

**REPORT ON GROUNDWATER EXPLORATION AT SPINIFEX BORE
(AUGUST-SEPTEMBER 2014)
FOR
AUSTRALIAN ABRASIVE MINERALS PTY LTD**

1. INTRODUCTION

The water supply requirement for the Harts Range Spinifex Bore Garnet Project is 21L/s for 20 years, the water to be used for ore processing.

Previous works have established a borefield (Spinifex Borefield), capable of supplying 14L/s for at least 5 years, as indicated by computer modelling. As the model is based on conservative values for hydraulic parameters, the life of the borefield is likely to be greater than the estimated 5 years. The projected life of the borefield can be verified after 1-2 years monitoring of actual drawdowns in operating production bores.

There is thus a current need to prove an additional 7L/s plus an allowance for standby for pump and bore repair and maintenance: a minimum recommended standby allowance would be 5L/s.

A staged exploration and development programme to achieve the above supply objectives was proposed as follows:

Phase 1: Drilling and testing of two sites, HR137(W3) and HR148(W5) where previously drilled shallow exploration holes had encountered groundwater. Any bore with potential significant yield to be cased and tested by pumping.

Redevelopment by airlifting of five existing bores in the Spinifex Borefield: OLY1, OLY4, OLY7, OLY8 and OLY9.

Phase 2A: If either or both sites drilled in Phase 1 proved successful, drilling of up to six additional sites on magnetic or structural lineaments in the same area.

Phase 2B: If Phase 1/Phase 2A unsuccessful, drilling of up to six sites aimed at identifying potential eastward and western extensions to the Spinifex Borefield.

Phases 1 and 2A were designed to test a weathered and fractured rock aquifer to the north of, and hydrogeologically distinct from, the Spinifex Borefield aquifer.

Phases 1 and 2A were carried out by Tomlin Drilling under the supervision of Hydrogeologist John Barnett, over the period 27 August to 5 September 2014. The results are set out below.

2. PHASE 1 AND 2A DRILLING AND TESTING

The two sites at HR137 and HR148 were drilled, with promising results obtained at HR148 (the new bore being designated W5P), but not at HR137 (termed W3A). W5P was cased and test-pumped.

Two exploratory sites were drilled as Phase 2A, neither of which gave encouraging results, so this phase was then abandoned.

Summary of the four bores is as follows:

TABLE 1: BOREHOLE DETAILS

NAME	CO-ORDINATES		DRILLED DEPTH (m)	CASINGS	YIELD (L/s)	WATER LEVEL (m)*	E.C (microS/cm)	
	EAST	NORTH					DEPTH (m)	SLOTTED (m)
W5P	489512	7466578	54	53.3	23.3 - 47.3	0.9	12.0	4,200
W3A	485975	7463006	42	-	-	0.1	10.6	-
W11A	486186	7462160	36	-	-	-	-	-
W12A	489710	7467935	45	-	-	-	-	-

Notes: *Below casing top

Further details of the four individual bores are given below:

2.1 Bore W5P

This was drilled on the site of an original aircore bore drilled to 21m and recorded as wet.

Bore W5P was drilled at 250mm to 6m, and 200mm nominal diameter steel surface casing was installed to that depth. Drilling was continued to 54m, at 200mm diameter, airlifting at 2.5L/s during drilling, as measured by weir-board. The bore was then cased with 155mm steel casing, with 4.8mm wall thickness, to 53.3m, slotted from 23.3m to 47.3m, and fitted with a welded steel bottom cap.

The aquifer interval in the bore is from 23m to 43m, consisting of weathered and fractured quartz-hornblende-mica schist.

The bore was test-pumped with an initial three-step step-drawdown test, followed by a constant rate test at 1.8L/s. The constant rate test was intended for a duration of 24 hours, but was terminated at 11 hours when drawdown approached the pumping depth towards the bottom of the aquifer.

The step-drawdown test results are summarised below.

TABLE 2: STEP-DRAWDOWN TEST, BORE W5P

STEP	DISCHARGE RATE Q (L/s)	DRAWDOWN SW (m)*	Sw/Q
1	1.9	10.1	5.32
2	3.0	15.4	5.13
3	4.1	20.4	4.98

Note: *Corrected for recovery from previous step.

The drawdown to discharge ratio over the range of tested rates was constant within 5 percent, indicating an efficient bore, possibly with some very slight continuing development.

Drawdown after 10 hours of pumping in the constant rate test was 23.5m, corrected for recovery from the preceding step-drawdown test. The drawdown rate increased markedly over the next hour as the bottom of the aquifer was approached, and the test was terminated at that point.

Analysis of the constant rate test results indicates a long-term sustainable yield of 0.9L/s (78 kL/day).

A water sample taken at the end of the constant rate test showed the water to be of sodium-chloride-sulphate type, similar to the Spinifex Bore aquifer. The water is slightly alkaline, with Total Dissolved Solids content of 2,673 mg/L.

2.2 Bores W3A, W11A and W12A

Bore W3A was drilled to 42m, through 9m of alluvial sand and calcrete into quartz-hornblende-mica schist. The schist is very weathered from 9-23m, reduced to grey-green and grey clay, weathered and soft from 23-30m, and hard, fresh and unfractured below 30m. It contains a few quartz veins, but made very little water, 10 litres per 80 seconds, essentially the same as the original aircore bore HR137.

The schist contains abundant garnet crystals. The bore was backfilled and abandoned.

Bore W11A, sited on a magnetic trend line about 900m south-southeast of Bore W3A, was drilled to 36m into quartz-hornblende-mica schist bedrock, the final 10m being very slightly weathered to fresh, hard and unfractured. There was only very slight seepage of groundwater from above 26m. The bore was backfilled and abandoned.

Bore W12A is sited on a structural trend about 1.5km north-northeast of W5P. The bore intersected a contact zone between weathered granite or granite-gneiss and quartz-hornblende-mica schist, but only very minor groundwater seepage. It was drilled to 45m, the final 10m being hard, unfractured, slightly weathered to fresh schist. The bore was backfilled and abandoned.

3. REDEVELOPMENT OF PRODUCTION BORES

Five existing production bores in the Spinifex Borefield were redeveloped by airlifting and air-surfing. Details of these five bores are tabulated below:

TABLE 3: PRODUCTION BORES, SPINIFEX BOREFIELD

BORE	CO-ORDINATES		CASED DEPTH (m)	CASING TYPE	SCREEN DEPTH (m)	WATER LEVEL 5/9/14 (mbct)	
	EAST	NORTH					
OLY1	490411	7462664	104	Steel 152mm 1D	92-98	33.10	
OLY4	489929	7462125	118	PVC 102mm 1D	108-118	37.51	
OLY7	492035	7464236	77.5	PVC 160mm 1D	71.5-77.5	31.68	
OLY8	492929	7464994	64	PVC 160mm 1D	58-64	30.05	
OLY9	493151	7464292	89.4	PVC 150mm 1D 0-23.4, PVC 160mm 1D 23.4-83.4	83.4-89.4	CAPPED (Not Measured)	

Bores OLY1, 4, 7 and 9 all cleared up very quickly after initially producing slightly turbid water, with suspended clay. Bores OLY4 and OLY7 also produced a little very fine sand during the first half hour of airlifting.

Bore OLY8 continued to produce significant amounts of fine to coarse sand, even after six hours of airlifting. The bore also produced a number of large pebbles, up to 25mm minimum dimension, too large to enter the screen. This indicates that the bore is damaged, and that either the bottom cap is damaged or missing, or that the screen itself is damaged, or that the screen has parted from the casing. The bore may still function satisfactorily if the pump is placed a minimum of 5m above the top of the screen. The bore was cleared out to 2m above the base of the screen, but could not be cleared right to the base because of continuing ingress of sand.

4. CONCLUSIONS

1. Bore W5P has an estimated long-term sustainable yield of 0.9L/s, with EC (electric conductivity) of 4,200 micro S/cm, equivalent to about 2,750 mg Total Dissolved Solids. The water is very slightly alkaline, with pH 7.9.
2. The weathered and fractured rock aquifer to the north and northwest of the Spinifex Borefield has been tested by four exploration bores during the Phase 1 and Phase 2A programme, producing one production bore capable of a long-term sustainable yield of only 0.9 L/s (about 80 kL/day). This aquifer has therefore been shown to be unlikely to provide a significant yield for the AAM Garnet Project.
3. Four of the existing five production bores in the Spinifex Borefield have been redeveloped and are in good condition; these are OLY1, OLY4, OLY7 and OLY9.

The fifth, OLY8, is damaged, probably either at the top or bottom of the screened section or within it. It may still perform satisfactorily as a production bore, providing the pump intake is set at least 5m above the top of the screen.

The yield of OLY4 is limited by the small diameter of the production casing (100mm).

5. RECOMMENDATIONS

1. Any additional groundwater supplies for the Spinifex Bore Garnet Project should be sought by exploring for extensions of the aquifer to the east and west of the existing Spinifex Borefield.
2. The available yield at the OLY4 production bore site could be increased by redrilling this bore and installing 150mm diameter production casing and screen.

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W5P Co-Ordinates 489512E; 7466578N

0-4m	Sand	Red-brown, silty, fine to very coarse grained, subrounded to rounded, moderately to poorly sorted, a few pebbles to 15mm. Quartz, ironstone, minor mica, a few garnets 3-4m
4-6m	Sand	As above, poorly sorted, grains of calcrete, minor angular fragments of silcrete.
6-9m	Calcrete	Pink and white, minor sand as above.
9-12m	Calcrete and Sand	Sand medium to very coarse-grained, generally well sorted.
12-23m	Saprolite	Very weathered bedrock-silty, clayey, fine-sand size fragments of quartz and mica, some larger angular fragments of quartz-hornblende-mica schist, weathered and iron-stained, 18-23m.
23-25m	Weathered Schist	Quartz-hornblende-mica, iron-stained fractures, abundant quartz fragments.
25-27m	Schist	As above, slightly weathered, minor quartz.
27-33m	Clay	Grey-green, minor weathered schist.
33-37m	Schist	As above, iron-stained fractures, slightly weathered, large fragments of iron-stained quartz.
37-43m	Schist	Very slightly weathered, minor quartz, abundant iron-stained fractures 41-43m.
43-44m	Quartz	Iron-stained fractures, minor schist as above.
44-47m	Schist	Fresh, minor iron-stained fractures, minor quartz.
47-54m	Schist	Quartz-hornblende-mica, fresh, hard, unfractured.

W3A Co-Ordinates 485975E; 7463006N

0-5m	Sand	Silty, red-brown, fine to medium grained, well sorted, quartz, ironstone, trace mica. Minor calcrete 3-5m.
5-7m	Calcrete	Pink and white, and sand, as above. Minor white clay and garnets.
7-9m	Sand	Grey-green, medium to very coarse grained, poorly sorted, subrounded to rounded quartz, garnets abundant 7-8m, minor 8-9m.
9-23m	Clay	Grey-green, becoming pale grey 16-23m, quartz, mica and garnets, fine to medium grained sand size, hornblende also present 19-23m. Saprolite.
23-24m	Quartz	Large angular fragments, commonly iron-stained. Slight water return.
24-30m	Quartz-Mica Schist	Garnetiferous, very weathered, soft.
30-42m	Quartz-Hornblende-Mica Schist	Garnetiferous, hard, fresh, unfractured. Minor angular quartz, more abundant quartz 34-35m.

W3(S) ≡ W11A Co-Ordinates 486186E; 7462160N

0-1m	Silty Sand	Red-brown, very fine-grained, very well sorted, subrounded to rounded, quartz, minor ironstone, trace mica.
1-3m	Silty Sand	Red-brown, fine to medium with a few coarse grains, well sorted, quartz and ironstone.

3-5m	Sand	Fine to very coarse grained, poorly sorted, otherwise as above, and Calcrete, pink and brown.
5-26m	Saprolite	Grey-green clay, with sand size quartz grains, minor mica and garnets. Some white clay and hornblende 21-26m
26-36m	Quartz-Hornblende-Mica Schist	Slightly garnetiferous, very slightly weathered to fresh, hard, unfractured. Very minor angular quartz.

W5N ≡ W12A Co-Ordinates 489710E; 7467935N

0-1m	Silty Sand	Red-brown, fine-grained, very well sorted, subrounded to rounded quartz, ironstone, minor mica.
2-6m	Sand	Red-brown, fine to very coarse-grained mainly fine-medium, poorly sorted, subrounded to rounded quartz, ironstone, minor mica. A few chips of silcrete 3-4m, minor garnets 5-6m.
6-7m	Sand and Gravel	Fine to gravel size, very poorly sorted, subrounded to rounded, orange and white quartz, ironstone, minor garnets. Also some white clay with angular quartz.
7-20m	Clay	White to pale yellow, with angular quartz, clear, minor smokey..? Weathered granite.
20-26m	Clay	Yellow, with angular quartz, angular fragments of yellow-dark brown ironstone (? Contact zone)
26-45m	Quartz-Hornblend-Mica-Schist	Soft, very weathered 26-28m. Weathered 28-35m. Slightly weathered to fresh, unfractured 35-45m.