DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT BK NO. 91/64

COWELL AREA, 1989 DRILLING

GEOLOGICAL SURVEY

by

R E READ

GROUNDWATER AND ENGINEERING

JUNE, 1991 DME 598/48

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT BK NO.91/64
DME NO. 598/48
G02830

COWELL AREA, 1989 DRILLING

ABSTRACT

The Cowell area, which is mostly underlain by metamorphosed Proterozoic rocks was investigated for stock water supplies.

The Tertiary Cowell Basin, while capable of substantial yields, contains only saline water and has no potential for stock supplies.

Examination of records for previous drilling showed that for quartzites, median yield was 0.09 L/s and median depth 23 m and for gneisses and schists 0.06 L/s and 18 m.

Optimum depths are about 40 m. Saline water is widespread.

Five wells were drilled in 1989. Two were dry, one yielded 0.25 L/s, one yielded 2 L/s from dolomite and one 4 L/s from a fracture zone.

A proposed subsidized drilling scheme for 1990 was abandoned because of lack of support following the disastrous fall in wool and grain prices.

The water shortage that much of this district suffers is not solely due to lack of water resources, but to the factors below.

Marginally economic agriculture does not generate the funds needed for groundwater exploration.

Underground water is unevenly distributed. Limited funds make farmers cautious of drilling further than needed for the minimum usable supply.

The high cost and difficulty of obtaining good hydrogeological advice.

The above have combined to inhibit the best use of the available resources.

Possible solutions include encouraging the development of communal schemes and providing the services of an experienced hydrogeologist.

INTRODUCTION

In response to the concern of the Eyre Advisory Committee over water supplies in the Cowell Area, $40 000 was allocated for water exploration.

The original intention was to explore the Cowell Basin, but a study of existing data showed that this had no potential for supplying stock quality water. Attention was therefore directed to determining if better supplies than the existing ones could be developed by deeper drilling into the Proterozoic rocks.

GEOLOGY

All the area investigated had been mapped at 1:250 000 scale (Parker, 1983a) and parts at 1:50 000 scale (Parker, 1983b and c).

The Cowell Basin under the plains west of Cowell contains Tertiary sediments to a depth of about 100m.

Elsewhere the area is underlain at shallow depth by Proterozoic rocks. These are schist, meta-quartzites, minor dolomites and gneisses with some intrusive granites.

HYDROGEOLOGY

Outside the Cowell Basin all the aquifers are in fractured and weathered Proterozoic rocks.

These are generally of low permeability, as shown by the generally low well-yields in the area.

Cowell Basin

This is a 'wedge' basin formed by down-faulting along a series of north and north-easterly trending faults.

Near the base of the sedimentary sequence there are Tertiary sands which have reasonable yields (over 6 L/s) of saline water (Read, 1986).

However, all known wells in the basin have salinities of over 15 000 mg/L.

There are no obvious sources of fresh recharge water. Creeks such as Salt Creek carry a high salt load, and in any case the basin geology, in which about 100m of clays overlie the aquifer, would prevent any large quantities of water reaching the aquifer.

The Cowell Basin has no potential for supplying water suitable for stock without desalination.

It has good potential for the supply of industrial water, and possibly for storage of storm run-off. The latter use would require a source of good quality run-off in an area where the water table is deep.

PREVIOUS DRILLING

An assessment was made of previous drilling divided up according to the major rock units. Results are shown in Figures 2 to 5.

An attempt was made to compare the yields of wells in the major rock units (Fig. 2), by comparing well locations with the published geological maps. Results are summarized below.

Table 1

Well yields by rock type

Rock type	Units on Map	Median well-depth (m)	Median well-yield (L/s)	25 Percentile well-yield (L/s)
Schist	Yadnarie Schist, Ᵽhy Mangalo Schist, Ᵽhc	17	0.06	0.13
Quartzite	Warrow Quartzite, Ᵽhw	23	0.09	0.25
Gneiss	Miltalie Gneiss, AᵽS Minbrie Gneiss, Ᵽlm Coolanie Gneiss, Ᵽlc	18	0.05	0.13

While the quartzite has the best yields they are not as good as would be expected. This is at least partly because the Warrow Quartzite as mapped includes a large proportion of schist interbeds.

Cumulative depth-yield graphs are shown in Figures 3, 4 and 5.

Estimated optimum-depths are shown in Table 2.

Table 2

Optimum depth from Figures 3, 4 and 5

Rock type	Optimum-depths for 0.05 L/s	for 0.1 L/s	for 0.2 L/s
Schist	40 approx.	40 approx.	20
Quartzite	30	40	50
Gneiss	30m	30m	insufficient data.

The higher optimum depth for small supplies in schist is probably a result of drilling on, in the hope of finding a larger supply.

Too few wells were identified in dolomite or granite to allow a useful study.

Salinity

The area has a problem not only with low well-yields but also widespread saline water.

Salinity of all wells on the four sheets was plotted against well-depth, standing water levels and depth below water table.

These, plots showed no relation between standing water level and salinity and a rather weak relation between depth below water table and salinity.

1989 DRILLING PROGRAM

Five wells were drilled in 1989. Locations are shown in Figure 6, depth-yield graphs in Figure 7 and results in Table 3.

Summarized reasons for siting each well are in Table 4. Geological logs are in Appendix A and water analyses in Table 5.

It was planned to drill at least two more wells in the northern part of the area. Because the only suitable sites were some distance off roads and the rig used had very poor mobility the program had to be cut short.

It was intended to complete the program with a rig mounted on a 6 x 6 truck, but because of other work commitments this was not done.

DISCUSSION OF DRILLING RESULTS

While only two of the five wells drilled had substantial yields the results were better than for previous drilling.

The following lessons were learnt:

1. Dolomites are good targets where of reasonable thickness.

2. Otherwise structure is more important than lithology.

Overall quartzites have potential for better yields than schists and gneisses.

The optimum depth of drilling is still problematical.

In well fractured zones such as that intersected by 6230/468 weathering clearly persists to over 80m. In such cases drilling should always continue to fresh rock.

Table 3: 1989 Drilling

Permit No.	Unit No.	Date Completed	Depth (m)	Status	SWL (m)	Yield (L/s)	Casing	Grid (6230-4)	Hundred	Section
23139A	6230/469	3/8/89	66.6	A	-	Nil	-	595755	Hawker	Adj 180
23139B	6230/470	4/8/89	66.6	P	5.4	0.25	16.5	498714	Mann	50
23140	6230/463	8/8/89	80.3	P	34	2	51	642807	Miltalie	Adj 19
23188	6230/467	10/8/89	86	P	16.4	4	80	693867	Miltalie	Adj 52
23137	6231/179	11/8/89	34.5	A	-	-	-	853978	Glynn	Adj 35

Table 4: Reasons for siting wells

Permit No.	Unit No.	
23139A	Over quartzite projected onto road reserve, near fault	Dry
23139B	Over quartzite, near mapped fault line.	Small supply
23140	Over dolomite	Success
23138	Zone of better jointing indicated, by air-photo linear feature, low portion of ridge (see Fig. 6).	Success
23137	Very weak 'valley' on higher ground above Salt Creek.	Failure (dry)

Table 5: Water Analyses

Unit No.	TDS mg/L	Cond. ECu	Ca^{2+}	Mg^{2+}	Na^{2+}	K^{+}	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-
6230/467	8 033	13 600	222	331	2 292	54.5	492	742	4 146	<0.1
6230/468	4 040	7 080	99	195	1 157	24.4	725	288	1 912	1.8
6230/470 (66.5m)	3 148	5 680	66	105	964	35.2	451	270	1 483	<0.1
6230/470 (61m)	5 710	3 201	67	106	990	35.4	453	264	1 512	0.1

The appropriate depth for drilling into fresh rock is problematic but 40 to 50m from surface is probably a good rule of thumb.

TEST-PUMPING

Well 6230/468 was test-pumped to determine its suitability for equipping to supply a group of farmers to the north. Results are in Appendix B.

PROPOSED SUBSIDIZED PROGRAM, 1990

Only limited funds were available for drilling in the 1990-1 financial year.

It was proposed that drilling be undertaken on agreements where the farmers would pay for successful wells and SADME for unsuccessful wells.

Initially interest was shown in the scheme by a number of landholders in the northern part of the area (see Fig. 6).

However, the proposed program coincided with a disastrous collapse of the wool and grain markets. Added to this was the fact that farmers had not recovered from a run of poor seasons and concern as to the cost of successful wells drilled to the specified maximum depths.

Only two landholders signed up for the scheme which was then shelved.

DISCUSSION

Much of this area suffers water shortages at times, with farmers having to cart water for stock long distances.

This is not purely a result of lack of water resources. The following factors contribute:

1) Agriculture in much of the area is marginal and farmers have little spare funds for groundwater exploration.

2) Underground water is unevenly distributed with some properties having no prospects of useable supplies, while others have aquifers with the potential to supply several properties.

3) Because of lack of funds drilling has often been governed by '1000 gallon/day thinking', where landholders instruct drillers to stop as soon as small supply is struck, rather than drill on for maximum yield.

4) Farmers have limited access to geological advice. The cost of bringing a consultant hydrogeologist from Adelaide is prohibitive for individual farmers. Further a hydrogeologist would need to spend days familiarizing himself with the districts difficult hydrogeological conditions.

5) A considerable amount of past drilling has been in areas with poor prospects of success, often in low-lying areas likely to be saline and sometimes close to previous wells abandoned because of excessive salinity.

The above problems have compounded with the expenses of exploration and development to leave the district undersupplied with water.

Possible solutions, where they exist, are listed below.

1) Cannot be changed.

2) Requires the development of communal schemes where groups of farmers equip wells and reticulate the water.

   The major obstacle to this type of development is the natural fear of farmers on whose land suitable water exists that their water supplies may be jeopardized.

   By including an agreement that guarantees the landholder priority to a designated daily quantity of water it may be possible to overcome this.

   All wells for which such developments are planned should be systematically pump-tested for 24 hours and the recovery observed for 2½ days.

3) Possibly better access to geological advice and an appreciation of the fact that long term yields will be less than short term yields might help.

4) Government can assist in this area by providing the services of a hydrogeologist free. While there is a general principle that this type of work should be done by consultant hydrogeologists, economic and groundwater conditions in this area make it a special case.

A hydrogeologist could visit the area annually to give advice to farmers as required. This work should only be done by hydrogeologists with fractured rock experience who have acquainted themselves with the peculiarities of this area.

CONCLUSIONS

1) Moderate supplies of stock quality water (sufficient to supply several farms) can be obtained by drilling on favourable sites in more elevated areas above the salt water filled valleys.

2) Favourable geological conditions include:

   dolomites
   quartzites, when fractured
   linear structural features.

3) The lack of water supplies in the area and the need for carting for stock is a result of the high cost of development and lack of funds.

RECOMMENDATIONS

1) Hydrogeological advice should be provided free to farmers in this area.

2) Group schemes should be promoted. This might include assistance with drawing up legally-binding agreements.

3) All wells for which group schemes are planned should first be test pumped.

ACKNOWLEDGEMENTS

Thanks are due to Mr Niel Smith for his assistance in planning the program.

The invaluable assistance of Mr Reg Deer, a local drilling contractor is acknowledged. He freely made available his extensive first hand knowledge of the area and assisted wherever possible.

R.E. Read

R E READ

SENIOR GEOLOGIST

REFERENCES

Clarke, D.K., 1980. WHYALLA 1:250 000 sheet, water well survey. South. Aust. Dept. Mines and Energy. unpubl. report 80/12.

Parker, A.J., 1983(a). WHYALLA map sheet. *South Australia. Geological Survey. Geological Atlas 1:250 000 Series,* sheet SH 53-8.

Parker, A.J., 1983(b). *Cowell map sheet. South Australia. Geological Atlas 1:50 000 Series,* sheet 6230-I.

Parker, A.J., 1983(c). *Mangalo map sheet. South Australia. Geological Atlas 1:50 000 Series,* sheet 6230-IV.

Read, R.E., 1986. Whyalla Cowell road, drilling for construction water 1985. South Aust. Dept. Mines and Energy. unpubl. report 86/21.

APPENDIX A
GEOLOGICAL LOGS

Contents

MF32

PROJECT: COWELL AREA INVESTIGATION

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

HOLE NO: PN 23139A

UNIT / NO. 6230WW469

LOCATION OR COORDS:

SEC. HD. HAWKER

El. Surface m

El. Ref. Point m Datum

DME

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	INTERVAL TESTED To:	SUPPLY l/sec *	SUPPLY Test Length (hrs)	SUPPLY Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No:
					Nil		AIRLIFT		W —

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia(mm)	CASING From(m)	CASING To(m)
0	3		SOIL	Brown, silty sand with quartzite pebbles.	RECENT				
3	12		QUARTZITE	Very weathered and broken.	Warrow Quartzite.				
12	21		QUARTZITE	White metaquartzite, somewhat schistose, partly weathered with yellow brown iron-oxide stains.					
21	27		QUARTZITE	Quartzite, white to plae brown, fairly hard.					
27	30		QUARTZITE	Similar to above with deep yellow brown soft weathered zone at 27m.					
30	51		QUARTZITE	Pale pink brown.					
57	60		SCHIST	Very dark grey biotite schist with red feldspar, some white schistose quartzite.					
60	67		QUARTZITE	Pale brown.					

REMARKS:

* NOTE: l/sec = 800gals/hr

DRILL TYPE: ROTARY

COMPLETED: 3/8/89

CIRCULATION: AIR

LOGGED BY: R E READ

DATE: 3/8/89

SHEET 1 OF 1

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PROJECT: COWELL AREA

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

HOLE NO: PN 231139B

UNIT / NO. 6230/470

DME

LOCATION OR COORDS:

SEC. 60 HD. MANN

El. Surface m

El. Ref. Point m Datum

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	INTERVAL TESTED To:	SUPPLY l/sec *	SUPPLY Test Length (hrs)	SUPPLY Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No:
	34*	5.4	0	66	0.25	1.5 hr approx	Airlift while drilling	3140	W —

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
0	2		SOIL	Grey horizon micaceous schistose quartzite	Recent				
2	6		QUARTZITE	Pale brown.	Warrow Quartzite				
6	9		QUARTZITE	Grey brown plus vein quaartz.					
15	19		SCHIST	Dark grey mica schist.					
19	24		QUARTZITE	Light grey quartzite, stained yellow brown, with iron oxides plus vein quartz.					
24	30		QUARTZITE	White to medium grey micaceous quartzite with some yellow brown staining.					
30	33		SCHIST	Medium grey quartz-schist plus white iron-oxide stained quartzite.					
33	39		QUARTZITE	Light to medium grey micaceous quartizte.					
39	45		QUARTZITE	Light grey, micaceous					
45	57		QUARTZITE	Light to medium grey.					
57	60		QUARTZITE	Medium grey schistose quartzite. Some vein quartz.					
60	66		QUARTZITE	Medium grey					

REMARKS:

* See depth yield graph

* NOTE: l/sec = 800gals/hr

DRILL TYPE: ROTARY

COMPLETED: 5/8/89

CIRCULATION: AIR

LOGGED BY: R E READ

DATE: 4/8/89

SHEET 1 OF 1

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MF32

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

PROJECT: COWELL AREA

LOCATION OR COORDS:

SEC. HD. El. Surface m El. Ref. Point m Datum

HOLE NO: PN 23140

UNIT / NO. 6230 WW 468

DME

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	To:	SUPPLY l/sec *	Test Length (hrs)	Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No: W—
	36	34	0	39	1	Airlift while drilling		3597	3740/89
			0	44	1.5	"	"	3684	3741/89
			0	48	2.0	"	"	3712	3742/89
						Final sample		4030	3743/89

DEPTH (m) From	To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	From (m)	To (m)
0	2		SOIL	Light orange brown	Recent				
2	6		DOLOMITE	White to pale yellow brown	Katunga				
6	9		DOLOMITE	White	Dolomite				
9	12		DOLOMITE	Mostly with yellow brown ferruginous staining, partly silicified.					
12	18		DOLOMITE	White, with numerous brown-stained ferruginous patches					
18	23		DOLOMITE	White, some green diopside.					
23	32		DOLOMITE	Yellow-brown stained weathered.					
32	35		TALC	Pale green with iron-oxide stained joints.					
35	39		DOLOMITE	White, partly weathered and vugular.					
42	45		CHERT	Brown iron stained chert, some dolomite.					
45	48		DOLOMITE	White dolomite with some yellow-brown staining.					
48	51		DOLOMITE	White					
51	60		DOLOMITE	White with dark grey patches.					

REMARKS:

* NOTE: l/sec = 800gals/hr

DRILL TYPE: ROTARY

CIRCULATION: AIR

DATE: 7/8/89

COMPLETED: 7/8/89

LOGGED BY: R E READ

SHEET 1 OF 2

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DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

HOLE NO:
UNIT / NO 6230 WW 468
DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
60	63		DOLOMITE	Yellow brown stained and broken.					
63	75		DOLOMITE	White, smell of hydrogen sulphide at 73m.					
75	80		DOLOMITE	White, with some green calc-silicates. Smell of H_2S at 79m.					

SHEET 2 OF 2

MF32

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

PROJECT:	COWELL AREA
LOCATION OR COORDS:	
SEC.	52
HD.	MILTALIE
El. Surface	m
EL Ref. Point	m Datum
HOLE NO:	PN 23138
UNIT / NO.	6230/467
	DME

AQUIFER SUMMARY:

Depth to water cut (m)	Depth to standing water (m)	Interval tested From:	Interval tested To:	Supply l/sec *	Supply Test Length (hrs)	Supply Method	Total Dissolved Solids milligrammes/litre	Analysis No:
82		0	84	1.4	Airlift while drilling		7491	W —
84		0	86	5	" /	very rough estimate.	8033	

Depth (m) From	Depth (m) To	Graphic Log	Rock / Sediment Name	Geological Description	Formation / Age	Depth Core Sample	Casing Dia (mm)	Casing From (m)	Casing To (m)
0	6		GRAVEL	Brown silty sand matrix with angular quartzite pebbles.					
6	9		SANDSTONE	Orange-brown sandstone with angular pebbles of quartzite and black schist.					
9	12		CLAY	Brown (weathered schist)					
12	29		CLAY	Grey with chips quartzite and weathered schist.					
21	27		SCHIST	Medium grey biotite schist with some quartzite banded and vein quartz.					
27	36		SCHIST	Medium grey mica schist, somewhat weathered. Somewaht weathered. Some brown iron-staining and vein quartz.					
36	42		SCHIST	Green grey chlorite schist, some iron-oxide staining..					
42	69		SCHIST	Similar to the above, but more weathered with with yellow and green patches. Some black graphitic schist at 48-51.					
69	72		SCHIST	Dark grey weathered graphitic schist.					

REMARKS:

* NOTE: l/sec = 800gals/hr

DRILL TYPE:	ROTARY	COMPLETED:	10/8/89
CIRCULATION:	AIR	LOGGED BY:	R E READ
DATE:	10/8/89 2	SHEET 1 OF 2	

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MF32 A

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

CONTINUATION SHEET

HOLE NO:

UNIT / NO 6230/467

DME

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia (mm)	CASING From (m)	CASING To (m)
72	78		SCHIST	Moderately hard, medium grey, some weathered brown.					
78	81		SCHIST	Medium to dark grey, some of it graphitic.					
81	84		SCHIST	Medium to dark grey, some vein quartz very broken 82-84m.					
84	86		QUARTZITE	Quartz with pyrite coatings, plus dark grey schist.					

SHEET 2 OF 2

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MF32

PROJECT: Cowell Area

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

WATER WELL LOG

HOLE NO: PN 23137

UNIT / NO. 6231WW179

DME

LOCATION OR COORDS:

SEC. HD. Glynn

El. Surface m

El. Ref. Point m Datum

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	To:	SUPPLY l/sec *	Test Length (hrs)	Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No:
	Nil								W —

DEPTH (m) From	To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia(mm)	From(m)	To(m)
0	3		Weathered granite	Pink brown clay and quartz.					
3	6		Weathered granite	Pink weathered coarse quartz feldspar granite.					
6	12		Granite	Coarse pink feldspar quartz granite, slightly weathered.					
12	15		Granite	Similar to the above with large flakes of biotite. More weathered from 12.5m to 30m.					
15	34.5		Gneiss	Quartz-feldspar-biotite gneiss. Some weathering and iron-oxide coated joints around 24m.					

REMARKS:

* NOTE: l/sec = 800gals/hr

DRILL TYPE: Rotary

COMPLETED: 11/8/89

CIRCULATION: Air

LOGGED BY: R. Read

DATE: 11/8/89

SHEET 1 OF 1

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APPENDIX B
TEST PUMPING

Test Pumping 6230/467

The well was pumped for 1210 minutes on 12/12/90. During the test the pump rate declined from 1.4 to 0.96 L/s.

The plot of a drawdown against log time (Fig. 8) is a downward steepening curve, while the plot drawdown against the square root of time (Fig. 9) is approximately linear.

The recovery plot confirms this.
The following equation was derived.

$$s = Q\,(1 + 3\sqrt{t})$$

where s is drawdown in m.
Q is pump rate in L/s
t is pumping time in days.

At the time of the test standing water level was 17m. The aquifer was cut at 82m.

Allowing for seasonal fluctuations available drawdown will be assumed to be 60m.

Using the above equation the following estimates were made:

1) for 2 years continuous pumping, 0.7 L/s (560 gph).
2) for pumping for 100 day periods for three consecutive seasons, 1.5 L/s (1200 gph).

Conductivity varied erratically with time (Fig. 10). There is no evidence of any increase, but it might be wise to equip the well for carting only first before investing in a long pipeline.

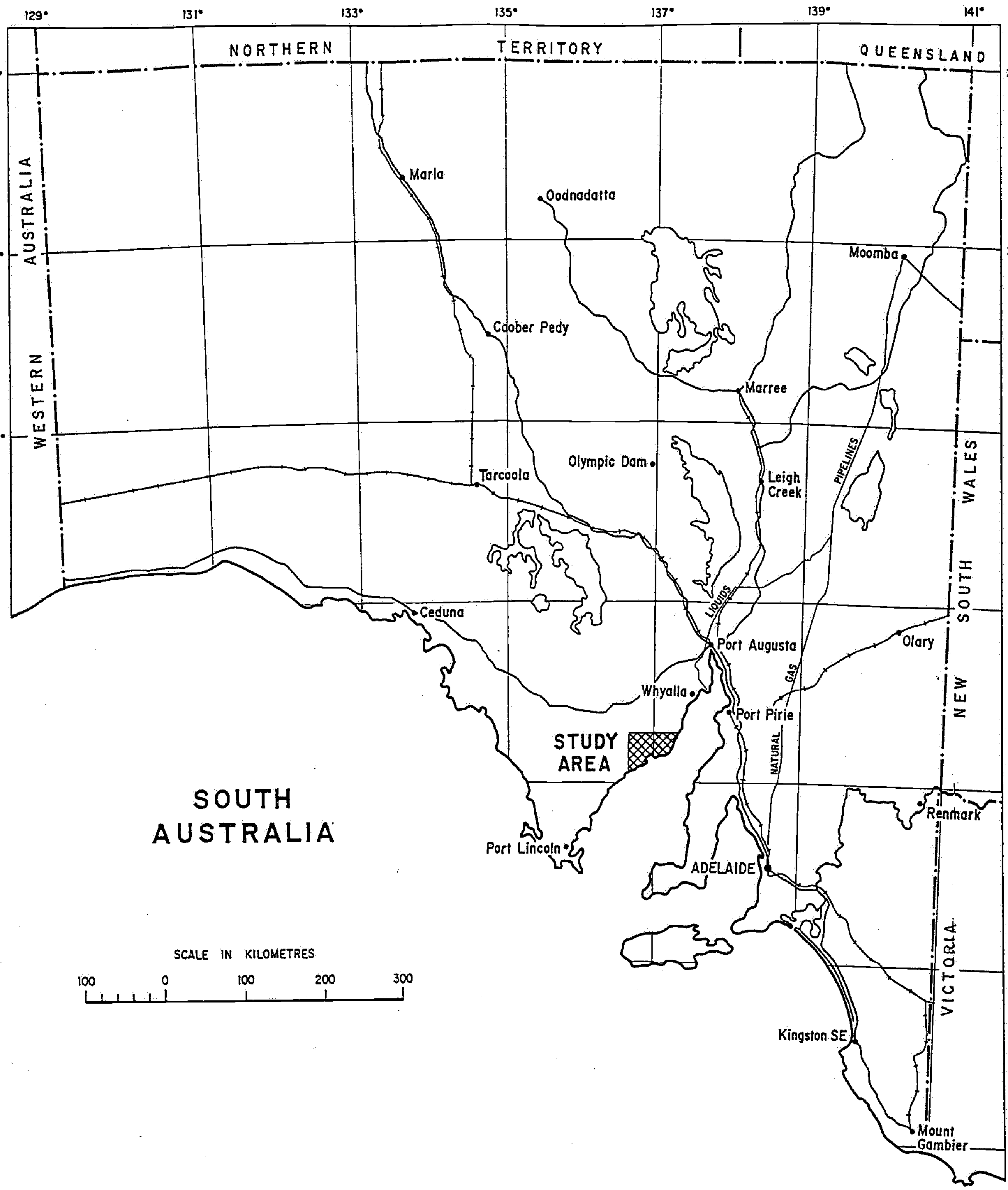


Figure 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING
LOCALITY PLAN

COMPILED R.R.	C.D.O.	DATE 8.7-91
DRAWN M.B.	SCALE	
DATE May '91	PLAN NUMBER	
CHECKED	S22200	

5326

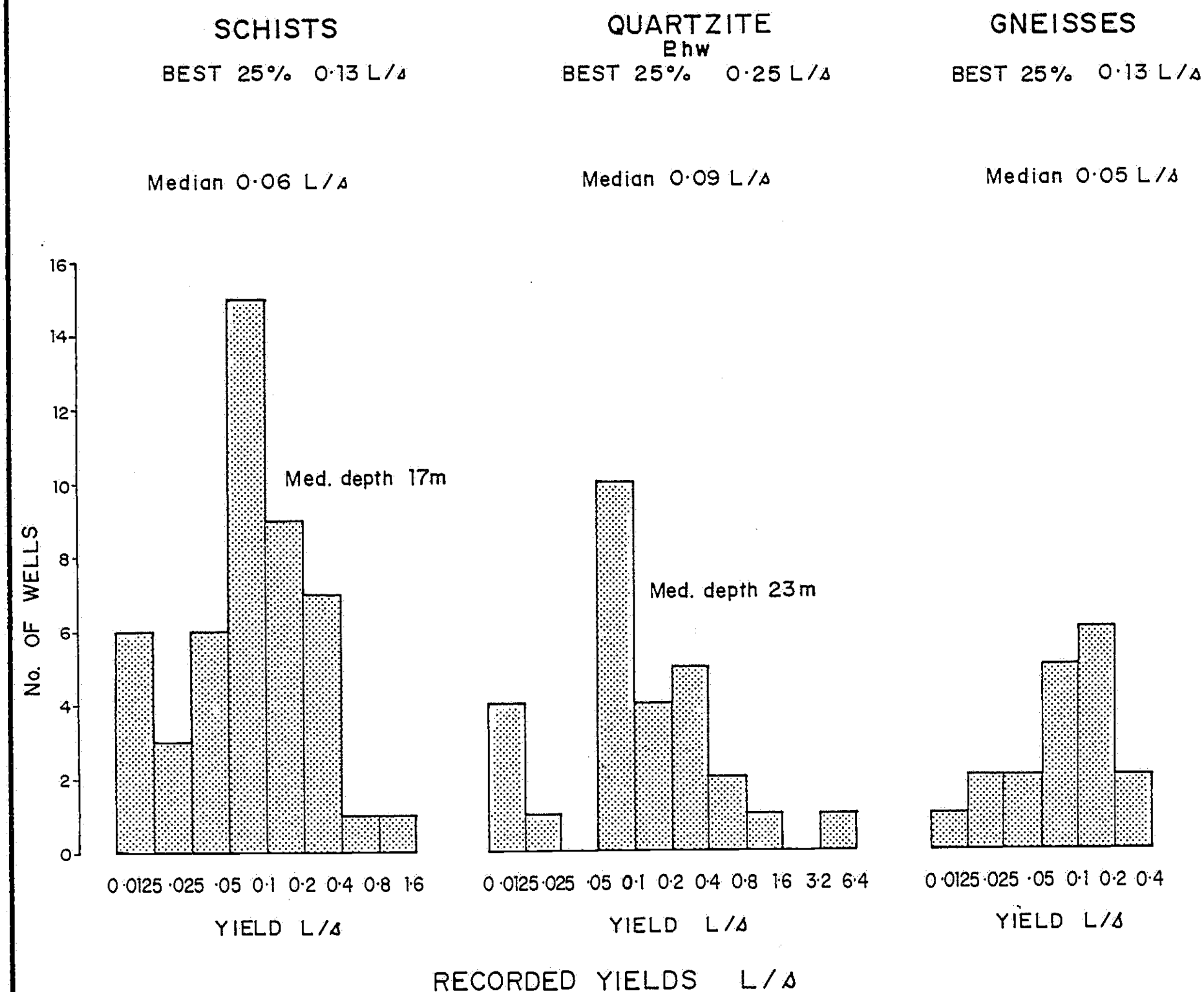


Figure 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING

WELL YIELDS IN ROCK UNITS

COMPILED R. R.	C.D.O.	DATE 8.7.91.
DRAWN M.B.	SCALE	
DATE May '91	PLAN NUMBER	
CHECKED	S22201	

5326

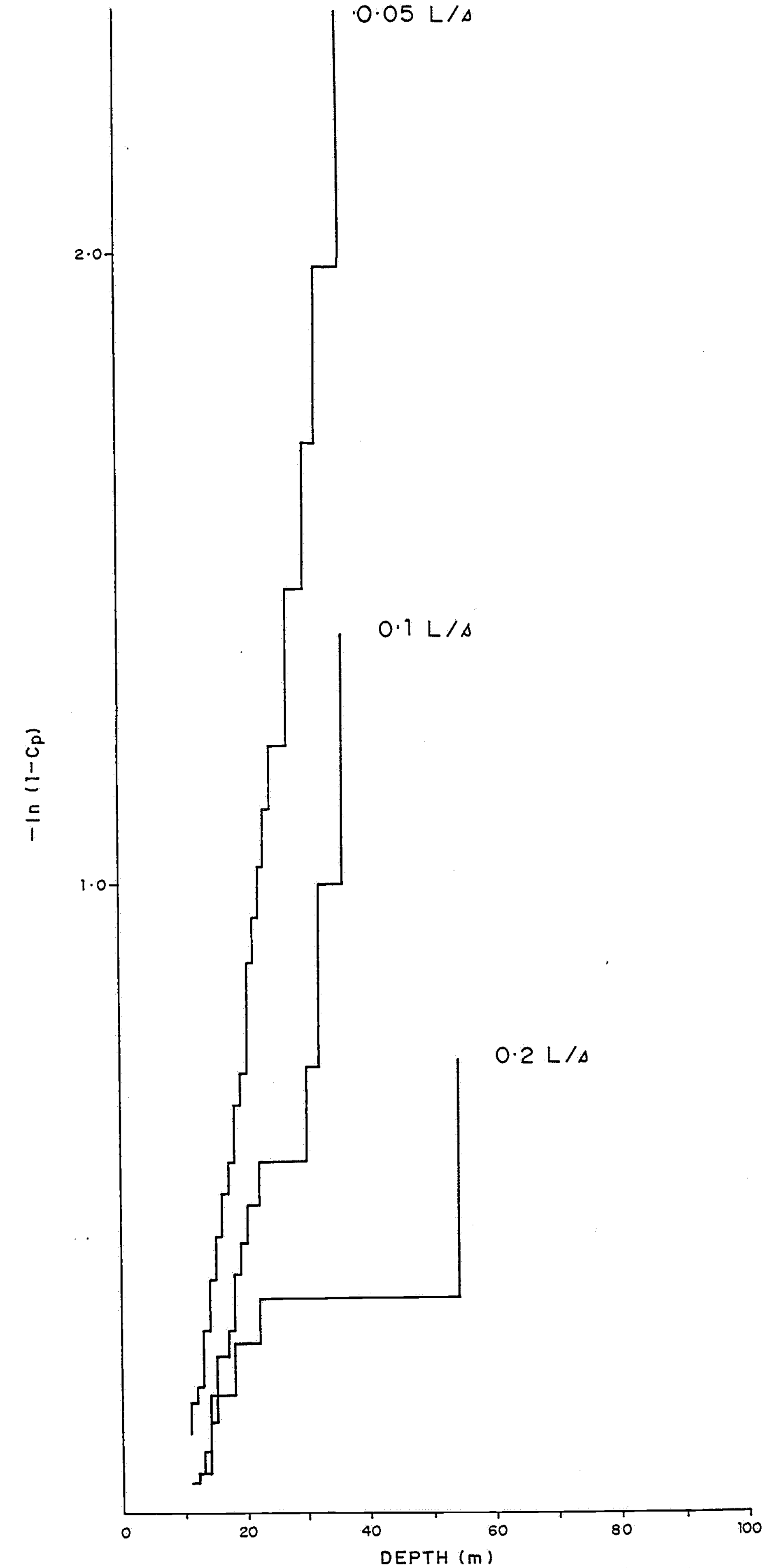


Figure 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING

CUMULATIVE DEPTH-YIELD GRAPH FOR SCHIST

COMPILED R.R.	C.D.O.	8·7·91. DATE
DRAWN M. B.	SCALE	
DATE May '91	PLAN NUMBER	
CHECKED	S22202	

5326

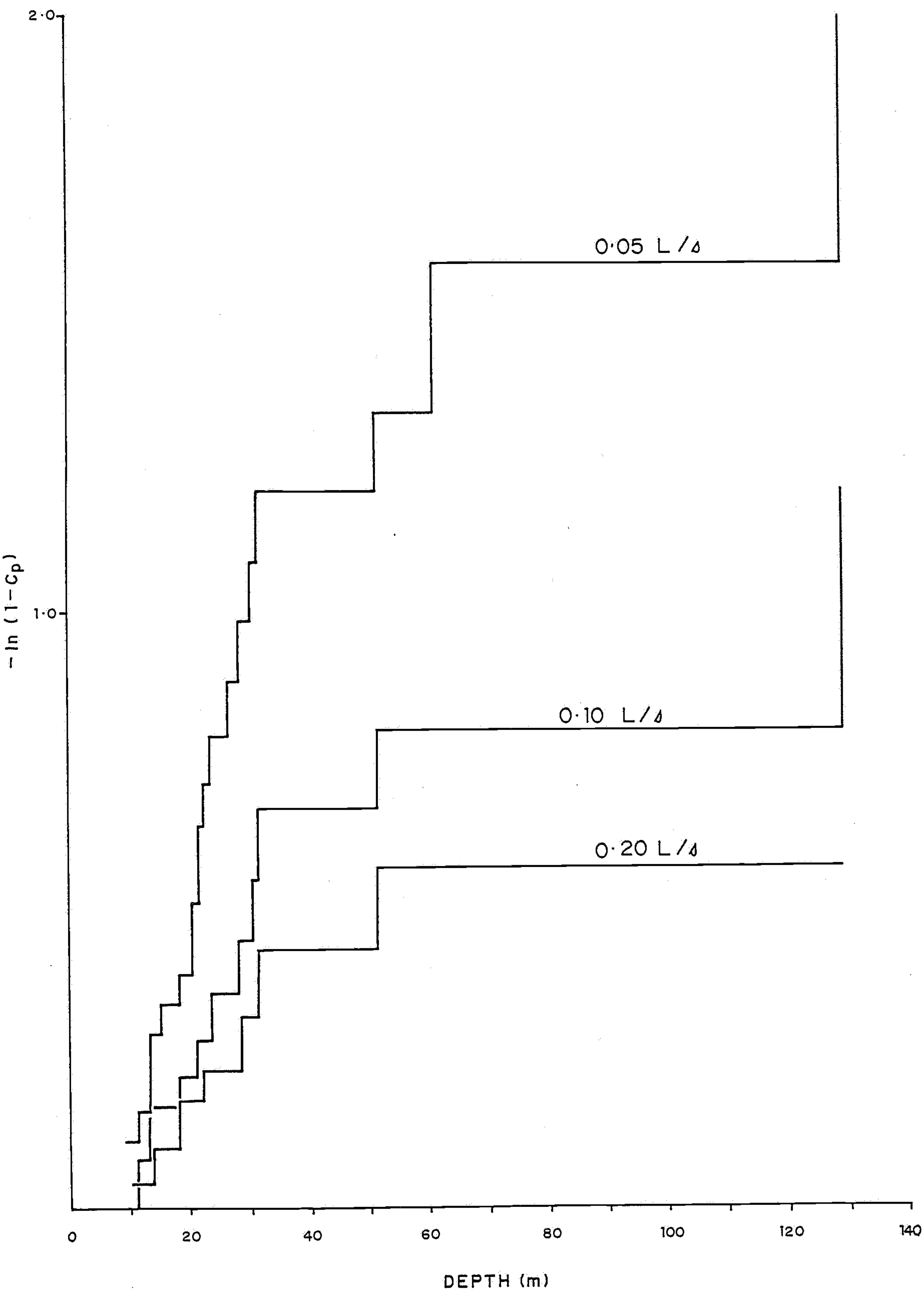


Figure 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING

CUMULATIVE DEPTH-YIELD GRAPH FOR QUARTZITE

COMPILED R. R.	C.D.O.	DATE 8-7-91
DRAWN M. B.	SCALE	
DATE May '91	PLAN NUMBER	
CHECKED	S22203	

5326

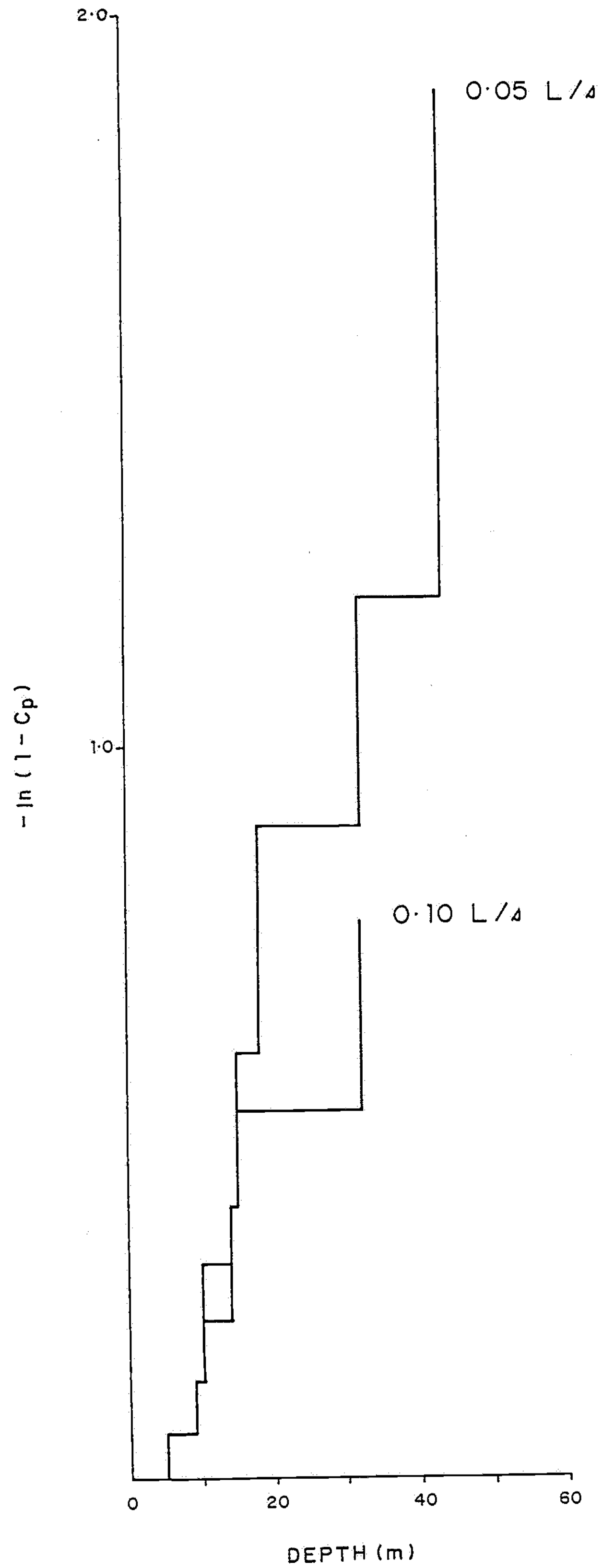


Figure 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING

CUMULATIVE DEPTH-YIELD GRAPH FOR GNEISS

COMPILED R.R.	C.D.O.	DATE 8.7.91.
DRAWN M. B.	SCALE	
DATE May '91	PLAN NUMBER	
CHECKED	S22204	

5326

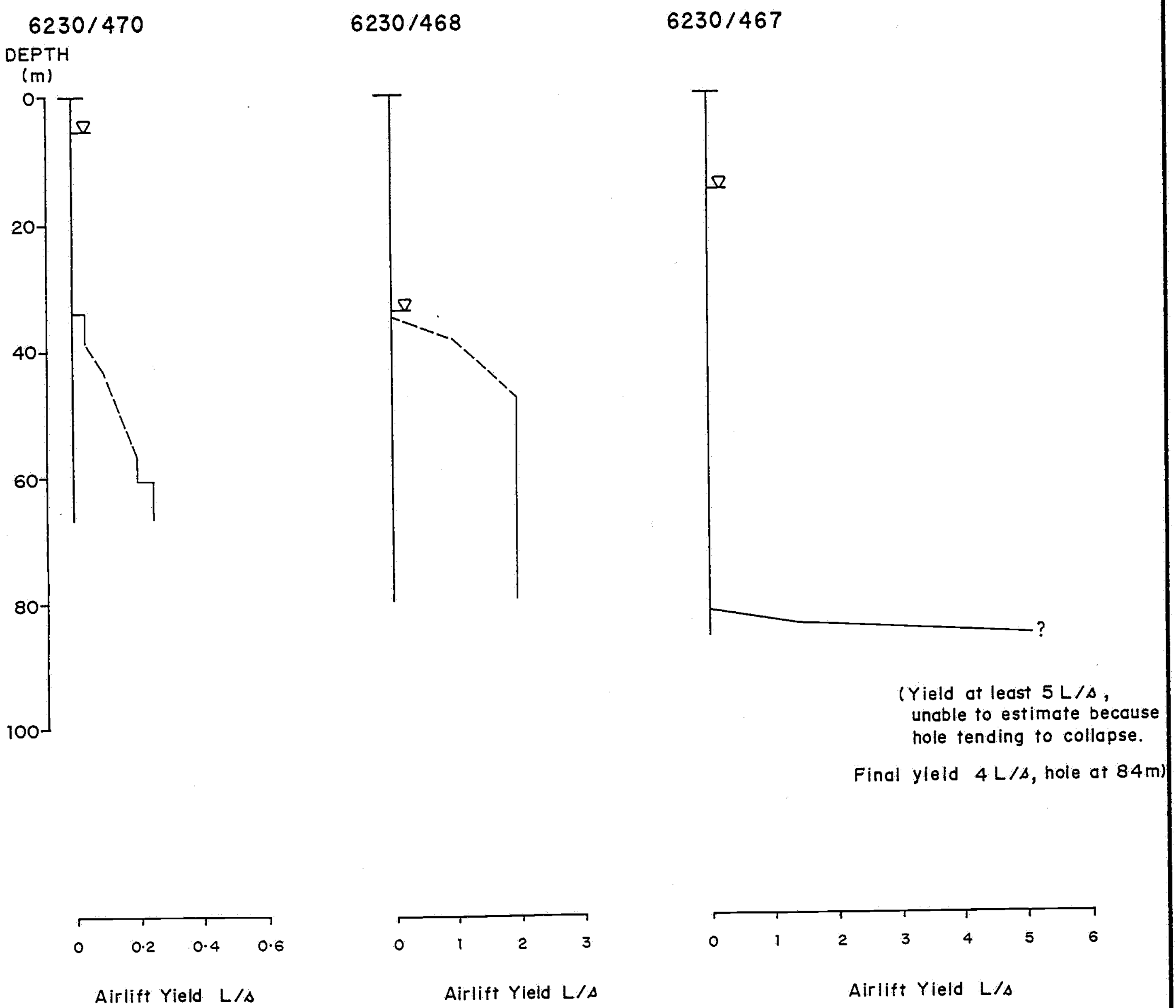
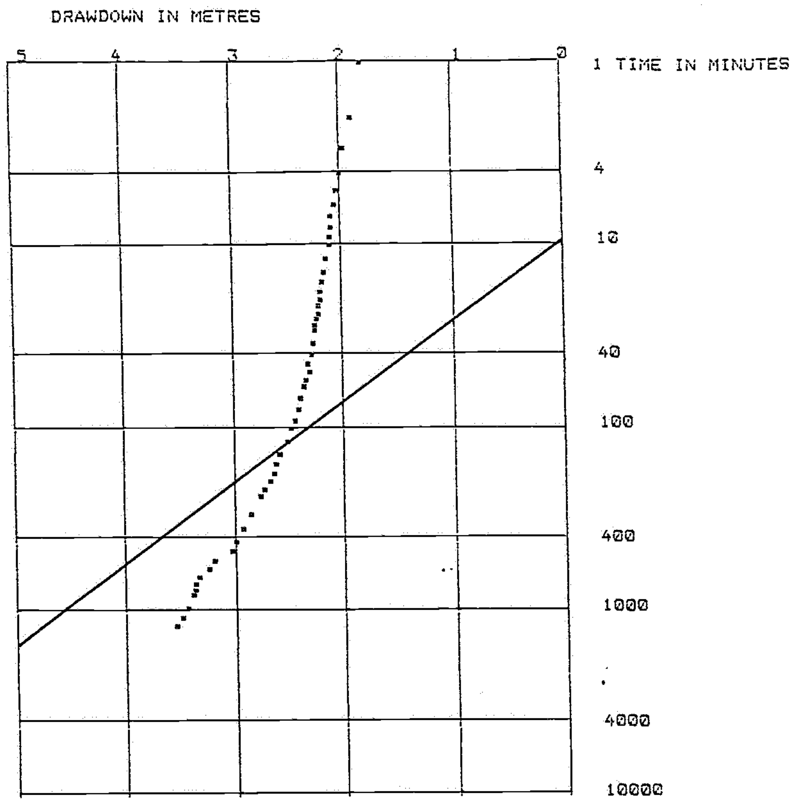


Figure 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.R.	C.D.O. 8.7.91. DATE
COWELL AREA - 1989 DRILLING DEPTH-YIELD GRAPHS	DRAWN M. B.	SCALE
	DATE May '91	PLAN NUMBER
	CHECKED	S22205

5326



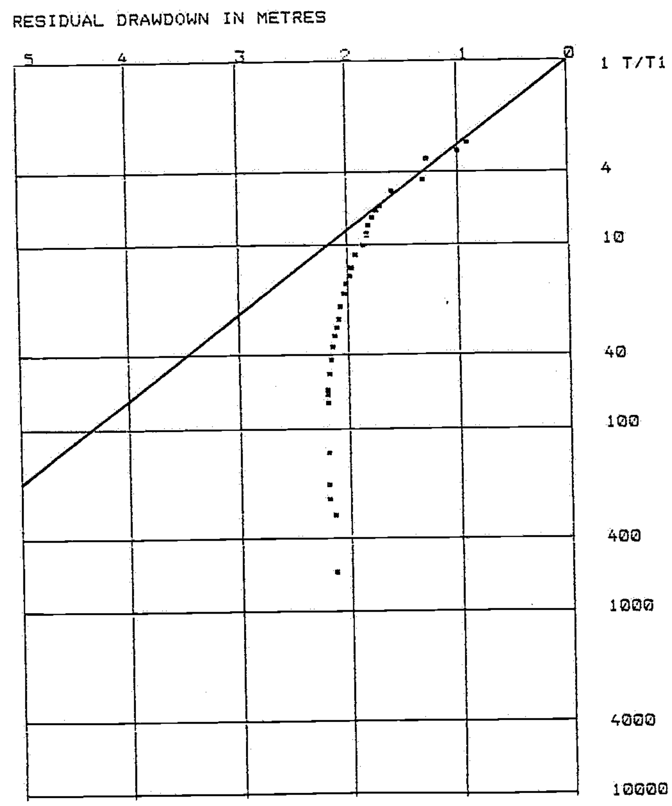
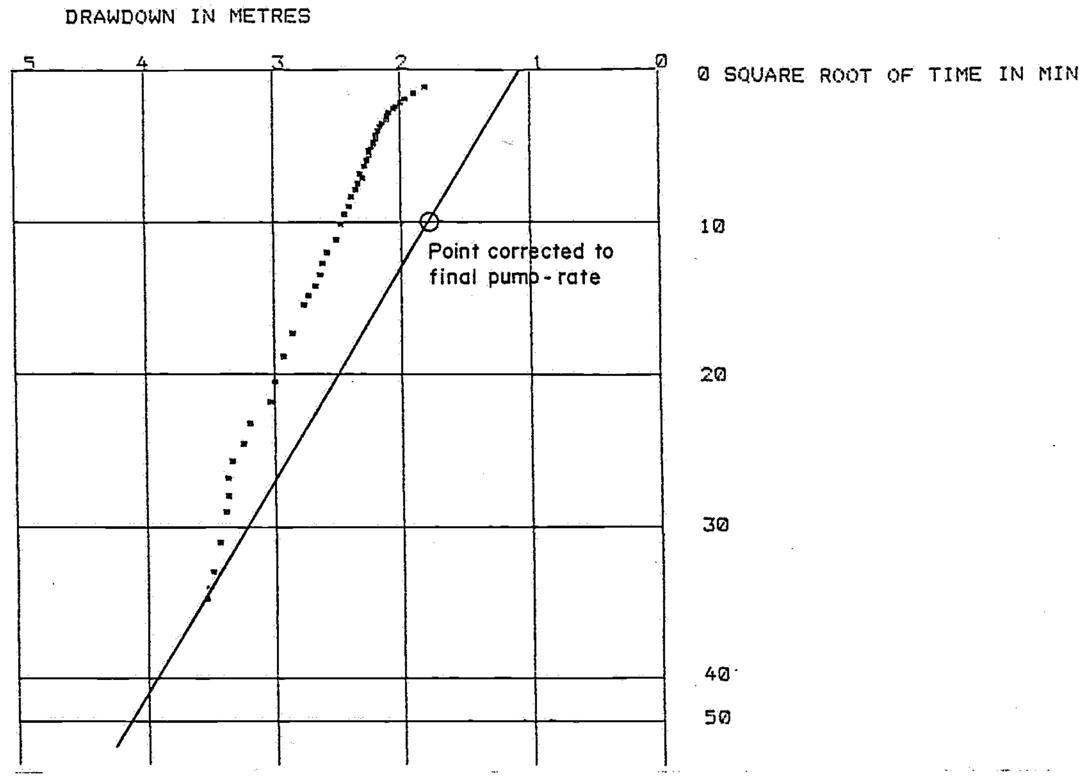


Figure 8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. R.	C.D.O. DATE 8.7.91.
COWELL AREA - 1989 DRILLING	DRAWN M. B.	SCALE
6230/467 SEMI-LOG DRAWDOWN AND RECOVERY	DATE May '91	PLAN NUMBER S22206
	CHECKED	

5326



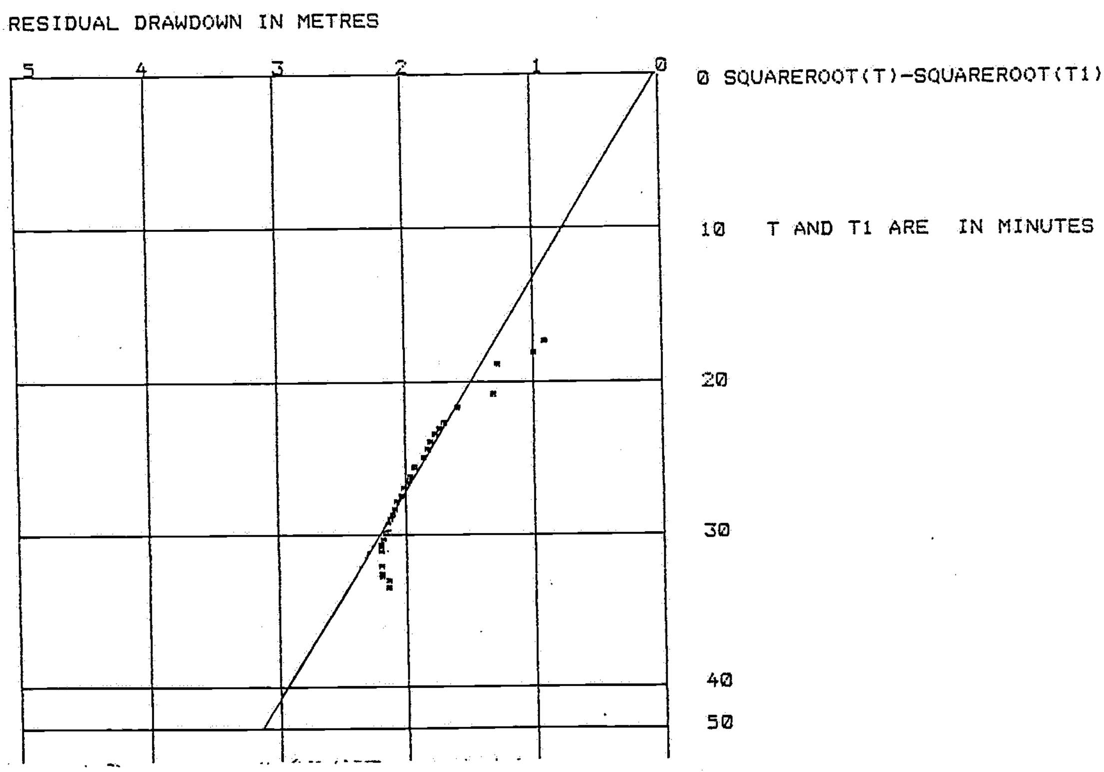


Figure 9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.R.	C.D.O.	DATE 8-7-91
COWELL AREA – 1989 DRILLING	DRAWN M. B.	SCALE	
√t DRAWDOWN AND RECOVERY	DATE May '91	PLAN NUMBER S 22207	
	CHECKED		

5326

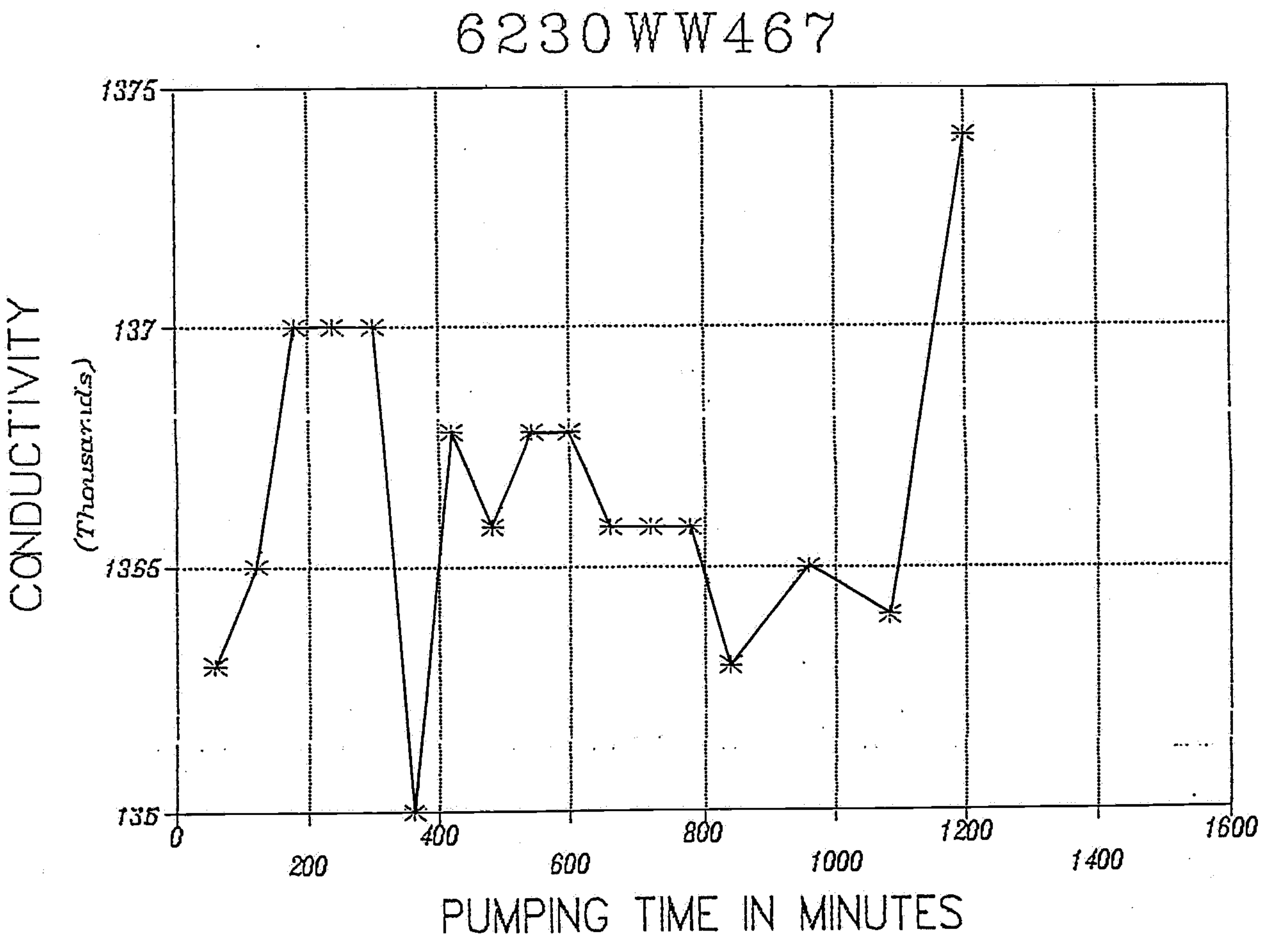


Figure 10

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COWELL AREA - 1989 DRILLING

6230/467 CONDUCTIVITY AGAINST TIME

COMPILED R.R.	C.D.O.	DATE 8.7.91.	
DRAWN M.B.	SCALE		
DATE May '91	PLAN NUMBER		
CHECKED	S 22208		

5326