71/76

6634 IV

SECTION

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

REPORT ON PUMP TEST, WILPENA POUND,
NATIONAL PLEASURE RESORT 106,
OUT OF HUNDREDS, CO. HANSON

Grid J6

by

K. LYE
GEOLOGIST
HYDROGEOLOGY SECTION

Rept.Bk.No. 71/76

12th May, 1971

71/76

DEPARTMENT OF MINES
SOUTH AUSTRLAIA

REPORT ON PUMP TEST
WILPENA POUND
NATIONAL PLEASURE RESORT 106

by

K, LYE
GEOLOGIST
HYDROGEOLOGY SECTION

CONTENTS

	PAGE
LOCATION	1
INTRODUCTION	1
BOREHOLE DETAILS	1
GEOLOGY OF BORESITE	1
HYDROGEOLOGY OF BORESITE	2
PUMPING	3
DRAWDOWN AND RECOVERY READINGS	4
ANALYSIS OF DATA	5
INTERPRETATION OF TIME-DRAWDOWN GRAPH	5
PREDICTION OF DRAWDOWNS	7
WATER SAMPLING AND ANALYSES	8
RECOMMENDATIONS	9
SUMMARY	10

PLANS

TITLE.	NO.	FIG.
Locality Plan	S9287	1
Time-Drawdown Graph	71-382	2

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 71/76
G.S. No. 4653
Hyd. No. 2325
D.M. No. 843/63

REPORT ON PUMP TEST, WILPENA POUND, NATIONAL PLEASURE RESORT 106, OUT OF HUNDREDS, CO. HANSON

Location

The Wilpena Chalet is about 35 miles by road north of Hawker.

Introduction

Following a request by the S.A. Tourist Bureau, a 36 hour pump and recovery test preceded by a 6 hour development test, was conducted on a new bore near the Wilpena Pound Chalet from the 12th to the 14th March, 1971.

The bore is almost due west of the Chalet Office in a braided section of Wilpena Creek, just downstream of the gorge mouth. It is situated on vegetation-stabilised flood wash, to the west of the main channel and approximately 10ft. above it.

A permanent pool of water occurs about one mile upstream. This pool provides the present water supply for the motel and caravan park.

Borehole Details

The hole was drilled in ?November, 1970. It is 102ft. deep, has a diameter of 6 inches and has 20ft. of 6 inch casing at the top. The casing protrudes 1.7ft. above ground level.

Geology of Boresite

The underlying rocks belong to the Bonney Sandstone

Member (Forbes, D.M. Rept.Bk. 71/31) of the Pound Quartzite Formation - the uppermost Formation of the Wilpena Group, Adelaide System (Proterozoic).

The rocks dip to the south at about 30°.

The driller's log of the bore is given as:

0 - 40' : clay, clayey sand, sand, gravel.

40 - 60' : slate, purple.

60 - 102' : sandstone, purple.

The sandstone (60-102') was observed in outcrop about 200 yards east of the boresite. It is a reddish-purple medium-grained felspathic sandstone, micaceous in part. The rock itself is well cemented and has a very low porosity. Jointing is not strongly developed but it forms a regular 3 dimensional network, and interconnection of open joints does occur.

The beds immediately overlying this sandstone - "slate", 40-60' in the driller's log - were not observed in outcrop. They are probably finely-bedded shales and micaceous siltstones.

Wilpena Creek may follow a fault line in this area but there was no conclusive evidence of faulting in outcrop observed adjacent to the creek.

Hydrogeology of Boresite

Alluvium and alluvium/eluvium may be more than 100 yards wide and up to 50ft. deep in the vicinity of the bore. This material is likely to be generally poorly sorted, and porosity and permeability are expected to be low. A small flow of water was noted by the driller at about 25ft.

The pre-pumping water level in the bore was 21.22ft. but this may represent a piezometric level rather than a water table level. The water table may be less than 10ft. below the main channel.

Beneath the alluvium, the shale and sandstone dip up-stream at about 30°. In the absence of faulting, a hydrologic boundary will occur at about 90ft. downstream where the alluvium lies directly on the sandstone. This would be reflected in the bore as a discharging boundary, and its effect would become pronounced when the drawdown has reached about 40ft. below the static water-level.

From observation of the sandstone outcrop, porosity is almost entirely secondary (i.e. water contained in joints and other fractures). Permeability of the unobserved overlying shales may be higher than the permeability of the sandstone, as partings may occur along bedding planes.

Conditions in the vicinity of the bore are favourable to recharge of the aquifers. In normal years, Wilpena Creek flows for several weeks during winter months, and it is likely that groundwater is moving downstream throughout the year.

<u>Pumping</u>

The pump intake was set at 70ft.

In the development test, the bore was initially pumped at 3500 gallons per hour for 60 minutes, resulting in a rapid draw-down of 38ft. This drawdown rate was considered unsatisfactorily high. After allowing the water to recover for one hour towards the pre-pumping level, the bore was then pumped at 1500 gallons per hour which resulted in a slow drawdown rate. After recovery, the bore was then tested at 1800 gallons per hour which produced a satisfactory drawdown rate for a 24 hour pump test.

The water level was allowed to completely recover, and the pump test commenced with a pumping rate of 1800 gallons per hour. Due to increasing head loss in the bore, the pumping rate declined slightly throughout the test. The average pumping rate was 1730 gallons per hour.

Drawdown and Recovery Readings

Readings were made using an electrical depth probe attached to a tape. The top of the casing was used as a reference point. Levels were marked on the tape, and measurements adjusted relative to ground level, were made when convenient.

Drawdown readings were taken as shown below:

From	To	Interval
1 minute	10 minutes	Every half minute
10 minutes	30 "	" minute
30 "	60 "	" 5 minutes
60 "	200 "	" 10 minutes
200 "	1000 "	" 50 minutes
1000 "	1400 "	" 100 minutes

Final reading at 1440 minutes.

Recovery readings were taken as shown below:-

From	To	Interval
0 minutes	10 minutes	Every minute
10 "	30 "	" 2 minutes
30 "	60 "	" 5 minutes
60 "	200 "	" 10 minutes
200 "	700 "	" 50 minutes

Final reading at 720 minutes.

Analysis of Data

Of the methods available for analysis of pump-test data and for determination of aquifer characteristics, safe yield, bore efficiency and prediction of drawdowns, all require data from at least one observation hole for accurate results.

However, the Jacob method can be applied to a single-rate pump test of a bore without observation holes, to yield limited but useful information.

In the Jacob method, s is plotted against log t, and s^1 is plotted against lot t/t_1,

where s - drawdown (ft.)

s^1 - residual drawdown or recovery (ft.)

t - time since pumping started (minutes)

t_1 - " " " stopped (minutes)

The resulting Time-Drawdown graph is shown in Figure 2.

No data adjustments were made because

(1) three aquifers are present, and while the alluvium aquifer may be unconfined, the shale and sandstone aquifers may be partly confined, as the water level rose 4ft. in the hole during drilling.

(ii) a partial-penetration correction cannot be applied to the shale and sandstone as the thickness of these beds is not known.

Interpretation of the Time-Drawdown Graph

From the Time-Drawdown Graph, Transmissivity (T) can be calculated using the formula:

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

where T - Transmissivity (cusec/ft.)

Q - Pumping Rate (ft^3/sec.)

s - Drawdown per log cycle (ft.)

As three aquifers are present, the value of T approximates an average ofthe T values of each aquifer.

An approximate value of T can be obtained by $T \approx Q/s$, where s is the total drawdown (ft.). This gives $T \approx 2.9 \times 10^{-3}$ cusec/ft. This figure is in close accord with the T value obtained from late-time data (300-1440 minutes), where $\Delta s = 5.1$,

$$T = \frac{0.183 \times 0.077}{5.1} = 2.76 \times 10^{-3} \text{ cusec./ft.}$$

The relatively high Δs (10.32) for the early-time data (10-300 minutes) is thought to be related to the low T of the alluvium as a whole, and the upper part of the shale, and to the delayed drainage effect in the unconfined alluvium aquifer. The late-time data can be considered as the effect of a recharge boundary and is probably related to the good flow of water in the shale reported by the driller at about 50ft. This aquifer is of limited areal extent but it is likely to remain effective until the drawdown approaches 40ft. below the static water-level (cf. comment on discharging boundary p.3).

It should be noted that the late-time recharge effect is probably slightly exaggerated by the reduced pumping rate during this part of the test.

Prediction of Drawdowns

During the development test a drawdown of 38ft. occurred in 60 minutes at a pumping rate of 3500 gallons per hour. At this pumping rate, bore efficiency is probably reduced, and a high drawdown rate is likely to continue. Also, as mentioned before (p.3) a discharging boundary is expected when the drawdown reaches about 40ft. (although at this higher pumping rate the effect might not be pronounced until the drawdown has exceeded 40ft.). It is likely then that the drawdown may continue at a rate in excess of 10ft. per log cycle, and could be as high as 55ft. after 1000 minutes continuous pumping at 3500 gallons per hour.

The following table shows predicted drawdowns for average pumping rates of 1730 gallons per hour (assuming s = 10 after 100 minutes). It is assumed that pumping is continuous.

	Predicted Drawdowns (ft.) - SWL - 21.2ft.				
	12 hrs.	1 day	2 days	3 days	4 days
1730 g.p.h. assume s = 5	26.3	27.6	29.4	30.3	30.9
3350 g.p.h. assume s = 10	51	54	57	59	60

Recovery

The water recovered to within 3ft. of the static water level in the 12 hours following the pump test.

Water Sampling and Analyses

Seven water samples were taken during the test. One sample was taken at the commencement of pumping and further samples were taken every 4 hours for the first 16 hours. Two samples were taken after 24 hours pumping.

The analyses expressed as approximate total salts (ATS) are given below:

Time Sampled	Depth (ft.) (Below static water level)	pH	ATS (ppm)
start	0	6	555
4 hrs.	23.5	6	585
8 hrs.	25.3	6	585
12 hrs.	26.3	6	615
16 hrs.	27.2	6	645
24 hrs.	27.6	6	645
24 hrs.	27.6	6	653*

* A full analysis of one of the final samples was performed by AMDEL. The analysis sheet is included and follows Figure 2 at the back of this report.

An increase in salinity with depth will be noted in the above table. This phenomenon is not uncommon. Partly interdependent factors influencing the increase include: distance from "freshwater" recharge areas, regularity of recharge, rate ofdownstream groundwater movement, amount of soluble salts released by chemically unstable material, distance travelled by groundwater through material containing soluble salts, and age of water.

It should be noted that if the bore is deepened below 102ft. it will most likely encounter water more saline than 650 parts per million. It should also be noted that the average salinity of pumped water will increase with the pumping rate as well as the time of pumping.

The water tested is entirely suitable for human consumption and general domestic purposes.

Recommendations

1. Casing.

It would be advantageous to extend the solid casing to 45ft. to prevent clay and silt entering the bore from the alluvium (0-40'). It would be unwise to extend solid casing below 45ft., as a recharge boundary was met during the test when the drawdown cone had reached 49ft.

2. Deepening.

Deepening the bore may increase its capacity but the average salinity of the pumped water may considerably exceed 650 parts per million. Because of the importance of maintaining a low salinity, deepening the bore is not recommended.

3. Pump Intake Depth.

In view of the likelihood of the drawdown exceeding 50ft. during periods of peak demand, the pump intake should be set no higher than 80ft. - at 80ft., the available drawdown is about 59ft.

4. Salinity check.

In view of the direct relationship between drawdown and salinity during the test, it is recommended that the bore be pumped at 3500 gallons per hour and water samples taken every 5ft. of drawdown, and submitted for ATS analysis. This is important because if the salinity greatly exceeds 1000 parts per million beyond a known drawdown, then to maintain the quality of the water encountered during the test (average 600 parts per million), a pumping programme will have to be planned so that the known drawdown is not exceeded.

5. Pumping Plant.

A recommendation on a suitable pumping plant to link the bore to the present water-supply system, will be forwarded under separate cover.

Summary

The test is considered satisfactory for a general understanding of the bore's capacity and performance.

The salinity of the water for drawdowns up to 27.6ft. is entirely suitable for human consumption and general domestic purposes.

It appears that the bore can be safely pumped at 3500 gallons per hour for short periods, but the importance of a salinity check for drawdowns greater than 27.6ft. is stressed.

Kerry A. Lye

Geologist: K. Lye

Survey Date: 12th to 14th March, 1971

12.5.1971
KL:MFV:MK

CONYNGHAM ST. FREWVILLE SOUTH AUSTRALIA 5063 TELEPHONE 79 1662 TELEGRAMS 'TELEX' AA82520

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

PLEASE ADDRESS ALL CORRESPONDENCE TO THE DIRECTOR.

OUR REFERENCE: AN1/6/0 - 4118/71
YOUR REFERENCE: W1281/71

21 April 1971

The Director
Department of Mines
Box 38 Rundle Street PO
ADELAIDE SA 5000

FORM 13

WATER ANALYSIS

Constituent	Parts Per Million	Equivalents Per Million	Assumed Composition of Salts	Parts Per Million	Hardness (as Calcium carbonate)	Parts Per Million
Anions Chloride (Cl)	240	6.8	Calcium bicarbonate	133	Total	290
Sulphate (SO_4)	145	3.0	Calcium sulphate	7	Temporary	80
Bicarbonate (HCO_3)	100	1.6	Calcium chloride		Permanent	210
Nitrate (NO_3)*	Nil	-	Magnesium bicarbonate		Due to Calcium	85
Fluoride (F)			Magnesium sulphate	175	Due to Magnesium	205
			Magnesium chloride	59	Due to Iron	
Cations Sodium (Na)	118	5.1	Sodium bicarbonate			
Potassium (K)	15	0.4	Sodium sulphate		Total alkalinity as Calcium carbonate	80
Calcium (Ca)	35	1.7	Sodium chloride	300	Free Carbon dioxide	
Magnesium (Mg)	50	4.1	Sodium nitrate		REMARKS	
Iron (Fe)			Potassium chloride	29		
Silica (SiO_2)			Iron bicarbonate			
			pH ... units			
Sodium to Total Cations Ratio (Equivs.)		44.0 %	Conductivity 1220 Micromhos/cm/25°C			

Total Dissolved Salts
a. Determined at 180°C — ppm
b. Calculated (Carbonate as CO_3) 653 ppm

*Note: Trace NO_3 = < 20 ppm Detected. Nil NO_3 = < 20 ppm Not Detected.

Name Wilpena Chalet, Hole No. Chalet

Water Cut

Address Wilpena, Water Level

Via HAWKER, 5434. Supply 1,730

Out of Hundreds N.P.R. 106 Depth Hole 102'

~~Section~~ County HANSON Date Collected 14/3/71

Sample collected by L. Hariett

Director [signature]

1,100,000. 6634

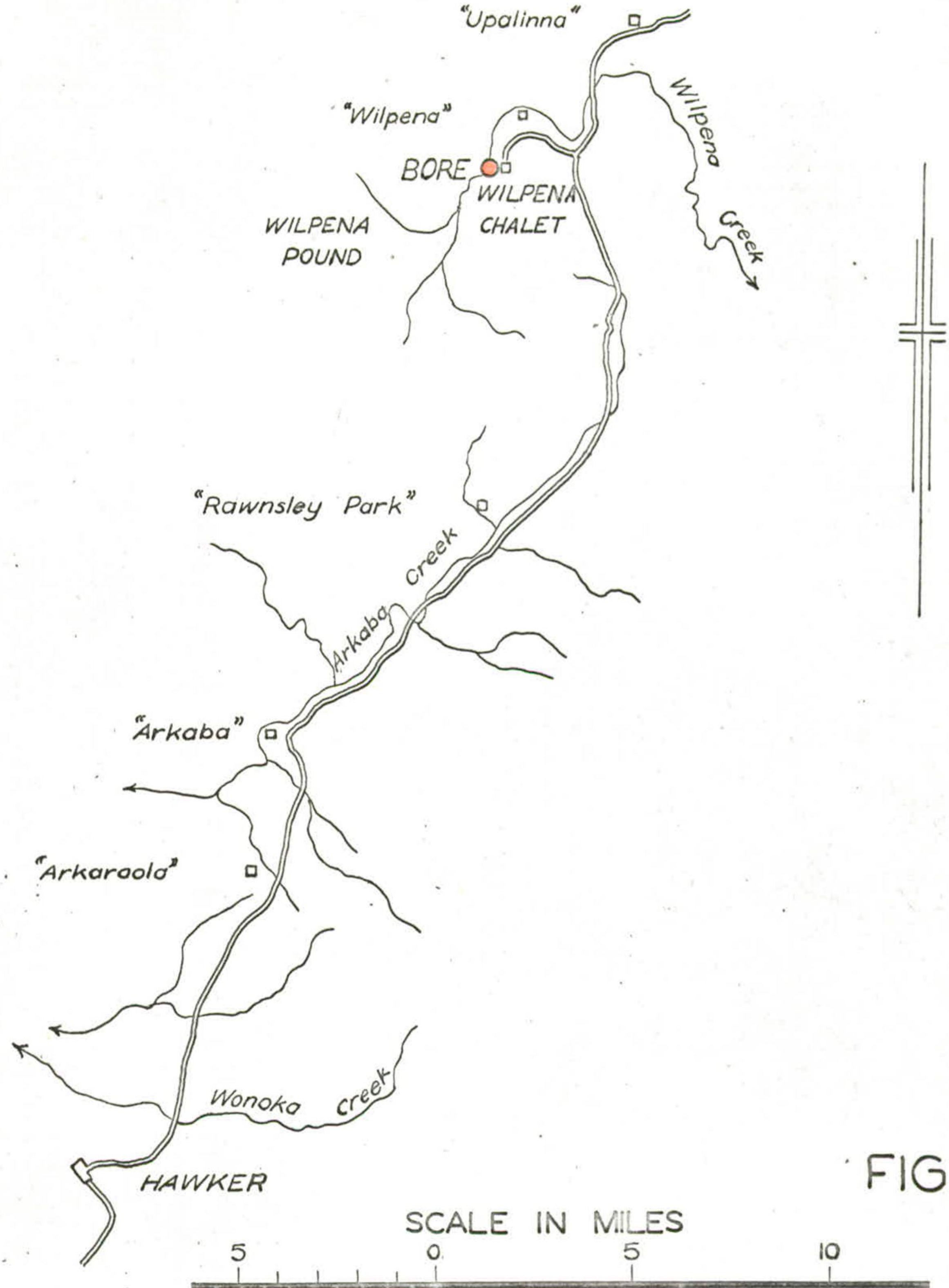
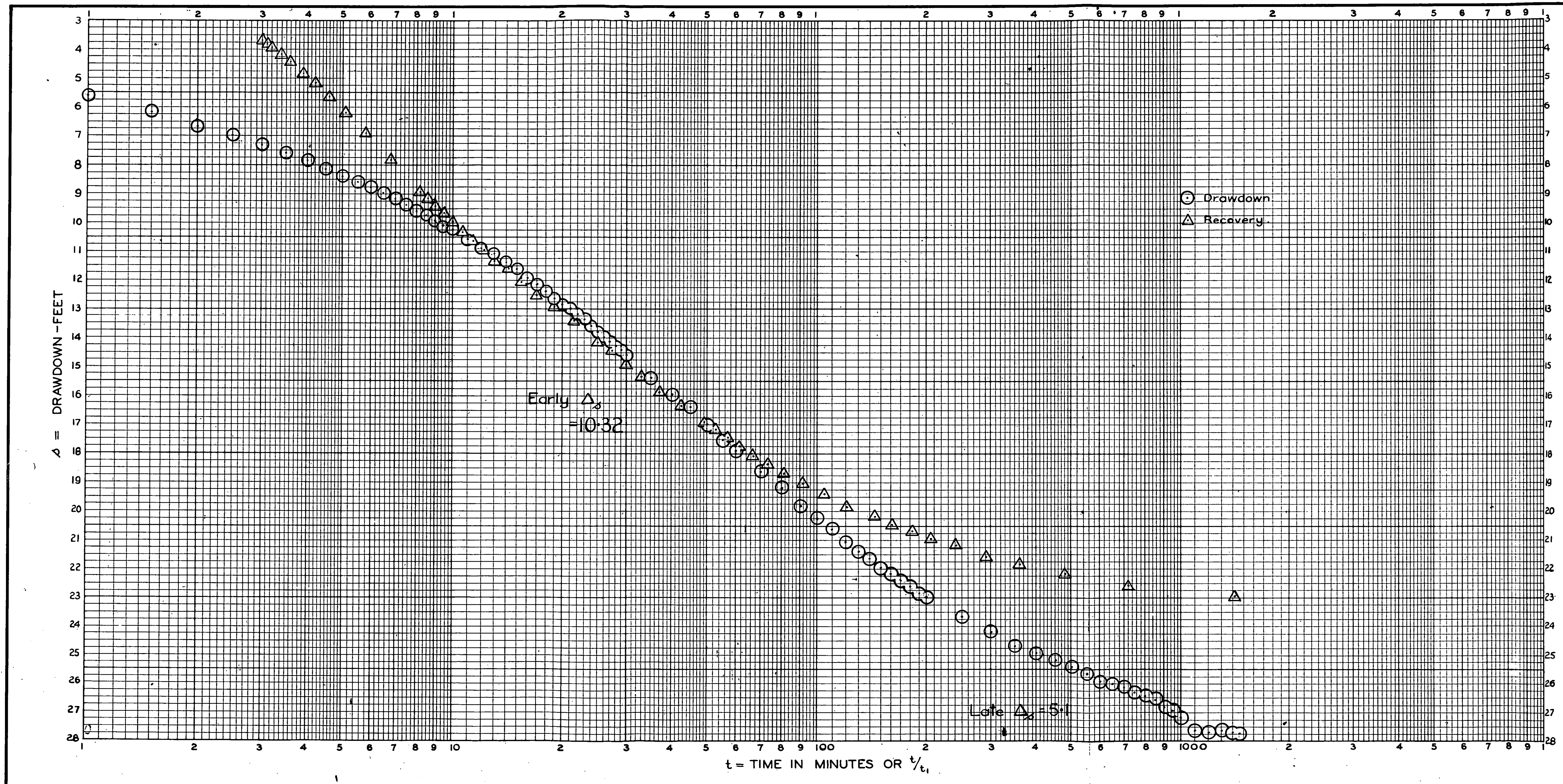


FIG. 1.

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: *As Shown*
Compiled: K.LYE	HAWKER–WILPENA MAIN ROAD	Date: *26 May 1971*
Drn. J.M.B. Ckd. L.V.W.	LOCATION OF WILPENA CHALET BORE	Drg. No. S9287 Fc

1M–2.70 A1810

No 9 - 6634? or 17?



BOREHOLE STATE Nº ____________
DEPTH TO WATER LEVEL
AT TEST START (L_2) 21·2 FT.
PUMP INTAKE-DEPTH (L_1) 70·0 FT.
* AVAILABLE DRAWDOWN 48·8 FT.

TYPE OF PUMP FRANKLIN SUBMERSIBLE
DISCHARGE STARTED AT 08·30 ON 13-3-71
" STOPPED AT 08·30 ON 14-3-71
HOLE DEPTH 102 ft. (L)

EQUATION

$$T = \frac{0{\cdot}183 \times Q}{\Delta_{\delta}}$$

In which
T = Transmissivity - ft.³/sec./ft.
Q = Pumping Rate - ft.³/sec.
Δ_{δ} = Drawdown per log cycle - ft.

DATA

Q	Δ_{δ}
1730 gph. 0·077 Cusec.	5·1 ft.

CALCULATIONS

$$T = \frac{0{\cdot}183 \times 0{\cdot}077}{5{\cdot}1} = 2{\cdot}76 \times 10^{-3}\ ft.^3/sec/ft = \quad ft.^3/day/ft.$$

FIG. 2

* Available drawdown = $L_1 - (L_2 + \_\_\_\_\ ft.)$

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	D.M. 843 / 63
COMPILED: K. LYE	WILPENA POUND "CHALET" BORE	DATE: 28 April 1971.
DRN. J.M.B. CHD. L.V.W.	TIME - DRAWDOWN GRAPH	DRG. No. 71-382 Fc.

P.F. No. 69-953 MB