Lake Disappointment Potash Project

Hydrogeological Assessment of the Impact of Process Water Abstraction from the Cory Bore Field

An H2 Level Assessment for 1.5GL/year

Prepared by: Strategic Water Management

Prepared For: Reward Minerals Ltd.

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Introduction

Reward Minerals Ltd is developing the Lake Disappointment potash project 300km east of Newman in the Shire of East Pilbara. Lake Disappointment forms one of the larger playa lakes in Western Australia with the main body measuring approximately 1,240km^2. It is the lowest point in the Little Sandy Desert with an endorheic (internally draining) catchment of 600km by 500km (Beard 2005).

Reward Minerals Ltd (Reward) proposes to extract and process in the order of 2000 L/s (63 GL per year) of potash brine from Lake Disappointment (LD). Production from the LD project will ramp up over approximately four years, with planned potash production reaching 200,000 tonnes in Year three and reaching target production of 400,000 tonnes in Year five. The initial construction and production phase will require approximately 1.5GL/a of process water. By year five, when in full production, process water demand for brine processing and all other elements of the operation will total 3.4GL/a.

A programme of groundwater exploration has identified two prospective aquifers with suitable water quality to the north of Lake Disappointment. These occur in the bedrock of the Coolbro sandstone (formerly the Gunanya sandstone of the Tarcunyah formation) and within the tertiary sediments overlying the Coolbro, Broadhurst and Connaughton formations respectively and form independent groundwater sources. Drilling and test pumping has identified two bore field development areas named as the 'Cory bore field' and the 'Northern Bore field' respectively.

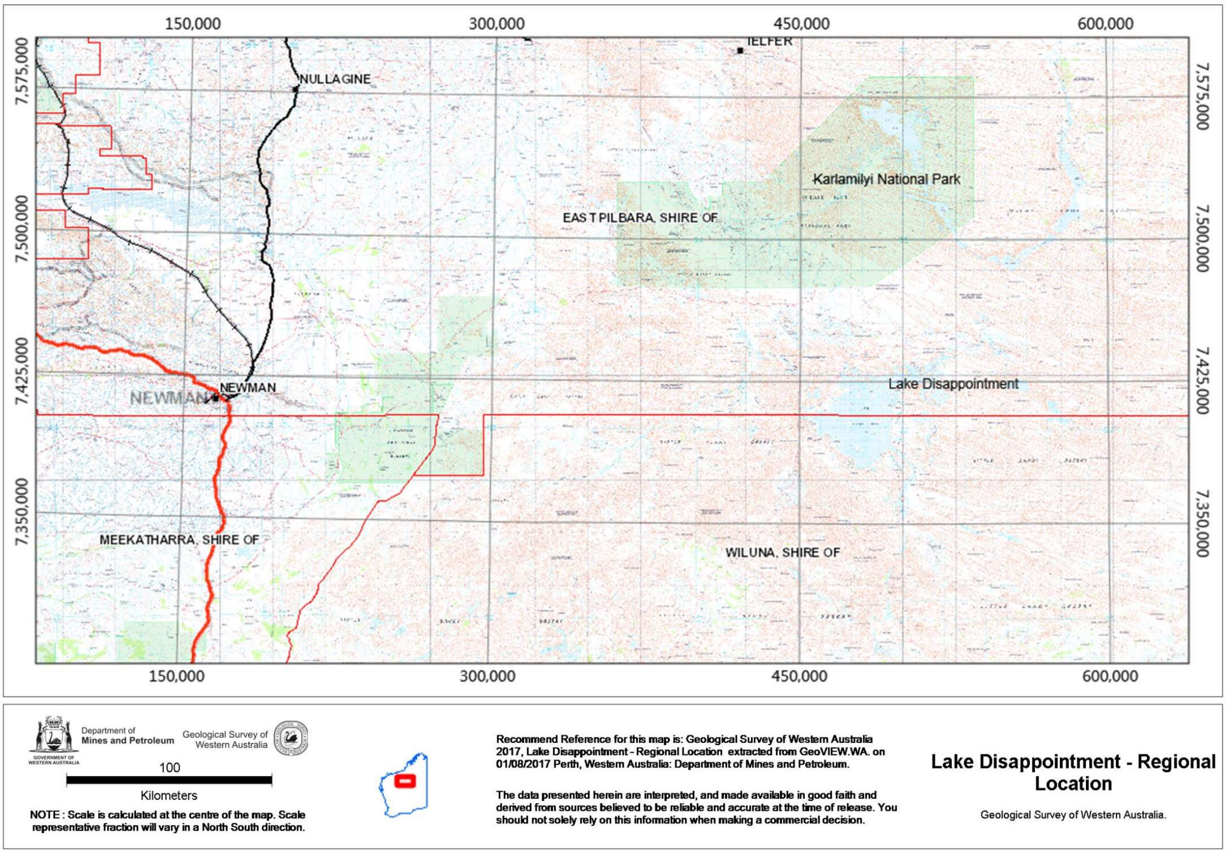
This hydrogeological assessment was prepared by Strategic Water Management for Reward Minerals and supports a groundwater licence application for the abstraction of up to 1.5GL/a of groundwater from the Cory bore field for use in construction and initial processing. The study and report complies with a H2 hydrogeological assessment as set out in the Department of Water Operational Policy 5.12 (Department of Water, 2009). A separate hydrogeological assessment will be provided for the Northern Bore field.

Technical reports to support the submission are referred to in the text and attached as Appendices. The assessment of the regional and local geology, as well as the hydrogeology was completed by Strategic Water Management. Associated bore completion reports (including core photos), test pumping data and analysis and hydrochemistry analysis are attached in Appendices A to C respectively. Investigations into the presence of subterranean fauna were undertaken by Bennelongia Consultants and flora and vegetation impact assessments were undertaken by Botanica Consulting. Relevant reports are attached in Appendix D.

Location

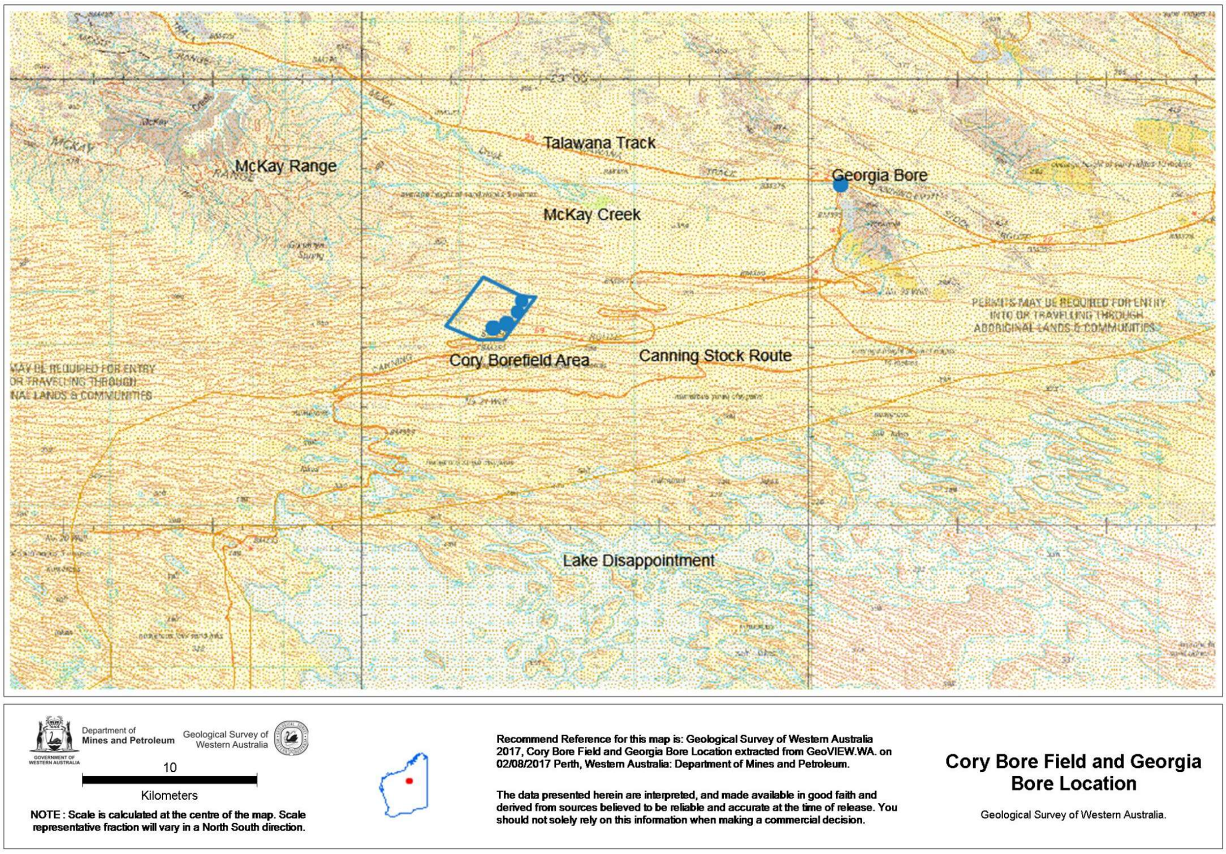
Lake Disappointment is approximately 300km due east of Newman and 180km south of Telfer in the Shire of East Pilbara, Figure 1. The boundary of the Karlamilyi (Rudall River) National Park is 50km to the north of the Lake. The location is remote with the nearest community, Parnngurr (Cotton Creek), approximately 80km to the north northwest. The Talawana Track passes some 30km to the north and the Canning stock route passes immediately west of the Lake.

Figure 1: Lake Disappointment Regional Location



The proposed Cory bore field area lies approximately 17km north of Lake Disappointment, (Figure 2).

Figure 2: Proposed Location of the Cory bore field



Existing Groundwater Use

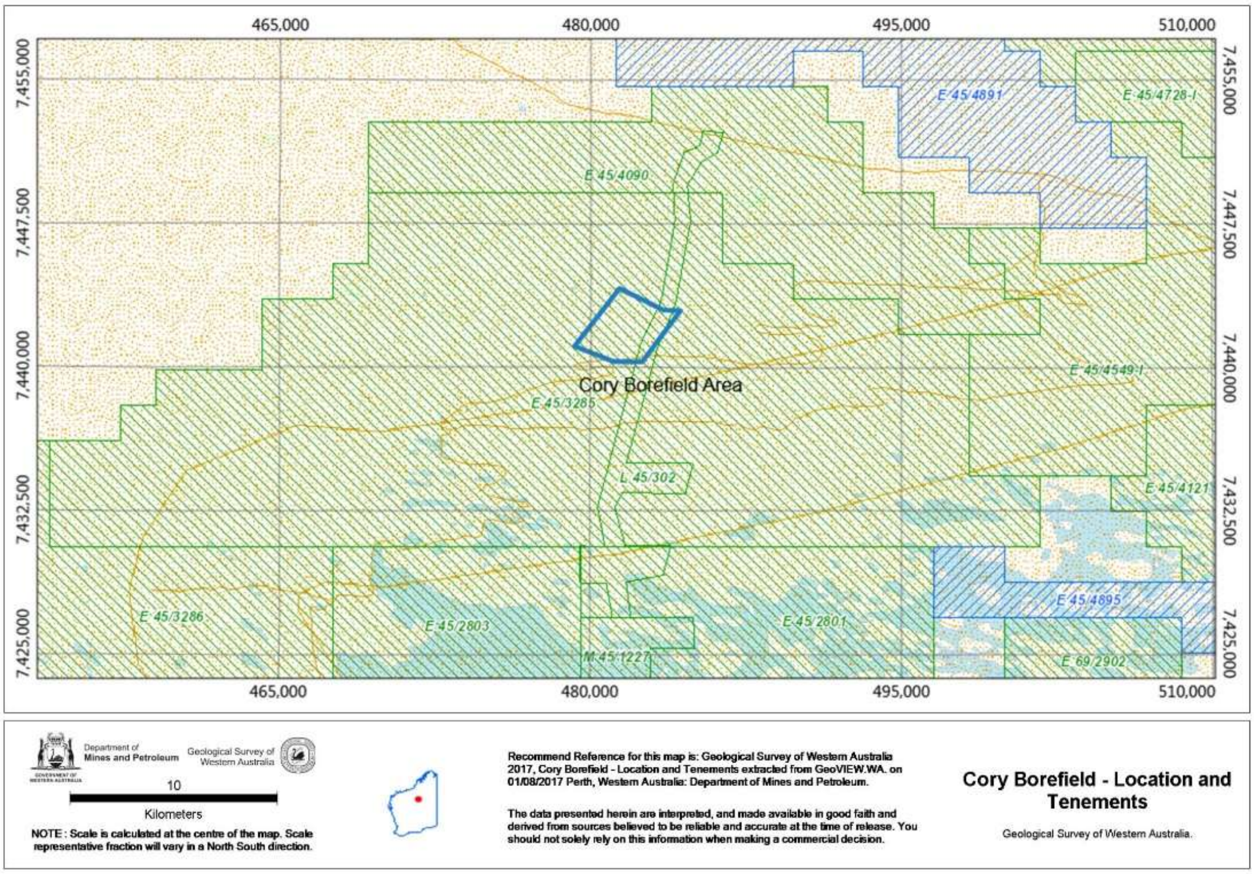
The only existing groundwater use in the Cory bore field area is from the Cory bore, which is licensed under GWL182580 for 90,000 kL per annum and is used to supply the Reward Minerals' exploration camp via an electric submersible pump powered by a small diesel generator. The bore is pumped intermittently via a 20m pipe into a 10,000 litre tank, and transferred to the Reward Minerals camp via a standpipe and truck operation, the water is non potable at source and is processed through an RO plant at the site for domestic use. Approximately 5.5km to the south of the Cory bore is Well 21 of the Canning Stock route; this well has been long abandoned and has caved.

Other bores within 20km are Reward's Northern bore field test production and monitoring bores and diamond holes LDCH1701 to LDCH1704 drilled between 2016 and 2017 for geological control, groundwater exploration and aquifer definition.

CRA Exploration drilled the Georgia bore in 1990 for exploration camp water supply. This bore is still functioning, having been fitted with a hand pump, and is reportedly used by travellers along the Talawana Track and Canning stock routes. The bore was drilled to 35m depth, the last 20m being in sandstone of the Throssell group. Georgia bore is 20km to the north east of the Cory bore field (Figure 2), given this distance and the different stratigraphy it is unlikely that abstraction from the Cory bore field will impact water levels in this area

There are currently no activities in the vicinity other than mineral and groundwater exploration by Reward. The only proposed activity within the area is the future development of the LD potash operation. Figure 3 shows the mineral tenements held by Reward in the area. The Cory bore field area is covered by tenements: E45/3285 and L45/302 belonging to Reward Minerals Ltd (registered under Holocene Pty Ltd).

Figure 3: Reward Minerals Tenements Covering the Cory bore field area


465,000
480,000
495,000
510,000
7,455,000
7,447,500
7,440,000
7,432,500
7,425,000
E 45/4891
E 45/4728-I
E 45/4090
Cory Borefield Area
E 45/3285
E 45/4549-I
L 45/302
E 45/4121
E 45/4895
E 45/3286
E 45/2803
E 45/2801
M 45/1227
E 69/2902
Department of Mines and Petroleum
Geological Survey of Western Australia
10
Kilometers
NOTE : Scale is calculated at the centre of the map. Scale representative fraction will vary in a North South direction.
Recommend Reference for this map is: Geological Survey of Western Australia 2017, Cory Borefield - Location and Tenements extracted from GeoVIEW.WA. on 01/08/2017 Perth, Western Australia: Department of Mines and Petroleum.
The data presented herein are interpreted, and made available in good faith and derived from sources believed to be reliable and accurate at the time of release. You should not solely rely on this information when making a commercial decision.
Cory Borefield - Location and Tenements
Geological Survey of Western Australia.

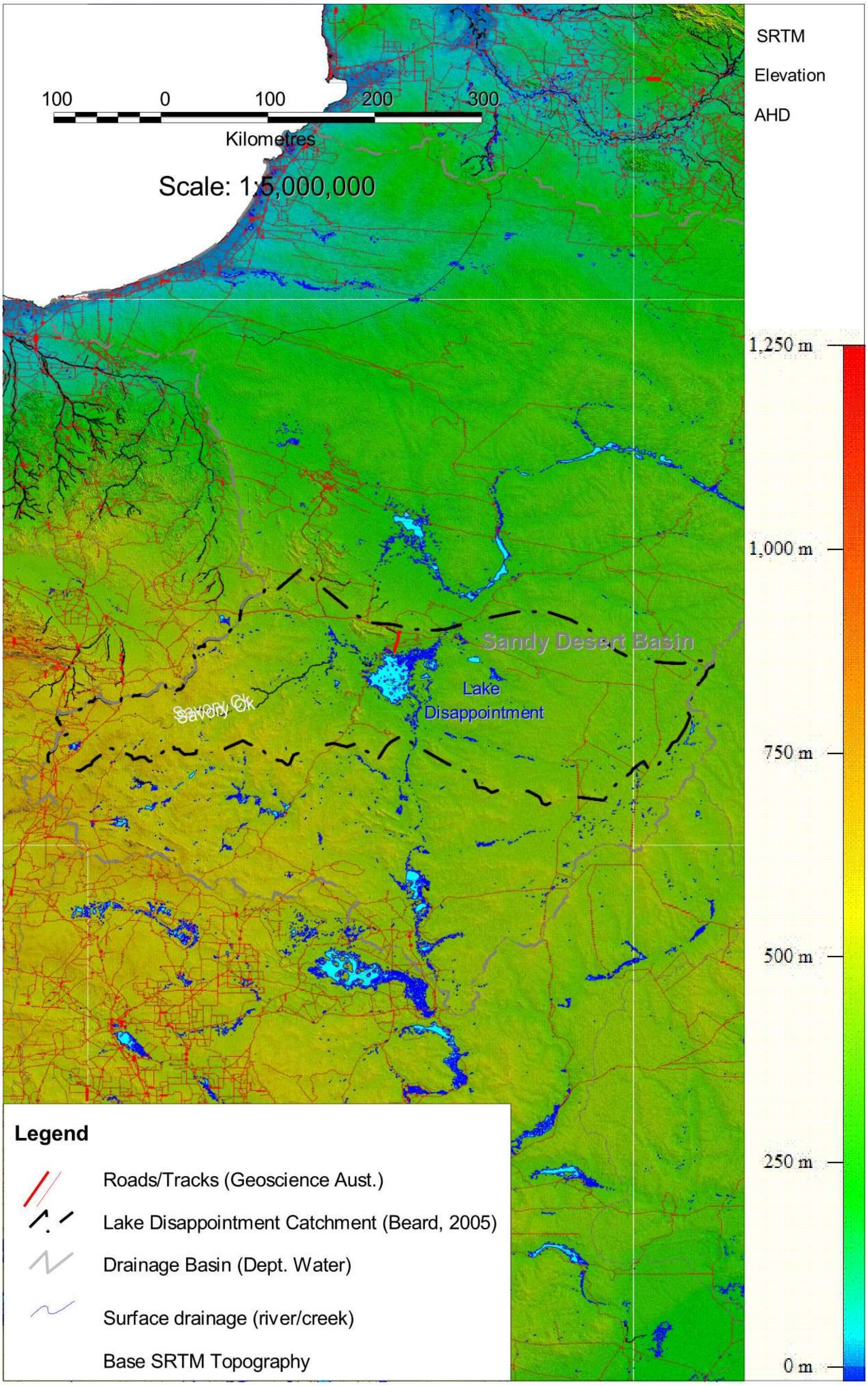
Geography and Drainage

Administratively, Lake Disappointment and the proposed bore field lie within the Sandy Desert Basin Surface Water Allocation Area (SWAA) and the extreme south east corner of the East Pilbara groundwater subarea.

Lake Disappointment is one of the larger playa lakes in Western Australia with the main body of the Lake being approximately 1,240km^2. The lake is the lowest point of the Little Sandy Desert at 325mamsl and lies within an endorheic (internally draining) catchment that is 600km by 500km (Beard 2005). The largest feeder is Savory Creek which drains east from just south of Newman.

Semeniuk (1987) classified the lake as a mega scale, irregular sump land with numerous microscale to macroscale islands. The lake is typically dry but can be inundated after tropical cyclones. The surrounding area is characterised by WNW – ESE longitudinal dunes up to 10m in height above a shallow rocky basement. Figure 4 shows the regional hydrology and the Lake Disappointment catchment.

Figure 4: Hydrography of the Lake Disappointment District

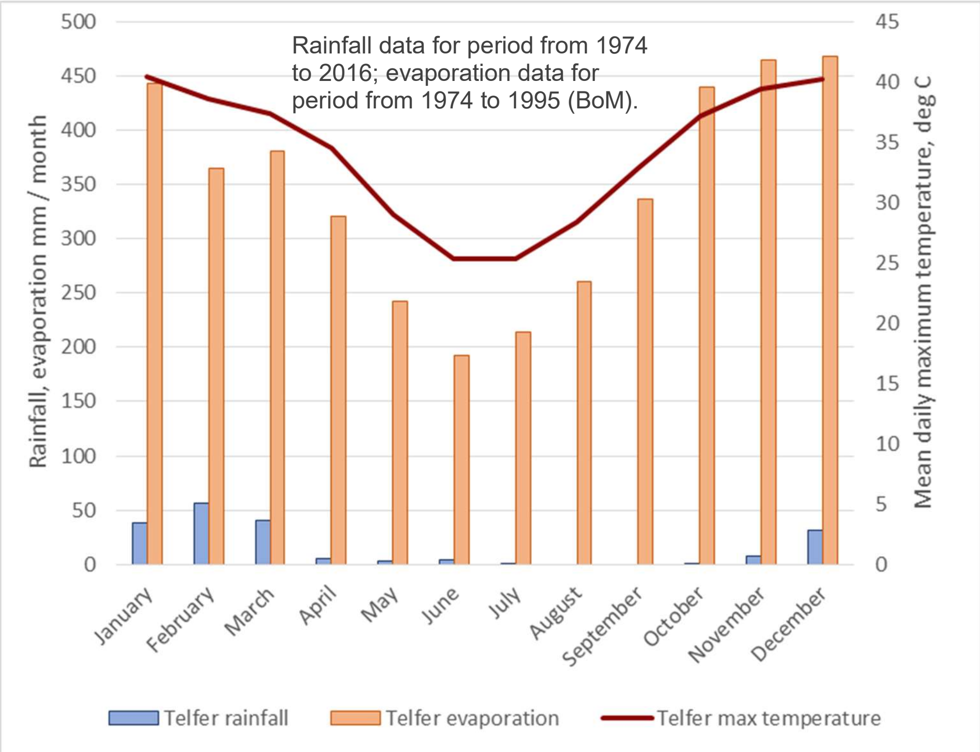


Climate and Rainfall

The nearest Bureau of Meteorology climate station to the project area is at Telfer Aero, approximately 180km north of Lake Disappointment. Daily rainfall data is available from 1974 through to 2017 and pan evaporation data from 1974 through to 1995.

The climate in the project area is arid, with hot summers and mild winters. Mean daily maximum temperature ranges from 25°C to 40°C. The mean annual rainfall at Telfer is 363mm. Most rainfall occurs during the summer months (December through March). Annual average evaporation rate exceeds 4,000mm significantly exceeding rainfall in every month (Figure 5).

Figure 5: Monthly rainfall, evaporation and maximum daily temperature (Telfer, WA)



The region occasionally experiences intense cyclonic rainfall events: five cyclones passed within 100km of Lake Disappointment during the 40 years from 1970 to 2010 (Figure 6). In 2013, Cyclone Rusty delivered in the order of 260mm of rain during a 3-day period. The 2017 wet season delivered exceptionally high rainfall of approximately 500mm, estimated to correspond to at least a 1 in 100 year event (**Error! Reference source not found.**7).

Figure 6: Cyclone tracks within 100 km of Lake Disappointment (1970 – 2010)

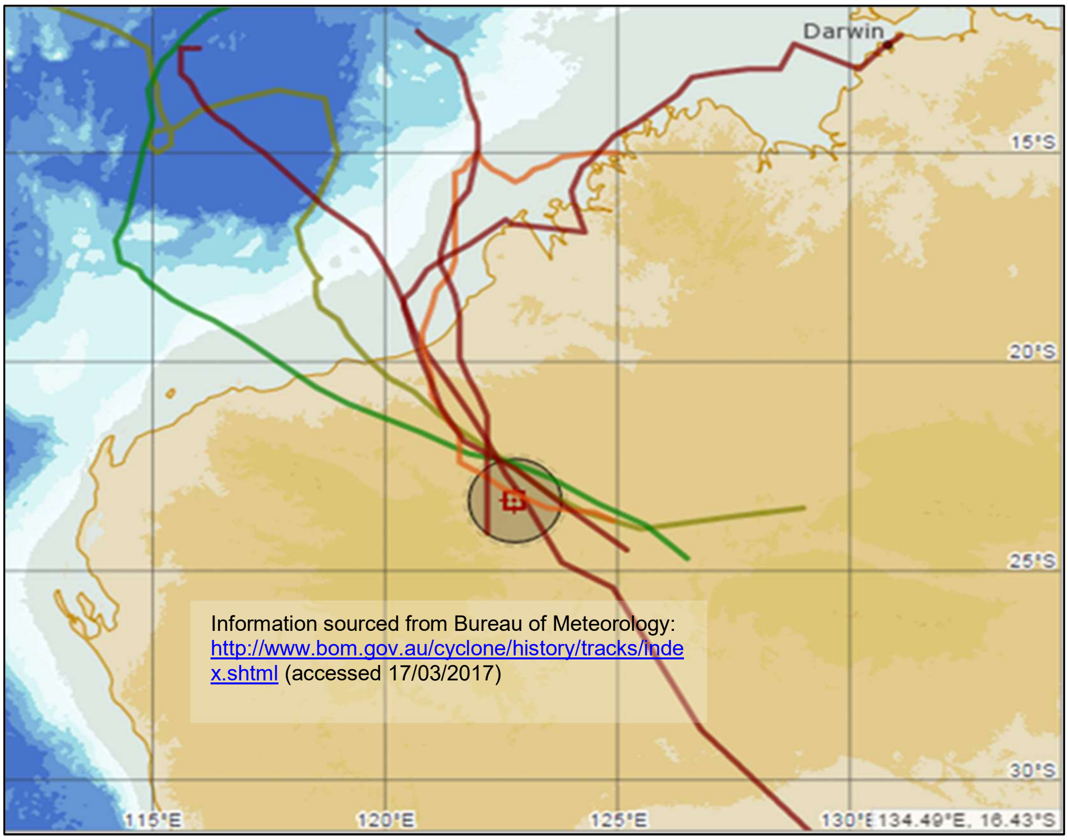
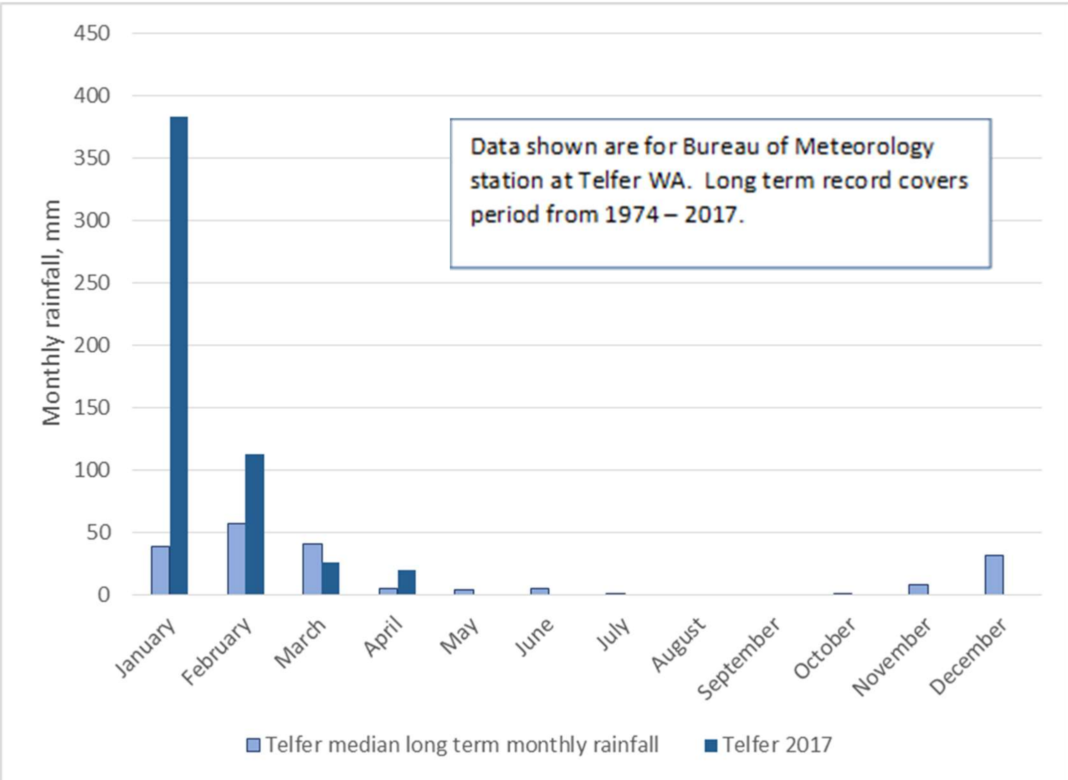


Figure 7: 2017 Rainfall, relative to long term monthly medians (Station No 013030)

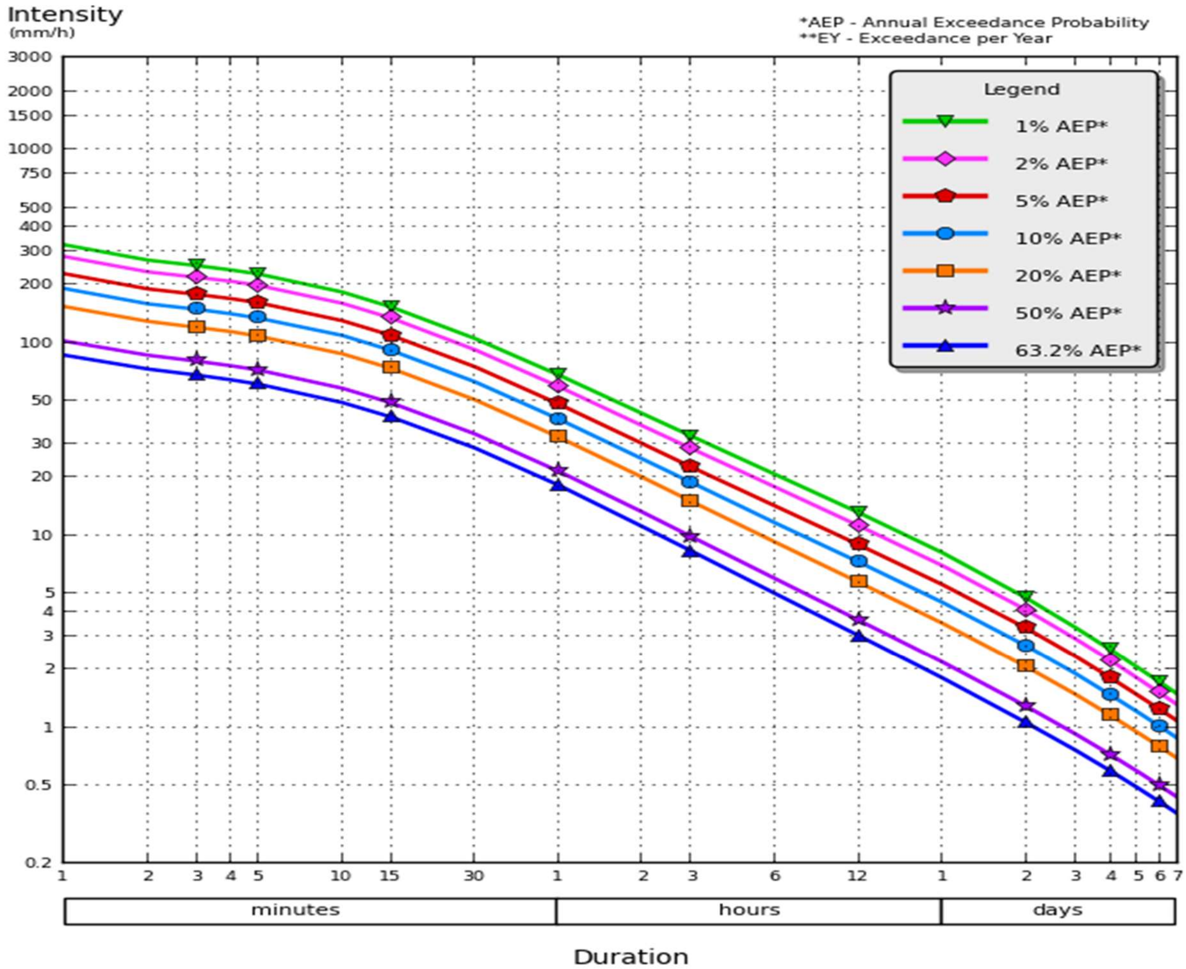


Estimated rainfall depths for a range of durations and return intervals are summarized below and rainfall intensity-frequency-duration curves are presented in **Error! Reference source not found.**8.

Table 1

Storm duration	Average recurrence interval (years)						
	1	2	5	10	20	50	100
5 mins	4.2	5.6	7.9	9.3	11.2	13.7	15.7
6 mins	4.69	6.25	8.82	10.5	12.5	15.3	17.6
10 mins	6.45	8.58	12.17	14.45	17.33	21.33	24.33
20 mins	9.7	12.93	18.33	21.80	26.20	32.17	37.00
30 mins	11.9	15.95	22.65	26.95	32.4	39.85	45.75
1 hour	15.9	21.3	30.7	36.7	44.3	54.8	63.1
2 hours	19.66	26.6	39	47.2	57.6	72	83.4
3 hours	21.72	29.52	44.1	53.7	66	83.1	96.9
6 hours	25.32	34.86	53.64	66.6	82.8	105.6	124.2
12 hours	30	41.52	65.52	82.2	103.32	133.2	158.4
24 hours	36.48	50.64	80.64	101.76	128.16	166.32	198.24
48 hours	44.02	60.96	96.96	122.4	154.08	200.16	238.56
72 hours	46.73	64.66	103.68	131.04	165.6	216	257.76

Figure 8: Rainfall intensity-frequency-duration curves – Lake Disappointment



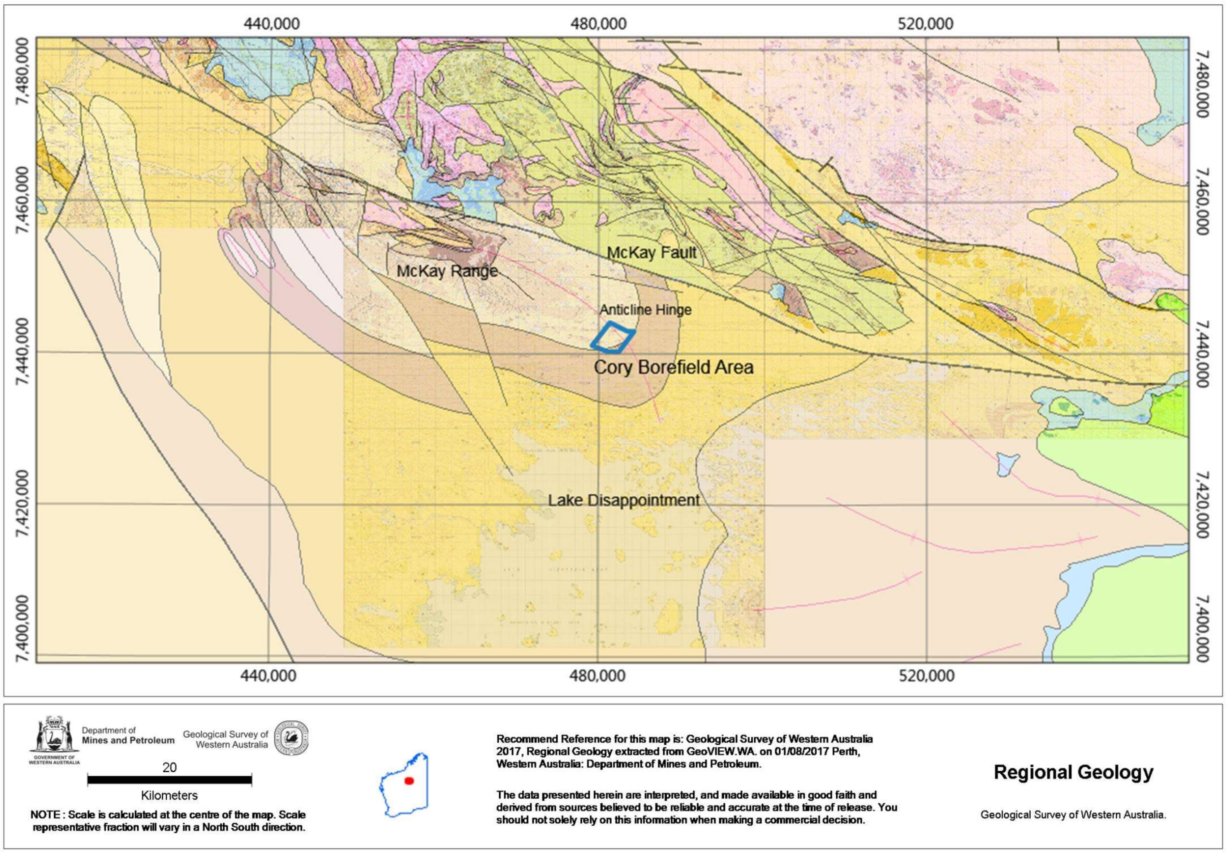
Regional Geology

The Gunanya 1:100,000 Geological Series Sheet (Bagas, 1998), the Blanche-Cronin 1:100,000 Geological Series Sheet (Bagas, 1999) and the Gunanya 1:250,000 Geological Series Sheet (Williams and Williams, 1980) indicate the following geological units occur in the vicinity of the Cory bore field.

These geological units were reclassified in 2016 by GSWA and presented at the 1:500,000 scale in Geoview. For the purposes of this report the names and descriptions set out in the Gunanya 1:100,000 sheet Bagas (1998) will be used.

Figure 9 shows the 1:100,000 and subsequent 2016 reinterpretation and the location of the borefield within the landscape.

Figure 9: Regional Geology and Structure



The area lies within the Paterson Orogeny, which refers to the north-westerly trending belt of folded and metamorphosed sedimentary and igneous rocks. The orogen is flanked to the west and southwest by the Archean rocks of the Pilbara and Yilgarn cratons and to the north and east is unconformably overlain by the Neoproterozoic and Phanerozoic rocks of the Canning and Officer basins (Bagas, 1998).

Quaternary and Tertiary

The Quaternary and Tertiary sequences are the seif (longitudinal) dunes comprising of dark red aeolian sand and clayey sand. The dunes are orientated approximately east west and up to 1km apart within the proposed bore field area.

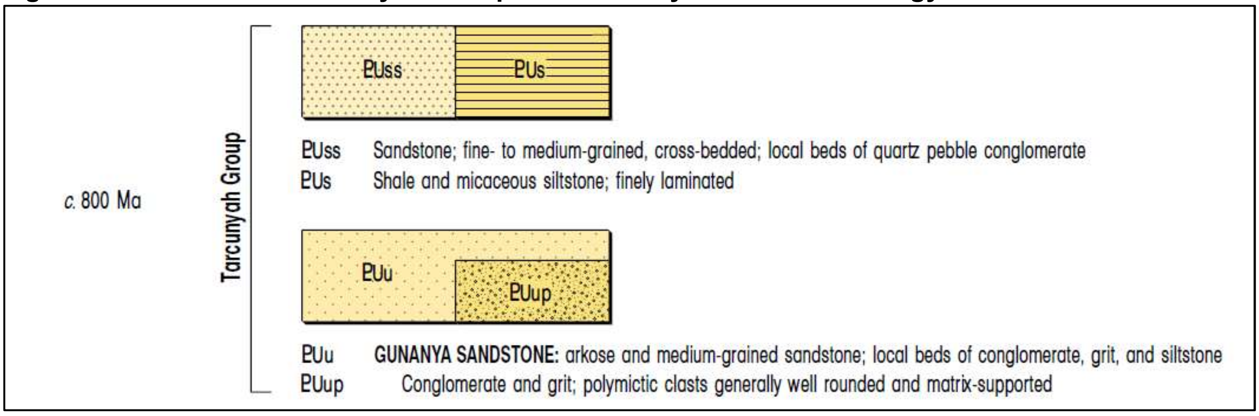
At the northern fringe of the Cory bore field area the core holes LDCH1701 and LDCH1702 intersected a thin sequence of vuggy, poorly cemented to well cemented breccia extending to a depth of 16mbgl overlying the various units of the Tarcunyah group. This sequence represents recent fluvial activity that may represent past flood channels of the McKay creek.

Neoproterozoic

The superficial sequence unconformably overlies the Neoproterozoic Tarcunyah Group (Officer Basin), which comprises an interbedded sequence of sandstones, siltstone and shale deposited around 800 Ma. The upper Tarcunyah group consists of an unassigned sequence of sandstone (PUss), interbedded siltstones and shales (PUs), which are collectively "PUsx". The sequence has been folded into an anticlinal structure which exposes the underlying Gunanya Sandstone (PUu), where the upper units have been eroded away. The sandstone outcrops extensively to the northwest where it forms the McKay range.

The stratigraphy of the Tarcunyah Group is taken from the Gunanya 1:100 000 Geology sheet GSWA and presented in Figure 10. In the 2016 reinterpretation the Tarcunyah group has been consolidated into the Coolbro sandstone.

Figure 10: Units of the Tarcunyah Group after Gunanya 1:100 000 Geology sheet GSWA



Bedrock Sequence (PUsx) – Unassigned Units

Unassigned bedrock units outcrop immediately to the east and the south west of Lake Disappointment. The core hole LDRC 1702, 6.5km north of the test production bore LDRC1602 intersected this sequence at 16mbgl.

The basal part of this sequence comprises massive medium to coarse grained, cross-bedded sandstone with local beds of quartz pebble conglomerate. The sandstone commonly contains clay and is interbedded with minor amounts of granular conglomerate containing intraformational mudstone clasts. The sequence fines upward through a 100 m interval to interbedded flaggy siltstone, shale and minor amounts of thin fine grained micaceous sandstone.

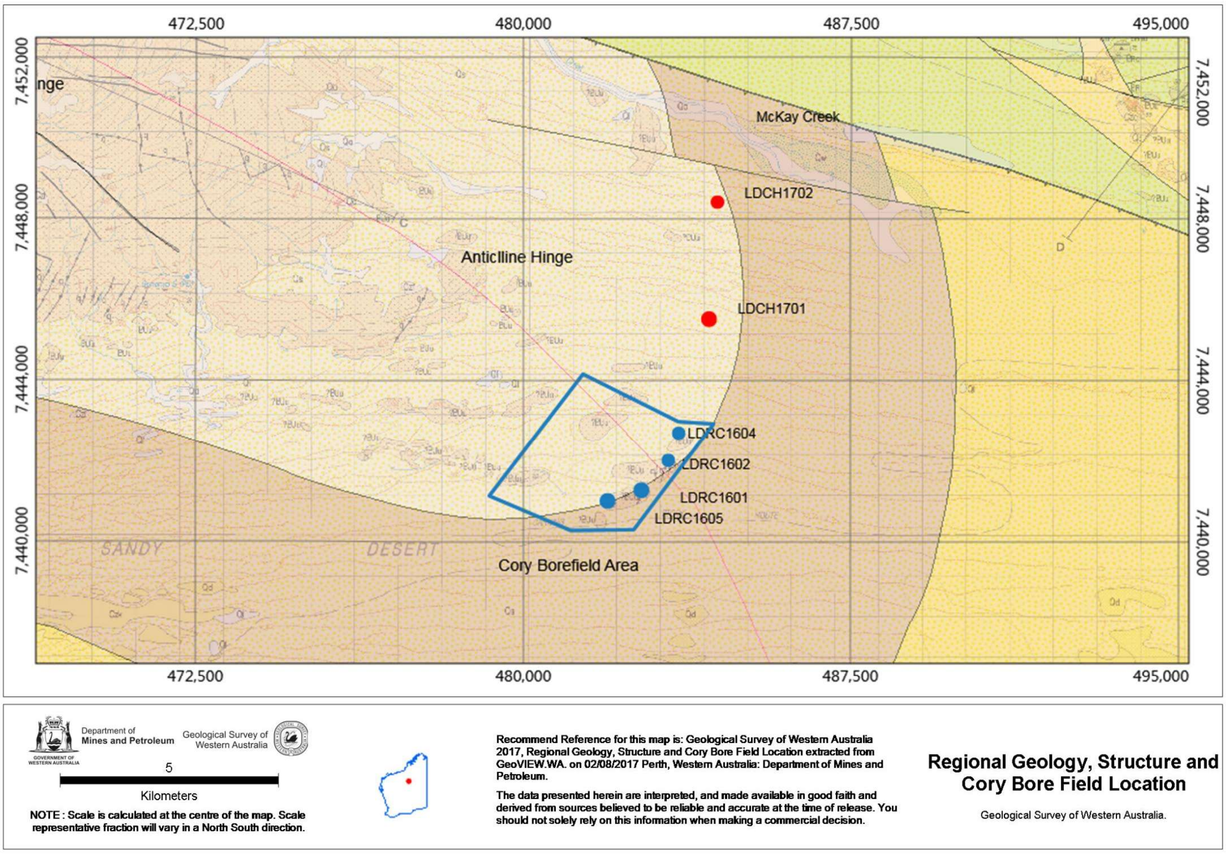
Bedrock Sequence (PUu) – Gunanya Sandstone

The Gunanya Sandstone consists of a medium to coarse grained characteristically light pink to purple arkosic sandstone. It is highly jointed and fractured with irregular but significant quartz veins as a result of secondary deformation.

Regional Structure

The major structural feature of the Cory bore field is the NW – SE trending McKay anticline, the location of the anticline is shown as a prominent regional structure on the 1:100,000 geological map (Figure 11).

Figure 11: Regional Structure and Cory bore field Location



Jointing within the sandstone indicates a steep dip of approximately 60 degrees: this and the fact that there is only 16m of Quaternary and Tertiary cover indicates that the regional anticlinal structure has been eroded away to leave an outlier of the Gunanya sandstone at surface, leaving a relatively flat land surface covered by the Quaternary dunes.

In the north south orientation within the borefield the Gunanya sandstone is encountered from surface to end of hole in all the reverse circulation observation and production bores (LDRC1601 – 1605). Approximately 3km to the north of bore LDRC1604 along the Willjabu track diamond hole LDCH1701 intersects weathered sandstone between 16.3mbgl and 23.1mbgl and fresh sandstone from 23.1mbgl to the end of hole at 38.1mbgl.

Core hole LDCH1702 drilled some 3km to the north of LDCH1701 intersects the same Quaternary and Tertiary sequence as LDCH1701 but then intersects a competent siltstone throughout the remainder of the hole to 68.1 mbgl. The siltstone exhibits the same steep jointing as the sandstone in bore LDCH 1701 and is representative of the unassigned units of the Tarcunya formation as described in the 1:100,000 sheet.

This change in lithology indicates that the limbs of the anticline dip steeply to the north and south with a change in lithology from the older Gunanya sandstone to the younger unassigned units somewhere between LDCH1701 and LDCH1702.

Hydrogeology

The Gunanya sandstone is the target aquifer of the bore field and outcrops extensively in the broader area. Further outliers are seen some 12km to the north east (Figure 9). The total area of outcrop and areas covered by loose thin Quaternary overburden was estimated from the Western Australian Geological Survey 1:100,000 scale geological map. The area of Gunanya Sandstone outcrop is large and extends some distance further to the west beyond the area covered by the Figure 9. The formation was recognised by Bagas (1998) as being a significant groundwater resource.

Structurally the proposed bore field is located in the apex of a regionally significant anticline orientated northwest / southeast and dipping gently to the southeast. The anticline has undergone significant erosion, exposing the core at surface. This core is composed of Gunanya sandstone, the basal unit of the Tarcunya formation.

According to the 2016 interpretation the Coolbro sandstone (containing the previously named Gunanya sandstone and the Unassigned units of the Tarcunyah formation) and adjacent Broadhurst formation cover an area in excess of 200km^2. The highly jointed and fractured nature of the sandstone and shallow depth to water table suggest it forms a major aquifer unit. It dips below and is hydraulically connected to the Unassigned units which are more argillaceous interbedded sandstones and siltstones.

For the purposes of delineating the regional extent of the aquifer only the outcropping flat areas below and to the southeast of the McKay Range have been included, resulting in an estimate of 60km^2. There is a significant area of sub-outcrop where the formation dips below the unassigned units to the south, west and east which is not included. Furthermore, the thickness of the sandstone can be inferred from cross sections in the Gunanya sheet as being many hundreds of metres thick.

The Gunanya Sandstone outliers to the northwest of the proposed Cory bore field are structurally separated lying to the north of the inferred McKay fault (Bagas 2005). The proposed Northern bore field is located in this area to avoid any potential interference effects

The proposed Cory bore field area is approximately 11km^2 composed of flat basement outcrop on which lie a series of longitudinal dunes up to 10m in height. The existing and proposed production and monitoring bores are located on the flat areas between the dunes.

Groundwater Dependent Ecosystems

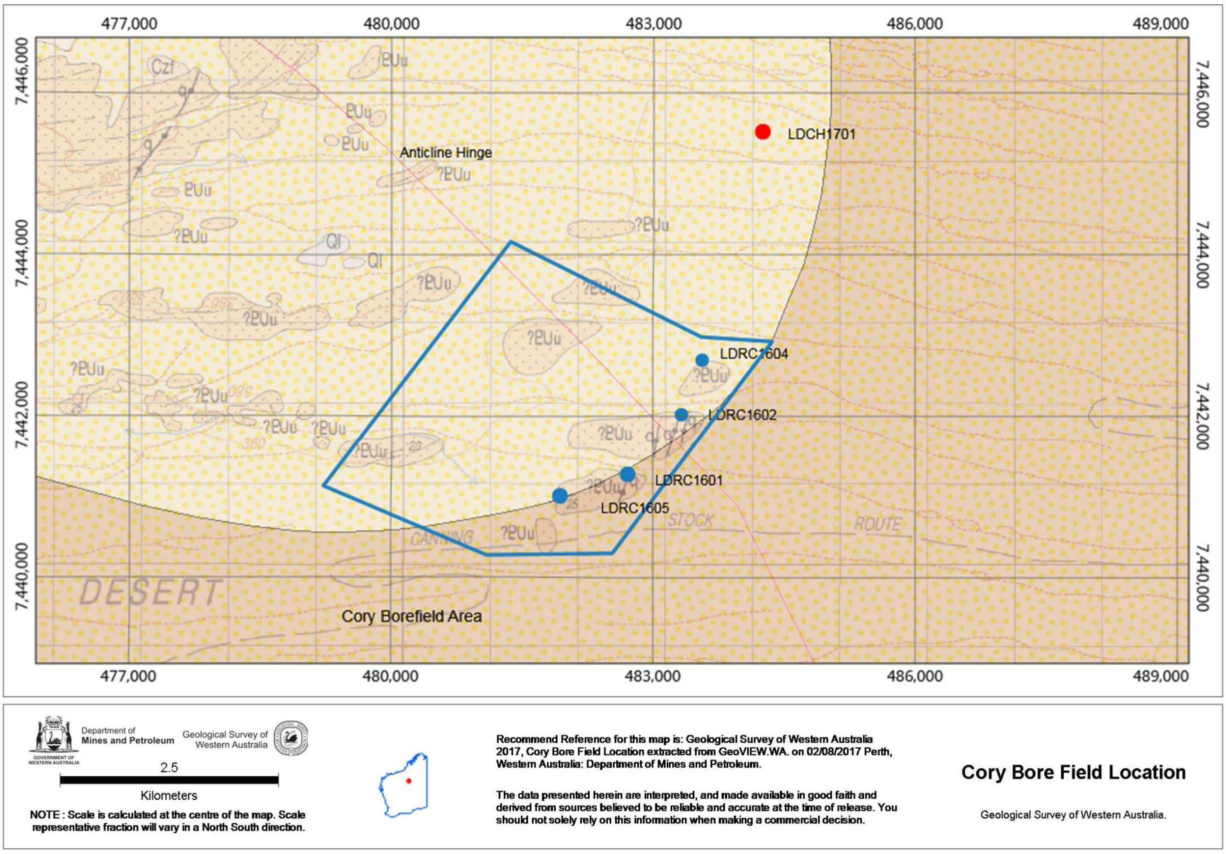
Flora and fauna surveys within the area of the Cory borefield were conducted by Botanica Consulting. The surveys did not identify any groundwater dependant vegetation (Appendix B). Similarly, the Bureau of Meteorology, Atlas of Groundwater Dependent Ecosystems (http://www.bom.gov.au/water/groundwater/gde/) indicates there are no aquatic groundwater dependent ecosystems and low potential for terrestrial groundwater dependent ecosystems within the Cory bore field area.

The proposed bore field and surrounding area were found to host a stygofauna community of 13 species, about half of which are known to be widespread (i.e. those that have been recorded outside the study area) and the other half unclassified or new. These species are considered, based on habitat and sampling results, likely to have at least locally widespread distributions (Bennelongia, 2017) (Appendix D).

Groundwater Investigations

The proposed bore field area approximates a diamond shape and lies immediately to the west of the Willijabu track just to the north of the Canning Stock route. The area identified is approximately 11km^2 (Figure 12) within which Reward Minerals propose to install at least six production bores to abstract up to a total of 1.5GL/year (48L/s)

Figure 12: Cory bore field Development Envelope Location with Exploration Bores and 1:100,000 and 1:500,000 Geology Interpretation



Boundary coordinates of the proposed bore field are set out in Table 2.

Table 2: Coordinates of the proposed Cory bore field

Corner point	Easting	Northing
1	483529	7442968
2	484373	7442922
3	482483	7440292
4	481067	7440274
5	479238	7441097
6	481393	7444109

Exploration Drilling

In 2016, Reward Minerals undertook an exploration drilling program in the Cory bore field using a reverse circulation drilling rig. The drilling consisted of five boreholes LDRC1601 to LDRC1605. Bores LDRC1601 and LDRC1602 were subsequently converted to production bores following positive airlift results. Bores LDRC1604 and LDRC1605 were retained as regional monitoring bores whilst bore LDRC1603 was abandoned and backfilled to surface.

Installed infrastructure in the bore field consists of one bore (Cory bore - currently in use for camp water supply), two test production bores, two observation bores, two regional monitoring bores and one diamond core hole all drilled by Reward Minerals since 2016. There is an additional diamond hole to north on the Willijabu track that provides further geological control. Table 3 sets out the coordinates for all existing bores as of July 2017.

In 2017, two observation bores were installed adjacent to the two production bores (LDRC1601MB and LDRC1602MB), and two core holes LDCH1701 and LDCH1702 were drilled on the Willjabu access track to the north of the Cory bore field for geological control. All reverse circulation bores were drilled in the Gunanya Sandstone to a depth of 110m. The observation, regional monitoring bores and core holes were cased with blank and slotted 50mm Cl9 PVC and the production bores with blank and slotted 203mm CL12PVC. The positions of all Cory borefield bores are shown in Figure 11 and all information pertaining to geology, bore construction and aquifer testing is attached in Appendix A.

Table 3: Cory Bore field Installed bores purpose and location (UTM Coordinates Zone 51k)

Bore Name	Bore Type	Easting	Northing
LDRC1601pb	Test Production	482685	7441245
LDRC1601mb	Observation	482681	7441240
LDRC1602pb	Test Production	483336	7441999
LDRC1602mb	Observation	483337	7441989
LDRC1603	Abandoned - backfilled	482202	7443052
LDRC1604	Regional Monitoring	483561	7442676
LDRC1605	Regional Monitoring	481925	7440927
LDCH1701	Diamond core (geological control)	484261	7445441
LDCH1702	Diamond core (geological control)	484428	7448333
Cory Bore	Camp Water Supply	483011	7441695

The test production bores were sited to intersect quartz veins within the Gunanya sandstone outcropping at surface. These quartz outcrops represent zones of increased permeability and have proven to be successful target aquifers for production bores. On the basis of the test pumping results to date it is estimated that an additional 6 production bores, for a total of eight, will be required to deliver up to the 1.5GL/year requirement.

Test Pumping

During June and July of 2017, bores LDRC1601 and LDRC1602 were test pumped as detailed in Table 4.

Table 4: Test Pumping Program

Bore	Steps	Constant Rate	Recovery
LDRC1601	3 x 60 min	6L/s – 24 hours	Up to 72 hrs
LDRC1602	3 x 60 min	15 L/s – 48 hrs	Up to 72 hrs

Figures 13 and 14 show the geometry of the exploration production and monitoring bores with relative distances from exploration production bores LDRC1601 and LDRC1602.

Figure 13: Test Bore LDRC1601 and observation bore geometry

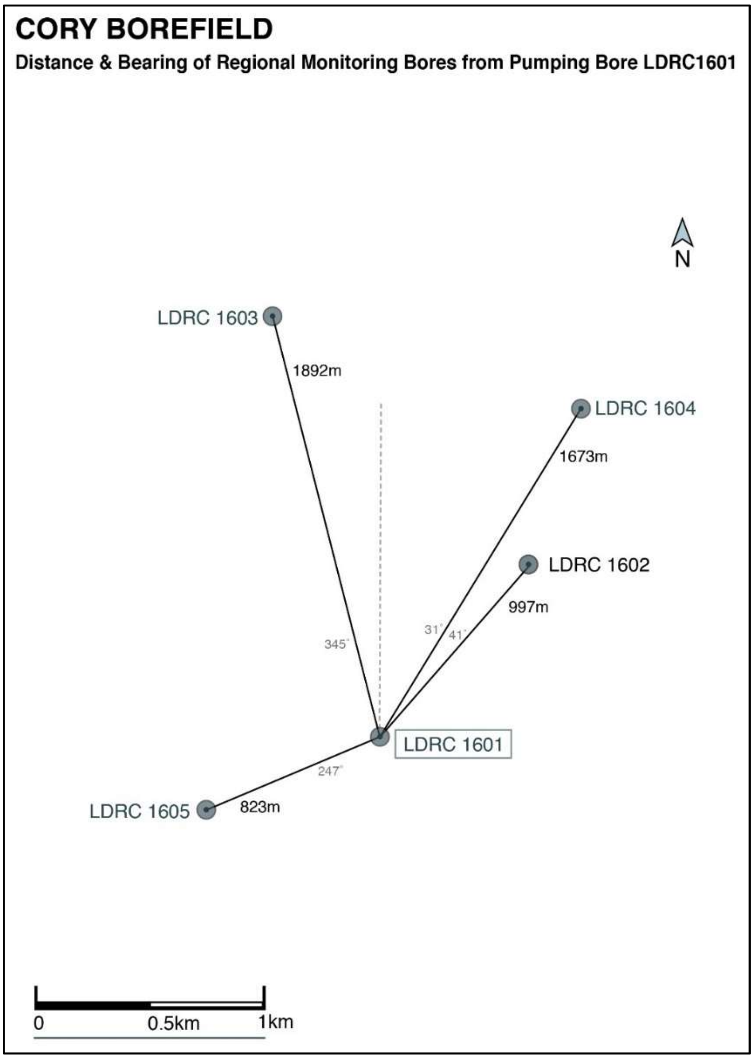
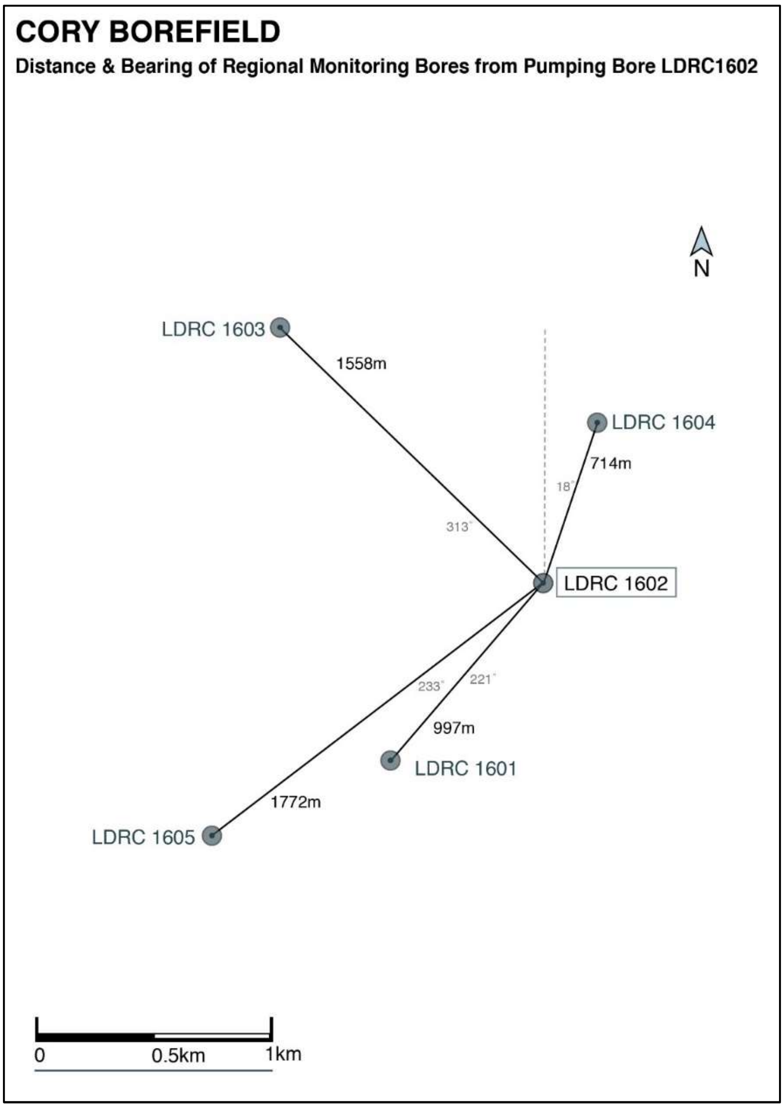


Figure14: Test Bore LDRC1602 and observation bore geometry



Hydrogeological Assessment

The hydrogeological assessment has applied the geological interpretation as described by Bagas (1998). The 2016 interpretation of the Gunanya Sandstone and unassigned units of the Tarcunyah formation as a single unit – the Coolbro sandstone doesn't provide sufficient detail for the purposes of this assessment. Core logs from LDCH1701 and LDCH1702 show that the formations within these bores are quite distinct with different hydraulic properties.

The principle aquifer in the Cory bore field is the Gunanya sandstone. This is highly jointed and fractured arkosic sandstone that forms a well-developed secondary type aquifer with dual porosity characteristics. Fractured quartz veining appears to provide higher permeability zones connecting secondary structure and enhancing bore yields.

The formation is exposed at surface with a thin veneer of sands in places and widely spaced longitudinal seif dunes. The Australian Stratigraphic Units Database (ASUD) records a maximum thickness of 500m and is saturated from approximately 10mbgl.

Recharge is by direct infiltration after rainfall events and leakage from overlying Cenozoic sediments and the Tarcunyah formation that conformably overlie the southerly dipping limb and east plunging nose of the anticline. No mapped discharges are apparent and with the water table at +/- 10m and minor vegetative cover there is limited evapotranspiration.

Aquifer Properties

LDRC1601 and LDRC1602 were tested in accordance with AS 2368-1990. Drawdown data was collected at 1 minute intervals using data loggers in all pumping and observation wells.

Test data were collated and evaluated for broad aquifer stress responses. Observations include:

- Both tests provide similar responses to pumping;
- A rapid response of observation bores;
- Drawdown achieved during pumping is moderate (<1m in bores >50m away) with no apparent directional bias;
- Equilibrium condition was achieved in LDRC1601 but not in LDRC1602 during the test duration
- Recovery is rapid achieving 95% of original SWL within 46% time of pumping (11 hours);
- No boundary effects are apparent, although there is some evidence of leakage from fractures higher up in the column which slow the rate of drawdown, this effect is more marked in LDRC1602;
- No aquifer dewatering trends are observed in the test data; and
- No dual porosity is noted although longer pumping times may induce a typical dual porosity response.

Drawdown responses recorded are more typical of a confined aquifer than unconfined aquifer. This is attributed to the extensive fractured rock matrix and dipping bedding of the aquifer that result in low unconfined storativity and rapid response of observation bores. Analyses using various fracture flow models shows poor correlation with type curves and do not provide any consistent results. On a broad scale, it appears that for purposes of interpretation, the extent of fracturing and jointing allow the aquifer to be considered analogous to a porous medium confined aquifer and Theiss (1935), or for late time and proximal drawdown, the Cooper Jacob (1946) methodology, can be used for unsteady state flow, or steady state where 2 piezometers are available.

Recovery data from the test pumping of LDRC1601 and LDRC1602 after pumping stopped was rapid in both the observation and the regional monitoring bores. In bore LDRC1601 MB 75% of drawdown within the aquifer had recovered in 40 minutes with 95% of drawdown recovering in 11 hours. This response suggests no dewatering is taking place and the aquifer has an extensive interconnected fracture network that responds rapidly to changes in the subregional hydraulic head.

Test data were processed using AquatestSolv analysis software. A summary of the test results and analyses is provided in Table 5 below, and test curves and interpretation provided in Appendix 1.

Table 5

Test Bore *Rate (L/s)*	**Observation Bore**	**Distance**	**Drawdown end of CRT**	**Calculated T (m^2/day)**	**Calculated S**	**Method**
LDRC1601	LDRC1601MB	10m	2.9m	193	1.4×10^{-5}	Theis
				170	5.5×10^{-5}	Cooper-Jacob
6L/s						
LDRC1602	LDRC1602MB	10m	1.9m	266	1.4×10^{-5}	Copper - Jacob
				270	1.3×10^{-5}	Theis
15L/s						

The analysis of both sets of data yielded similar results; relatively high transmissivity, low unconfined storativity and rapid response of observation bores are typical of highly fractured rock aquifers. Observation bore responses suggest good connectivity between fractures and joints enabling groundwater flows. The variability in aquifer properties spatially and with depth is uncertain and can only be determined following sustained long term pumping. Permeability is estimated from the thickness of saturated aquifer intersected by the pumped wells and averages 2.0m/day.

From the tests, the adopted aquifer hydraulic values for groundwater resource analysis are:

- Transmissivity T = 200m^2/day
- Unconfined storativity S_y = 1 X 10^{-5}
- Permeability K = 2m/day
- Aquifer thickness = 100m

Rainfall Recharge

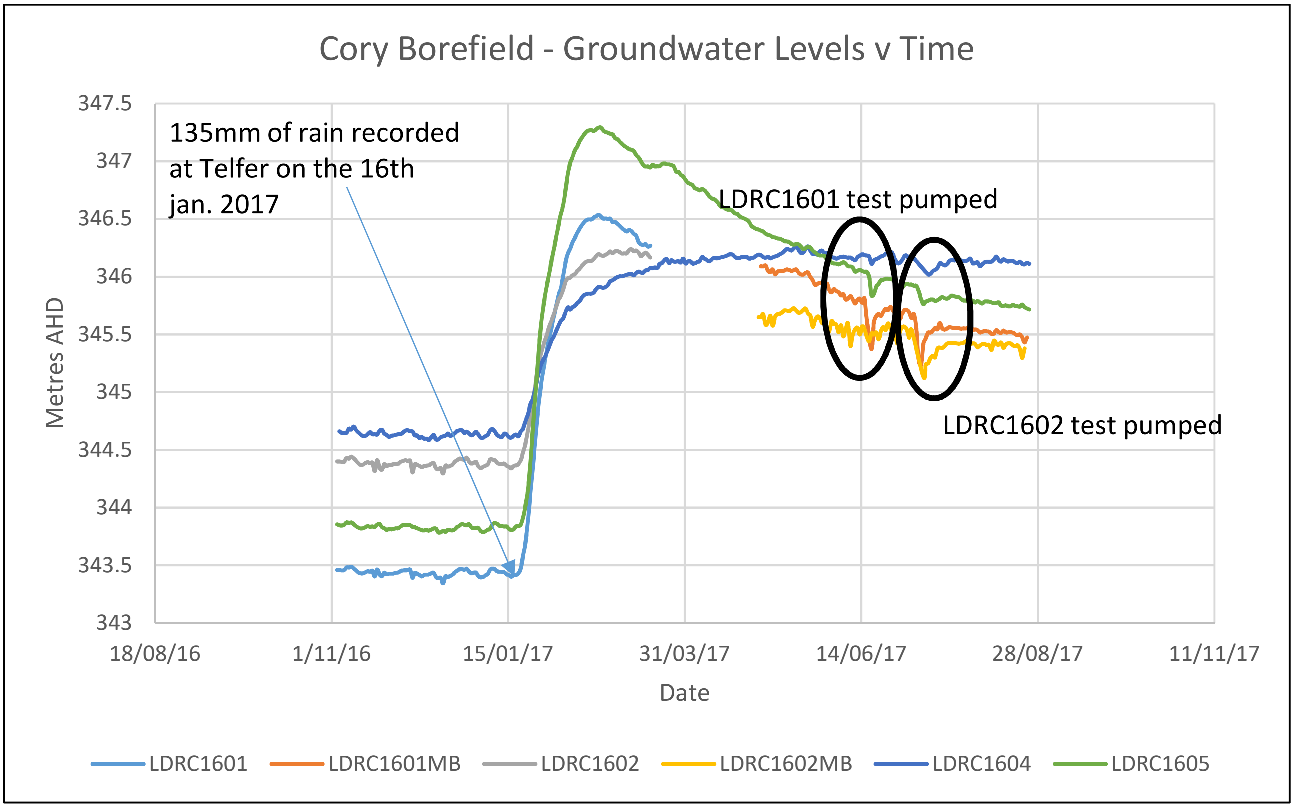
The static water level at the end of the dry season is approximately 10mbgl and depending on duration of rainfall events can rise to 6mbgl during the wet season, the groundwater flow direction is from the NW to the SE. Groundwater movement within the Gunanya sandstone occurs via the secondary porosity of the fractures.

The subregional connection within the fracture network can be seen both in the response to rainfall recharge and to the recent test pumping (Figure 15). A significant rainfall event of 135mm was recorded on 16 January 2017 at Telfer, and a similar significant event happened in the Cory borefield area where the water level responses were captured in the monitoring bores.

The response is greatest in bores LDRC1601 and LDRC1605 and the recession curves are also similar in form. These bores are 800m apart and lie within the same dune pair, given the speed and size of the response it could be interpreted that the rainfall event was more intense in this area. The rapid rise leads to a change in the local hydraulic gradient moving water away from the centre of the recharge event outward. Following the event recovery commences quickly, bore 1605 shows a nice recession curve which is continuing as of late August. What is apparent is that the groundwater levels are still 2m above the static at the end of the last dry season. The rate of decay would indicate that the levels will remain above last dry seasons static level as the 2017 wet season begins, this confirms the significance of the 2016 – 2017 wet season as at least a 1:100 year (if not more) event.

Whilst the water levels in bores 1602 and 1604 also respond to rainfall the levels continue to rise albeit slowly even whilst 1605 is declining. Bore 1604 (light blue) shows a different response to rainfall and recharge and to date hasn't really declined at all remaining 1.5m above the November 2016 level.

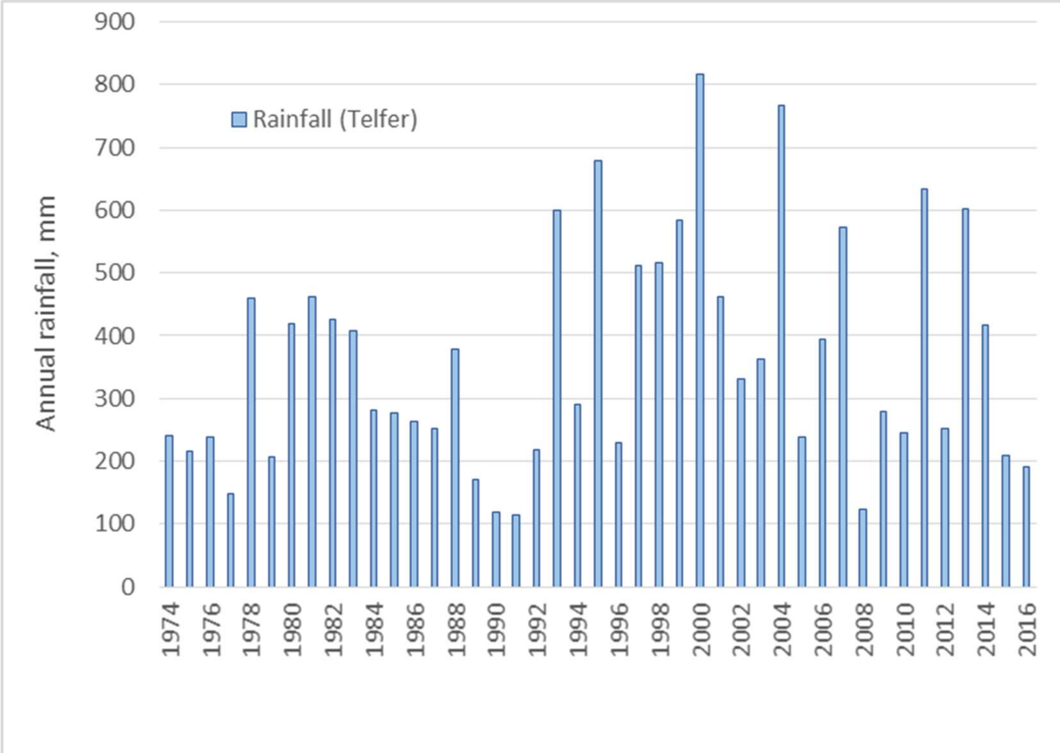
Figure 15: Groundwater Response to rainfall and test pumping



There is the potential for runoff from the McKay range to the north west of the borefield but in the absence of creeks it is assumed that this runoff infiltrates up groundwater gradient and ultimately recharges the borefield via throughflow. There are no surface drainage features within the borefield area and runoff from the dunes is assumed to be negligible. However the dunes play an important role in impounding high intensity rainfall in interdunal areas, facilitating greater recharge to the underlying bedrock formations. They are also a source of delayed seepage into the bedrock.

The rainfall record for Telfer over the past 40 years (Figure 16) indicates that annual recharge is likely to occur to some extent. Since 1993 there has been a greater number of above average rainfall years since 1993 than recorded in the previous 20 years. Ten of the last 23 years have recorded an annual rainfall exceeding 500mm. This is consistent with other rainfall trends observed in the Pilbara and Kimberley over the past 50 years. Climate change predictions for these areas suggest annual rainfall records will be characterised by fewer but higher intensity events in the future.

Figure 16: Rainfall at Telfer



In this setting, effective recharge can vary substantially with rainfall intensity, frequency and duration (Table 1).

At this stage, for purposes of resource assessment, average recharge is estimated at 6% of MAP although it is noted that this could vary substantially year to year depending on rainfall IFD characteristics.

Groundwater Levels and Flow

Groundwater levels have been monitored in six monitoring bores in the Cory borefield since April 2016. There is no regional monitoring network available but the data collected over the borefield area indicates a low groundwater gradient from NW to SE of 0.001 (1:1000). This suggests recharge via runoff takes place from the northwest in the McKay Range area. It is also consistent with the regional distribution of average rainfall which is higher to the west and lower in the Great Sandy Desert to the east.

The subregional connection within the fracture network is indicated by the convergence of the recession curves seen in Figure 15 as heads re-equilibrate through the aquifer. All the Cory borefield bores are approaching equilibrium at a higher static water level than that seen at the end of the 2016 dry season in November. This rapid response to rainfall and higher equilibrium indicate that groundwater flow away from the area of the Cory borefield is slow reflecting the very flat regional hydraulic gradient.

The data in Figure 15 shows a static water level at the end of the 2016 dry season of approximately 10mbgl. The static at the same time in 2017 is going to be 1.5 – 2m higher. Figures 17 and 18 shows the rate of change with time in bores LDRC1604 and 1605, the figure show how the water levels respond to rainfall, as much as 3.5m in the case of LDRC1605, which reversed the local hydraulic gradient. The data suggests that water is banked within the system in wet years as subsequent recharge events occur before the system has fully discharged. Prior to the 2017 wet 2015 and 2016 were lower than average rainfall years at Telfer hence the system discharged to the regional equilibrium seen in November 2016, with the 2017 event the system has filled up and in all likelihood, will not fully discharge before the commencement of the 2017 wet season.

Figure 17 Rate of Change in Water Level in Bore LDRC1604

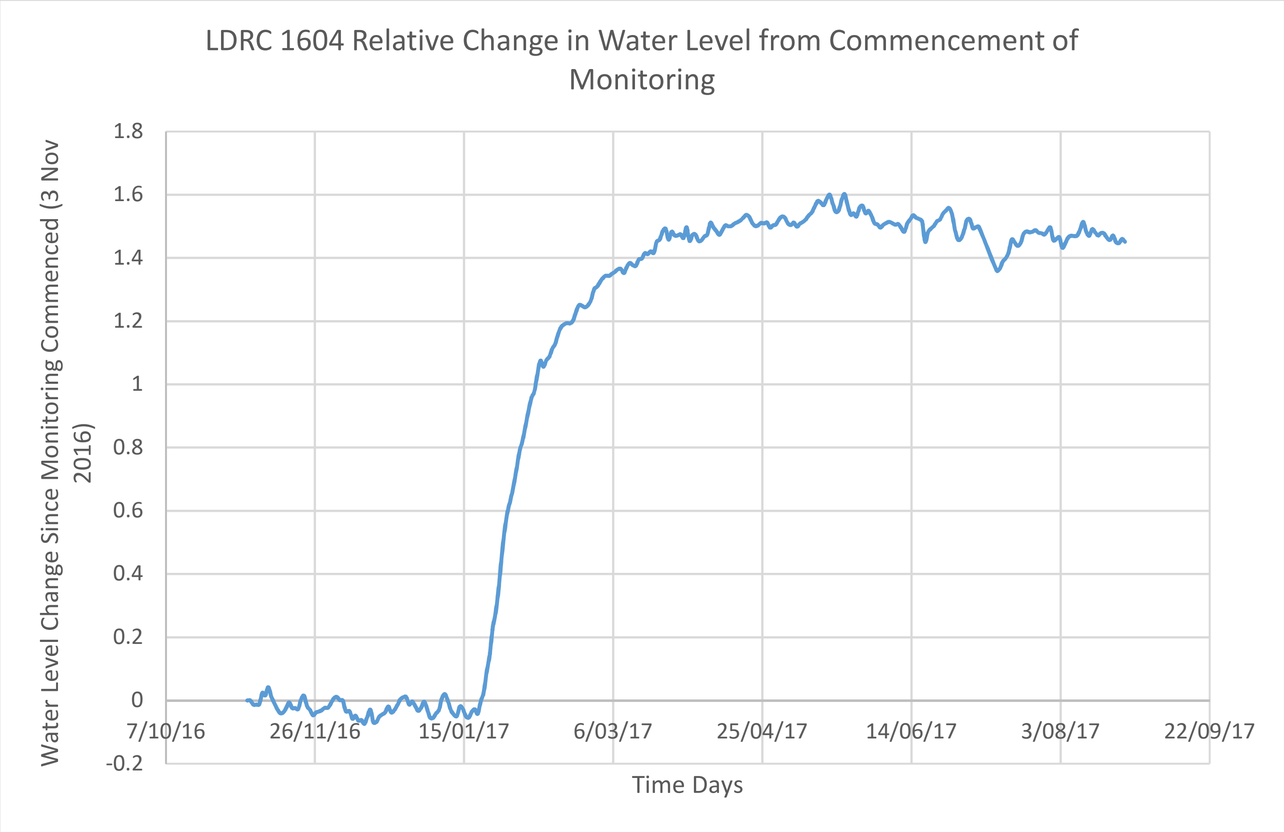
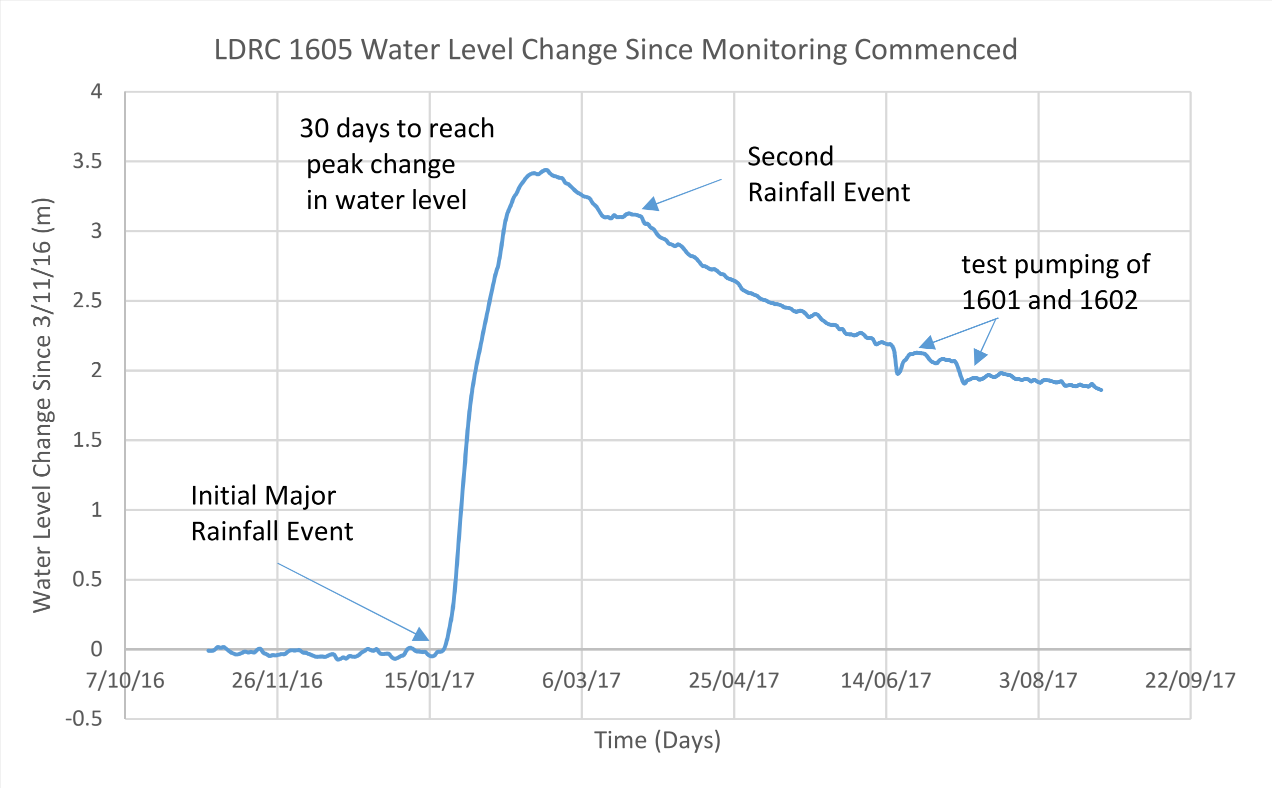


Figure 18 Rate of Change in Water Level in Bore LDRC1605


LDRC 1605 Water Level Change Since Monitoring Commenced
Water Level Change Since 3/11/16 (m)
Time (Days)
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
7/10/16
26/11/16
15/01/17
6/03/17
25/04/17
14/06/17
3/08/17
22/09/17
30 days to reach peak change in water level
Second Rainfall Event
test pumping of 1601 and 1602
Initial Major Rainfall Event

Groundwater Chemistry

The groundwater in the Cory borefield can be described as slightly alkaline and brackish with a typical TDS of 2500mg/L. Major components analysis (Appendix C3, Operational Policy 5.12, DoW 2009) are included in Appendix A. The hydrochemistry is dominated by sodium chloride.

Two full analysis have been completed for both LDRC1601 and LDRC1602 both following a period of test pumping. The first analysis was completed in November 2016 at the end of the dry season whilst the second was completed in June 2017 following the 9th highest rainfall recorded at Telfer between 1974 and 2017, in both cases the data are similar indicating that the groundwater chemistry is stable and has not been altered due to rainfall recharge. However, the TDS in1601 has gone up and in 1602 gone down, Na and Ca has gone down in both. Whilst these differences are not really that different there is a need to establish a long term trend in both seasonal and spatial terms.

Long-term pumping is unlikely to significantly alter groundwater chemistry and given the regular episodic recharge from rainfall a regular injection of good quality water will act to maintain the water quality within the limits required for processing at lake Disappointment. As stated above there remains the need to develop a longer term understanding of variations across the borefield, as well as for processing needs, ongoing monitoring and analysis will be required during future production.

Table 7: Hydrochemical Analysis for Cory Borefield Test Production Bores

			Cory Borefield Production Bores			
Analyte	Units	Limit	LDRC1601 7/11/2016	LDRC1601 17/6/2017	LDRC1602 7/11/2016	LDRC1602 8/7/2017
pH**	pH Units	0	8.0	7.7	8.0	8.0
Conductivity @ 25°C	µS/cm	2	4400	4700	4200	4000
TDS Dried at 175-185°C	mg/L	10	2500	2700	2400	2100
TSS Dried at 103-105°C	mg/L	5	<5	<5	<5	11
Total Alkalinity as $CaCO_3$	mg/L	5	230	240	210	200
Carbonate Alkalinity as CO_3	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity as HCO_3	mg/L	5	290	290	250	240
Chloride, Cl	mg/L	1	1100	1200	1100	1100
Sulphate, SO_4	mg/L	1	280	290	230	200
Calcium, Ca	mg/L	0.2	94	84	72	59
Potassium, K	mg/L	0.1	38	40	33	32
Magnesium, Mg	mg/L	0.1	45	43	37	33
Sodium, Na	mg/L	0.5	780	770	790	680
Uranium, U	µg/L	1	12	12	7	7
Thorium, Th	µg/L	1	<1	<1	<1	<1

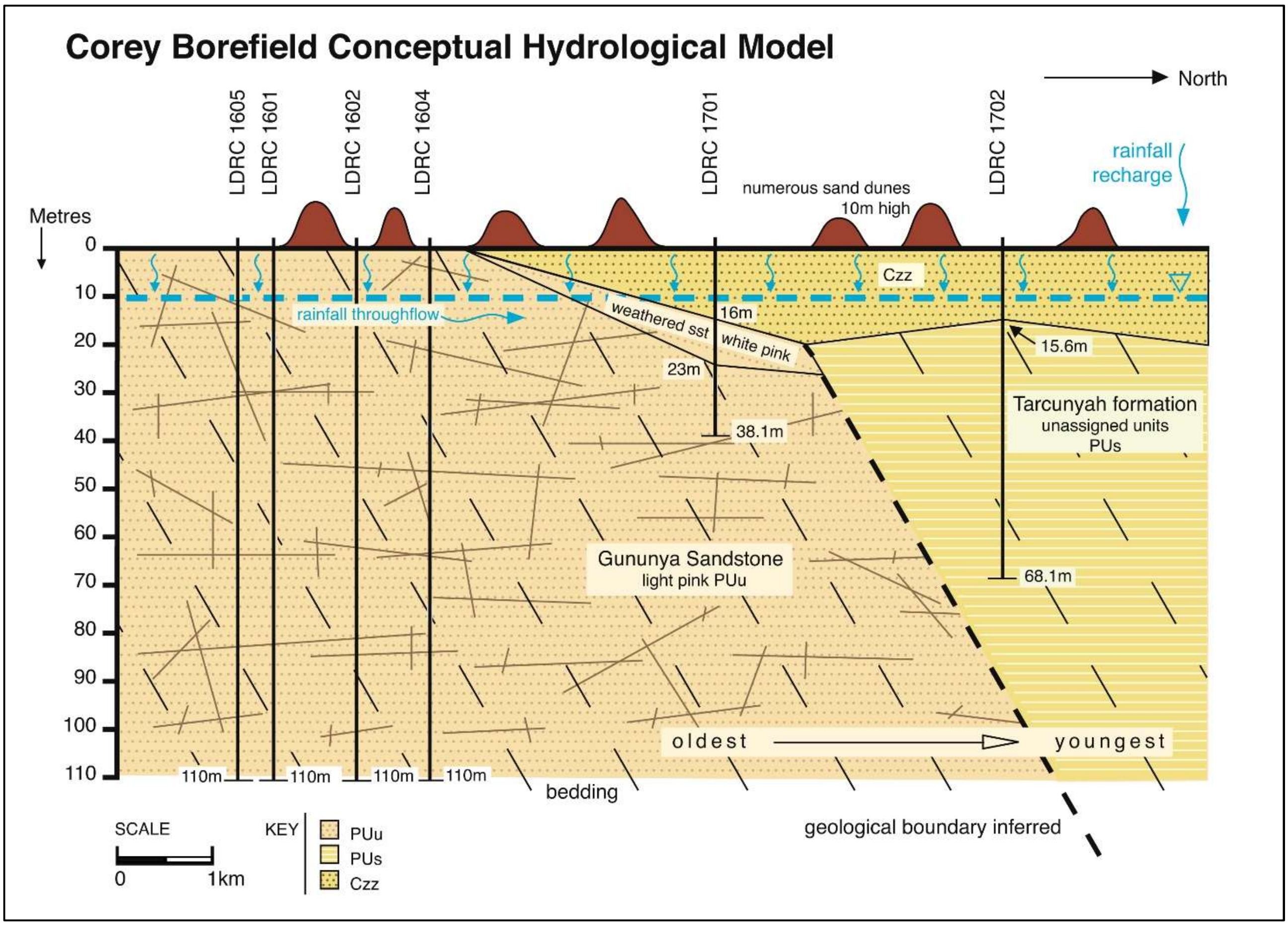
Groundwater Resource Estimation

Conceptual Hydrogeological Model

The proposed borefield will be installed within the outcrop area of the Gunanya sandstone between Quaternary dunes. The nominated area of the borefield represents only a small proportion of the overall exposed Gunanya sandstone aquifer. The conceptual hydrogeological model of the Cory borefield is shown in the Figure 19.

Recharge to the borefield is via direct infiltration of rainfall, groundwater throughflow and leakage from the overlying Quaternary, Tertiary and Tarcunyah sandstone formations. Groundwater levels suggest all these formations are in hydraulic continuity.

Figure 19 Conceptual Hydrogeological Model of the Cory Borefield



The full extent of subcrop and thickness of the Gunanya sandstone formation implies groundwater storage is likely to be significant despite the low unconfined storativity. Long term abstraction is expected to induce leakage from the overlying formations.

The response of monitoring bores to both rainfall recharge and test pumping suggests an extensive and connected fracture and jointing network on a regional scale that facilitates drainage and recharge of the formation.

Proposed abstraction is greater than the average annual estimated rainfall recharge, although this is expected to vary significantly and exceed calculated averages at least 1 in every 4 years. The total planned abstraction of 30GL from the aquifer over the life of the operation is significantly less than the estimated volumes of storage held within the greater aquifer system.

Resource calculations

The groundwater resource available is calculated by:

- Estimating direct rainfall recharge over the borefield area only, not the full extent of the exposed formation;
- Estimating throughflow in response to an increase in gradient due to borefield abstraction;
- Estimating leakage from adjacent and overlying formations;
- Considering any additional losses (evapotranspiration) or infiltration (surface water) that may occur.

The approach adopted is conservative and relies principally on direct recharge and throughflow to arrive at a resource estimate as leakage has not yet been quantified.

Rainfall recharge

The defined borefield area is 11km^2 and the mean annual rainfall is assumed to be 363mm. With recharge for the exposed Gunanya sandstone estimated as 6% the total direct annual recharge in the Cory borefield area is:

11×10^6 m^2 x 0.363m/yr x 0.06 = 240 000m^3/year (240 ML/year)

In years such as 2017 where over 500mm of rainfall was recorded at Telfer or a cyclonic event such as Cyclone Rusty occurs recharge will increase to 330ML/year. Similarly, if the annual rainfall measures 100mm as recorded in 1991, recharge from rainfall would drop to 66 ML/year.

The entire outcrop area of Gunanya sandstone is approximately 60km^2 implying that total direct recharge to the formation in an average rainfall year is in the order of 1.3GL/a.

Throughflow

The low groundwater gradient in the area implies a high level of connectivity and well developed permeability within the formation. The response of the distant observation bores to test pumping (Figure 12) supports this assertion. The hydraulic gradient calculated from the monitoring bore data in the borefield area is 1:1000.

Using Darcy's equation, throughflow (Q) can be estimated under current steady state conditions from;

$Q = T\ i\ W$

Where:
Transmissivity (T) = 200m^2/day (average from both tests and overall estimation)
Hydraulic Gradient (i) = 0.001
Aquifer width (W) = 5000m

Q= (200m^2/day x 0.001 x 5000m) x 365 days = 0.365 GL/year

This throughflow estimate applies to the flow in the upper 100m of aquifer under natural conditions. Planned production bore depths are 150m each and pumping induces flow toward the borefield under increased hydraulic gradients. Groundwater is drawn from all sides into the cone of depression. Analytical modelling predicts that the hydraulic gradient around the borefield will increase to 1:500 or 0.002 in all directions and extend some 3000m from the borefield perimeter. This provides a throughflow perimeter of some 30000m.

Q = (200m^2/day x 0.002 x 30 000m) x 365 days = 4.4 GL/a)

Based on the aquifer testing and analysis, it is apparent that abstraction of 1.5GL/a from a properly constructed and operated borefield is feasible. While rainfall recharge to the aquifer can be unpredictable, the Telfer rainfall record indicates rainfall years above 500mm/a occur at least every 4 years. There is significant storage in the aquifer to accommodate years where rainfall is below average, and years where the deficit will be corrected through rapid recharge.

It is apparent that throughflow under an increased hydraulic gradient can support planned abstraction volumes of 1.5GL/a. Direct recharge over the aquifer outcrop area in an average year is approximately 1.3GL. The difference can be drawn via leakage from overlying formations and aquifer storage, and will likely be replenished in above average rainfall events over a period of years. As the borefield is developed and the aquifer exploited, monitoring and analysis will provide greater resolution of the broader aquifer system and sustainable yields.

Analytical Modelling

There is insufficient data or monitoring to develop a numerical model. The excellent fit of test pumping data to Theiss (1935) and Cooper Jacob (1946) analytical method techniques allows use of the modified non equilibrium equation developed by Cooper and Jacob (1946) to be used to determine:

- Distance drawdown over time
- Well interference effects in the borefield
- The sensitivity of drawdown to transmissivity, storativity, time and distance

The modified non equilibrium equation can be expressed as:

$$s = \left(\frac{0.183Q}{T}\right)\log\left(\frac{2.25Tt}{r^2\,S}\right)$$

Where:

s = drawdown

T = transmissivity

t = time since pumping started

r = distance from pumping well

S = storativity

The validity of the method was calibrated by calculating drawdown in observation bore LDRC1602MB. The actual measured drawdown was 5.4m after 2 days at 15L/s (1296m^3/day). The method calculated drawdown as 5.4m. In bore LDRC1601 the actual measured drawdown was 2.9m after 1 day at 6 L/s (518.4m^3/day) and the method calculated drawdown was 3.4m.

Distance Drawdown

Distance drawdown plots for LDRC1601 at 6L/s and LDRC1602 at 10L/s, an appropriate long term production rate and 15L/s, the test pumping rate after 1 year of pumping are shown in Figures 20 and 21. These estimations have applied a Transmissivity of 200m^2/day and a Storativity of 1 x 10^{-5}. The overall drawdowns are also conservative as no recharge has been applied to the estimation.

Figure 20: LDRC 1601 Distance Drawdown Plot after 1 year of Pumping

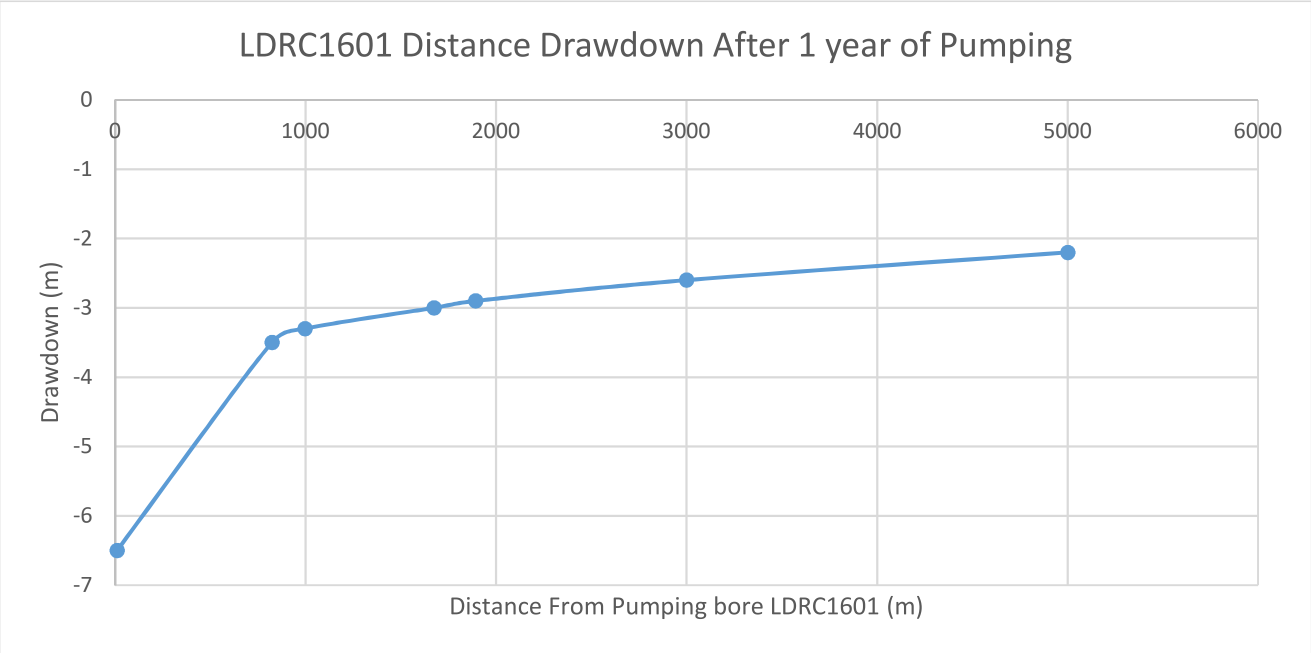
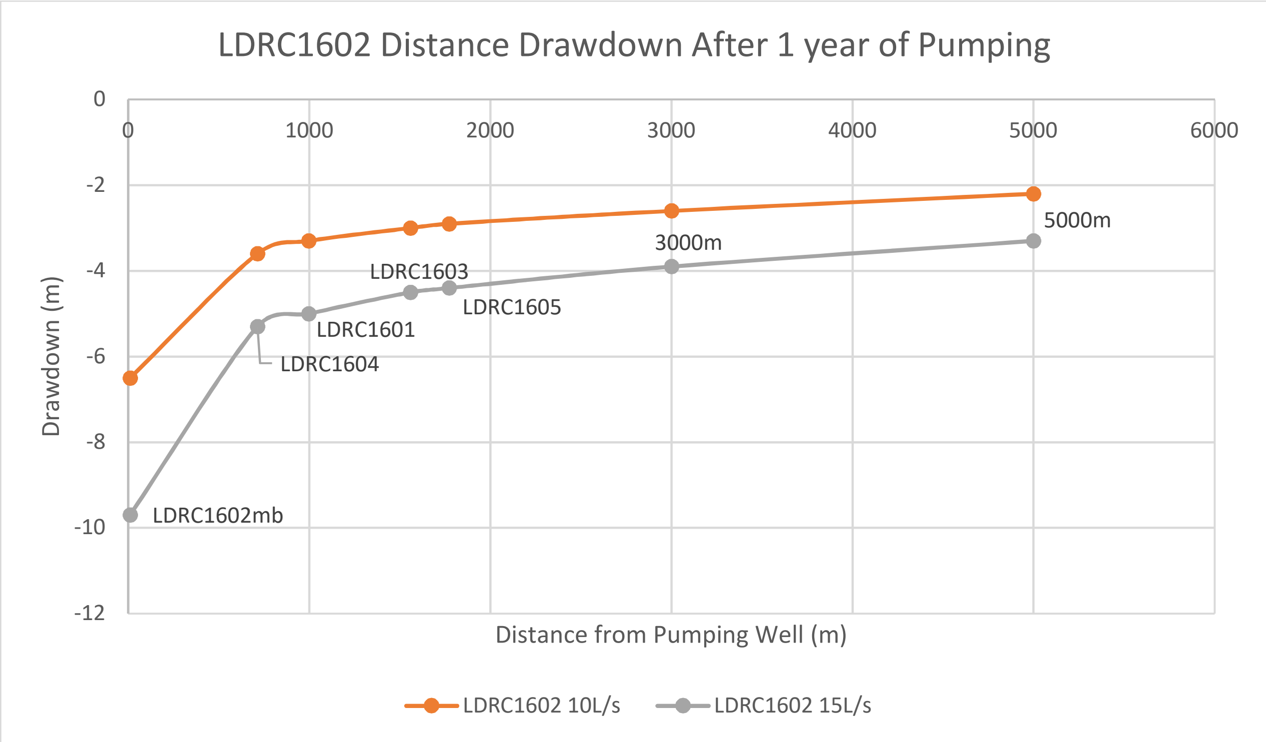


Figure 21: LDRC1602 Distance Drawdown Plot After 1 year of Pumping



The data show a cone of depression that whilst extensive is very shallow. These drawdowns are theoretical and approximate as they take no account of geological variation or recharge. They do provide an indication of potential drawdown and highlight the response of a fractured rock aquifer with a high hydraulic conductivity and low storativity to sustained pumping.

In order to provide a truer indication of the extent of the cone of depression only 1 year of pumping was used as the recharge influence will be limited, beyond 1 year the likelihood of recharge influencing and indeed limiting the cone of depression is high.

Superposition Effects

Figure 22 show the effects of superposition on drawdowns within the borefield centred on bore LDRC1602 for 1 year in the absence of recharge.

Figure 22: Superposition Effects Across the Cory Borefield Area

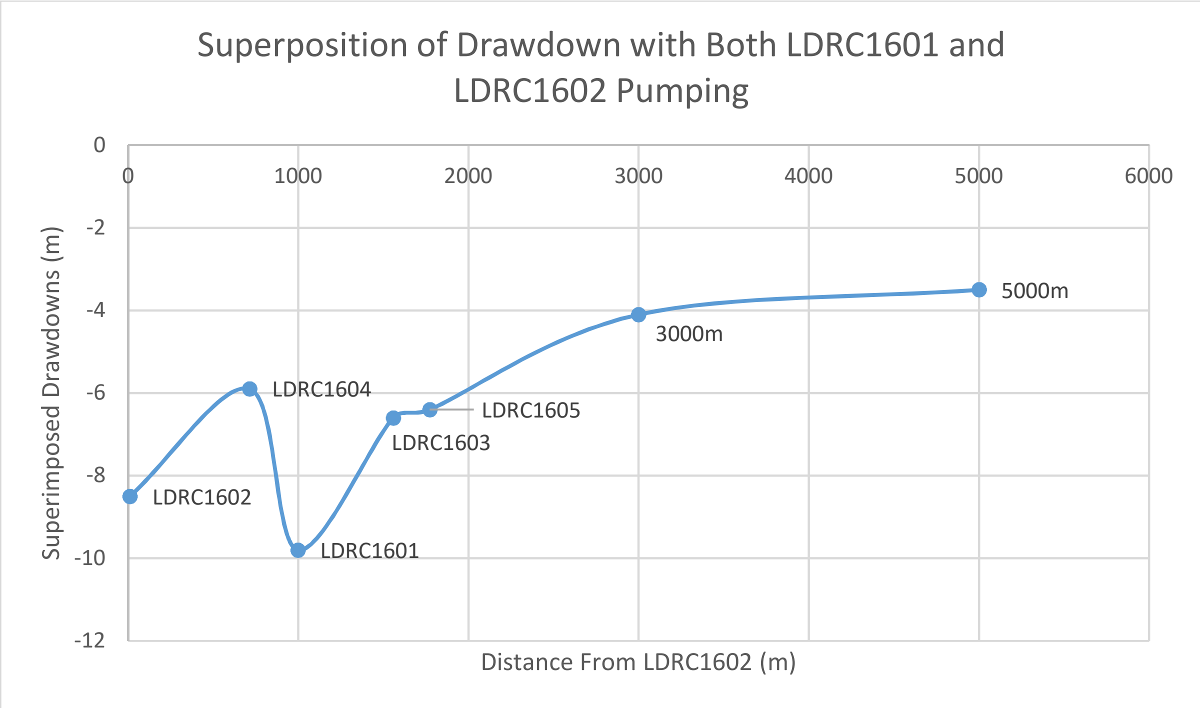
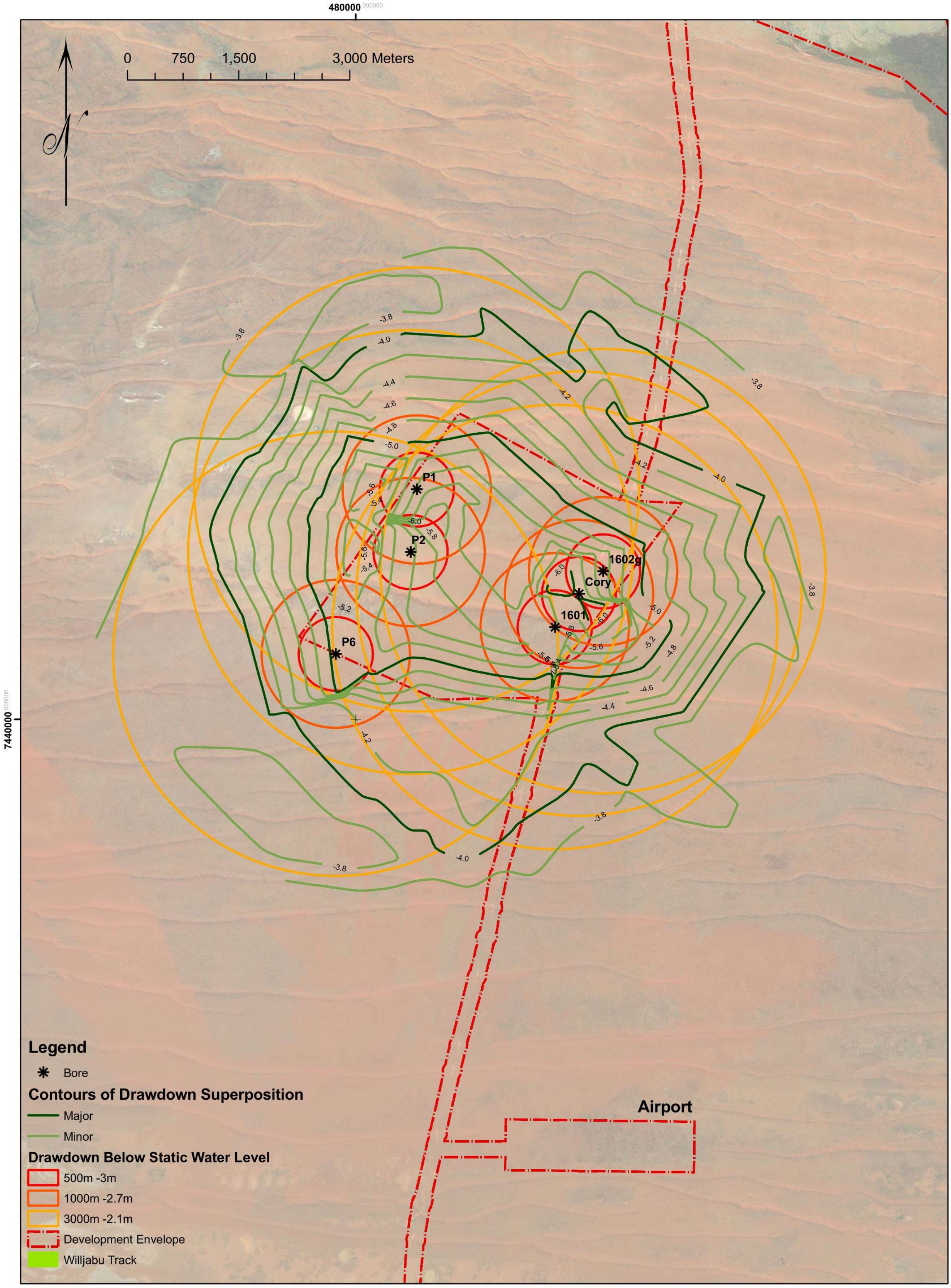


Figure 23 provides an estimate of the extent of drawdown across the Cory borefield in the absence of recharge after 1 year of pumping with 6 bores all pumping at 8L/s.

Figure 23: Cory Borefield - Development of the Cone of depression after 1 year's Abstraction



Lake Disappointment - Cory Borefield

SGRMI15002-097-Drawdown Below Static Water Level

19/07/2017

SURVEYGROUP

REWARD MINERALS LTD

Assessment of Impacts

Abstraction of 1.5GL/year for 20 years from the Gunanya sandstone aquifer will not significantly impact the groundwater resource or the flora and fauna of the area within the cone of depression.

Impact on the Groundwater Resource

Over the course of the proposed 20 year life of operations at Lake Disappointment Reward Minerals proposes to abstract 30GL from the Cory borefield. The impact of this abstraction on the regional groundwater resource will result in the removal of groundwater from storage as estimates of annual recharge are less than the proposed abstraction.

This pumping from storage will propagate the cone of depression within the aquifer, however whilst the lateral extent may well be significant the actual drawdown experienced will be small, calculations using the Cooper Jacob formula and calculated aquifer parameters from the test pumping indicate that after 10 years at a distance 10km from the pumping well and with no recharge drawdown will be of the order of 1.6m. Given the observed recharge post rainfall, the banking effect following high rainfall years, the greater frequency of high rainfall years and the low regional hydraulic gradient creating a slow rate of regional discharge recharge across the borefield will result in net effective recharge of approximately 5 – 10m every 10 years. Over the long term given the interconnectedness of the fracture system and the high transmissivity there will be no net effect on the groundwater resource.

The short term effects of the rainfall recharge occuring in short high intensity bursts will be a slowing of or even local recovery of water levels, particularly some distance away from the pumping bore. The effects of throughflow will also be seen as a limit on the development of the cone of depression. Furthermore, during times of maintenance or downtime (as may occur when production is halted or limited during the wet season) water levels will recover.

Impacts on groundwater dependant ecosystems

No groundwater dependent ecosystems have been identified within the area. The interdunal vegetation is characterised by low scrub of *Acacia/ Hakea spp*. (no more than 2m high) and mid-dense hummock grass of *Triodia spp*. Given the rocky nature of the ground, the lack of soil and a static water level that is approximately 10m below ground level, at the end of the dry season, the local vegetation is more likely to be reliant on pooled water at the surface, water bound up in the shallow soils and shallow infiltration.

Impact on Subterranean Fauna

Stygofauna have been found to be present within the Cory borefield

"The proposed borefield and surrounding area were found to host a modest stygofauna community of 13 species, about half of which are known to be widespread (i.e. those that have been recorded outside the study area) and the other half new. The new species are considered, based on habitat and sampling results, likely to have at least locally widespread distributions." (Bennelongia, 2017) (Appendix B).

The regional extent of the Gunanya sandstone is greater than 60km^2, and the Cory borefield 11km^2 representing less than 20% of the regional area. The analysis has shown that the cone of depression due to pumping from the Cory borefield will be extensive in area but shallow, slow to develop and quick to recover/ recharge. This quick recovery/ recharge can be seen in the observed water level change of 3.5m in 3 days in bore LDRC1605 (Figure 13) following a rainfall event.

Given the previously estimated drawdowns after 1 year of pumping, excluding recharge effects, beyond 1000m from the borefield are less than 2m (Table 5) and the response to localised recharge events has the potential to be greater than 2m, the impacts of localized recharge events in any one year have the potential to be more significant than the effects of pumping beyond a certain distance from the borefield.

On this basis, it could be projected that in 20% of the identified aquifer area of 60km^2 the water table will be lowered by more than 2m, in 15% the water table will be lowered between 1 and 2m whilst the remainder of the identified area will have a low to no impact based on drawdowns of between 0 and 1m and the recharge effects of localized rainfall and throughflow.

Given the likely locally widespread distribution and the low drawdown potential beyond 1km from the borefield the impact on the stygofauna is likely to be low beyond this point.

Impacts on Other Users

As there are no other groundwater users within 80Km of the Cory borefield there will be no impacts to any third party.

Impact of Abstraction on Groundwater Chemistry

Recharge occurs primarily via rainfall and throughflow via the fracture system. The depth to the water table, uniform geology, rapid response to recharge events and local quick recovery when pumping stops indicates that there will be an ongoing mixing of groundwater and rainfall infiltration, it is unlikely that the aquifer will become more saline, however ongoing monitoring to fully understand the cause and effect of the albeit minor variations seen to date will be required.

Groundwater Monitoring

The overall long-term impacts and rate of abstraction from fractured rock aquifers are difficult to predict and more accurate assessments can only be made once pumping has commenced and real data based on long term borefield performance and rigorous local and regional monitoring becomes available.

Current Monitoring

Monitoring of groundwater levels occurs at every location via data loggers which were installed in November 2016 and are set to take one reading every 24 hours. Between April and November 2016 monthly water level readings were taken manually.

Data loggers have also been installed into the cored holes LDCH1701 and LDCH1702 to observe any impacts of pumping or other factors across the geological boundary between the Unassigned units of the Tarcunyah formation and the Gunanya sandstone.

In addition to the water level readings, a monthly measure of EC, pH and temperature is taken from a bailed sample.

Future Monitoring Network Design and Intent

The proposed production borefield will consist of 6 production bores each with at least one monitoring bore within 10 – 20m. A regional monitoring network will also be installed within the borefield and potentially beyond the current area depending on perceived risk and need, the number of bores to be determined closer to borefield development but not less than 10 monitoring bores. Each of these bores will be fitted with loggers and the data analysed monthly.

The intent of the monitoring will be to develop an understanding of the hydraulic relationship of the Gunanya sandstone to the Tarcunyah formation. This information in turn will enable Reward Minerals to manage the borefield operation and abstraction from individual wells to control the development of the cone of depression.

Operating Strategy

The borefield operation will be managed through a Groundwater Operating Strategy developed in accordance with the DOW Operational Policy 5.08, *use of operating strategies in the water licencing process*. This strategy will be active and involve the development of a system that delivers the required flows in the most efficient manner possible. Supply and demand management that provides for water balancing enabling short term borefield shut down and local recovery will also be considered in the development of the operating strategy.

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Appendix A – Bore Completion Reports and Core Photos

Appendix B – Test Pumping Data and Analysis

Appendix C – Groundwater Levels and Hydrochemistry

Appendix D – Contributing Consultants Reports