70/137

Section 7022 II

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

RESULTS OF A PUMPING TEST ON THE WATER SUPPLY BORE FOR THE SOUTH WEST FROZEN FOOD PRODUCERS, MT. GAMBIER

Section 364 Hundred Blanche /GREY

by

B.M. HARRIS
ASSISTANT SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

9th September, 1970

Rept.Bk.No.70/137

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SOUTH AUSTRALIA

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G.S.No.4523
Hyd.No.2771
D.M.No.231/69

9th September, 1970

DEPARTMENT OF MINES
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HYDROGEOLOGY SECTION

SUMMARY AND CONCLUSIONS

A pumping test has been conducted on the water supply bore for the new South West Frozen Food Producers' factory at Mt. Gambier. The bore intersects a limestone aquifer containing solution channels and cavities. In the test the supply bore was pumped continuously for three days at a constant rate of 655 gpm. The drawdowns observed in the pumped bore and four nearby observation bores were very small but they conformed to the normal distance drawdown relationship. This suggests that the solution cavities and channels are widespread and interconnected within the zone of aquifer influenced by the test. The high values of transmissivity and specific capacity obtained indicate a very good aquifer.

Therefore the supply bore should have no difficulty in meeting the design requirements of 600 gpm. for long periods of continuous pumping. The bore could probably supply twice this amount if required.

INTRODUCTION

A three day pumping test has been conducted on a water supply bore for the new South West Frozen Food Producers' factory in Mount Gambier. This work was requested by F.M.C. Aust. Pty. Ltd. the engineering consultants for the project. The factory is located in Commercial Street West, Section 364 of the Hundred of Blanche.

This report describes the test results and discusses some aspects of the hydrogeology which will affect the operation of the bore.

HYDROGEOLOGY

The water bearing horizon or aquifer occurs in the Mount Gambier Limestone, a rock which is almost entirely composed of fossil coral and shell fragments. The limestone has only a moderate permeability in its original state. However in the Mount Gambier region solution cavities and channels have developed as a secondary feature from the action of circulating groundwaters. As a result the aquifer can store and transmit water much more readily.

Although cavernous limestones of this type have excellent aquifer properties they also present special problems in evaluating the long term capacity of the bore. These problems arise from the fact that the aquifer properties may vary widely from one point to another. For example it is possible that a bore will have intersected a cave in the aquifer. If the cave has poor interconnections with other parts of the aquifer then a short term pumping test will not give a true estimate of the long term capacity.

This is because drawdown will be very small until the large storage in the cave is drained. From that time drawdowns will greatly increase and may severely reduce the bore capacity. Alternatively the cave may have good interconnections with other parts of the aquifer and therefore no reduction in the bore capacity would occur after long periods of pumping.

These conditions are best investigated by a long term pumping test. Observations made in bores at some distance from the pumping bore greatly assist the analysis.

The existence of solution channels can provide direct interconnection between bores and sources of pollution. Pollutants may travel long distances quickly and may quickly become apparent in a discharging bore and particularly in a bore being pumped at a high rate.

TEST RESULTS

Drawdown observations were made in the pump bore F and in five observation holes nearby. The bore locations are shown in Figure 1 and the bore details are given in Table 1 below.

TABLE 1

Bore Details

Bore No.	Depth (feet)	Diameter (inches)	Casing (feet)	Distance from pump bore (ft.)	Comments
A	115	8	9	400	Observation Bore
B	110	8	20	About 555	Observation Bore
C	125	8	8	243	Observation Bore
D	115	8	-	302	Observation Bore
E	126	10	40	146	Observation Bore
F	127	10	40	0	Pump Bore

It was originally intended to conduct a step drawdown test in conjunction with the main test so that a relationship between drawdown and discharge could be obtained, but as the drawdowns were very small only the main test was carried out.

In this test the supply bore was pumped continuously for three days at a constant rate of 1.75 c.f.s. or 655 g.p.m. Semi-logarithmic plots of the drawdown observations are shown in Figures 2, 3 and 4. There was no observable drawdown in Bore B which appeared to be outside the zone of influence of the pumping bore. Because they are small the values show considerable fluctuation which is due partly or wholly to:-

(a) Atmospheric pressure changes producing temporary changes in water levels.

(b) Recharge to the aquifer from rainfall. (There were periods of rain during the test).

(c) Inhomogeneity of the aquifer.

(d) Errors of measurement. (With small drawdowns extremely small errors in measurement are magnified).

There was a steady increase in drawdowns during the first 300 minutes of the test. After 300 minutes the observed drawdowns did not increase but fluctuated about fairly constant levels. After 3,500 minutes the drawdowns in the majority of bores steadied. At 4,000 minutes the passing of a storm front produced another fluctuation of levels.

The semi-logarithmic plot of the steady drawdown levels in observation bores at 3,500 minutes versus their distance from the pumped bore almost fall on a straight line. (Fig.5). A straight line drawn through the points represents the cone of drawdown developed around the pumping bore. This line has a slope of -0.45 ft. per log cycle and from this the Transmissivity* of the aquifer is estimated to be 1.4 ft^2/sec. It is stressed that this is an estimate of transmissivity only, because:-

(1) Neither the pumped bore nor the observation bores fully penetrated the aquifer.

(2) The measured drawdowns were small.

(3) The aquifer is cavernous and the pumped bore appeared to have an effective radius greater than 150 feet. This means that the system cannot be considered as having a point discharge, whereas the method used to analyse the results assumes a point discharge.

The specific capacity of the supply bore is 3,270 gallons per minute per foot of drawdown.

No reliable value for the Specific Yield (or effective porosity) can be obtained from the data.

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* Transmissivity is the product of the permeability and aquifer thickness.

AQUIFER PERFORMANCE

The fact that a reasonable distance drawdown relationship is obtained from a random distribution of observations suggests that solution cavities and channels are widespread and interconnected within the area influenced by the test. Transmissivity and Specific Capacity values are very high indicating a very good aquifer. Because the Specific Yield cannot be estimated it is not possible to predict the long term drawdowns. It is anticipated that the drawdown in the pumped bore after prolonged pumping will not be much greater than that observed at the end of the three day test.

Therefore the supply bore should have no difficulty in meeting the design requirements of 600 g.p.m. for long periods of continuous pumping. The bore could probably supply twice this amount if required.

9th September, 1970
BMH:PMM

B.M. HARRIS
ASSISTANT SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

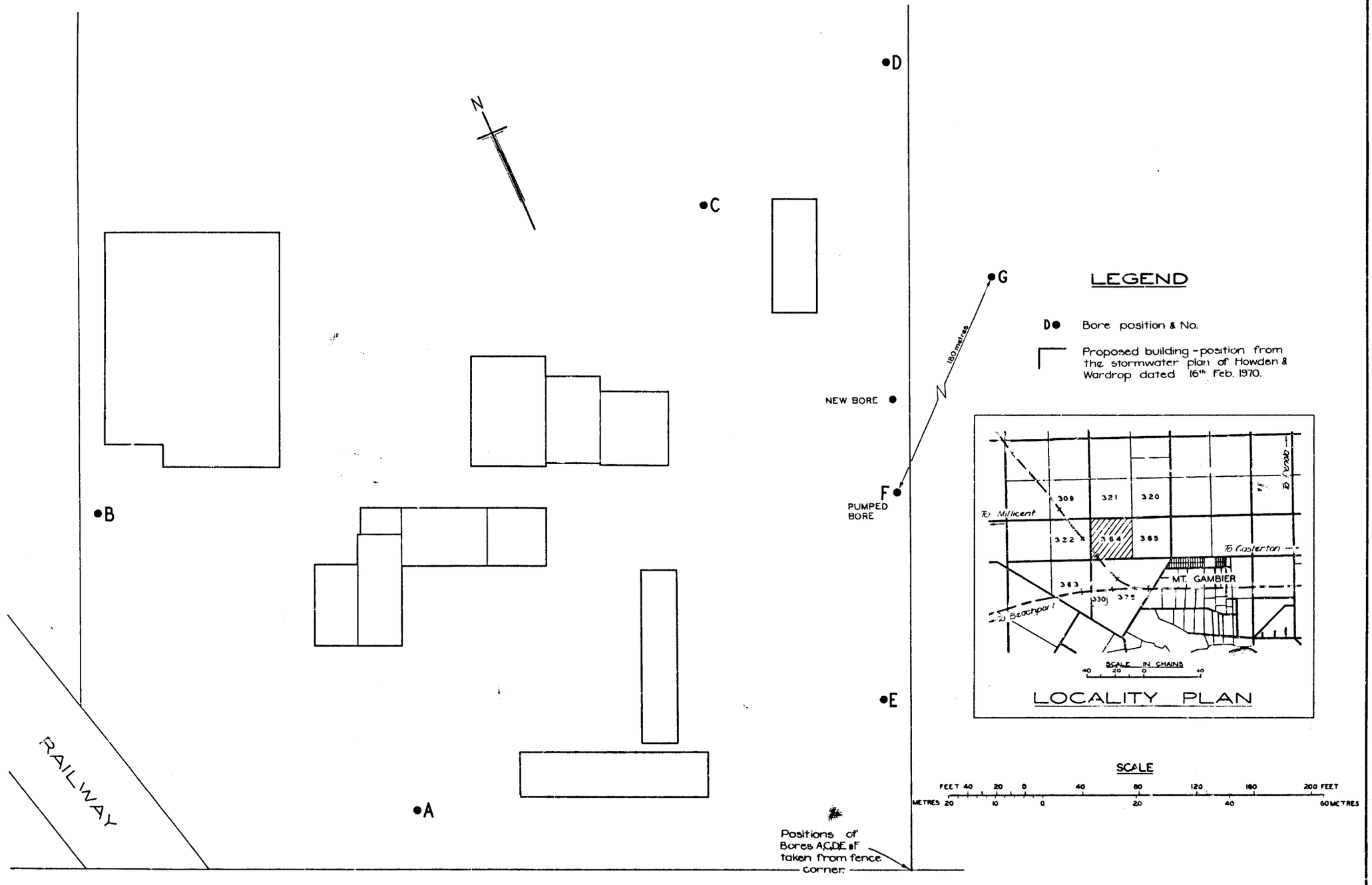
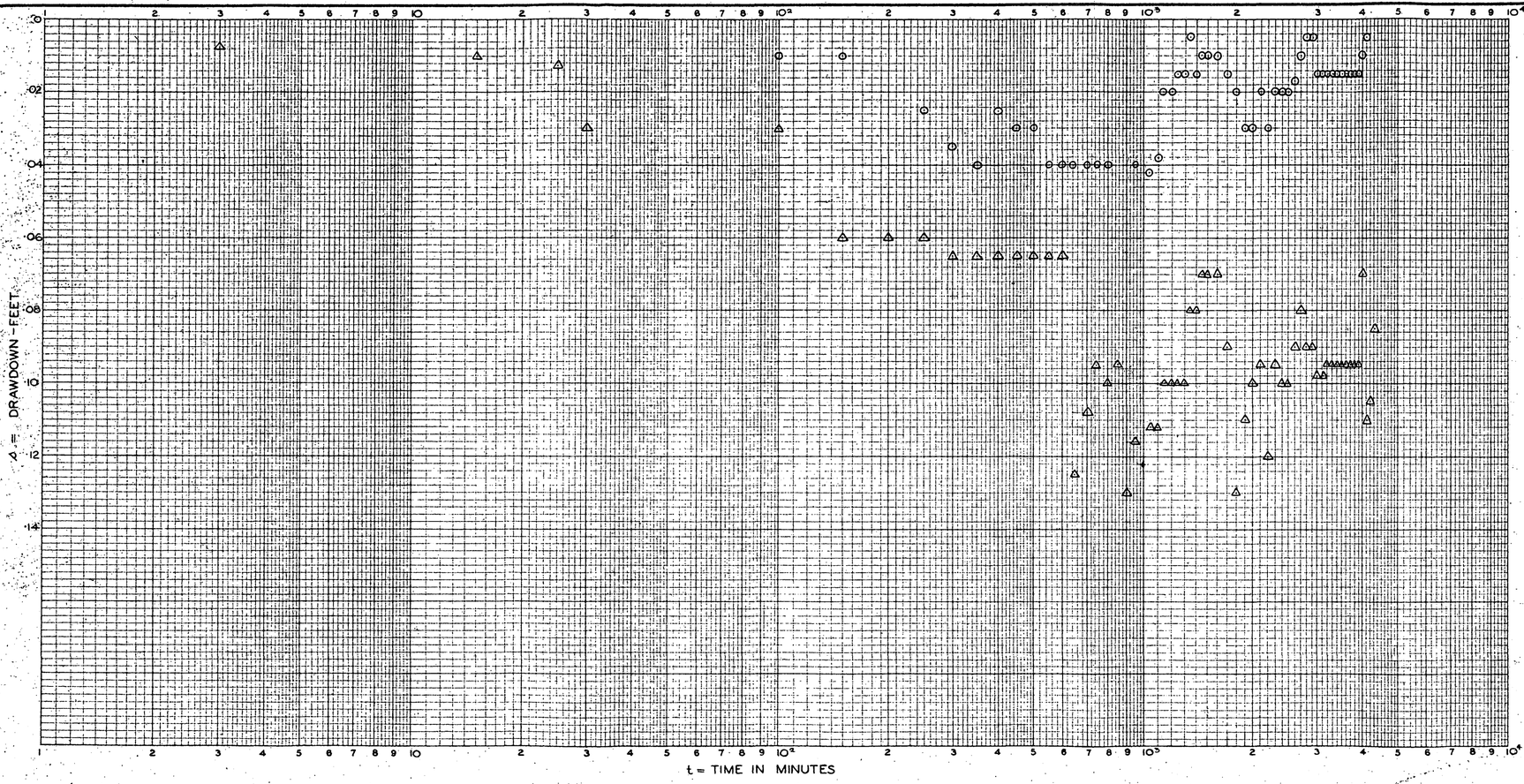


FIG. 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

BORE LOCATION PLAN FOR PUMPING TEST AT FROZEN FOOD PRODUCERS FACTORY MT. GAMBIER SECTION 364 HUNDRED BLANCHE

HYDROGEOLOGY SECTION	GEOLOGIST	Drn. B.M.H	SCALE: AS SHOWN
		Tod. A.G.R	70-744 Kd17
Director of Mines	SEN. GEOLOGIST	Chd. L.V.W.	
		Encl.	DATE: 28TH AUG. 1970



BOREHOLE STATE N°_____ TYPE OF PUMP Peerless

DEPTH TO WATER LEVEL 85·39 ft A DISCHARGE STARTED AT 1500 ON 17·8·70

AT TEST START (ℓ_2) 86·58 ft C (L) ** " STOPPED AT 1440 ON 20·8·70

PUMP INTAKE DEPTH (ℓ_1)_____(L) AQUIFER FROM_____TO_____(L)

*AVAILABLE DRAWDOWN_____(L) HOLE DEPTH 115 ft A (L)
125 ft C

EQUATIONS

$$T = \frac{0{\cdot}183 \times Q}{\Delta_\delta} \qquad S = \frac{2{\cdot}25 \times T t_o}{r^2}$$

In which

T = Transmissivity ($L^3/t/L$)
Q = Pumping Rate (L^3/t)
Δ_δ = Drawdown per log cycle (L)
S = Storage Coefficient
t_o = Zero drawdown time - (t)
r = Distance to Observation Bore - (L)
1 day = $8{\cdot}64 \times 10^4$ secs.

DATA

Q	Δ_δ	t_o
1·75 c.f.s.		

CALCULATIONS

$T = \frac{0{\cdot}183 \times \quad}{\quad} =$

$S = \frac{2{\cdot}25 \times \quad}{\quad} =$

LEGEND

⊙ BORE A

△ BORE C

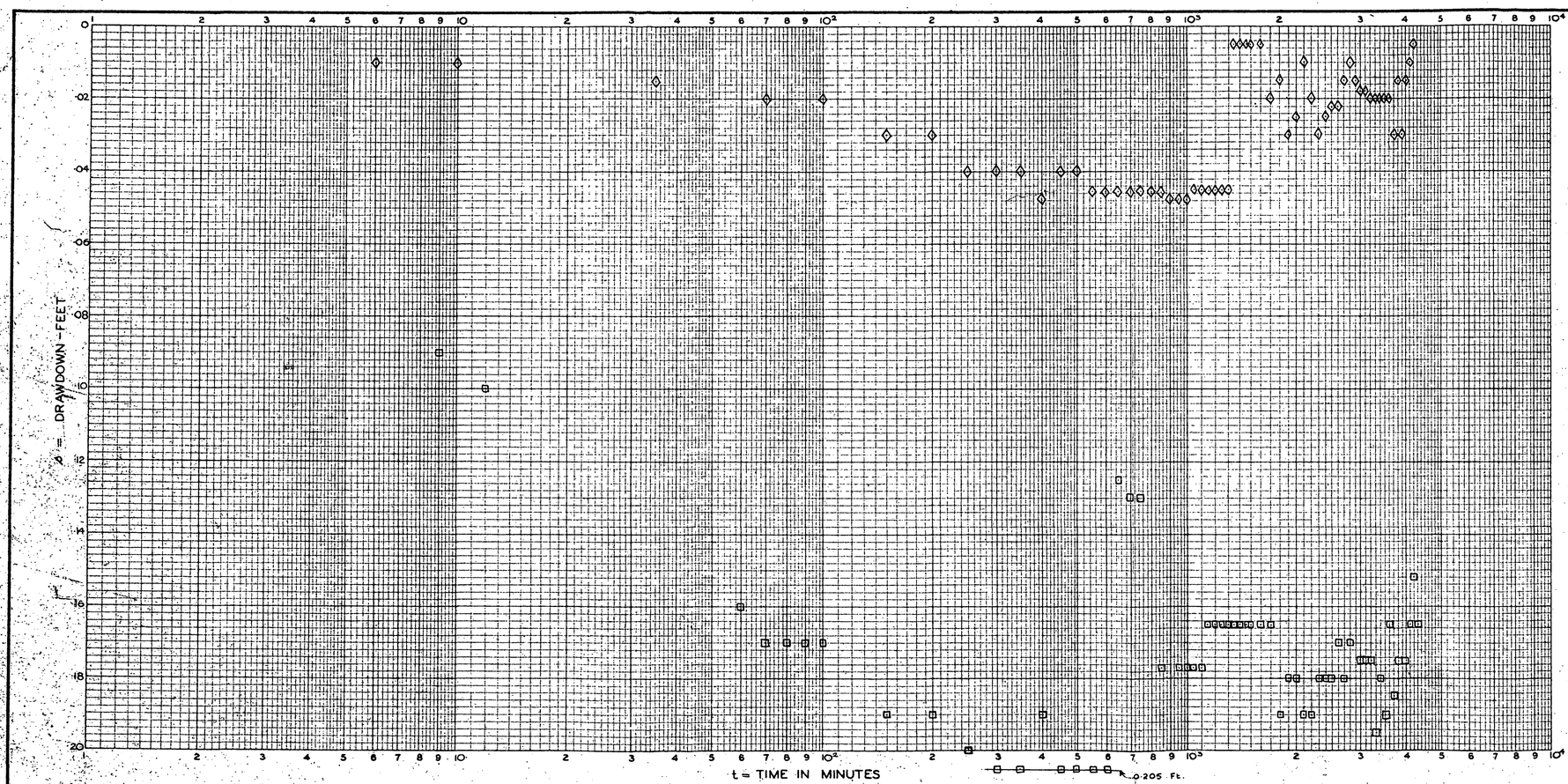
FIG 2

** L = unit of length.
t = time unit.

* Available drawdown = $\ell_1 - (\ell_2 + \text{-----})$

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM. /
COMPILED: B.M.H.	PUMPING TEST	DATE: 25TH AUG 1970
DRN. A.G.R. CHD.	SOUTH WEST FROZEN FOOD PRODUCERS DRAWDOWN CURVES BORES A & C	DRG. No. 70-745 Kd7

P.F. No. G9—953 MH



BOREHOLE STATE N°_____
DEPTH TO WATER LEVEL 85.32 ft D
AT TEST START (ℓ_2) 85.84 ft E (L) **
PUMP INTAKE DEPTH (ℓ_1)_____(L)
* AVAILABLE DRAWDOWN_____(L)

TYPE OF PUMP Peerless
DISCHARGE STARTED AT 1500 ON 17-8-70
" STOPPED AT 1440 ON 20-8-70
AQUIFER FROM_____TO_____(L)
HOLE DEPTH 127 ft D (L)
126 ft E

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta_s} \qquad S = \frac{2.25 \times T t_0}{r^2}$$

In which
T = Transmissivity ($L^3/t/L$)
Q = Pumping Rate (L^3/t)
Δ_s = Drawdown per log cycle. (L)

S = Storage Coefficient
t_0 = Zero drawdown time - (t)
r = Distance to Observation Bore - (L)
1 day = 8.64×10^4 secs.

DATA

Q	Δ_s	t_0
1.75 c.f.s.		

CALCULATIONS

$T = \frac{0.183 \times}{\quad} =$

$S = \frac{2.25 \times}{\quad} =$

LEGEND

◊ : BORE D.
□ : BORE E.

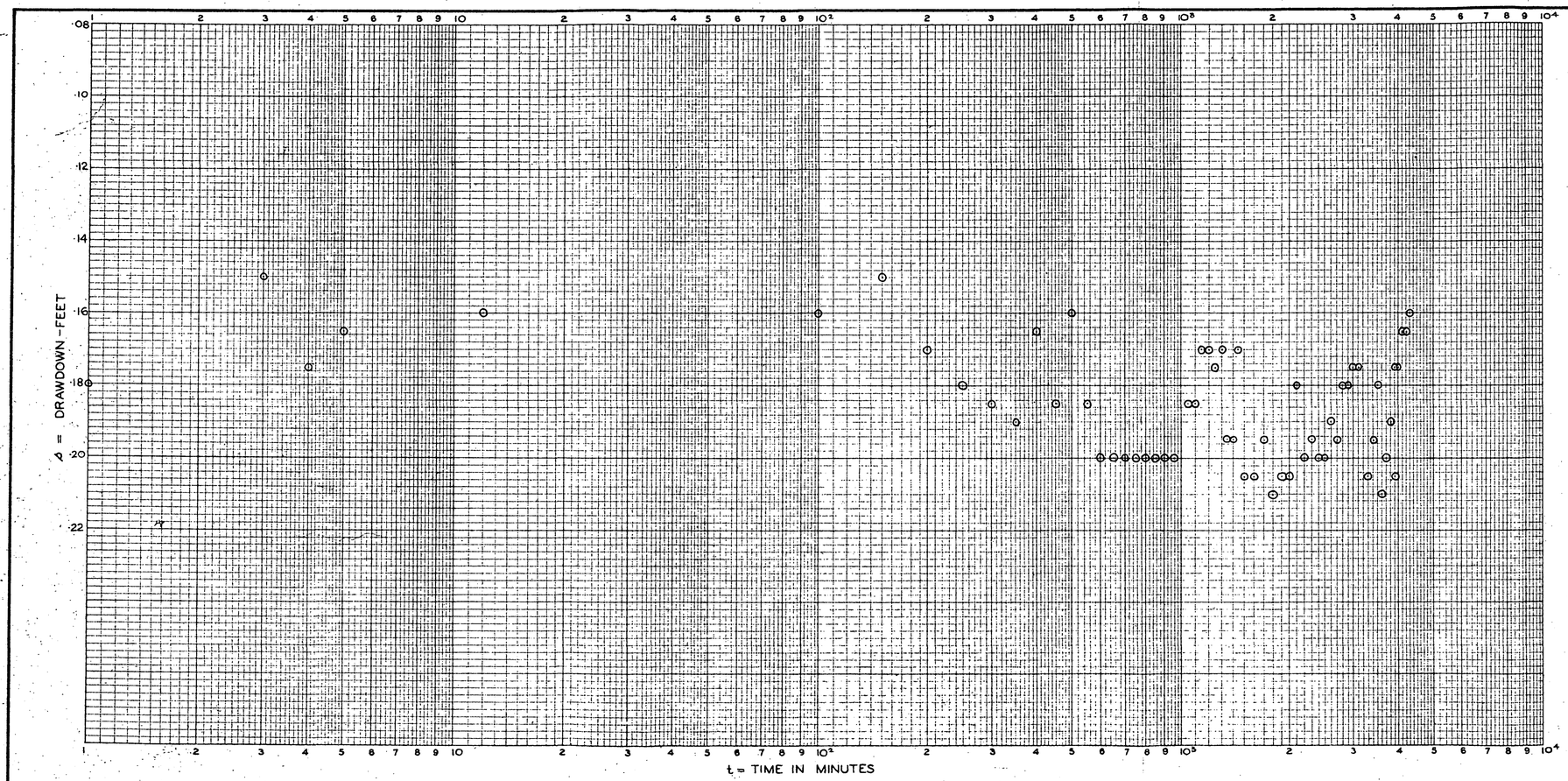
FIG. 3

** L = unit of length.
t = time unit.

* Available drawdown = $\ell_1 - (\ell_2 + \text{----})$

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM. /
COMPILED: B.M.H.	PUMPING TEST	DATE: 25TH AUG 1970
DRN. A.G.R. CHD.	SOUTH WEST FROZEN FOOD PRODUCERS DRAWDOWN CURVES BORES D & E	DRG. No. 70-746 Kdn

P.F. No. 69—953 MH



BOREHOLE STATE N°_____
DEPTH TO WATER LEVEL
AT TEST START (ℓ_2) 87·00ft. (L) **
PUMP INTAKE DEPTH (ℓ_1) 100 ft. (L)
*AVAILABLE DRAWDOWN_____(L)

TYPE OF PUMP Peerless
DISCHARGE STARTED AT 1500 ON 17-8-70
" STOPPED AT 1440 ON 20-8-70
AQUIFER FROM_____TO_____(L)
HOLE DEPTH 127 ft. (L)

EQUATIONS

$$T = \frac{0{\cdot}183 \times Q}{\Delta_o} \qquad S = \frac{2{\cdot}25 \times T t_o}{r^2}$$

In which
T= Transmissivity ($L^3/t/L$)
Q= Pumping Rate (L^3/t)
Δ_o= Drawdown per log cycle. (L)

S= Storage Coefficient
t_o= Zero drawdown time- (t)
r = Distance to Observation Bore- (L)
1 day = $8{\cdot}64 \times 10^4$ secs.

DATA

Q	Δ_o	t_o
1·75 c.f.s.		

CALCULATIONS

$T = \frac{0{\cdot}183 \times \quad}{\quad} =$

$S = \frac{2{\cdot}25 \times \quad}{\quad} =$

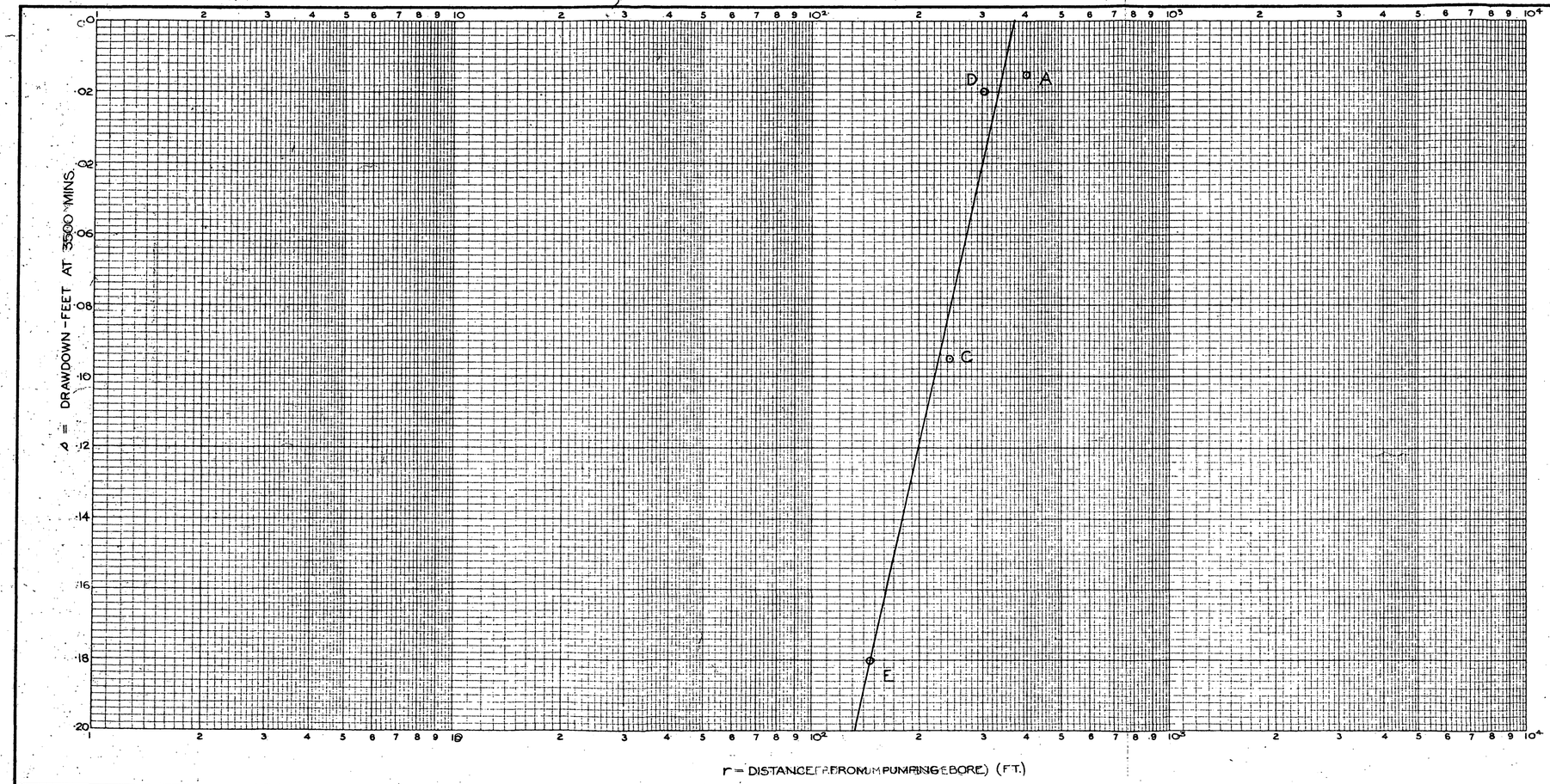
FIG. 4

** L = unit of length.
t = time unit.

* Available drawdown = $\ell_1 - (\ell_2 + \text{-----})$

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM. /
COMPILED: B.M.H.	PUMPING TEST	DATE: 25TH AUG. 1970
DRN. A.G.R. CHD.	SOUTH WEST FROZEN FOOD PRODUCERS DRAWDOWN CURVE BORE F	DRG. No. 70-747 Kd 1

P.F. No. 69—953 MH



BOREHOLE STATE No _____ TYPE OF PUMP Peerless

DEPTH TO WATER LEVEL DISCHARGE STARTED AT 1500 ON 17-8-70

AT TEST START (ℓ_2) _____ (L) ** " STOPPED AT 1440 ON 20-8-70

PUMP INTAKE DEPTH (ℓ_1) 100 ft (L) AQUIFER FROM _____ TO _____ (L)

*AVAILABLE DRAWDOWN _____ (L) HOLE DEPTH _____ (L)

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta_s} \qquad S = \frac{2.25 \times T t_o}{r^2}$$

In which

T = Transmissivity ($L^3/t/L$)

Q = Pumping Rate (L^3/t)

Δ_s = Drawdown per log cycle (L)

S = Storage Coefficient

t_o = Zero drawdown time - (t)

r = Distance to Observation Bore - (L)

1 day = 8.64×10^4 secs.

DATA

Q	Δ_s	t_o
1.75 c.f.s	-0.45 ft/log cycle	

CALCULATIONS

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

$S = \frac{2.25 \times}{} =$

$T = \frac{230}{2\Pi\Delta_s} \quad Q = \frac{230 \times 1.75}{2\Pi \times 0.45} = 1.42$ ft²/sec.

Specific Capacity of Bore: f

$= \frac{Q}{D}$ where Q = discharge (g.p.m)
D = drawdown (ft)

$= 655$

$= 0.2$

$= 3275$ galls/min. per foot of drawdown

FIG 5

** L = unit of length.
t = time unit.

* Available drawdown = $\ell_1 - (\ell_2 + \_\_\_\_\_)$

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM: /
COMPILED: B.R.M.H.	PUMPING TEST.	DATE: 25TH AUG 1970
DRN. A.G.R. CHD.	SOUTH WEST FROZEN FOOD PRODUCERS	DRG. No. 70-748 Kd17
	DISTANCE DRAWDOWN CURVE	

P.F. No. 69—953 MH