

SECTION

Rept. Bk. No. 69/37
G.S. No. 4294
Hyd. No. 2164

R/B 69/37



6922I

DEPARTMENT OF MINES SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

GROUNDWATER SUPPLY FOR INDUSTRIAL USE

PICT. LIMITED, MILLICENT

Pt. Sec. 573, Hd. Mt. Muirhead /GREY

by

C. BLEYS
SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

D.M. 540/69

5th August, 1969

69/37

DEPARTMENT OF MINES
SOUTH AUSTRALIA

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GROUNDWATER SUPPLY FOR INDUSTRIAL USE

PICT LIMITED MILLICENT

Pt. Sec. 573, Hd. Mt. Muirhead

SUMMARY AND CONCLUSIONS

A borehole has been drilled 620 feet into the Gambier limestone at Millicent and pump tested for 29 hours. The test results indicate that good quality groundwater supplies can be withdrawn continuously from the borehole at the required pumping rates of $Q = 0.67$ cusecs (15,000 g.p.h.) and 0.87 cusecs (20,000 g.p.h.) with a pump setting of 103 ft. below the surface. The borehole could be pumped at a rate greater than 1.64 cusecs (35,800 g.p.h.) as there was still some underflow at this rate. Pump settings for 1.6 cusecs should be 164ft. below the surface.

INTRODUCTION

Pict Limited required assistance from the Department of Mines to obtain a minimum supply of 0.67 cusecs and a maximum supply of 0.87 cusecs at their property on the outskirts of Millicent part Section 573, Hundred of Muirhead, Fig. 1.

On receipt of a request dated 16th April, 1969, a 620 ft. deep borehole was drilled. This borehole is recorded in Department of Mines records as No. 521057301. The borehole was pumped at a maximum rate of 1.6 cusecs (35,800 g.p.h.). The capacity of the borehole and the drawdown expected at 3 different pumping rates are examined.

BOREHOLE DATA

Drilling was commenced on 13th May and completed on 9th June.

The standing water level after completed was 9.93ft. below the surface. The hole intersected Gambier limestone throughout, the most abandoned rock being offwhite to grey. A bore log giving the geological succession penetrated is given in Appendix 1.

In the Millicent area the groundwater to a depth of about 200 feet contains up to 6 parts per million of iron. In an attempt to reduce this iron content casing was set at 276 feet and detailed chemical analyses W.4093/69 shows that the groundwater discharged during the pumping test contained 742 parts per million of dissolved solids, including only 0.08 parts per million of iron.

PUMPING TEST DETAILS

A line shaft pump was set at 150ft. below the surface giving an available drawdown of 120ft. as the water level is about 10ft. below the surface and 20ft. of water should remain above the pump during testing to ensure that no turbulence occurs within the borehole. Such turbulence would reduce the reliability of pump test data.

The test results are tabled below:

Table 1

Test			Discharge		Max. draw-down in ft.	Transmissivity			Fig. No.
No.	Date	Duration in min.	In Cusecs	In gal/hour		Δ in ft.	in cusec/ft.	Recovery	
1	4.6.69	100	0.588	13,200	28.55	2.4	4.5×10^{-2}		2
						3.6		3×10^{-2}	
2	4.6.69	100	1.11	25,500	62.98	4.9	4.1×10^{-2}	4.1×10^{-2}	3
3	4.6.69	100	1.6	35,800	95.65	6.2	4.7×10^{-2}		4
						7.8		3.8×10^{-2}	4
4	5.6.69	1450	1.58	35,500	100	6.9	4.2×10^{-2}	4.2×10^{-2}	5

The drawdown curves of Figures 2, 4 and 5 show nick points after 50 minutes, 55 minutes and 115 minutes. A nick point is not clearly defined on Figure 3 - the curve deviates due to unknown factors. However, a flattening of the curve occurs after 60 minutes. The presence of nick points and flattening of the curves suggest the occurrence of underflow indicating that the borehole was not tested on its full capacity. For drawdown predictions the steeper parts of the curves have been used.

The transmissivities "T" calculated are in fairly good agreement although the "T" calculated from the drawdown curve of test No. 3 is high and the "T" calculated from the recovery curve of test No. 1 is low. Pumping tests made on boreholes elsewhere in the Gambier Limestone have yielded "T's" of the same order. If predictions are to be made on the extent of the cone of drawdown a "T" of $4.2 \times 10^{-2} \text{ ft}^3/\text{sec}/\text{ft}$. should be used.

PREDICTIONS OF DRAWDOWNS

Theoretical drawdowns can be calculated by using the equations

$$s_{w100} = BQ + CQ^2$$

$$\text{and } \Delta \frac{s_1}{Q_1} = \Delta \frac{s_2}{Q_2}$$

in which s_{w100} = the drawdown expected after 100 minutes pumping at any rate Q

Q = pumping rate

B = aquifer loss

C = well loss

Δs = the drawdown per log cycle obtained from the drawdown curves figures 2 to 5.

Calculations of the expected drawdown for 3 rates are given in Appendix 2. They are based on the dynamic curve of figure 6. The results are tabulated below:

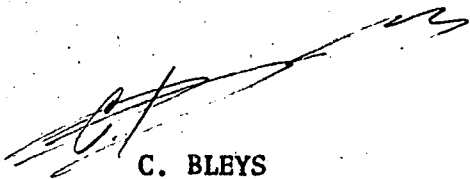
Table 2

(In cusecs)	Discharge	Safe pump setting (in ft.)	Predicted drawdown in ft. after continous pumping for		
	(In gall/ hour;)		(7 days)	(70 days)	(3 yrs)
1.6	35,500	164	110	117	124
0.89	20,000	103	55	59	63
0.67	15,000	87	41	44	47

In order to predict the drawdown at any pumping rate, use can be made of the graph on Figure 7, which is based on the equation $s_{w100} = BQ = CQ^2$. It should be noted however that only drawdown after 100 minutes pumping can be read from this graph. If it is used for pump settings for rates not given in Table 2 then the following should be taken into account,

- the water level below the surface
- the expected difference in water level during summer and winter
- the water head required above the pump.

CB:JMM:JKD
5.8.1969


C. BLEYS
SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

APPENDIX 1

Log of Borehole

No.521057301

BORE LOG PERCUSSION · ROTARY DRILLING

BORE No 01
SHEET 1 OF 7

PURPOSE OF BORE WATER SUPPLY

HIRER PICT LTO

HUNDRED MUIRHEAD

DRILLER ATKINSON

COMMENCED 13-5-69 COMPLETED 9-6-69

LOGGED BY B.M. HARRIS J. OODSON DATE 14-7-69

BORE SERIAL No. 78/69

ADDRESS

SECTION 573

DOCKET No. 540/69

R.L. COLLAR (M.S.L.)

R.L. SURFACE

CO-ORDS: E

N

DEPTH 620'

CASING 280 ft of 8"

WATERS CUT

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	993	35.000	24 hr. pump test.	742	W4093 /69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
280 ft. of 8" Casing	14	993	0				3 pump tests of 100 mins. duration and one of 450 min. duration carried out.	
			0-5ft.					CLAY, grey, calcareous, some shell fragments.
			5-40ft					CALCARENITE, fine, grey, shelly, bryozoal. Flint - small amount 10-30ft. band 35-40ft.
			40-60ft					CALCARENITE, light grey to off white, bryozoal shelly
			60-65ft					CALCARENITE, grading to CALCISILTITE, grey, shelly, bryozoal.
			65-125ft.					CALCARENITE, grey, silty, fine, shelly, bryozoal, abundant flint.

BORE LOG PERCUSSION · ROTARY DRILLING

BORE No 01
SHEET 2 OF 7

521057301

PURPOSE OF BORE WATER SUPPLY

HIRER PICT. LTD.

HUNDRED MUIRHEAD

DRILLER ATKINSON

COMMENCED 13.5.69 COMPLETED 9.6.69

LOGGED BY B.M. HARRIS J. DODGSON DATE 14.7.69

BORE SERIAL No. 78/69

ADDRESS

SECTION 573

DOCKET No. 540/69

R.L. COLLAR (M.S.L.)

R.L. SURFACE

CO-ORDS: E

N

DEPTH 620'

CASING 280' of 8"

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.95	35,000	24 hr. pump test	742	W4093/69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
280ft of 8" casing			110				65-125ft. <u>CALCARENITE</u> , grey, fine, silty, shelly, bryozoal abundant flint.	
			120					
			130				125-140ft. <u>CALCARENITE</u> grading to <u>CALCISILTITE</u> , grey shelly, bryozoal.	
			140					
			150				140-175ft. <u>CALCARENITE</u> , grey, bryozoal, shelly with abundant flint.	
			160					
			170					
			180					
			190				175-315ft. <u>CALCARENITE</u> , off white to pale grey, silty, bryozoal, grading in part to <u>CALCISILTITE</u> .	

BORE LOG PERCUSSION - ROTARY DRILLING

BORE No 01
SHEET 3 OF 7
521057301

PURPOSE OF BORE WATER SUPPLY

HIRER PICT. LTD.

HUNDRED MUIRHEAD

DRILLER ATKINSON

COMMENCED 13-5-69 COMPLETED 9-6-69

LOGGED BY B.M. HARRIS J. 000504 DATE 14-7-69

BORE SERIAL No. 78/69

ADDRESS

SECTION 573

DOCKET No. 540/69

R.L. COLLAR (M.S.L.)

R.L. SURFACE

CO-ORDS: E

N

DEPTH 620'

CASING 280' of 8"

WATERS CUT

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.93	35.000	24 hr. pump test.	742	W4093/69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
280 ft. of 8" casing			210				3 pump tests of 100 mins duration and one of 1450 mins. duration, carried out.	
			220				175'-315ft. <u>CALCARENITE</u> off white to pale grey, silty bryozoal, grading in part to <u>CALCISILTITE</u> .	
			230					
			240				240-245ft. <u>CALCARENITE</u> , coarse grained	
			250					
			260					
			270					
			280					
			290					

BORE LOG PERCUSSION · ROTARY DRILLING

BORE No. 01
SHEET. 4. OF 7.

PURPOSE OF BORE WATER SUPPLY

BORE SERIAL No. 78/69

521057301

HIRER. PICT. LTO.

ADDRESS

HUNDRED. MUIR HEAD.

SECTION 573

CO-ORDS: E

DRILLER. ATKINSON

DOCKET No. 540/69

N

COMMENCED 13.5.69 COMPLETED 9.6.69

R.L. COLLAR (M.S.L.)

DEPTH 620'

LOGGED BY B.M. HARRIS, J. OGDON DATE 14.7.69.

R.L. SURFACE

CASING 280' of 8"

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.93	35.000	24 hr. pump test.	742	W4093/689

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
							3 pump tests of 100 mins. duration and one of 1450 mins. duration, carried out.	
			310				175-315ft. <u>CALCARENITE</u> , off white to pale grey, bryozoal grading in part to <u>CALCISILTITE</u> .	
			320				315-330ft. <u>CALCIRUDITE</u> , grey, bryozoal, appears clean. Probably a good aquifer.	
			330					
			340					
			350					
			360				330-390ft. <u>CALCARENITE</u> , offwhite, bryozoal.	
			370					
			380					
			390				390-410ft. <u>CALCARENITE</u> , white, bryozoal	

BORE LOG PERCUSSION · ROTARY DRILLING

BORE No 01
SHEET 5 OF 7

PURPOSE OF BORE WATER SUPPLY

HIRER PICT. LTO.

HUNDRED MUIRHEAD

DRILLER ATKINSON

COMMENCED 13-5-69 COMPLETED 9-6-69

LOGGED BY B.M. HARRIS J. DOOSON DATE 14-7-69

BORE SERIAL No. 78/69

ADDRESS

SECTION 573

DOCKET No. 540/69

R.L. COLLAR (M.S.L.)

R.L. SURFACE

CO-ORDS: E

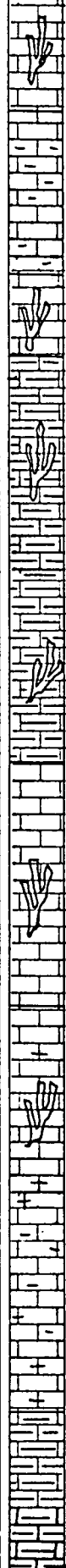
N

DEPTH 620'

CASING 280' of 8"

WATERS CUT

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.93	35000	24 hr. pump test.	742	W4095/69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
							3 pump tests of 100 mins. duration and one of 1450 mins. duration carried out.	
			390-410ft.				<u>CALCARENITE</u> , white, bryozoal	
			410-420ft.				<u>CALCARENITE</u> , silty.	
			420-425ft.				<u>CALCARENITE</u> , off white, bryozoal.	
			425-450ft.				<u>CALCILUTITE</u> , white, bryozoal, glauconitic.	
			450-465ft.				<u>CALCARENITE</u> , off white, coarse, bryozoal, appears clean - probably good aquifer.	
			465-490ft.				<u>CALCARENITE</u> , off white to pale grey, bryozoal, silty, grading in part to <u>CALCISILTITE</u> .	
			490-620ft.				<u>CALCILUTITE</u> , bryozoal with bands of flint. Grey 490-495 ft. Off white 495'-505 ft.	

BORE LOG PERCUSSION · ROTARY DRILLING

BORE No 01.
SHEET. 6. OF 7

PURPOSE OF BORE. WATER SUPPLY

BORE SERIAL No. 78/69

521057301

HIRER. . PICT LTO

ADDRESS

HUNDRED. MUIRHEAD

SECTION 573

CO-ORDS : E

DRILLER . ATKINSON

DOCKET No. 540 169

4

COMMENCED 13-5-69 COMPLETED 9-6-69

R.L. COLLAR (M.S.L.)

DEPTH 620'

LOGGED BY B.M. HARRIS. J. DOOSON DATE 14.7.69

R.L. SURFACE

CASING 280' of 8"

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.93	35.000	24 hr pump test	742	W4093/69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
							3 pump tests of 100 mins. duration and one of 1450 mins. duration, carried out.	
			510				Offwhite 500 - 505 ft	
			520					
			530					
			540				Grey 505 - 570 ft.	
			550					
			560					
			570					
			580				Dark Grey 570 - 620 ft	
			590				490-620ft. <u>CALCULUTITE</u> , bryozoal	

BORE LOG PERCUSSION - ROTARY DRILLING

BORE No 01
SHEET 7 OF 7
521057301

PURPOSE OF BORE WATER SUPPLY

BORE SERIAL No. 78/69

HIRER PICT. LTO.

ADDRESS

HUNDRED MUIRHEAD

SECTION 573

CO-ORDS: E

DRILLER ATKINSON

DOCKET No. 540/69

N

COMMENCED 13-5-69 COMPLETED 9-6-69

R.L. COLLAR (M.S.L.)

DEPTH 620'

LOGGED BY G.M. HARRIS J. DOOSON DATE 14-7-69

R.L. SURFACE

CASING 280' of 8"

DEPTH IN FEET	WATER LEVEL	SUPPLY GALLONS PER HOUR	HOW TESTED	TOTAL SALTS PARTS PER MILLION	ANALYSIS No.
14	9.93	35000	24 hr. pump test	742	W4093/69

CASING	WATER CUT	WATER LEVEL	DEPTH IN FEET	CORE	GRAPHIC LOG	AGE	DRILLING REMARKS	REMARKS	DESCRIPTION
			610					3 pump tests of 100 mins. duration and one of 1450 mins. duration, carried out.	
			620					490-620ft. CALCILUTITE, dark grey, bryozoal	
			630					End of Hole 620ft.	
			640						
			650						
			660						
			670						
			680						
			690						

APPENDIX 2

Calculations of Expected drawdowns

CALCULATION SHEET

PROJECT: PICT LTD.

PAGE 1 of 4

SUBJECT: PUMPING TEST ON BOREHOLE 521057301

REFERENCE DM.540/69

CALCULATED C. Bleys

CHECKED W. Morton

DATE 18.6.1969

Multiple stage test, calculation of B and C in $s_w = BQ + CQ^2$

Case 1

Stage	Q	s_{w100}	s/Q
1	0.588	28.57	48.5
2	1.11	62.98	57.2
3	1.68	95.65	57.4
4	1.6	96.35	60.2

From graph C = 11.1 and B = 43.6

$$s_{w100} = BQ + CQ^2$$

$$s_w = 43.6Q + 11.1Q^2$$

Case 2

Stage	Q	s_{w100}	s/Q
1	0.588	28.85	48.8
2	1.11	63.38	57.6
3	1.68	96.	57.1
4	1.6	96.35	60.2

From graph B and C are similar to Case 1

hence:

$$s_{w100} = 43.6Q + 11.1Q^2$$

CALCULATION SHEET

PROJECT: PICT LTD.

PAGE 2 of 4

SUBJECT: PUMPING TEST ON BOREHOLE 521057301

REFERENCE DM.540/69

CALCULATED C. Bloys

CHECKED W. Morton

DATE 20th June 1969.

Estimate of drawdown at various times and pumping rates.

Drawdown s at 100 min. at rate $Q = 1.6$ is 96.4ft.

Drawdown per log cycle at this rate is 7ft.

The drawdown expected at different times is:

$$s_{w100} + x \times \Delta s \quad \text{or}$$

$$\text{Drawdown after 7 days} = s_{w100} + 2 \times \Delta s = 96.4 + 2 \times 7 = 110\text{ft.}$$

$$\text{Drawdown after 70 days} = s_{w100} + 3 \times \Delta s = 96.4 + 3 \times 7 = 117\text{ft.}$$

$$\text{Drawdown after 3 years} = s_{w100} + 4 \times \Delta s = 96.4 + 4 \times 7 = 124\text{ft.}$$

Assuming an annual fluctuation of 10ft. and

Allowing 20ft. of water above the pump setting

The recommended pump setting for $Q = 36,000\text{g/h}$ or 1.9 cusec.

is WL below surface + annual fluctuation + water above pump
+ drawdown after times t

hence:

$$\text{for 7 days continuous pumping } 10 + 10 + 20 + 110 = 150\text{ft.}$$

$$\text{" 70 days " " } 10 + 10 + 20 + 117 = 157\text{ft.}$$

$$\text{" 3 years " " } 10 + 10 + 20 + 124 = 164\text{ft.}$$

If it is assumed that the maximum pumping rate is 15,000 g/h.

or 0.67 cusecs. then the drawdown per log cycle Δs

can be calculated using the equation:

$$\frac{\Delta s}{Q} = \frac{\Delta s_1}{Q_1}$$

Substituting the known and the assumptions yields.

$$\frac{7}{1.6} = \frac{\Delta s}{0.67}$$

or

$$\Delta s = \frac{7 \times 0.67}{1.6} = 3\text{ft.}$$

Drawdowns expected can be calculated using Δs and

$$\text{the equation } s_{w100} = 43.6Q + 11.1Q^2$$

CALCULATION SHEET

PROJECT: PICT LTD.

PAGE 3 of 4

SUBJECT: PUMPING TEST ON BOREHOLE 521057301

REFERENCE DM.540/69

CALCULATED C. Bleys

CHECKED N. Morton

DATE 20.6.1969

at rate $Q = 0.67$

$$s_{w100} = 43.6 \times 0.69 + 11.1 \times 0.67^2 =$$

$$30.1 + 5.0 = 35\text{ft.}$$

Drawdown levels expected after 7 days, 70 days and 3 years
pumping continuously are as follows:

Assume 10ft. annual fluctuation

" 10ft. of water required above pump setting.

Water level on 4th June 1969 10ft.

7 days drawdown expected

$$s_{w100} + 2 \times 3\text{ft. (page 2)} = 35 + 6 = 41\text{ft.}$$

70 days drawdown expected

$$s_{w100} + 3 \times 3\text{ft.} = 35 + 9 = 44\text{ft.}$$

approx. 3 years' drawdown expected

$$s_{w100} + 4 \times 3\text{ft.} = 35 + 12 = 47\text{ft.}$$

Pump settings

$$10\text{ft.} + 10\text{ft.} + 20\text{ft.} + \text{drawdown.}$$

$$7 \text{ days } 10 + 10 + 20 + 41 = 81\text{ft.}$$

$$70 \text{ days } 10 + 10 + 20 + 44 = 84\text{ft.}$$

$$\text{app. } 3 \text{ years } 10 + 10 + 20 + 47 = 87\text{ft.}$$

Assume a maximum pumping rate of 20,000 g/h or 0.89 cusecs.

Calculation of drawdown at 100 minutes:

$$s_{w100} = BQ + CQ^2$$

$$s_{w100} = 43.6 \times 0.89 + 1.11 \times 0.89^2 =$$

$$38.83 + 3.8 = 47.6\text{ft.}$$

Drawdown per log cycle for $Q = 0.89$ cusec.

$$\text{using } \frac{\Delta s}{Q} = \frac{\Delta s_2}{Q_2} = \frac{7 \times 1.6 \Delta s_2}{0.89}$$

$$\Delta s_2 = \frac{7 \times 0.89}{1.6} = 3.9\text{ft.}$$

CALCULATION SHEET

PROJECT: PICT LTD.

PAGE 4 of 4

SUBJECT: PUMPING TEST ON BOREHOLE 521057301

REFERENCE

CALCULATED C. Bloys

CHECKED W. Morton

DATE 20.6.1969

Drawdowns expected after 7 days, 70 days and approx. 3 years.

$$7 \text{ days} \quad s_{w100} + 2 \times \Delta s = 47.6 + 2 \times 3.9 = 55.4 \text{ft.}$$

$$70 \text{ days} \quad s_{w100} + 3 \times \Delta s = 47.6 + 3 \times 3.9 = 59.3 \text{ft.}$$

$$\text{approx. 3 years} \quad s_{w100} + 4 \times \Delta s = 47.6 + 4 \times 3.9 = 63.2 \text{ft.}$$

Proposed pump settings for continuous pumping at

$$\text{rate } Q = 0.89$$

10ft. W.L. 10ft. annual fluctuation

20ft. of water above pump setting

$$7 \text{ days} \quad 55.4 + 10 + 10 + 20 = 95 \text{ft.}$$

$$70 \text{ days} \quad 59.3 + 10 + 10 + 20 = 99 \text{ft.}$$

$$\text{approx. 3 years} \quad 63.2 + 10 + 10 + 20 = 103 \text{ft.}$$

APPENDIX 3

Pump Test Data

40	27.83		623630	13200	0.584	
35	27.74					
30	27.63		621430	13200	0.584	
28	27.56					
26	27.50					
24	27.40					
22	27.31					
20	27.21		619225	13300	0.592	
18	27.10					
16	27.00					
14	26.88					
12	26.75					
10	26.54		617000	13300	0.592	
9	26.42					
8	26.29					
7	26.12					
6	25.97					
5	25.86					
4	25.74					
3	25.44					
2	24.86					
1	24.06					
Φ	11.99		614775			w/s
Mins. after start	Observed <i>drawn.</i>	Adjusted	Meter Readings	Galls per hour	Cusecs	Remarks
TIME	DRAWDOWN		DISCHARGE			

AQUIFER FROM 12..... TO 620.. FT. WATER LEVEL BELOW REF. PT.
 REF. PT. ABOVE GR. LEVEL 2:00. FT. AT START OF TEST 11:99... FT.
 MILITARY SHEET PUMP STARTED AT .. 8:30 AM ON .. 4-6-69...
 AERIAL SURVEY NO. PUMP STOPPED AT .. 10:10 AM ON .. 4-6-69...
 RUN PHOTO NO. PUMP SETTING 150..... FT.
 OWNER .. P.C.T. LTD TEST SERIAL NO.
 SECTION .. P4 573 PUMPED HOLE NO. 1.....
 HUNDRED .. M.T. Mauricead 521 OBS. HOLE NO'S.
 PROJECT OBS. AT HOLE NO.
 DATE OF TEST 4-6-69 DISTANCE FROM PUMPHOLE TO OBS. HOLE

Step Draw Down / PUMPING TEST

Sheet 1... of 2...

[illegible]

AQUIFER FROM ..14..... TO ..620... FT.	WATER LEVEL BELOW REF. PT.
REF. PT. ABOVE GR. LEVEL ..2'00. FT.	AT START OF TEST11'99.. FT.
MILITARY SHEET	PUMP STARTED AT ...8:30AM ON ...4-6-69...
AERIAL SURVEY NO.	PUMP STOPPED AT ...10:10... ON ...4-6-69...
RUN PHOTO NO.	PUMP SETTING150..... FT.
OWNERPICT. LTD.	TEST SERIAL NO. ...040669-1.....
SECTION573.....	PUMPED HOLE NO.1.....
HUNDRED ...M.F. Muirhead.	OBS. HOLE NO.'S.
PROJECT	OBS. AT HOLE NO.
DATE OF TEST4-6-69.....	DISTANCE FROM PUMPHOLE TO OBS. HOLE

Step Draw Down 1

RECOVERY TEST

PROJECT: OBS at HOLE NO:
 OWNER: *P.I.C.T. LTD.* HUNDRED: *HT. MURKHEAD* SECTION: ... *573* ...
 AVERAGE PUMPING RATE: ... *13,000 gph* ... PUMP STOPPED AT: ... *10:10* ... ON: ... *4-6-69* ...
 DISTANCE TO PUMPED HOLE: WATER LEVEL BELOW REF PT:
 AT START OF TEST: ... *40.56* ... ft.
 STAGE NO: ... *1* ...

TIME				TIME			
Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown	Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown
Start(t)	Stop(t ₁)			Start(t)	Stop(t ₁)		
100	0		28.57	160	60	2.7	.57
101	1	101	4.42	165	65	2.52	.52
102	2	51	3.67	170	70	2.4	.49
103	3	34.3	3.23	175	75	2.33	.45
104	4	26	2.95	180	80	2.25	.42
105	5	21	2.65	185	85	2.18	.38
106	6	17.7	2.49	190	90	2.1	.37
107	7	15.3	2.32	195	95	2.05	.34
108	8	13.5	2.19	200	100	2	.31
109	9	12.1	2.08				
110	10	11	1.97				
112	12	9.33	1.80				
114	14	8.1	1.68				
116	16	7.2	1.55				
118	18	6.6	1.44				
120	20	6.0	1.35				
122	22	5.6	1.28				
124	24	5.2	1.21				
126	26	4.8	1.14				
128	28	4.6	1.09				
130	30	4.3	1.03				
135	35	3.9	.92				
140	40	3.5	.81				
145	45	3.2	.75				
150	50	3.0	.69				
155	55	2.8	.62				

40	61.19		653900	25500		
35	61.05					
30	60.77		649650	25300		
28	60.67					
26	60.55					
24	60.44					
22	60.35					
20	60.19		645425	25900		
18	59.94					
16	59.76					
14	59.55					
12	59.22					
10	58.88		641100	25500		
9	58.69					
8	58.52					
7	58.20					
6	57.87					
5	57.45					
4	57.03					
3	56.39					
2	55.55					
1	54.32					
①	12.50		636840			w/s
Mins. after start	Observed <i>drawn.</i>	Adjusted	Meter Readings	Galls per hour	Cusecs	Remarks
TIME	DRAWDOWN		DISCHARGE			

AQUIFER FROM TO FT. WATER LEVEL BELOW REF. PT.
 REF. PT. ABOVE GR. LEVEL 2.00. FT. AT START OF TEST 12.30. FT.
 MILITARY SHEET PUMP STARTED AT ... 11.50 AM ON ... 4-6-69...
 AERIAL SURVEY NO. PUMP STOPPED AT ... 1.30 PM ON ... 4-6-69...
 RUN PHOTO NO. PUMP SETTING 150 FT.
 OWNER PICT. LTD. TEST SERIAL NO. 040669-2...
 SECTION 573 PUMPED HOLE NO. 1
 HUNDRED MT. MAIRHEAD OBS. HOLE NO'S.
 PROJECT OBS. AT HOLE NO.
 DATE OF TEST ... 4-6-69 DISTANCE FROM PUMPHOLE TO OBS. HOLE

PUMPING TEST

Step Draw Down 2

Sheet 1 of 2

AQUIFER FROM	TO	FT.	WATER LEVEL BELOW REF. PT.	
REF. PT. ABOVE GR. LEVEL	2.00	FT.	AT START OF TEST	12.30 FT.
MILITARY SHEET			PUMP STARTED AT	11.50 ON 4-6-69
AERIAL SURVEY NO.			PUMP STOPPED AT	1.30 ON 4-6-69
RUN	PHOTO NO.		PUMP SETTING	150 FT.
OWNER	Pict LTD		TEST SERIAL NO.	040669AR
SECTION	573		PUMPED HOLE NO.	1
HUNDRED	MT. MURHEAD		OBS. HOLE NO.'S.	
PROJECT			OBS. AT HOLE NO.	
DATE OF TEST	4-6-69		DISTANCE FROM PUMPHOLE TO OBS. HOLE	

Step Draw Down 2

PUMPING TEST

RECOVERY TEST 100 MINUTE STAGE

Stage 2

PROJECT: OBST at HOLE NO: ..1.....

OWNER: ..P. l. e. t. R. t. a. AVERAGE PUMPING RATE: $28.500 \frac{g}{h}$..
1.11 case

HUNDRED: ..Mt. M. u. l. h. a. SECTION: 573.. DISTANCE TO PUMPED HOLE:

PUMP STOPPED AT: 13.30.....ON 4.11.69 STAGE NO: ..2.....

WATER LEVEL BELOW REF. PT.

AT START OF TEST:ft.

TIME				TIME			
Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown	Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown
Start(t)	Stop(t ₁)			Start(t)	Stop(t ₁)		
100	0		62.96	160	60	2.7	1.06
101	1	101	9.09	170	70	2.4	0.89
102	2	51	7.52	180	80	2.25	0.75
103	3	34.3	6.51	190	90	2.1	0.64
104	4	26	5.86	200	100	2	0.54
105	5	21	5.32				
106	6	17.7	4.99				
107	7	15.3	4.64				
108	8	13.5	4.38				
109	9	12.1	4.15				
110	10	11	3.97				
112	12	9.33	3.59				
114	14	8.1	3.34				
116	16	7.2	3.09				
118	18	6.6	2.89				
120	20	6.0	2.60				
122	22	5.6	2.44				
124	29	5.2	2.31				
126	26	4.8	2.19				
128	28	4.6	2.04				
130	30	4.3	1.96				
135	35	3.9	1.60				
140	40	3.5	1.55				
145	45	3.2	1.39				
150	50	3.0	1.26				
155	55	2.8	1.15				

40	93.52		703375	35800		
35	93.14					
30	92.92		697400	35400		
28	92.57					
26	92.35					
24	92.15					
22	91.88					
20	91.68		691500	36300		
18	91.35					
16	91.01					
14	90.64					
12	90.25					
10	89.78		685445	36300		
9	89.50					
8	89.13					
7	88.79					
6	88.31					
5	87.77					
4	87.03					
3	85.98					
2	84.48					
1	81.03					
0	1284		679390			W/S
Mins. after start	Observed	Adjusted	Meter Readings	Galls per hour	Cusecs	Remarks
TIME	DRAWDOWN		DISCHARGE			

AQUIFER FROM TO FT. WATER LEVEL BELOW REF. PT.
 REF. PT. ABOVE GR. LEVEL 2.00 FT. AT START OF TEST ... 12.84... FT.
 MILITARY SHEET PUMP STARTED AT ... 3.10... ON 4-6-69...
 AERIAL SURVEY NO. PUMP STOPPED AT ... 4.50... ON 4-6-69...
 RUN PHOTO NO. PUMP SETTING 150 FT.
 OWNER ... Pict. LTD. ... TEST SERIAL NO. ... 040669-3...
 SECTION 573 PUMPED HOLE NO. 1
 HUNDRED ... MT. ... MUIRHEAD ... OBS. HOLE NO'S.
 PROJECT OBS. AT HOLE NO.
 DATE OF TEST ... 4-6-69 ... DISTANCE FROM PUMPHOLE TO OBS. HOLE

Step Draw Down 3 PUMPING TEST

Sheet ... 1 ... of 2 ...

Mean
35.910
91h

Step Draw Down 3

Sheet 2 of 2

RECOVERY TEST 100 MINUTE STAGE

Stage 3

PROJECT: OBST at HOLE NO: ..1.....

OWNER: *P. ut. Rtu* AVERAGE PUMPING RATE: *35,800 g/h.* *1.88 cusecs.*HUNDRED: *100* SECTION: *5.72*. DISTANCE TO PUMPED HOLE:PUMP STOPPED AT: *16:50* ON *4.11.69* STAGE NO: *3*WATER LEVEL BELOW REF. PT.
AT START OF TEST: *108.49*.ft.

TIME				TIME			
Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown	Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown
Start(t)	Stop(t ₁)			Start(t)	Stop(t ₁)		
100	0		<i>95.65</i>	160	60	2.7	<i>1.46</i>
101	1	101	<i>13.06</i>	170	70	2.4	<i>1.22</i>
102	2	51	<i>10.52</i>	180	80	2.25	<i>1.01</i>
103	3	34.3	<i>9.21</i>	190	90	2.1	<i>0.80</i>
104	4	26	<i>8.24</i>	200	100	2	<i>0.69</i>
105	5	21	<i>7.41</i>				
106	6	17.7	<i>6.98</i>				
107	7	15.3	<i>6.49</i>				
108	8	13.5	<i>6.02</i>				
109	9	12.1	<i>5.74</i>				
110	10	11	<i>5.45</i>				
112	12	9.33	<i>4.96</i>				
114	14	8.1	<i>5.54</i>				
116	16	7.2	<i>4.22</i>				
118	18	6.6	<i>3.91</i>				
120	20	6.0	<i>3.66</i>				
122	22	5.6	<i>3.43</i>				
124	29	5.2	<i>3.22</i>				
126	26	4.8	<i>3.05</i>				
128	28	4.6	<i>2.88</i>				
130	30	4.3	<i>2.74</i>				
135	35	3.9	<i>2.43</i>				
140	40	3.5	<i>2.15</i>				
145	45	3.2	<i>1.92</i>				
150	50	3.0	<i>1.73</i>				
155	55	2.8	<i>1.59</i>				

40	93.55		763350	36000		
35	93.12					
30	92.65		757340	35900		
28	92.49					
26	92.25					
24	92.04					
22	91.74					
20	91.54		751350	36000		
18	91.25					
16	90.90					
14	90.55					
12	90.21					
10	89.70		745350	36600		
9	89.42					
8	89.59					
7	89.30					
6	88.56					
5	87.98					
4	87.42					
3	86.67					
2	85.73					
1	82.12					
0	109.3		739240			w/s
Mins. after start	Observed	Adjusted	Meter Readings	Galls per hour	Cusecs	Remarks
TIME	DRAWDOWN		DISCHARGE			

AQUIFER FROM TO FT. WATER LEVEL BELOW REF. PT.
 REF. PT. ABOVE GR. LEVEL .2.00. FT. AT START OF TEST11.93... FT.
 MILITARY SHEET PUMP STARTED AT .08.15 AM ON .5.6.69...
 AERIAL SURVEY NO. PUMP STOPPED AT .08.25... ON .6.6.69...
 RUN PHOTO NO. PUMP SETTING150..... FT.
 OWNER PICT. LTD. TEST SERIAL NO. ...050669...
 SECTION573..... PUMPED HOLE NO.1.....
 HUNDRED ...MT. ...MURHEAD..... OBS. HOLE NO'S.
 PROJECT OBS. AT HOLE NO.
 DATE OF TEST5.6.69..... DISTANCE FROM PUMPHOLE TO OBS. HOLE

PUMPING TEST

Sheet1. of 3...

700	100.00		115 7180	35700		w/s
650	99.90		112 7460	35700		
600	99.72		109 7710	35700		w/s
550	99.48		106 7980	35700		
500	99.29		103 8200	35700		w/s
450	99.11		100 8450	35800		
400	98.84		97 8650	35500		w/s
350	98.59		94 8970	35600		
300	98.33		91 9060	35800		w/s
250	98.01		88 9220	35900		
200	97.60		85 9320	35900		w/s
180	97.43		84 7350	35900		
160	97.22		83 5370	35900		
140	96.94		82 3380	36000		
120	96.68		81 1370	36000		
100	96.26		79 9370	36000		→ Given Mean to 100 min 36,078 g.p.h. w/s
90	96.97		79 3360	36000		
80	95.70		78 7350	36000		
70	95.21		78 1350	36000		
60	94.81		77 5340	36000		
55	94.53					
50	94.20		76 9340	35900		
45	93.90					
Mins. after start	Observed	Adjusted	Meter Readings	Galls per hour	Cusecs	Remarks
TIME	DRAWDOWN		DISCHARGE			

AQUIFER FROM TO FT. WATER LEVEL BELOW REF. PT.
 REF. PT. ABOVE GR. LEVEL ..2.00. FT. AT START OF TEST11.9.3... FT.
 MILITARY SHEET PUMP STARTED AT ..08:15 AM. ON 5.6.69....
 AERIAL SURVEY NO. PUMP STOPPED AT ..08:25... ON 6.6.69....
 RUN PHOTO NO. PUMP SETTING150..... FT.
 OWNER Pict. LTD. TEST SERIAL NO.050669....
 SECTION573..... PUMPED HOLE NO.1.....
 HUNDRED ..MT. MURHEAD..... OBS. HOLE NO'S.
 PROJECT OBS. AT HOLE NO.
 DATE OF TEST5.6.69..... DISTANCE FROM PUMPHOLE TO OBS. HOLE

PUMPING TEST

PUMP TEST

RECOVERY TEST

Serial No 06066g

PROJECT:

OBS at HOLE NO:

OWNER: ... P.I.C.T. ... LTD.

HUNDRED MT. MURHEAD... SECTION: ... 5.73.

AVERAGE PUMPING RATE: 35700.....

PUMP STOPPED AT: 08:25 AM. ON: 6-6-69^o

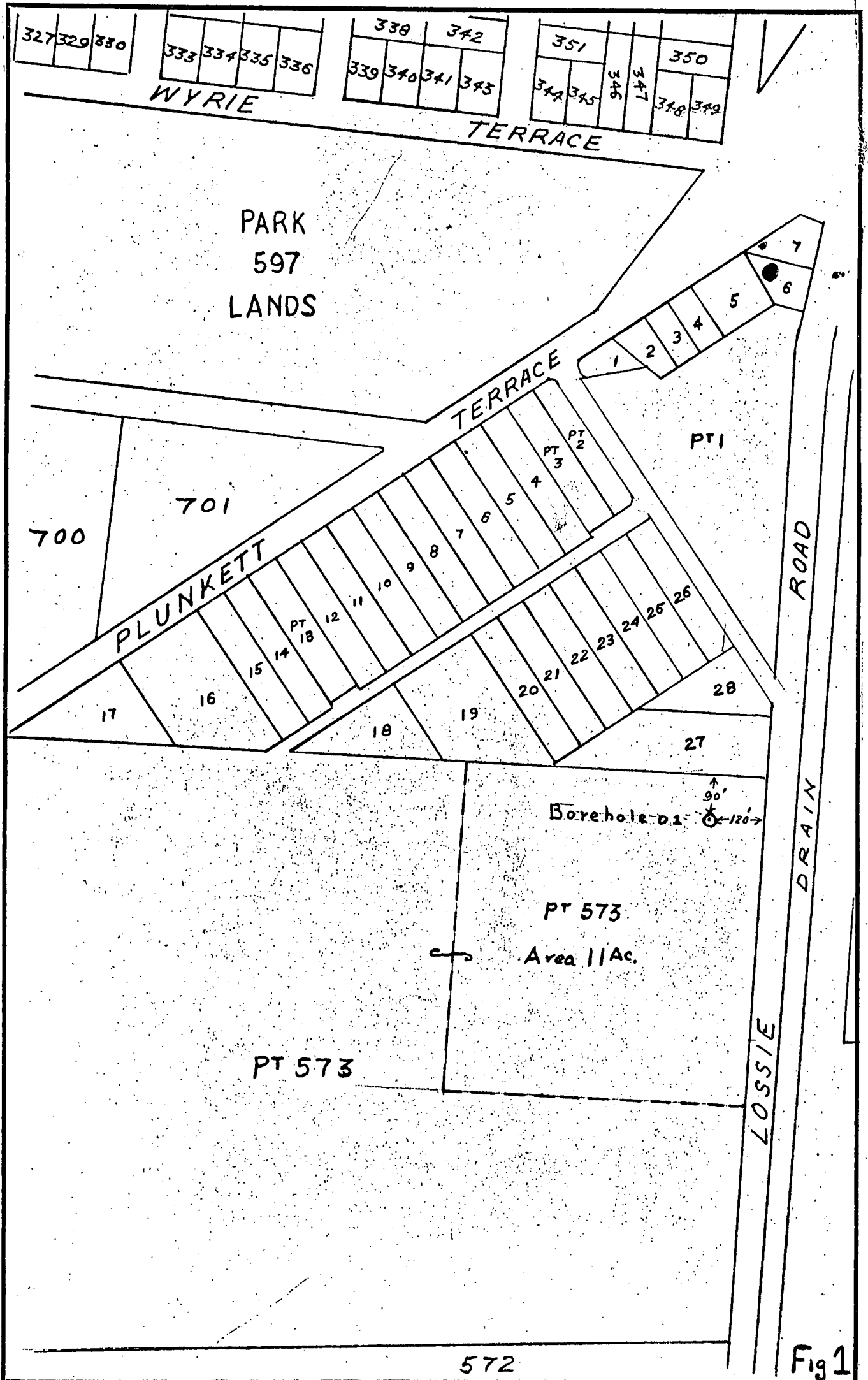
DISTANCE TO PUMPED HOLE:

WATER LEVEL BELOW REF PT:

AT START OF TEST: ... 113... 16. ft.

STAGE NO:

TIME				TIME			
Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown	Mins. after pump		$\frac{t}{t_1}$	Residual Drawdown
Start(t)	Stop(t ₁)			Start(t)	Stop(t ₁)		
1450	0		101.23	1510	60	25.2	5.63
1451	1	1451	17.86	1520	70	21.7	5.25
1452	2	72.6	15.35	1530	80	19.1	4.98
1453	3	48.43	13.77	1540	90	17.1	4.74
1454	4	363.5	12.94	1550	100	15.5	4.54
1455	5	291	12.20	1570	120	13.1	4.22
1456	6	242.7	11.61	1590	140	11.4	3.89
1457	7	208.1	11.11	1610	160	10.1	3.69
1458	8	182.3	10.74	1630	180	9.1	3.48
1459	9	162.1	10.39	1650	200	8.25	3.27
1460	10	144.6	10.10	1700	250	6.8	2.85
1462	12	121.8	9.58	1750	300	5.8	2.57
1464	14	104.6	9.14	1800	350	5.1	2.36
1466	16	91.6	8.78	1850	400	4.6	2.19
1468	18	81.5	8.46	1900	450	4.2	2.04
1470	20	73.5	8.20	1950	500	3.9	1.91
1472	22	66.9	7.95	2000	550	3.6	1.82
1474	24	61.4	7.72	2050	600	3.4	1.75
1476	26	56.9	7.53	2100	650	3.2	1.63
1478	28	52.8	7.34	2150	700	3.07	1.55
1480	30	49.3	7.17	2200	750	2.9	1.49
1485	35	42.4	6.87				
1490	40	37.3	6.47				
1495	45	33.2	6.20				
1500	50	30	5.94				
1505	55	27.4	5.76				



DEPARTMENT OF MINES - SOUTH AUSTRALIA

HYDROGEOLOGY SECTION.

Drn. *[initials]*

Tcd. *[initials]*

Ckd. *[initials]*

Exd.

PICT LTD
SEC. 573, HP MT MUIRHEAD
LOCATION of BOREHOLE
No. 521-0573-01

SCALE: 1" = 4 chains

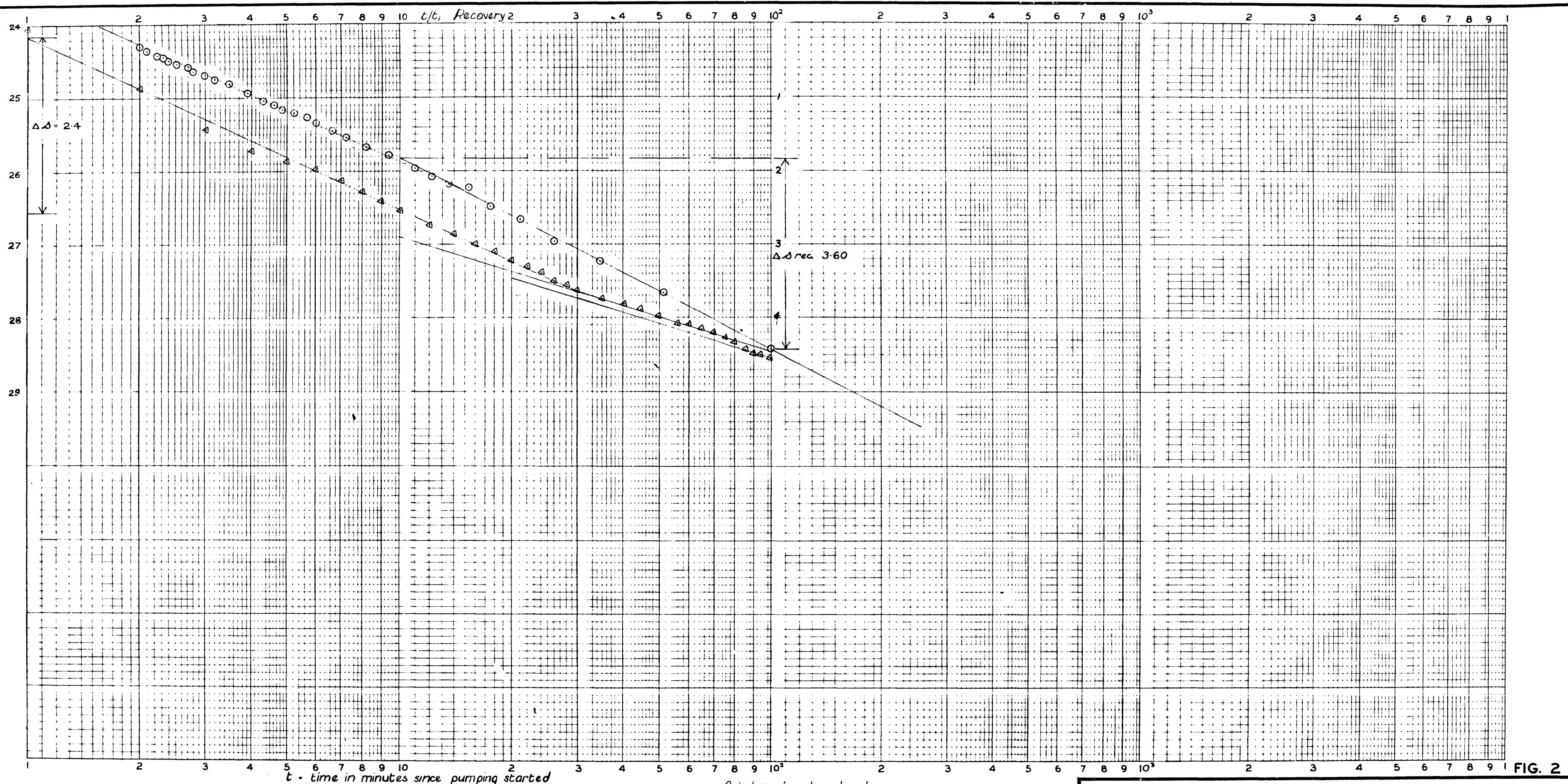
S 7380

Kd8

DATE: 16-7-69

SENIOR GEOLOGIST

is Drawdown or Recovery in feet



File no. DM540/69

Date of test 4th June 69

Water level before start of test = 9.99 ft.

Type of pump, line shaft

Pump intake settings 150 ft.

Available drawdown 120 ft.

Analyses by C. Bley.

t - time in minutes since pumping started

Pumping rate 0.588 Cusecs = 13,200 Gall/hr.

Adopted rate of drawdown 2.4 ft./log cycle.

Adopted rate of recovery 3.6 ft./log cycle.

Equation:

$$T = \frac{0.183 Q}{\Delta s}$$

in which T = transmissivity.

Q = pumping rate in cusecs.

Δs = draw or recovery per log cycles

$$T = \frac{0.183 \times 0.588}{2.4}$$

Calculation based on drawdown.

$$\approx 4.5 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft} \text{ or } 3.9 \times 10^{-3} \text{ ft}^2/\text{day}/\text{ft}.$$

$$T = \frac{0.183 \times 0.588}{3.6}$$

Calculation based on recovery.

$$\approx 3 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft} \text{ or } 2.6 \times 10^{-3} \text{ ft}^2/\text{day}/\text{ft}.$$

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PICT LTD.

PT. SECT. 573-HD MT. MUIRHEAD

PUMPING TEST ANALYSES FOR BOREHOLE 521057301

FIRST 100 MINUTES STAGE.

HYDROGEOLOGY SECTION

GEOLOGIST

SENIOR GEOLOGIST

DRN. CB.

TCD. S.J.C.

CKD. E.B.T.

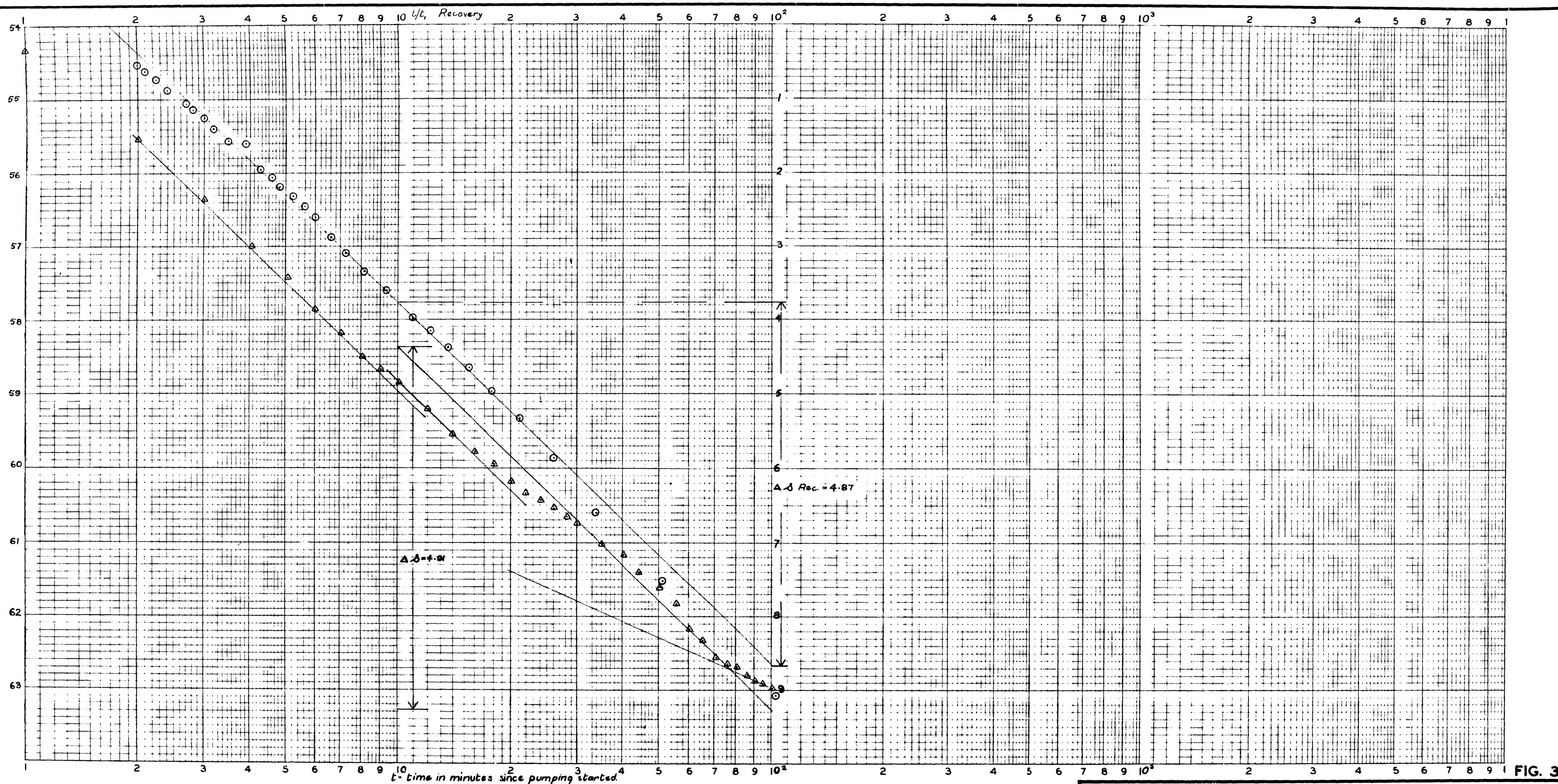
EXD.

69-367/6

Kd B

DATE: 30th July 1969

Δ = Drawdown or recovery in feet.



File no. DMS40/69

Date of test 4th June '69

Water level before start of test - 10.30 ft.

Type of pump, line shaft

Pump intake settings 150 ft.

Available drawdown 120 ft.

Analyses by C. Blays.

Pumping rate 1.11 Cusecs = 25,500 Gall./hr.

Adopted rate of drawdown 4.91 ft./log cycle

Adopted rate of recovery 4.87 ft./log cycle

Equation:

$$T = \frac{0.183Q}{\Delta\delta}$$

in which T = transmissivity.

Q = pumping rate in cusecs

$\Delta\delta$ = drawdown or recovery per log cycles

Calculation based on drawdown.

$$T = \frac{0.183 \times 1.11}{4.91} = 4.1 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft. or } 3.6 \times 10^3 \text{ ft}^2/\text{day}/\text{ft.}$$

Calculation based on recovery

$$T = \frac{0.183 \times 1.11}{4.87} = 4.1 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft. or } 3.6 \times 10^3 \text{ ft}^2/\text{day}/\text{ft.}$$

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PICT LTD.
PT. SECT. 573-HD MT. MUIRHEAD
PUMPING TEST ANALYSES FOR BOREHOLE 521057301
SECOND 100 MINUTES STAGE

HYDROGEOLOGY
SECTION

GEOLOGIST

SENIOR GEOLOGIST

DRN. C.B.

TCD. S.J.C.

CKD. E.B.T.

EXD.

69-368/6

Kd 8

DATE: 4th August 1969

FIG. 3

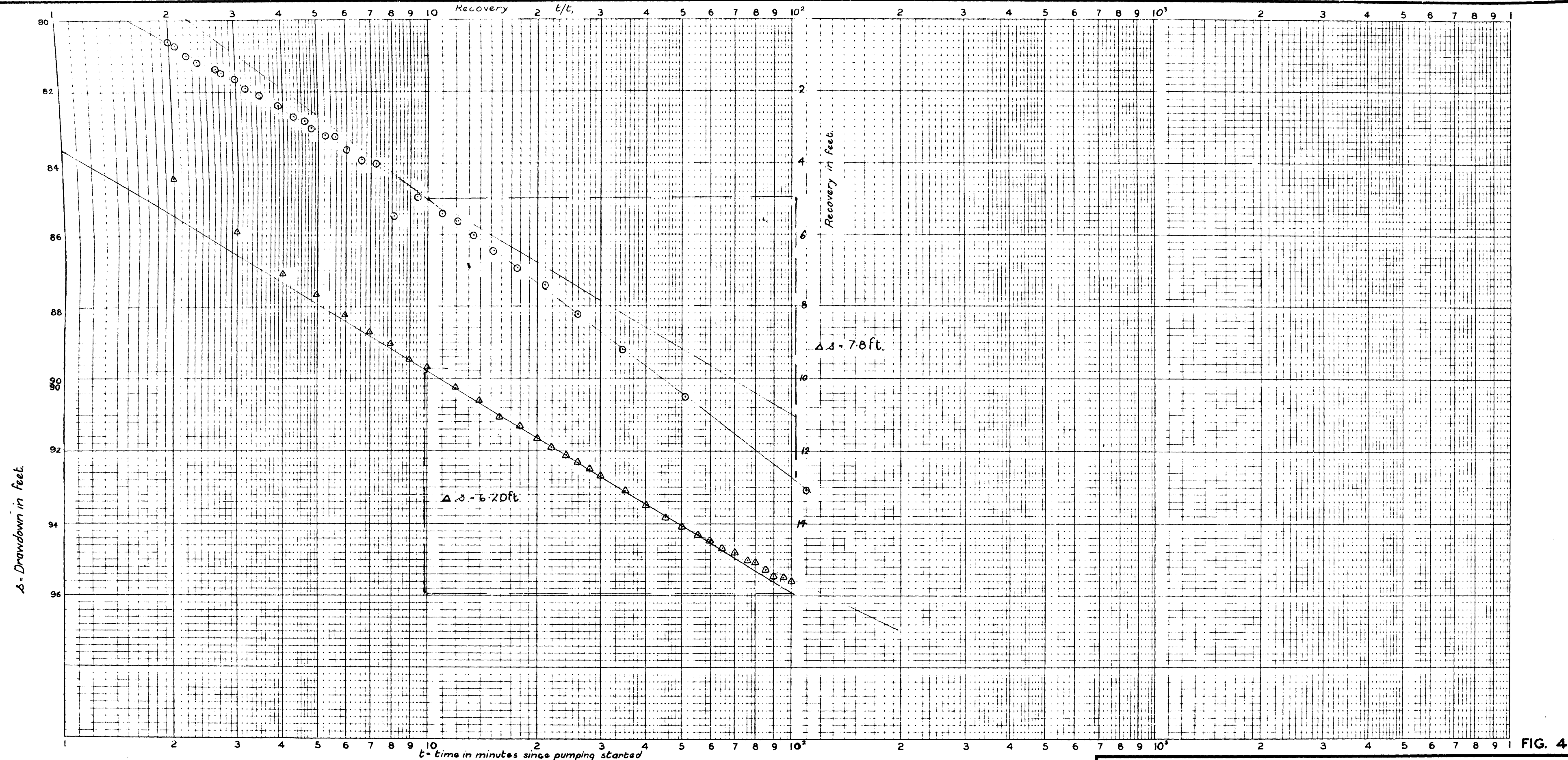


FIG. 4

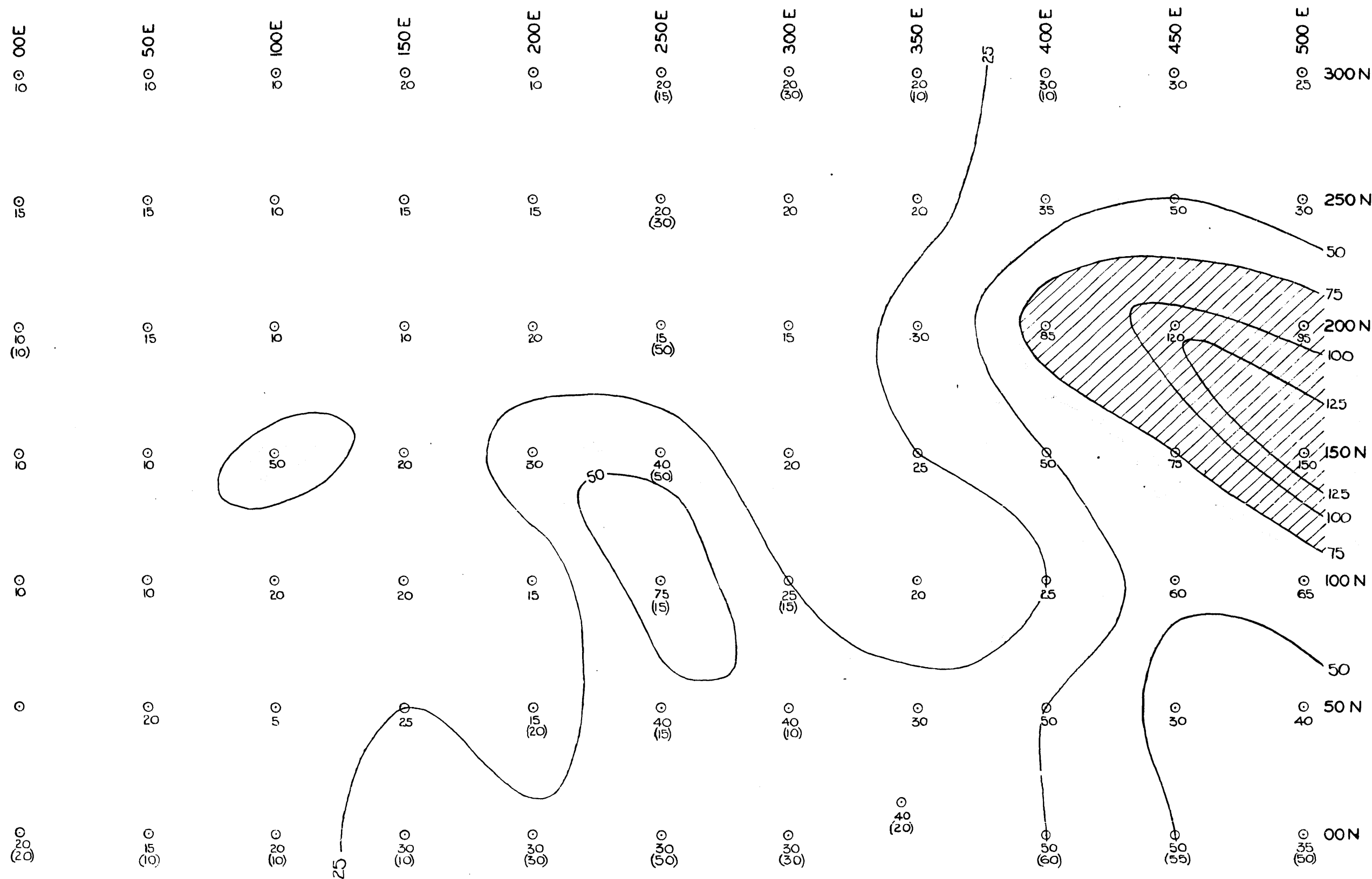
File no. DM540/60
 Date of test 4th June 60
 Water level before start of test - 10.84 ft.
 Type of pump, line shaft
 Pump intake settings 150 ft.
 Available drawdown 120 ft.
 Analyses by C. B. Eys.

Pumping rate 1.6 Cusecs = 35,800 Gall./hr.
 Adopted rate of drawdown 6.20 ft./log cycle
 Adopted rate of recovery 7.8 ft./log cycle
 Equation:
 $T = \frac{0.183 Q}{\Delta s}$
 in which T = transmissivity.
 Q = pumping rate in cusecs
 Δs = drawdown or recovery per log cycles.

Calculation based on drawdown.
 $T = \frac{0.183 \times 1.6}{6.20} = 4.7 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft. or } 4.1 \times 10^3 \text{ ft}^2/\text{day}/\text{ft.}$

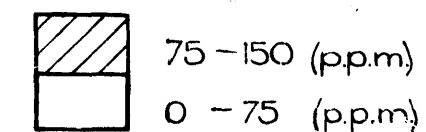
Calculation based on recovery.
 $T = \frac{0.183 \times 1.6}{7.8} = 3.8 \times 10^{-2} \text{ ft}^2/\text{sec}/\text{ft. or } 3.2 \times 10^3 \text{ ft}^2/\text{day}/\text{ft.}$

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
PICT LTD. PT. SECT. 573-HD MT. MUIRHEAD PUMPING TEST ANALYSES FOR BOREHOLE 521057301 THIRD 100 MINUTES STAGE			
HYDROGEOLOGY SECTION	 SENIOR GEOLOGIST	DRN. CB	69-369/6 Kd 8 DATE: 4 th August 1969
		TCD. S.M.C.	
		CKD. F.B.T.	
		EXD.	

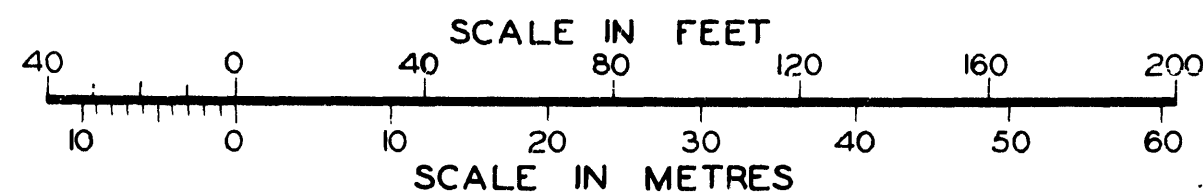


LEGEND

CONTOUR VALUES



○ Sample position.
30 Pb in soil (p.p.m.)
(35) Pb in bedrock or 4ft. below surface (p.p.m.)



APPENDIX NO.3.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

COPPER — BISMUTH
BALHANNAH GOLD MINES N.L.
SECTION 4048, HUNDRED ONKAPARINGA
GEOCHEMICAL SURVEY
LEAD RESULTS.

NON - METALLICS
SECTION

John Brown
GEOLOGIST

Drn. M.G.M.

SCALE: 1 INCH = 40 FEET

Trd. A.G.R.

69-379/6

Ckd. L.V.W.

Ha7

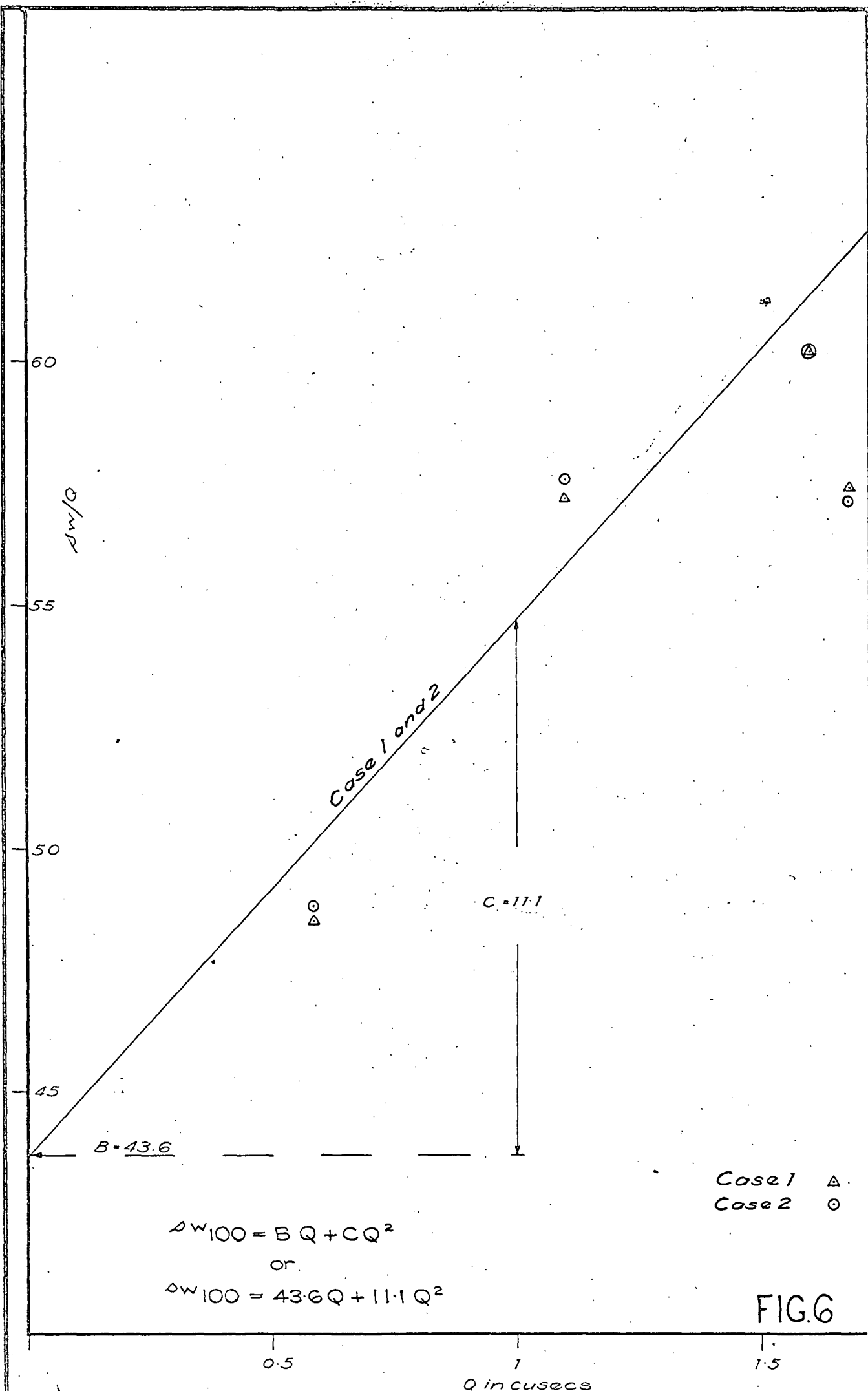
Exd.

DATE: APRIL

1969

Director of Mines

SUP. GEOLOGIST



DEPARTMENT OF MINES - SOUTH AUSTRALIA

Drn. C.B.

Tcd. G.M.

Ckd.

Exd.

PICT LTD.
SEC. 573, H.P. M. MUIRHEAD
JACOB METHOD TO OBTAIN
B + C OF BOREHOLE

SCALE:

\$7308
Kd 8

DATE: 17. 6. 69

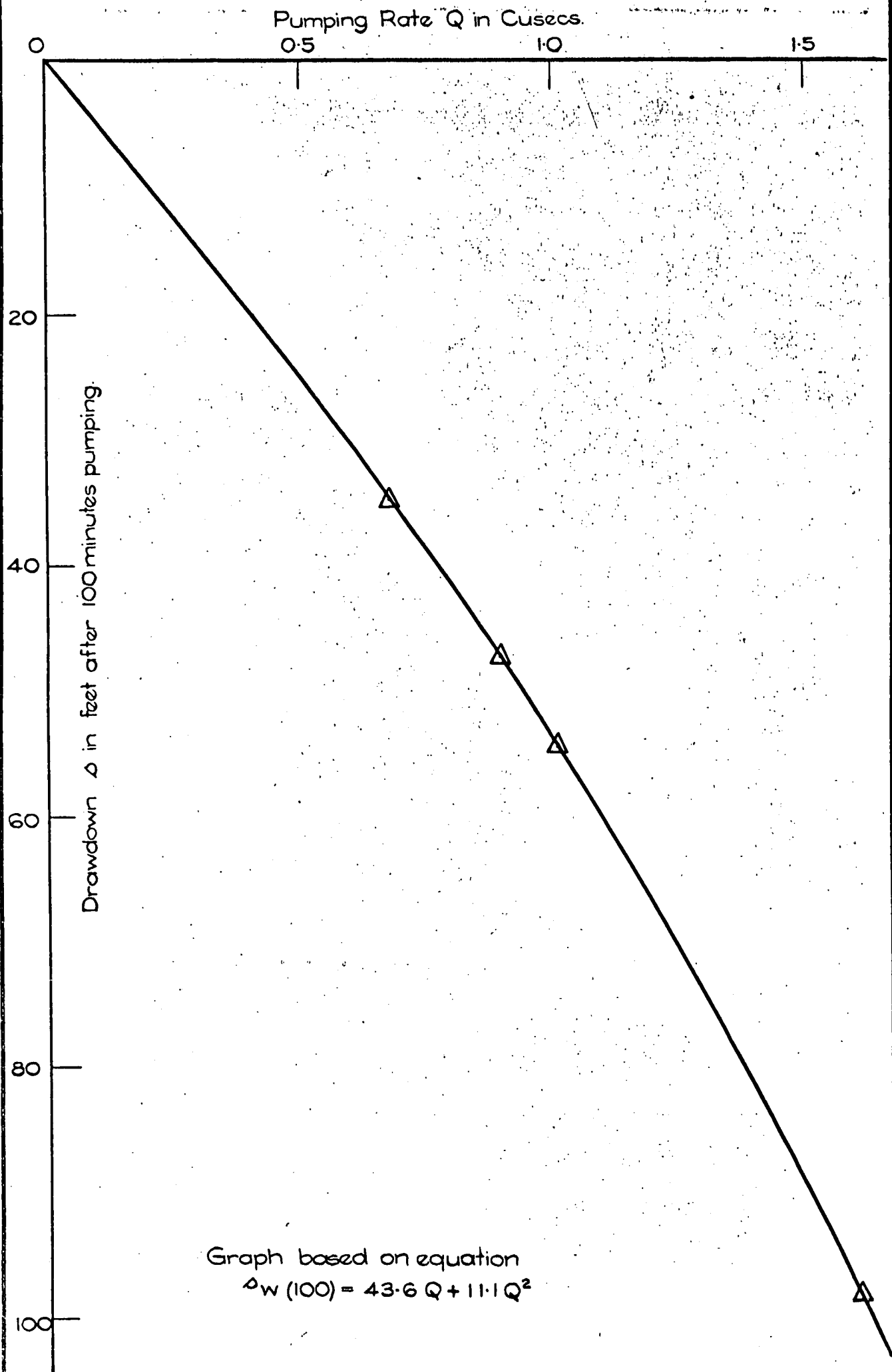


FIG 7

DEPARTMENT OF MINES — SOUTH AUSTRALIA

HYDROGEOLOGY SECTION	Drn. E.B.	PICT LTD. SEC. 573, HD. MT. MUIRHEAD BOREHOLE No. 521-0573-01 DRAWDOWN AFTER 100 MIN. FOR DIFFERENT PUMPING RATES	SCALE: AS SHOWN
	Ted. A.M.D.		S 7374 Kd 8
SENIOR GEOLOGIST	Ckd. L.Y.W.		DATE: 16 JULY '69
	Exd. C.B.		