Well Siting, Drilling and Discharge Testing, AP Lands, 1999/2000

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by

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PRIMARY INDUSTRIES AND RESOURCES
SOUTH AUSTRALIA

REPORT BOOK 2000/00034

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PRIMARY INDUSTRIES AND RESOURCES
SOUTH AUSTRALIA

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David Clarke

Water well sites were selected on eight homelands in the vicinity of Umuwa community and along a section of road (Fregon to Mimili) that was scheduled for upgrading. A total of thirteen wells were drilled at seven of the homelands, with at least one successful well at each homeland. One successful well and one failed well were drilled on the road. To the time of writing no wells had been drilled at Umuwa.

INTRODUCTION

The Pitjantjatjara Council (Projects) engaged the Department for Water Resources (DWR, then PIRSA) to select water well sites at a number of homelands in the far northwest of South Australia in August and September, 1999 (See Fig. 1). Homelands are areas of special significance to family groups of Aborigines.

GEOLOGY AND HYDROGEOLOGY

The area is within the Musgrave Block; a region of stable, mainly Proterozoic acidic high-grade metamorphic and medium to coarse grained igneous rocks intruded by numerous basic dykes. There is negligible primary porosity in these rocks.

The geomorphology is of the mature arid-land slope-retreat type; that is, steep-sided hills rise abruptly from large areas of near-flat land. The steep and rocky hills yield run-off from the uncommon rainfalls, providing a source of groundwater recharge.

Hard-rock is rarely far below the surface; even within the broader valleys alluvium is usually too thin to contain or yield useful supplies of groundwater. Fractures, fracture zones, areas of deep weathering, and possibly areas of ancient hydrothermal activity seem to provide the aquifers within the Musgrave Block. Lineations visible on satellite images, aerial photographs, or from the air, offer clues to areas that may have more intense than usual fracturing. Deeply fractured areas are more likely to be deeply weathered, the fracturing having provided soil-water access to the rocks.

THE WELL SITES

Figure 1 shows the location of the homelands involved in this report within the region. Other figures show more accurate locations of the well sites.

Well sites were chosen after examination of satellite imagery and aerial photography, viewing of the sites from a light aircraft, on-ground examination, and study of past drilling results. Factors considered included: Lineations, including major fractures, gullies or stream beds; location of water courses (which provide occasional recharge sources and might indicate weaknesses in the underlying rocks); rock types; dykes; degree of jointing and distance from outcrop. Ephemeral swamps or denser than usual patches of vegetation

was also considered as favourable indications, since they indicate the possibility of occasional local recharge.

All coordinates in this report are AMG66.

All drilling results reported here are from David Franklin, who was on-site at the time of drilling. Only where David Franklin has not provided data has the driller's figure been used, if available.

For the discharge test analysis, the well equation has the form:

$s = AQ + BQ \log (t) + CQ^2$

s is drawdown,
A, B and C are constants for the particular discharge test,
Q is discharge rate,
t is time.

The units in all well equations in this report are metres and days. Where file names are given in the discharge test result tables, these are the .ctd and .ctn files containing the discharge test data.

AP ROADS

A water supply was required for upgrading the Mimili to Fregon road. Of two wells which had been tried earlier in the year, well 'AP Roads 99A' achieved 0.7 L/sec while 'AP Roads 99B' was dry (See Fig. 2).

Six sites were chosen; see below.

AP Roads - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority*	Depth**
1	221084	7023184	53	26°53'07"	132°11'32"	2	30 m
2	213424	7029877	53	26°49'24"	132°07'01"	4	20 m
3	239019	7019951	53	26°55'04"	132°22'19"	5	30 m
4	241008	7018085	53	26°56'06"	132°23'30"	1	30 m
5	246770	7013916	53	26°58'25"	132°26'56"	3	30 m
6	237085	7021445	53	Location approximate		6	30 m

* Drilling priority
** Anticipated maximum drilling depth

Site 1 was one kilometre east of AP Roads 99B and in a possible palaeochannel (based on observations of salinas, clay pans and vegetation patterns from the air and satellite image). The water in this area may be saline.

Site 2 was one kilometre ESE of Mulga Bore Homeland on the north side of the road. Recorded well yields have been higher this end of the road section than elsewhere.

Site 3 was on a low point (watercourse) 2.5 km east of Tunton Bore (5344–16). A water course can indicate a weakness in the underlying rock, and the water table can be expected to be closer to the surface near a water course than elsewhere.

Site 4 was on a lineation visible from the air and on the satellite image. There is a watercourse on the same lineation.

Site 5 was on an E/W trending watercourse, visible from the air and on a satellite image.

Site 6 was close to Tunton Bore. The yield of the original well was not recorded, but must have been sufficient to supply the stock watering point, which is still present although not in use.

There is a large gap between Sites 1 and 6. If a well is required in this section then it was suggested that it be drilled on one of the lowest points along the road. There is little hydrogeological evidence that indicates one point being significantly better than another, other than altitude.

Drilling

Only sites 1 and 2 were drilled to the time of writing. Results are summarised below.

AP Roads - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	41	?	Seepage only	26 to 27	3600
2	42	9.0	2.5	21 to 35	900

AP Roads - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	AP Roads 99C	50500	5344–58	Failure
2	AP Roads 99D	50501	5344–59	Water productive

Discharge Testing

Well 'AP Roads 99D' - well equation coefficients derived from discharge test results

Step test, File	Main test, File	A	B	C	Transmissivity
APR99D1	APR99D2	0.031	0.0103	9.28e-5*	18

*9.28e-5 = 9.28×10^{-5}

Standing water level was measured at 8.63 m (the driller recorded 9 m); water cut, as recorded by the driller, was 21 to 35 metres; available drawdown, based on the test results, was at least 18.5 m (this conservative figure was used for calculation of maximum pumping rates).

Well storage effects were significant during the step test. Recovery was much faster than would be expected from the well equation, probably due to the effects of entrapped air in the previously dewatered parts of the aquifer.

Well AP Roads 99D - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	250	2.9
20 days	200	2.3
One year	160	1.9

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 205 kL/day or 2.4 L/sec, (this equates to an average discharge rate of 69 kL/day or 0.79 L/sec for the whole year).

DAVID'S WELL

David's Well is a small homeland seven kilometres NNW of Umuwa (See Fig. 3). Two sites were selected, but when neither of these was fully successful (one cut no water, the other was saline) a third site was chosen (by David Franklin) 15 m east of the existing well ('David's Well 99C'). There was an existing water supply well at David's Well, but a back-up well was required.

David's Well - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	201404	7076183	53	26°24'12"	132°00'25"	1	30 m
2	201711	7076747	53	26°23'54"	132°00'36"	2	30 m

Site 1 was situated in a clearing 220 m south of David's Well windmill bore (5345–5).

Site 2 was approximately 250 m on 35 degrees magnetic from David's Well house on the northwest side of the access road.

There was very little evidence that could be used for selecting specific sites in this area. The above sites were selected for a reasonable distance from the existing well and for convenience. It is inadvisable to go very far to the east because of the higher salinity recorded in well 5345–55.

Drilling

Drilling at Site 1 was stopped at 17.5 m because the unweathered granite looked unpromising. The well drilled at Site 2 proved to be too saline to be potable. The well drilled at Site 3 should ideally be used only as an alternative to the current well, not in addition to it, because of the likely interference between the two.

David's Well - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	17	?	0?	None	?
2	19	?	2.0	?	2500
3	36	21	0.3	18 to 36	1000

David's Well - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	David's Well 99A	50509	5345–131	Abandoned
2	David's Well 99B	50510	5345–132	Unequipped, future use
3	David's Well 99C	50511	5345–133	Water productive

Well 'David's Well 99C' was not discharge tested.

MULGA BORE

Two sites were selected. There was already one operating well and only a back-up supply was required. The approximate location is shown on Figure 2.

Mulga Bore - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	212918	7030478	53	26°49'04"	132°06'43"	1	16 m
2	212981	7030749	53	26°48'55"	132°06'45"	2	16 m

Site 1 is on the southwest side of the ephemeral swamp near the homeland, approximately 100 m south of the windmill bore (5344–49).

Site 2 is approximately 130 m north of the windmill bore and 100 m northwest of the swamp.

There is no evidence to indicate that one direction from the existing wells is any better than any other; so the sites are selected for convenience. Salinity, yield, and depth were expected to be similar to the existing well, and it was anticipated that unconsolidated sand might be a problem.

Drilling

Only Site 1 was drilled, there being no need to drill Site 2.

Mulga Bore - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	23.0	4.0	3.3	17 to 18	800

Mulga Bore - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	Mulga Bore 99A	50502	5344–60	Water productive

Well ‘Mulga Bore 99A’ was not discharge tested.

TJIWIRU

The existing well at Tjiwiru was at risk of contamination from nearby stockyards. Two sites were chosen at a greater distance from the homeland and stockyards (See Fig. 4).

Tjiwiru - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	221787	7076589	53	26°24’13”	132°12’40”	2	25 m
2	221153	7076325	53	26°24’21”	132°12’17”	1	25 m

Site 1 is 300 m east of the existing windmill bore, 200 m west of the stockyard.

Site 2 is on a minor creek, approximately 400 m southwest from the existing well and 110 m from a small rubbish dump. It was felt that this site had the stronger possibility of success because it was further from outcrop than was Site 1. Salinities at both sites were expected to be acceptable.

Drilling

Both sites were drilled, the second because the first had a small yield.

Tjiwiru - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	25.0	11.0	0.58	17 to 25	700
2	30.0	14.5	0.65	17 to 23	900

Tjiwiru - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	Tjiwiru 99B	50507	5345–129	Backup
2	Tjiwiru 99A	50506	5345–128	Water productive

Discharge Testing

Tjiwiru 99A

Well 'Tjiwiru 99A' - data derived from discharge test results (units are metres and days)

Step test, File	Main test, File	A	B	C	Transmissivity
TJIW99A1	TJIW99A2	0.050	0.0122	4.92e–4	15

Standing water level was measured at 7.3 m before the well test; the available drawdown, based on the driller's reported water cut, was 9.7 m.

Recovery was much faster than would be expected from the well equation, probably due to the effects of entrapped air in the previously dewatered parts of the aquifer.

Well 'Tjiwiru 99A' - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	78	0.91
20 days	66	0.77
One year	56	0.65

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 67 kL/day or 0.78 L/sec, (this equates to an average discharge rate of 22 kL/day or 0.26 L/sec for the whole year).

Tjiwiru 99B

Well 'Tjiwiru 99B' - data derived from discharge test results (units are metres and days)

Step test, File	Main test, File	A	B	C	Transmissivity
TJIW99B1	TJIW99B2	0.13	0.012	7.94e–4	15

It seems that this well was developing during discharge testing; drawdowns were inconsistent during the test, with stepped changes in drawdown happening independently of changes in discharge rate. The recommended maximum discharge rates were based on the well's worst responses.

Well storage effects were very significant during the stepped rate test. Recoveries in both tests were much faster than would be expected from the well equation, probably due to entrapped air in the previously dewatered fractures.

Standing water level was measured at 8.77 m (the driller recorded 11 m), water cut was recorded by the driller at 17 to 25 m, therefore available drawdown was taken as 8.2 m.

Well 'Tjiwiru 99B' - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	39	0.45
20 days	34	0.39
One year	29	0.34

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 34 kL/day or 0.39 L/sec, (this equates to an average discharge rate of 11 kL/day or 0.13 L/sec for the whole year).

UMERINA

Umerina - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	303956	7026910	53	26°51'56"	133°01'36"	1	25 m
2	304777	7026751	53	26°52'02"	133°02'06"	2	25 m

Site 1 is near the entrance to a pound west of the house. There is an old stock well further up this pound, and the spoil around the well indicated deep weathering. The site is on the junction of two lineations, one trending 40°, the other 85° magnetic (the second of these is the major one, which also passes near the existing windmill bore).

Site 2 is on the watercourse below the existing windmill bore in an area where there is little outcrop; possibly indicating more fracturing or deeper weathering. Salinity may be higher at this site.

Drilling

Neither site had been drilled at the time of writing.

UMUWA AREA

See Figure 3.

Umuwa well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	204148	7073415	53	26°25'43"	132°02'01"	1	35 m
2	204207	7070803	53	26°27'08"	132°02'01"	4	30 m
3	204006	7072360	53	26°26'18"	132°01'56"	3	30 m
4	205129	7070177	53	26°27'29"	132°02'34"	2	30 m

Site 1 is at the top of the valley on a major WSW trending lineation (the valley itself being another lineation).

Site 2 is approximately 200 m southeast of 'Umuwa Solar 2', on the centre line of the valley and a possible E/W lineation.

Site 3 is toward the top of the valley and on a possible NW/SE lineation.

Site 4 is where the watercourse coming out of the valley curves around to the east on the north side of Umuwa township. This well is on the same possible E/W lineation as is Site 2.

Salinities are likely to be lowest higher in the catchment.

WALALKARA

At least four water wells have been drilled in the vicinity of Walalkara homeland (See Fig. 5). Only two of these have had any success, and the yields of both these were very limited.

Walalkara - well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	774910	7009596	52	27°00'31"	131°46'14"	5	60 m
2	775675	7009391	52	27°00'37"	131°46'41"	4	55 m
3	776019	7009990	52	27°00'17"	131°46'53"	3	55 m
4	778518	7009414	52	27°00'34"	131°48'24"	2	55 m
5	778775	7009258	52	27°00'39"	131°48'34"	1	55 m

Site 1 is 400 m west of the granite hill, 1.9 km west of the house and is 11 m higher than the house.

Site 2 is 150 m SSE of the granite hill, 1.2 km WSW of the house and 4 m higher than the house.

Site 3 is 500 m northeast of the granite hill and 5 m higher than the house.

Site 4 is in pebbly calcrete ground 1.8 km east of the house and 5 m lower than the house. The calcrete is a weathering product and is not expected to extend more than a few centimetres or at most a very few metres, but it may indicate deeply weathered bedrock.

Site 5 is 300 m east of Site 4 and is about 3 m lower than the house. The ground is massive marble (with superficial calcrete) and is more promising than the dolerites, gneisses and granites nearer the house.

It was recommended that unless sites 4 and 5 prove to be totally without promise, drilling should concentrate on the area east of the house rather than going west, ie. sites 4 and 5 should be drilled first. The land to the east is lower, which means that the water table will probably be closer to the surface, and the geology looks more promising.

Drilling

Good yields of relatively saline water were obtained from sites 4 and 5. These wells will be kept in reserve, and used for observation purposes.

Site 6 (15 metres northeast of the windmill well, 5243–5) was chosen by David Franklin. The windmill bore is 53 metres deep and it is hoped that PN50505, being 10 metres deeper and having a deeper water cut, may prove to be more reliable.

Walalkara - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
4	41	20.5	3.0	?	2600
5	62	24.5	2.5	?	2500
6	63	36.5	2.7	51 to 59	500

Walalkara - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
4	Walalkara 99B	50504	5243–10	Water productive
5	Walalkara 99A	50503	5243–9	Water productive
6	Walalkara 99C	50505	5243–11	Water productive

Discharge Testing

It was not possible to derive coefficients for the well equation for well 'Walalkara 99C' because the rate at which the well was pumped was much greater than its sustainable yield. A second complicating factor was that there is apparently an hydraulically closely connected fracture system that can yield about 5000 litres of water per metre drawdown in the well. However, calculations indicate that at a drawdown of 12.5 metres, water flows into this fracture system at only about 0.16 L/sec.

Standing water level was measured at 38.76 m. Given the odd hydraulic characteristics of the well the driller's reported water cut could not be confirmed from the discharge test data.

It is suggested that the long-term sustainable yield of this well is probably around 0.1 L/sec.

WALLANY

Wallany is alternatively spelt 'Walyny'.

See Figure 6.

Wallany – well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	723050	7084798	52	26°20'22"	131°14'06"	2	30 m
2	723112	7085023	52	26°20'14"	131°14'07"	1	30 m

Site 1 was 300 m on bearing 100 degrees magnetic from Wallany Solar Bore. It is closer to the creeks that are further to the east.

Site 2 was 200 m north of Site 1. Well 5145–57, several kilometres further north indicates that salinity might gradually improve toward the north.

There was little reason to prefer one place to another within several hundred metres of Wallany homeland.

Drilling

Only site 2 was drilled, as there is already a working well at Wallany and only a backup was required.

Wallany - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
2	30	10	3.5	10 to 30	600

Wallany - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
2	Wallany 99A	50514	5145–107	Water productive

Discharge Testing

Well 'Wallany 99A' - data derived from discharge test results (units are metres and days)

Step test, File	Main test, File	A	B	C	Transmissivity
WALL99A1 and 2	WALL99A3	0.0067	0.0013	4.82e–7	150

There were several aborted attempts at a 24 hour steady rate test; only the last (at the highest discharge rate) was analysed.

Standing water level was measured at 10.29 m, the driller recorded water cuts from 10 to 30 m, and available drawdown was conservatively taken as being 5 m because this was the maximum drawdown achieved during the tests.

Well 'Wallany 99A' - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	570	6.6
20 days	440	5.0
One year	320	3.7

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 430 kL/day or 5.0 L/sec, (this equates to an average discharge rate of 140 kL/day or 1.7 L/sec for the whole year).

Note: the above figures are based on the hydraulics of the well and adjacent aquifer as indicated by the discharge test data. Great cautions should be exercised in making any decisions concerning pumping any well in this region at such high rates for extended periods of time because dewatering of the aquifer could result.

WATINUMA

See Figure 7

Watinuma – well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	787956	7063463	52	26°31'12"	131°53'22"	1	65 m
2	788025	7062777	52	26°31'35"	131°53'25"	2	65 m

Site 1 is in a lineation indicated by a straight section of the Officer Creek (the relative locations are approximately depicted on Fig. 7). It is also on the same side of the creek as Watinuma 97B, which is the only well in the area with good quality water, (Site 1 is 300 m on 12° magnetic from Watinuma 97B).

Site 2 is in a possible second lineation, while still being close to the major lineation. It is also in the area expected to yield good quality water, (Site 2 is 380 m on 143° magnetic from Watinuma 97B).

Drilling

The well drilled on Site 1 encountered a strongly fractured zone from 9 to 14 m.

The well on Site 2 was abandoned due to uncontrolled loose sand from 6 to 8 m. This site may be redrilled at some future date if necessary.

Watinuma - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	21	9	3.0	9 to 14	900
2	30 (backfilled)	?	1.5 to 2.0	?	600

Watinuma - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	Watinuma 99A	50512	5244–21	Water productive
2	Watinuma 99B	50513	5244–22	Backfilled

Discharge Testing

Well 'Watinuma 99A' - data derived from discharge test results (units are metres and days)

Step test, File	Main test, File	A	B	C	Transmissivity
WAN99A_1, 2 and 3	WAN99A_4, 5 and 6	0.0119	0.0036	4.8e–6	50

This well exhibited odd behaviour, short-term flow appears to be strip, while long-term (especially late recovery) is isotropic.

Standing water level was measured at 7.8 m; discharge test results indicate that there is a major water cut about 10.3 m, therefore available drawdown was taken as being 2.5 m.

Well 'Watinuma 99A' - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	200	2.3
20 days	150	1.7
One year	120	1.3

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 176 kL/day or 2.0 L/sec, (this equates to an average discharge rate of 59 kL/day or 0.68 L/sec for the whole year).

Note: In the long-term, regional changes in the standing water level could impose major effects on this well. It is quite possible for seasonal effects to lower the water table by two or three metres; if this happened, this well would loose most of its supply.

WOMIKATA

There is a small ephemeral swamp on the northern side of Womikata house. It seems that this swamp was created when the Womikata sand dune blocked a minor watercourse. The swamp, which is not at all saline, could be a good source of recharge in this area.

Womikata – well sites

Site No.	Easting	Northing	Zone	Latitude	Longitude	Priority	Depth
1	215405	7109445	53	26°06'22"	132°09'16"	1	30 m
2	215633	7109990	53	26°06'05"	132°09'24"	2	30 m

Site 1 is 400 m SSW of the windmill bore (5345–74) and is adjacent to an abandoned stock bore. It is in a minor watercourse.

Site 2 is 200 m NW of the windmill and 200 m WSW of the house. This site is also in the watercourse and it is about 400 m south of the swamp.

Drilling

Only one site was drilled, as the requirement was for a backup to the existing well.

Womikata - Drilling results

Site	Depth (m)	SWL (m)	Yield (L/sec)	Main water cut (m)	Salinity (mg/L)
1	30	10.8	2.0	18 to 30	600

Womikata - Well numbering and status data

Site	Pit Projects	Permit No.	Unit No.	Status/Remarks
1	Womikata 99A	50508	5345–130	Water productive

Discharge Testing

Well 'Womikata 99A' - data derived from discharge test results (units are metres and days)

Step test, File	Main test, File	A	B	C	Transmissivity
WOMI99A1	WOMI99A2	0.043	0.0057	2.69e–5	32

Standing water level was measured at 11.00 m (the driller recorded 17 m). Drawdowns during the discharge test seem to have been insufficient to reach any significant water cut, therefore available drawdown has been conservatively taken as equal to the maximum drawdown achieved, 10.7 m.

Well 'Womikata 99A' - recommended maximum pumping rates

Maximum duration of pumping	kL/day	L/sec
1 day	180	2.0
20 days	140	1.7
One year	120	1.4

If the well is to be pumped eight hours per day every day for a year, then the recommended maximum discharge rate is 150 kL/day or 1.7 L/sec, (this equates to an average discharge rate of 49 kL/day or 0.57 L/sec for the whole year).

Figures

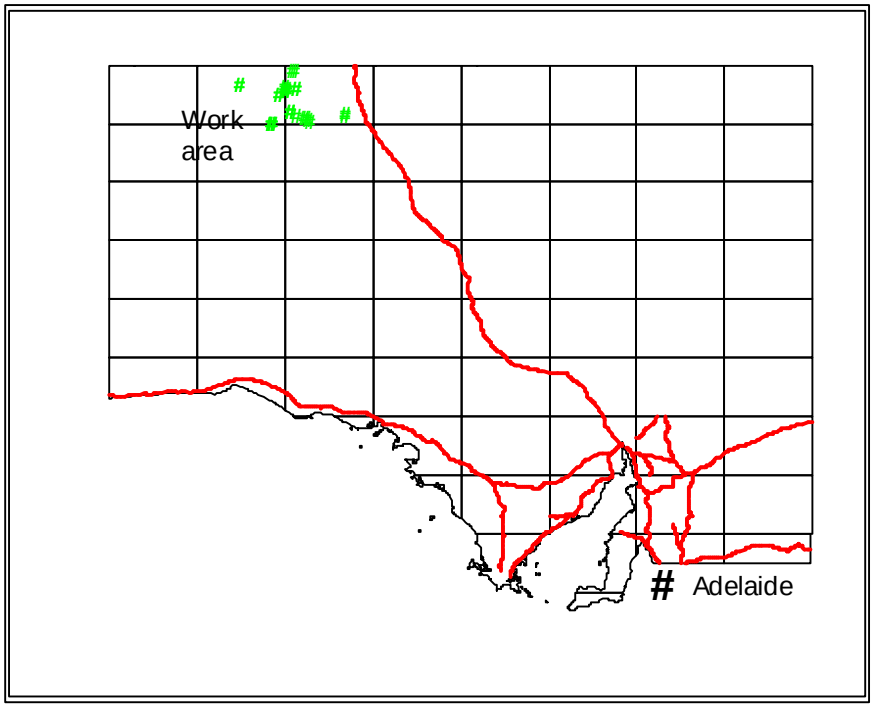

Figure 1 *General locality plan*

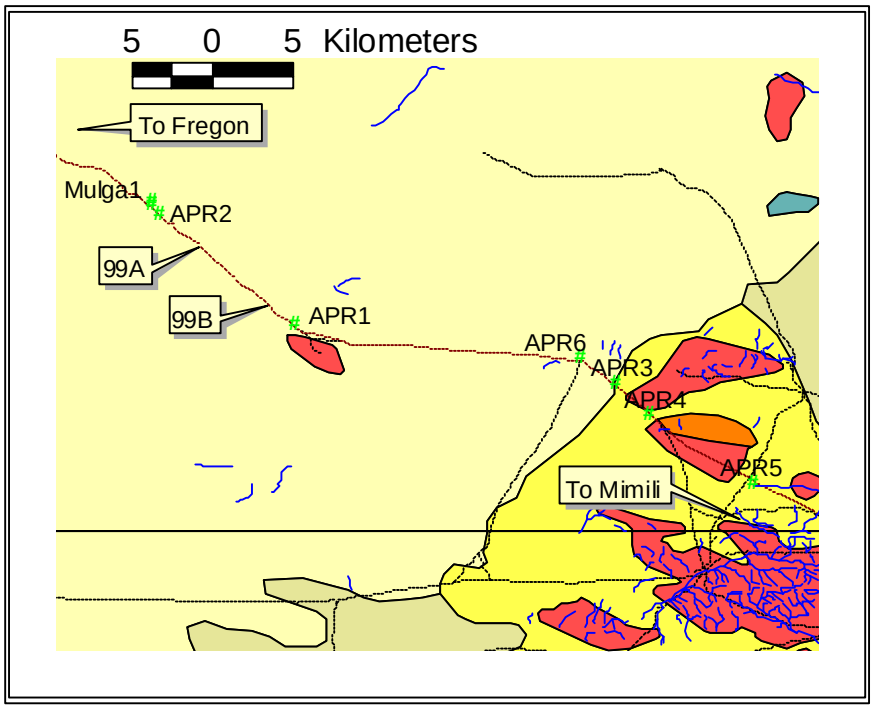

Figure 2 *AP Roads and Mulga Well sites (APR1 is AP Roads site 1, etc.)*

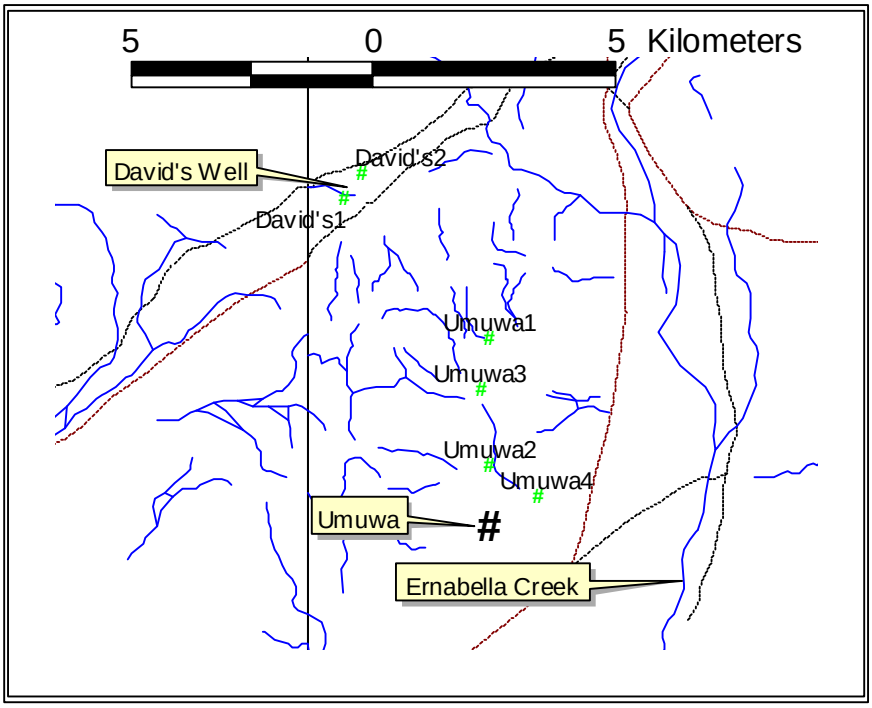

Figure 3 *David's Well and Umuwa well sites*

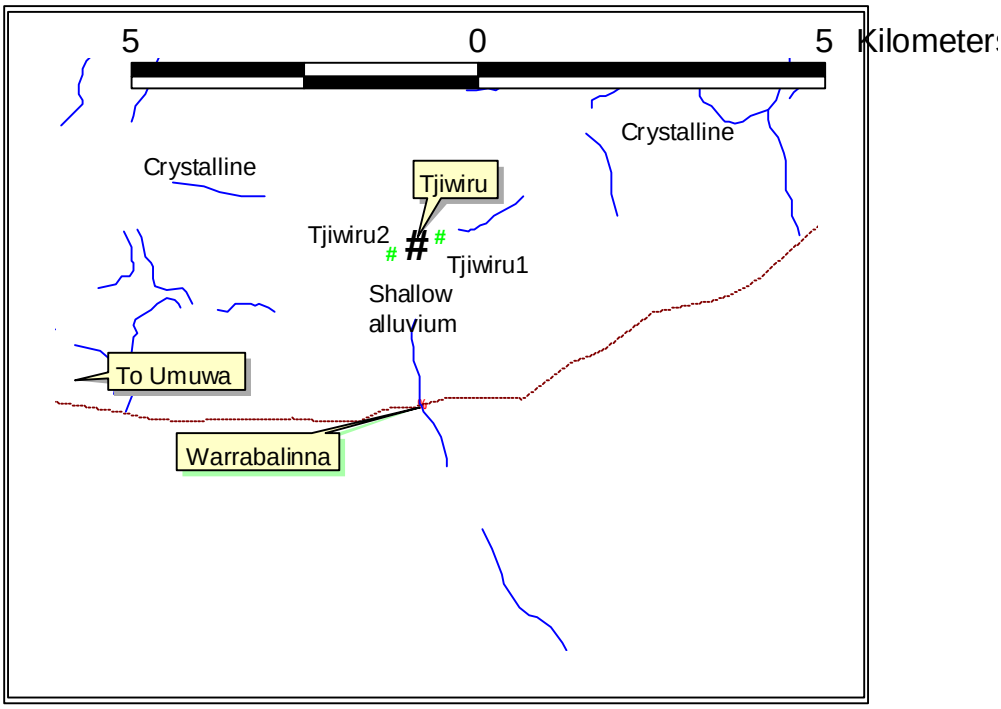

Figure 4 *Tijwiru well sites*

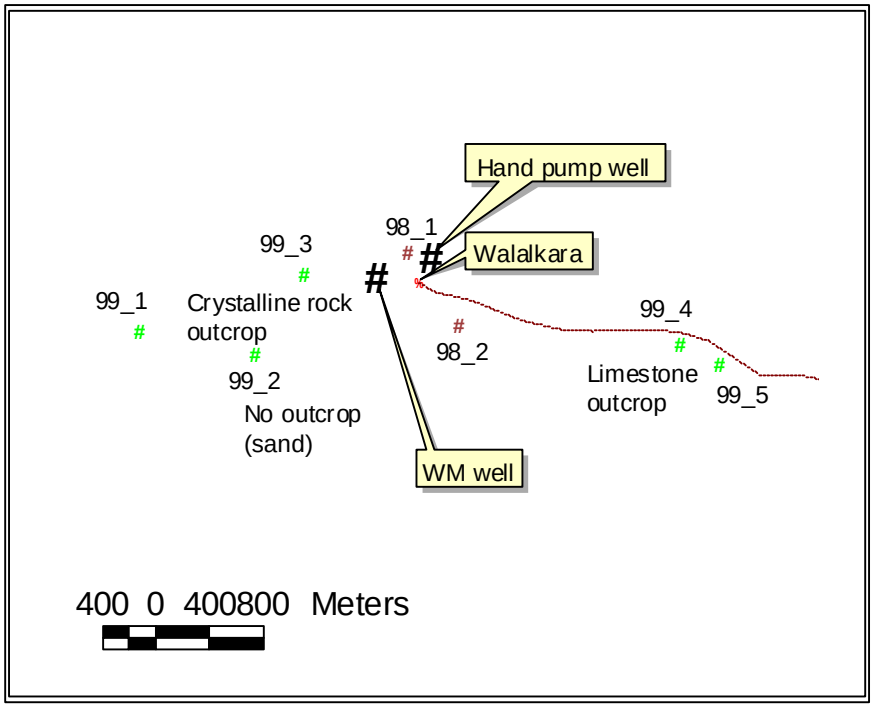

Figure 5 *Walalkara well sites*

The sites shown on Figure 5 as 98_1 and 98_2 were unsuccessfully drilled in 1998. The well on Site (99) 6 was drilled 15 m northeast of the windmill

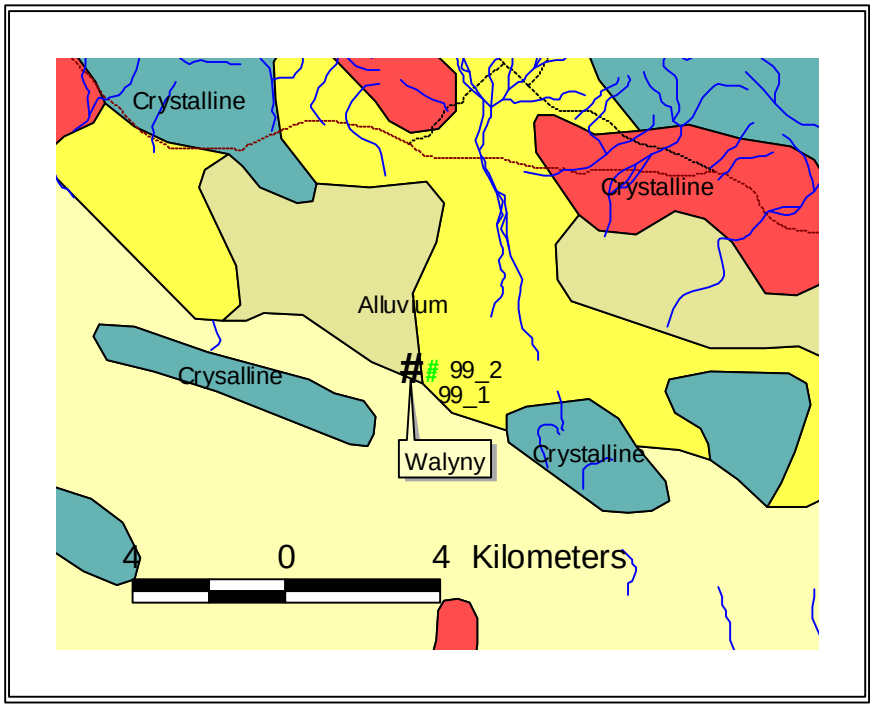

Figure 6 *Wallany well sites*

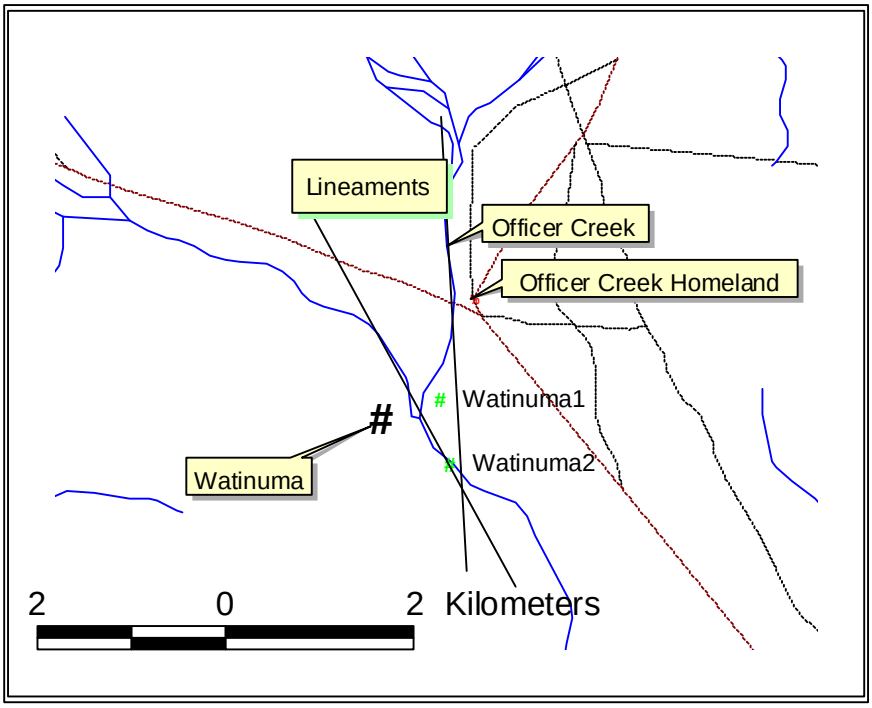

Figure 7 *Watinuma well sites*

Locatin of lineaments, creeks, homeland and well sites in Figure 7 are approximate

Appendix A

Well logs

WELL LOGS

Some samples were collected by David Franklin of Pitjantjatjara Council (Projects) and forwarded to DWR, Crystal Brook. All the samples were logged by the author at Crystal Brook. Colours are from the Munsell soil colour charts and apply to damp samples.

Well 'David's Well 99C'

Depth (m)	Description
33	Gneiss Composed of feldspar, biotite mica, apparently little quartz, possibly some other mafic minerals and some garnet. Reddish yellow (iron) staining in places – indicating weathering. The feldspar is white and pink.

Well 'Mulga Well 99A'

Depth (m)	Description
18	Sandstone Highly weathered, feldspathic; the grains are coarse and angular. Red 10R 4/6.
23	Conglomerate Composed of rounded grains of weathered feldspathic sandstone. Mainly red 10R 4/6, some white, cherty or chalky textured fragments, some of which are calcareous.

Well 'Walalkara 99A'

Depth (m)	Description
5	Calcrete, sandstone and chert. Red 2.5YR 4/6 and white.
8	Quartz sandstone Permeable and conspicuously porous; the grains are moderately sorted up to 4 mm and are subrounded. Little silt and clay. No reaction to dilute HCl. Yellowish brown 10YR 5/6.
11	As above (the sample is mainly unconsolidated sand, but some fragments are cemented).
14	Highly weathered feldspar (?) with mainly coarse quartz sand. Red, 2.5YR 4/6.
17	Coarse quartz sand, highly weathered feldspar, and ?pyrolusite (black, submetallic lustre, possibly goethite, some particles weakly magnetic). Dark reddish brown 2.5 YR 3/4.
20	Silty sand Silt, very poorly sorted (mainly coarse) quartz sand, weathered feldspar, ?pyrolusite, some epidote. Mainly reddish brown 5YR 5/3.
23	As above, but no epidote seen. Light red 7.5Y 6/8.
26	As above.
29	As above (some clay).
38	Sandy clay The sand is very poorly sorted, mainly coarse, angular, quartz; ?goethite/pyrolusite is fairly abundant. Reddish yellow 7.5YR 6/6.
44	Clayey gravel The 'gravel' is broken quartz; again, ?goethite is fairly abundant.
50	Gneiss Composed mainly of quartz, with weathered feldspar, mica, and ?goethite.
53	As above, with abundant biotite, less ?muscovite.
56	Gneiss The sample is mainly broken feldspar and quartz, some ?goethite, very little mica. (No mafic minerals other than the submetallic ?goethite.) Pinkish gray 7.5YR 7/2.
59	As above.
62	Gneiss Mainly quartz, little feldspar, abundant mafic minerals (including biotite). Very dark gray N 3/ with some dark brown 7.5YR 3/2.

Well ‘Walalkara 99B’

Depth (m)	Description
3	Calcrete and chert The calcrete contains iron-stained sand. Mainly weak red 10R 5/3, some red, some white.
11	Sandy silt The sand is very poorly sorted, angular, quartz; up to 3 mm. No more than a trace of limestone in the sample, no indication of induration. Dusky red 10R 3/3.
20	Sandstone Highly feldspathic, highly weathered, moderately indurated. Some black, submetallic, mineral grains (?goethite or pyrolusite). Weak red 10R 4/4.
23	As above.
26	Gritty clay Weak red 10R 4/4.
29	Clayey grit.
32	As for 20 m, but with 10% clay.
36	As above.
37	Sandstone Highly feldspathic, highly weathered, well indurated. Minor goethite. Red 2.5YR 4/6.
41	As above.

Well ‘Womikata 99A’

Depth (m)	Description
16–17	Gravelly clay Apparently alluvium (although it’s difficult to be sure that any of the rounded surfaces on the quartz pebbles are from abrasion rather than from conchoidal fracture). The gravel is quartz, containing black, dendritic inclusions. The remainder is silt and clay, light brown 7.5YR 6/4.
24–30	Sandstone Strongly cemented, approaching a quartzite. Light gray N6/, reddish brown where highly weathered. Abundant indications of weathering.