL: Size 8" - W.T.6.35mm: Cased off void. 8" casing actually goes 0-66m. (5.40-66.00)
40			GL				QUATERNARY DETRITAL, (MM), Yellow and Brown, Extremely Weathered, Extremely Weak Rock. Goethite and limonite. Trace quartz. Small to med. chips.					
50			G	L			BRECCIA, (MM), Dark or Black and Yellow, Extremely Weathered, Extremely Weak Rock. Goethite, minor large vuggy clast of goethite. Minor limonite. Trace quartz 18-22m. Minor medium sized quartz and chert chips 22-28m. Green chert 26-28m.					
60		MM	8V				GRAVEL, (BRECCIA), Missing, Extremely Weathered, Very Soft, Uniform, Angular. No returns. Alterntaing cavities and soft fractured bands.					
70			GK				CLAY, (MM), Brown and Yellow, Extremely Weathered, Extremely Weak Rock. Clay and minor goethite. Trace quarts. Very fine chips. Only 30% returns.					
80			KV				CLAY, (CLAY), Missing, Soil, Very Soft, Uniform, Angular. No sample					
90			S	C			CLAY, (MM), Yellow and Brown, Extremely Weathered, Extremely Weak Rock. Clay with trace goethite and quartz. Only 30% returns from 62-66m. Possibly MM.					
100			S	C								
			B	J								
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5428 **Hole Length:** 210.00

Easting: 702930.38
Northing: 7455974.80
Surface RL: 727.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 May 18 - 13 May 18
Comments: Assess yield for water supply PB - targeting fault zone at 171-179m. Lost circulation from 29 to 56m...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 66.0	WLDRIG6	CH	250		WELLDRILL	KKR
66.0 - 210.0	WLDRIG6	CH	200		WELLDRILL	SS7

TOC RL: 728.22 (Stickup 0.97m) (drilled) SWL: 88.05 MBTOC (15 May 18) Dev: N Final pH: -
TOC RL: 728.22 (Stickup 0.97m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Notes
0		ST3	XHG	I						BLANK STEEL: Size 18" - W.T.9.53mm (0.00-5.40)
		GS3	XHG	I						BLANK PVC: Size 50 - Class 18 (0.00-150.00)
			XHG	8						GRAVEL MED (0.00-210.00)
			GL							
10			GL							
			G	L						BLANK STEEL: Size 8" - W.T.6.35mm: Cased off void. 8" casing actually goes 0-66m. (5.40-66.00)
20										
			8V							
30										
40										
50		MM								
			GK							
60			KV							
			S	C						
70										
80			S	C		SHALE, (MM), Yellow and Brown, Extremely Weathered, Weak Rock.				
90										
			B	J		SHALE, (MM), Dark or Black and Blue, Fresh, Strong Rock. fresh black shale.				
100					0 100 200		0-5000	0-14	0-50	

Diagram Scaled to 400mm

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5428	Hole Length:	210.00

Easting: 702930.38
Northing: 7455974.80
Surface RL: 727.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 May 18 - 13 May 18
Comments: Assess yield for water supply PB - targeting fault zone at 171-179m. Lost circulation from 29 to 56m...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 66.0	WLDRIG6	CH	250		WELLDRILL	KKR
66.0 - 210.0	WLDRIG6	CH	200		WELLDRILL	SS7

TOC RL: 728.22 (Stickup 0.97m) (drilled) SWL: 88.05 MBTOC (15 May 18) Dev: N Final pH: -
TOC RL: 728.22 (Stickup 0.97m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100			B	J			SHALE, (MM), Dark or Black and Blue, Fresh, Strong Rock. fresh black shale.					BLANK PVC: Size 50 - Class 18 (0.00-150.00) GRAVEL MED (0.00-210.00)
110			JBC				FRESH MAGNETIC BIF, (MM), Dark or Black and Blue, Fresh, Very Strong Rock. green,clear and blue cherts.					BLANK STEEL: Size 8" - W.T.6.35mm: Cased off void. 8" casing actually goes 0-66m. (5.40-66.00)
120			J	C			FRESH MAGNETIC BIF, (MM), Blue and Grey, Fresh, Very Strong Rock. less shale. slower drilling.					
130		MM										
140												
150			J				FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. fws at 147 at fracture zone. 1L/s - poss strat change.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm (150.00-180.00)
			J				FRESH MAGNETIC BIF, (F), Grey, Fresh, Very Strong Rock. fws at 147 at fracture zone. 1L/s - poss strat change.					
			J									
160			JC				FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. fws at 147 at fracture zone. 1L/s - poss strat change.					
							FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. Consistent flow.					
170							FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. Fractures from 191m flow jump at 196-198. driller noticed at 192m chips were out by 2m. Agreed that it was an extra BIF-FR pile after thorough investigation.					
		MM										WELLCAP(175.00) ID: 2880
180							FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. 10-20L/s surging flow. Broken ground noted by driller, water cleaned up very quickly.					END CAP (180.00)
190			JC				FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. messed up BIF cobbles, hammer struggling to fire due to water. Asbestos intercept 200-204m.					
	BG		J									
200			J									
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5428 **Hole Length:** 210.00

Easting: 702930.38
Northing: 7455974.80
Surface RL: 727.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 May 18 - 13 May 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 66.0	WLDRIG6	CH	250		WELLDRILL	KKR
66.0 - 210.0	WLDRIG6	CH	200		WELLDRILL	SS7

Comments: Assess yield for water supply PB - targeting fault zone at 171-179m. Lost circulation from 29 to 56m...

TOC RL: 728.22 (Stickup 0.97m) (drilled) SWL: 88.05 MBTOC (15 May 18) Dev: N Final pH: -
TOC RL: 728.22 (Stickup 0.97m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200		MM	J				FRESH MAGNETIC BIF, (MM), Grey, Fresh, Very Strong Rock. messed up BIF cobbles, hammer struggling to fire due to water. Asbestos intercept 200-204m.					GRAVEL MED (0.00-210.00)
210												
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5430	Hole Length:	240.00

Easting: 705866.38
Northing: 7455820.03
Surface RL: 737.29
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 27 Apr 18 - 28 Apr 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	300		WELLDRILL	AF4
6.0 - 240.0	WLDRIG6	CH	150		WELLDRILL	AF4

Comments: Targeting fault at 180m for water supply. Consistently 4L/s from 162m even through fractures at 188m...

TOC RL: 738.11 - (drilled) SWL: 97.96 MBTOC (01 May 18) Dev: N Final pH: -
TOC RL: 738.11 - (current) Is Live: N (28 May 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		VB2	ZXG	H			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Extremely Weathered, Non-Cohesive soils, Gap graded, Sub-rounded. Surface scree (maghemite (pisolites), goethite, hematite					BLANK PVC: Size 50 - Class 18 (0.00-162.00) GRAVEL MED: used 9 tonnes (0.00-240.00)
10		N3	ZXG	H			GRAVEL, (QUATERNARY DETRITAL), Red and Brown, Extremely Weathered, Non-Cohesive soils, Gap graded, Sub-rounded. Surface scree (maghemite (pisolites), goethite, hematite					
			G	L			GRAVEL, (QUATERNARY DETRITAL), Brown and Red, Extremely Weathered, Hard, Gap graded, Angular. Goethite, minor limonite. Top sample yellow.					
20			G				QUATERNARY DETRITAL, (N3), Brown and Red, Extremely Weathered, Extremely Weak Rock. Vuggy, pitted clasts of goethite					
			G	C			QUATERNARY DETRITAL, (N3), Brown and Red and yellow, Moderately Weathered, Weak Rock. Goethite and minor chert					
30			G	S			QUATERNARY DETRITAL, (N3), Brown and Yellow, Moderately Weathered, Weak Rock. Goethite, minor siliciousore, minor white shale and limonite. Chips 2-10cm					
			G	S			QUATERNARY DETRITAL, (N2), Brown and Yellow, Moderately Weathered, Weak Rock. Goethite, minor siliciousore, minor white shale and limonite. Chips 2-10cm					
40			L				MINERALISED BIF, (N2), Brown and Dark or Black, Moderately Weathered, Medium Strong Rock. Mineralised limonite, trace angular BIF.					
							MINERALISED BIF, (N2), Yellow and Brown, Slightly Weathered, Strong Rock. Goethite, limonite, minor red shale, minor silicious goethite.					
50			GL	S			MINERALISED BIF, (N2), Brown and Blue and dark or black, Slightly Weathered, Strong Rock. BIF (Goethite/hematite), minor limonite.					
							PARTIALLY MINERALISED, (N2), Yellow and Brown, Slightly Weathered, Medium Strong Rock. Limonitic Shale					
60			JGH	L								
		N2										
70												
80												
			LS									
90			J									
		N1	J									
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

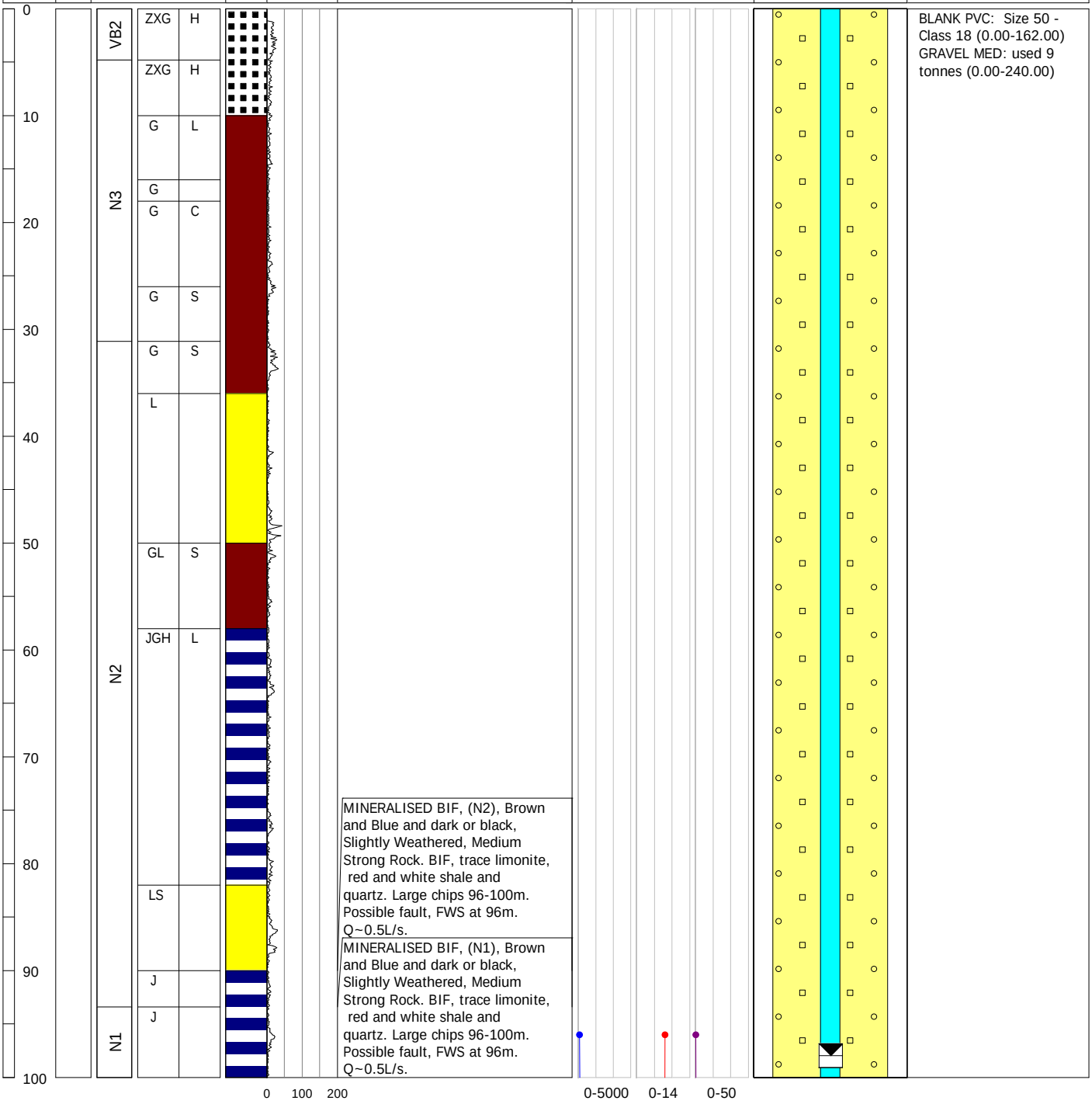
BHP

Project: SOUTH FLANK | Hole Name: HSF5430 | Hole Length: 240.00

Easting: 705866.38
Northing: 7455820.03
Surface RL: 737.29
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 27 Apr 18 - 28 Apr 18
Comments: Targeting fault at 180m for water supply. Consistently 4L/s from 162m even through fractures at 188m...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	300		WELLDRILL	AF4
6.0 - 240.0	WLDRIG6	CH	150		WELLDRILL	AF4

TOC RL: 738.11 - (drilled) SWL: 97.96 MBTOC (01 May 18) Dev: N Final pH: -
TOC RL: 738.11 - (current) Is Live: N (28 May 19) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5430	Hole Length:	240.00

Easting:	705866.38
Northing:	7455820.03
Surface RL:	737.29
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	27 Apr 18 - 28 Apr 18
Comments:	Targeting fault at 180m for water supply. Consistently 4L/s from 162m even through fractures at 188m...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	300		WELLDRILL	AF4
6.0 - 240.0	WLDRIG6	CH	150		WELLDRILL	AF4

TOC RL:	738.11	-	(drilled)	SWL:	97.96 MBTOC	(01 May 18)	Dev:	N	Final pH:	-
TOC RL:	738.11	-	(current)	Is Live:	N	(28 May 19)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100		N1	J				MINERALISED BIF, (N1), Brown and Blue and dark or black, Slightly Weathered, Medium Strong Rock. BIF, trace limonite, red and white shale and quartz. Large chips 96-100m. Possible fault, FWS at 96m. Q~0.5L/s.					BLANK PVC: Size 50 - Class 18 (0.00-162.00) GRAVEL MED: used 9 tonnes (0.00-240.00)
110			J	SQC			MINERALISED BIF, (N1), Grey and Brown, Slightly Weathered, Medium Strong Rock. BIF,minor leached BIF, quartz and chert. Trace red shale.					
120							MINERALISED BIF, (N1), Brown, Slightly Weathered, Medium Strong Rock. BIF (goethite), minor leached BIF and trace quartz. Chips up to 0.5cm.					
130			J				MINERALISED BIF, (F), Brown, Slightly Weathered, Medium Strong Rock. BIF (goethite), minor leached BIF and trace quartz. Chips up to 0.5cm.					
		N2	J				MINERALISED BIF, (N2), Brown, Slightly Weathered, Medium Strong Rock. BIF (goethite), minor leached BIF and trace quartz. Chips up to 0.5cm.					
140			J				PARTIALLY MINERALISED, (N2), Brown, Slightly Weathered, Medium Strong Rock. BIF (goethite), minor quartz, trace limonite and white shale.					
			JG	S			PARTIALLY MINERALISED, (N2), Brown and Blue and grey, Slightly Weathered, Medium Strong Rock. BIF (Goethite), minor red shale, trace quartz and chert.					
150			J	CS			PARTIALLY MINERALISED, (N2), Brown and Yellow, Slightly Weathered, Medium Strong Rock. BIF (goethite, limonite, hematite), minor white chert, red shale and tyrace quartz. Q=2L/s at 150m.					
			J	SG			PARTIALLY MINERALISED, (N1), Brown and Yellow, Slightly Weathered, Medium Strong Rock. BIF (goethite, limonite, hematite), minor white chert, red shale and tyrace quartz. Q=2L/s at 150m.					SLOTTED PVC: Size 50 - Class 18, Slots 1mm: extended casing past manufacture recommendation as gravel packing bridged around the casing meaning that when casing is released it would fall down hole, casing from 162-180 should be fine for monitoring. (162.00-236.00)
160							PARTIALLY MINERALISED, (N1), Brown and Grey, Slightly Weathered, Medium Strong Rock. BIF (goethite) with trace white shale, trace quartz and chert. Possible fracture 154-156m, 158-160m. Q= 3l/s at 156m. Q= 4l/s at 162m.					
			J									
170		N1	J	C								
180												
190			J	C								
			JGC	HL								
200												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

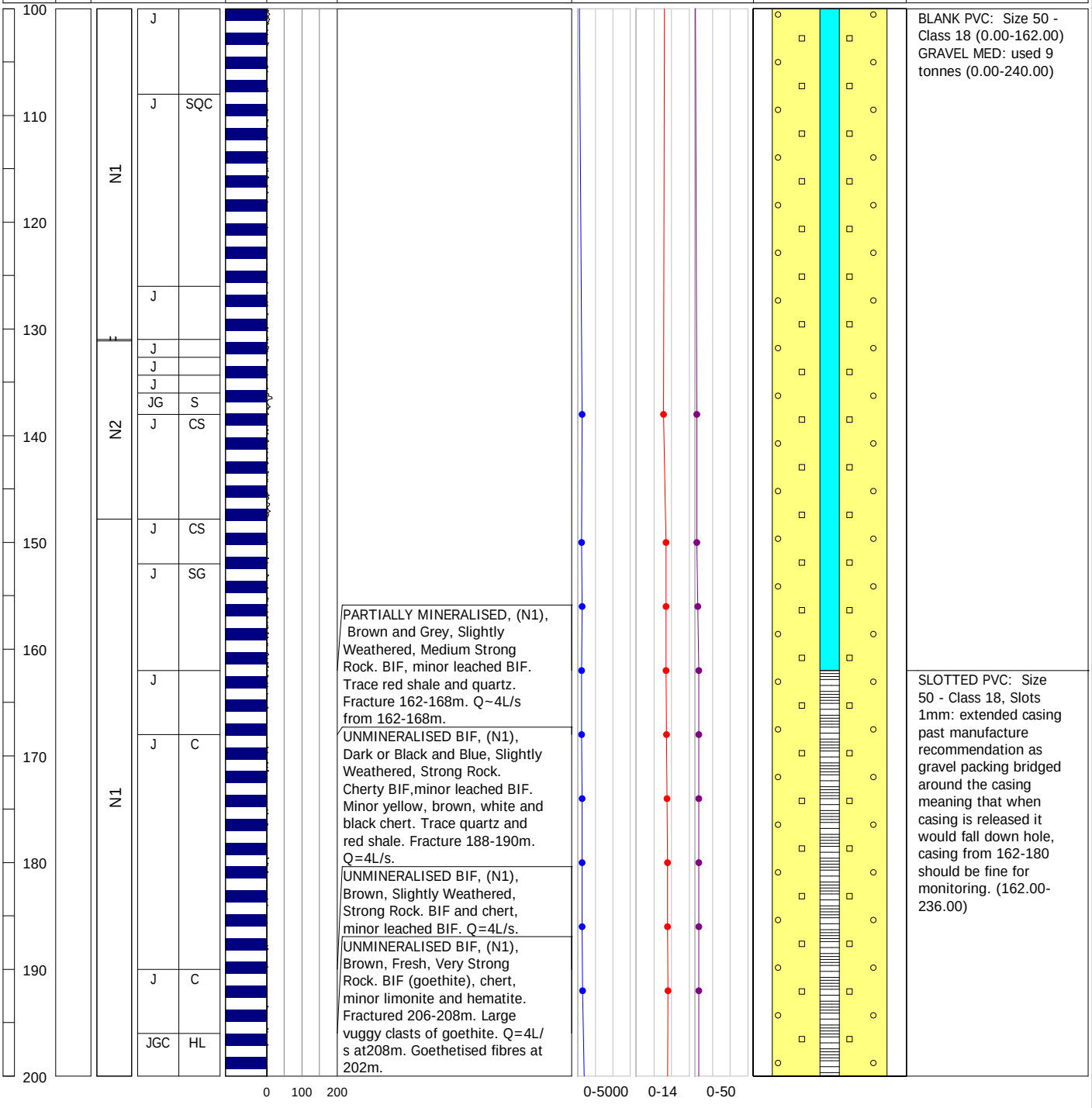
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5430	Hole Length:	240.00

Easting: 705866.38
Northing: 7455820.03
Surface RL: 737.29
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 27 Apr 18 - 28 Apr 18
Comments: Targeting fault at 180m for water supply. Consistently 4L/s from 162m even through fractures at 188m...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	300		WELLDRILL	AF4
6.0 - 240.0	WLDRIG6	CH	150		WELLDRILL	AF4

TOC RL: 738.11 - (drilled) SWL: 97.96 MBTOC (01 May 18) Dev: N Final pH: -
TOC RL: 738.11 - (current) Is Live: N (28 May 19) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5430	Hole Length:	240.00

Easting: 705866.38
Northing: 7455820.03
Surface RL: 737.29
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 27 Apr 18 - 28 Apr 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG6	CH	300		WELLDRILL	AF4
6.0 - 240.0	WLDRIG6	CH	150		WELLDRILL	AF4

Comments: Targeting fault at 180m for water supply. Consistently 4L/s from 162m even through fractures at 188m...

TOC RL: 738.11 - (drilled) SWL: 97.96 MBTOC (01 May 18) Dev: N Final pH: -
TOC RL: 738.11 - (current) Is Live: N (28 May 19) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200		N1	JGC	HL			UNMINERALISED BIF, (N1), Brown, Fresh, Very Strong Rock. BIF (goethite), chert, minor limonite and hematite. Fractured 206-208m. Large vuggy clasts of goethite. Q=4L/s at208m. Goethetised fibres at 202m.					GRAVEL MED: used 9 tonnes (0.00-240.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm: extended casing past manufacture recommendation as gravel packing bridged around the casing meaning that when casing is released it would fall down hole, casing from 162-180 should be fine for monitoring. (162.00-236.00)
210			JC	GH			PARTIALLY MINERALISED, (N1), Brown, Slightly Weathered, Very Strong Rock. BIF and chert. Q~4L/s					
220			JG	S			PARTIALLY MINERALISED, (N1), Brown, Slightly Weathered, Very Strong Rock. BIF, large clasts of vuggy goethite. Red and white banded BIF and shale. Possible fracture 224-226m. Q4L/s.					
230			GC				UNMINERALISED BIF, (N1), Brown, Fresh, Very Strong Rock. Goethite, siliceous goethite, chert and trace quartz. Goethetised fibres 34m. Slow drilling. Q4-5L/s.					
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5432	Hole Length:	230.00

Easting: 693523.29
Northing: 7455335.26
Surface RL: 796.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Aug 18 - 21 Aug 18
Comments: Production bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	500		EASTERNWELL	MNT, KS6, MNT, KS6

License: CAW201218

TOC RL: 796.82 (Stickup 0.58m) (drilled) SWL: 144.88 MBTOC (28 Aug 18) Dev: N Final pH: 8.5
TOC RL: 796.82 (Stickup 0.58m) (current) Is Live: N (01 Apr 21) Date: 20 Aug 2018 Final EC: 731.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	8GZ	JK			MINERALISED BIF, (SZ), Brown and Yellow, Moderately Weathered, Medium Strong Rock. Mineralised Colluvium/ Detritals, Vitreous Goethite, Goethite,Goethite, Minor Clay					CEMENT (0.00-2.00)
10			JLG	H			MINERALISED BIF, (MU), Brown and Yellow, Moderately Weathered, Medium Strong Rock. Mineralised BIF, yellow/ brown, Etremely weathered, 26m-22m minor fracturing, 30m-38m minor fracturing.					BLANK STEEL: Size 12" - W.T.4.78mm (0.00-152.00)
20												GRAVEL MED (2.00-230.00)
30							MINERALISED BIF, (MU), Yellow and Brown and grey, Slightly Weathered, Medium Strong Rock. MineralisedBIF, Brown/ Yellow, interminent minor fracturing.					
40			JHG				MINERALISED BIF, (MU), Brown and Pink, Slightly Weathered, Medium Strong Rock. Mineralised BIF, Pink/Red/Brown, SA to SR.					
50		MU	Z3G	S			MINERALISED BIF, (MU), Brown and Yellow, Slightly Weathered, Medium Strong Rock. Mineralised BIF, Yellow/brown, Minor fracturing 52m-56m, Minor fracturing 60m-62m.					
60			JLG				MINERALISED BIF, (MU), Brown and Yellow and dark or black, Slightly Weathered, Medium Strong Rock. Mineralised BIF, Brown/Red, sub angular.					
70			J	LG			MINERALISED BIF, (MU), Brown and Red and dark or black, Slightly Weathered, Medium Strong Rock. Mineralised BIF, Brown/Red/Pink, angular/sub angular.					
80			JG	L			PARTIALLY MINERALISED, (MU), Brown and Light or White, Moderately Weathered, Medium Strong Rock. mixed mineralised and cherty BIIF					
90			JGC	SL			UNMINERALISED BIF, (MU), Brown and Yellow, Moderately Weathered, Medium Strong Rock. Mixed Lith- Cherty BIF, SHL and minor well mineralised GOE and MagHem					
100	MG		JCG	S								
			JS	C1			UNMINERALISED BIF, (MU), Yellow and Brown, Moderately Weathered, Medium Strong Rock. BIF with minor SHL, Inreasing minor GEO & HEM CHERT + subrounded and angular Quartz					
			J	CF								
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5432	Hole Length:	230.00

Easting: 693523.29
Northing: 7455335.26
Surface RL: 796.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Aug 18 - 21 Aug 18
Comments: Production bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	500		EASTERNWELL	MNT, KS6, MNT, KS6

License: CAW201218

TOC RL: 796.82 (Stickup 0.58m) (drilled) SWL: 144.88 MBTOC (28 Aug 18) Dev: N Final pH: 8.5
TOC RL: 796.82 (Stickup 0.58m) (current) Is Live: N (01 Apr 21) Date: 20 Aug 2018 Final EC: 731.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	8GZ	JK								CEMENT (0.00-2.00)
			JLG	H								BLANK STEEL: Size 12" - W.T.4.78mm (0.00-152.00)
10												GRAVEL MED (2.00-230.00)
20												
30												
40			JHG									
			Z3G	S								
50		MU	JLG									
60			J	LG								
70			JG	L								
			JGC	SL								
80			JCG	S								
90			JS	C1								
100	MG		J	CF			UNMINERALISED BIF, (MU), Brown, Highly Weathered, Medium Strong Rock. SHL + BIF with minor jaspilitic chert					
						0 100 200		0-5000	0-14	0-50		

Program: Grand Central Hydro Construction Pilot FY18 Planned Hole: HSF5432 Page: 276

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5432	Hole Length:	230.00

Easting: 693523.29
Northing: 7455335.26
Surface RL: 796.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Aug 18 - 21 Aug 18
Comments: Production bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	500		EASTERNWELL	MNT, KS6, MNT, KS6

License: CAW201218

TOC RL: 796.82 (Stickup 0.58m) (drilled) SWL: 144.88 MBTOC (28 Aug 18) Dev: N Final pH: 8.5
TOC RL: 796.82 (Stickup 0.58m) (current) Is Live: N (01 Apr 21) Date: 20 Aug 2018 Final EC: 731.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	MU	J	CF			UNMINERALISED BIF, (MU), Brown, Highly Weathered, Medium Strong Rock. SHL + BIF with minor jaspilitic chert					BLANK STEEL: Size 12" - W.T.4.78mm (0.00-152.00)
			JGC	QF			PARTIALLY MINERALISED, (MU), Red and Brown, Moderately Weathered, Medium Strong Rock. partially mineralsed BIF + minor SHL, QTZ & Jasp Chert					GRAVEL MED (2.00-230.00)
110			JC	S			UNMINERALISED BIF, (MU), Brown, Moderately Weathered, Medium Strong Rock. Cherty BIF + minor green & dark green shale & vuggy quartz					
120												
130			S	JM			UNMINERALISED BIF, (MU), Green and Brown, Moderately Weathered, Medium Strong Rock. light & dark green Shale + minor magnetic BIF & QTZ					
			JSM	C			FRESH MAGNETIC BIF, (MU), Blue and Green and grey, Fresh, Medium Strong Rock. Si rich magnetc BIF wth varyng hard fresh green shale. variable penetration rates (hard and soft).					
140												
150	MG		JMC	S			FRESH MAGNETIC BIF, (MU), Blue and Green and grey, Fresh, Medium Strong Rock. Si rich magnetc bif wth decreasing fresh Shale and minor brown BIF (contamination?) with depth, QTZ viens and sulphde on fractures @ 152 and water strike and fracture reported at 154m. Variable penetration (hard and soft) competent.					SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 1mm (152.00-206.00)
160			JMC									
170			JMC	S			FRESH MAGNETIC BIF, (MU), Blue and Grey, Fresh, Medium Strong Rock. Blue-Grey Si rich mag-BIF					
180							FRESH MAGNETIC BIF, (MU), Blue and Grey and brown, Fresh, Medium Strong Rock. Blue-Grey Si rich mag-BIF + minor brown Shale & si BIF (possible contamination)+ trace whte & bright green quartz					
			JMC									
190			JMC	S			FRESH MAGNETIC BIF, (MU), Grey and Green, Fresh, Medium Strong Rock. Blue-Grey mag-BIF & pale green quartz					
	MG		J	S			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Medium Strong Rock. Blue-Grey mag-BIF + minor grey shale and trace opaque white quartz					
200												

0 100 200 0-5000 0-14 0-50

BHPIO - Hydrogeology Log

BHP

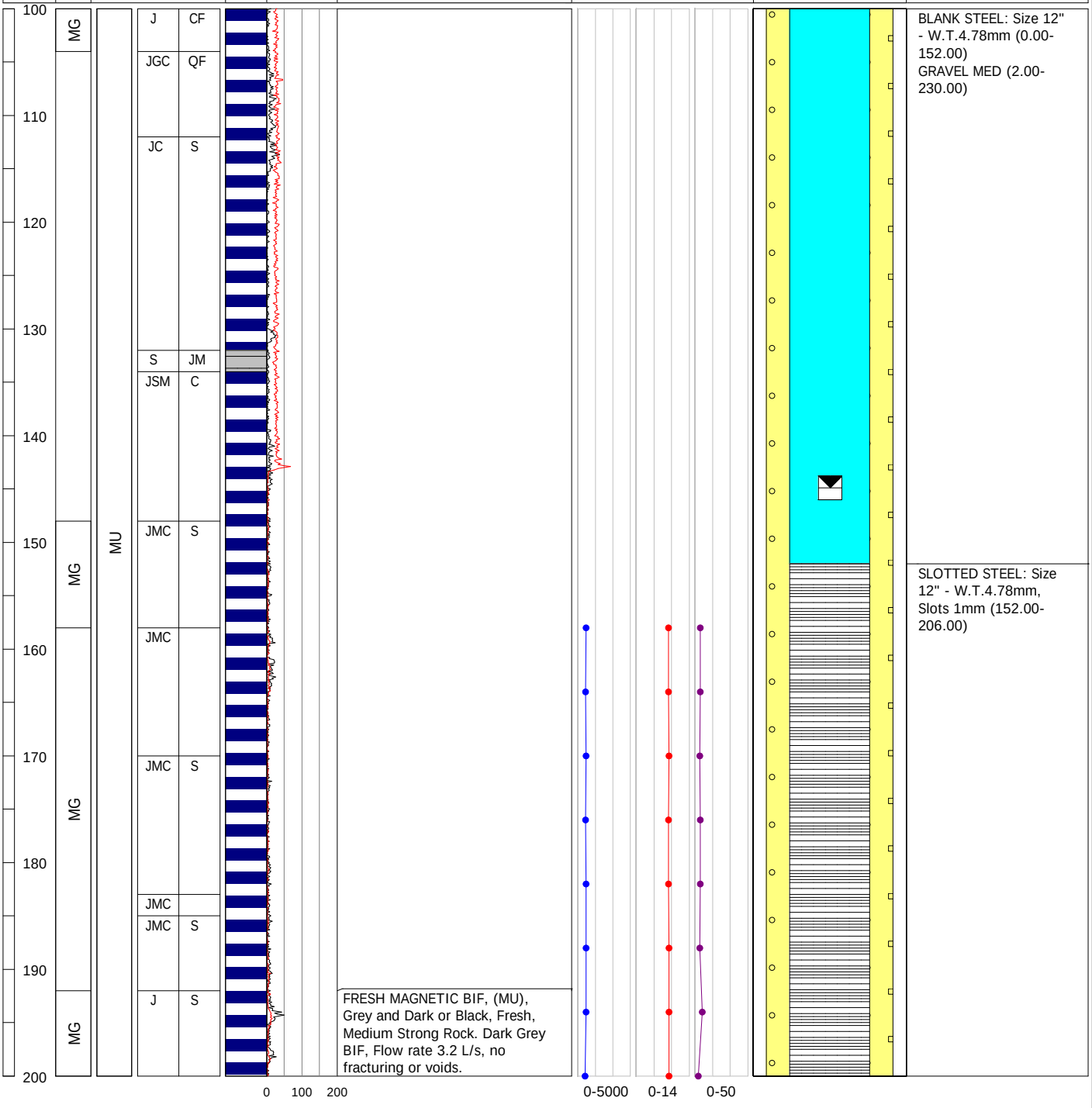
Project:	SOUTH FLANK	Hole Name:	HSF5432	Hole Length:	230.00

Easting: 693523.29
Northing: 7455335.26
Surface RL: 796.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Aug 18 - 21 Aug 18
Comments: Production bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	500		EASTERNWELL	MNT, KS6, MNT, KS6

License: CAW201218

TOC RL: 796.82 (Stickup 0.58m) (drilled) SWL: 144.88 MBTOC (28 Aug 18) Dev: N Final pH: 8.5
TOC RL: 796.82 (Stickup 0.58m) (current) Is Live: N (01 Apr 21) Date: 20 Aug 2018 Final EC: 731.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5432	Hole Length:	230.00

Easting: 693523.29
Northing: 7455335.26
Surface RL: 796.24
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Aug 18 - 21 Aug 18
Comments: Production bore drilled on pilot pad

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 230.0	DR5	DR	500		EASTERNWELL	MNT, KS6, MNT, KS6

License: CAW201218

TOC RL: 796.82 (Stickup 0.58m) (drilled) SWL: 144.88 MBTOC (28 Aug 18) Dev: N Final pH: 8.5
TOC RL: 796.82 (Stickup 0.58m) (current) Is Live: N (01 Apr 21) Date: 20 Aug 2018 Final EC: 731.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200	MG	MU	J	S			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Medium Strong Rock. Dark Grey BIF, Flow rate 3.2 L/s, no fracturing or voids.					GRAVEL MED (2.00-230.00)
210	BG		SJ	CK			FRESH MAGNETIC BIF, (MU), Dark or Black and Grey, Moderately Weathered, Weak Rock. Mostly BIF with small bands of Black Shale, fractured ground from 205m+, Flow rate of 10-12 l/s.					SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 1mm (152.00-206.00)
220			S	JC			SHALE, (MU), Dark or Black and Grey, Moderately Weathered, Extremely Weak Rock. Mostly Black Shale with small amounts of BIF. Fractured ground, Flow rate of 10-12 l/s.					S/S SCREEN: Size 12" - W.T.4.78mm, Slots 1mm (206.00-224.00)
230	MG		J	S			FRESH MAGNETIC BIF, (MU), Grey and Dark or Black, Fresh, Medium Strong Rock. Mostly BIF with minor Blacke Shale, flow rate of 10 l/s, no significant fracturing.					SLOTTED STEEL: Size 12" - W.T.4.78mm, Slots 1mm (224.00-230.00)
240												END CAP (230.00)
250												
260												
270												
280												
290												
300												

0 100 200 (Gamma CPS API)
0-5000 0-14 0-50 (EC us/cm, pH, Yield L/s)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5433	Hole Length:	242.00

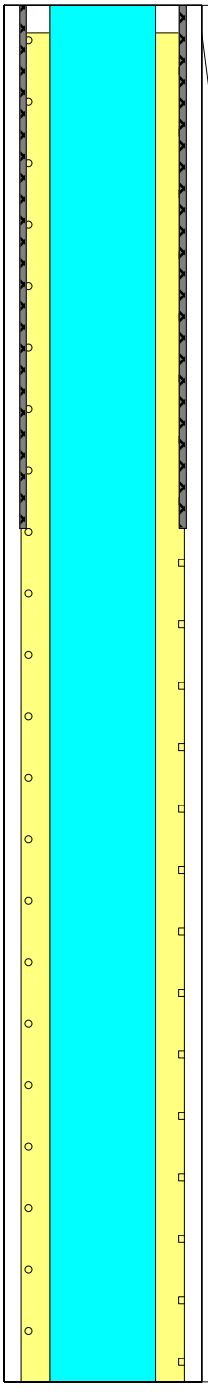
Easting: 695899.99
Northing: 7454894.54
Surface RL: 758.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jun 18 - 23 Jun 18
License: CAW201218
Comments: water supply bore drilled on pilot pad 0013, pilot hole HSF5436

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 38.0	DR5	DR	500		EASTERNWELL	KKR
38.0 - 187.0	DR5	DR	450		EASTERNWELL	MM9
187.0 - 242.0	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 758.75 (Stickup 0.50m) (drilled) SWL: 120.14 MBGL (22 Jun 18) Dev: N Final pH: 8.1
TOC RL: 758.75 (Stickup 0.50m) (current) Is Live: Y (-) Date: 23 Jun 2018 Final EC: 334.00

Depth mgbl	Strat	Major	Minor	Hydrogeological Description
0	SZ	ZXH	GI	GRAVEL, (QUATERNARY DETRITAL), Red, Transported, Non-Cohesive soils, Gap graded, Angular. Mixture of maghemite, hematite, goethite and minor pisolites.
10	TD3	H		GRAVEL, (QUATERNARY DETRITAL), Red, Extremely Weathered, Hard, Gap graded, Angular. Hematite with trace goethite and maghemite.
20		XGH		BRECCIA, (TD3), Red and Brown, Moderately Weathered, Medium Strong Rock. Maghemite, goethite and hematite. Trace white shale/ clay. Smal chips.
30		G	X	BRECCIA, (TD3), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Goethite with minor maghemite. Small chips.
40	WA2	GL	J	MINERALISED BIF, (WA2), Brown and Yellow and grey, Moderately Weathered, Medium Strong Rock. Limonite goethite yellow to brown. Mineralised BIF grey to brown. Moderately weathered, sub-angular gravel.
50				
60				
70				
80		J	G	MINERALISED BIF, (WA2), Yellow and Grey, Moderately Weathered, Strong Rock. possible fault from 80-86m
90	WA1	J		MINERALISED BIF, (WA1), Brown and Grey and yellow, Highly Weathered, Strong Rock.
100		J		MINERALISED BIF, (WA1), Brown and Yellow and pink, Highly Weathered, Strong Rock.

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50



Notes:
BLANK STEEL: 508mm : DR casing (0.00-38.00)
BLANK STEEL: 324mm : Blank casing (0.00-158.00)
GRAVEL MED: Gravel Pack (2.00-237.00)

BHPIO - Hydrogeology Log

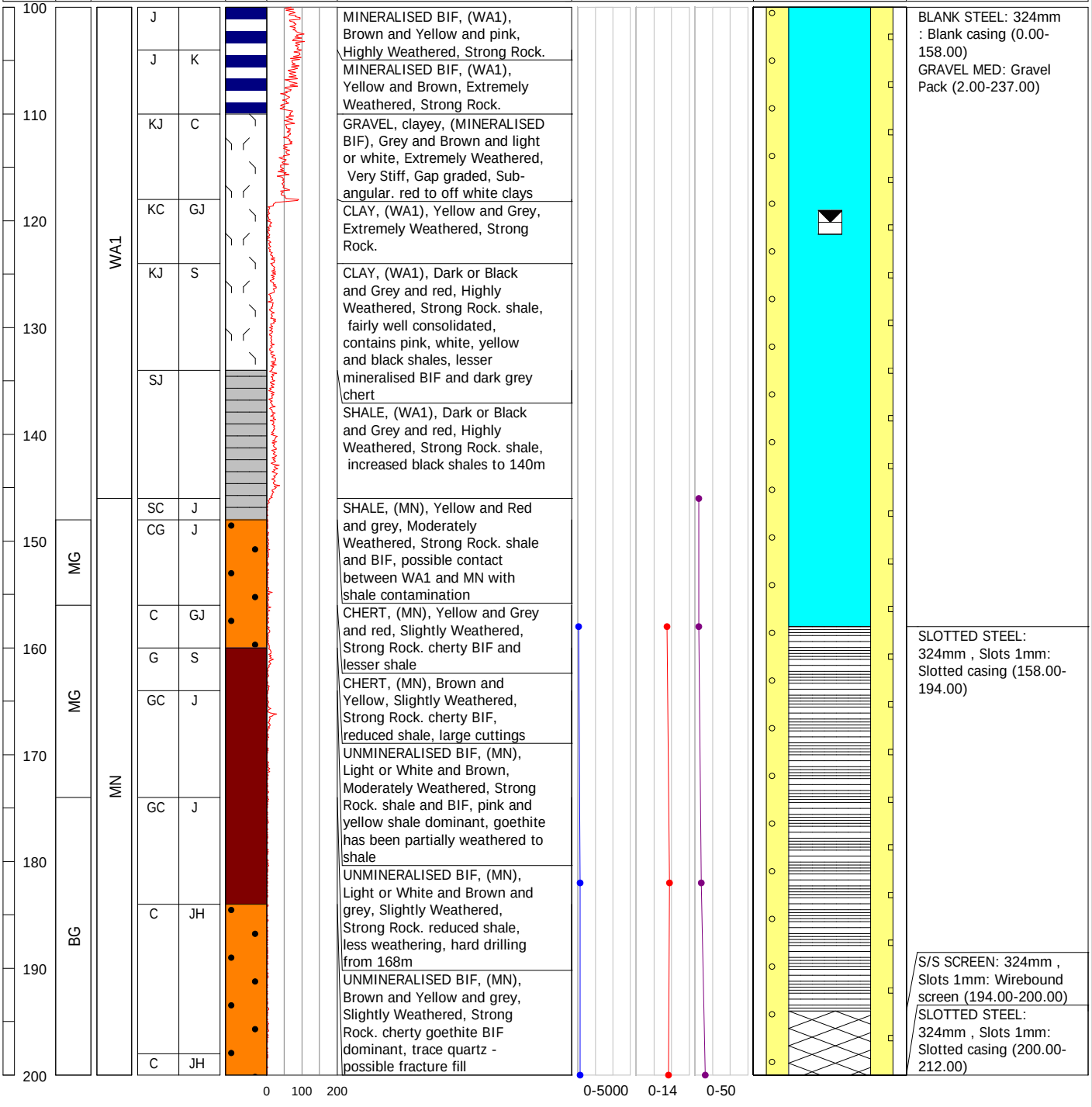
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5433	Hole Length:	242.00

Easting: 695899.99
Northing: 7454894.54
Surface RL: 758.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jun 18 - 23 Jun 18
License: CAW201218
Comments: water supply bore drilled on pilot pad 0013, pilot hole HSF5436

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 38.0	DR5	DR	500		EASTERNWELL	KKR
38.0 - 187.0	DR5	DR	450		EASTERNWELL	MM9
187.0 - 242.0	DR5	CH	450		EASTERNWELL	KP3

TOC RL:	758.75	(Stickup 0.50m) (drilled)	SWL:	120.14 MBGL	(22 Jun 18)	Dev: N	Final pH: 8.1
TOC RL:	758.75	(Stickup 0.50m) (current)	Is Live:	Y	(-)	Date: 23 Jun 2018	Final EC: 334.00



BHPIO - Hydrogeology Log

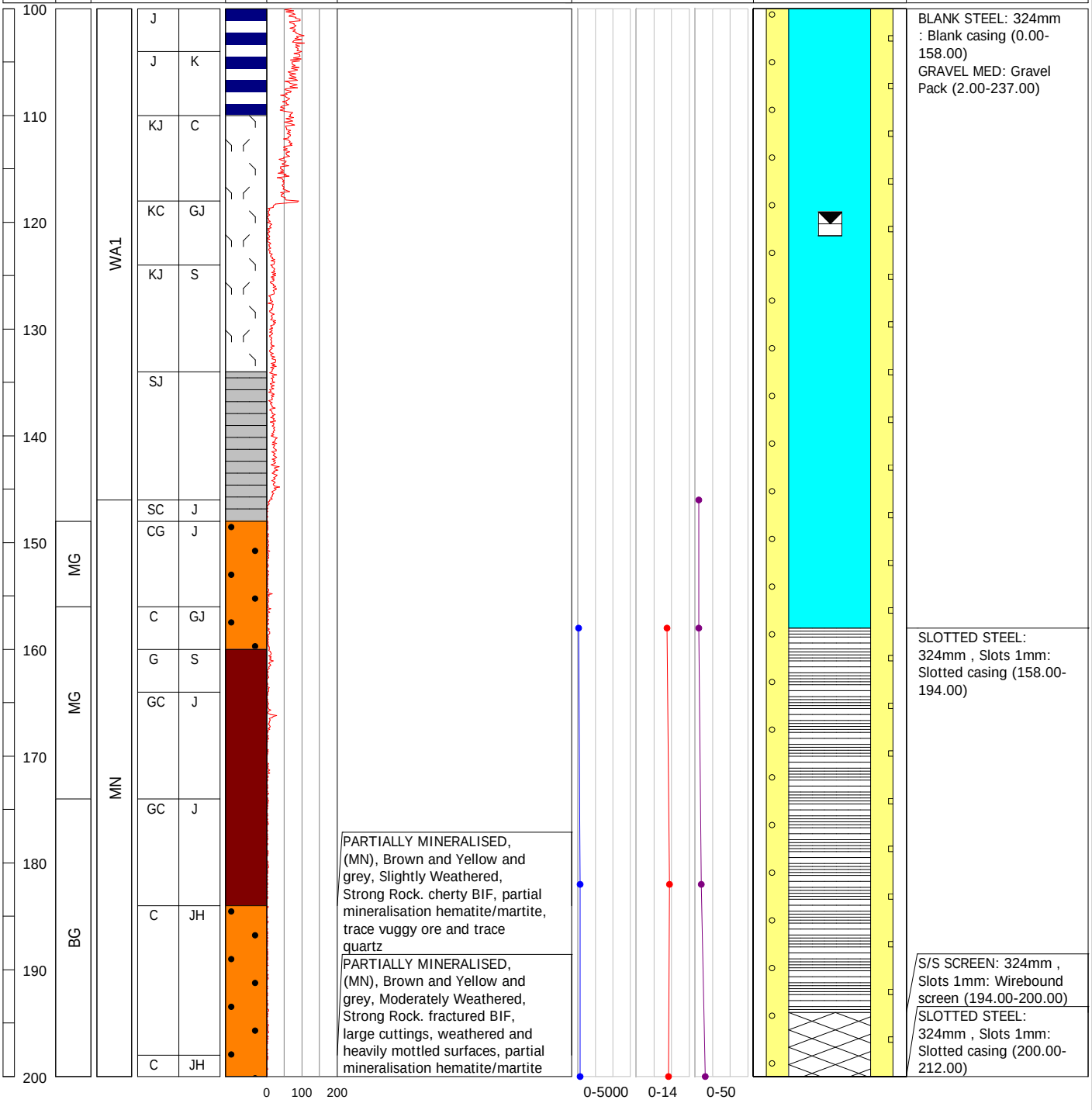
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5433	Hole Length:	242.00

Easting: 695899.99
Northing: 7454894.54
Surface RL: 758.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jun 18 - 23 Jun 18
License: CAW201218
Comments: water supply bore drilled on pilot pad 0013, pilot hole HSF5436

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 38.0	DR5	DR	500		EASTERNWELL	KKR
38.0 - 187.0	DR5	DR	450		EASTERNWELL	MM9
187.0 - 242.0	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 758.75 (Stickup 0.50m) (drilled) SWL: 120.14 MBGL (22 Jun 18) Dev: N Final pH: 8.1
TOC RL: 758.75 (Stickup 0.50m) (current) Is Live: Y (-) Date: 23 Jun 2018 Final EC: 334.00



BHPIO - Hydrogeology Log

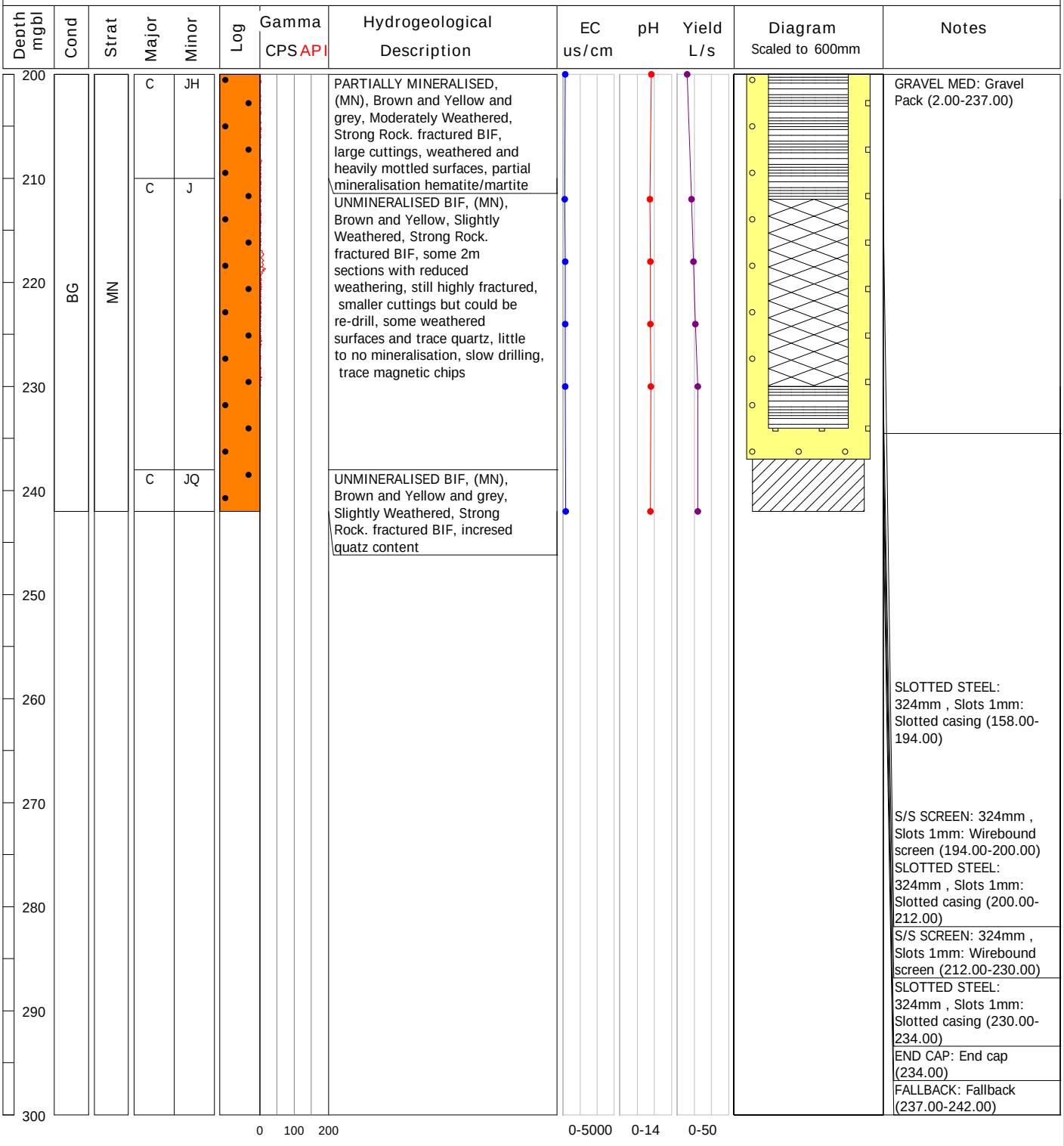
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5433	Hole Length:	242.00

Easting: 695899.99
Northing: 7454894.54
Surface RL: 758.25
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 13 Jun 18 - 23 Jun 18
License: CAW201218
Comments: water supply bore drilled on pilot pad 0013, pilot hole HSF5436

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 38.0	DR5	DR	500		EASTERNWELL	KKR
38.0 - 187.0	DR5	DR	450		EASTERNWELL	MM9
187.0 - 242.0	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 758.75 (Stickup 0.50m) (drilled) SWL: 120.14 MBGL (22 Jun 18) Dev: N Final pH: 8.1
TOC RL: 758.75 (Stickup 0.50m) (current) Is Live: Y (-) Date: 23 Jun 2018 Final EC: 334.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5434	Hole Length:	201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18
License: CAW201218
Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 727.89 (Stickup 0.67m) (drilled) SWL: 88.90 MBTOC (23 Jul 18) Dev: N Final pH: 8.3
TOC RL: 727.89 (Stickup 0.67m) (current) Is Live: Y (-) Date: 21 Jul 2018 Final EC: 1099.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	ST3	IX	8			GRAVEL, (BRECCIA), Dark or Black and Red and brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Pisolites; dark red to brown, well rounded pisolites (Maghemite) mixed with lesser angular goethite hardcap, trace shale, unconsolidated					BLANK STEEL: 508mm (0.00-80.00)
		GS3	IX	8								BLANK STEEL: Size 14" - W.T.9.53mm (0.00-153.00)
10			8	IX								GRAVEL MED (0.00-201.00)
			GL	C								
			GL	C								
20	UG						GRAVEL, (BRECCIA), Dark or Black and Red and brown, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Pisolites; dark red to brown, well rounded pisolites (Maghemite) mixed with lesser angular goethite hardcap, trace shale, unconsolidated					
			G	LCQ								
30	BG		GC	L			BRECCIA, (GS3), Red and Brown and dark or black, Highly Weathered, Strong Rock. Red brown. Hard capping, minor pisolites (Meghamite) and goethite. Weathered.					
			GC	SQ								
40			GL	CVQ			UNMINERALISED BIF, (GS3), Brown and Yellow, Moderately Weathered, Strong Rock. Yellow brown, goethite and limonie minor chert, trace quartz. Cavity at 20m. Very unconsolidated drilling. Some vuggy texture.					
50	MG		GC				UNMINERALISED BIF, (MM), Brown and Yellow, Moderately Weathered, Strong Rock. Yellow brown, goethite and limonie minor chert, trace quartz. Cavity at 20m. Very unconsolidated drilling. Some vuggy texture.					
	BG	MM	L	GQC								
60			LC	SQ								
70	MG		SL	GJ			UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Brown yellow Goethite, minor chert, limonite and quartz. Quartz increasing with depth. Broken ground, difficult drilling.					
			GJ	SC								
80							UNMINERALISED BIF, (MM), Brown, Moderately Weathered, Strong Rock. Brown , Goethite and chert. Minor limonite and trace quartz. Most chips are 0.25cm but some are 1cm.					
90			GJ	SLC			CHERT, (MM), Brown, Moderately Weathered, Strong Rock. Brown. Goethite and green, red and brown chert. Green shale and white vuggy.					
			JS	CG								
100			J	C								
					0	100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5434 **Hole Length:** 201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18 **License:** CAW201218
Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

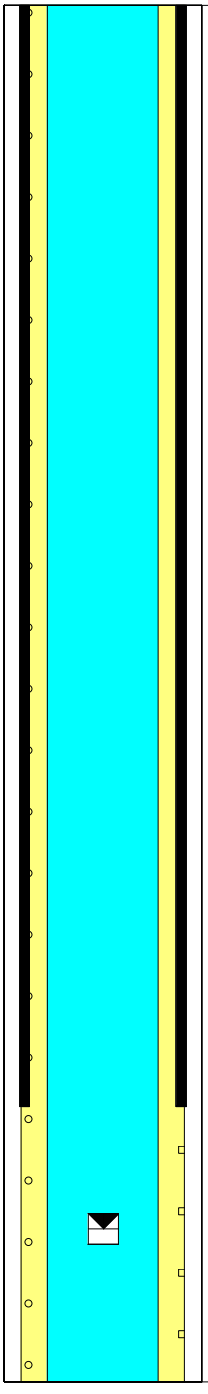
Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 727.89 (Stickup 0.67m) (drilled) **SWL:** 88.90 MBTOC (23 Jul 18) **Dev:** N **Final pH:** 8.3
TOC RL: 727.89 (Stickup 0.67m) (current) **Is Live:** Y (-) **Date:** 21 Jul 2018 **Final EC:** 1099.00

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description
0	UG	ST3	IX	8		
		GS3	IX	8		UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown. Goethite and limonite. Minor Chert, shale and quartz. Yellow and brown chert. Quartz, chip size and limonitic shale increasing with depth.
10			8	IX		
			GL	C		
	UG		GL	C		
20						UNMINERALISED BIF, (MM), Brown and Dark or Black, Moderately Weathered, Strong Rock. Dark brown and smaller chips. Limonitic shale and trace red an yellow shale.
			G	LCQ		
30			GC	L		UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown. Limonite with minor goethite, chert and quartz. Broken ground.
	BG		GC	SQ		
40			GL	CVQ		UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown. Limonitic chert and red chert, minor red and green shale, minor quartz. Weathered (green) Stipnomoline. Very slow drilling.
50	MG		GC			UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Yellow brown, wethered goethite bif, increase in soft brown shales
	BG		L	GQC		
60						UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Light brown yellow, weathered bif, goethite has been weathered out to well consolidated shale, trace soft shale, weathered surfaces and some rounding of chips, trace quartz
			LC	SQ		
70	MG		SL	GJ		
			GJ	SC		UNMINERALISED BIF, (MM), Yellow and Brown, Moderately Weathered, Strong Rock. Light brown yellow, weathered bif and shale, increased shale content, limonite weathered surfaces, some rounding
80						
90			GJ	SLC		UNMINERALISED BIF, (MM), Brown and Yellow and green, Highly Weathered, Very Weak Rock. Dark green to brown, weathered bif mixed with dark green to grey shale, looks to be the transition zone to fresh bif
			JS	CG		
100			J	C		
					0 100 200	

EC us/cm: 0-5000 pH: 0-14 Yield L/s: 0-50

Diagram Scaled to 600mm



Notes:
BLANK STEEL: 508mm (0.00-80.00)
BLANK STEEL: Size 14" - W.T.9.53mm (0.00-153.00)
GRAVEL MED (0.00-201.00)

BHPIO - Hydrogeology Log

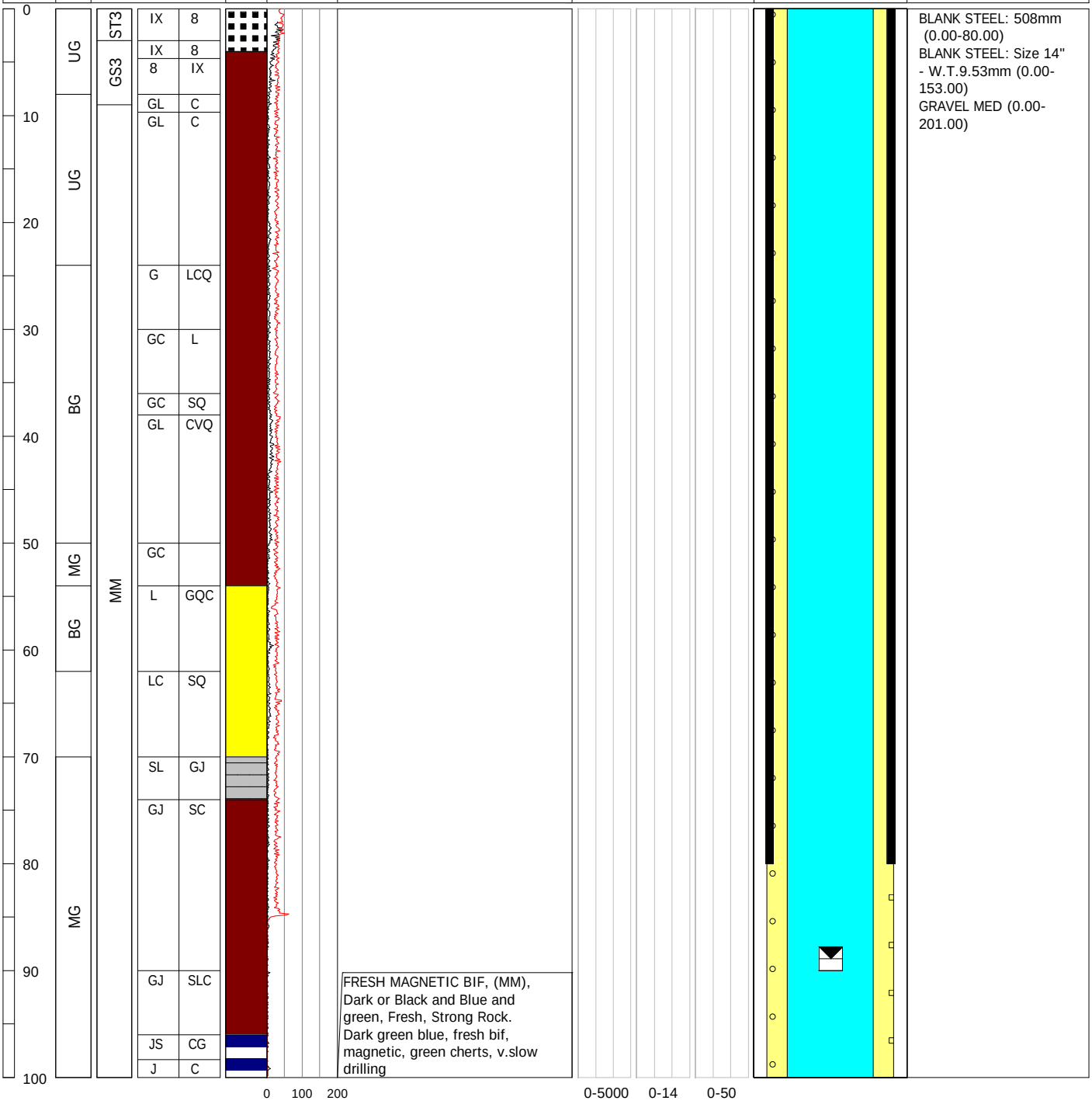
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5434		Hole Length:	201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18
License: CAW201218
Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

TOC RL:	727.89	(Stickup 0.67m)	(drilled)	SWL:	88.90 MBTOC	(23 Jul 18)	Dev:	N	Final pH:	8.3
TOC RL:	727.89	(Stickup 0.67m)	(current)	Is Live:	Y	(-)	Date:	21 Jul 2018	Final EC:	1099.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5434	Hole Length:	201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18
License: CAW201218
Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 727.89 (Stickup 0.67m) (drilled) SWL: 88.90 MBTOC (23 Jul 18) Dev: N Final pH: 8.3
TOC RL: 727.89 (Stickup 0.67m) (current) Is Live: Y (-) Date: 21 Jul 2018 Final EC: 1099.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	MM	J	C			FRESH MAGNETIC BIF, (MM), Dark or Black and Blue and green, Fresh, Strong Rock. Dark green blue, fresh bif, magnetic, green cherts, v.slow drilling					BLANK STEEL: Size 14" - W.T.9.53mm (0.00-153.00)
110												GRAVEL MED (0.00-201.00)
120							FRESH MAGNETIC BIF, (MM), Blue and Green, Slightly Weathered, Strong Rock. Green blue, increased quartz fill and slight weathering, quicker drilling, trace shale, possible fracture zone					
130			J	CQ								
140			J	C			FRESH MAGNETIC BIF, (MM), Dark or Black and Blue and green, Fresh, Strong Rock. Dark green blue, fresh bif and green cherts					
150		MM	J	C			FRESH MAGNETIC BIF, (F), Dark or Black and Blue and green, Fresh, Strong Rock. Dark green blue, fresh bif and green cherts					
			J	C			FRESH MAGNETIC BIF, (MM), Dark or Black and Blue and green, Fresh, Strong Rock. Dark green blue, fresh bif and green cherts					
			J	C								
160			J	C			FRESH MAGNETIC BIF, (MM), Blue and Green, Fresh, Strong Rock. Light to dark blue green, larger cuttings, first water strike, fractured with increased quartz with streaked and weathered surfaces, trace soft khaki clay					SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (153.00-176.00)
170							FRESH MAGNETIC BIF, (MM), Dark or Black and Blue, Fresh, Strong Rock. Dark blue to black, fresh bif and silica, makes up the stilpnomelane band within the macleod, reduced magnetism, hard, fractured with increases in yield					
180			JC				FRESH MAGNETIC BIF, (MM), Dark or Black and Blue and green, Fresh, Strong Rock. Dark blue green, fresh cherty bif, reduced fractures, large amount of green chert, magnetic					S/S SCREEN: Size 14" - W.T.9.53mm, Slots 1mm (176.00-182.00)
190			JC	Q			FRESH MAGNETIC BIF, (MM), Dark or Black and Blue and green, Fresh, Strong Rock. Dark blue green, increased quartz, fractured surfaces, increase in yield					SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (182.00-188.00)
			JC	Q								S/S SCREEN: Size 14" - W.T.9.53mm, Slots 1mm (188.00-200.00)
200			JC	Q								SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (200.00-201.00)
						0 100 200		0-5000	0-14	0-50		

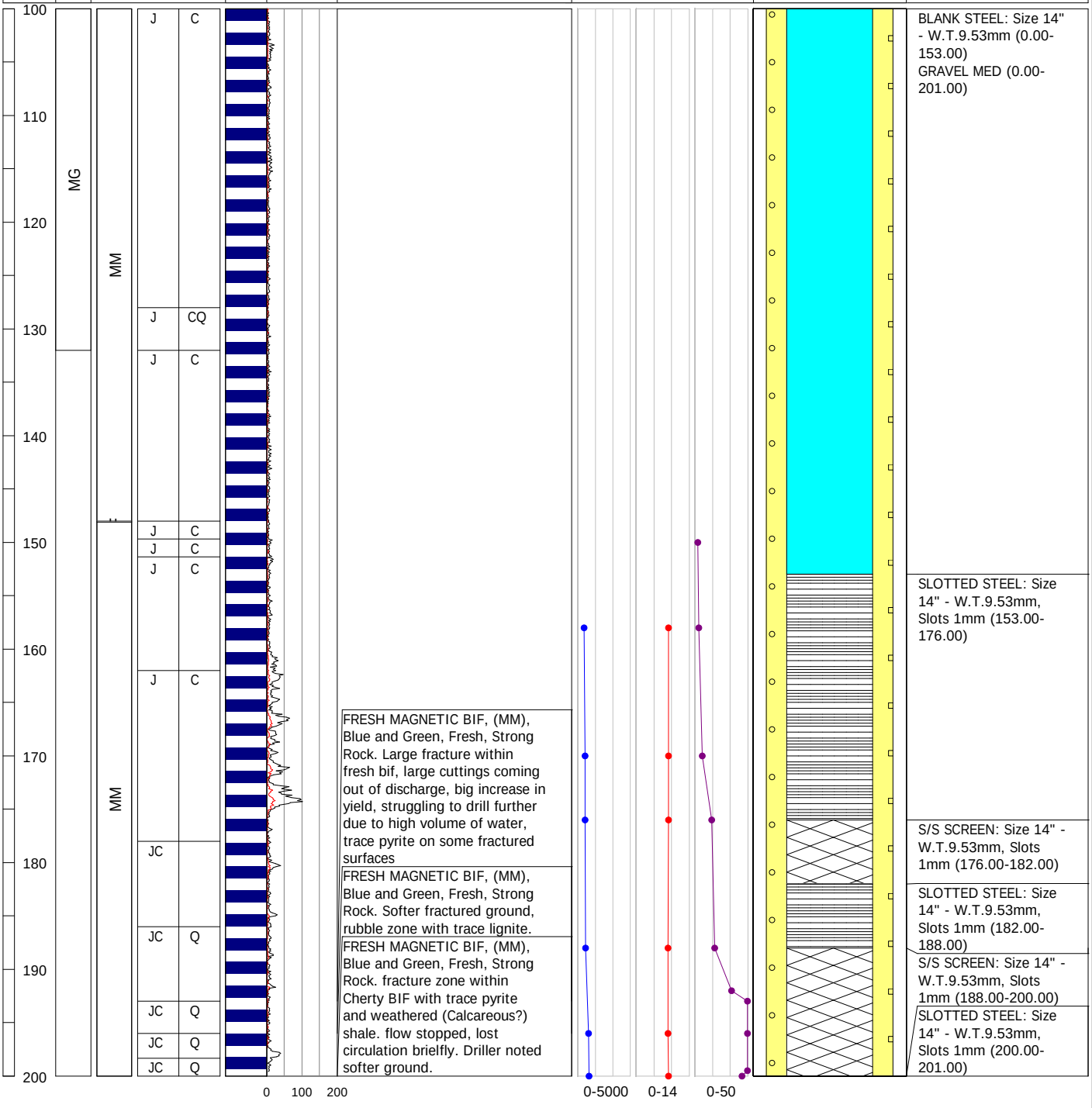
BHPIO - Hydrogeology Log

Project: SOUTH FLANK **Hole Name:** HSF5434 **Hole Length:** 201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18
License: CAW201218
Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

TOC RL: 727.89 (Stickup 0.67m) (drilled) SWL: 88.90 MBTOC (23 Jul 18) Dev: N Final pH: 8.3
TOC RL: 727.89 (Stickup 0.67m) (current) Is Live: Y (-) Date: 21 Jul 2018 Final EC: 1099.00



BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5434 **Hole Length:** 201.50

Easting: 702920.08
Northing: 7455974.69
Surface RL: 727.22
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 15 Jul 18 - 23 Jul 18

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 80.0	DR5	DR	500		EASTERNWELL	AF4
80.0 - 104.0	DR5	DR	450		EASTERNWELL	KP3
104.0 - 201.5	DR5	CH	450		EASTERNWELL	KP3

License: CAW201218

Comments: water supply bore, pilot hole: HSF5428. Likely intersected fault zone.

TOC RL: 727.89 (Stickup 0.67m) (drilled) SWL: 88.90 MBTOC (23 Jul 18) Dev: N Final pH: 8.3
TOC RL: 727.89 (Stickup 0.67m) (current) Is Live: Y (-) Date: 21 Jul 2018 Final EC: 1099.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200		MM	JC	Q			FRESH MAGNETIC BIF, (MM), Blue and Green, Fresh, Strong Rock. fracture zone within Cherty BIF with trace pyrite and weathered (Calcareous?) shale. flow stopped, lost circulation brielfly. Driller noted softer ground.					GRAVEL MED (0.00-201.00)
210												
220												
230												
240												
250												SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (153.00-176.00)
260												
270												
280												S/S SCREEN: Size 14" - W.T.9.53mm, Slots 1mm (176.00-182.00)
												SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (182.00-188.00)
290												S/S SCREEN: Size 14" - W.T.9.53mm, Slots 1mm (188.00-200.00)
												SLOTTED STEEL: Size 14" - W.T.9.53mm, Slots 1mm (200.00-201.00)
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK | Hole Name: HSF5462 | Hole Length: 185.00

Easting: 692683.58
Northing: 7453663.38
Surface RL: 720.00
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Feb 19 - 19 Feb 19
License: CAW201214
Comments: Hole is part of the scheme to monitor and develop a robust minitoring network for the planned future...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 26.0	DR5	DR	500		EASTERNWELL	MRC1
26.0 - 170.0	DR5	DR	450		EASTERNWELL	MRC1
170.0 - 185.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 720.60 - (drilled) SWL: 90.99 MBTOC (19 Feb 19) Dev: N Final pH: -
TOC RL: 720.60 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	BG	SZ	J	Y			COBBLE, gravelly, trace silt, (QUATERNARY DETRITAL), Red and Brown and yellow, Transported, Non-Cohesive soils, Poorly graded, Sub-angular. Colluvial material, surface scree ranging from cobble to silty fines.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-108.00)
10	UG	TD3	JI	YZ			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Soft, Well graded, Sub-rounded. Detritals with alluvial and colluvial material. Increasing silty material and sub-rounded pisolites, some cherty BIF. Good ROP (Rate of Penetration)					GRAVEL MED (2.00-92.00)
40	MG		IY	JKZ			SILT, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Very Soft, Gap graded, Sub-rounded. Detritals red to brown with increasing fines somewhat rounded and relatively well sorted cuttings					
60		TD2	K3	S			CLAY, (TD2), Red and Yellow, Moderately Weathered, Very Weak Rock. Shaly calcrete material, red brown to offwhite yellow. Calcrete beds with shale and clay. slower ROP.					
80			K	S			CLAY, (TD2), Red and Yellow, Moderately Weathered, Very Weak Rock. Shaly clays with some calcrete, orange to yellow with traces of grey BIF.					
90			K	S			CLAY, (TD2), Grey and Red, Moderately Weathered, Very Weak Rock. Dark to redish yellow clays with dark sub-rounded, moderately weathered and poorly sorted shale.					CEMENT (92.00-104.00)
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5462	Hole Length:	185.00

Easting: 692683.58
Northing: 7453663.38
Surface RL: 720.00
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Feb 19 - 19 Feb 19
License: CAW201214
Comments: Hole is part of the scheme to monitor and develop a robust minitoring network for the planned future...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 26.0	DR5	DR	500		EASTERNWELL	MRC1
26.0 - 170.0	DR5	DR	450		EASTERNWELL	MRC1
170.0 - 185.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 720.60 - (drilled) SWL: 90.99 MBTOC (19 Feb 19) Dev: N Final pH: -
TOC RL: 720.60 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	TD2	K	S			CLAY, (TD2), Grey and Red, Moderately Weathered, Very Weak Rock. Dark to redish yellow clays with dark sub-rounded, moderately weathered and poorly sorted shale.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-108.00)
110			S	GZ			GRAVEL, (SHALE), Dark or Black and Grey and brown, Extremely Weathered, Very Soft, Poorly graded, Angular. Shale goethitic material with some detrital material and traces of hematite.					GRAVEL MED (2.00-92.00)
120			D4	S			DOLOMITE, (OB), Grey and Blue, Moderately Weathered, Medium Strong Rock. Dolomitic shale with traces of calcrete. Grey to redish and offwhite, moderately well weathred and sub-rounded cuttings					CEMENT (92.00-104.00)
130												GRAVEL MED (104.00-182.00)
140	BG	OB	D	S			DOLOMITE, (OB), Grey and Blue and light or white, Slightly Weathered, Strong Rock. Dolomite and shale with traces of quartz. Grey to blue and off white. Hard slow penetration. Slightly weathered, poorly sorted and angular gravel.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 1mm (108.00-180.00)
150			DC	S			DOLOMITE, (OB), Blue and Yellow and light or white, Moderately Weathered, Strong Rock. Cherty blue to grey dolomite with yellow to offwhite shale. Moderately well sorted and moderately weathered angular cuttings. Fractured ground with increasing yields up to 20L/s.					
160			D	S								
170			4D	S			DOLOMITE, (OB), Grey and Yellow, Moderately Weathered, Strong Rock. Shaly dolomite, grey blue to offwhite, moderately sorted with some weathering and very hard. fractured zone.					
180							DOLOMITE, (OB), Grey and Yellow and red, Moderately Weathered, Strong Rock. Shaly dolomite, leached bluish grey to red and yellow cuttings, Hard, moderately weathered angular cuttings. Fractured rock between 174-176m, high yields 80+L/s. Slow penetration rate.					END CAP (180.00)
190												FALLBACK (182.00-185.00)
200												
						0 100 200		0-5000		0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5463	Hole Length:	200.00

Easting: 691203.02
Northing: 7453750.10
Surface RL: 705.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 23 Mar 19 - 05 Apr 19
License: CAW202447
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	KS6
44.0 - 122.0	DR5	DR	450		EASTERNWELL	KS6
122.0 - 200.0	DR5	CH	450		EASTERNWELL	KS6

TOC RL: 706.04 - (drilled) SWL: 76.49 MBTOC (06 Apr 19) Dev: N Final pH: -
TOC RL: 706.04 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	SZ	ZX	IK			QUATERNARY DETRITAL, (SZ), Red and Brown, Moderately Weathered, Strong Rock. Red/ brown, surface scree, sub-angular, detritials and maghemite.					CEMENT (0.00-2.00) BLANK STEEL: Size 12" - W.T.9.53mm (0.00-98.00) GRAVEL MED (2.00-77.00)
10												
20		TD3	ZI	XK			QUATERNARY DETRITAL, (TD3), Red and Brown, Moderately Weathered, Strong Rock. Red/brown, detritials and pisolites, sub-rounded.					
30												
40												
50			X3	IK			CALCRETE, (TD2), Dark or Black and Yellow and brown, Extremely Weathered, Strong Rock. Dark/yellow/brown, major calcrete and maghemite with minor pisolites and clays, sub-angular.					
60		TD2	3K	X			CALCRETE, (TD2), Yellow and Light or White, Extremely Weathered, Strong Rock. Yellow/light, sub-angular, major clays and calcrete with minor maghemite.					
70			H	KG			BRECCIA, (TD2), Dark or Black and Yellow, Moderately Weathered, Strong Rock. Dark/ yellow, major hematite with minor clays and geothite, sub rounded, vuggy breccia.					
80			HG	K			BRECCIA, (TD2), Yellow and Dark or Black, Moderately Weathered, Strong Rock. Yellow/dark, major hematite and geothite with minor clays, sub-angular, fracture at 72 metres.					CEMENT (77.00-85.00)
90		WA2	D	HGK			DOLOMITE, (WA2), Grey and Yellow and dark or black, Slightly Weathered, Strong Rock. Grey/yellow/dark, sub-angular, major dolomite with minor clays, geothite and hematite, FWS @ ~90 metres, yields at 98m of 5 l/s, at 104m of 9.4 l/s.					GRAVEL MED (85.00-200.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)
100					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5463 **Hole Length:** 200.00

Easting: 691203.02
Northing: 7453750.10
Surface RL: 705.50
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 23 Mar 19 - 05 Apr 19 **License:** CAW202447
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	KS6
44.0 - 122.0	DR5	DR	450		EASTERNWELL	KS6
122.0 - 200.0	DR5	CH	450		EASTERNWELL	KS6

TOC RL: 706.04 - (drilled) SWL: 76.49 MBTOC (06 Apr 19) Dev: N Final pH: -
TOC RL: 706.04 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	MG	WA2	D	HGK			DOLOMITE, (WA2), Grey and Yellow and dark or black, Slightly Weathered, Strong Rock. Grey/yellow/dark, sub-angular, major dolomite with minor clays, geothite and hematite, FWS @ ~90 metres, yields at 98m of 5 l/s, at 104m of 9.4 l/s.					GRAVEL MED (85.00-200.00)
			D	GC								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)
110			D	H								
		WA1					DOLOMITE, (WA1), Grey and Yellow, Slightly Weathered, Strong Rock. Grey/yellow, major dolomite with minor geothite and clays, sub-angular.					
120							DOLOMITE, (WA1), Grey and Yellow, Moderately Weathered, Strong Rock. Grey/yellow, major dolomite with minor BIF and trace chert. Fractures at 109m, at 115m, soft ground from 110 to 118m, yield at 110m of 12.5 l/s, at 116m of 15 l/s, at 122m of 15 l/s, at 130m of 15 l/s.					
130			D	S								
140							DOLOMITE, (WA1), Brown and Grey, Moderately Weathered, Strong Rock. Brown/grey, moderately weathered dolomite with minor shale and chert. Fracture at 133m, yields at 130m of 15 l/s, at 136m of 12 l/s, at 142m of 11 l/s.					
			D	S								
150							DOLOMITE, (WA1), Grey and Dark or Black, Fresh, Strong Rock. Grey/dark, major dolomite with minor shale and chert, yield at 146m of 11 l/s, at 152m of 13 l/s, fractures at 151m					
160			DJ	SC			DOLOMITE, (N3), Grey and Light or White and green, Fresh, Strong Rock. Grey/light/green, sub-angular moderately sorted chips, major fresh dolomite and magnetic BIF with minor shale and chert with trace of quartz, yields at 158m of 15 l/s, at 164 of 18 l/s, at 170-186m ~20 l/s. Fractures at 156m, 160m, 167-169m, 173m, 187m.					
170		N3										
180												
190		N2	DJ	SC			DOLOMITE, (N2), Grey and Light or White and dark or black, Fresh, Strong Rock. Grey/light/black, moderately sorted sub angular chips, major fresh dolomite and magnetic BIF with minor shale and chert, yields 188-200 of ~25 l/s, hard ground from 194 to EOH.					
200												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5464	Hole Length:	200.00

Easting: 691230.43
Northing: 7453127.82
Surface RL: 721.13
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Mar 19 - 13 Mar 19
License: CAW202446
Comments: V-notch was compromised early during drilling, yield values are most likely higher.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	MRC1
44.0 - 200.0	DR5	DR	450		EASTERNWELL	KS6

TOC RL: 721.67 - (drilled) SWL: 91.80 MBTOC (15 Mar 19) Dev: N Final pH: 8.4
TOC RL: 721.67 - (current) Is Live: Y (-) Date: 10 Mar 2019 Final EC: 562.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	YH	XG			GRAVEL, sandy, (QUATERNARY DETRITAL), Brown and Red, Transported, Non-Cohesive soils, Gap graded, Angular. Brown/ red surface scree. Angular gravel sized chips. Maghemite, hematite and silty soil present.					CEMENT (0.00-2.00)
10		TD3	HI	YG			GRAVEL, sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Sub-rounded. Red/Brown. Loose formation, Angular Detritals. Hematite, maghemite, some pisolites with silty soil.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-98.00)
20			J	H			GRAVEL, sandy, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Angular. Red/ brown. Anuglar chips 2-4cm. Minor pisolites, clay and silty soils. Maghemite and hematite.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-98.00)
30												GRAVEL MED (2.00-200.00)
40							SAND AND GRAVEL, (QUATERNARY DETRITAL), Red and Dark or Black, Transported, Non-Cohesive soils, Poorly graded, Sub-rounded. Red/Dark, sub round pisolites with some clasts of hematite.					
50			JK	H			CALCRETE, (TD2), Light or White and Red, Highly Weathered, Very Weak Rock. Light/red. Calcrete and clay with minor BIF and trace amounts of hematite and geothite. Sub angular heavily weathered chips.					
60		TD2	3K	J			BRECCIA, (TD2), Brown and Yellow, Moderately Weathered, Strong Rock. Brown/yellow. Sub-angular moderatley weathered hematite with clasts of calcrete with some minor BIF and clays. Fracture at 76 metres.					
70			H	J3K			UNMINERALISED BIF, (TD2), Red and Yellow and brown, Moderately Weathered, Strong Rock. Red/yellow/brown. Sub angular moderately weathered hematite with minor clay and BIF. Fracture at 76m.					
80			H	KJ			UNMINERALISED BIF, (TD2), Brown and Dark or Black, Slightly Weathered, Strong Rock. Brown/dark. Sub-angular moderately weathered BIF with minor clays and hematite.					CEMENT (82.00-90.00)
90			J	HK								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)
100			JH	K								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5464	Hole Length:	200.00

Easting: 691230.43
Northing: 7453127.82
Surface RL: 721.13
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Mar 19 - 13 Mar 19
License: CAW202446
Comments: V-notch was compromised early during drilling, yield values are most likely higher.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	MRC1
44.0 - 200.0	DR5	DR	450		EASTERNWELL	KS6

TOC RL: 721.67 - (drilled) SWL: 91.80 MBTOC (15 Mar 19) Dev: N Final pH: 8.4
TOC RL: 721.67 - (current) Is Live: Y (-) Date: 10 Mar 2019 Final EC: 562.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	YH	XG								CEMENT (0.00-2.00)
10			HI	YG								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-98.00)
20		TD3	J	H								BLANK STEEL: Size 12" - W.T.9.53mm (0.00-98.00)
30												GRAVEL MED (2.00-200.00)
40												
50			JK	H								
60		TD2	3K	J								
70			H	J3K								
80			H	KJ								
90			J	HK			UNMINERALISED BIF, (TD2), Dark or Black and Brown and yellow, Slightly Weathered, Strong Rock. Dark/brown/ yellow. Angular slightly weathered BIF and hematite with minor clay. FWS at 90-92 metres. Fracture zone from 96-98 metres. low yields 1-2 l/s.					CEMENT (82.00-90.00)
100			JH	K								S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)
						0 100 200		0-5000	0-14	0-50		S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5464	Hole Length:	200.00

Easting:	691230.43
Northing:	7453127.82
Surface RL:	721.13
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	04 Mar 19 - 13 Mar 19

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	MRC1
44.0 - 200.0	DR5	DR	450		EASTERNWELL	KS6

License: CAW202446

Comments: V-notch was compromised early during drilling, yield values are most likely higher.

TOC RL:	721.67	-	(drilled)	SWL:	91.80 MBTOC	(15 Mar 19)	Dev:	N	Final pH: 8.4
TOC RL:	721.67	-	(current)	Is Live:	Y	(-)	Date:	10 Mar 2019	Final EC: 562.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100		TD2	JH	K			UNMINERALISED BIF, (TD2), Dark or Black and Brown and yellow, Slightly Weathered, Strong Rock. Dark/brown/ yellow. Angular slightly weathered BIF and hematite with minor clay. FWS at 90-92 metres. Fracture zone from 96-98 metres. low yields 1-2 l/s.					GRAVEL MED (2.00-200.00)
110			HJ	DK								
120		OB	D	CQH			UNMINERALISED BIF, (TD2), Brown and Yellow and grey, Slightly Weathered, Strong Rock. Brown/yellow/grey. Sub-angular slightly weathered hematite and BIf with minor dolomite and clays. Some leeching observed. Broken ground 108-110m (cobble size chips), with corresponding increase in yield. Yield at 110 of 9 l/sec.					
130			D									
140			D				DOLOMITE, (OB), Grey and Light or White and red, Fresh, Strong Rock. Grey/light/red. Sub-round to sub angular Fresh dolomite with some minor chertz and quartz, some hematite observed (possibly from fallback). Quite competent ground. Yield at 116m of 16.5 l/sec.					
150			D									
160							DOLOMITE, (OB), Brown and Yellow and grey, Moderately Weathered, Strong Rock. Brown/yellow/grey. Sub-angular moderately weather dolomite. Some leeching observed. Fracture zone from 126-128m. Yield at 122m 10 l/secs, at 128m 29 l/sec, at 134m 27 l/ sec, at 140m 30 l/s.					
170							DOLOMITE, (OB), Grey and Light or White, Fresh, Strong Rock. Grey/light. Sub-angular fresh dolomite. Yield at 146m 28 l/sec, at 152m 31 l/sec.					
180		N3	D				DOLOMITE, (OB), Brown and Yellow and grey, Moderately Weathered, Strong Rock. Brown/yellow/grey. Sub-rounded moderately weather dolomite with traces of chert and quartz. Fracture at 166m. Yield at 158m 30 l/sec, at 164m 28 l/sec, at 170m 43 l/ secs, at 176m 30-35 l/sec. Due to comprised v-notch and water coming back up the DR casing, yield data is most likely higher.					CEMENT (82.00-90.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (98.00-200.00) END CAP (200.00) END CAP (200.00)
190												
200												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

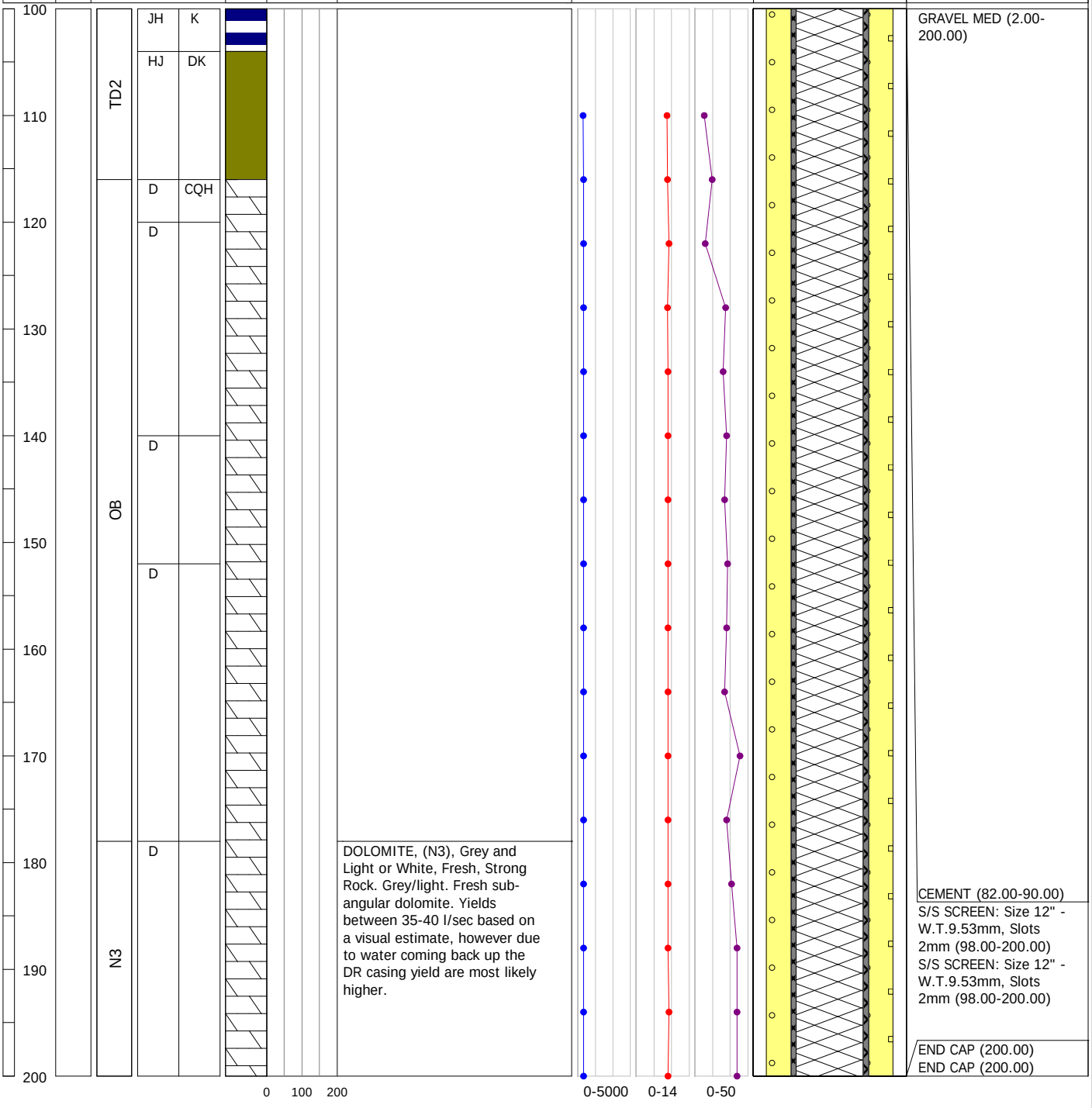
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5464	Hole Length:	200.00

Easting: 691230.43
Northing: 7453127.82
Surface RL: 721.13
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 04 Mar 19 - 13 Mar 19
License: CAW202446
Comments: V-notch was compromised early during drilling, yield values are most likely higher.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 44.0	DR5	DR	500		EASTERNWELL	MRC1
44.0 - 200.0	DR5	DR	450		EASTERNWELL	KS6

TOC RL: 721.67 - (drilled) SWL: 91.80 MBTOC (15 Mar 19) Dev: N Final pH: 8.4
TOC RL: 721.67 - (current) Is Live: Y (-) Date: 10 Mar 2019 Final EC: 562.00



BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5465 **Hole Length:** 212.00

Easting: 692732.44
Northing: 7453280.73
Surface RL: 728.79
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 19 - 16 Jun 19
License: CAW202447
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 140.0	DR5	DR	500		EASTERNWELL	KS6
140.0 - 212.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 729.44 - (drilled) SWL: 99.99 MBTOC (17 Jun 19) Dev: N Final pH: -
TOC RL: 729.44 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	SZ	XHZ	JK			QUATERNARY DETRITAL, (SZ), Red and Brown, Moderately Weathered, Strong Rock. Surface scree, silty mixture of hematite, BIF and clays. Moderately well weathered, angular and poorly sorted grains					CEMENT: Surface seal (0.00-3.00)
10		TD3	ZHX	JC			QUATERNARY DETRITAL, (TD3), Red and Brown and yellow, Moderately Weathered, Strong Rock. Silty detritals, redish brown. Hematite and maghemite with minor BIF and chert, some fines. moderately well weathered, sub-angular to sub-rounded poorly sorted gravel.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-102.00)
20												GRAVEL MED (2.00-84.00)
30			HJ	K			QUATERNARY DETRITAL, (TD3), Red and Brown and dark or black, Slightly Weathered, Strong Rock. Hematite and BIF, dark to redish brown, very hard with some weathering. Consistently larger modertely well sorted cuttings.					
40												
50							QUATERNARY DETRITAL, (TD3), Red and Dark or Black, Moderately Weathered, Strong Rock. Pisolites with hematite in fine clay matrix.					
60			I	H			QUATERNARY DETRITAL, (TD3), Yellow and Brown, Moderately Weathered, Strong Rock. Pisolite rich with clay and traces of goethite. Well weathered, moderatelt sorted and hard fine gravel.					
70			I	K			QUATERNARY DETRITAL, (TD3), Brown and Red and dark or black, Highly Weathered, Strong Rock. BIF with hematite and clays with trces of goethite. Poorly sorted and well weathered gravels.					
80			J	HK			QUATERNARY DETRITAL, (TD2), Brown and Yellow and grey, Extremely Weathered, Medium Strong Rock. Clay and calcrete, extremely weathered and relatively soft. Some traces of leaching.					CEMENT: Cement & bentonite seal (84.00-92.00)
90		TD2	3K	H			BRECCIA, (TD2), Red and Brown, Extremely Weathered, Medium Strong Rock. Vuggy Breccia redish brown with sub-rounded goethite. Well sorted, hard and fine gravel.					GRAVEL MED (92.00-212.00)
100			KG	H								
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** HSF5465 **Hole Length:** 212.00

Easting: 692732.44
Northing: 7453280.73
Surface RL: 728.79
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 19 - 16 Jun 19
License: CAW202447
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 140.0	DR5	DR	500		EASTERNWELL	KS6
140.0 - 212.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 729.44 - (drilled) SWL: 99.99 MBTOC (17 Jun 19) Dev: N Final pH: -
TOC RL: 729.44 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	UG	TD2	KG	H			BRECCIA, (TD2), Red and Brown, Extremely Weathered, Medium Strong Rock. Vuggy Breccia redish brown with sub-rounded goethite. Well sorted, hard and fine gravel.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-102.00)
110			H	GK			BRECCIA, (TD2), Dark or Black and Red and brown, Moderately Weathered, Strong Rock.					GRAVEL MED (2.00-84.00)
120												
130		OB	D	KQ			DOLOMITE, (OB), Grey and Blue and brown, Moderately Weathered, Strong Rock. Fractured dolomite, light grey to bluish, very hard and mineralised. Weathered sub-rounded gravel. Fracture between 127-128m					
140	MG		D	Q			DOLOMITE, (OB), Grey and Blue and light or white, Fresh, Strong Rock. Fresh dolomite, bluish with white quartz veining. Major fractured zones noted at 175m, 185m, 192m and 206m					CEMENT: Cement & bentonite seal (84.00-92.00)
150												GRAVEL MED (92.00-212.00)
160												
170												
180												S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (102.00-210.00)
190												
200						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

Project: SOUTH FLANK **Hole Name:** HSF5465 **Hole Length:** 212.00

Easting: 692732.44
Northing: 7453280.73
Surface RL: 728.79
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 03 Jun 19 - 16 Jun 19
License: CAW202447
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 140.0	DR5	DR	500		EASTERNWELL	KS6
140.0 - 212.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 729.44 - (drilled) SWL: 99.99 MBTOC (17 Jun 19) Dev: N Final pH: -
TOC RL: 729.44 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200	MG	OB	D	Q			DOLOMITE, (OB), Grey and Blue and light or white, Fresh, Strong Rock. Fresh dolomite, bluish with white quartz veining. Major fractured zones noted at 175m, 185m, 192m and 206m					GRAVEL MED (92.00-212.00) S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (102.00-210.00) END CAP (210.00)
210												
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5466	Hole Length:	200.00

Easting: 693744.96
Northing: 7453505.53
Surface RL: 727.77
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 14 May 19 - 23 May 19
License: CAW201214
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 200.0	DR5	DR	500		EASTERNWELL	MRC1

TOC RL: 728.39 - (drilled) SWL: 99.88 MBTOC (23 May 19) Dev: N Final pH: 8.7
TOC RL: 728.39 - (current) Is Live: Y (-) Date: 19 May 2019 Final EC: 586.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0		SZ	ZJ	C			COBBLE, gravelly, (QUATERNARY DETRITAL), Red and Brown and grey, Transported, Non-Cohesive soils, Well graded, Sub-angular.					CEMENT: (0.00-2.00) BLANK STEEL: Size 12" - W.T.9.53mm (0.00-128.00) GRAVEL MED: (2.00-108.00)
10		TD3	ZJ	C			COBBLE, gravelly, (QUATERNARY DETRITAL), Red and Brown and grey, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Broken ground 10-14m					
20	BG		ZCJ	GH			COBBLE, gravelly, (QUATERNARY DETRITAL), , Transported, Non-Cohesive soils, Gap graded, Sub-angular. Mineralsisation/magnetic					
30			ZJ	CH			GRAVEL, trace cobble and silt, (QUATERNARY DETRITAL), , Transported, Non-Cohesive soils, Gap graded, Sub-rounded. Broken ground 40-44m.					
40												
50			Z3G	IC			GRAVEL, trace cobble, (QUATERNARY DETRITAL), , Transported, Soft, Well graded, Sub-rounded. Broken ground 48-50m.					
60												
70		TD2	3K	J			CALCRETE, (TD2), Light or White and Yellow, Moderately Weathered, Weak Rock. Orange/yellow sample piles with hard, chunky green/yellow calcrete.					
80			JL	3			QUATERNARY DETRITAL, (TD2), Yellow and Grey, Moderately Weathered, Weak Rock. Yellow, silty limonitic sample piles with weathered vuggy BIF. Some haematite staining on surfaces. Fracture zones 106-110. FWS 110m ~2.6 L/s followig fracture zone. Fracture zone 116-118 red/ purple vuggy BIF, then returning back to yellow limonite rich piles.					
90												
100												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5466	Hole Length:	200.00

Easting:	693744.96
Northing:	7453505.53
Surface RL:	727.77
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	14 May 19 - 23 May 19

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 200.0	DR5	DR	500		EASTERNWELL	MRC1

License: CAW201214

Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

TOC RL:	728.39	-	(drilled)	SWL:	99.88 MBTOC	(23 May 19)	Dev:	N	Final pH: 8.7
TOC RL:	728.39	-	(current)	Is Live:	Y	(-)	Date:	19 May 2019	Final EC: 586.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	BG	TD2	JL	3			QUATERNARY DETRITAL, (TD2), Yellow and Grey, Moderately Weathered, Weak Rock. Yellow, silty limonitic sample piles with weathered vuggy BIF. Some haematite staining on surfaces. Fracture zones 106-110. FWS 110m ~2.6 L/s followig fracture zone. Fracture zone 116-118 red/ purple vuggy BIF, then returning back to yellow limonite rich piles.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-128.00) GRAVEL MED: (2.00-108.00)
110												BENTONITE: (108.00-121.00)
120		OB	CJ	K			DOLOMITE, (OB), Red and Grey, Moderately Weathered, Medium Strong Rock. Transition to OB. Piles less silty and more purple/gray.					GRAVEL MED: (121.00-200.00)
130			C	DJ			DOLOMITE, (OB), Red and Yellow and grey, Moderately Weathered, Medium Strong Rock. Major chert band.					S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (128.00-200.00)
140			D	C			DOLOMITE, (OB), Yellow and Grey, Moderately Weathered, Medium Strong Rock.					
150			D	CH			DOLOMITE, (OB), Brown and Yellow and grey, Moderately Weathered, Medium Strong Rock. Fracture zone, chunky weathered dolomite. Fracture zone 161m, yeild 23 L/s.					
160			D	C			DOLOMITE, (OB), Yellow and Grey, Moderately Weathered, Medium Strong Rock.					
170			QCD	S			DOLOMITE, (OB), Yellow and Grey, Moderately Weathered, Medium Strong Rock. Fracture zone, yield increase to ~30L/s. Becomming very cherty with white quartz.					
180			CDJ	S			DOLOMITE, (OB), Yellow and Grey and light or white, Moderately Weathered, Medium Strong Rock. Extremely weathered, very vuggy. Increasing chert content, highly fractured.					
190												
200												
						0 100 200		0-5000		0-14 0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5467	Hole Length:	200.00

Easting: 696625.72
Northing: 7453596.85
Surface RL: 717.86
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Apr 19 - 30 Apr 19
License: CAW201214
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 68.0	DR5	DR	500		EASTERNWELL	MRC1
68.0 - 200.0	DR5	DR	450		EASTERNWELL	MRC1

TOC RL: 718.53 - (drilled) SWL: 89.91 MBTOC (30 Apr 19) Dev: N Final pH: -
TOC RL: 718.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	UG	SZ	ZJ	Y			COBBLE AND GRAVEL, (QUATERNARY DETRITAL), Brown and Red, Transported, Non-Cohesive soils, Poorly graded, Angular. 0-12m Unconsolidated loose ground, slow ROP, transported detrital, non-cohesive soils, surface scree, BIF, silt and chert.					CEMENT (0.00-2.00)
10		TD3	Z	JY			GRAVEL, (QUATERNARY DETRITAL), Brown and Dark or Black and red, Transported, Non-Cohesive soils, Gap graded, Sub-angular. 12-38m Transported detritals non-cohesive soils, unconsolidated ground, surface scree, slow drilling, surface scree, BIF, silt, goethite, chert. Fracture 24-26m and fault/fracture 30-38m					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-146.00)
20												GRAVEL MED (2.00-132.00)
30												
40			ZK	J			GRAVEL AND SAND, (QUATERNARY DETRITAL), Red and Brown and dark or black, Transported, Non-Cohesive soils, Gap graded, Sub-angular. Transported detritals, red/brown/dark sub-angular chips, mainlly detritals and clays withF and trace amounts of chert.					
50	MG		ZK	J3			QUATERNARY DETRITAL, (TD3), Red and Brown, Extremely Weathered, Strong Rock. Red/borwn sub-rounded chips, mainly detritals and clays with minor BIF and calcrete with trace amounts of chert.					
60												
70		TD2	3	KZ			CALCRETE, (TD2), Light or White, Moderately Weathered, Strong Rock. White sub-angular chips, mainly calcrete with minor clay and detritals with trace amounts of chert. Slow drilling penetration.					
80			HK	3			BRECCIA, (TD2), Yellow and Dark or Black, Slightly Weathered, Strong Rock. Yellow/brown sub-angular poorly sorted chips, mainly hematite (vuggy breccia) with clays and some minor calcrete. FWS at ~94m, yield of <1 l/sec at 98m.					
90							BRECCIA, (TD2), Dark or Black and Yellow, Slightly Weathered, Strong Rock. Dark/yellow sub-angular chips, mainly hematite with minor geothite and clays. yield of 6.5 l/sec at 104m.					
100			H	GK								
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5467	Hole Length:	200.00

Easting: 696625.72
Northing: 7453596.85
Surface RL: 717.86
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Apr 19 - 30 Apr 19
License: CAW201214
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 68.0	DR5	DR	500		EASTERNWELL	MRC1
68.0 - 200.0	DR5	DR	450		EASTERNWELL	MRC1

TOC RL: 718.53 - (drilled) SWL: 89.91 MBTOC (30 Apr 19) Dev: N Final pH: -
TOC RL: 718.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	Notes
100	MG	TD2	H	GK		BRECCIA, (TD2), Dark or Black and Yellow, Slightly Weathered, Strong Rock. Dark/yellow sub-angular chips, mainly hematite with minor geothite and clays. yield of 6.5 l/sec at 104m.	BLANK STEEL: Size 12" - W.T.9.53mm (0.00-146.00)
110			HK	G6		BRECCIA, (TD2), Yellow and Dark or Black and brown, Moderately Weathered, Strong Rock. Yellow/dark/brown sub-angular chips, mainly hematite and clays with minor geothite and lignite. Yields of 4 l/sec at 110m, 7 l/sec at 116m, 10 l/sec at 122m, 31 l/sec at 128m. Whilst there was a dramatic increase in yield from 122m to 128m no significant broken ground was observed.	GRAVEL MED (2.00-132.00)
120							
130			K	GH6		CLAY, gravelly, (BRECCIA), Pink and Dark or Black and brown, Extremely Weathered, Soft, Gap graded, Sub-angular. Pink/yellow/brown sub-angular to sub-round chips, mainly clay with minor geothite, hematite and lignite. Yield at 134m of 33 l/sec	CEMENT (132.00-139.50)
			K	G			
140			K	6S			GRAVEL MED (139.50-200.00)
150	UG		HS	G		CLAY, gravelly and sandy, (CLAY), Dark or Black and Yellow, Extremely Weathered, Very Soft, Gap graded, Sub-rounded. Dark/yellow sub-angular to sub round chips, Mostly clay with minor geothite and trace amounts of lignite. Yield at 140m of 33 l/sec	S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (146.00-200.00)
160		OB				BRECCIA, (TD2), Dark or Black and Brown, Extremely Weathered, Strong Rock. Grey clays and fine shale with layers of black to light grey lignite. Lignite is brittle and wood like some possibly leached or extremely weathered.	
170			SH	KG			
180						BRECCIA, (OB), Red and Yellow, Extremely Weathered, Strong Rock. Redish brown hematite and shale with goethite and traces of quartz, well weathered, sub-rounded cuttings. Broken ground at 156m.	
190	MG		D4	SC		SHALE, (OB), Red and Brown and grey, Extremely Weathered, Strong Rock. Redish to brown shale and hematite with some yellowish clays and goethite. Well weathered, sub-rounded, hard.	
200							

Gamma CPS API: 0 100 200
EC us/cm: 0-5000
pH: 0-14
Yield L/s: 0-50
Diagram Scaled to 600mm

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5467	Hole Length:	200.00

Easting: 696625.72
Northing: 7453596.85
Surface RL: 717.86
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 21 Apr 19 - 30 Apr 19
License: CAW201214
Comments: Production/injection bore to assess hydraulic properties of the aquafer and enable long term injecti...

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 68.0	DR5	DR	500		EASTERNWELL	MRC1
68.0 - 200.0	DR5	DR	450		EASTERNWELL	MRC1

TOC RL: 718.53 - (drilled) SWL: 89.91 MBTOC (30 Apr 19) Dev: N Final pH: -
TOC RL: 718.53 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor
100	MG	TD2	H	GK
110			HK	G6
120				
130			K	GH6
			K	G
140			K	6S
150		OB	HS	G
160	UG			
170			SH	KG
180				
190	MG		D4	SC
200				

Log: Gamma CPS API (0 100 200)

Hydrogeological Description:

DOLOMITE, (OB), Red and Grey and dark or black, Highly Weathered, Strong Rock. Dark dolomitic shale and grey dolomite with quartz vaining, chert dark to yellowish with dark hard dolomite and traces of quartz and pyrite

EC us/cm (0-5000) pH (0-14) Yield L/s (0-50)

Diagram Scaled to 600mm

Notes:

- BLANK STEEL: Size 12" - W.T.9.53mm (0.00-146.00)
- GRAVEL MED (2.00-132.00)
- CEMENT (132.00-139.50)
- GRAVEL MED (139.50-200.00)
- S/S SCREEN: Size 12" - W.T.9.53mm, Slots 2mm (146.00-200.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5469	Hole Length:	202.00

Easting: 691458.66
Northing: 7453438.18
Surface RL: 713.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Sep 19 - 24 Sep 19
License: CAW202447
Comments: Spare capacity injection bore for the South Flank MAR.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	DR5	DR	500		EASTERNWELL	MRC1
86.0 - 188.0	DR5	DR	450		EASTERNWELL	MRC1
188.0 - 202.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL:	714.33	-	(drilled)	SWL:	84.83 MBTOC	(24 Sep 19)	Dev:	N	Final pH: 7.8
TOC RL:	714.33	-	(current)	Is Live:	Y	(-)	Date:	17 Sep 2019	Final EC: 582.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	BG	SZ	Z				COBBLE, gravelly, (QUATERNARY DETRITAL), Red and Brown, Transported, Non-Cohesive soils, Gap graded, Angular. Surface scree redish brown, transported and poorly sorted cobble to gravel					CEMENT: Surface seal (0.00-2.00)
10		TD3	JX	H			COBBLE, gravelly, (QUATERNARY DETRITAL), Red and Grey, Extremely Weathered, Non-Cohesive soils, Gap graded, Sub-rounded. Detrital. BIF, hematite, maghemite and goethite, well weathered and poorly sorted cobble to gravels.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-110.00)
20			JX	HG			GRAVEL, cobbled, (QUATERNARY DETRITAL), Brown and Red and grey, Extremely Weathered, Non-Cohesive soils, Gap graded, Sub-angular. Detrital as above, more gravel and less cobble some pisolites, well weathered.					GRAVEL MED (2.00-72.00)
30			JH	XG			QUATERNARY DETRITAL, (TD3), Red and Grey, Highly Weathered, Strong Rock. Detrital. BIF and hematite with less maghemite and goethite trace silty. Highly weathered gravels to cobble.					
40			YK	J			CLAY, trace gravel, (CLAY), Red, Extremely Weathered, Stiff, Poorly graded, Sub-rounded. Detrital. Silty clays extremely weathered soft sample, some BIF gravel subrounded.					
50			3	K			CLAY, gravelly, (CALCRETE), Light or White and Yellow, Extremely Weathered, Stiff, Poorly graded, Angular. Calcrete off white to yellow and extremely weathered angular cuttings. Ground more competent and stable.					
60		TD2										
70	MG											
80												CEMENT: Seal (72.00-86.00)
90	BG		K	H			CLAY, trace gravel, (CLAY), Green and Red, Extremely Weathered, Firm, Poorly graded, Sub-angular. Greenish sticky clays with hard hematite and traces of cacrete from above. Extremely weathered sample, first yields of approximately 5 L/s.					GRAVEL MED (86.00-202.00)
100			HJ	K								
					0 100 200			0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

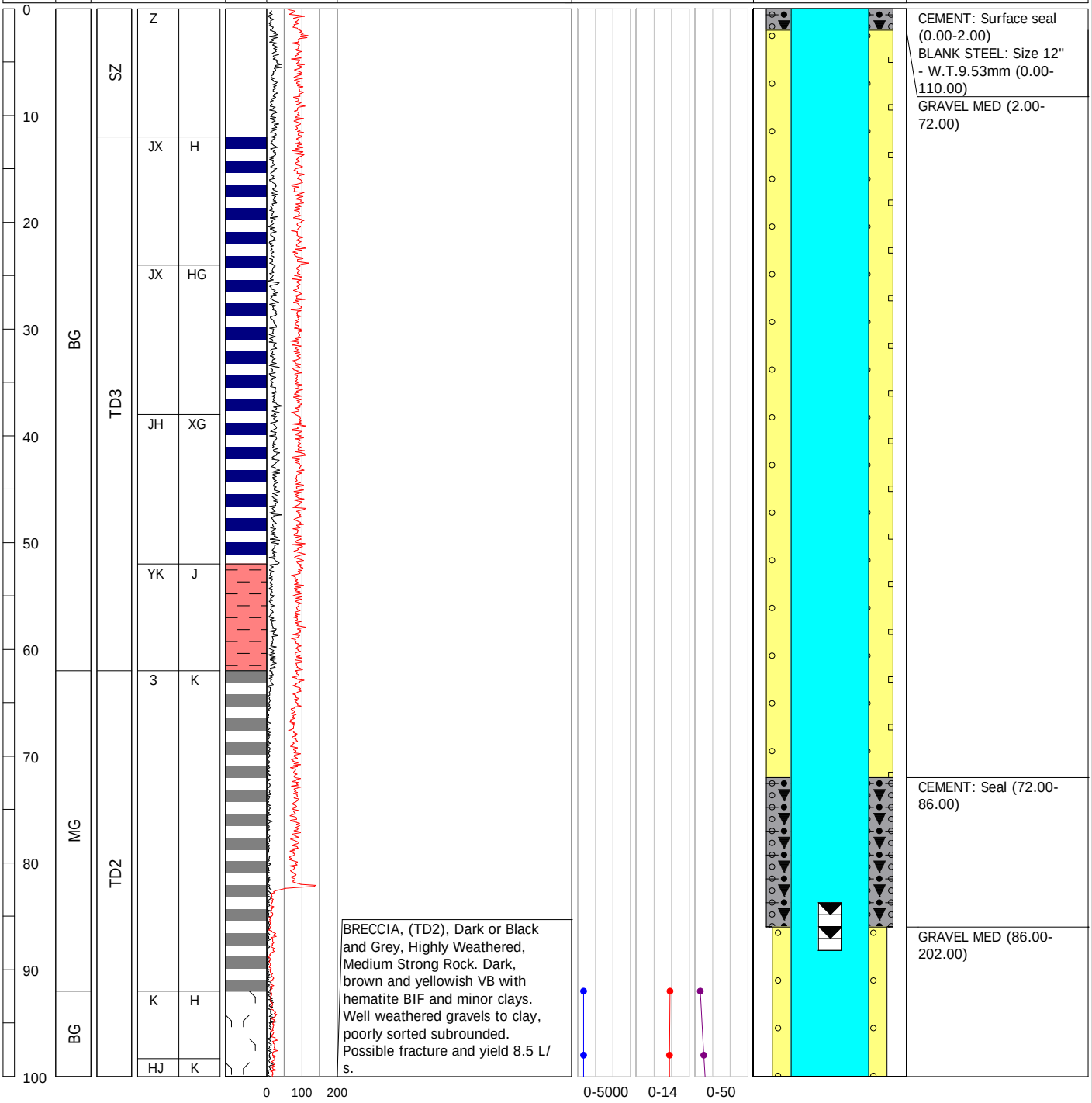
BHP

Project:	SOUTH FLANK	Hole Name:	HSF5469	Hole Length:	202.00

Easting: 691458.66
Northing: 7453438.18
Surface RL: 713.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Sep 19 - 24 Sep 19
License: CAW202447
Comments: Spare capacity injection bore for the South Flank MAR.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	DR5	DR	500		EASTERNWELL	MRC1
86.0 - 188.0	DR5	DR	450		EASTERNWELL	MRC1
188.0 - 202.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL:	714.33	-	(drilled)	SWL:	84.83 MBTOC	(24 Sep 19)	Dev:	N	Final pH: 7.8
TOC RL:	714.33	-	(current)	Is Live:	Y	(-)	Date:	17 Sep 2019	Final EC: 582.00



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5469	Hole Length:	202.00

Easting: 691458.66
Northing: 7453438.18
Surface RL: 713.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Sep 19 - 24 Sep 19
License: CAW202447
Comments: Spare capacity injection bore for the South Flank MAR.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	DR5	DR	500		EASTERNWELL	MRC1
86.0 - 188.0	DR5	DR	450		EASTERNWELL	MRC1
188.0 - 202.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL:	714.33	-	(drilled)	SWL:	84.83 MBTOC	(24 Sep 19)	Dev:	N	Final pH:	7.8
TOC RL:	714.33	-	(current)	Is Live:	Y	(-)	Date:	17 Sep 2019	Final EC:	582.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
100	BG	TD2	HJ	K			BRECCIA, (TD2), Dark or Black and Grey, Highly Weathered, Medium Strong Rock. Dark, brown and yellowish VB with hematite BIF and minor clays. Well weathered gravels to clay, poorly sorted subrounded. Possible fracture and yield 8.5 L/s.					BLANK STEEL: Size 12" - W.T.9.53mm (0.00-110.00)
110			KH	GJ								GRAVEL MED (2.00-72.00)
120			GH	JS			BRECCIA, (TD2), Light or White and Grey and yellow, Highly Weathered, Weak Rock. More clay dominant that above. Dark VB with minor goethite and traces of shale. Relatively soft broken ground. Yields 12 L/s.					
130	MG		GHJ				BRECCIA, (TD2), Dark or Black and Red and yellow, Highly Weathered, Medium Strong Rock. Reduced clays and more goethite dominant with hematite and BIF, shales still present. Moderately hard and highly weathered subangular cuttings. Yields continue to increse 20 L/s.					
140			JGH				BRECCIA, (TD2), Red and Yellow and grey, Highly Weathered, Medium Strong Rock. Yellow to grey weathered VB with some clays. Weathered BIF and hematite, large fracture at 140m, yields 41 L/s.					
150			JHG				BRECCIA, (TD2), Green and Yellow, Highly Weathered, Medium Strong Rock. Goethitic BIF with a greenish fine clay film. Highly weathered, moderately hard and moderately sorted gravel. Fracture at 145m, Q=27L/s					
160												
170	MG						BRECCIA, (TD2), Grey and Brown, Highly Weathered, Medium Strong Rock. Harder material, slow penetration.					CEMENT: Seal (72.00-86.00)
180												GRAVEL MED (86.00-202.00)
190		VB2	JC	GHS			BRECCIA, (VB2), Dark or Black and Red and yellow, Moderately Weathered, Strong Rock. Goethitc BIF with CID characteristics, dark and very hard gravel to cobble. Moderately weathered with minor shale and hematite and traces of dolomite and quartz. Fracture 194-198m, Q=80L/s					SLOTTED STEEL: Size 12" - W.T.9.53mm, Slots 2mm (110.00-200.00)
200												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5469	Hole Length:	202.00

Easting: 691458.66
Northing: 7453438.18
Surface RL: 713.72
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 Sep 19 - 24 Sep 19
License: CAW202447
Comments: Spare capacity injection bore for the South Flank MAR.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 86.0	DR5	DR	500		EASTERNWELL	MRC1
86.0 - 188.0	DR5	DR	450		EASTERNWELL	MRC1
188.0 - 202.0	DR5	CH	450		EASTERNWELL	MRC1

TOC RL: 714.33 - (drilled) SWL: 84.83 MBTOC (24 Sep 19) Dev: N Final pH: 7.8
TOC RL: 714.33 - (current) Is Live: Y (-) Date: 17 Sep 2019 Final EC: 582.00

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
200	MG	VB2	JC	GHS			BRECCIA, (VB2), Dark or Black and Red and yellow, Moderately Weathered, Strong Rock. Goethitc BIF with CID characteristics, dark and very hard gravel to cobble. Moderately weathered with minor shale and hematite and traces of dolomite and quartz. Fracture 194-198m, Q=80L/s					GRAVEL MED (86.00-202.00)
210												
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK | Hole Name: HSF5496 | Hole Length: 200.00

Easting: 694502.09
Northing: 7453600.25
Surface RL: 723.85
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 May 20 - 21 May 20
Comments: Re-drill of HSF5468P.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 74.0	EWMWW04	DR	500		EASTERNWELL	MC9
74.0 - 200.0	EWMWW04	DR	450		EASTERNWELL	MC9

License: CAW202447

TOC RL: 724.34 - (drilled) SWL: 96.05 MBTOC (22 May 20) Dev: Y: 15.3 hour(s) Final pH: -
TOC RL: 724.34 - (current) Is Live: Y (-) Date: 16 May 2020 Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 600mm	Notes
0	MG	TD3	ZH	GC			GRAVEL, (QUATERNARY DETRITAL), Dark or Black and Red and brown, Transported, Non-Cohesive soils, Uniform, Sub-rounded. nothing unusual noted by driller					CEMENT (0.00-2.00) BLANK STEEL: 324mm (0.00-158.00) GRAVEL MED (2.00-110.00)
70		TD2	Z3				GRAVEL, (QUATERNARY DETRITAL), Light or White and Yellow, Transported, Non-Cohesive soils, Uniform, Sub-angular. chemical deposit					
			V				Large cavity, no sample return.					
80			ZL				CLAY, (QUATERNARY DETRITAL), Light or White and Yellow, Transported, Non-Cohesive soils, Uniform, Sub-rounded.					
			ZG				GRAVEL, (QUATERNARY DETRITAL), Brown and Red, Transported, Non-Cohesive soils, Uniform, Sub-rounded.					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

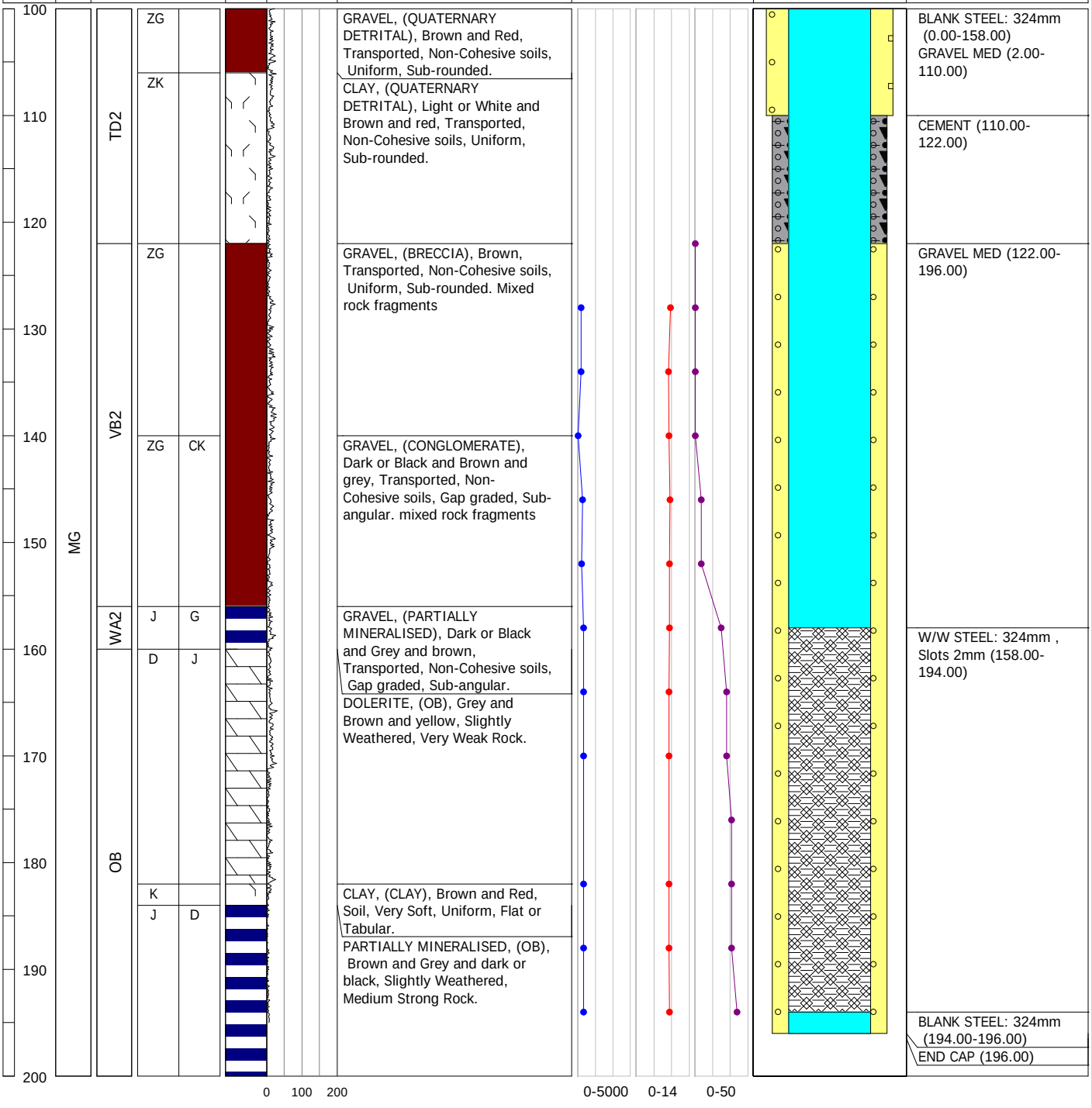
Project:	SOUTH FLANK	Hole Name:	HSF5496	Hole Length:	200.00

Easting: 694502.09
Northing: 7453600.25
Surface RL: 723.85
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 09 May 20 - 21 May 20
Comments: Re-drill of HSF5468P.

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 74.0	EWMWW04	DR	500		EASTERNWELL	MC9
74.0 - 200.0	EWMWW04	DR	450		EASTERNWELL	MC9

License: CAW202447

TOC RL: 724.34 - (drilled) SWL: 96.05 MBTOC (22 May 20) Dev: Y: 15.3 hour(s) Final pH: -
TOC RL: 724.34 - (current) Is Live: Y (-) Date: 16 May 2020 Final EC: -



Program: South Flank MAR HSF5468 Re Drill
Planned Hole: HSF5496

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5519	Hole Length:	230.00

Easting: 706747.16
Northing: 7455571.66
Surface RL: 765.38
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Mar 21 - 04 Mar 21
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	KS6
6.0 - 230.0	WLDRIG5	CH	200		WELLDRILL	KS6

TOC RL: 766.18 (Stickup 0.70m) (drilled) SWL: 125.24 MBTOC (07 Mar 21) Dev: N Final pH: -
TOC RL: 766.45 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0	MG	MM	S	GK			SHALE, (MM), Yellow and Brown, Moderately Weathered, Medium Strong Rock. Shale with minor geothite. Clay band at 28 to 30 metres. Sub-angular chips.					GROUT: Surface Seal (0.00-2.00) BLANK STEEL: Size 8" - W.T.8.18mm (0.00-6.00) BLANK PVC: Size 50 - Class 18 (0.00-134.00) GRAVEL MED: 13 tonnes (2.00-230.00)
60			SG	L			SHALE, (MM), Red and Grey and brown, Moderately Weathered, Strong Rock. Shale and geothite with minor limonite. Intermittment clay bands throughout sequence. Some martite bands as well.					
80		MU	J	SK			UNMINERALISED BIF, (MU), Grey, Slightly Weathered, Strong Rock. Partially magnetic slight weathered unmineralised BiF, with some minor shale and clay bands.					
100						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5519	Hole Length:	230.00

Easting: 706747.16
Northing: 7455571.66
Surface RL: 765.38
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Mar 21 - 04 Mar 21
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	KS6
6.0 - 230.0	WLDRIG5	CH	200		WELLDRILL	KS6

TOC RL: 766.18 (Stickup 0.70m) (drilled) SWL: 125.24 MBTOC (07 Mar 21) Dev: N Final pH: -
TOC RL: 766.45 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100	MG	MU	J	SK			UNMINERALISED BIF, (MU), Grey, Slightly Weathered, Strong Rock. Partially magnetic slight weathered unmineralised BiF, with some minor shale and clay bands.					BLANK PVC: Size 50 - Class 18 (0.00-134.00) GRAVEL MED: 13 tonnes (2.00-230.00)
110												
120												
130												
140												SLOTTED PVC: Size 50 - Class 18, Slots 1mm (134.00-229.00)
150												
160												
170							SHALE, (MU), Brown and Yellow, Slightly Weathered, Strong Rock. Shale with minor chert and some clay bands. Extremely broken ground. significant signs of leeching and water flow. Yield increase to 2 L/s at 180 and went up to 7 L/s by 200 metres. This broken ground is mostly associated with the Korev fault.					
180	BG		S	CK								
190							UNMINERALISED BIF, (MM), Grey and Dark or Black and brown, Slightly Weathered, Strong Rock. Partially magenite BIF with some minor shale bands. heavily broken ground. Signs of weathered due to water flow. Yields of ~10 L/s at 228 metres.					
200		MM	J	S								

0 100 200 | 0-5000 0-14 0-50

Program: Vista Oriental VA DEW Phase 1 Planned Hole: HSF5519 Page: 313

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	HSF5519	Hole Length:	230.00

Easting: 706747.16
Northing: 7455571.66
Surface RL: 765.38
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: 02 Mar 21 - 04 Mar 21
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 6.0	WLDRIG5	CH	300		WELLDRILL	KS6
6.0 - 230.0	WLDRIG5	CH	200		WELLDRILL	KS6

TOC RL: 766.18 (Stickup 0.70m) (drilled) SWL: 125.24 MBTOC (07 Mar 21) Dev: N Final pH: -
TOC RL: 766.45 - (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	U Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200	BG	MM	J	S			UNMINERALISED BIF, (MM), Grey and Dark or Black and brown, Slightly Weathered, Strong Rock. Partially magenite BIF with some minor shale bands. heavily broken ground. Signs of weathered due to water flow. Yields of ~10 L/s at 228 metres.					GRAVEL MED: 13 tonnes (2.00-230.00) SLOTTED PVC: Size 50 - Class 18, Slots 1mm (134.00-229.00)
210												
220												
230												END CAP (229.00)
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** SF3503R **Hole Length:** 271.00

Easting: 699610.86
Northing: 7454002.51
Surface RL: 691.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: lots of ground water at about 260-270m, canned hole due to sump overflow

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	GD20	RHF	140	AIR/WATER	BLY	HAM
150.0 - 271.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	IP1

TOC RL: 691.97 (Stickup 0.58m) (drilled) SWL: 64.43 mbtoc (22 Apr 19) Dev: N Final pH: -
TOC RL: 691.97 (Stickup 0.58m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description
0		ST3	ZXY	G		Quite silty pad
			ZYX	G		Typical td3
			ZYX	JC		Silt dominant
10			ZXY	CG		
			ZYX	G		Very magnetic rounded and angular chips
			ZXY	G		
20			ZY	XG		Silty fines
			ZY	X		
			ZY	X		Very small pisos
			ZY	X		Low chip %
30			ZYK	XG		
			ZYK	XG		
			ZYK	G		Hard lumps of clay
40			ZXY	GK		Increase in chips
			ZXK	G		Pisos dominate
		VB2	ZXK	LGW		
			ZXG	KL		
50			ZG	LKX		Looks almost like b-rock
			ZG	LK		Lump yellow clay
			ZG	LK		Large chip%
60			ZLK	G		Could be wa2
			ZLK	1G		Lumps of limonitic clay
			ZLG	K		Lumps of limonitic clay
70			ZKG	L		Ochrous goethitw
			ZLK	G		Some magnetic fragmentd is this still detrital
			ZLS	GK		Ochreous fines friable g
80			ZLG			Friable g
			ZSL	G		
			ZLG			Higher chip%
90			ZKL	TG		
			ZKT	FG		
			ZKT	FLG		Soft chips
			ZF	KT		
100			ZKF	T		Low chip%

0 100 200

EC us/cm: 0-5000 pH: 0-14 Yield L/s: 0-50

Diagram Scaled to 400mm

Notes:
BLANK PVC: 50MM: water table is at 90m (0.00-84.00)
SLOTTED PVC: 50MM (84.00-247.00)
LEVELTROLL(95.00) ID: 2307

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3503R	Hole Length:	271.00

Easting: 699610.86
Northing: 7454002.51
Surface RL: 691.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	GD20	RHF	140	AIR/WATER	BLY	HAM
150.0 - 271.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	IP1

Comments: lots of ground water at about 260-270m, canned hole due to sump overflow

TOC RL: 691.97 (Stickup 0.58m) (drilled) SWL: 64.43 mbtoc (22 Apr 19) Dev: N Final pH: -
TOC RL: 691.97 (Stickup 0.58m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description
100		VB2	ZKF	T			Low chip%
			ZKF	T			Low chip%
			ZFW	KG			High chip % but mainly f
110			ZWH	FGK			Looks like td1 maybe
			ZKW	FG			Some vit g
			ZK	WG			
			ZK	WG			
120			ZWK	G			Looks like pretty good ore
			ZK	W			
			ZK	W			Rod
130		CY2	ZKW	G			
			ZK				Thick stiky clays
			ZK				Less viscous clay
			ZK				
140			ZK				Maybe carneceous shael?
			ZK				
			ZK				Very few fines
150			ZK				Yellow, red clays,thick and sticky, some g chips
			ZK				As ab
		VB2	ZK	G			Increase in g, more red clays now
160			ZK	G			As ab
			ZK	W			Red clays and increase in w chips
			ZK	W			As ab+some fer shales and g chips
			ZK	W			More w chips now, red clays
170			ZK				As ab, less chips
			ZK				As ab, sample low due to splitter blockage
			ZK				As ab
180		WB	ZK				As ab
			ZK				As ab
			ZK	G			Getting brownish more, large g chips
			ZK	W			Dark brown to red clays. More w now
190		WA2	ZK				As ab
			ZK				Asab
			ZK				As ab
200			ZK	WG			As ab

0 100 200

EC us/cm	pH	Yield L/s
0-5000	0-14	0-50

Diagram Scaled to 400mm

Notes: SLOTTED PVC: 50MM (84.00-247.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3503R	Hole Length:	271.00

Easting: 699610.86
Northing: 7454002.51
Surface RL: 691.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	GD20	RHF	140	AIR/WATER	BLY	HAM
150.0 - 271.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	IP1

Comments: lots of ground water at about 260-270m, canned hole due to sump overflow

TOC RL: 691.97 (Stickup 0.58m) (drilled) SWL: 64.43 mbtoc (22 Apr 19) Dev: N Final pH: -
TOC RL: 691.97 (Stickup 0.58m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200		WA2	ZK	WG			As ab					SLOTTED PVC: 50MM (84.00-247.00)
			ZK	FW			As ab					
			ZK	WG			As ab					
			ZK	GW			As ab					
210			ZK				As ab					
			S				As ab,possibly in wa2 now					
			S				Some q present, mostly clays					
			S				As ab					
220			S				As ab					
			S				Brownish and black shles, g and q chips trace, looks more like shales and almost sure it is wa2					
			S				As ab, but more chips, big blck n chips with big glassy q chips and red shales trace					
230			S	NGQ			Buff color, shaley, weathered dolomite, soft, reaction to acid good, leached pink to brownish cherts					
			S	DQ			Less dolomite, mor cherts white to grey and biffy chips					
			SJC	D			Still in detritals???calcrete-awesome rection with acid, soft, white to yellowish					
240			S	3			As ab					
			S	3			As ab					
			S	3			Increase in clays, sticky whitish/ yellowish,some trace calcrete, glassy q and g chips					
			S				Mostly dolomitic biff chips, bigger, harder, from brownish to greyish chips, trace q,out of detritals??roundish chips					
250			DJ	S			Really weathered dolomitc biff???or just calcrete? hard to tell, similar to above, strong reaction to acid					
			DJ	3			Dolomitic biff now-lots of chips, good reaction to acid,very hard, some red shales					
			JD				Similar to above, apearance of red to pink cherts now and trave glassy q-in wa1??brown reddish shales s well					
260			JD	C			More biff chips, less dolomite, some d chips are qite soft and leached, others are whitish that look more like dolomitic cherty bigg-sprkling-sugary, lots of red and dark pink shales+fer shales					
			JS	D			Similar to previous, some d chips are soft and mybe it is just dolomitic shales, red, pink, ochreous shales, som g looking like shales, in wa1???due to shales??black shales-possibly b instead of n					
			JD	SC								
270			BS	JD								
280												
290												
300												
						0 100 200		0-5000	0-14	0-50		

Program: SOUTH FLANK EXPLORATION_STERILISATION 2012 Planned Hole: SF_2725_2011 Page: 317

BHPIO - Hydrogeology Log

BHP

Project: SOUTH FLANK **Hole Name:** SF3503R **Hole Length:** 271.00

Easting: 699610.86
Northing: 7454002.51
Surface RL: 691.39
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments: lots of ground water at about 260-270m, canned hole due to sump overflow

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 150.0	GD20	RHF	140	AIR/WATER	BLY	HAM
150.0 - 271.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	IP1

TOC RL: 691.97 (Stickup 0.58m) (drilled) SWL: 64.43 mbtoc (22 Apr 19) Dev: N Final pH: -
TOC RL: 691.97 (Stickup 0.58m) (current) Is Live: Y (-) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor
200		WA2	ZK	WG
			ZK	FW
			ZK	WG
			ZK	GW
210			ZK	
			S	
			S	
220			S	
			S	
			S	
			S	
230			S	NGQ
			S	DQ
			SJC	D
240			S	3
			S	3
			S	3
			S	
250			DJ	S
			DJ	3
			JD	
260			JD	C
			JS	D
			JD	SC
270			BS	JD
280				
290				
300				

Log: Gamma CPS API (0 100 200)

Hydrogeological Description:
Lots od carb shales or mg shales?very hard!lots of whitish pinkish and red shales dolomiic, trace q, sump is full, eoh

EC us/cm (0-5000) pH (0-14) Yield L/s (0-50)

Diagram Scaled to 400mm

Notes:
SLOTTED PVC: 50MM (84.00-247.00)

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3505R	Hole Length:	210.00

Easting: 701419.66
Northing: 7454057.55
Surface RL: 681.53
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 210.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	SP3, IP1, LG

TOC RL: 681.53 - (drilled) SWL: 54.80 mbtoc (29 Apr 19) Dev: N Final pH: -
TOC RL: 681.53 - (current) Is Live: N (01 Dec 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
0		ST3	ZFX	C			Several mm pisolites, white chert, soft g					BLANK PVC (0.00-48.00)
			ZXF	WG			Soft and vitr goethite, soft w, also some cherty g, brown bif chips					
			ZXK	JG			Small pisolites , lots of red fines					
10			ZXK	F1			Small to cm large pisolites, red fines					
			ZK	XJ			Very small pisos and chips of pisos, red clay fines, dark red shiny bif					
			ZKX	F			Small pisos, red clay fines					
20			ZKX	JG			Small pisos, dense red clay, dark grey bif chips,m soft g					
			ZKX	CH			Small pisos, white chert, dark red clay					
			ZKX	JH			Some large chunks, mostly small chips, small pisos, soft h					
30			ZK				Very sticky clay					
			ZK				Sticky clay with small leached bif chips					
			ZK				Sticky clay, small pisos					
			ZK	X			Vitr g, small to cm large pisos, red fluid clay fines					
40			ZX	K			3 mm small pisos, clay matrix					
			ZK	3			Still red clay, some white clay and white beige calcrete chips					
		CA2	Z3K	X			2.5m cavity, beige calcrete, small pisos					
			Z3K	X			2.5m cavity, beige calcrete, small pisos					
50			Z3	X			Beige calcrete, some red clay matrix, small pisos					SLOTTED PVC (48.00-210.00)
			Z3	K			Beige buff clay with some red, beige white calcrete chips, small pisos					
			Z3K				Calcrete chips with buff bright pink clay, small pisos					
60			Z3K				Similar					
		VB2	ZK				Light brown buff clay, dense and sticky					
			ZKL	3GF			Small chips, mustard colored fines					
			ZKL	G3F			Mustard yellow clay, hit watertable, small chips					
70			ZKL				Mustard color, soft fg chips					
			ZKL				vitr to soft goethite cips					
			ZKL				More chips now, still small chips					
			ZKL				Few calcrete chips, still sticky clay					
80			ZKL	FG			Could be wa1, small chips, quite soft chips					LEVELTROLL(80.00) ID: 2308
			ZKL	FG			Very sticky, small soft chips					
			ZKL	FG			Some very dense white pink banded clay parts					
90		OB	SW	GFQ			Whitish-yellowish shales, soft w chips and soft fer shales chips, lots of big glassy q chips, some leached g almost l,and trace cherts					
			SW	GFQ								
			SF	Q								
			S	FQ								
100			SC	FQ								
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

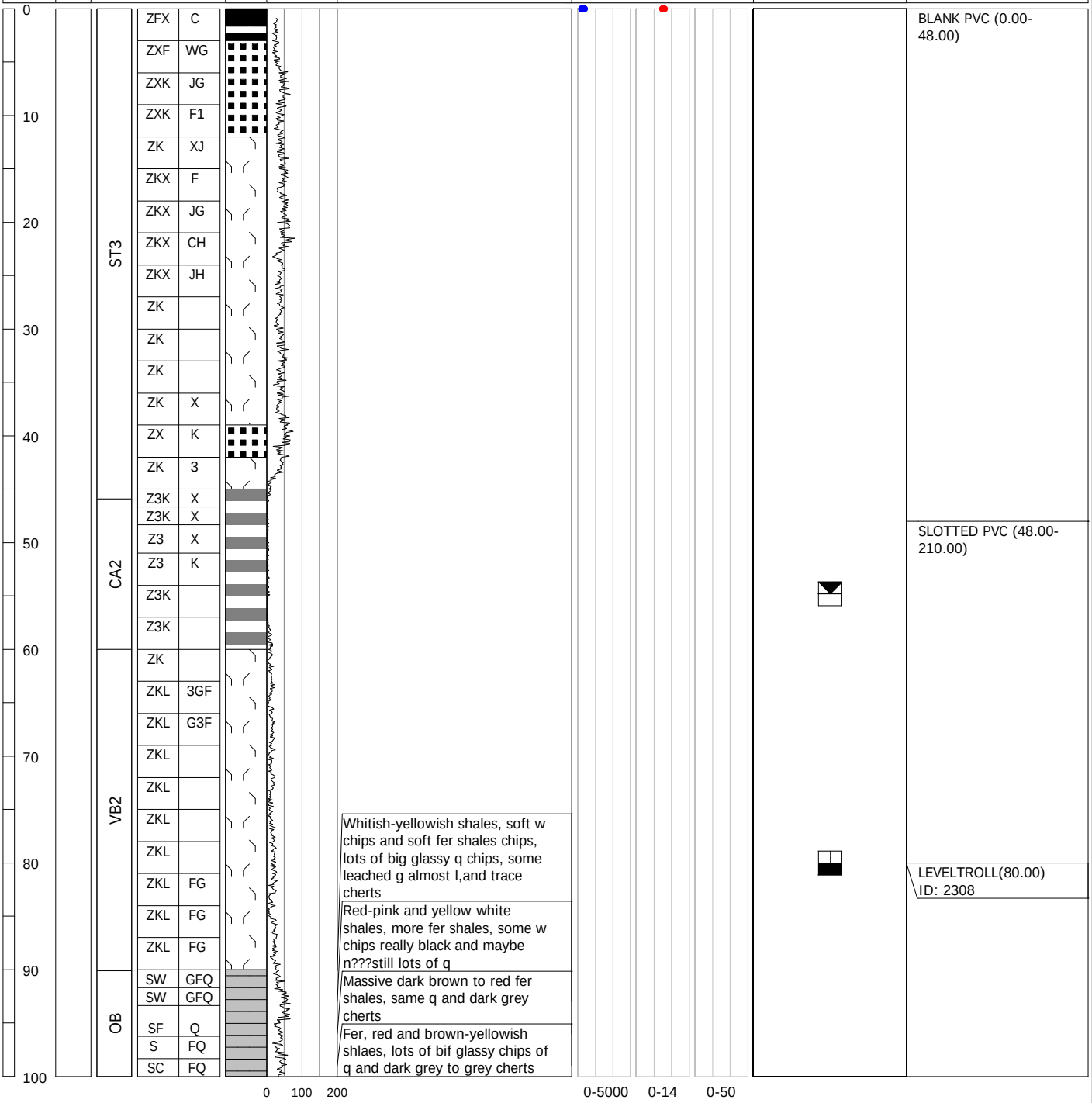
BHP

Project:	SOUTH FLANK	Hole Name:	SF3505R	Hole Length:	210.00

Easting: 701419.66
Northing: 7454057.55
Surface RL: 681.53
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 210.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	SP3, IP1, LG

TOC RL: 681.53 - (drilled) SWL: 54.80 mbtoc (29 Apr 19) Dev: N Final pH: -
TOC RL: 681.53 - (current) Is Live: N (01 Dec 22) Date: - Final EC: -



BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3505R	Hole Length:	210.00

Easting: 701419.66
Northing: 7454057.55
Surface RL: 681.53
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 210.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	SP3, IP1, LG

TOC RL: 681.53 - (drilled) SWL: 54.80 mbtoc (29 Apr 19) Dev: N Final pH: -
TOC RL: 681.53 - (current) Is Live: N (01 Dec 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Gamma CPS API	Hydrogeological Description	Notes
100		OB	SC	FQ		Fer, red and brown-yellowish shlaes, lots of bif glassy chips of q and dark grey to grey cherts	SLOTTED PVC (48.00-210.00)
			D	QG		Lard d chips with visible calcite veins, good rection to acid, earthy soft g chips almost limonitic, lots of q and pink, red shales	
			D			Similar to above. Looks like trace lim and g shales, but maybe just yellow and brown shales?also some red s	
			D			Low sample due to ground conditions, similar to above sample, trace white shales	
110			NS	1C		Black mang shales? hard chips, but when break-soft shales, lots of yellow to brown g cherts, red shales trace and q trace	
			D	1		Good pile of dolomitic chips with calcite veins, minor g cherts from brown hard to brownish soft leached, trace q	
			D			Really light grey color,dolomite with higher ca content, dust is white, some leached cherts present	
			D			Similar to above, possibly some shales-nit sure	
120			D			Light blue color-very pretty!same as above, more darker chips and trace some brown shale	
			D			As ab+red s trace	
			D			Light blue color! similar to previous	
			D			Possible fault-cavity of 2,5m, some chips are weathered and soft, lots of big glassy q chips	
130			D			As ab-cavity from137 to 141m!!!	
			D	Q		Low sample due to cavity, red and white shales	
			D	CQ		More weathered chips, some fer and n shales, possibly g and l shales as well	
			D			Slightly weathered d, pitted chips, with bropwn s	
140			D	FLG		Fresher d	
			D	S		Red, browbn and dolomitic s	
			D	S4		Still a bit weathered	
			D			Some banded dark grey siliceous chips. Could be some carb bif?	
150			D			More weathered	
			D			Voids, brpeken ground., weathered d	
			D	S4		Strat? looks like bif now with red/brown s	
			D				
160			D				
			D				
			D				
			D	J			
170			D				
			DV				
			D				
		WA2	SJ				
			SJ				
180			S	1J			
			SF	J1			
		WA1	J				
			J				
190			C	J			
			J				
200							

0 100 200

EC us/cm: 0-5000 pH: 0-14 Yield L/s: 0-50

Diagram Scaled to 400mm

Program: SOUTH FLANK EXPLORATION_STERILISATION 2012 Planned Hole: SF_2734_2011

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3505R	Hole Length:	210.00

Easting:	701419.66
Northing:	7454057.55
Surface RL:	681.53
Grid Name:	MGA94_50
Incl / Azm:	-90-->0
Construct:	-
Comments:	

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 210.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	SP3, IP1, LG

TOC RL:	681.53	-	(drilled)	SWL:	54.80 mbtoc	(29 Apr 19)	Dev:	N	Final pH:	-
TOC RL:	681.53	-	(current)	Is Live:	N	(01 Dec 22)	Date:	-	Final EC:	-

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
100			SC	FQ								SLOTTED PVC (48.00-210.00)
			D	QG								
			D									
			D									
110			NS	1C								
			D	1								
			D									
120			D									
			D									
			D									
			D									
130			D									
			D	Q								
			D	CQ								
			D									
140		OB	D	FLG								
			D	S								
			D	S4								
			D									
150			D									
			D									
			D	S4								
			D									
160			D									
			D									
			D	J								
170			D									
			DV				Strat? looks like bif now with red/brown s					
			D				Thick sloppy fines, brown/red s with chips of altered c and bif. Could be wa?					
			SJ									
			SJ				Thick fines, shales and with altered c - wa?					
180		WA2	S	1J								
			SF	J1			Mod hard, more chips. Banded bif with altered c					
			J				Cherty bif, rare banding, no s. Huntsman in the bucket!					
		WA1	J									
190			C	J			Very very cherty. Yellowy fines - shale washed out? could be into n2					
			J				Cherty banded bif					
200												
						0 100 200		0-5000	0-14	0-50		

BHPIO - Hydrogeology Log

BHP

Project:	SOUTH FLANK	Hole Name:	SF3505R	Hole Length:	210.00

Easting: 701419.66
Northing: 7454057.55
Surface RL: 681.53
Grid Name: MGA94_50
Incl / Azm: -90-->0
Construct: -
Comments:

Depth	Drill Rig	Type	Size	Fluid	Drilled By	Logged By
0.0 - 210.0	GD20	RHF	140	AIR/WATER/FOAM	BLY	SP3, IP1, LG

TOC RL: 681.53 - (drilled) SWL: 54.80 mbtoc (29 Apr 19) Dev: N Final pH: -
TOC RL: 681.53 - (current) Is Live: N (01 Dec 22) Date: - Final EC: -

Depth mgbl	Cond	Strat	Major	Minor	Log	Gamma CPS API	Hydrogeological Description	EC us/cm	pH	Yield L/s	Diagram Scaled to 400mm	Notes
200		WA1	J				Cherty banded bif					SLOTTED PVC (48.00-210.00)
			J									
		N3	J				Hard cherty bif, unsure of strat					
210			J				Dark cherty bif, eoh					
220												
230												
240												
250												
260												
270												
280												
290												
300						0 100 200		0-5000	0-14	0-50		

Program: SOUTH FLANK EXPLORATION_STERILISATION 2012 Planned Hole: SF_2734_2011 Page: 323