RioTinto

Orebody Knowledge & Planning - Water Resource Evaluation & Services

West Angelas – Deposits C, D and G

H3 Hydrogeological Assessment

RTIO-PDE-0155692 - WANG Deposit C, D and G H3 Report.docx:

http://iodms/iodms/drl/objectId/090188a380ac9893

5th July 2018

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Stakeholders: Studies and Technology, Approvals

Accountability: Shane Trott (Principal, Hydrogeology)

Version History				
Version	**Description of Changes**	**Custodian**	**Approved**	**Date**
1.0	Draft for internal review	S. Page		
1.1	Incorporated review mark ups and comments	S. Page		
1.2	Incorporating revisions to mine plan, site conceptualisation and modelling results	S.Page		
1.3	Incorporated base case dewatering rates and comments external reviewer	S. Page		

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1. Introduction

Rio Tinto is seeking to develop its existing West Angelas iron ore mine site, at Deposits C, D and G (The proposal), to sustain its operations in the central Pilbara region of Western Australia. The proposal will involve construction and operation of new mine pits, waste dumps and associated infrastructure to enable sustained production from the existing Operations. The Proposal is expected to have a total iron ore throughput of up to 25 million tonnes per annum (Mtpa), as the existing Operations are depleted, and have an operational mine life of approximately nine years.

The Proposal area is located approximately 100km north-west of Newman and is covered by mining lease AML70/00248, as part of the HI State Agreement. The location of the site is provided in Figure 1.

Deposits C, D and G are located to the west of the current active mining areas at Deposits A, B, E and F, as shown in Figure 2.

Hydrogeological investigations conducted to-date have been carried out to enable assessment of the following:

- Available water supply options to satisfy construction and dust suppression demand,
- Determination of dewatering requirements to facilitate below water table (BWT) mining,
- Drawdown of groundwater levels associated with dewatering activities for the duration of life of mine (LOM),
- Appropriate water management strategy, including discharge of surplus dewatering.

Hydrogeological field investigations initially targeted the deepest sections of each orebody. This enabled assessment of hydraulic characteristics of key hydrostratigraphic units, specifically, mineralised fractured rock aquifer of the Marra Mamba Iron Formation and West Angela Member of the Wittenoom Formation.

Additional drilling outside of the proposed footprint of each orebody was conducted to target underlying and adjacent Wittenoom Formation. In particular, drilling in the area west of Deposit C and D has enabled the establishment of a groundwater monitoring network directly adjacent Karijini National Park (KNP), where a potential groundwater dependent ecosystem (GDE) has been identified approximately 2.5km's from the western perimeter.

Hydrogeological investigations completed to-date within and in the immediate vicinity of Deposits C, D and G have resulted in the installation of 24 vibrating wire piezometers, 88 monitoring bores and nine production bores.

A summary of the current mining schedule (WACD FS Schedule_No_C2-BWT_Bench), with predicted BWT reserves is presented in Table 1.

Table 1: Summary scheduled mining

Deposit	Date Mining	Date Dewatering Commences	Percentage Reserve BWT
Deposit C	2020 - 2028	2023	18
Deposit D	2020 - 2028	2021	45
Deposit G	2022 - 2028	2027	4

In order to achieve dry mining conditions, it is estimated groundwater abstraction will peak at 8GL/year (22ML/day) and 53GL of groundwater will be abstracted over the LOM (RTIO, 2016a, 2017a and 2018a).

1.1 Dewatering activities related to existing operations

Rio Tinto requires a combined dewatering groundwater well licence for the entire Operation of 14GL/a, which represents 8GL/a increase on the existing 5.4GL/a allocation administered under GWL98740. Management of surplus dewatering volumes will occur via discharge to a tributary of Turee Creek East (TCE), downstream of the current licensed discharge. The extent of the surface water discharge is not anticipated to reach KNP (RTIO, 2018b).

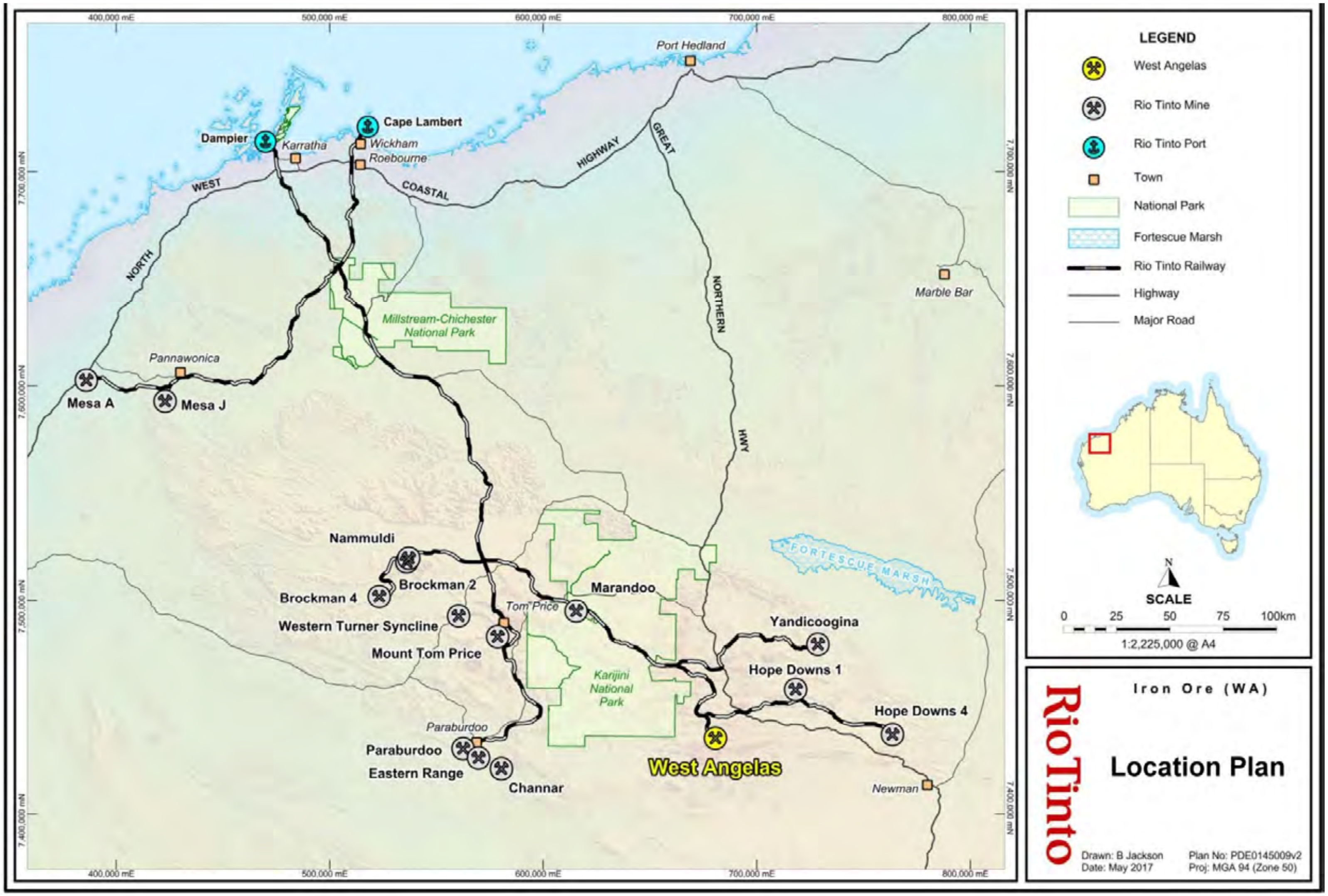

Figure 1: West Angelas site location plan

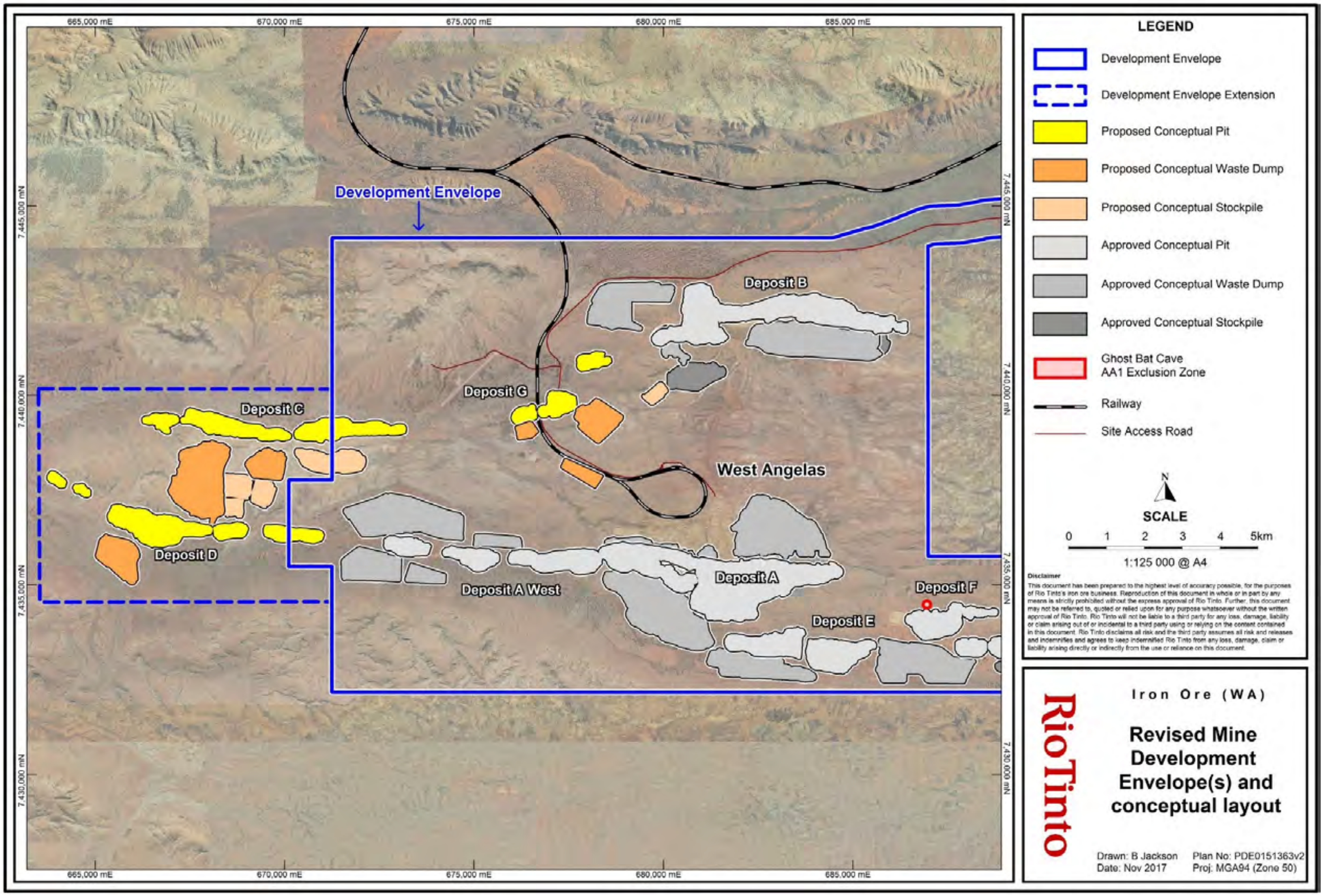

Figure 2: Location map of the proposed Deposits C, D and G mining area

2. Regional Setting

2.1 Climate

Rainfall at West Angelas is typically associated with tropical low pressure systems and thunderstorm activity from the monsoonal trough that develops over northern Australia during summer.

Analysis of Bureau of Meteorology (BoM) recorded daily rainfall (BoM, 2012), show on average there are 37 rain event days per year for the area, with only 8 of those rain event days having a rainfall total greater than 10 mm.

The long term mean annual rainfall (1907 to 2015) for West Angelas is 317 mm, estimated based on gridded rainfall data (BOM AWAP data accessed 2015), with a historical annual range of 75 to 820 mm illustrating the high inter-annual variability (Figure 3).

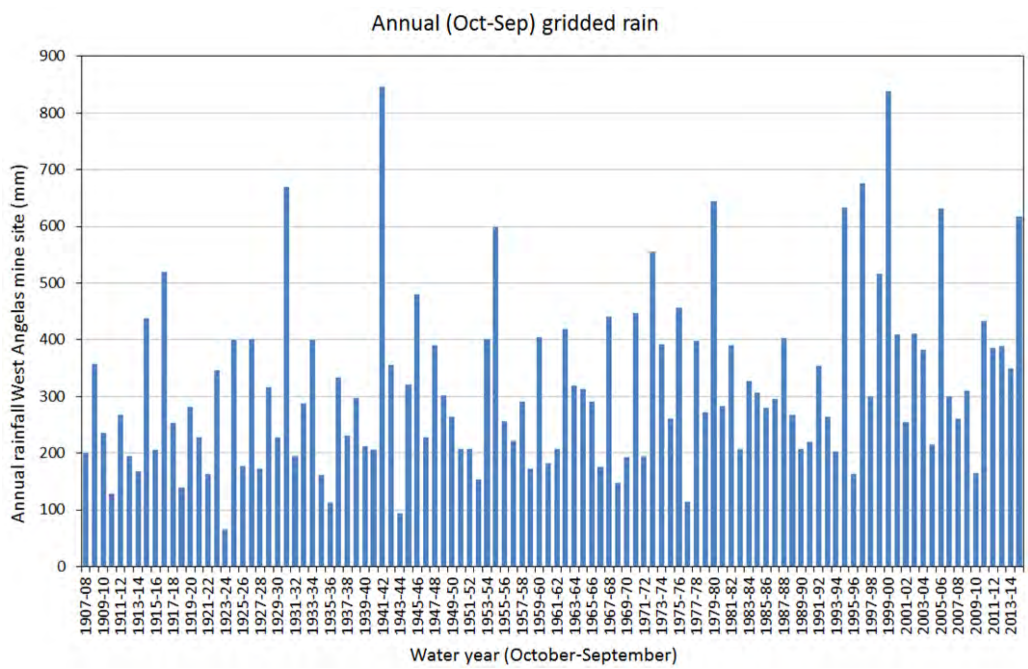

Figure 3: Annual (October to September) gridded rainfall for West Angelas

As depicted in Figure 4, the monthly rainfall is highly seasonal with approximately 72% of the annual total occurring between December and April. Winters are typically dry and mild though winter rain events can occur in June and July as a result of tropical cloud bands that intermittently affect the area.

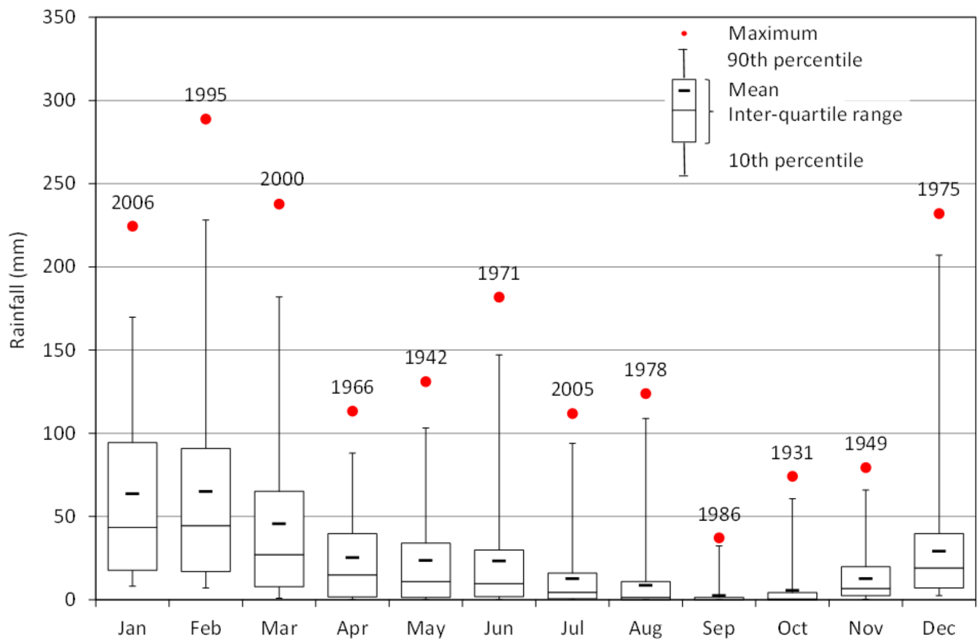

Figure 4: Monthly gridded rainfall distribution for West Angelas

2.2 Hydrology

Deposits C, D and G are located in the catchment of Turee Creek East (TCE), with a surface water catchment area of approximately 298km^2 (Figure 5). Although surface water management infrastructure has been proposed to divert TCE entering Deposits C, D and G, run-off from local catchments will still be intercepted by the pits and require active management (e.g. sump and pump).

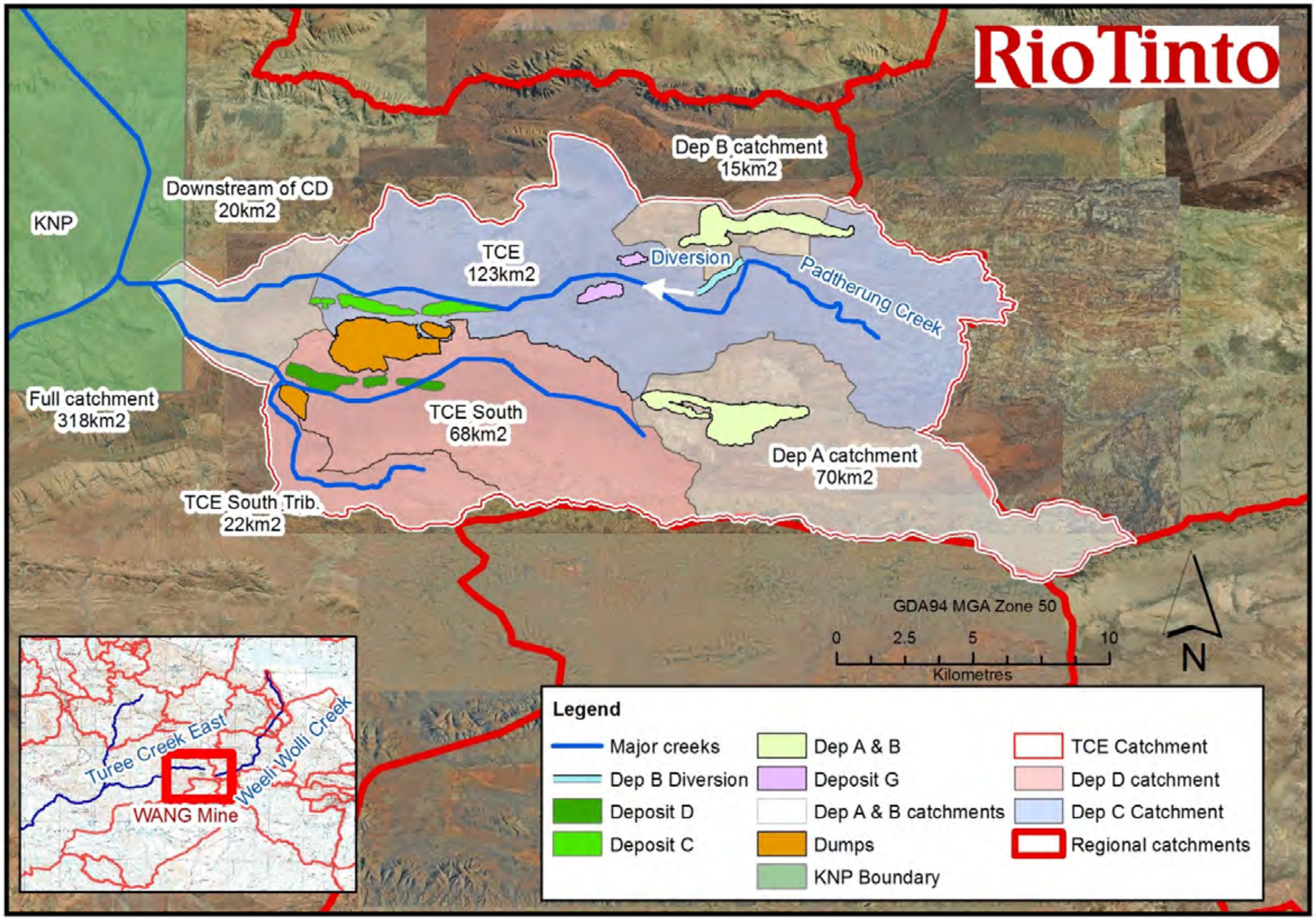

Figure 5: Major creeks and catchments at West Angelas Deposit C, D and G

2.3 Regional Geology

Deposits C, D and G are principally Marra Mamba Iron Formation deposits (Mount Newman Member), with minor mineralisation present in the MacLeod Member as well as the Wittenoom Formation (West Angela Member) and Tertiary Detritals (RTIO, 2017b). A summary of the regional stratigraphy is presented in Figure 6.

2.3.1 Stratigraphy

A summary of the stratigraphy encountered in the area of Deposits C, D and G on the basis of resource and hydrogeological drilling investigations conducted to-date is presented in Appendix 1 and Table 2.

Table 2: Summary of stratigraphy encountered

Stratigraphy	Max. thickness encountered (m)
Nammuldi Member (BIF, chert, shale)	172
MacLeod Member (BIF, shale, chert)	72
Mount Newman Member (ore, BIF, chert, shale)	93
Un-differentiated Wittenoom Formation (clay, shale, chert, ore, BIF, clay, silcrete, dolomite)	172
Detritals (hematite, goethite, chert, BIF with clay, silcrete, calcrete, limonite, shale)	130

2.3.2 Structure

The main structural feature of the West Angelas region is the regional east-west trending Wonmunna Anticline, with Deposits C and G located on the northern limb and Deposit D located on the southern limb.

Deposit C and G is dominated by lithologies dipping to the north for the most part at around 30 degrees. Deposit D is dominated by lithologies dipping to the south for the most part at around 35 degrees. However, the western area of Deposit D is structurally more complex, with an open syncline interpreted in this area (RTIO, 2017b). Similar to other iron ore deposits in the Pilbara, the area has been subject to intrusion by NE/SW and NW/SE trending Dolerite dykes.

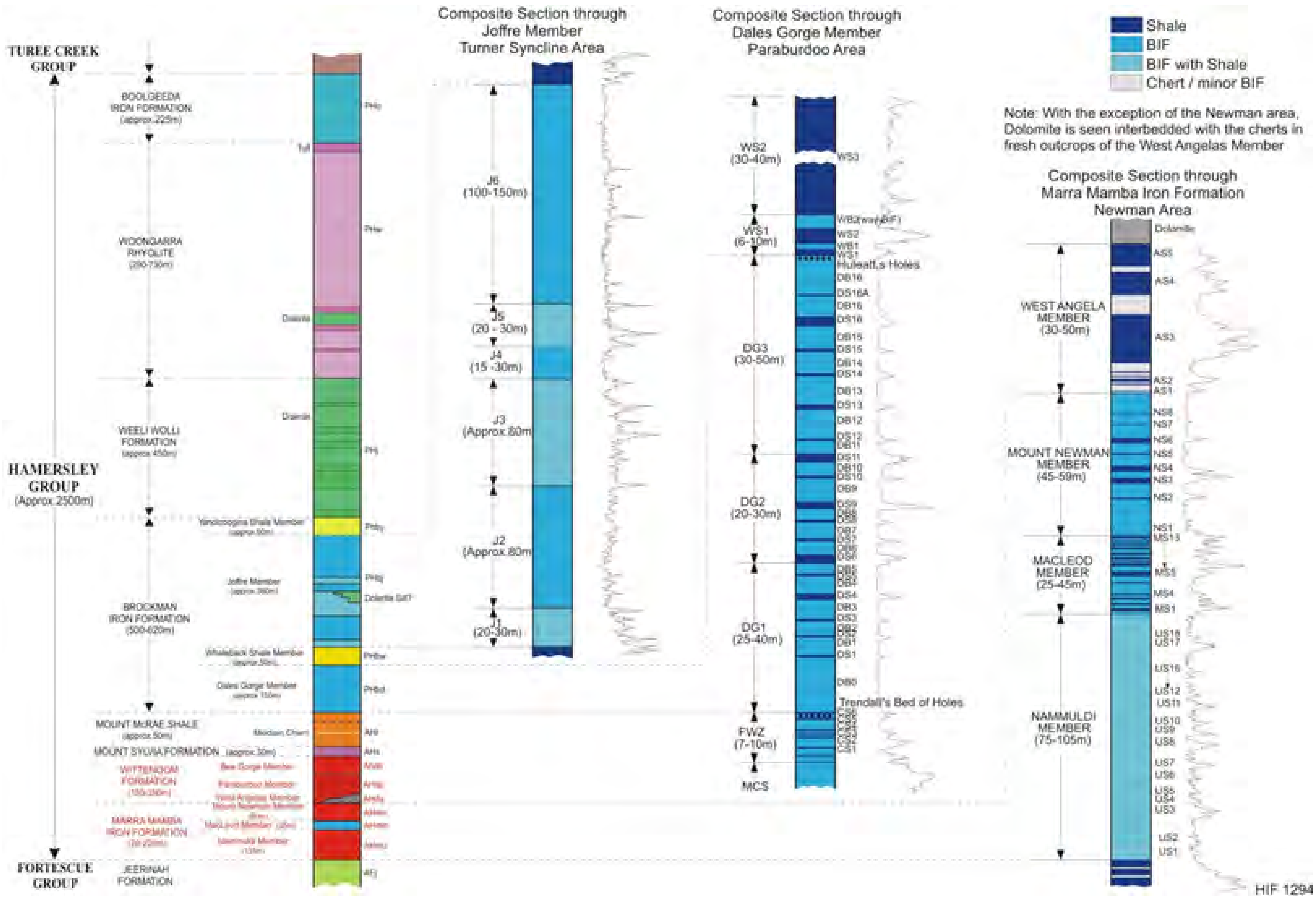

Figure 6: Stratigraphic column Deposit C, D and G

3. Hydrogeology

3.1 Bore network

Two dedicated hydrogeological phases of fieldwork, comprising drilling and pumping testing, followed by groundwater sampling, hydrochemical and isotoptic analysis were completed in 2016 and 2017 (RTIO, 2016b and RTIO, 2017c). Groundwater level records pre-date these investigations and extend back to 2004, when groundwater level monitoring commenced at WANG14, a monitoring bore located ~2.5 km west of the KNP boundary. Further groundwater level data has been obtained from monitoring bores installed as part of a potable water supply investigation completed in 2015 (RTIO, 2017d) and monitoring bores installed opportunistically as part of multiple Resource Evaluation (RE) drilling programs completed at Deposits C and D since 2013.

Hydrogeological investigations completed to-date within and in the immediate vicinity of Deposits C, D and G have resulted in the installation of 24 vibrating wire piezometers, 88 monitoring bores and nine production bores (Figure 7).

Hydrogeological drilling has generally targeted a combination of the Mount Newman Member, Wittenoom Formation (un-differentiated) and the orebody (i.e. mineralised Mount Newman Member and Wittenoom Formation), as well as multiple stratigraphic units, to enable characterisation of key aquifer units.

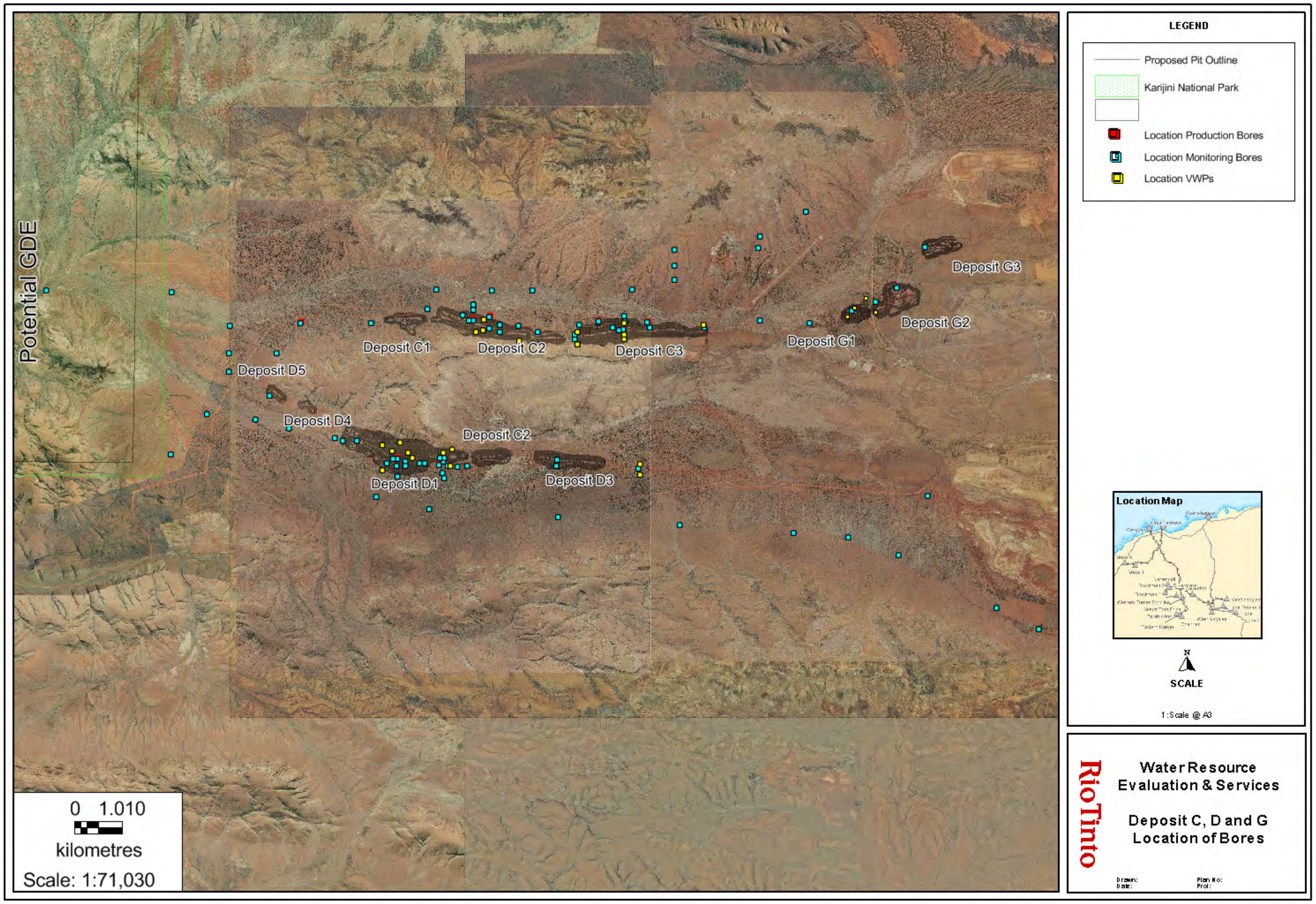

Figure 7: Location of bores area Deposit C, D and G

3.2 Data sources and previous studies

The area in and around Deposits C and D and more broadly West Angelas, has been subject to numerous hydrogeological drilling and pumping testing programs to investigate the occurrence of groundwater as outlined in Table 3.

Table 3: Summary of previous relevant hydrogeological investigations

Date of Issue	Document Name	Summary	IODMS link
17/09/2015	RTIO-PD-0135550: West Angelas - Deposit C Hydrogeological Conceptual Model Report	Summary of the hydrogeological conceptual model at West Angelas Deposit C. Results indicate the water table sits between 635m RL in the east and 623m RL in the west, with the presence of a groundwater divide up to 12m in the central area of the site, possibly associated with a dyke. In addition, it was noted that groundwater abstraction associated with dewatering activities might extend off site and beneath the area of the KNP.	http://iodms/iodms/drl/objectId/090188a380959287
01/10/2015	RTIO-PDE-0136009: Deposit C Analytical Modelling (9.1 base case)	Memo presenting results of analytical modelling solutions to approximate dewatering Deposit C. Results indicated that up to 13GL of groundwater might need to be abstracted to facilitate BWT mining.	http://iodms/iodms/drl/objectId/090188a38096343d
12/09/2016	RTIO-PDE-0145302 - Deposit C Analytical Modelling (Option 5A).doc	Memo presenting results of analytical modelling solutions to approximate dewatering Deposit C. Results indicated that up to 17GL of groundwater would need to be abstracted to facilitate BWT mining. Increase in predicted volume from previous work associated with increase in duration and planned depth BWT mining.	http://iodms/iodms/drl/objectId/090188a380a1359b
15/11/2017	RTIO-PDE-0155446 - Deposit C Analytical Modelling (FS).docx	Memo presenting results of analytical modelling solutions to approximate dewatering Deposit C. Results indicated that up to 27GL of groundwater would need to be abstracted to facilitate BWT mining. Increase in predicted volume from previous work associated with utilising a combination of in-pit and ex-pit production bores for dewatering and changing the aquifer storage value in accordance with other groundwater models at West Angelas.	http://iodms/iodms/drl/objectId/090188a380ac49ad
29/09/2015	RTIO-PD-0135949: West Angelas - Deposit D Hydrogeological Conceptual Model Report	Summary of the hydrogeological conceptual model at West Angelas Deposit D. Results indicate the groundwater elevation varies between 624 and 625m RL. In addition, it was noted that groundwater abstraction associated with dewatering activities might extend off site and beneath the area of the KNP.	http://iodms/iodms/drl/objectId/090188a380960e52

Date of Issue	Document Name	Summary	IODMS link
30/09/2015	RTIO-PDE-0135997: Deposit D Analytical Modelling (9.1 base case)	Memo presenting results of analytical modelling solutions to approximate dewatering at Deposit D. Results indicated that up to 38GL of groundwater would need to be abstracted to facilitate BWT mining.	http://iodms/iodms/drl/objectId/090188a380962d7c
14/10/16	RTIO-PDE-0146330 - 2016 Deposit C & D and Western End PFS Field Program Report_06102016 (Final).doc:	Borehole drilling and pumping testing program in the area of Deposit C and D and the area between Deposit C / D and the nearby Karijini National Park (KNP). 30 monitoring bores and five 12" test production bores were installed. Results corroborate groundwater divide identified earlier between Deposit C. Recommended pumping rates varied between 8 and 30L/s.	http://iodms/iodms/drl/objectId/090188a380a2166e
12/09/2016	RTIO-PDE-0145263 - Deposit G Analytical Modelling.doc:	Memo presenting results of analytical modelling solutions to approximate dewatering at Deposit G. Results indicated that up to 2GL of groundwater would need to be abstracted to facilitate BWT mining.	http://iodms/iodms/drl/objectId/090188a380a13226
28/11/2016	RTIO-PDE-0147252 - West Angelas Deposits C&D Regional Groundwater model	Numerical modelling exercise to estimate the dewatering required at Deposits C and D for BWT mining and associated aquifer drawdown. The results indicated a maximum abstraction rate of between 9 and 25ML/day would be required, with between 10 and 53GL of groundwater removed. It was predicted that groundwater drawdown beneath the area of the potential GDE in KNP would be between 3 and 8m over a 100 year post mining time frame. In addition, it is currently envisaged groundwater would not return to pre-mining levels on cessation mining.	http://iodms/iodms/drl/objectId/090188a380a3561b
17/01/2018	RTIO-PDE-0158691 - West Angelas Deposit C & D Feasibility Study Groundwater Modelling Dewatering Prediction:	Numerical modelling exercise to estimate the dewatering required at Deposit D. The required total dewatering rate for Deposit D is predicted at 10.4 ML/d. The cumulative dewatering volume over 8 years (2021 to 2028) is predicted at 26 GL. The dewatering rates are similar to those predicted in the PFS model.	http://iodms/iodms/drl/objectId/090188a380ae2eef
17/02/2018	RTIO-PDE-0158692: West Angelas Deposits C & D Feasibility Study Groundwater Impact Assessment:	Numerical modelling exercise to evaluate aquifer drawdown associated with BWT mining at Deposit D. It was predicted that maximum groundwater drawdown beneath the area of the potential GDE in KNP would be up to 6m over a 100 year post mining time frame. Numerical groundwater model was developed adopting the conservative assumption that recharge is evenly distributed across the aquifer extent and equal to outflow via the estimated evapotranspiration loss from the potential GDE. However, evidence to suggest recharge may be more significant west of the project area beneath KNP.	http://iodms/iodms/drl/objectId/090188a380ae2f09

Not issued / In progress	2017 Field Program at Deposit C and D	Borehole drilling and pumping testing program in the area of Deposit C and D. Ten monitoring bores and four 12" test production bores were installed. Recommended pumping rates varied between 20 and 62L/s.	Draft status

3.3 Geology and hydrostratigraphy

The following section describes the geology and hydrostratigraphy encountered during the course of drilling undertaken in these respective areas, with Figure 8 presenting a geological map covering key focus areas and Figure 9, Figure 10 and Figure 11 presenting the conceptual hydrogeology.

Nammuldi Member

The Nammuldi Member is the oldest member of the Marra Mamba Iron Formation. On the basis of field mapping, in weathered outcrop, the Nammuldi Member consists of predominantly yellow and brown chert with thin hematite bands. It has distinctive and extensive development of chert pods, especially in the upper part of the unit.

Observations made during the 2016 and 2017 hydrogeological drilling programs show the Nammuldi Member consisted of hard, blue-grey-black BIF and chert, which was magnetic in places. The drilling method adopted did not permit acquisition of groundwater quality or airlift yield information during drilling.

The Nammuldi Member is considered to have low primary porosity.

MacLeod Member

On the basis of observations made during resource drilling, the boundary between the MacLeod Member and the underlying Nammuldi Member is at the base of a chert horizon within the MacLeod Member, consisting of large (up to 70 cm long and 30 cm diameter) distorted ellipsoidal chert pods. This boundary is approximately 17 m above the well-defined podded chert horizon within the Nammuldi Member known as the "potato beds". The MacLeod Member consists of shale, chert and minor bands of hematite or goethite.

Observations made during the 2016 and 2017 hydrogeological drilling programs show the MacLeod Member consisted of BIF, chert, and shale, described as hard to very hard, magnetic in places with traces of weathering. The drilling method adopted did not permit acquisition of groundwater quality or airlift yield information during drilling.

The MacLeod Member is considered to have low primary porosity.

Mount Newman Member

The Mount Newman Member is at the top of the Marra Mamba Iron Formation and is the main ore-bearing member of the formation. Observations made from resource drilling show it consists of nine macro bands of magnetite-rich, oxide-type BIF (with a significant silicate-carbonate content) alternating with eight macro bands of ferroan dolomite and limestone, with shaly intercalations and occasional chert beds (shaly bands NS1 – NS8).

Observations made during hydrogeological drilling investigations completed in 2016 and 2017 varied, depending on whether bores were drilled either in-pit or ex-pit. In-pit bores revealed ore with interbedded shales and chert, highly weathered with low to moderate strength and evidence of faulting (with hardness and magnetism typically increasing with depth, with associated decreasing mineralisation). Ex-pit bores revealed hard siliceous BIF, chert and shale.

Airlift yields obtained during development of monitoring bores in the Mount Newman Member ranged from 5 to <0.1 L/s, indicating enhanced permeability associated with mineralised sections within the orebody.

Outside of the orebody, un-mineralised sequences of the Mount Newman Member have limited permeability and constrain groundwater flow. Groundwater quality is generally of good quality ranging from conductivity values between 496 to 1,975 µS/cm.

Wittenoom Formation (un-differentiated)

The Wittenoom Formation conformably overlies the Marra Mamba Iron Formation. Elsewhere in the Pilbara it is divided into three distinct Members: West Angela (bottom), Paraburdoo (middle) and Bee Gorge (top). Only the West Angela Member has been intersected in resource drilling in the area, consisting of shale, dolomite and minor chert increasing towards the base. Near the base of the West Angela Member, there is a 10 to 20 m thick sequence of chert, BIF and shales.

Based on observations made during the 2016 and 2017 hydrogeological drilling program, it was not possible to subdivide the Wittenoom Formation in the area. Lithologies encountered consist of BIF, Ore with inter-bedded shales, clay, chert, dolomite and silcrete, with evidence of mineralisation increasing with depth. Although weathering/fractures, vugs etc. were observed towards the top of the profile, with increasing depth, the dolomite was described as hard and competent.

Airlift yields obtained during development of monitoring bores in the Wittenoom Formation ranged from 5 to 0 L/s. An increase in yield was typically associated with mineralisation or weathering and erosion indicating enhanced permeability in these horizons. Outside of the areas of mineralisation and/or weathering, the Wittenoom Formation will have limited permeability and constrain groundwater flow. Groundwater quality is fresh ranging from conductivity values between 757 to 1,219 µS/cm.

Mount Sylvia Formation and Mt McRae Shale

The Mount Sylvia Formation (consisting of BIF bands separated by shales, cherts and dolomite) and the Mount McRae Shale (consisting of a sequence of shales, cherts and BIF), conformably overlie the Wittenoom Formation. Based on RTIO experience of other sites in the Pilbara (e.g. Nammuldi, Marandoo etc.), the Mount Sylvia Formation/Mount McRae Shale is anticipated to act as a barrier to groundwater flow.

Dolerite

Based on observations during drilling, surface geological mapping and observed groundwater head variations, there is evidence for intrusion of Dolerite dykes in the area, acting as barriers to groundwater flow (RTIO, 2016c). Based on RTIO observations during pumping testing at Deposit C (RTIO, 2016b and 2017c), and observed groundwater elevations in the area, Dolerite dykes may act as barriers to groundwater flow in the area of the orebodies. However, results of drilling and pumping testing to the west of Deposit C and D, did not identify any barriers associated with Dolerite dykes in the area adjacent to KNP.

Detrital Material

In the vicinity of Deposits C, D and G a layer of Tertiary Detritals, comprising mineralised detritals and clay. Based on observations made during the 2016 and 2017 hydrogeological drilling programs, Detritals were encountered BWT at approximately 50% of locations tested.

Although Detritals typically exhibit high storage, attributed primarily to the presence of clay, it is anticipated this material will have limited permeability.

Based on the results of pumping testing in 2017, in the area of Turee Creek East, to the north of Deposit C (MB17WAC00004-0005), there is evidence of groundwater occurring within the Detritals and bedrock will behave differently to dewatering (i.e. delayed yield anticipated during dewatering the Detritals, due to differences in storage values in the Detritals and bedrock).

Groundwater quality in the Detritals is fresh, with an EC value of 781 µS/cm.

Calcrete

This material was observed in the western end of Deposits C and D during field mapping and in several monitoring bores extending BWT, with an average thickness of 12m as shown in Figure 12.

Based on observations during drilling, it is possible that this material will have enhanced permeability with high storage (i.e. material variously described as “blocky”, “fractured” and “highly weathered / broken”. However, with increasing depth, the calcrete was in turn in places described as hard. Airlift yields obtained during drilling in the calcrete ranged from 0.5 to 1L/s. The presence of calcrete in outcrop will likely result in locally enhanced aquifer recharge.

3.4 Aquifers

Based on the local hydrostratigraphy, the principal aquifer in the region is associated with mineralised sections of the Mount Newman Member and the overlying Wittenoom Formation (orebody aquifer) and the Wittenoom Formation (regional aquifer), where subjected to weathering resulting in secondary permeability and in hydraulic continuity with the orebody.

Note: The model domain has been expanded to the north and west from previous modelling as shown on Figure 8. This is discussed further in Section 5.1.

Due to the observed clay content, the overlying Detritals material are not considered a significant aquifer in the area of the orebody. However, to the west of Deposits C and D, in the area of the KNP, there is the presence of layer of calcrete up to ~20m thick below the water table. Based on visual observations during drilling, including chip sample returns and groundwater yields, there is evidence that the calcrete material may represent a locally important aquifer.

Figure 13 to Figure 19 inclusive present hydrostratigraphic cross sections as shown on Figure 8 in the area.

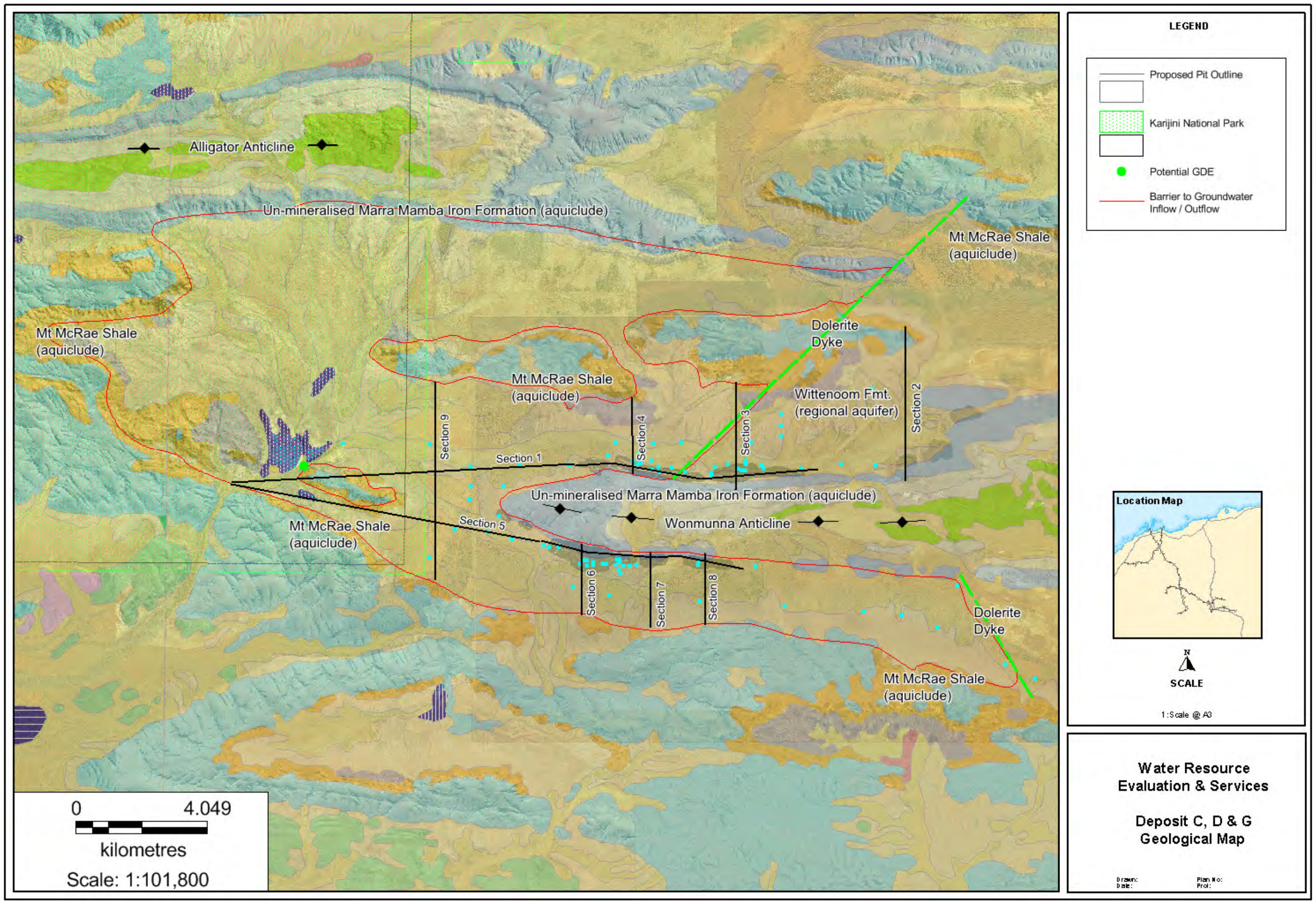

Figure 8: Distribution of key hydrostratigraphy Deposits C, D and G

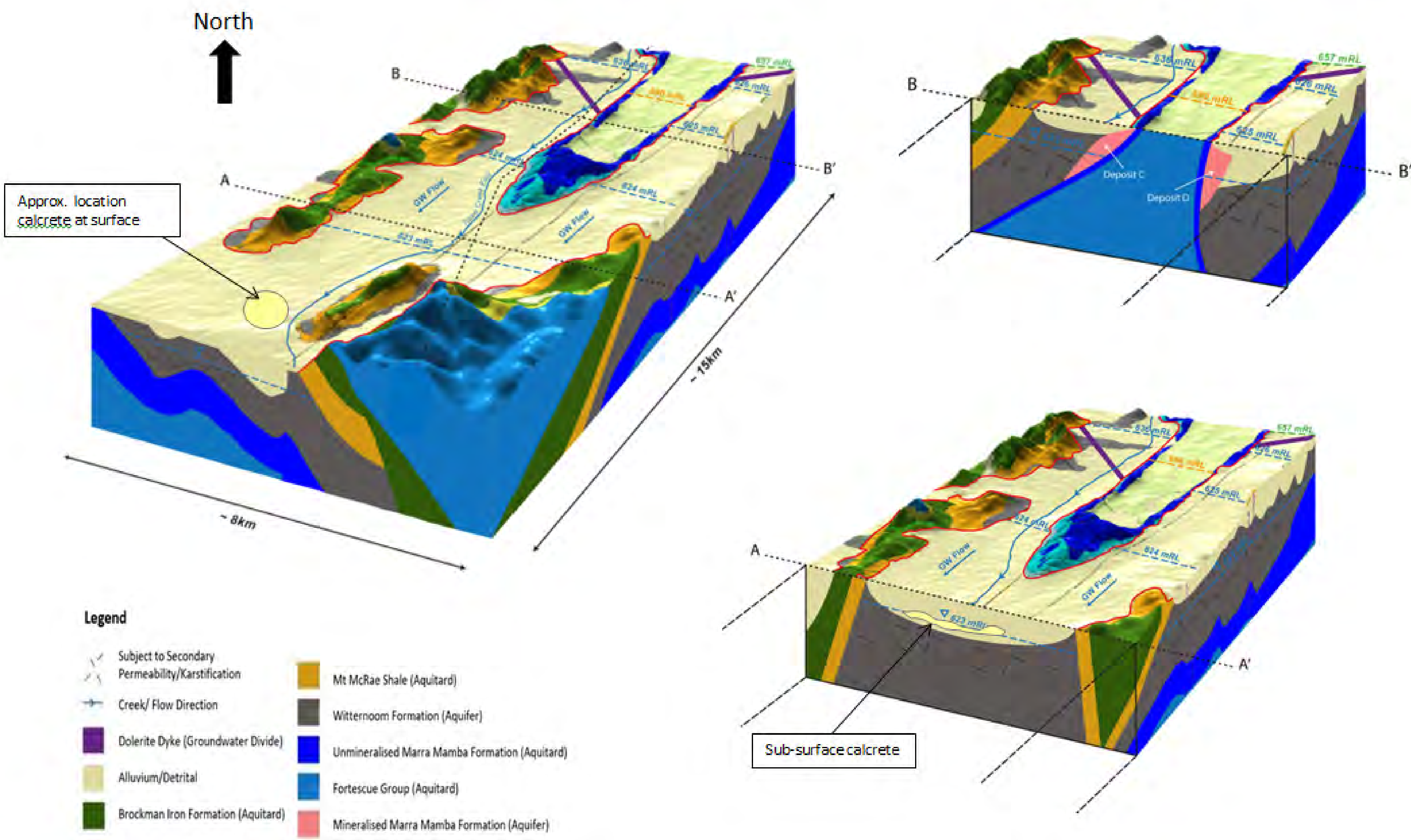

Figure 9: Conceptual hydrogeology Deposits C and D and G

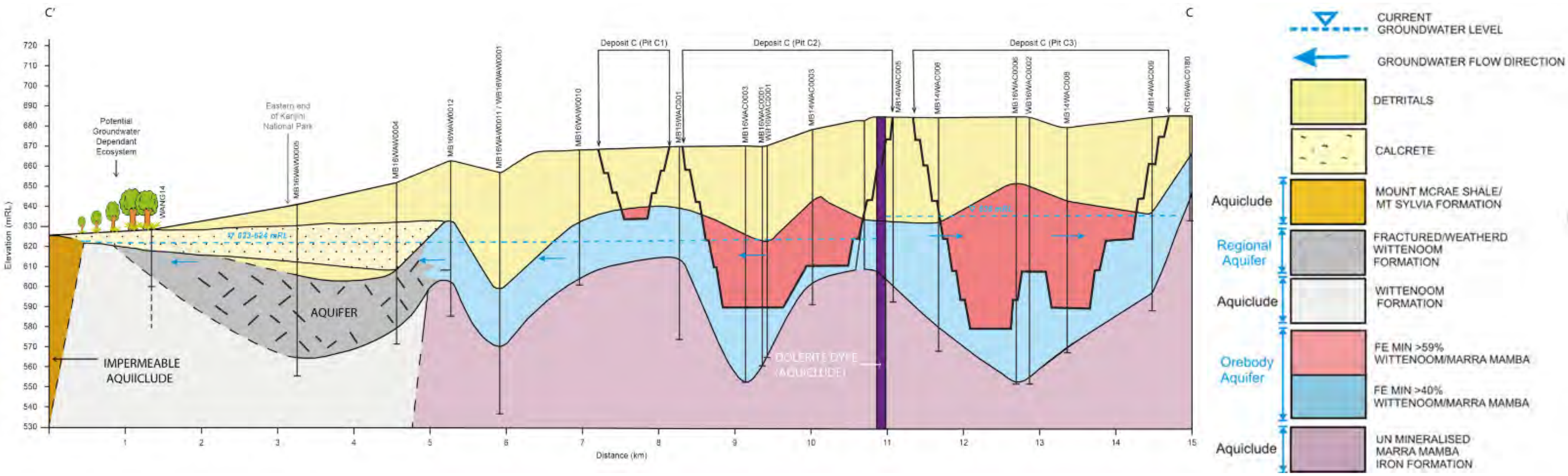

Figure 10 Conceptual hydrogeology Deposit C (east - west) – section 1

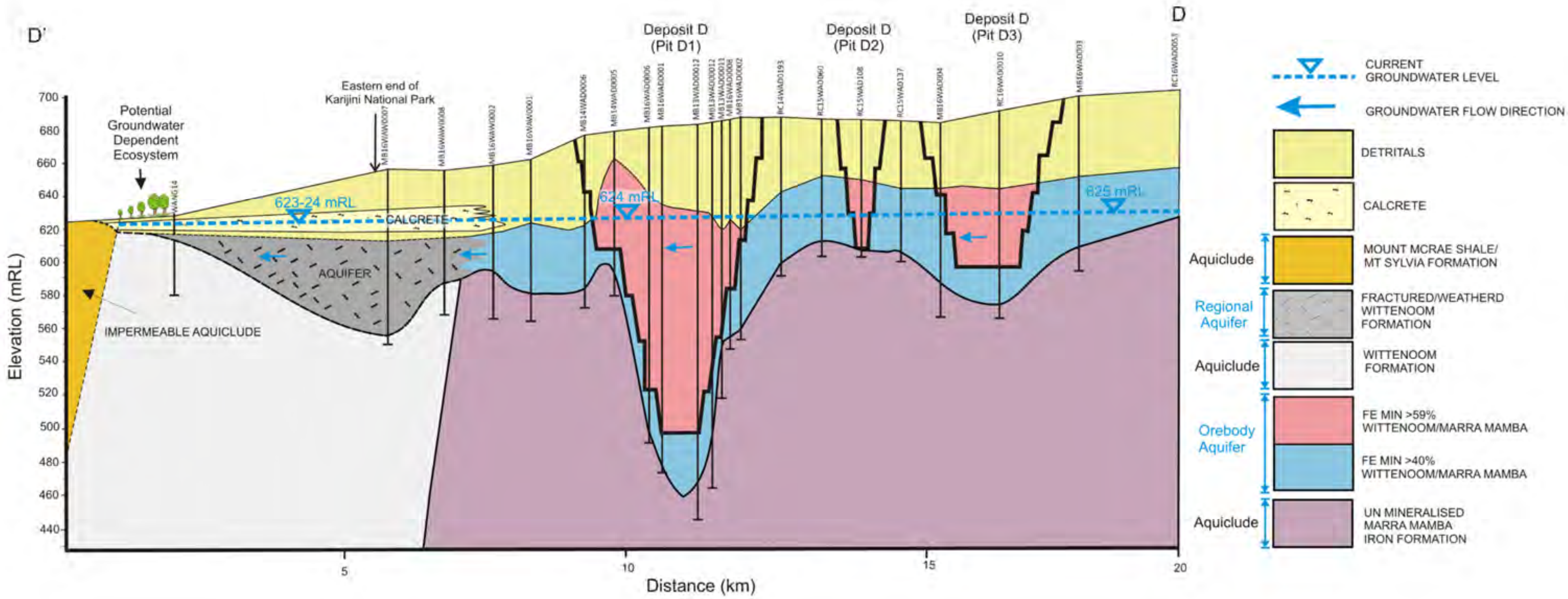

Figure 11: Conceptual hydrogeology Deposit D (east - west) – section 5

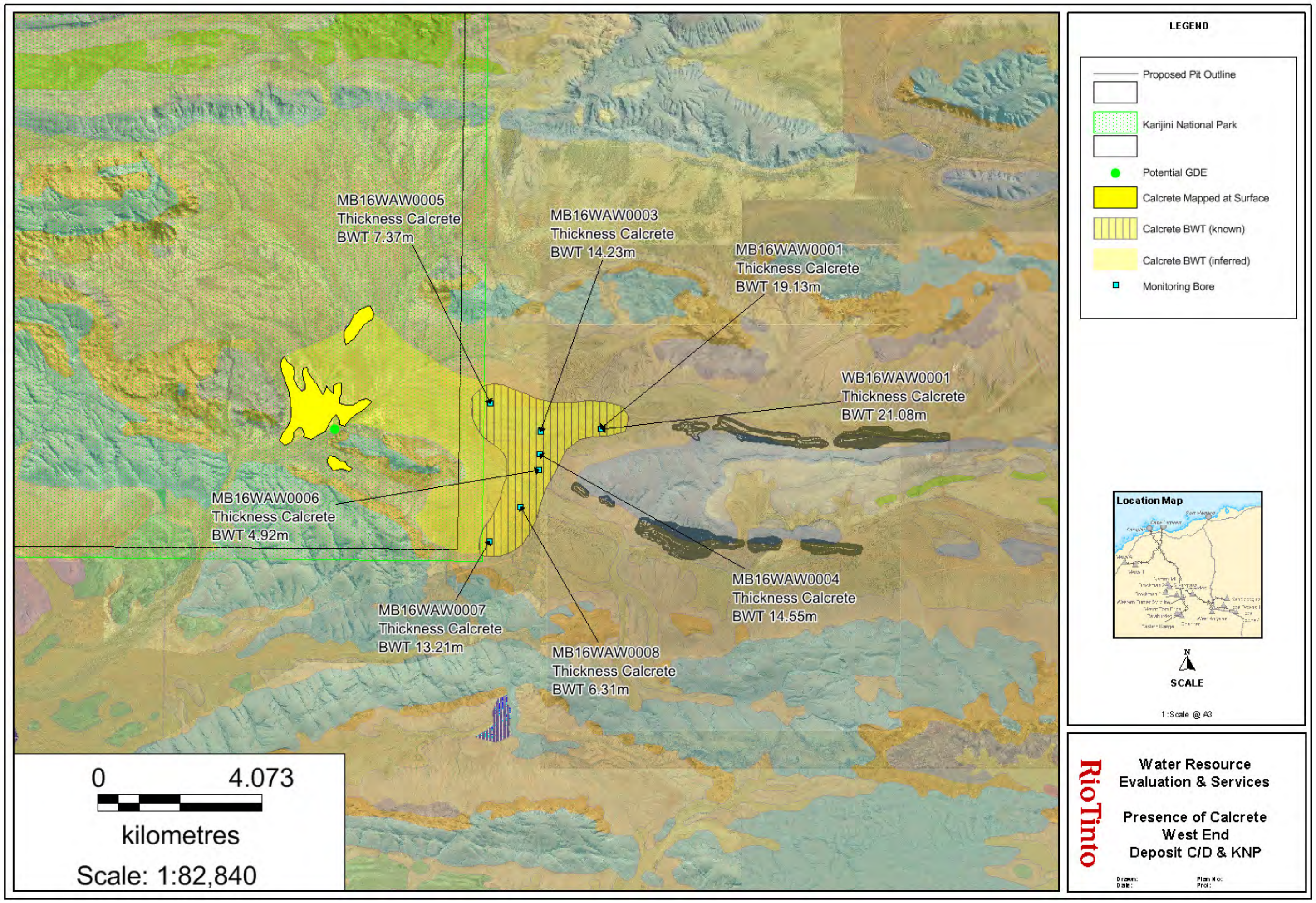

Figure 12: Presence of calcrete layer west end of Deposits C and D

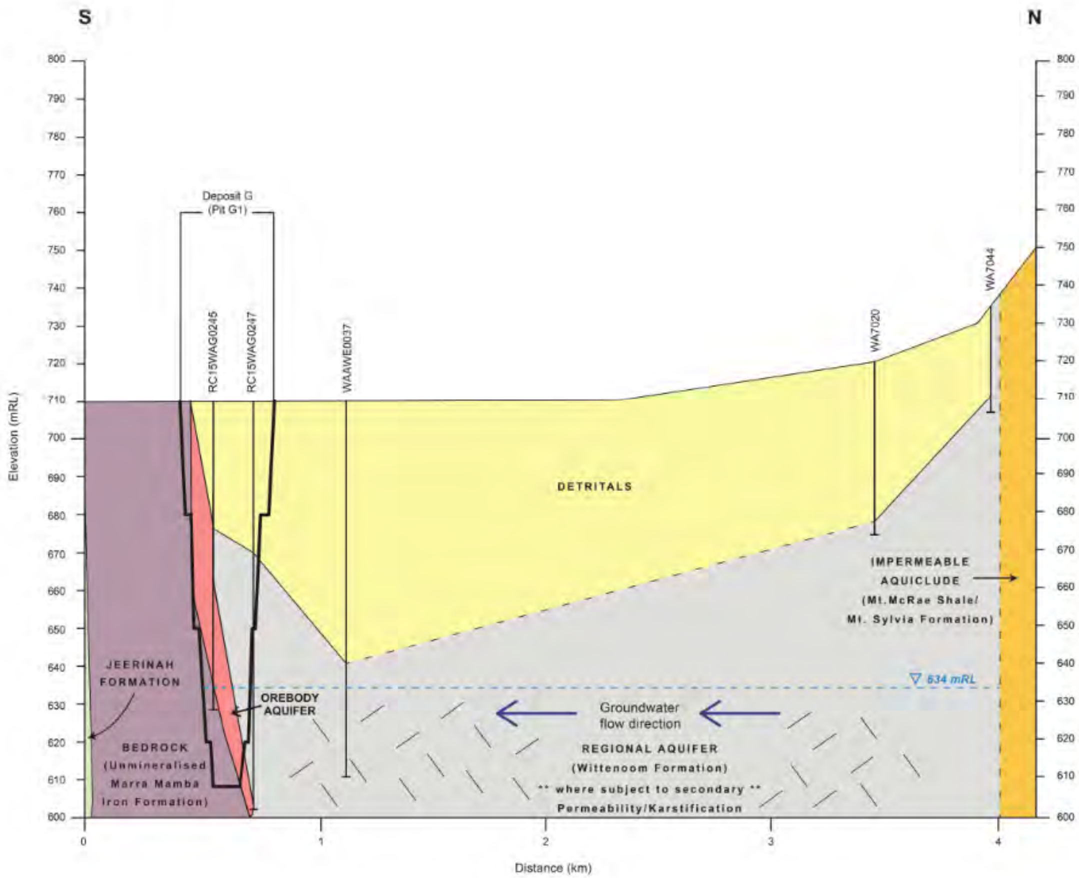

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Figure 13: Hydrostratigraphy cross section Deposit G1 (north – south) – section 2

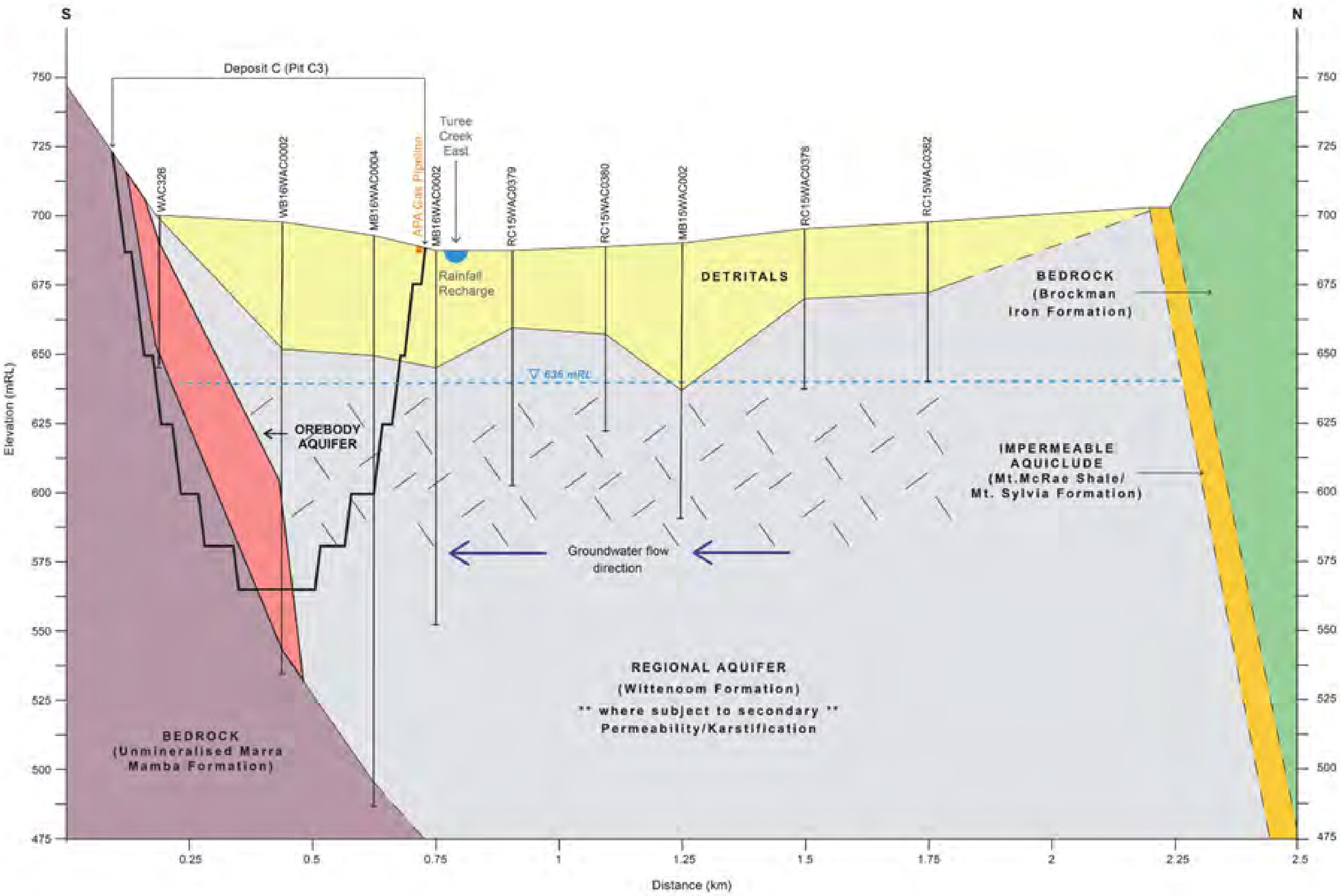

Figure 14: Hydrostratigraphy cross section Deposit C3 (north – south) – section 3

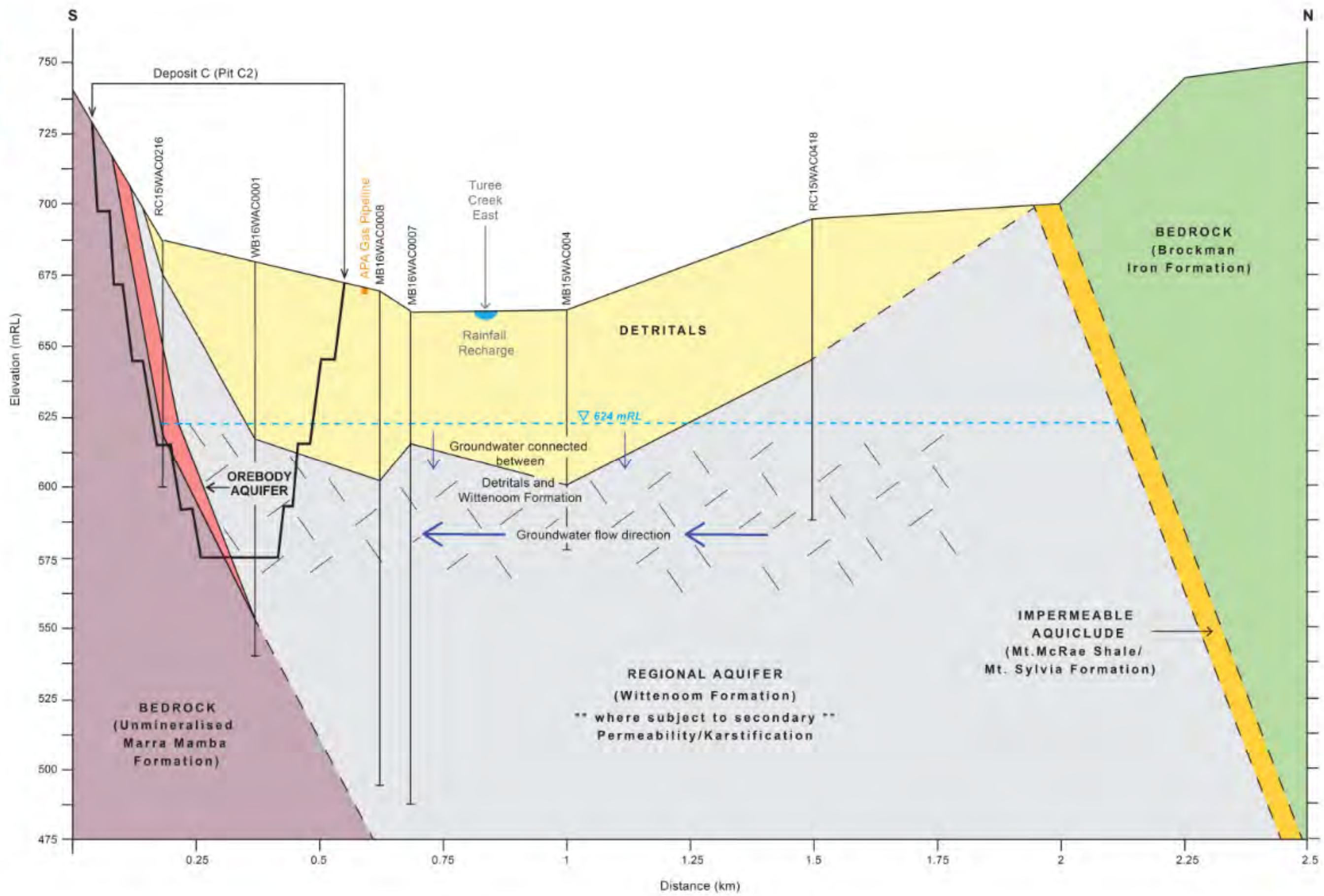

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Figure 15: Hydrostratigraphy cross section Deposit C2 (north – south) – section 4

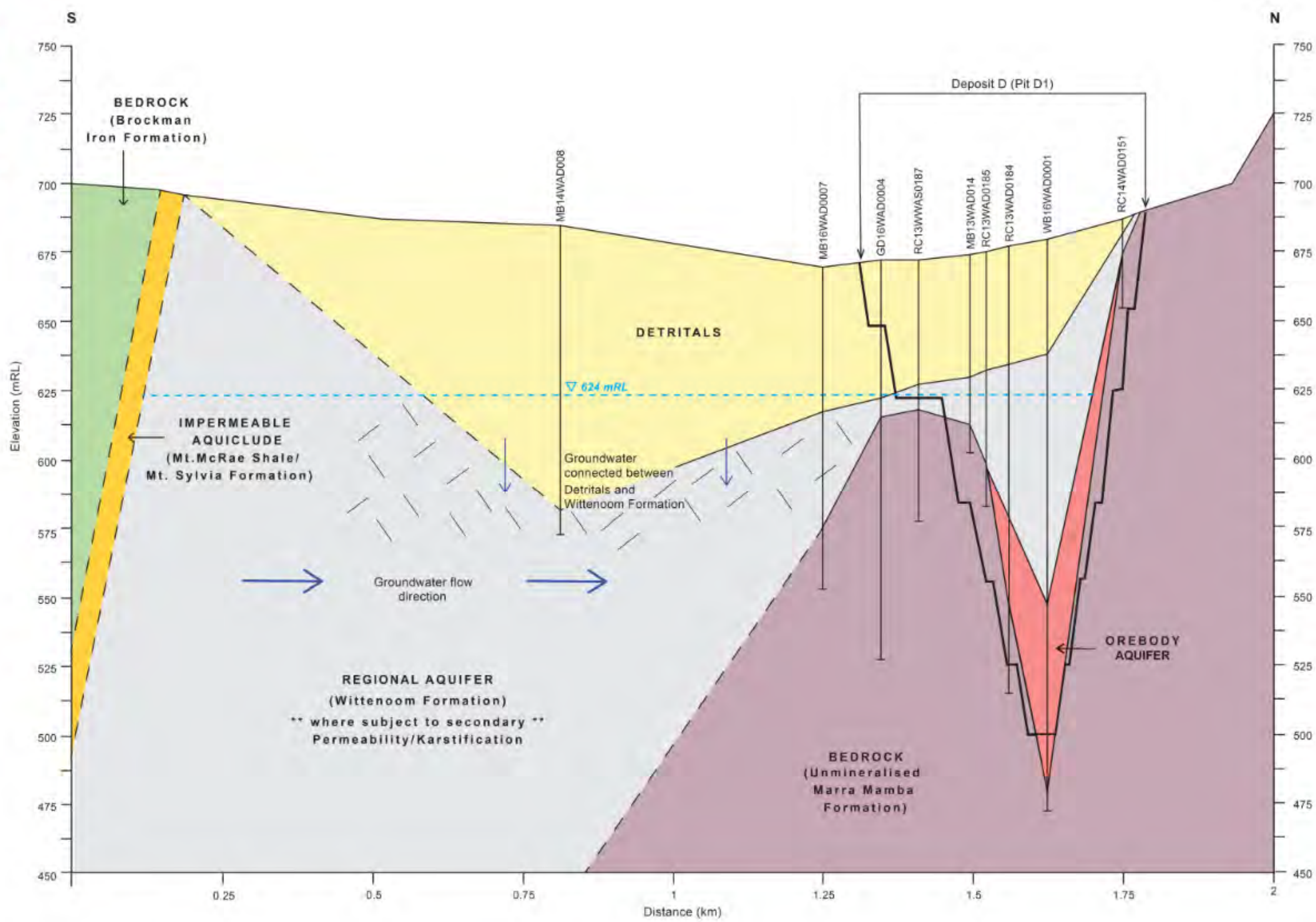

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Figure 16: Hydrostratigraphy cross section Deposit D1 (north – south) – section 6

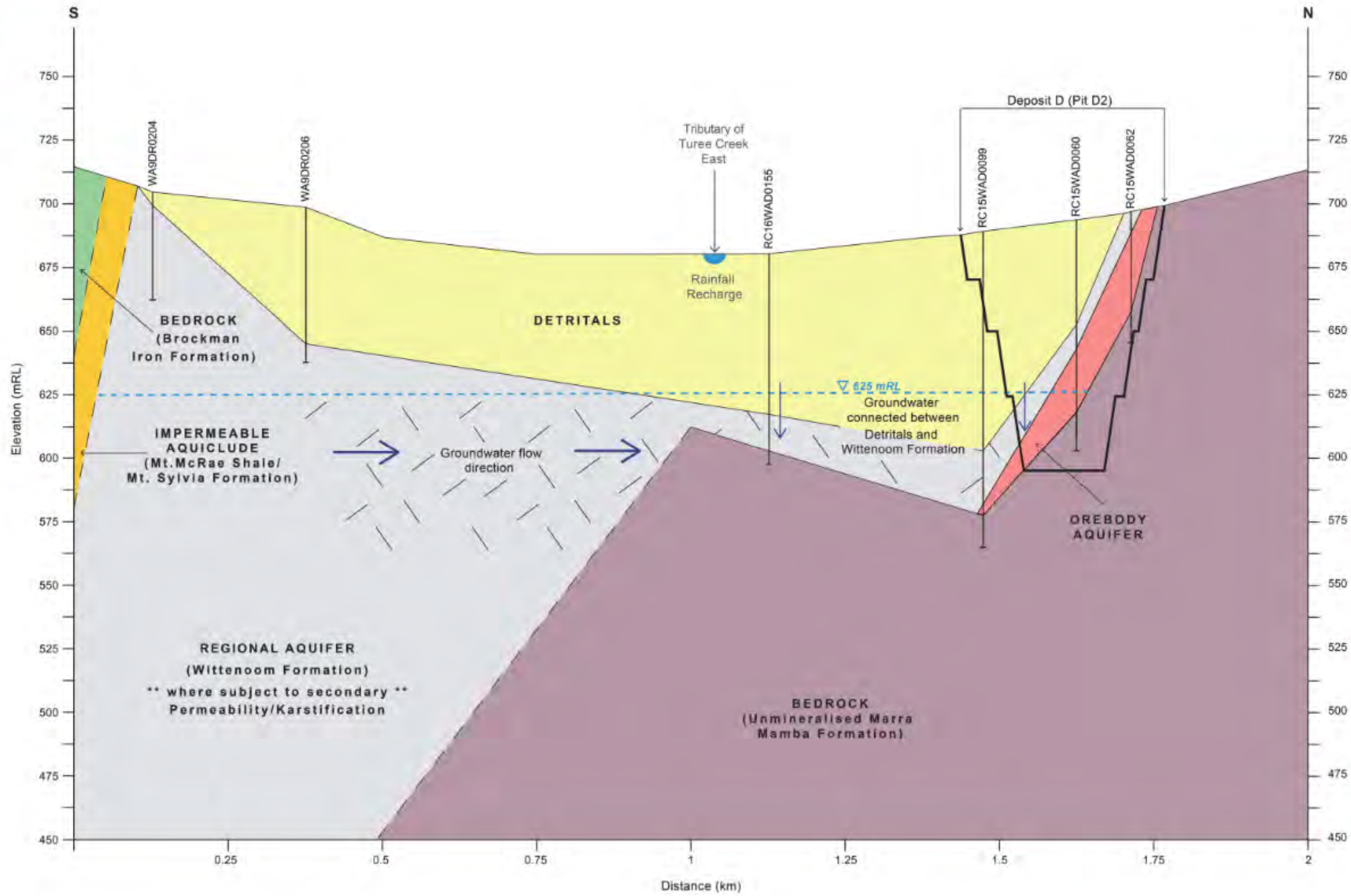

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Figure 17: Hydrostratigraphy cross section Deposit D2 (north – south) – section 7

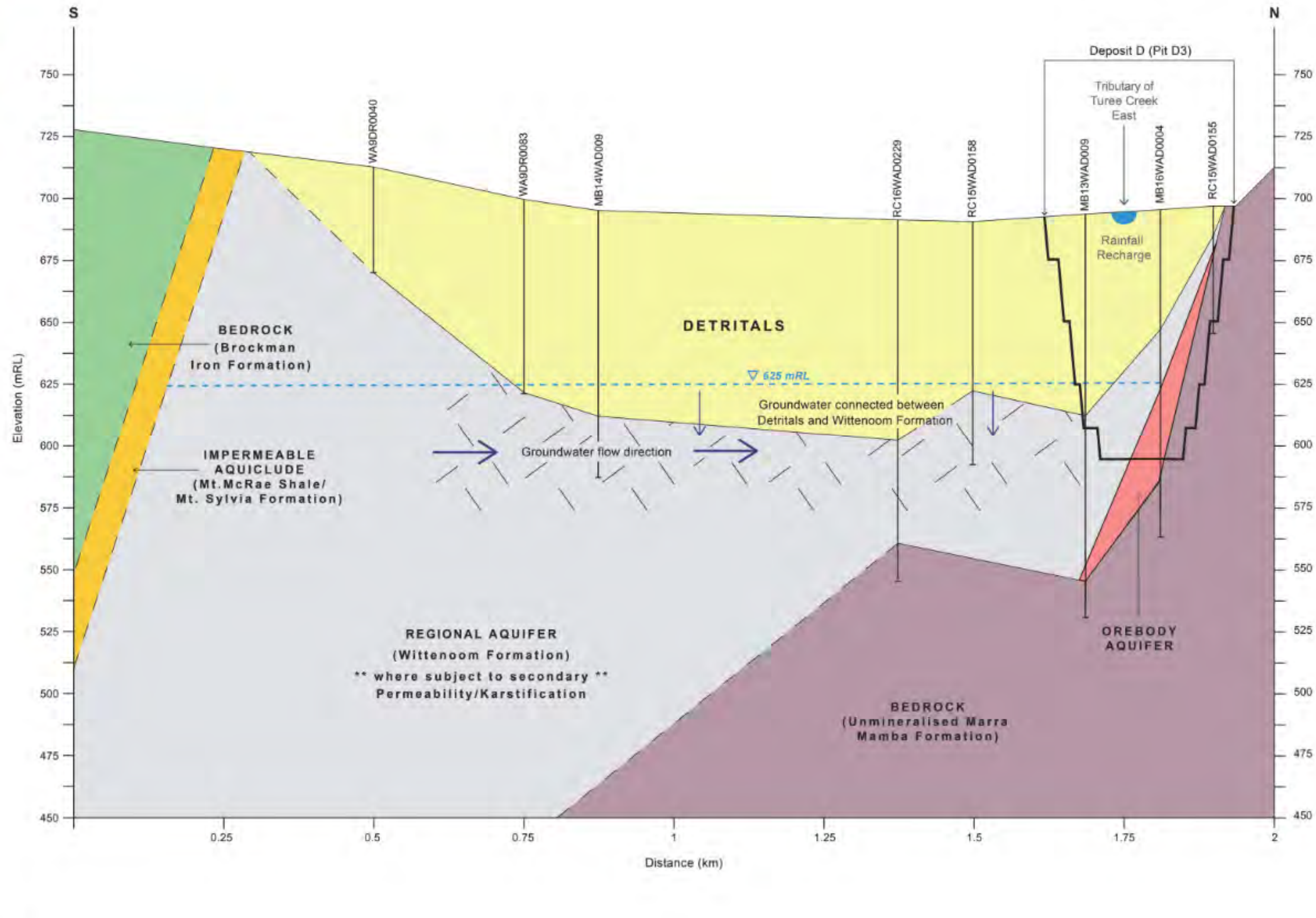

Figure 18: Hydrostratigraphy cross section Deposit D3 (north – south) – section 8

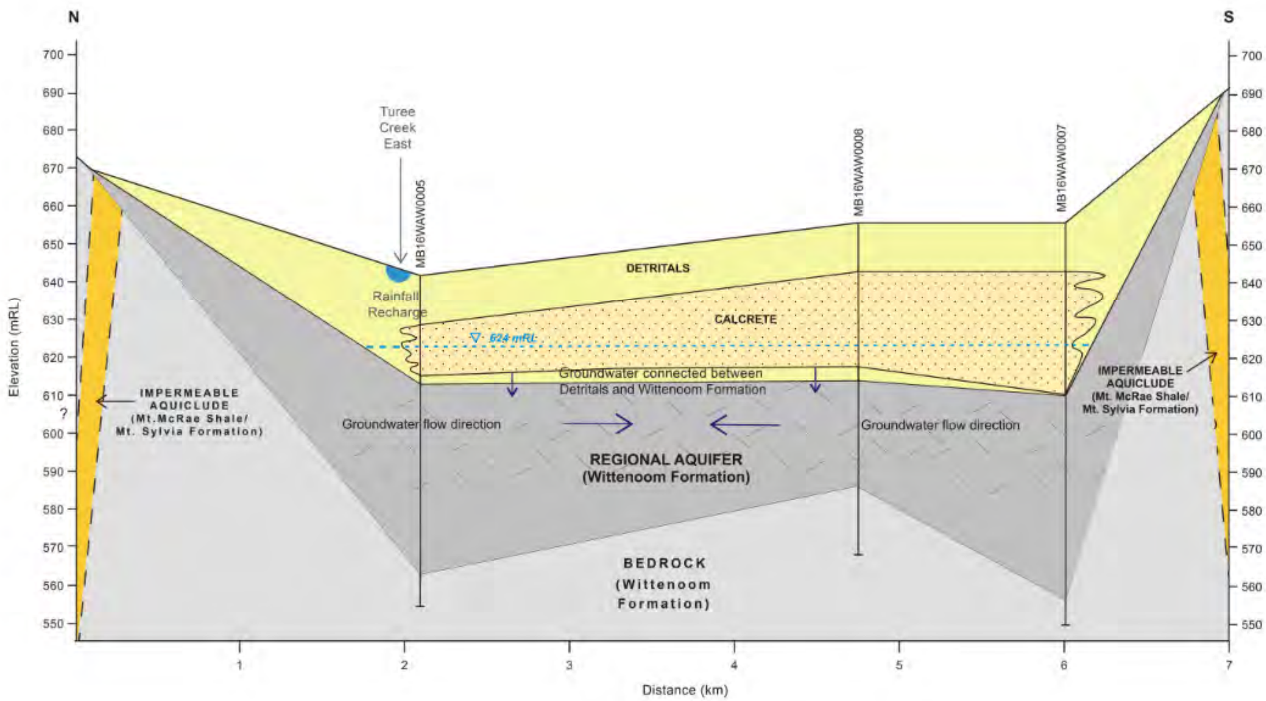

Figure 19: Hydrostratigraphy west end Deposit C and D (north – south) – section 9

3.5 Pumping testing

Pumping testing has been undertaken at all nine production bores completed in the area of Deposits C and D (Table 4) (RTIO, 2016b and 2017c).

Pumping testing was carried out in order to determine the following:

- Aquifer parameters in the area (permeability and storage),
- Provide information to inform engineering design (i.e. pump install depth, optimal abstraction rates, pumping water level),
- Assess the effectiveness of dewatering via ex-pit bores (drawdown in groundwater levels); and
- Assess hydraulic properties and any boundary conditions (e.g. associated with known dykes in the area).

Table 4: Summary of results pumping testing

Location	Aquifer	Constant rate test (L/s)	Drawdown (m)	K (m/d)	T (m^2/d)	Specific Yield	Sustainable rate operation (L/s)
WB16WAC0001	Detritals/Wittenoom Formation/Mt Newman Member	13	37.54	0.7	51	0.04	Not applicable (yield too low to fit out with pump)
WB16WAC0002	Wittenoom Formation/Mt Newman Member	50	13.42	5.9	554	0.049	30
WB17WAC0001	Detritals/Wittenoom Formation	55	40.67	2	138	0.02	40
WB17WAC0002	Detritals/Wittenoom Formation	62	4.98	6	996	0.03	62
WB17WAC0003	Wittenoom Formation	28	63.98	0.4	49	Not available	20
WB16WAD0001	Orebody (Wittenoom Formation/Mt Newman Member)	30	38.89	0.4	61	0.01	10
WB16WAD0002	Detritals/Wittenoom Formation/Mt Newman Member	18	31.68	1	59	0.036	8
WB17WAD0001	Detritals/Wittenoom Formation/Mt Newman Member	62	14.24	2	267	0.05	60
WB16WAW0001	Detritals/Wittenoom Formation/Mt Newman Member	25	19.8	7.6	403	0.022	None dewatering bore

Results indicate unconfined aquifer conditions, with bulk hydraulic conductivities ranging from 0.6 to 6m/day. As anticipated, due to the effects of mineralisation, drawdown is enhanced in an east – west direction and drawdown did not extend beyond the NE/SW trending Dolerite dyke between Deposits C2 and C3 which acts as a groundwater divide (Figure 20 to Figure 27 inclusive).

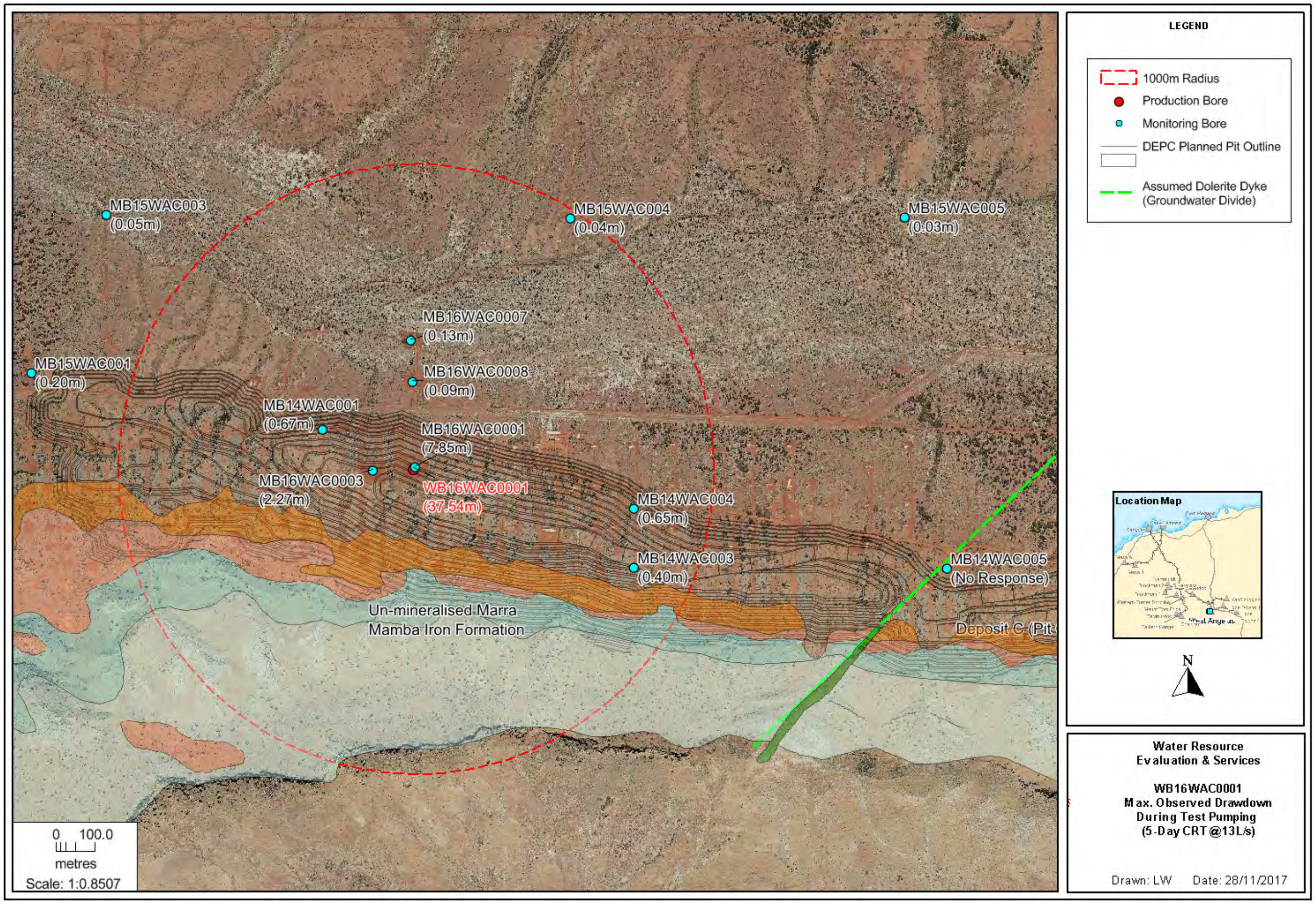

Figure 20: Maximum drawdown encountered during pumping testing WB16WAC0001

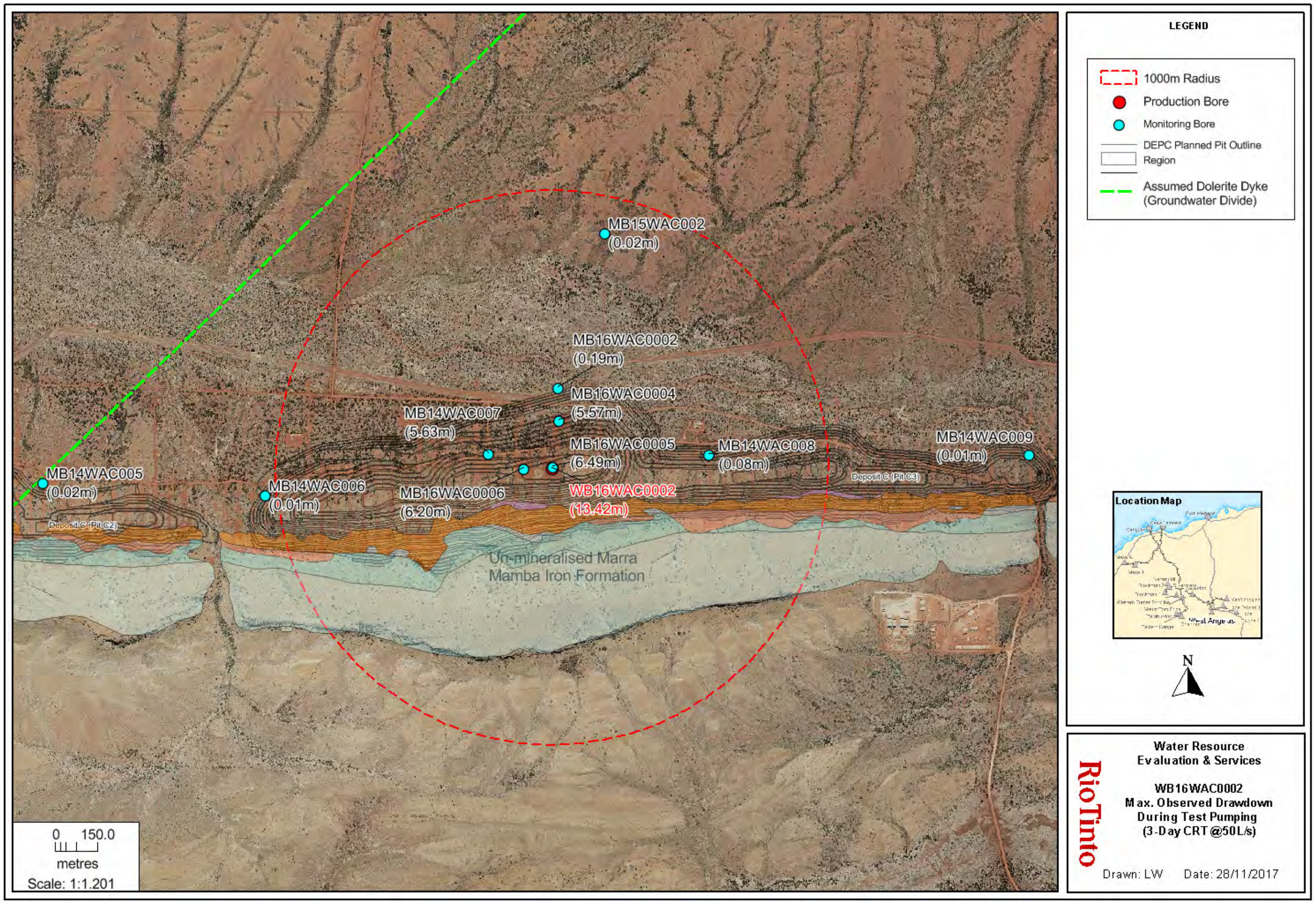

Figure 21: Maximum drawdown encountered during pumping testing WB16WAC0002

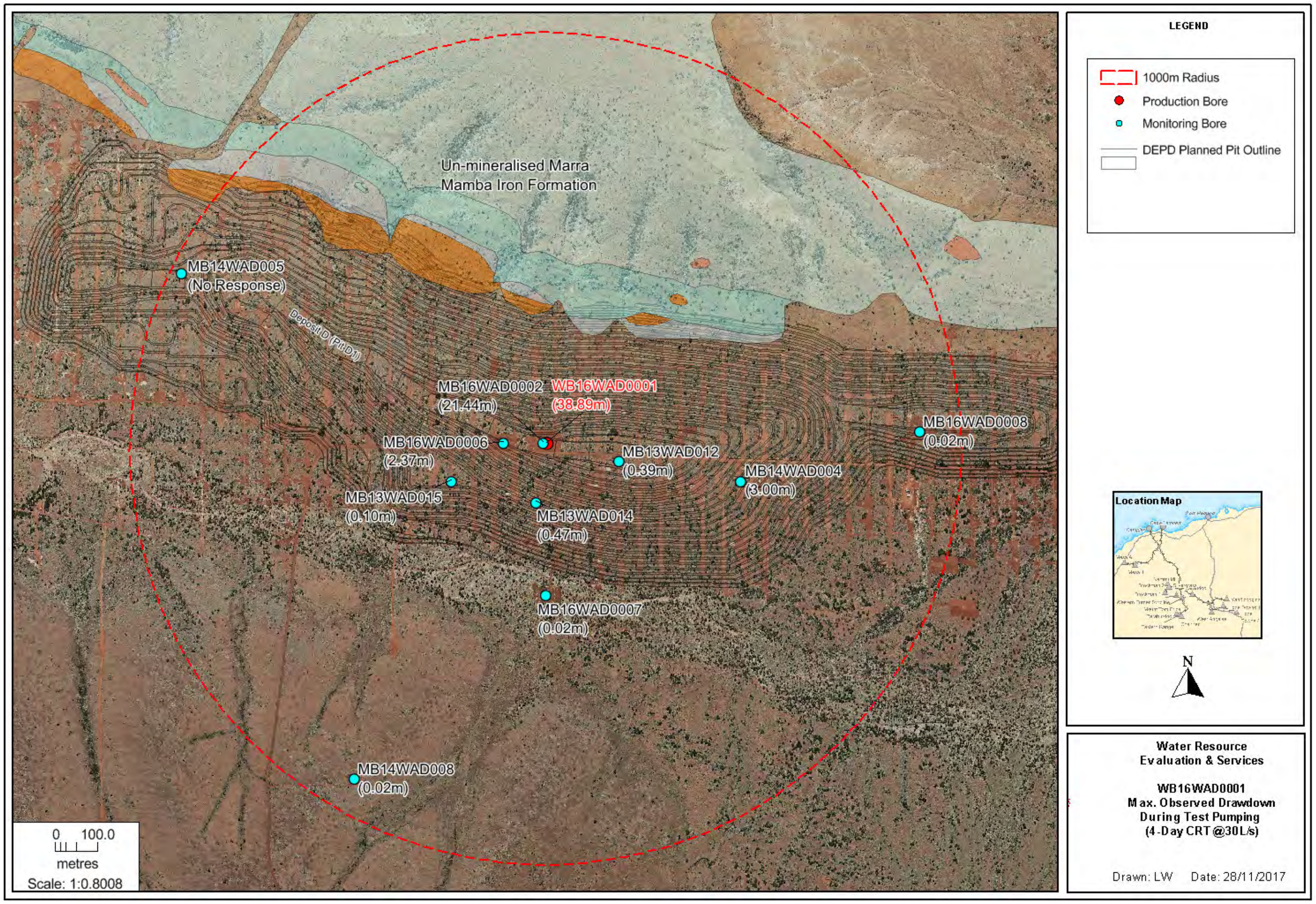

Figure 22: Maximum drawdown encountered during pumping testing WB16WAD0001

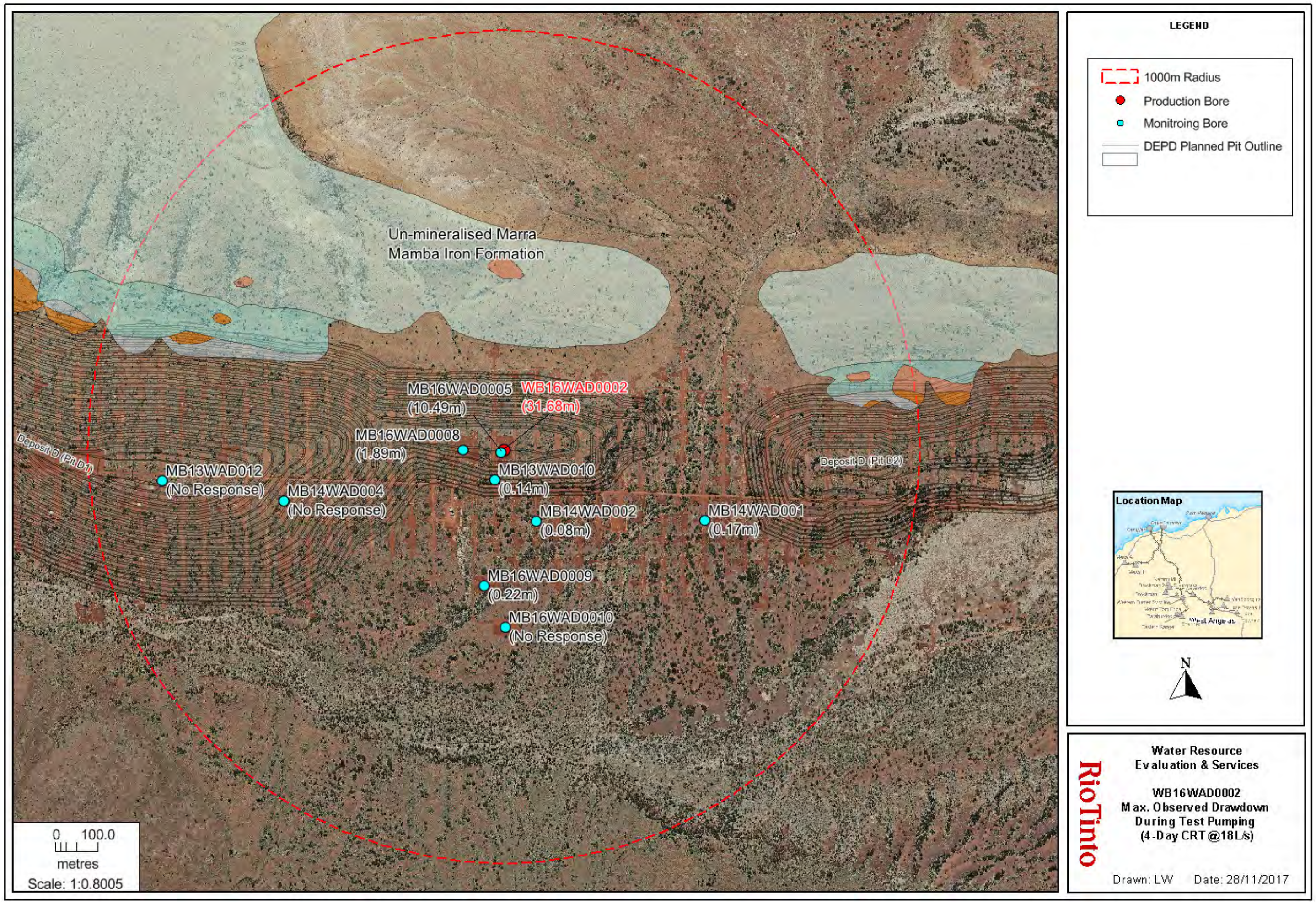

Figure 23: Maximum drawdown encountered during pumping testing WB16WAD0002

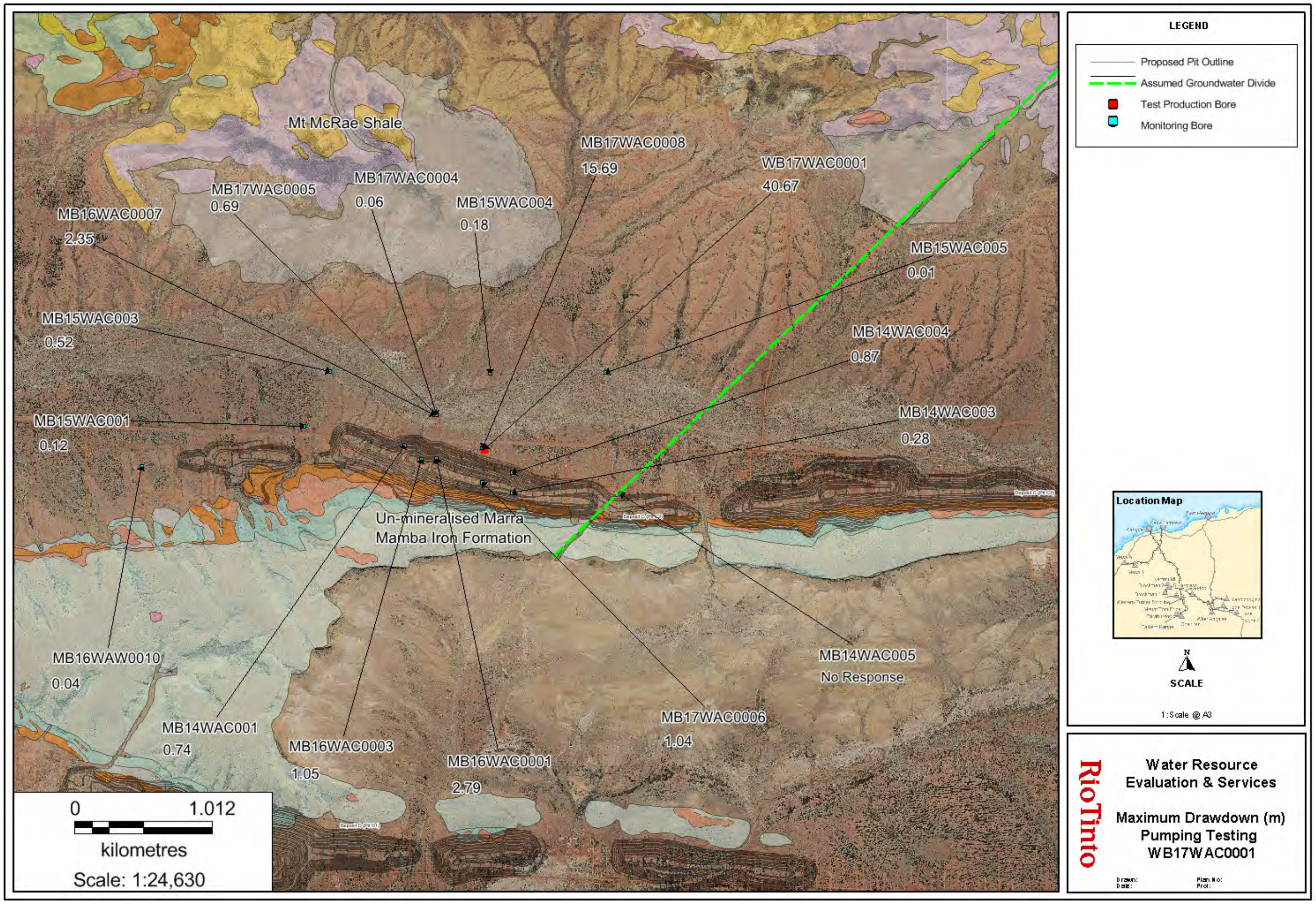

Figure 24: Maximum drawdown encountered during pumping testing WB17WAC0001

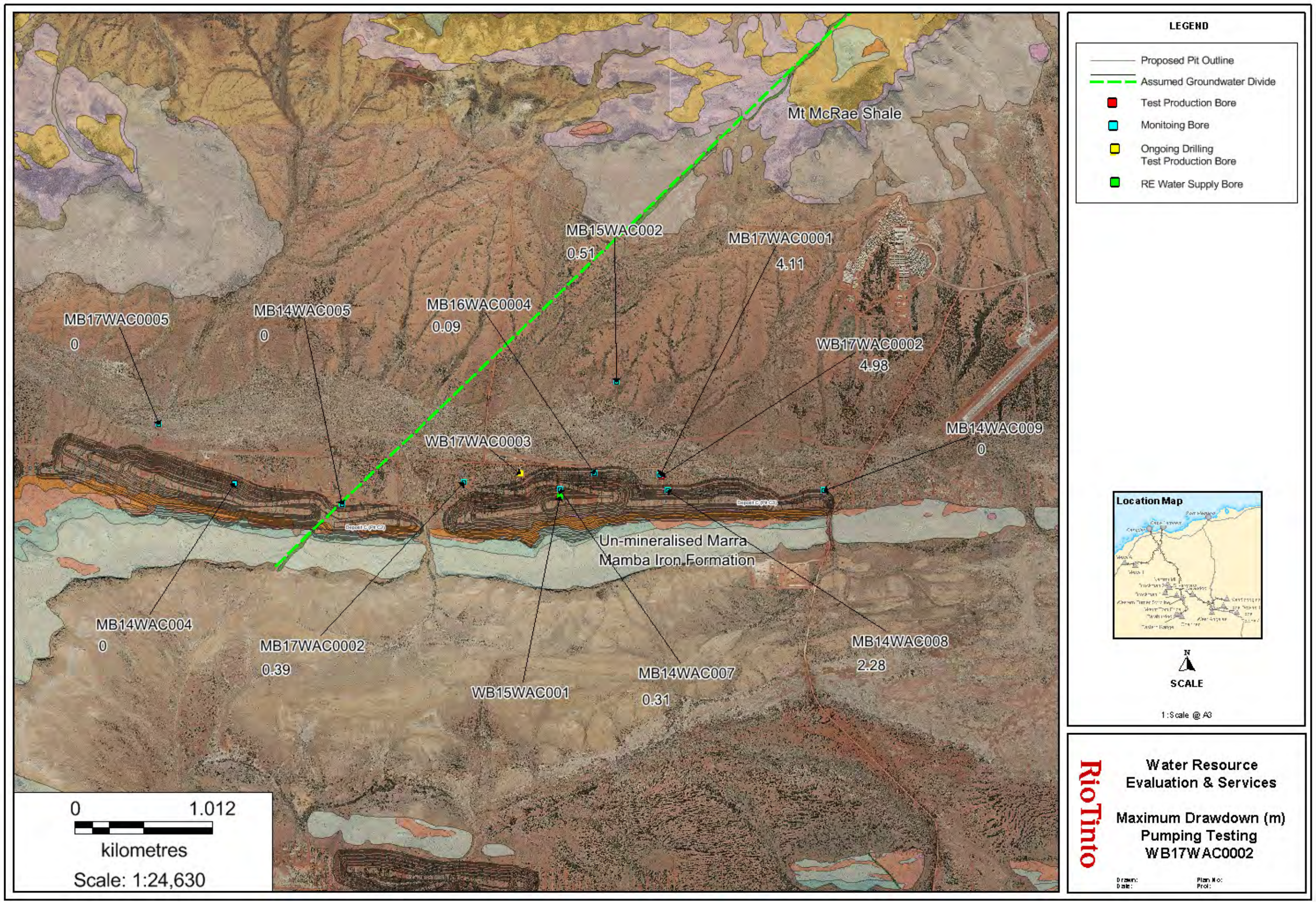

Figure 25: Maximum drawdown encountered during pumping testing WB17WAC0002

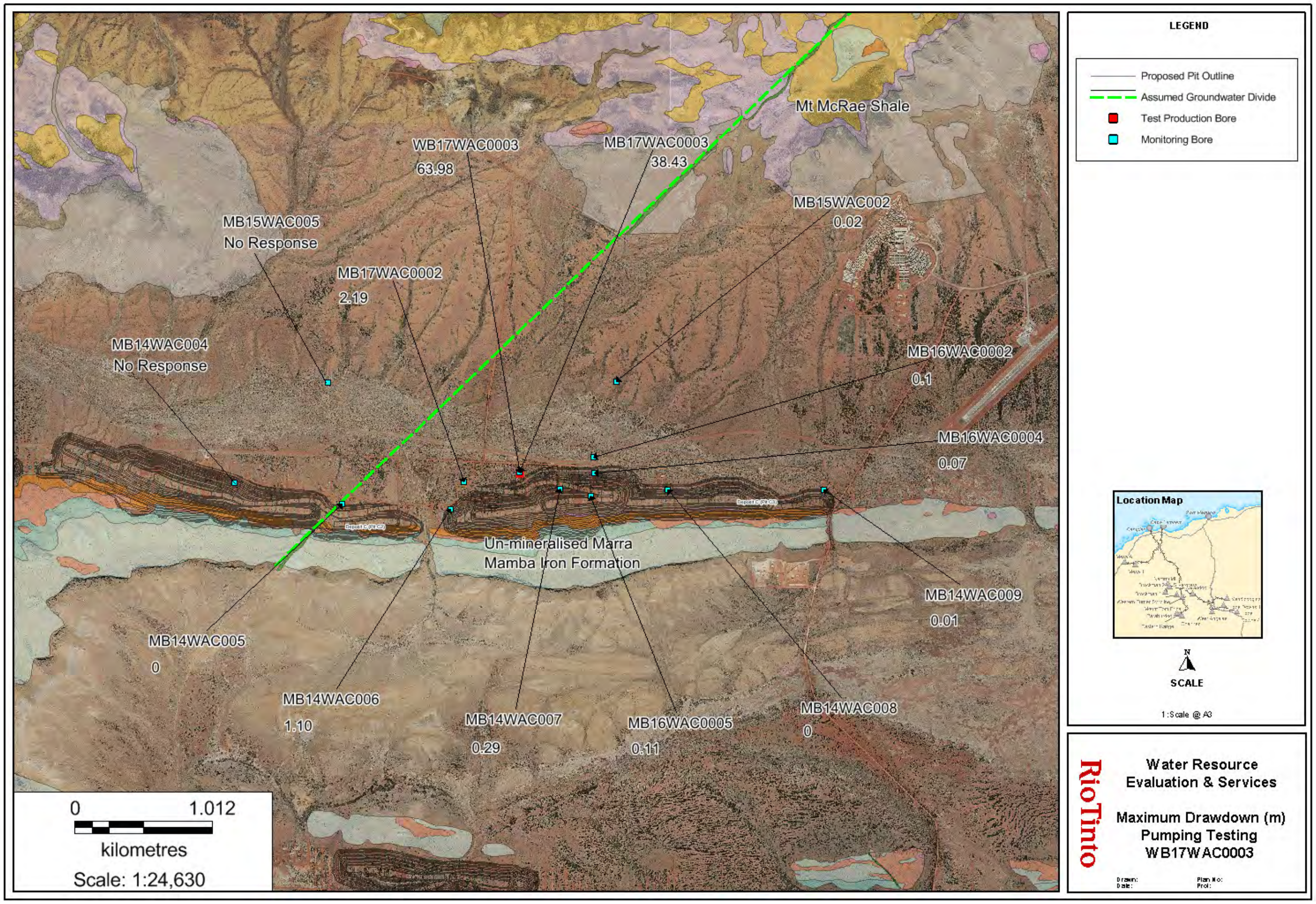

Figure 26: Maximum drawdown encountered during pumping testing WB17WAC0003

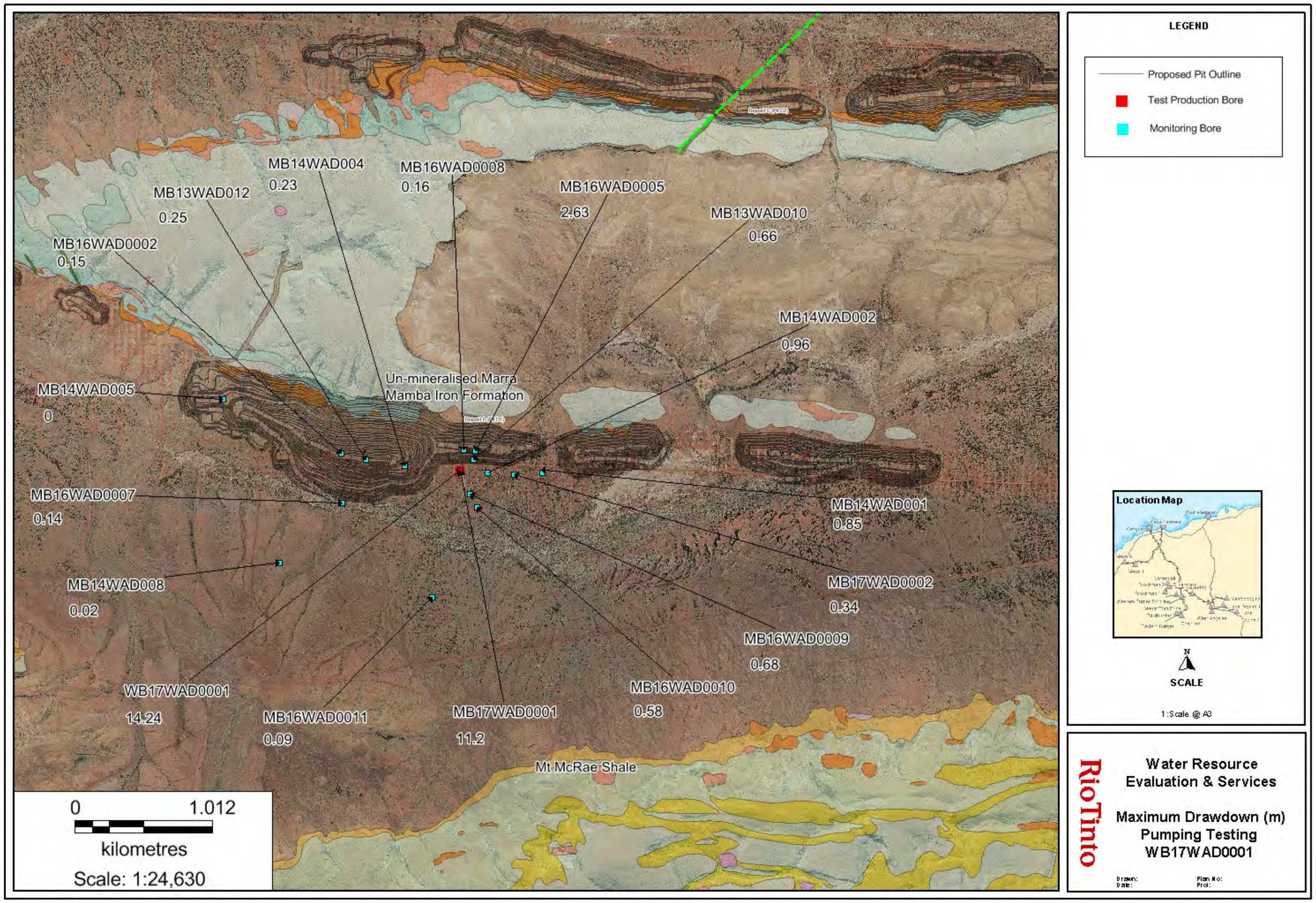

Figure 27: Maximum drawdown encountered during pumping testing WB17WAD0001

3.6 Recharge

Based on a review of available hydrographs with rainfall data (Figure 28 to Figure 32 inclusive), there is negligible response to rainfall events across most of the area, except in the location of WANG14 (~1.3m rise in groundwater level recorded in February 2017 and located to the west of the site in area of KNP and potential GDE). The observed response of groundwater level to rainfall at this location is assumed to be associated with the shallow depth to groundwater ~7m bgl, as well as possibly the presence of the enhanced permeability layer in the calcrete in this area.

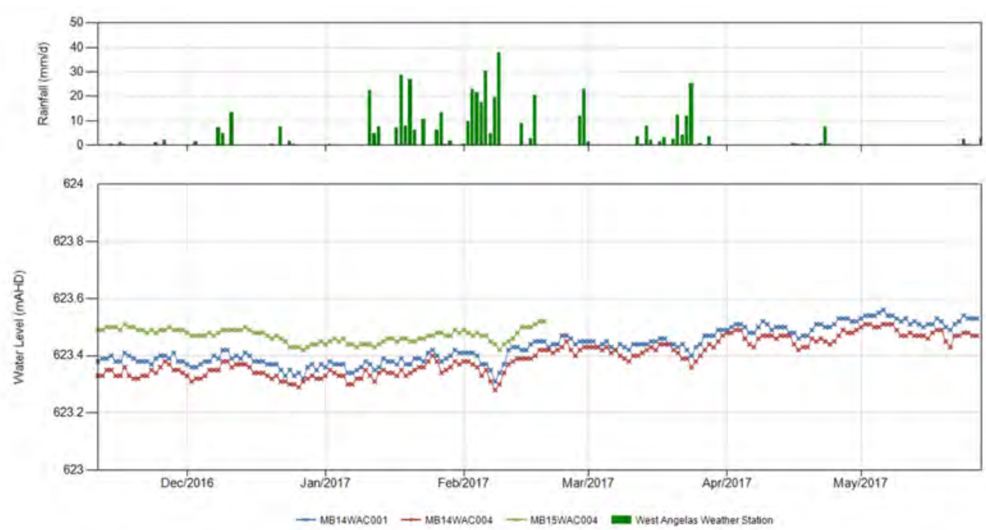

Figure 28: Hydrograph/rainfall data area Deposit C2

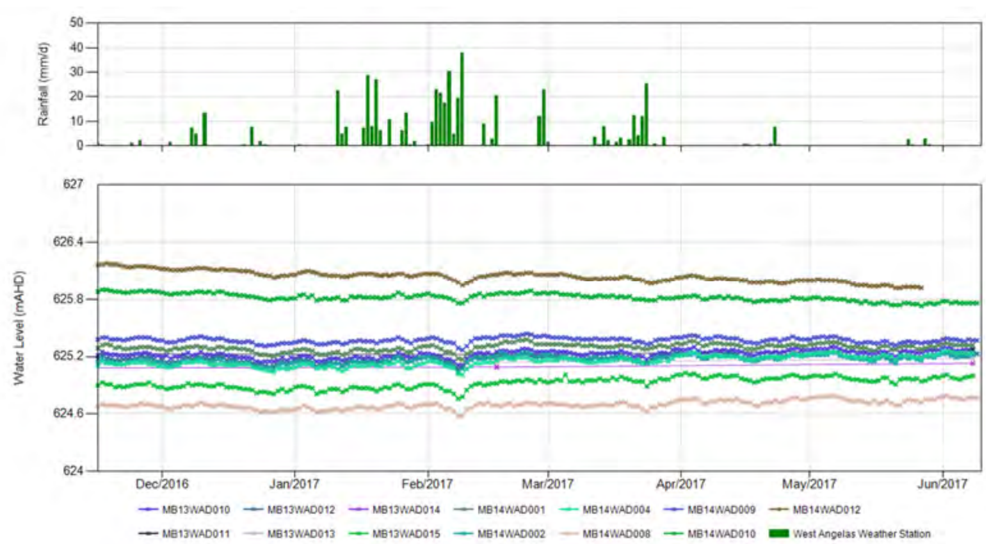

Figure 29: Hydrograph/rainfall data area Deposit D

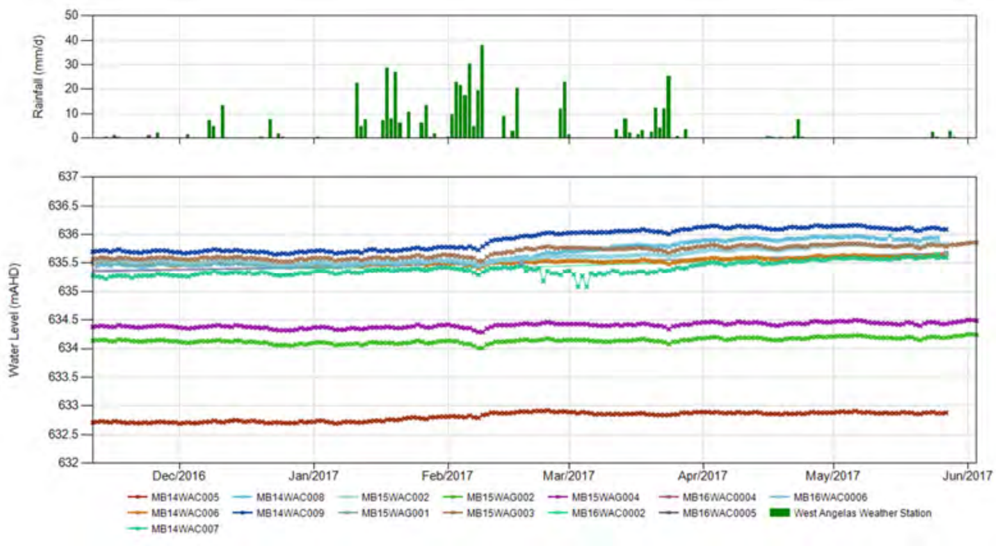

Figure 30: Hydrograph/rainfall data area Deposit C3 and Deposit G

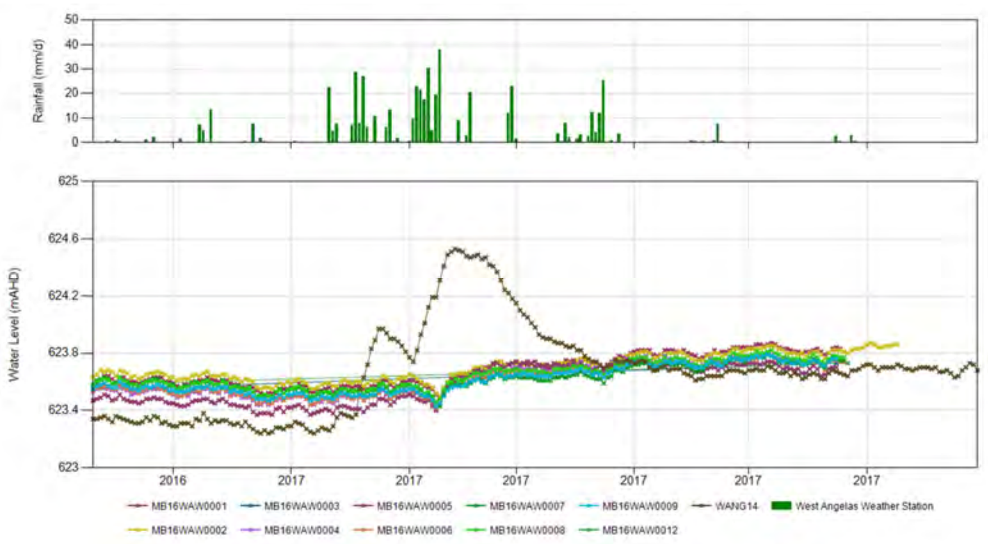

Figure 31: Hydrograph/rainfall data area west of Deposit C and D

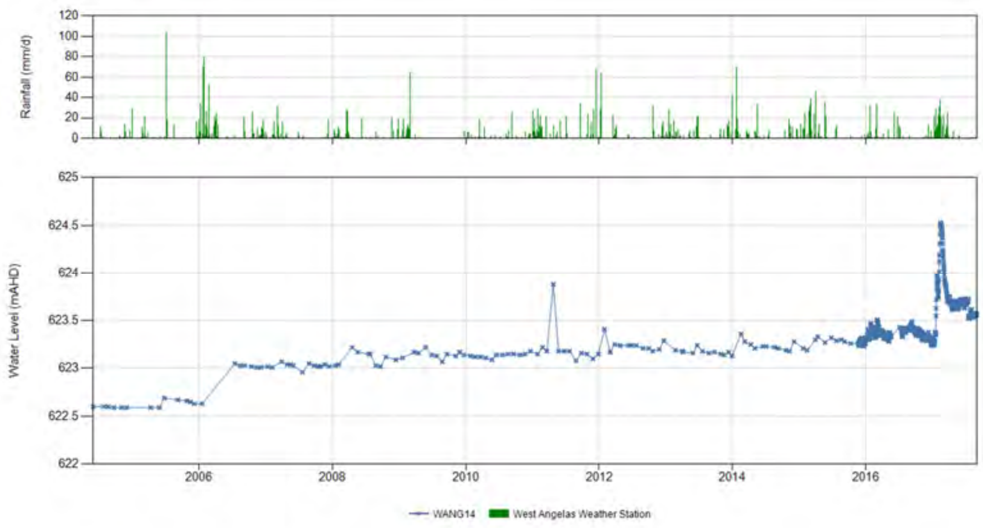

Figure 32: Hydrograph/rainfall data area WANG14 since 2004

In order to better understand recharge flux across the study area, an extensive study was carried out comprising hydrochemical sampling and analysis for electrical conductivity, major ions, ^{18}O, ^{2}H, ^{13}C, CFCs and ^{14}C and ^{39}Ar (Figure 33).

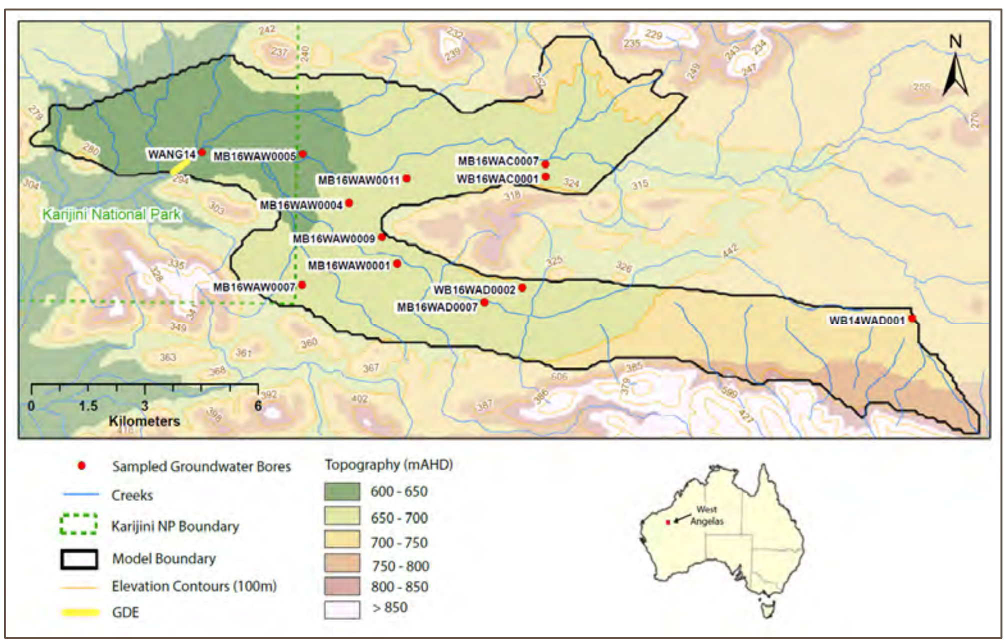

Figure 33: Location of sample points for environmental tracers

The geochemistry and isotope data suggest that the groundwater is generally of good quality, with total dissolved solids (TDS) ranging between 316 and 1,130 mgL^{-1}.

Stable isotope data of the area show that $\delta^{18}O$ ranges between -8.88‰ and -7.73‰, while $\delta^{2}H$ ranged from -58.45‰ to -50.60‰. This range suggests that intense rainfall events of 20mm or more, with limited evaporation prior to infiltration contribute most to recharge and the narrow range of variance suggests the water has the same origin.

Based on these ranges and assuming long term average of annual precipitation of 300mm yr^{-1} and mean chloride concentration in rainfall of 1.3mgL^{-1}, the recharge rate is estimated to vary from 0.1 to 4.1mm yr^{-1}.

The uncorrected ^{14}C activities range between 4 pmC and 47 pmC indicating water is generally old and showed no distinct regional pattern.

Analysis of chlorofluorocarbon (CFC) results were inconclusive due to likely mixing in the sampled bores all of which had large open screen intervals.

From the above calculations it is apparent that the current recharge flux in the study area is low reflecting current climatic conditions. However, at the time of the deposition of the older water (those waters with low pmC activities), recharge must have been much higher.

3.7 Groundwater flow

Groundwater levels obtained from monitoring bores in the vicinity of Deposits C, D and G are presented in Figure 34 and Appendix 2.

Monitoring results indicate a relatively flat hydraulic gradient of 0.00002 in the area of Deposit C2 to the west and towards KNP. In the area of Deposit C3 the groundwater flow direction is reversed, with a gradient of 0.002 and towards the east (i.e. indicating evidence of compartmentalisation between Deposit C2 and C3, associated with a Dolerite dyke. In the area of Deposit D, the groundwater gradient is 0.002 towards the west and KNP.

Recorded depths to groundwater decrease from east to west across the site in line with topography (i.e. ~135m bgl in the eastern end of Deposit D to ~ 7m bgl in the area of KNP (Figure 35).

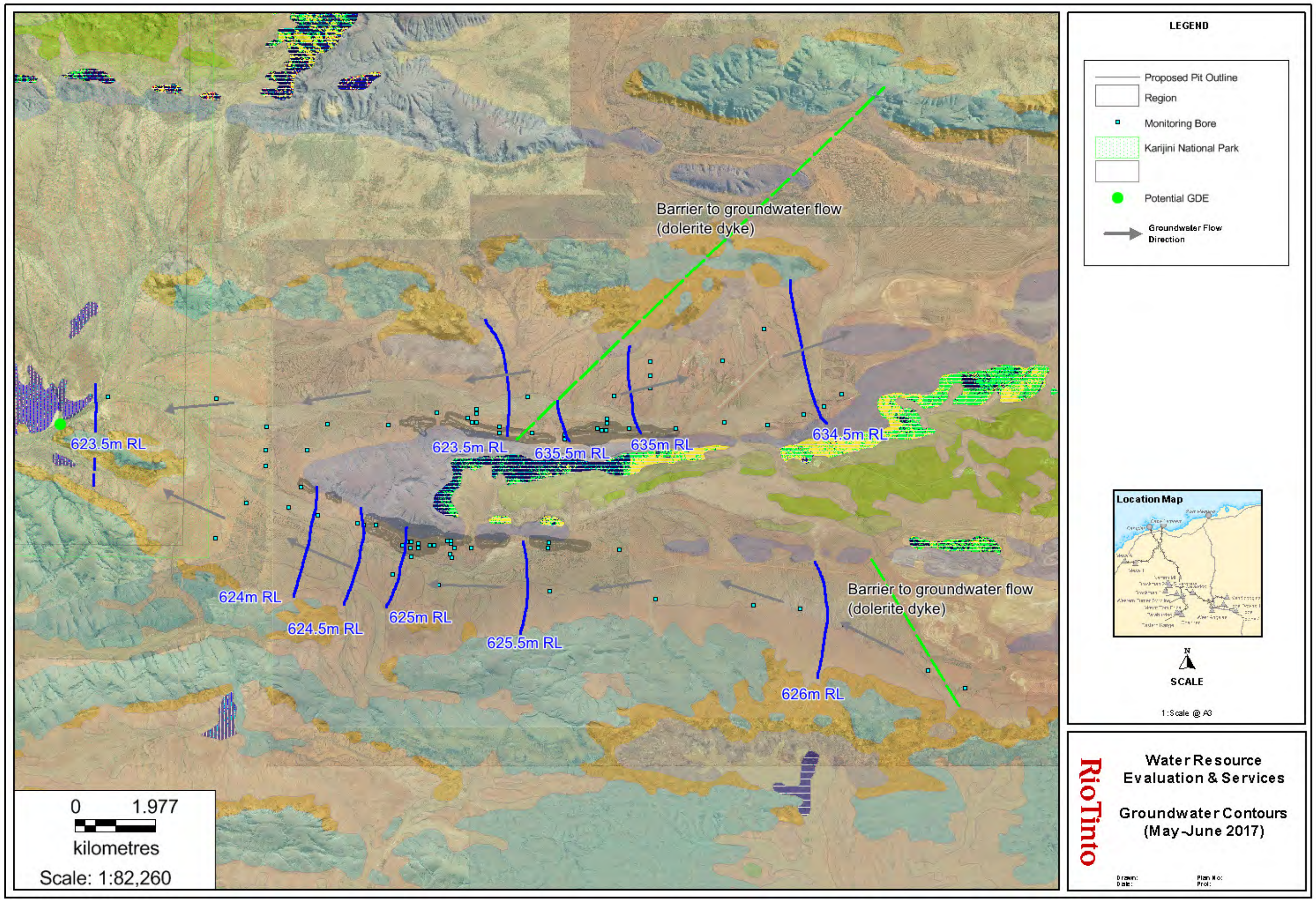

Figure 34**: **Groundwater contours (May-June 2017)

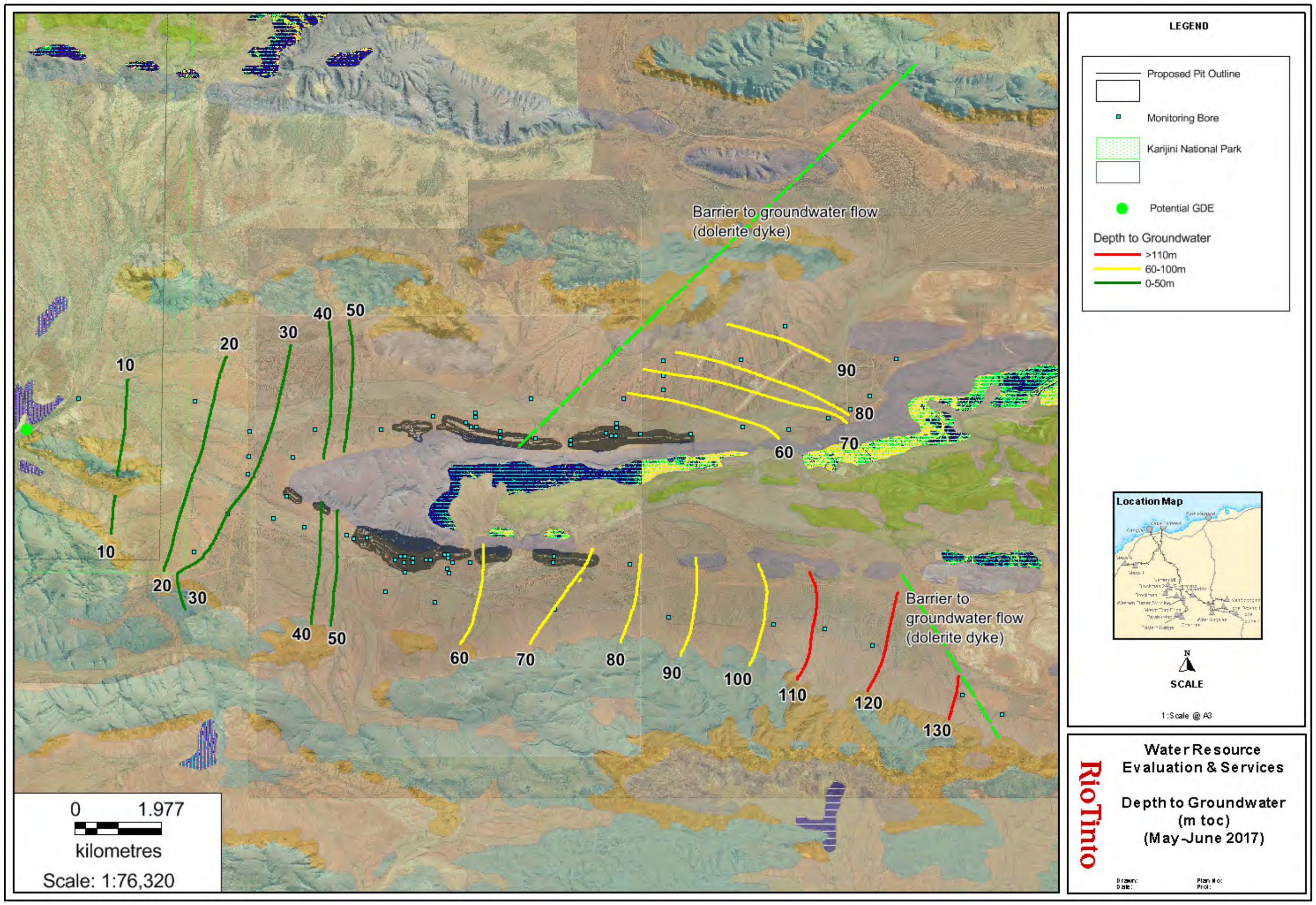

Figure 35: Depth to groundwater (May-June 2017)

3.8 Discharge

Based on the significant depth to groundwater across much of the area of Deposit C2 and D and minimal anticipated recharge, the closed groundwater catchment (i.e. no inflow boundaries associated with un-mineralised Marra Mamba Iron Formation, groundwater divides in the area etc.), the only discharge is assumed to be associated with evapotranspiration in the area of the potential GDE to the west, and the area of KNP. Based on RTIO Botanist information (pers. coms. J. Naaykens to Simon Page, 2016), it is currently estimated that the potential GDE may generate an evapotranspiration rate of 0.1 GL/year (Figure 36).

Based on the groundwater elevation across the area of Deposit C3 and G, the closed groundwater catchment to the north, south and west (i.e. no inflow boundaries associated with the Mount Sylvia Formation/Mt McRae Shale, un-mineralised Marra Mamba Iron Formation and the groundwater divide), the only discharge is assumed to be associated with groundwater flow to the east, with an assumed rate of 300 m^3/d (0.1 GL/year).

$$Q = T*i*W$$

Q = Discharge (m^3/d)

i = Hydraulic gradient - 0.002 (measured)

T = Transmissivity – 100 m^2/d (based on an assumed K = 5m/d and an aquifer thickness of 20m)

W = Width of valley – 1,500 m (inferred based on surface geological mapping)

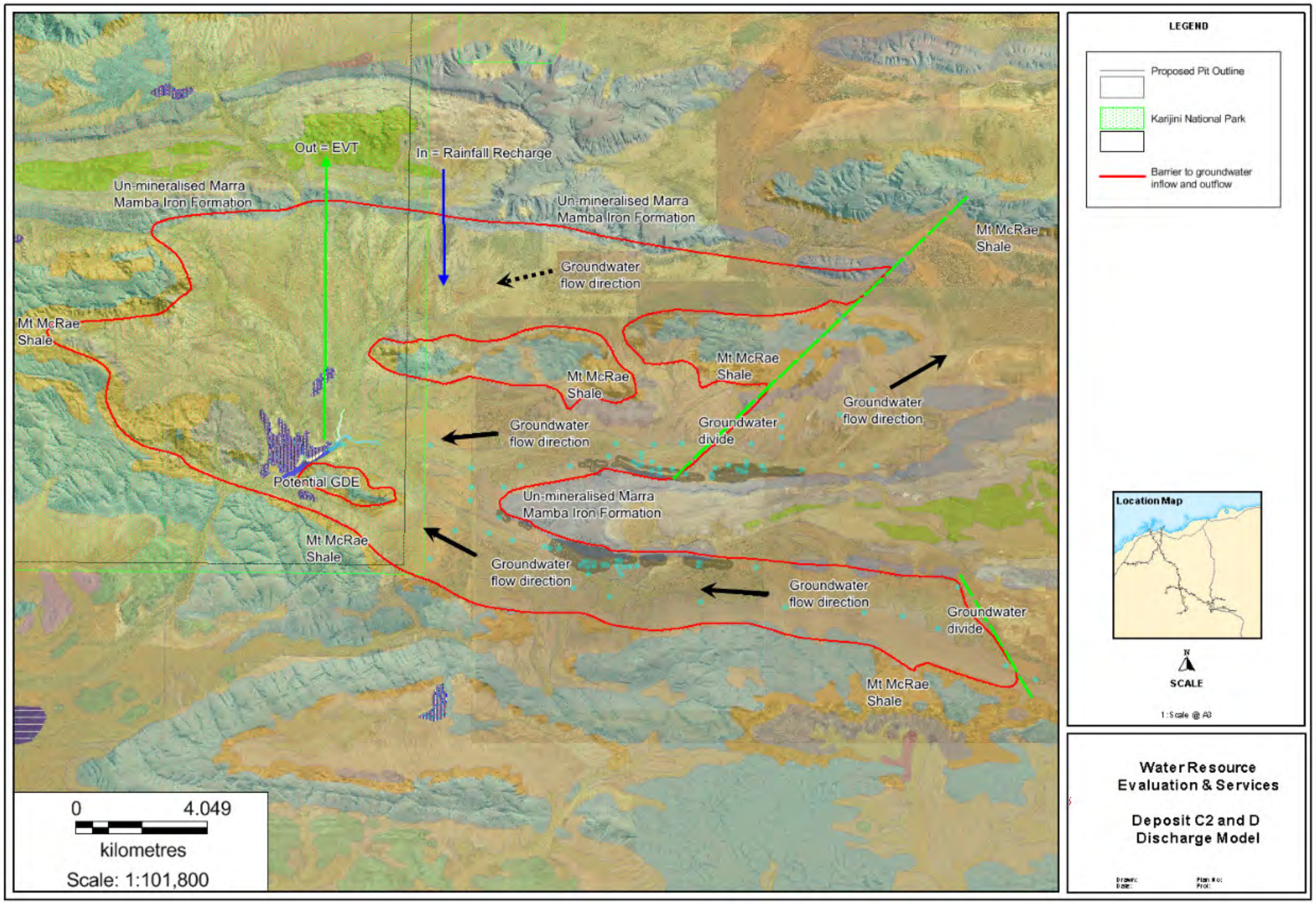

Figure 36: Discharge model

3.9 Hydrochemistry

The results of the analysis of filtered samples obtained during pumping testing during the 2016 and 2017 field programs (RTIO, 2016b and 2017c), revealed that groundwater samples showed similar values for major cations and anions, both for bores completed in the orebody aquifer (mineralised Mount Newman Member and Wittenoom Formation), as well as bores completed in the regional aquifer (Wittenoom Formation) (Figure 37 and Figure 38).

Results of pH analysis ranged from 6.60 to 8.24. Groundwater was fresh with conductivity values ranging from 421 to 1,790 µS/cm.

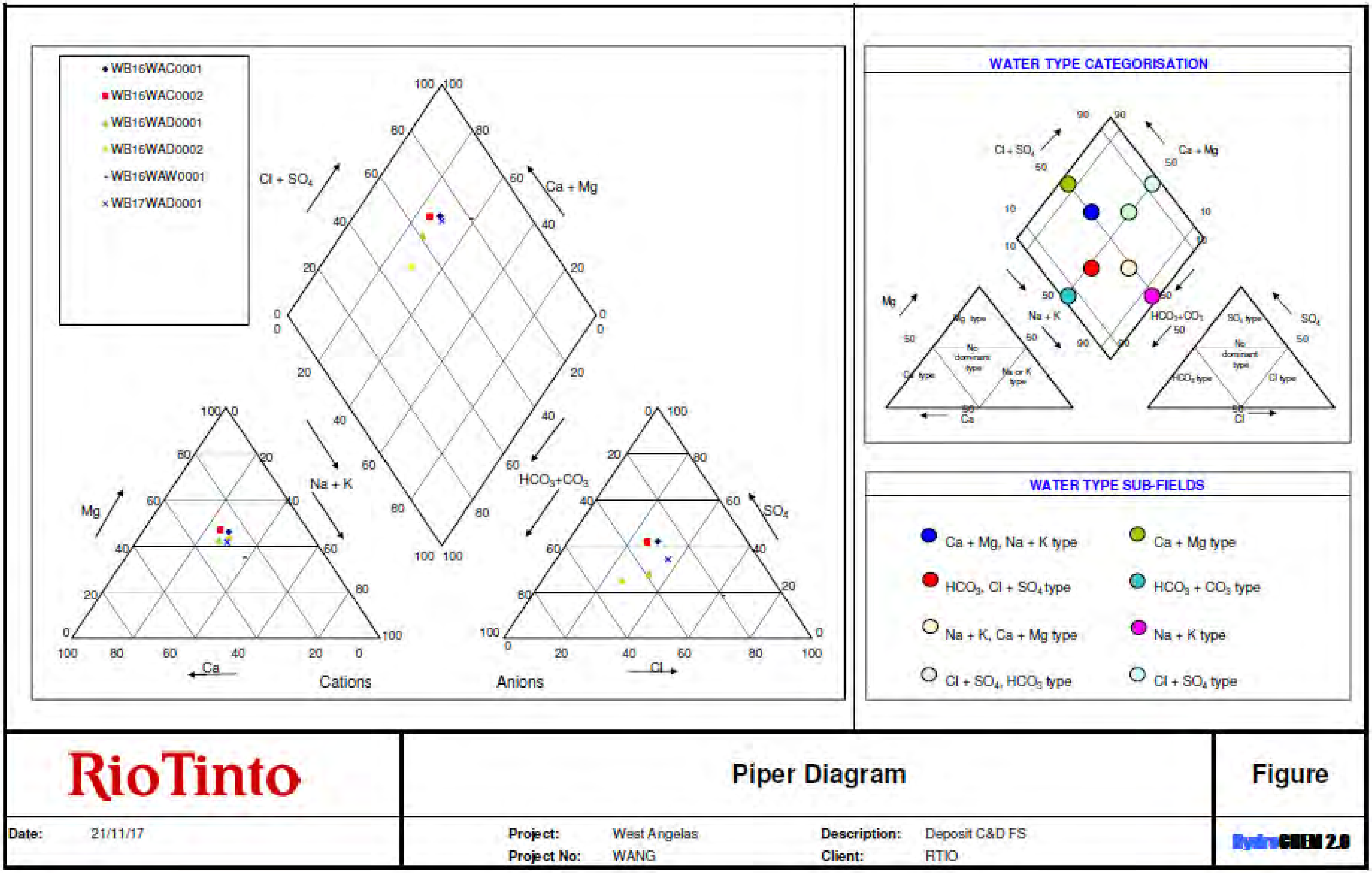

Figure 37: Piper diagram groundwater quality (MMIF and Wittenoom Formation)

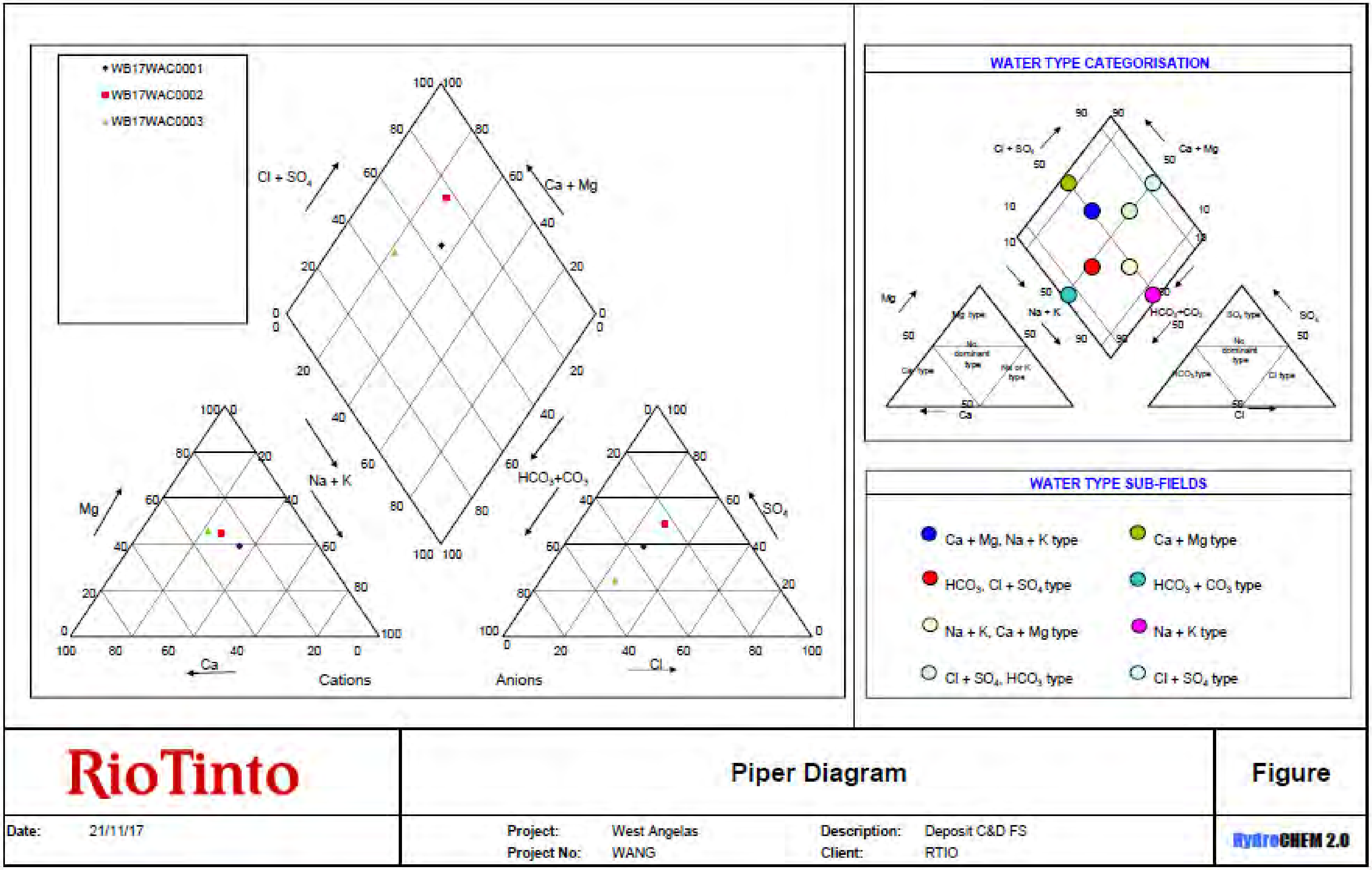

Figure 38: Piper diagram groundwater quality (Wittenoom Formation)

3.10 Water balance

A catchment scale water balance was undertaken to help refine the conceptualisation and to determine the likely volumetric inputs for each of the processes identified in the balance.

Components of the water balance can be expressed as follows:

Total inflow – total outflow = $\Delta S/\Delta t$

where ΔS = change in storage, and Δt = change in time.

Under natural long-term (steady state) conditions, the change in storage is zero relative to time, and hence:

Total inflow = Total outflow

Including the specific water balance components for the catchment results in the following equation:

$$P = ET + R + Q$$

where P = precipitation, ET = evapotranspiration, R = recharge and Q = run-off outflow.

If the basic water balance equation is combined to include the solute chloride, then:

$$PCl_p = ETCl_{et} + RCl_{gw} + QClq$$

where Cl_p, $Cl_{et,}$ Cl_{gw}, and Cl_q refer to chloride concentrations in rainfall, recharge, evapotranspiration and runoff respectively. The chloride ion is considered to behave conservatively. That is it does not participate in any hydrochemical reactions with other ions in groundwater or undergo rock interaction.

Aquifer recharge (R) can be calculated using the chloride mass balance method as follows:

$$R = (P*Cl_p)/Cl_{gw}$$

Based on an assumed annual rainfall of 317mm/year, a chloride concentration in rainwater of 1.3mg/l (Dogramaci et al, 2012), and an observed range of chloride concentration in groundwater between 37 and 460mg/l, recharge can be calculated between 4.1 and 0.1mm/year. Assuming even recharge across the catchment area and based on the measured expanded aquifer area of 180km^2, recharge across the entire area is calculated between 0.7 to 0.02GL/year.

4. Existing groundwater use

There are currently two groundwater licences in support of existing Operations at the West Angelas mine site.

1. Groundwater licence GWL103136 is associated with the Turee B borefield, located approximately 40km west of the mine site and has an abstraction limit of ~3.1GL/annum (Figure 39). The Turee B borefield is located on the basement of the Hamersley and Turee Creek Groups. Brockman (oldest), Weeli Wolli, Wongara and Boolgeeda (youngest) Formations, along with the Turee Creek Shale, have been identified in drill holes. The borefield provides water for potable supply, with a proportion used for mineral processing and dust suppression.

2. Groundwater licence GWL98740(10) encompasses dewatering and construction supply bores covering Deposits A, B, E and F. The total licensed abstraction is ~5.4GL/annum.

Deposits C, D and G will add to the volume of water being managed in the catchment, with an anticipated combined dewatering groundwater well licence for the entire Operation of 14GL/a, which represents 8GL/a increase on the existing 5.4GL/a.

Based on the local hydrogeology (i.e. presence of Mt McRae Shale acting as an impermeable barrier to groundwater flow between the two areas), the risk of drawdown from the Turee B borefield interacting with drawdown at Deposits C and D is considered negligible.

4.1 Surplus water management

Currently any excess water is directed to a licensed discharge point on a tributary of Turee Creek East, north of Deposit A. The current discharge licence has a limit 11.84GL/a. The most recent recorded total discharge volume in 2016 was ~276ML.

Moving forward, the key strategic objectives for water management at Deposits C, D and G are as follows:

- Enable dewatering of pits ahead of mine plan,
- Reduce the volume of surplus dewatering to be managed; and
- Maximise the beneficial use of surplus dewatering.

Subsequent to the maximum re-use of water on site, it is currently predicted that commencing 2021, up to 19ML/day of surplus dewatering water will be discharged to a point downstream of the existing discharge.

Note: The cumulative water balance of surplus dewatering water from Deposits B, C and D requiring management is up to approximately 12 GL/a.

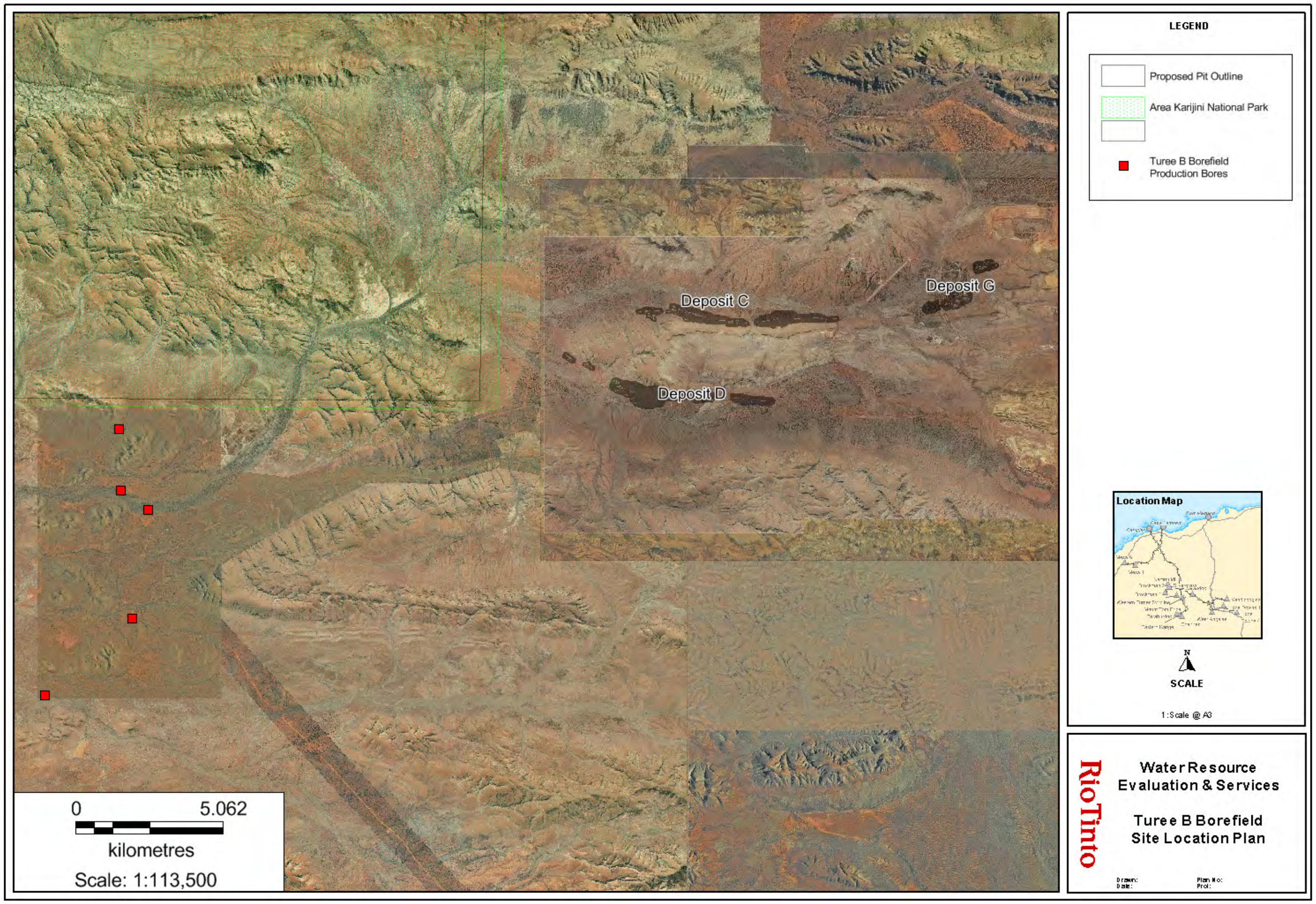

Figure 39: Location of Turee B borefield

5. Groundwater modelling

Groundwater modelling was undertaken to identify areas of potential environmental impact, and to predict what the likely risk would be to those areas, as a result of dewatering operations associated with mining West Angeles Deposits C, D & G.

The summary mine scheduling is as follows:

- Mining commences at Deposit C and D in 2020 (followed by Deposit G in 2022);
- Dewatering commences in 2021 (Deposit D), 2023 (Deposit C) and 2027 (Deposit G).

Three models were constructed and used as part of the assessment. This approach was preferred over other options due to the dominance on the hydrogeological system of dolerite dykes that act as hydraulic barriers, that are prevalent in the area, and effectively compartmentalise the groundwater system into separate water bodies or 'bathtubs'.

The three models used were:

- Regional numerical model.
- The Deposit C3 analytical model.
- The Deposit G analytical model.

The following sections provide a summary of each model.

5.1 Regional numerical model

Key elements of the original conceptual model are as follows (RTIO, 2017e).

The eastern boundary of the northern valley on the Deposit C side is given by a NE-SW trending dolerite structure which compartmentalises groundwater levels (623.5m RL on west side; 636m RL on east side of dyke).

- The eastern boundary on the southern valley (Deposit D side) is given by a NW-SE trending dolerite structure which compartmentalises groundwater levels (626 m RL on west side; 653m RL on east side of dyke).
- Deposit D lies within an interconnected groundwater system bounded by the outcropping un-mineralised MMIF to the north and Mount McRae Shale to the south and west, with the aquifer extending inside the KNP and including a potential GDE.
- Groundwater outflow is small, but consistent with water dating observations suggesting modern recharge is also very small.
- The majority of the groundwater in the system is ~ 10,000 years BP.
- Recharge is evenly distributed across the aquifer extent and the only outflow is via the estimated evapotranspiration loss from the GDE. However, this conceptualisation is considered conservative as it is likely that the area associated

with the potential GDE will receive cyclonic related recharge periodically, likely in the order of every three to four years.

- The lower un-mineralised Marra Mamba Iron Formation and Fortescue Group are excluded from the above regional aquifer as they form a low permeable barrier to groundwater.

The existing groundwater model has been upgraded to reflect revised conceptualisation. This accommodates two main changes:

- Removal of the assumed barrier to the north west which has resulted in an increase in the model domain as shown on Figure 8.

- Thickening of the aquifer north of C2.

Model parameters were retained as per previous modelling (hydraulic conductivity of 5 m/d and storage of 3 %).

The base of the aquifer within the expanded domain is shown in Figure 40.

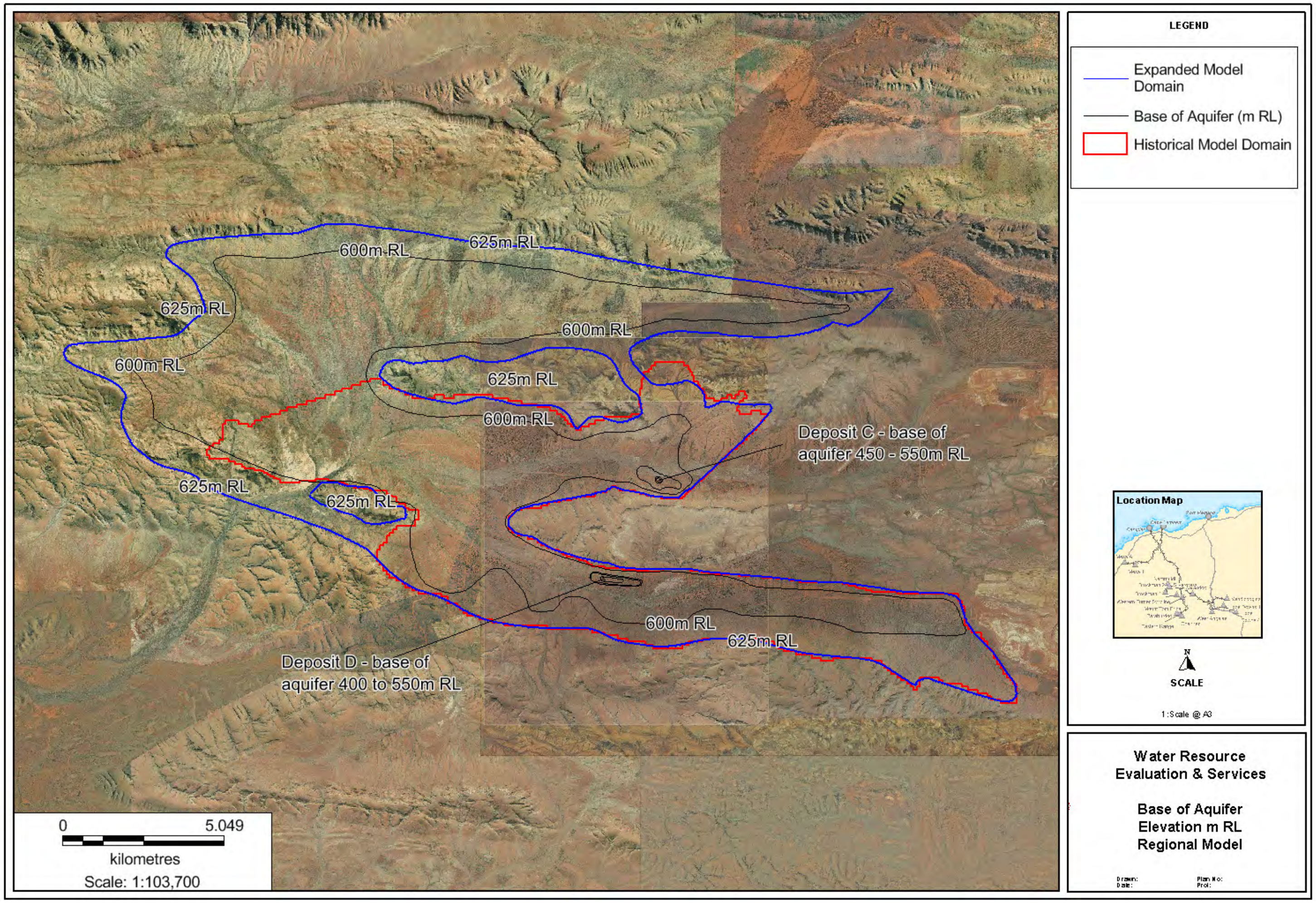

Figure 40: Base of aquifer (m RL)

5.1.1 Calibration

The model was calibrated in steady state, constrained by groundwater outflow as per the water balance, modelled against observed head distribution and hydraulic gradient. Recharge was applied uniformly across the model domain at the same rate as the previous model.

Statistical analysis of the calibration resulted in an RMS of 1.06 m (Figure 41), compared to the previous model which had an RMS of 0.65 m.

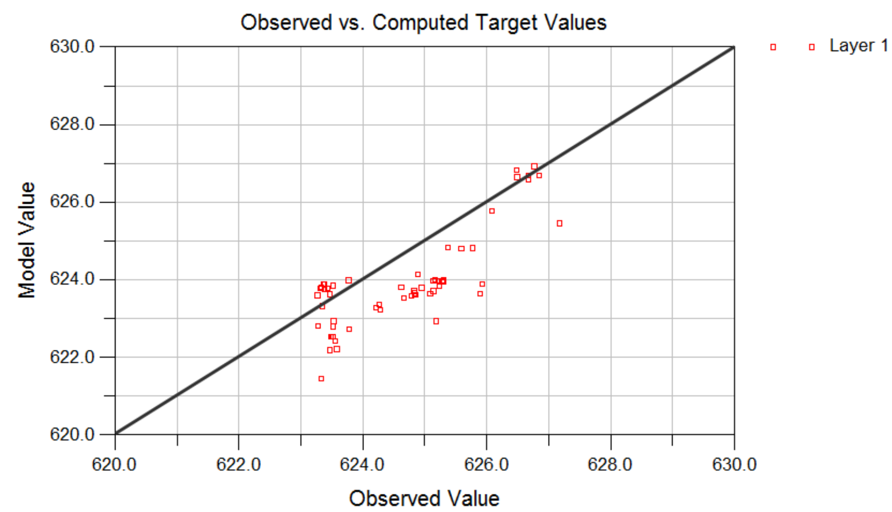

Figure 41: Observed versus computed groundwater levels

5.1.2 Dewatering predictions

Estimated peak dewatering volumes were 10.4 ML/d, with a cumulative volume of 26 GL over a below water table 6 year mine life plus two years advanced dewatering.

5.1.3 Groundwater impact assessment

Drawdown was predicted to occur across the potential GDE between 2023 and 2039, with the maximum rates of drawdown at the potential GDE expected to vary between 0.32 and 0.80m/year, as per the sensitivity analysis which considered a range of 1 to 10 %.

With no groundwater level recovery mitigation post dewatering, groundwater levels would continue to decline within KNP as groundwater levels recovered post mining. The absolute change in groundwater levels varied between 1 and 6 m over a 100 year post mining time frame which is comparable to previous predictions.

A summary of the anticipated drawdown, on cessation of mining in 2028 (assuming a base case storage value of 3%), is presented in Figure 42. Based on the different storage values adopted, a summary of the maximum anticipated drawdown in the area of the potential GDE is presented in Figure 43.

5.2 Deposit C3 model summary

A transient analytical superposition model was developed in 2017 to estimate approximate dewatering volumes and drawdown of the water table required for BWT mining at Deposit C3 (RTIO, 2017a).

The model was developed based on the following key attributes:

- Aquifer is unconfined,
- Adopted hydraulic conductivity (K) value of 1.5m/day,
- A specific yield range of 0.01 to 0.05 (i.e. three (3) scenarios),
- No-flow boundary conditions exist to the North (Mount. McRae Shale), South (un-mineralised Marra Mamba Iron Formation) and West (dolerite dyke),
- Standing water level at or around 636m RL.

The model estimates the annualised abstraction rate will be 4.0GL/year (11ML/day), with a cumulative abstraction volume of 20GL.

A summary of the anticipated drawdown on cessation of mining is presented in Figure 44:

5.3 Deposit G model summary

A transient analytical superposition model was developed in 2016 to estimate approximate dewatering volumes and drawdown of the water table required for BWT mining at Deposit G1 (RTIO, 2016a).

The model was developed based on the following key attributes:

- Aquifer is unconfined,
- Adopted hydraulic conductivity (K) value of 1.5m/day,
- A specific yield range of 0.015 to 0.05 (i.e. three (3) scenarios),
- No-flow boundary conditions exist to the North (Mount. McRae Shale) and South (un-mineralised Marra Mamba Iron Formation),
- Standing water level at or around 635m RL.

The model estimates the annualised abstraction rate will be 1GL/year (3ML/day), with a cumulative abstraction volume of 2GL.

A summary of the anticipated drawdown on cessation of mining is presented in Figure 45:

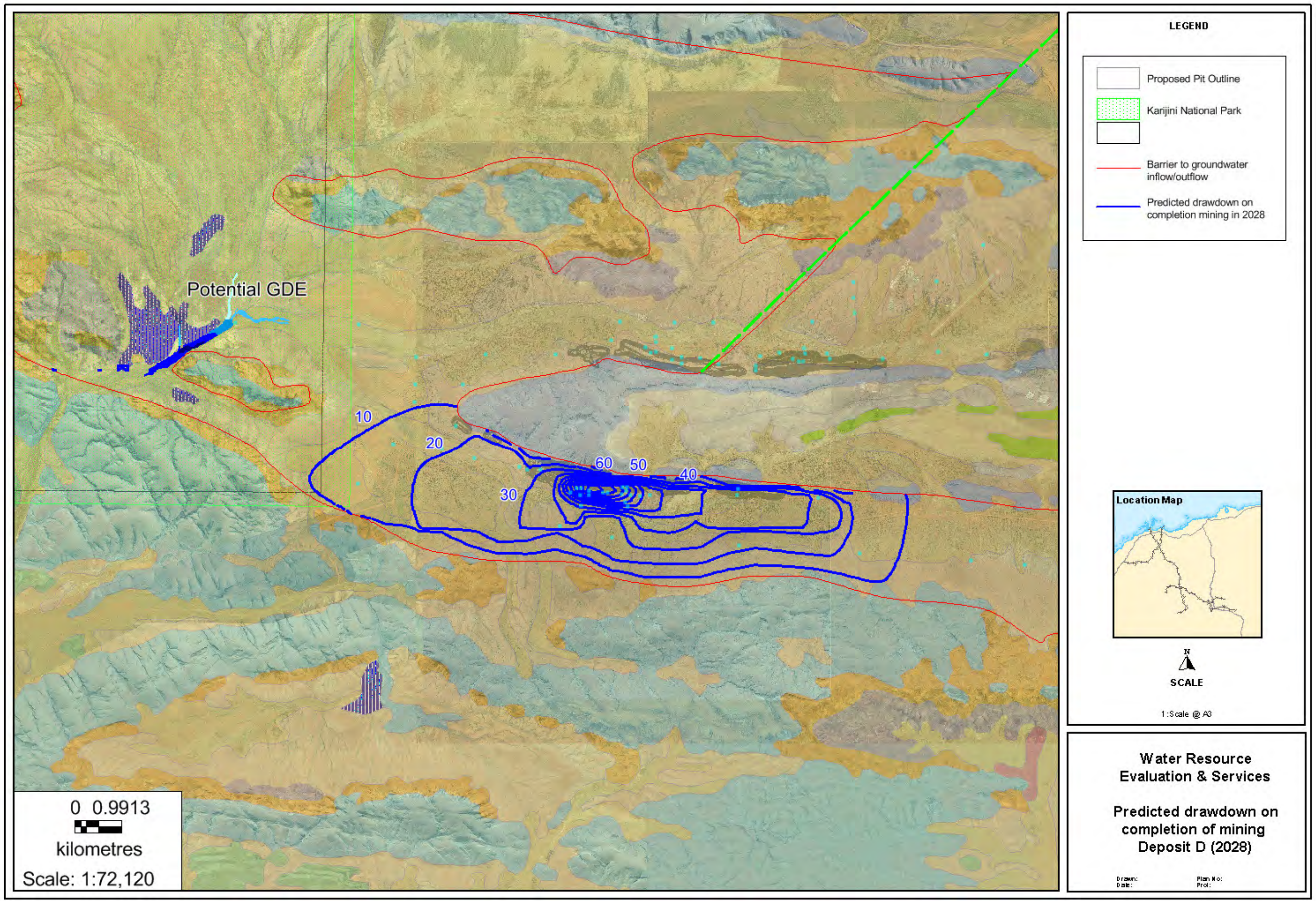

Figure 42: Groundwater level drawdown on cessation mining Deposit D

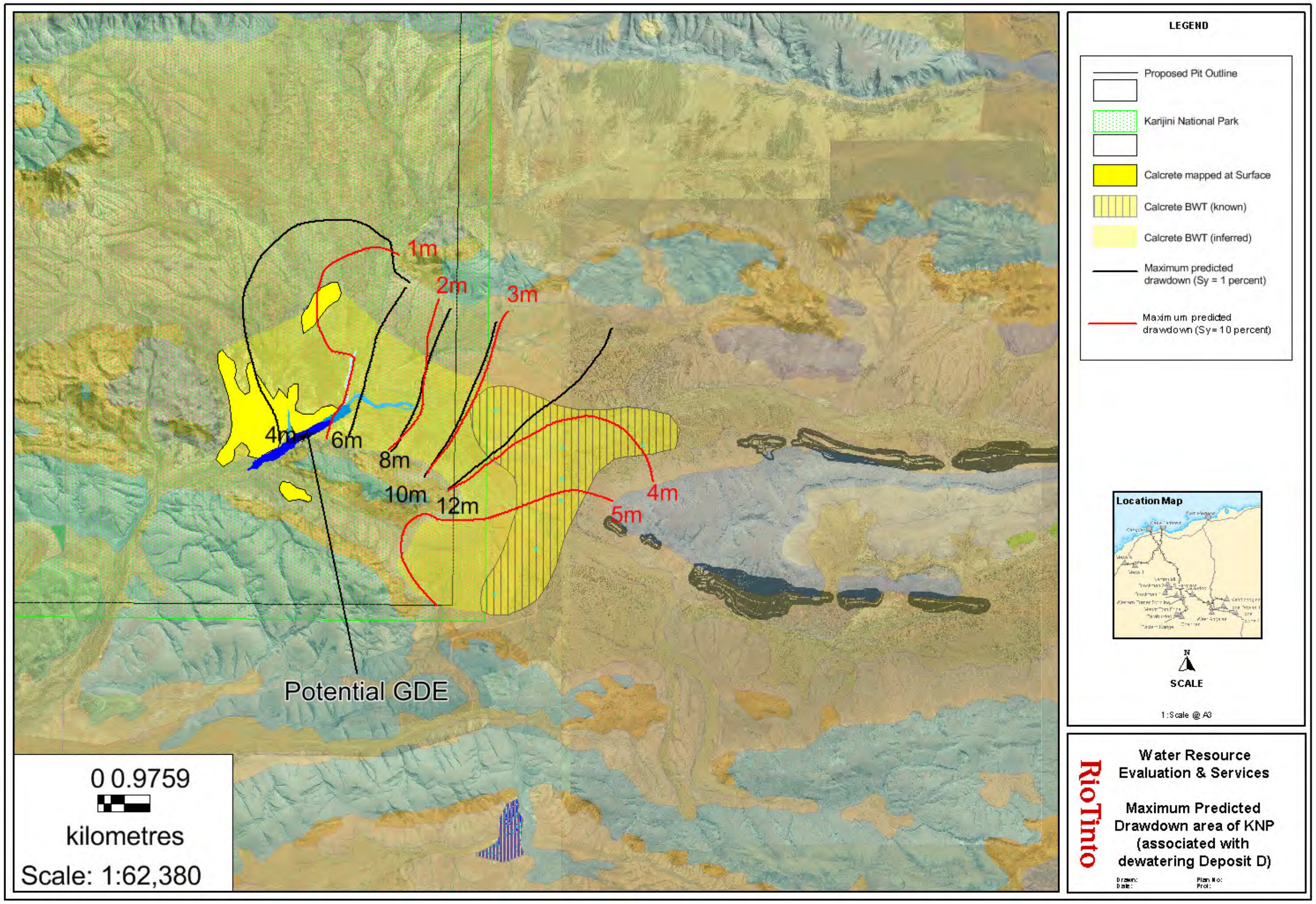

Figure 43: Maximum pr***edicted groundwater drawdown in area potential GDE***

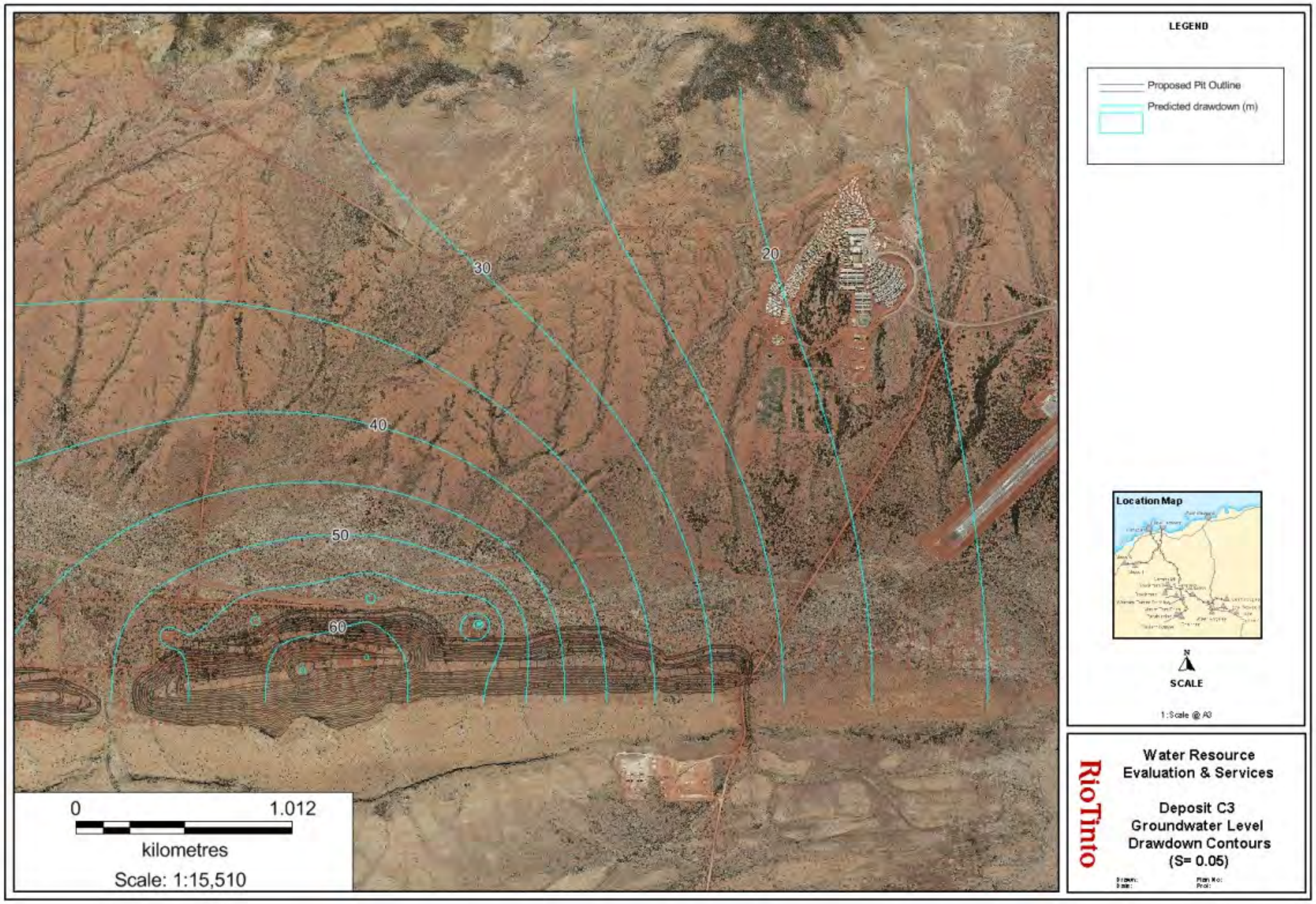

Figure 44: Groundwater level drawdown associated dewatering Deposit C3

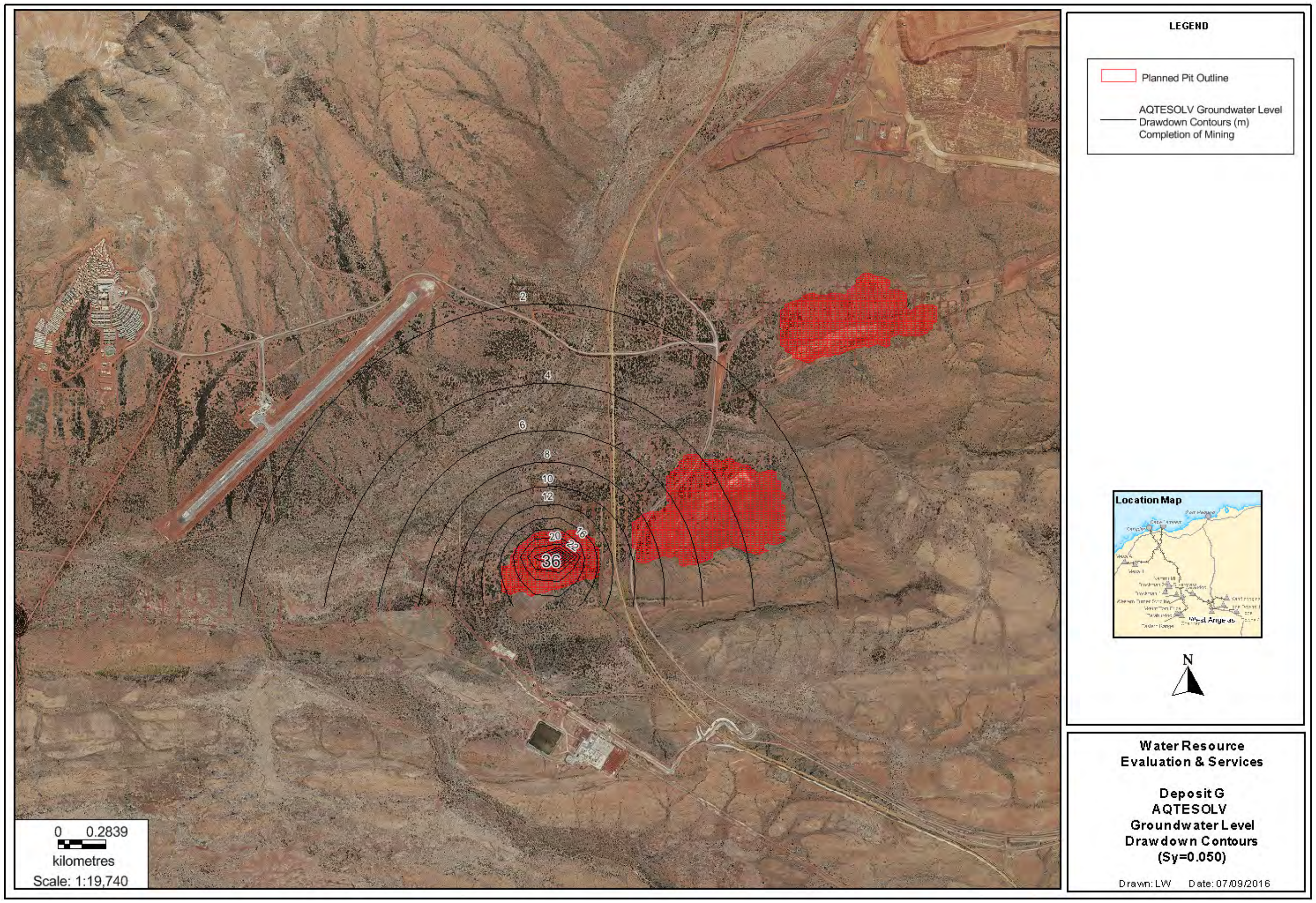

Figure 45: Groundwater level drawdown associated dewatering Deposit G

6. Assessment of potential impacts

Predicted drawdown of the groundwater table associated with dewatering activities at Deposits C, D and G extend towards the east and west, including the area of a potential GDE located within the eastern edge of KNP.

Based on the conservative modelling assumptions adopted, it is predicted that groundwater level drawdown in the eastern edge of the potential GDE will be between 1 and 6m. The upper limit will translate to a rate of groundwater drawdown of up to 80cm/ year. It is also predicted that drawdown will commence prior to the end of mining and ultimately the pre-mining water table elevation will not be re-established.

Subsequent to the maximum re-use of water on site, it is currently predicted that commencing 2021, up to 19ML/day of surplus dewatering water will be discharged to a point downstream of the existing discharge. The extent of the surface water discharge flow is not anticipated to reach KNP (RTIO, 2018c).

6.1 Management approach and considerations

Management approaches that are being considered in response to predicted drawdown beneath the area of the potential GDE include the following:

- Adaptive management of species – based on the conservative prediction of groundwater drawdown up to 80cm/year, and the nature of flora encountered in the area of the potential GDE, it is considered that any flora will adaptively respond to changes in groundwater level by obtaining there water from surface water in Turee Creek East;

If it is observed that drawdown in the area of the potential GDE is having a deleterious effect on vegetation then mitigation measures will be adopted as deemed appropriate (e.g. but not limited to aquifer reinjection, reticulating water locally to the area etc.).

7. References

BOM, 2012: High resolution daily rainfall gridded datasets from 1900 onwards, (http://www.bom.gov.au/climate/how/newproducts/images/daily_rainfall_metadata.pdf).

Dogramaci et al, 2012: Stable isotope and hydrochemical evaluation of groundwater in the semi-arid Hamersley Basin of subtropical northwest Australia.

RTIO, 2016a: RTIO-PDE-0145263 - Deposit G Analytical Modelling.doc: http://iodms/iodms/drl/objectId/090188a380a13226

RTIO, 2016b: RTIO-PDE-0146330 - 2016 Deposit C & D and Western End PFS Field Program Report_06102016 (Final).doc: http://iodms/iodms/drl/objectId/090188a380a2166e

RTIO, 2016c: RTIO, 2016b, RTIO-PDE-0148594 - East Pilbara Hydro Conceptual Model Report.docx: http://iodms/iodms/drl/objectId/090188a380a4e3a9

RTIO, 2017a: RTIO-PDE-0155446 - Deposit C Analytical Modelling (FS).docx: http://iodms/iodms/drl/objectId/090188a380ac49ad

RTIO, 2017b: http://riopersql13:8090/display/RHTS/West+Angelas+-+Deposit+A, http://riopersql13:8090/display/RHTS/West+Angelas+-+Deposit+D, http://riopersql13:8090/display/RHTS/West+Angelas+-+Deposit+G

RTIO, 2017c: RTIO-PDE-0158189 - 2017 WACD FS Field Programme Report_21122017.doc: http://iodms/iodms/drl/objectId/090188a380adf46b (Draft)

RTIO, 2017d: RTIO-PDE-0142105 - 2015_CWS_Drilling_GroundwaterSampling.doc: http://iodms/iodms/drl/objectId/090188a3809dc5f3

RTIO, 2017e: RTIO-PDE-0154308, West Angelas C and D, Regional Groundwater Model, 20th September 2017

RTIO, 2018a: RTIO-PDE-0158691 - West Angelas Deposit C & D Feasibility Study Groundwater Modelling Dewatering Prediction: http://iodms/iodms/drl/objectId/090188a380ae2eef

RTIO, 2018b: RTIO-PDE-0159085 - West Angelas deposits B C D surplus water discharge modelling: http://iodms/iodms/drl/objectId/090188a380ae7fd5

RTIO, 2018c: West Angelas Deposits C & D Feasibility Study Groundwater Impact Assessment: RTIO-PDE-0158692: http://iodms/iodms/drl/objectId/090188a380ae2f09

Appendix 1

Location	Easting (MGA 94)	Northing (MGA 94)	Slotted Formation
MB14WAC001	667,949	7,439,454	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAC002	670,344	7,438,950	Mt Newman/MacLeod Members
MB14WAC003	668,745	7,439,102	Wittenoom Formation/Mt Newman Member
MB14WAC004	668,745	7,439,252	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAC005	669,545	7,439,098	Detritals/Wittenoom Formation
MB14WAC006	670,345	7,439,054	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAC007	671,150	7,439,203	Wittenoom Formation/Mt Newman Member
MB14WAC008	671,945	7,439,200	Orebody (Wittenoom Formation/Mt Newman Member)
MB14WAC009	673,097	7,439,200	Orebody (Wittenoom Formation/Mt Newman Member)
MB15WAC001	667,207	7,439,598	Mt Newman/MacLeod Members
MB15WAC002	671,569	7,439,999	Wittenoom Formation
MB15WAC003	667,399	7,440,000	Detritals/Wittenoom Formation
MB15WAC004	668,582	7,439,992	Detritals/Wittenoom Formation
MB15WAC005	669,436	7,439,995	Wittenoom Formation
MB16WAC0001	668,186	7,439,358	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAC0002	671,399	7,439,443	Wittenoom Formation

MB16WAC0003	668,078	7,439,348	Wittenoom Formation/Mt Newman Member
MB16WAC0004	671,405	7,439,324	Wittenoom Formation/Mt Newman Member
MB16WAC0005	671,382	7,439,155	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAC0006	671,275	7,439,152	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAC0007	668,175	7,439,682	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAC0008	668,181	7,439,576	Wittenoom Formation
MB16WAC0009	674,297	7,439,348	Detritals/Wittenoom Formation
MB16WAC0010	675,349	7,439,299	Mt Newman Member
WB16WAC0001	668,181	7,439,352	Detritals/Wittenoom Formation/Mt Newman Member
WB16WAC0002	671,378	7,439,150	Wittenoom Formation/Mt Newman Member
MB17WAC0001	671,890	7,439,310	Wittenoom Formation
MB17WAC0002	670,442	7,439,256	Wittenoom Formation
MB17WAC0003	670,853	7,439,329	Detritals/Wittenoom Formation
MB17WAC0004/5	668,187	7,439,686	Detritals
MB17WAC0006	668,524	7,439,179	Wittenoom Formation/Mt Newman Member
MB17WAC0007	669,145	7,439,232	Detritals/Wittenoom Formation
MB17WAC0008	668,527	7,439,433	Detritals/Wittenoom Formation
WB17WAC0001	668,542	7,439,427	Detritals/Wittenoom Formation
WB17WAC0002	671,900	7,439,302	Detritals/Wittenoom Formation
WB17WAC0003	670,858	7,439,321	Wittenoom Formation

MB13WAD009	669,942	7,436,252	Detritals/Wittenoom Formation/Mt Newman Member
MB13WAD010	667,540	7,436,350	Detritals/Wittenoom Formation/Mt Newman Member
MB13WAD011	667,142	7,436,298	Detritals/Wittenoom Formation/Mt Newman Member
MB13WAD012	666,743	7,436,348	Wittenoom Formation/Mt Newman Member
MB13WAD013	666,741	7,436,251	Mt Newman Member
MB13WAD014	666,544	7,436,249	Mt Newman Member
MB13WAD015	666,340	7,436,301	Mt Newman Member
MB14WAD001	668,045	7,436,252	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAD002	667,642	7,436,249	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAD004	667,034	7,436,300	Wittenoom Formation/Mt Newman Member
MB14WAD005	665,692	7,436,799	Orebody (Wittenoom Formation/Mt Newman Member)
MB14WAD006	665,394	7,436,798	Orebody (Wittenoom Formation/Mt Newman Member)
MB14WAD008	666,106	7,435,586	Detritals/Wittenoom Formation
MB14WAD009	669,986	7,435,167	Detritals/Wittenoom Formation
MB14WAD010	672,585	7,434,990	Detritals/Wittenoom Formation
MB14WAD011	675,000	7,434,830	Detritals/Wittenoom Formation
MB14WAD012	676,159	7,434,732	Detritals/Wittenoom Formation
MB14WAD013	677,248	7,434,342	Wittenoom Formation
MB15WAD002	665,231	7,436,860	Orebody (Wittenoom Formation/Mt Newman Member)

MB16WAD0002	666,560	7,436,393	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAD0003	671,697	7,436,197	Mt Newman/MacLeod Members
MB16WAD0004	669,969	7,436,378	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAD0005	667,556	7,436,416	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAD0006	666,464	7,436,392	Wittenoom Formation/Mt Newman Member
MB16WAD0007	666,566	7,436,027	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAD0008	667,465	7,436,422	Orebody (Wittenoom Formation/Mt Newman Member)
MB16WAD0009	667,516	7,436,096	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAD0010	667,567	7,435,995	Wittenoom Formation/Mt Newman Member/MacLeod Member
MB16WAD0011	667,233	7,435,333	Detritals/Wittenoom Formation
WB16WAD0001	666,568	7,436,391	Orebody (Wittenoom Formation/Mt Newman Member)
WB16WAD0002	667,562	7,436,420	Detritals/Wittenoom Formation/Mt Newman Member
MB17WAD0001	667,444	7,436,262	Detritals/Wittenoom Formation/Mt Newman Member
MB17WAD0002	667,838	7,436,235	Detritals/Wittenoom Formation/Mt Newman Member
WB17WAD0001	667,440	7,436,271	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAW0001	664,253	7,437,049	Mt Newman Member
MB16WAW0002	663,544	7,437,251	Detritals/Mt Newman Member

MB16WAW0003	662,994	7,439,245	Detritals/Wittenoom Formation
MB16WAW0004	662,980	7,438,659	Detritals/Wittenoom Formation
MB16WAW0005	661,752	7,439,948	Detritals/Wittenoom Formation
MB16WAW0006	662,967	7,438,265	Detritals/Mt Newman Member
MB16WAW0007	661,739	7,436,489	Detritals/Wittenoom Formation
MB16WAW0008	662,506	7,437,349	Detritals/Wittenoom Formation
MB16WAW0009	663,849	7,437,754	Detritals/Mt Newman Member
MB16WAW0010	666,007	7,439,296	Mt Newman Member
MB16WAW0011	664,504	7,439,302	Detritals/Wittenoom Formation/Mt Newman Member
MB16WAW0012	663,999	7,438,653	Mt Newman Member
WB16WAW0001	664,511	7,439,300	Detritals/Wittenoom Formation/Mt Newman Member
MB14WAE005	679,318	7,433,216	Wittenoom Formation
MB14WAE006	680,233	7,432,778	Wittenoom Formation
WANG14	659,091	7,439,992	Not known

Appendix 2

SamplePoint	Easting	Northing	Date	Groundwater Elevation (m AHD)	Date of reading (last)
MB13WAD009	669942.2	7436252.26	1/06/2017	625.57	8/06/2017
MB13WAD010	667540.21	7436350.4	1/05/2017	625.28	8/05/2017
MB13WAD011	667142.09	7436298.39	1/06/2017	625.27	8/06/2017
MB13WAD012	666743.38	7436348.05	1/05/2017	625.2	23/05/2017
MB13WAD013	666740.59	7436251.14	1/06/2017	625.18	8/06/2017
MB13WAD014	666543.79	7436249.1	1/06/2017	625.13	8/06/2017
MB13WAD015	666339.89	7436300.53	1/05/2017	624.94	16/05/2017
MB14WAC001	667949.4	7439454.1	1/05/2017	623.53	26/05/2017
MB14WAC002	670344.31	7438950.03	1/05/2017	636.86	27/05/2017
MB14WAC003	668745.35	7439101.92	1/05/2017	623.47	27/05/2017
MB14WAC004	668745	7439251.6	1/05/2017	623.5	5/05/2017
MB14WAC005	669544.78	7439098.03	1/05/2017	632.88	22/05/2017
MB14WAC006	670345.11	7439053.54	1/05/2017	635.63	5/05/2017
MB14WAC007	671150.49	7439203.32	1/05/2017	635.57	10/05/2017
MB14WAC008	671945.11	7439200.27	1/05/2017	635.94	24/05/2017
MB14WAC009	673096.53	7439200.31	1/05/2017	636.11	12/05/2017
MB14WAD001	668044.89	7436252.22	1/05/2017	625.31	25/05/2017
MB14WAD002	667641.61	7436249.49	1/05/2017	625.21	8/05/2017
MB14WAD004	667033.86	7436299.97	1/05/2017	625.21	28/05/2017
MB14WAD005	665692.22	7436799.46	1/05/2017	624.75	31/05/2017
MB14WAD006	665393.67	7436798.19	1/05/2017	624.71	31/05/2017
MB14WAD008	666105.89	7435585.74	1/05/2017	624.77	31/05/2017
MB14WAD009	669985.63	7435166.73	1/05/2017	625.36	31/05/2017
MB14WAD010	672585.19	7434990.07	1/05/2017	625.76	31/05/2017
MB14WAD011	675000.48	7434829.64	1/05/2017	625.98	27/05/2017
MB14WAD012	676159.11	7434731.67	1/05/2017	625.92	27/05/2017
MB14WAD013	677248.48	7434341.89	1/05/2017	626.32	27/05/2017
MB14WAE005	679318.43	7433215.8	1/05/2017	626.72	29/05/2017
MB14WAE006	680233.17	7432777.58	1/05/2017	657.12	4/05/2017
MB15CWS001	672473.66	7440206.17	1/06/2017	635.69	10/06/2017
MB15CWS002	672469.37	7440517.5	1/06/2017	640.15	10/06/2017
MB15CWS003	672469.57	7440859.25	1/06/2017	642.33	10/06/2017
MB15CWS004	675261.79	7441659.98	1/06/2017	630.93	10/06/2017
MB15CWS005	674251.66	7440884.87	1/06/2017	635.76	10/06/2017
MB15WAC001	667207.08	7439597.79	1/05/2017	623.6	27/05/2017
MB15WAC002	671569	7439998.93	1/05/2017	635.81	18/05/2017
MB15WAC005	669435.65	7439995.33	1/05/2017	623.75	27/05/2017
MB15WAD002	665230.63	7436859.83	1/05/2017	624.74	31/05/2017
MB15WAG002	676252.01	7439553.24	1/05/2017	634.19	27/05/2017
MB15WAG003	677198.01	7440051.63	1/05/2017	635.81	26/05/2017

MB15WAG004	676751.33	7439749.89	1/05/2017	634.46	18/05/2017
MB16WAC0001	668186.31	7439358.43	1/05/2017	623.55	27/05/2017
MB16WAC0002	671399.29	7439442.99	1/05/2017	635.66	25/05/2017
MB16WAC0003	668078.14	7439347.57	1/05/2017	623.55	27/05/2017
MB16WAC0004	671405.2	7439323.84	1/05/2017	635.68	27/05/2017
MB16WAC0005	671382.02	7439155.42	1/05/2017	635.67	27/05/2017
MB16WAC0006	671275.28	7439151.71	1/05/2017	635.67	27/05/2017
MB16WAC0007	668175.28	7439682.44	1/05/2017	623.57	27/05/2017
MB16WAC0008	668180.54	7439575.58	1/05/2017	623.58	27/05/2017
MB16WAC0009	674297.02	7439347.98	1/05/2017	636.19	27/05/2017
MB16WAC0010	675349.48	7439299.19	1/05/2017	636.04	27/05/2017
MB16WAD0002	666559.9	7436392.74	1/06/2017	625.17	8/06/2017
MB16WAD0003	671697.28	7436197.36	1/06/2017	626.82	8/06/2017
MB16WAD0004	669969.3	7436378.01	1/06/2017	625.67	8/06/2017
MB16WAD0005	667555.69	7436416	1/06/2017	625.33	8/06/2017
MB16WAD0006	666464.09	7436392.43	1/06/2017	625.13	8/06/2017
MB16WAD0007	666565.77	7436026.77	1/06/2017	624.92	8/06/2017
MB16WAD0008	667465.39	7436421.85	1/06/2017	625.4	8/06/2017
MB16WAD0009	667516.3	7436095.61	1/06/2017	625.31	8/06/2017
MB16WAD0010	667567.06	7435995.04	1/05/2017	625.3	31/05/2017
MB16WAD0011	667233.22	7435332.8	1/06/2017	625.2	9/06/2017
MB16WAW0001	664253.12	7437049.18	1/05/2017	623.83	25/05/2017
MB16WAW0002	663543.86	7437251	1/05/2017	623.85	8/05/2017
MB16WAW0003	662994.18	7439245.35	1/05/2017	623.73	24/05/2017
MB16WAW0004	662980.31	7438658.81	1/05/2017	623.74	17/05/2017
MB16WAW0005	661752.35	7439947.98	1/05/2017	623.68	13/05/2017
MB16WAW0006	662967.16	7438265.47	1/05/2017	623.73	19/05/2017
MB16WAW0007	661738.75	7436489.08	1/05/2017	623.72	15/05/2017
MB16WAW0008	662506.08	7437348.8	1/05/2017	623.78	24/05/2017
MB16WAW0009	663849.01	7437754.17	1/05/2017	623.74	17/05/2017
MB16WAW0010	666007.45	7439295.58	1/05/2017	623.54	27/05/2017
MB16WAW0011	664503.69	7439302.31	1/05/2017	623.62	25/05/2017
MB16WAW0012	663999.13	7438652.58	1/05/2017	623.73	27/05/2017
WANG14	659090.73	7439992.2	1/05/2017	623.71	31/05/2017