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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 85/61
STUART HIGHWAY, PUMP-TESTING
CONSTRUCTION WATER SUPPLIES,
MARLA TO N.T. BORDER

- Highways Department -

GEOLOGICAL SURVEY

by

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GROUNDWATER AND ENGINEERING

NOVEMBER, 1985

DME.364/75

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FIGURES

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RPT. BK. NO. 85/61
DME NO. 364/75
DISK NO. 153

ABSTRACT

Thirteen wells were pump-tested on the Marla to NT Border section of the Stuart Highway. All but two wells were in fractured rock aquifers. Most of these showed drawdowns linear with the square root of time, and consequently longterm yields are generally much smaller than airlift yields.

Six of these wells were found to have longterm yields greater than 0.5 L/s.

INTRODUCTION

This report describes the pump-testing of thirteen wells on the Marla to NT Border section of the new Stuart Highway.

The drilling programme and geology will be discussed in detail in a report to be produced later, (Gerges, 1986). Briefly this area is underlain by crystalline rocks, and most wells tested tap fracture aquifers.

Well details are summarized in Table 1.

PUMP-TESTING

All wells were tested with helical rotor pumps installed and run by Highways Department crews. The Department of Mines and Energy provided supervision.

Initially tests were conducted by technical personnel under remote supervision of a geologist.

It was found from experience that in order to get useful results from tests in fractured rock environments it was advisable to have a geologist on site.

Details of tests are discussed in Appendix-A.

Results are summarized in Table 2.

TABLE 1

WELL DRILLING DETAILS

Unit No.	Permit No.	Depth (m)	SWL (m)	Casing (m)	Slots (m)	Air lift Yield	Aquifers	Locality
55 44 WW 135	93397	108	6.3	6	-	1.2	11 Fractured pC*	Twin Hill
140	93824C	62	5.8	6	-	4	10-16 Fractured pC*	W. of Twin Hill
148	93392	80	33	32	-	4.5	40-70 75-80 Fractured slates	Tarcoonyinna Creek
55 45 WW 45	93603	57	7	6	-	7	9-26 Fractured pC*	Dyke Hill
47	93606	30	7.7	3	-	2.2	9.6 11.6 Fractured pC*	Dyke Hill
50	93817	24	8.6	24	8.8-21.8	3.2	8.6-22 Alluvial sand	Marryat River
51	93602	67	10.7	41	14.8-27.9 34.3-41	4.2	15-23 Alluvial sand	Marryat River
52	93599	99	15.4	34	17.2-23.7	0.75	14-25, 51 Fracture pC	Marryat River
53	93600	103	6.3	27	18-27	0.75	18-28, 47 Fracture pC	Marryat River
54	93601	99	7	13	-	1.1	13-16, 76 Fractured pC	Marryat River
57	93594	34	4.7	22	2.5-22	1.1	6-22 Weathered & Fractured pC*	Eateringinna Creek
58	93609	53	5	16	6-16	2.2	6-9, 31-42 Weathered & Fractured pC*	Eateringinna Creek
59	93612	39	5.5	13	6.5-13	2	6.5-7, 13-30 Weathered & Fractured pC*	Eateringinna Creek
60	93611	39	5.5	18.5	6.5-18.5	1.2	7-17 Weathered & Fractured pC*	Eateringinna Creek

* pC, Crystalline basement

TABLE 2

ESTIMATED WELL YIELDS

Unit No.	Estimated well yields Yield	Time	Comments	Salinity mg/L
55 44 WW 135	0.5L/s	26 days	Possible source of camp or concrete water	925
	0.3L/s	100 days		
140	2.6L/s	100 days		1 125
	1.9L/s	200 days		
	1.4L/s	1 year		
148	0.6L/s	100 days		4 035
	1.9L/s	200 days		
	1.4L/s	1 year		
55 45 WW 45	5.2L/s	150 days		485
	4.5L/s	200 days		
	3.3L/s	1 year		
48	0.37L/s	100 days	Interference from 5545WW44 would further reduce yields	655
	0.26L/s	200 days		
50	3.8L/s	100 days		4 600
	3.0L/s	200 days		
	2.3L/s	1 year		
51	2.2L/s	100 days	To be used as a standby well only	
52	No useful supply			
53	<0.4L/s	100 days	Most optimistic possible estimate	19 300
54	0.6L/s	140 days		4 180
	0.5L/s	500 days		
57	No useful supply			8 700
58	0.28L/s	100 days	Approximate	16 000
59	0.25L/s	100 days	Optimistic estimate	30 800
60	0.1L/s	100 days	Approximate	22 000

DISCUSSION

In most of the wells tested drawdown increases linearly with the square root of time, and as a result estimated long term yields are generally much less than the observed airlift yields.

In most cases the available drawdowns are quite small, and estimation of available drawdowns is of great importance to the estimation of long term yields.

For poor yielding wells the top of the aquifer can often be found during pump-testing. With high yielding wells this may not be practicable and it may be neccessary to rely on the driller's record of waters cut.

Generally water does not become evident until the drill bit is ½ to 1 metre below the water bearing fracture.

Futher, the driller has other responsibilities and is unable to give his full attention to recording water data.

The only way to ensure that the necessary data is recorded to have a competent person, observing the drilling at all times.

CONCLUSIONS & RECOMMENDATIONS

Wells should be pumped at the rates shown in Table 2.

Drilling programmes in this type of environment require close supervision.

R. E. Read

R. E. READ
SENIOR GEOLOGIST

REFERENCE

GERGES, N.Z., (1986). 'Stuart Highway, Drilling for construction Water, Marla to N.T. Border. SADME unpublished report in prep.

APPENDIX A
PUMP-TESTING

TABLE OF CONTENTS

TABLES

FIGURES

A-21	Pump-test on 5544WW140,	semi-log	S18377
A-22	" " 5544WW140,	$\sqrt{t}$	8
A-23	" " 5545WW50,	semi-log	9
A-24	" " 50,	$\sqrt{t}$	80

Well 5544WW148

Introduction

This well was first tested on 28/5/84. Because of doubts, as to the interpretation of the results from the first test a second test was conducted on 28/9/84. All test pumping is shown below in table A-1.

TABLE A-1
Schedule of pumping well 5544WW148

Time	Date	Pumping Rate	Comments
1040	28/5/84	2 L/s	"Stage I"
1220	"	3 L/s	"Stage II"
1400	"	4.6 L/s	"Stage III"
1540	"	Pump stopped	
0935	29/5/84	4.0 L/s	Constant rate test
0855	30/5/84	Pump stopped	No recovery measurements
0800	28/9/84	2.2 L/s	Second test
0800	29/9/84	Pump stopped	

Response

The semi-log plot of drawdown (Fig. A-1) is a downward-steepening curve from about 20 minutes, suggesting double boundary conditions. The plot of drawdown against the square root of time (Fig. A-2) confirms this. At about 800 minutes the downward trend steepens, suggesting a reduction in the transmissivity of the fracture system away from the well.

The same effect can be observed in the recovery (Fig. A-2).

From Figure A-2 the well equation below was derived for pumping at the test rate.

$$s = 1.1 + 3.37 \sqrt{t}$$

where s is drawdown in metres
t is time in days

Long Term Yield

Recovery measurements (Fig. A-2) show that the above equation is valid in the medium term.

Assuming an available drawdown of 12 m the following yields are estimated:

0.6 L/s for 100 days
0.45 L/s for 200 days
0.34 L/s for 1 year

5544WW135 (Twin Hills)

Introduction

The well was pumped as shown in Table A-2.

TABLE A-2
Schedule of Pumping 5544WW135

Start Time	Start Date	Stop Time	Stop Date	Rate	Comments
1120	5/7/84	1120	6/7/84	1.51 L/s	Rate reduced when pump forked
	7/7/84				
1540	27/7/84	1540	28/7/84	0.59 L/s	

Response

The first tests showed a straight line semi-log response, followed by rapid steepening as the aquifer dewatered (Fig. A-3).

The last test showed a generally straight-line semi-log plot with possible steepening at the end of the test.

Recovery

The t/t^1 plot of residual drawdown (Fig. A-3) initially follows a straight line, curving up toward the origin for t/t_1 less than 2 (that is after about 1 day).

The $\sqrt{t}-\sqrt{t_1}$ plot of recovery (Fig. A-4) clearly shows the presence of double boundary conditions.

Well Equation and Long Term Yield

Using the recovery the following equation has been derived.

$$s = 2.8Q + 1.43\,Q\sqrt{t}$$

where s is drawdown in metres
t is time in days
Q is pump rate in L/s

From this the following yields have been estimated:

for 26 days, 0.5 L/s
for 100 days, 0.3 L/s

Therefore the well is of little use as a supply of construction water, but could possibly be used for camp or concrete water.

Well 5545WW57 (Eateringinna Creek)

Introduction

The well was tested as shown in Table A-3.

TABLE A-3
Schedule of Pumping 5545WW57

Start		Stop			
Date	Time	Date	Time	Rate L/s	Comments
8/7/84	1800	9/7/84	0546	3.8	Test stopped, problems with probe.
9/7/84	1202	9/7/84	1440	4.8	Test abandoned, pump-forked.
26/7/84	1041	27/7/84	0841	1.8	

Response

The first two tests showed a rapidly increasing drawdown when drawdowns reached about 2 to 3 metres.

To avoid this the well was pumped at a relatively low rate for the final test.

The semi-log plot of drawdown (Fig. A-5) follows a gently sloping straight line up to 500 minutes when it begins to curve downward.

This may either be because of aquifer dewatering or double-boundary conditions.

Recovery

The plot of t/t_1 (Fig. A-5) follows a straight line trending toward 0.15 m residual drawdown at infinite time, then flattened out at about 0.17 m. It appears that the aquifer has been permanently dewatered.

The plot of $\sqrt{t}-\sqrt{t_1}$ (Fig. A-6) confirms this.

Conclusion

This well has no useful long term yield.

Well 5545WW52.

Introduction

The well was pumped at 0.6 L/s for 40 minutes when the pump, which was set at 54 m, began to fork.

At 52 minutes the well was pumping at 0.3 L/s.

Conclusion

The well has no useful supply.

Well 5345WW53.

Introduction

The well was pumped at about 0.8 L/s starting at 12.35 hours on 3/8/84.

After 4 hours the water level had reached the pump intake.

Well performance was so poor that no further testing was needed.

Response

Neither the semi-log or √t plots of drawdown (Figs. A-7 & A-8) are linear, and the drawdown is hard to interpret.

An inflection point is evident at 40 m drawdown, corresponding to the aquifer recorded by the driller at 47 m. Another inflection point at 25 m drawdown suggests an unrecorded aquifer at 31 m.

Making the optimistic assumption that a linear extrapolation at the semi-log plot at drawdown can be used the 100 day yield would still be less than 0.4 L/s.

Conclusions

While the hydraulics of the aquifer are uncertain it is clear that the well has no useful yield.

Well 5345WW54.

Introduction

The well was pumped as shown in Table A-4.

TABLE A-4
Schedule of Pumping

Time	Date	Rate	Comments
1310	4/8/84	0.5 L/s	
0210	5/8/84	1.1 L/s)	Rate increased to
0942	"	1.6 L/s)	draw water level below top aquifer.
1110	"	1.3 L/s	Rate reduced to stop pump from forking.
1437	"		Pump stopped

Response

Testing and interpretation of this well are complicated by the presence of two aquifers.

During the first step the drawdown rapidly reached about 1.3 m, then appeared to stabilize, apparently due to dewatering of a fracture, before declining to 1.8 m. (Fig A-9)

In the second step dewatering the upper fractures of the upper aquifer caused the water level to decline fairly rapidly to 5.8 m, then flatten apparently because of dewatering of another aquifer.

In the third step the capacity of the upper aquifers was exceeded and water level fell rapidly. The balance of the water came from the bottom aquifer which shows double boundary characteristics, and the plot of drawdown versus the square root of time since the start of the third step is nearly linear (Fig. A-10)

In the fourth step the pumping rate was reduced to allow the contribution of the bottom aquifer to be estimated and to prevent the water level from reaching the pump.

The initial recovery when pumping was stopped was quite rapid, confirming the small capacity of the bottom aquifer.

The shape of the t/t_1 plot confirms that the dominant upper aquifer has radial flow.

Long Term Yields

The recovery plot suggests that this well should have a useful long term yield.

No useful well equation can be derived because of the effects of dewatering fractures in the upper aquifer.

Conservative estimates of yield based on available drawdowns achieved during pump-testing are as follows:

0.5 L/s for 500 days
0.6 L/s for 140 days

Well 5545WW51.

Introduction

The well was pumped at 2.57 L/s, starting at 1405 hours on 31/7/84 for 1425 minutes. The pumping rate was then increased to 3.27 L/s (the maximum for the pump) for a further 20 minutes.

Response

The semi-log plot of drawdown (Fig. A-11) follows a straight line with $\Delta s = 0.25$ m up to about 20 minutes, flattens to align with $\Delta s = 0.16$ m to 500 minutes and then appears to steepen to a line of $\Delta s = 0.28$ m.

Recovery

The semi-log plot of t/t_1 appears to follow three straight line segments, the last of which has been distorted by a pulse due to changing atmospheric pressure.

The late stages of recovery trend to the right of the origin, that is minor leakage or delayed drainage to the aquifer has occurred.

Well Equation

The linear semi-log (Fig. A-11) plot corresponds to an equation:

$$s = Q\ (0.55 + 0.12 \log t)$$

where s is drawdown in m
t is time in days
Q is discharge in L/s

However in view of the fact that the aquifer is probably a relatively narrow channel (see 5545WW50) a more conservative equation

$s = 0.42\ Q + 0.14\ \ Q\sqrt{t}$ may be appropriate. However this does not take account of possible interference from 5545WW50.

Long Term yield

It is suggested that this well only be used as a standby for 5545WW50 and should be equipped to pump 2L/s.

Well 5545 WW45.

Introduction

The pump-test on this well was repeated because it was necessary to test it at a higher rate.

The schedule of pumping is shown in Table A-5.

TABLE A-5
Schedule of Testing 5545WW45

Time	Date	Rate	Comments
0820	30/7/84	5.2 L/s	
0442	31/7/84		Pump broke down.
0810	24/9/84	11.3 L/s	
0801	25/10/84		Pump stopped.

Response

In the first test (Fig. A-13) the well showed normal behaviour for a fissure-aquifer, drawing down slowly to 0.43 m and then more rapidly to 0.48 m when it appears to have been stabilized by dewatering a fracture.

The second test was marred by a bad start and fluctuations in water level throughout the test.

Drawdowns remained almost constant at 1.45 m for much of the test before dewatering a fracture and drawing down more rapidly.

The recovery from both tests was similar. (Fig. A-13) The $\sqrt{t}-\sqrt{t_1}$ plot rises rapidly and trends toward a point above the origin, indicating that some radial flow is occurring. (That is that the aquifer is behaving as a leaky rather than a non-leaky strip-aquifer). Unfortunately there is no method available to quantify this.

Long Term Yield

An equation for pumping rates less than that of the first test has been derived as follows.

The time dependent term was derived from the late stages of the second test and the recovery and was used to extrapolate from the end of the first test.

$s = Q(0.03 + 0.063\sqrt{t})$

s is in m

Q is in L/s (<5.2 L/s)

t is time in days

Assuming that total available drawdown is 4 m discharges are as follows:

150 days	5.2 L/s
200 days	4.5 L/s
1 year	3.3 L/s

Well 5545WW48.

Introduction

This well was tested to determine whether it could be pumped concurrently with 5545WW45.

The well was pumped as shown in Table A-6.

TABLE A-6
Schedule of pumping 5545WW48

Time	Date	Rate	Comments
1053	22/9/84	0.9 L/s	
1113	22/9/84	3.4 L/s	Rate stepped up.
0554	23/9/84		Pump stopped (out of fuel!).

Response

The first step produced a drawdown of less than 0.05 m at 20 minutes.

The plot of the drawdown in the second step versus the square root of time (Fig. A-14) follows a straight line up to 400 minutes when the drawdown steepens, apparently due to dewatering a fracture 0.6 m below the water table.

The steepening of the curve at 0.6 m prevents the writing of a simple equation.

Yields can be calculated simply by using an equation for the first segment of the drawdown curve with the available drawdown reduced to allow for the steepening of slope below 0.6 m.

$$s = Q(0.06 + 0.21\sqrt{t})$$

Proven available drawdown is 1.0 m, which must be reduced to 0.8 in the above equation.

The following yields have been estimated:

100 days 0.37 L/s
200 days 0.26 L/s

Interference from 5545WW45 would reduce the long term yield still further.

The well is not worth equipping except as a mechanical standby.

Well 5545WW58.

Introduction

The well was pumped as shown in Table A-7.

TABLE A-7
Schedule of Pumping 5545WW58

Time	Date		
0935	8/8/84	Pumping started at	1.15 L/s
1035	8/8/84	Rate stepped up to	1.75 L/s
1135	8/8/84	" " "	2.37 L/s
1235	8/8/84	" " "	2.9 L/s
2015	8/8/84	" " down to	2.70 L/s
0835	9/8/84	" " " "	2.45 L/s
0905	15/9/84	Pump started at	2.2 L/s
1000	16/9/84	Pump stopped.	

The second test was needed because the recovery from the first test showed that recirculation had occurred.

Response

The driller reported two aquifers, one from 6 to 9 m with an airlift yield of 0.75 L/s and a deeper aquifer at 31 m yielding an additional 1.4 L/s.

In the first test the pumping rate was varied to allow the yield of each aquifer to be estimated separately.

The yield of the lower aquifer is much smaller than the top aquifer's, in contrast to the driller's estimate. (Fig. A-15 & A-16)

Recovery

The recovery from the first test was invalidated by recirculation of the discharge water.

The recovery from the second test clearly shows the presence of double boundary conditions.

Long Term Yield

The exact behaviour of the aquifer is difficult to predict, since the dewatering of the top aquifer is hard to model.

A reasonable approximation can be made as follows.

The one day yield would be approximately 2.8 L/s. Since double boundary conditions are present the yield will be roughly proportional to the square root of time.

Therefore the 100 day yield will be about 0.28 L/s.

Although this is not an exact answer it is clear that the well is not worth equipping.

Well 5545WW60.

Introduction

The well was pumped on 26/9/84 as shown in Table A-8.

TABLE A-8
Schedule of Pumping

Time Started	Time Stopped	Rate	Step
0800	0834	1.00 L/s	1
0834	0905	1.62 L/s	2
0905	1300	1.32 L/s	3
1300	0800	1.13 L/s	4

Aquifer Details

The driller reported that the aquifer was between 7 and 17 m and described it as 'sands and gravels'.

Gneiss outcrops in the nearby creek bed and bank, and it seems more likely that the aquifer is weathered and fractured gneiss.

Response

At the beginning of the first step the rate of drawdown was rapid, then was slowed down by drainage from the aquifer (Fig. A-17).

In the second step the capacity of the aquifer was exceeded and drawdowns increased rapidly. The aquifer is clearly thinner than reported by the driller.

The third and fourth steps both show an initial rise when the pumping rate was reduced followed by a decline as the rate at which the aquifer yielded water declined to less than the pumping rate. This rapid decline in yield is explained by the recovery (Fig. A-18) which clearly shows the presence of double boundary conditions.

Long Term Yield

The behaviour of the aquifer is difficult to predict precisely because of the importance of aquifer dewatering. However reasonable estimate can be made assuming that yield will be proportional to the square root of time.

One day yield is about 1.2 L/s, therefore 100 day yield is about 0.12 L/s, and the well is not worth equipping.

Well 5545WW59.

Introduction

The well was pumped as shown in Table A-9.

TABLE A-9
Schedule of Pumping

Time	Date	Pump rate	Comments
0842	30/9/84	1.3 L/s	
1332	30/9/84	2.6 L/s	
0725	11/10/84	3.0 L/s	
0800	1/10/84	3.0 L/s)	Attempted to increase pumping rate. Water level lowered and air pumped without measurable rate increase.
0900	1/10/84	Pump stopped)	

Well Details

The driller reported an aquifer yielding 0.25 L/s from 6.5 to 7 m and another yielding 1.75 L/s from 17 to 30 m.

These figures do not correspond with the behaviour of the well observed during test pumping.

Response

In the first step the rate of drawdown (semi-log, Fig. A-19) slowed at about 3 m, suggesting that aquifer dewatering is stabilizing drawdowns.

Doubling the pumping rate in the second step produced an increased rate of drawdown showing that the upper aquifer at about 10 m had been dewatered. This step came close to stabilizng at about 10 m of drawdown.

According to the driller it should have been possible to increase drawdowns below 10 m.

However attempting to do this merely produced aerated water without increasing the flow, indicating that the bottom of the aquifer had been reached and water was cascading into the well.

Recovery

Initial recovery was very rapid, but became slower with time. The plot of $\sqrt{t}-\sqrt{t_1}$ (Fig. A-20) at first suggested double boundary conditions, but with increasing time recovery appears to be trending below the origin.

Long Term Yield

The recovery suggests that the well taps a double boundary aquifer of limited extent.

At best the yield would be proportional to the square root of time, that is 100 day yield will be about 0.25 L/s. However this may be over-optimistic. The well is not worth equipping.

Well 5544WW140.

Introduction

Test pumping commenced at 0737 hrs. on 20/9/84 and stopped at 0800 hrs. on 21/9/84. The average pumping rate was 4.1 L/s.

Response

After an initial rapid fall due to near well head losses drawdown was linear with the square root of time (Fig. A-21). The recovery lies on a line above and steeper than that predicted from the drawdown (Fig. A-22). This suggests that long term performance may be better than would be expected from extrapolation of the drawdown.

Long Term Yield

From the drawdown plot an equation was derived:

$$s = Q(0.23 + 0.24\sqrt{t})$$

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

The driller recorded waters cut 12 m and 16 m, the largest water cut being at 16 m.

It has been assumed that the available drawdown to the top aquifer is 5 m, after which the rate of drawdown will double to the top of the next aquifer at 16 m.

Therefore the effective available drawdown is 7 m and yields are as follows:

100 days	2.6 L/s
200 days	1.9 L/s
1 year	1.4 L/s

Well 5545WW50.

Introduction

The well was pumped as shown in Table A-10.

TABLE A-10
Schedule of pumping 5545WW50

Time	Date	
0905	17/9/84	Pump started, rate 1.6L/s
1005	17/9/84	Rate increased to 2.9L/s
0900	18/9/84	Pump stopped

Water levels were observed in 5545WW51 during test, but no drawdown was detected.

Response

The plot of drawdown against log time (Fig. A-23) is roughly linear, with some down curving suggestive of double boundary conditions. The latter seems to be confirmed by the linear plot with the square root of time. (Fig. A-24)

On the other hand the plot of t/t_1 for the recovery period (Fig. 1-23) does not show clear evidence of double boundary conditions, but rather suggests the presence of delayed yield.

However for reasons as discussed for the nearby 5545WW51 it seems likely that the aquifer is a relatively narrow sand-filled channel. Therefore a square root of time extrapolation has been used.

The equation derived is

$$s = 0.40\ Q + 0.07\ Q\sqrt{t}$$

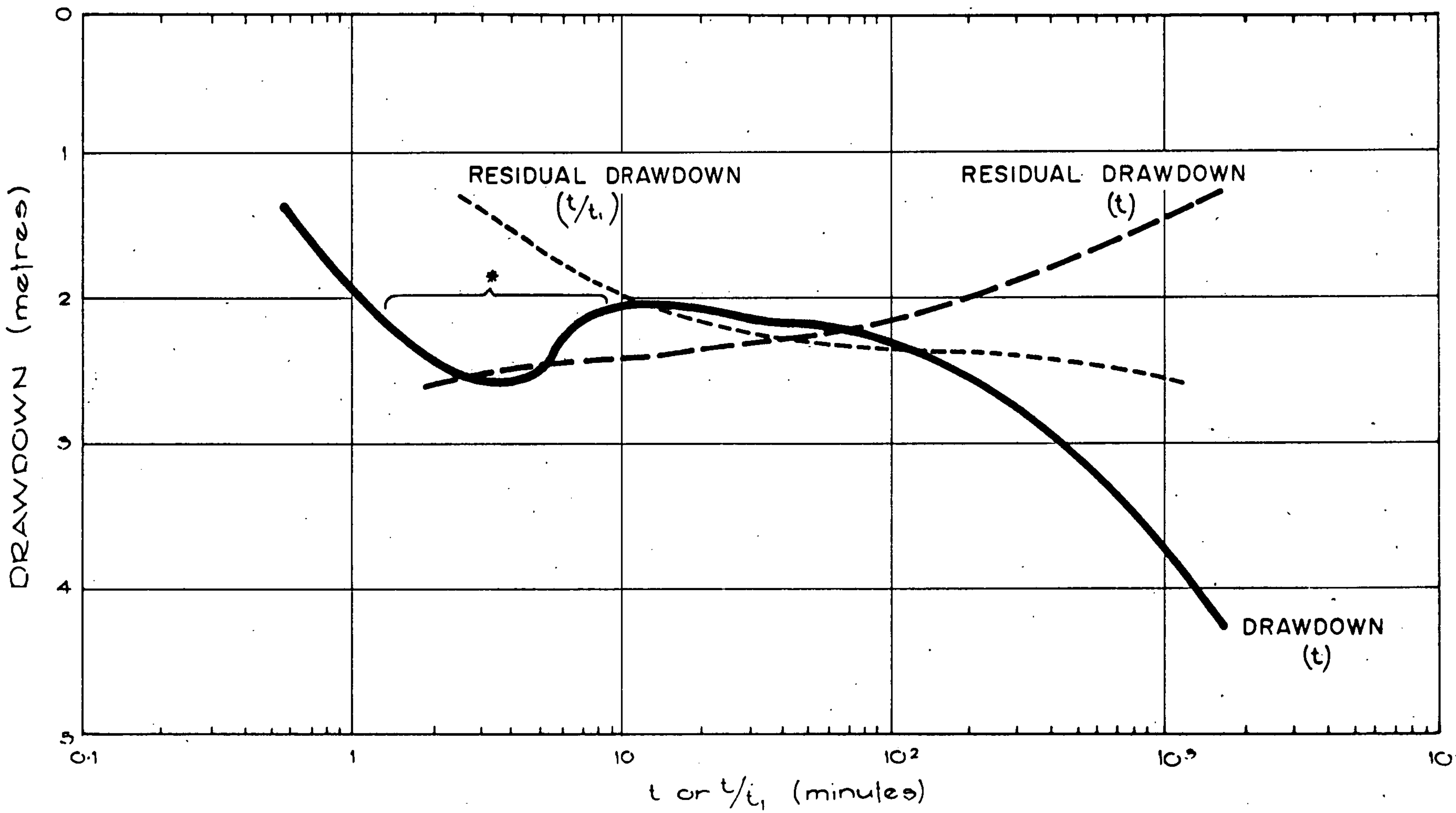
where s is in metres
Q is in L/s
t is in days

Long Term Yield

From the above equation assuming an available drawdown of 4 m the following yields can be derived:

1 year, 2.3L/s
200 days, 3.0L/s
100 days, 3,8L/s.

3885



* Varying Pump Rate

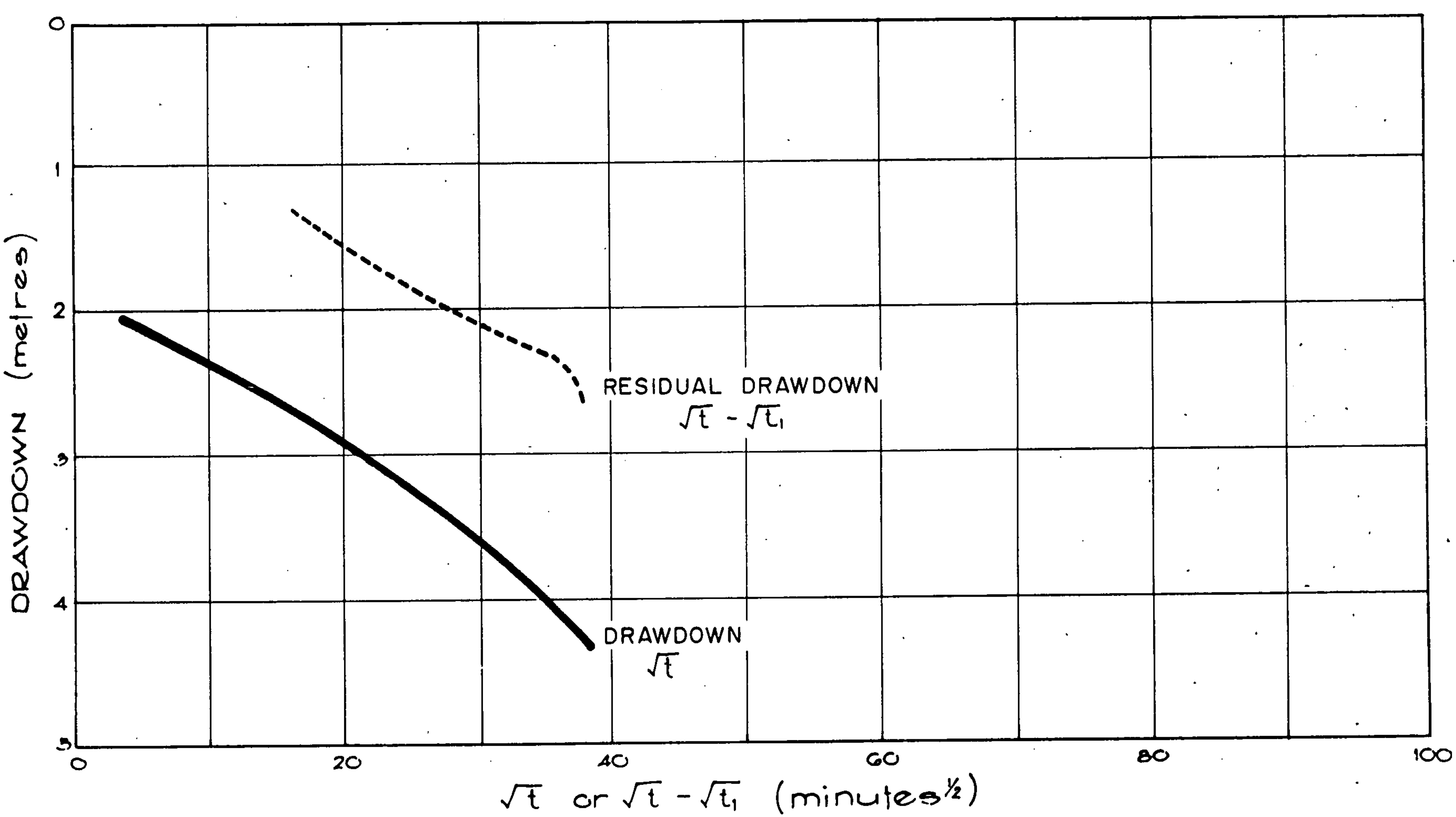
FIG. A-1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5544000WW00148
WELL DRAWDOWNS (SEMI-LOG)

COMPILED R. READ	C.D.O.	DATE 20-11-85
DRAWN E. Colabic	SCALE	
DATE Aug.'85	PLAN NUMBER	
CHECKED	S 18357	

3885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5544000WW00148
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED	R. Read		
DRAWN	E.C.	C D O	DATE 20.11.85
DATE	Aug. '85	SCALE	
CHECKED		PLAN NUMBER	S 18358

FIG. A-2

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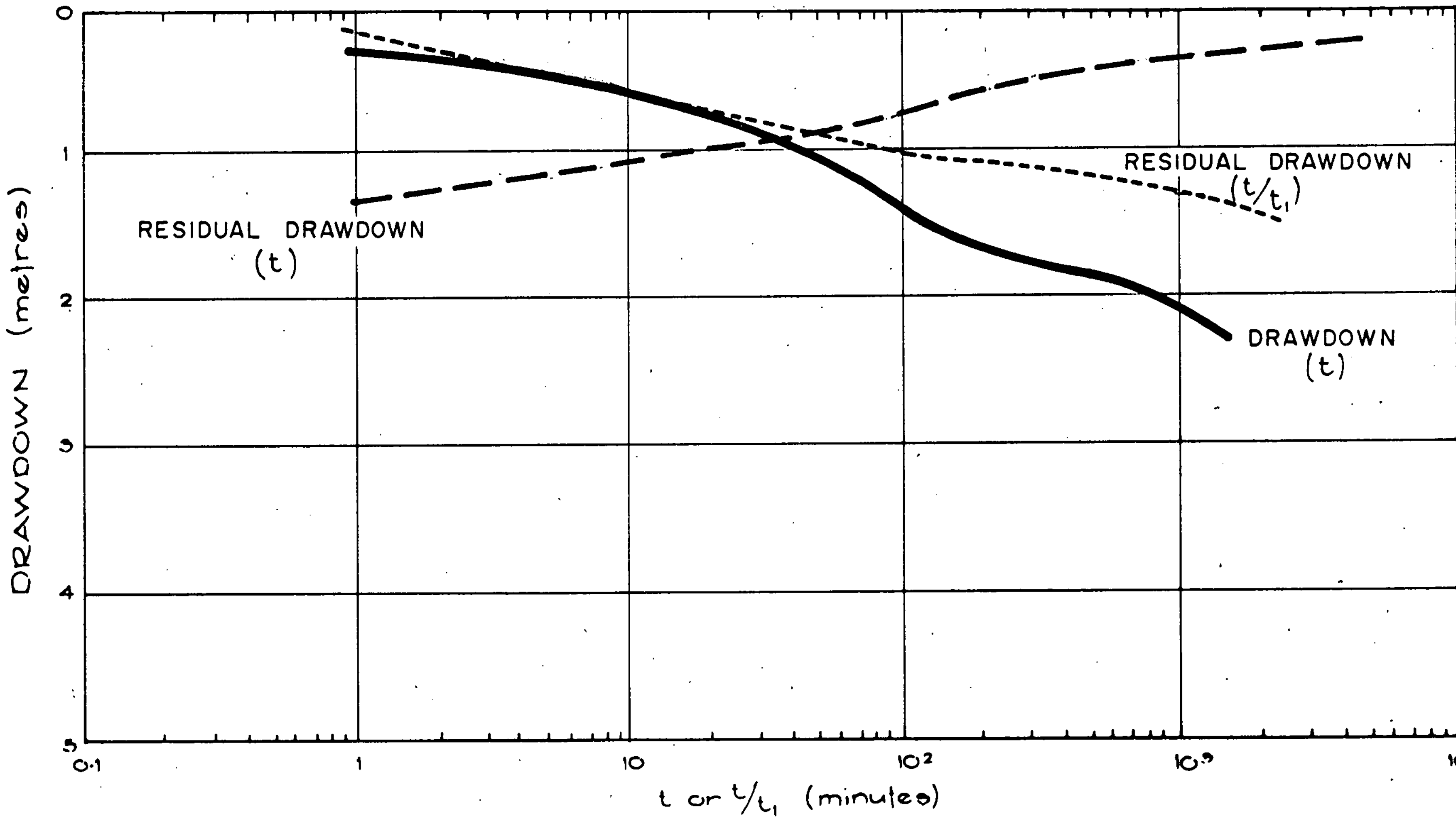


DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00135
WELL DRAWDOWNS (SEMI-LOG)

COMPILED	R. Reed	C.D.O.	20.11.85
DRAWN	E.C.	SCALE	
DATE	Aug. '85	PLAN NUMBER	S 18359
CHECKED			

FIG. A-3

3885

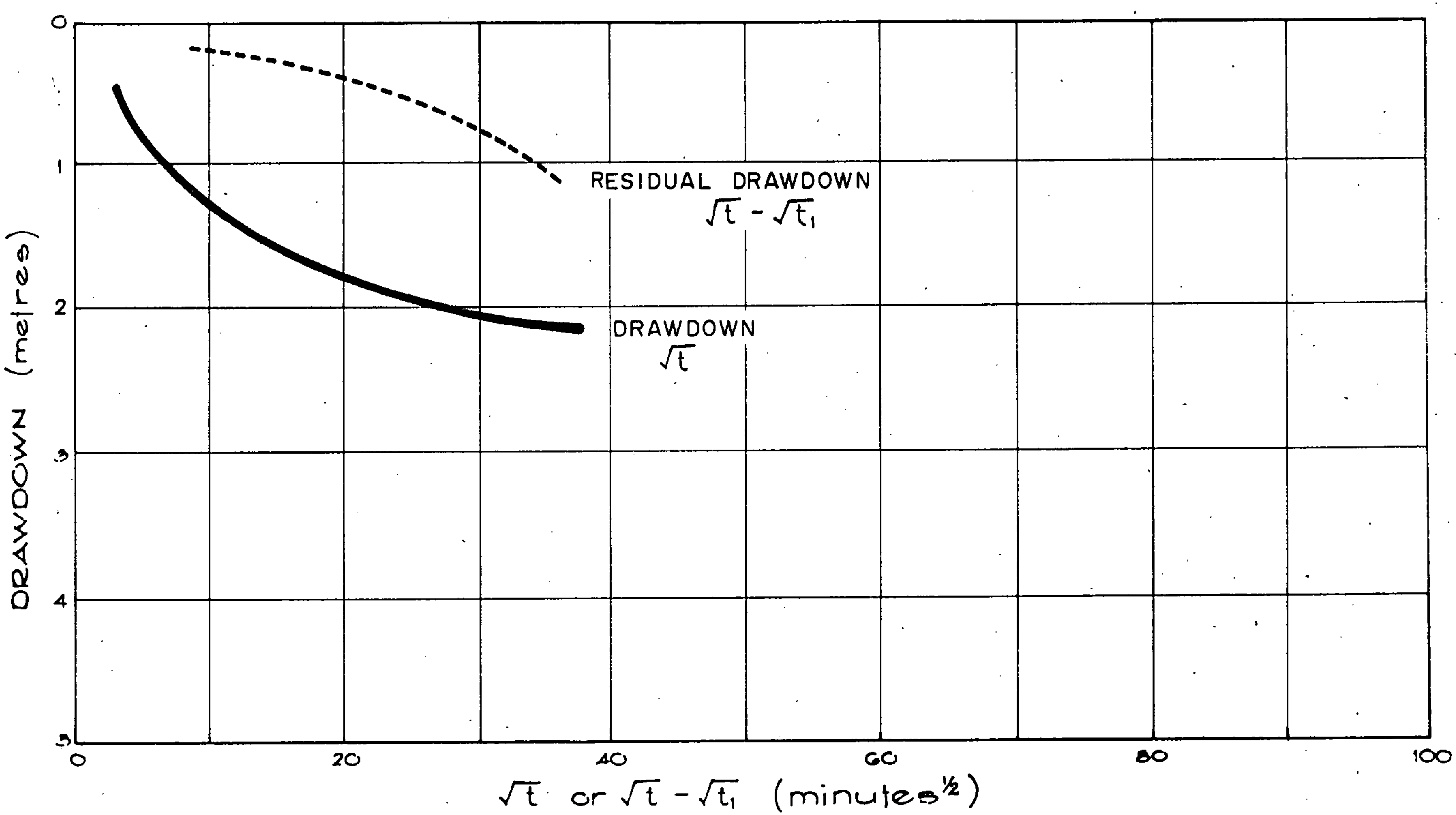


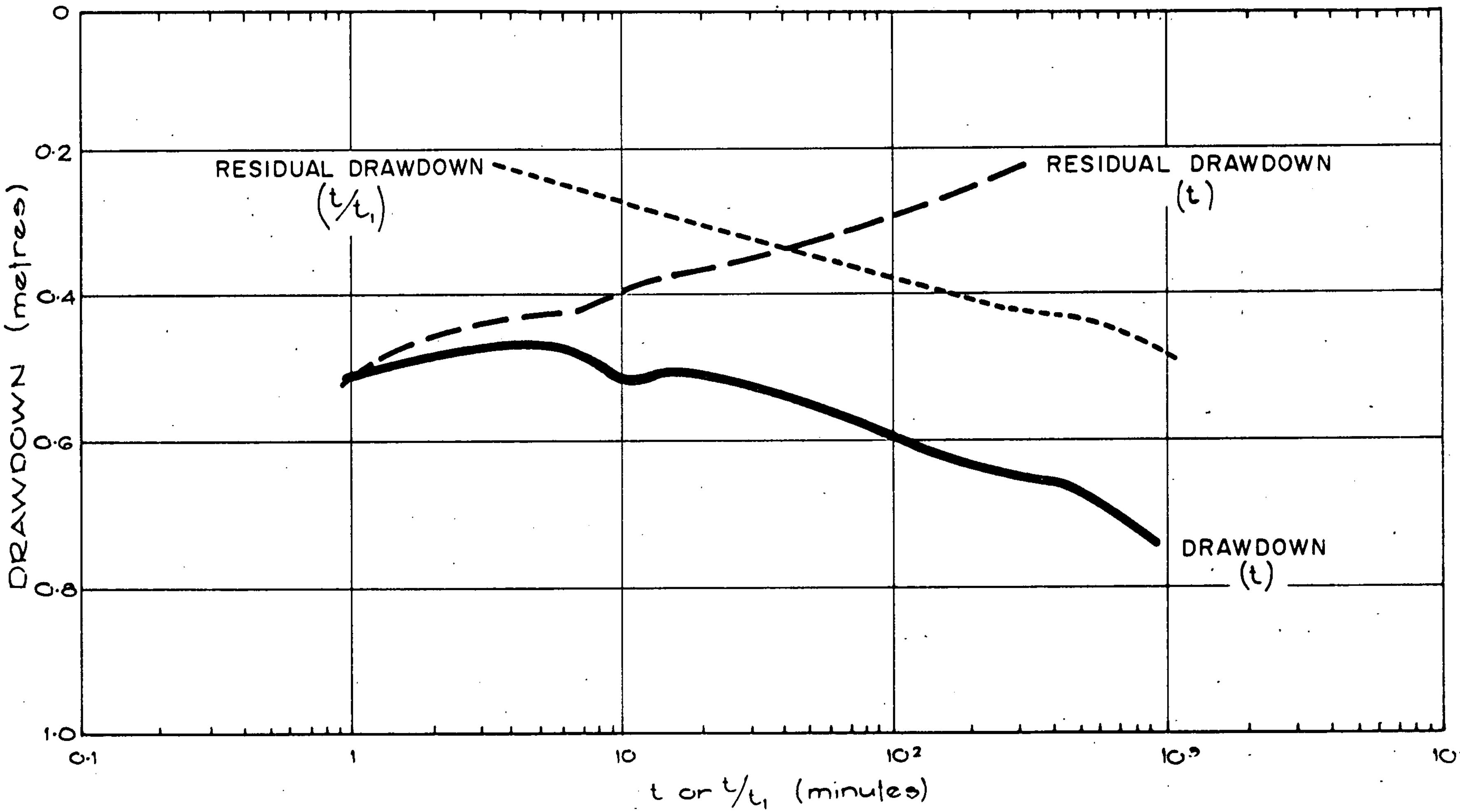
FIG. A-4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00135
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	C.D.O.	DATE 20.11.85	
DRAWN E.C.	SCALE		
DATE Aug. '85			
CHECKED	PLAN NUMBER S 18360		

3885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

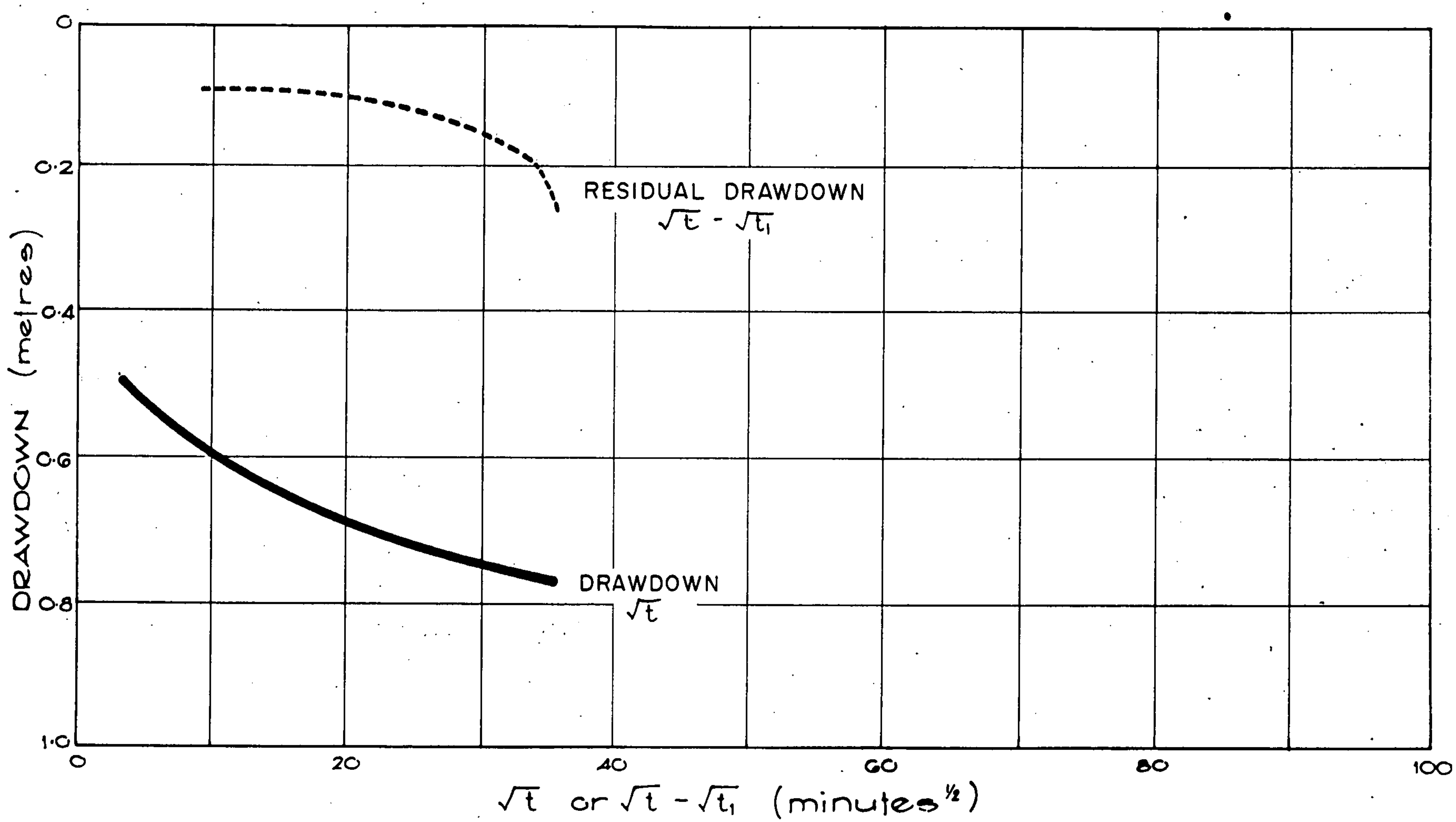
STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545WW00057
WELL DRAWDOWNS (SEMI - LOG)

COMPILED	R. READ	C.D.O	20·11·85 DATE
DRAWN	E.C.	SCALE	
DATE	AUG. 85	PLAN NUMBER	
CHECKED		S 18361	

FIG. A-5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00057
WELL DRAWDOWNS (SQUARE ROOT OF TIME)



COMPILED	R. Read	C.D.O.	DATE 20·11·85
DRAWN	E.C.	SCALE	
DATE	Aug. '85		
CHECKED		PLAN NUMBER	S 18362

FIG. A-6

3885

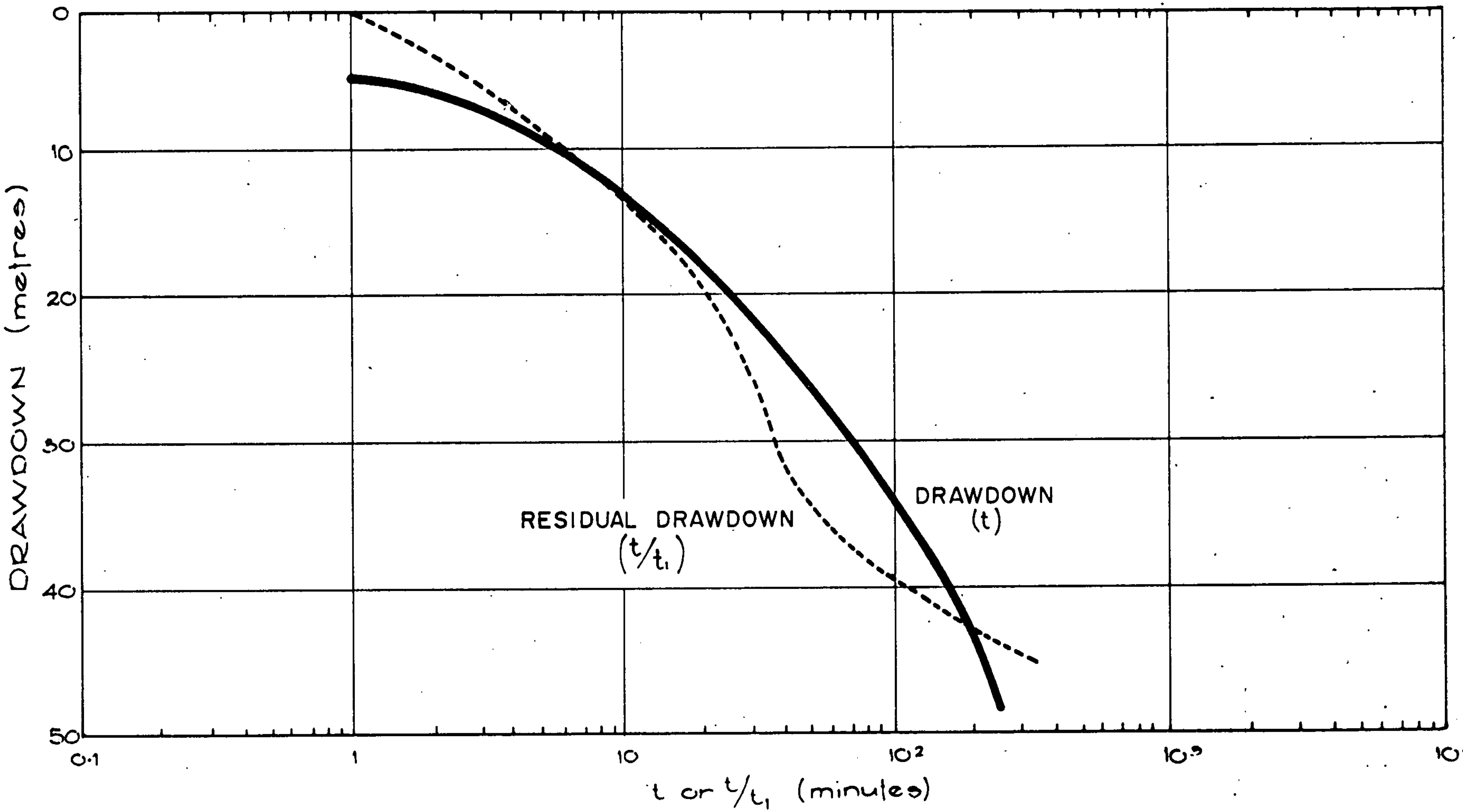


FIG. A-7.

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00053
WELL DRAWDOWNS (SEMI-LOG)

COMPILED R.Read	C.D.O.	DATE 20.11.85
DRAWN E.C.	SCALE	
DATE Aug.'85	PLAN NUMBER	
CHECKED	S18363	

5885

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00053
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED	DRAWN	DATE	CHECKED	C.D.O.	DATE	SCALE	PLAN NUMBER
R. Read	E.C.	Aug.'85			20.11.85		S18364

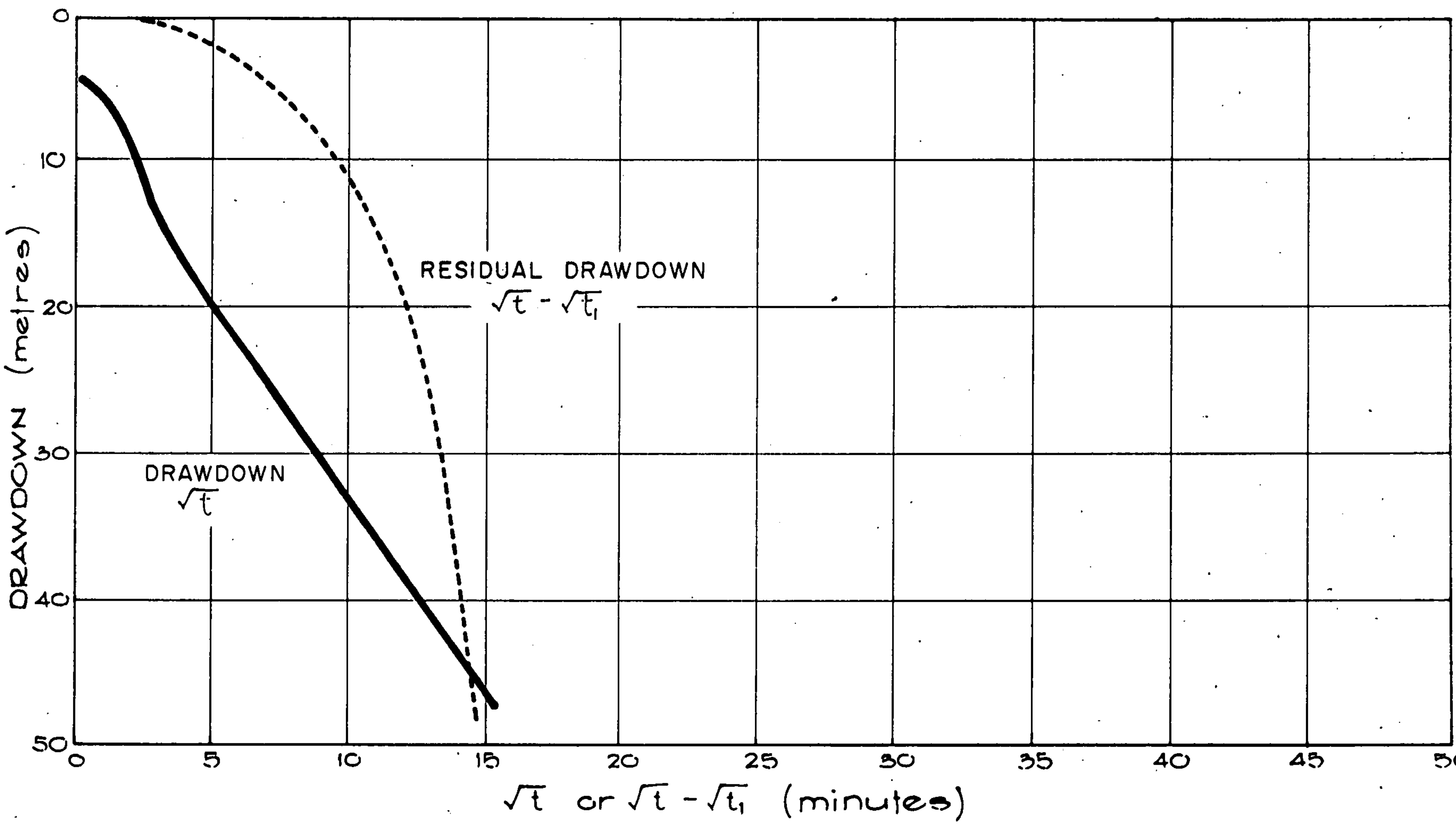


FIG. A-8

3885

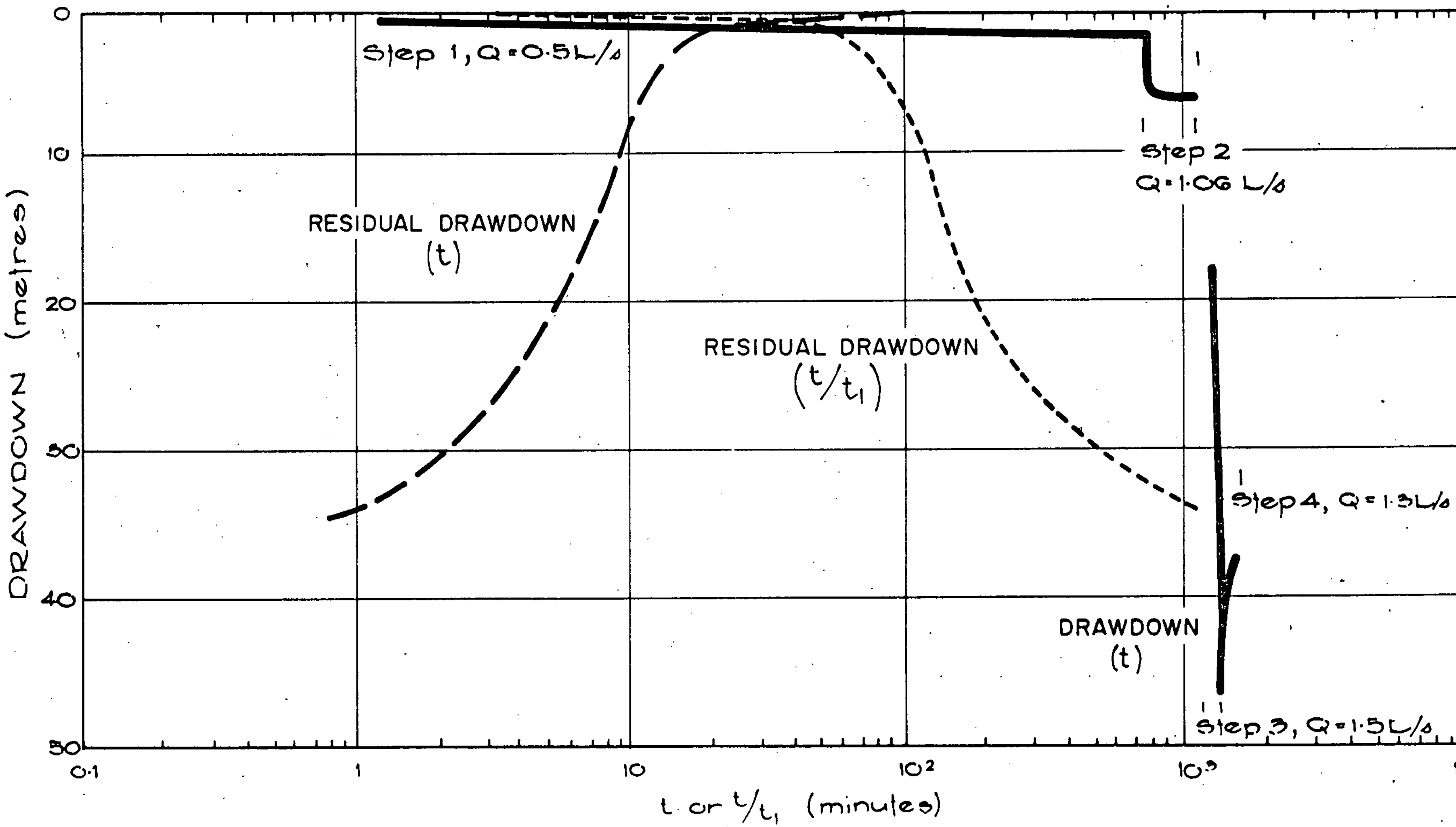


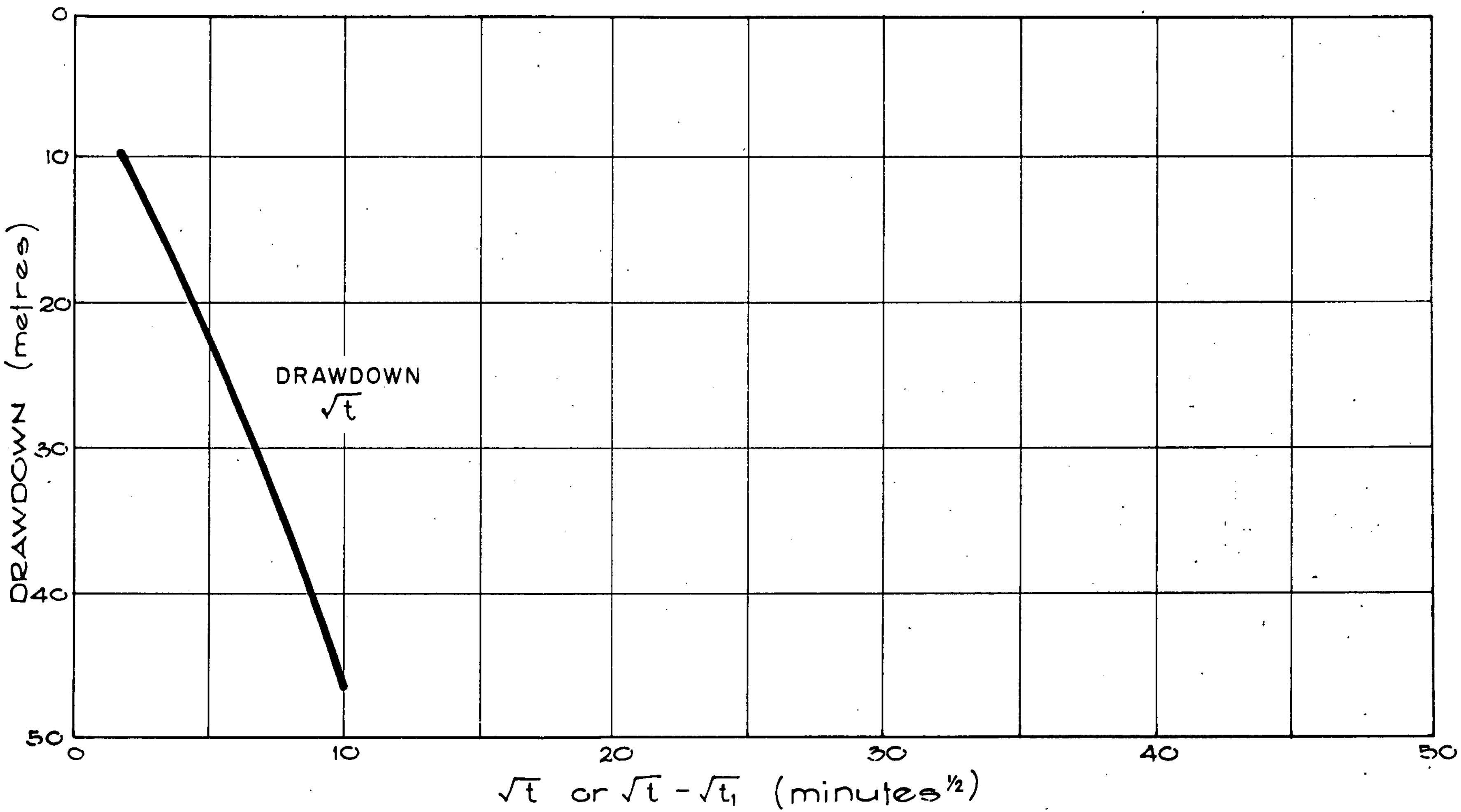
FIG. A-9

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00054
WELL DRAWDOWNS (SEMI-LOG)

COMPILED R.Read		C.D.O.	DATE 20.11.85
DRAWN E.C.		SCALE	
DATE Aug.'85	CHECKED	PLAN NUMBER	S 18365

3885



Note: Step 3 only.

FIG. A-10

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00054
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	C.D.O. 20.11.85 DATE
DRAWN E.C.	SCALE
DATE Aug '85	PLAN NUMBER
CHECKED	S18366

3885

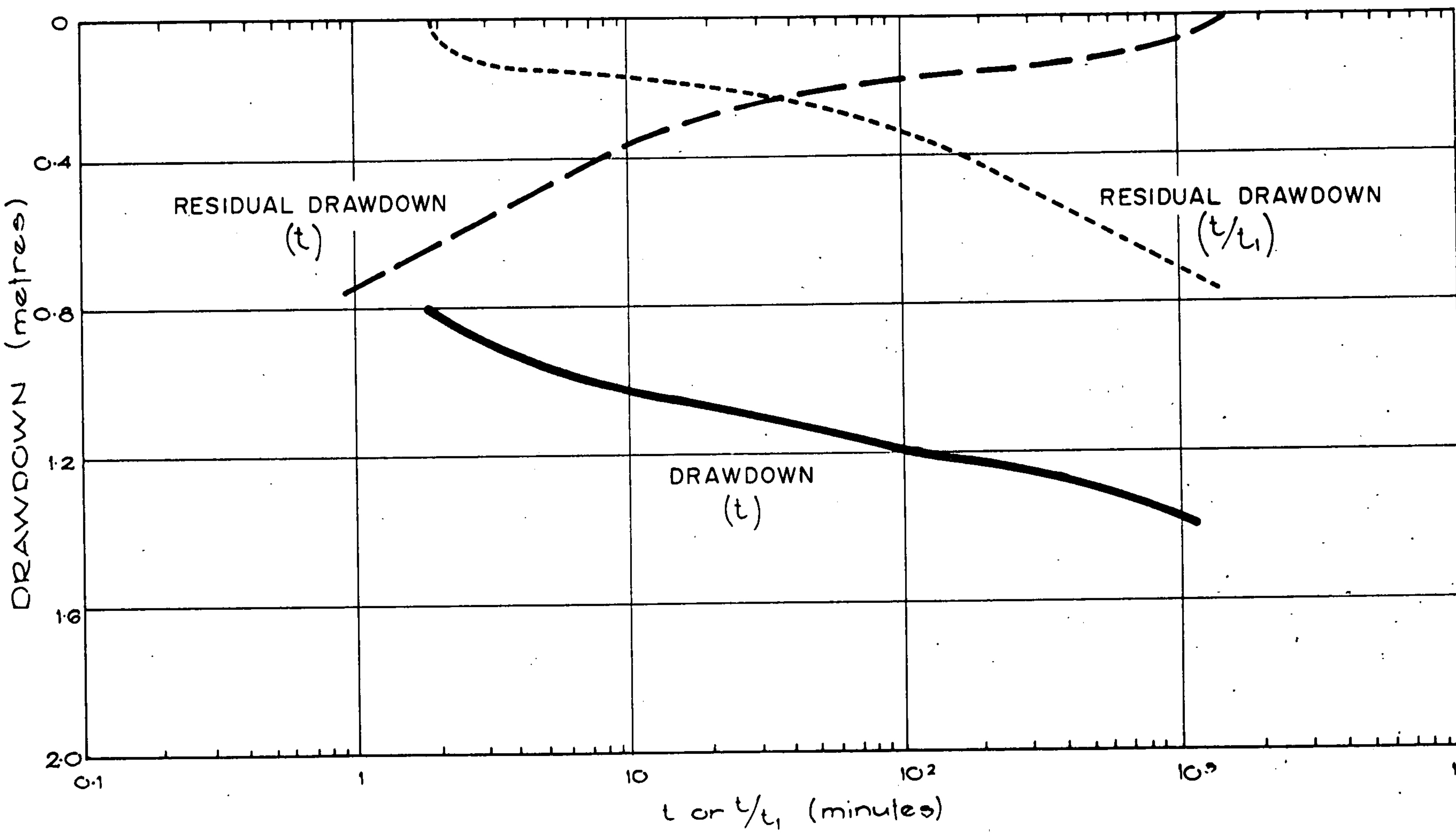


FIG. A-11

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00051
WELL DRAWDOWNS (SEMI-LOG)

COMPILED	R.Read	C.D.O.	DATE 20·11·85
DRAWN	E.C.	SCALE	
DATE	Aug.'85	PLAN NUMBER	S 18367
CHECKED			

3885

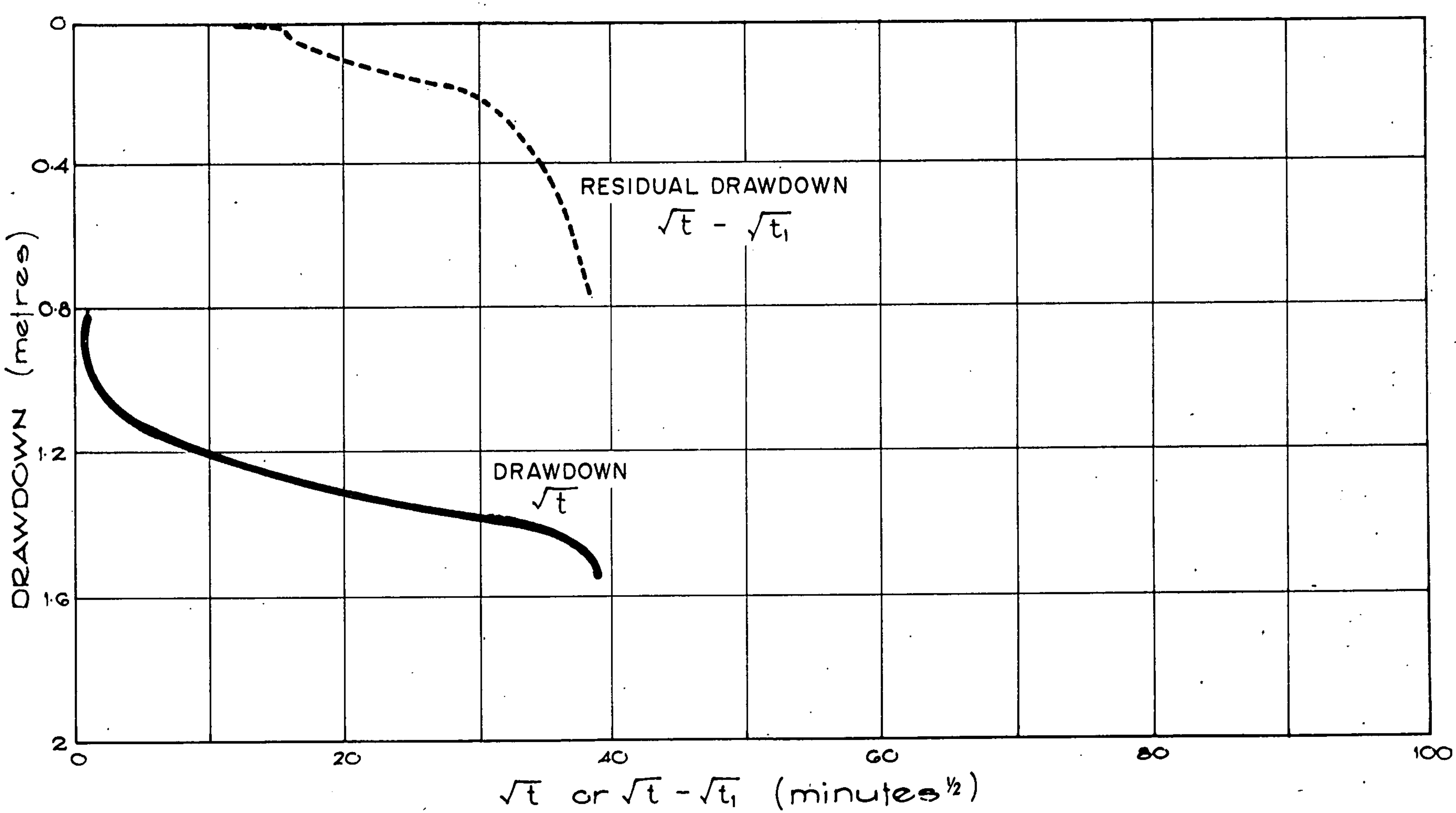


FIG. A-12

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00051
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R.Read	C.D.O.	DATE 20.11.85
DRAWN E.C.	SCALE	
DATE Aug.'85	PLAN NUMBER	
CHECKED	S 18368	

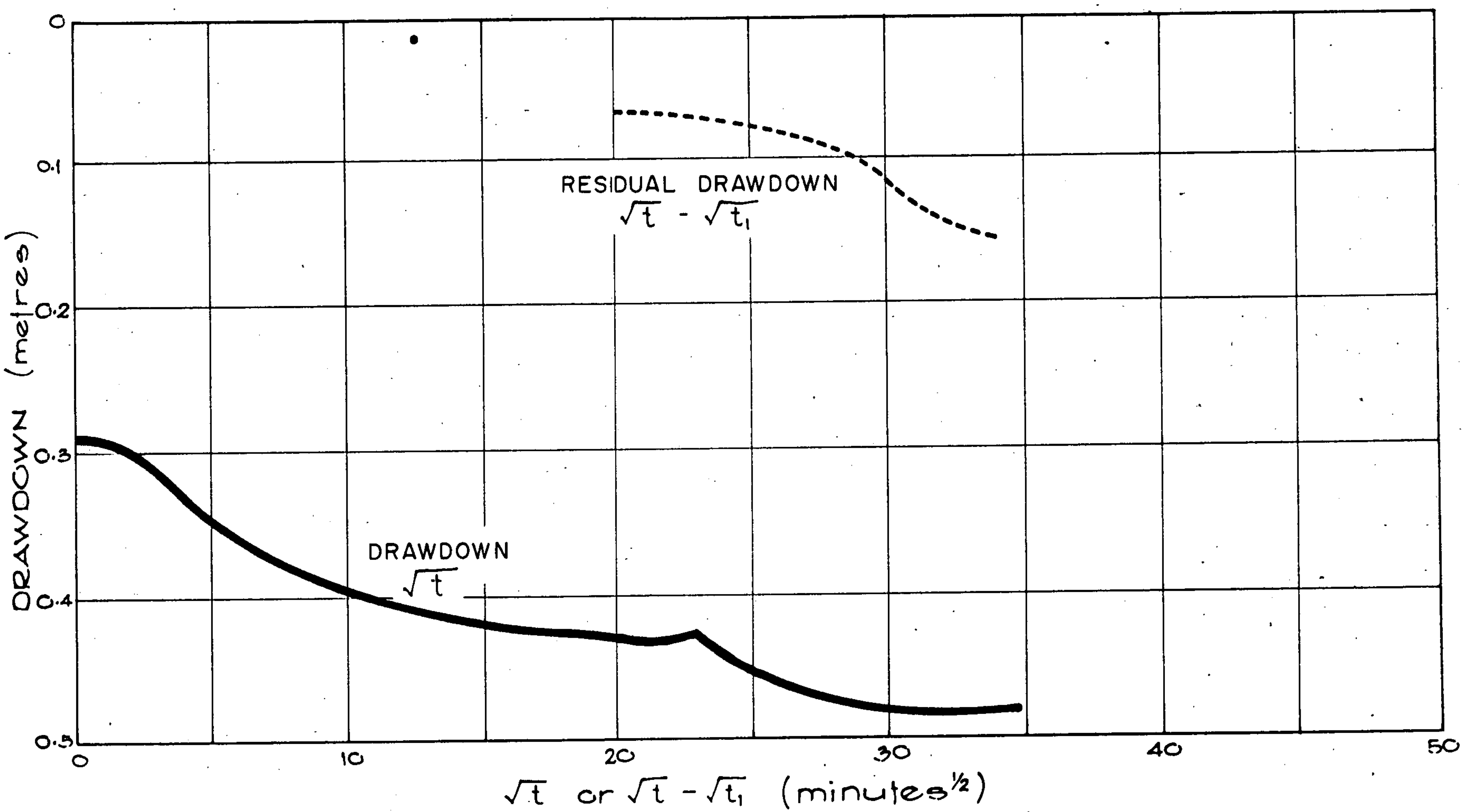
3885

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5544000WW00045
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	C.D.O. 20.11.85 DATE
DRAWN E.C.	SCALE
DATE Aug. '85	PLAN NUMBER
CHECKED	S 18369

FIG. A-13



3885

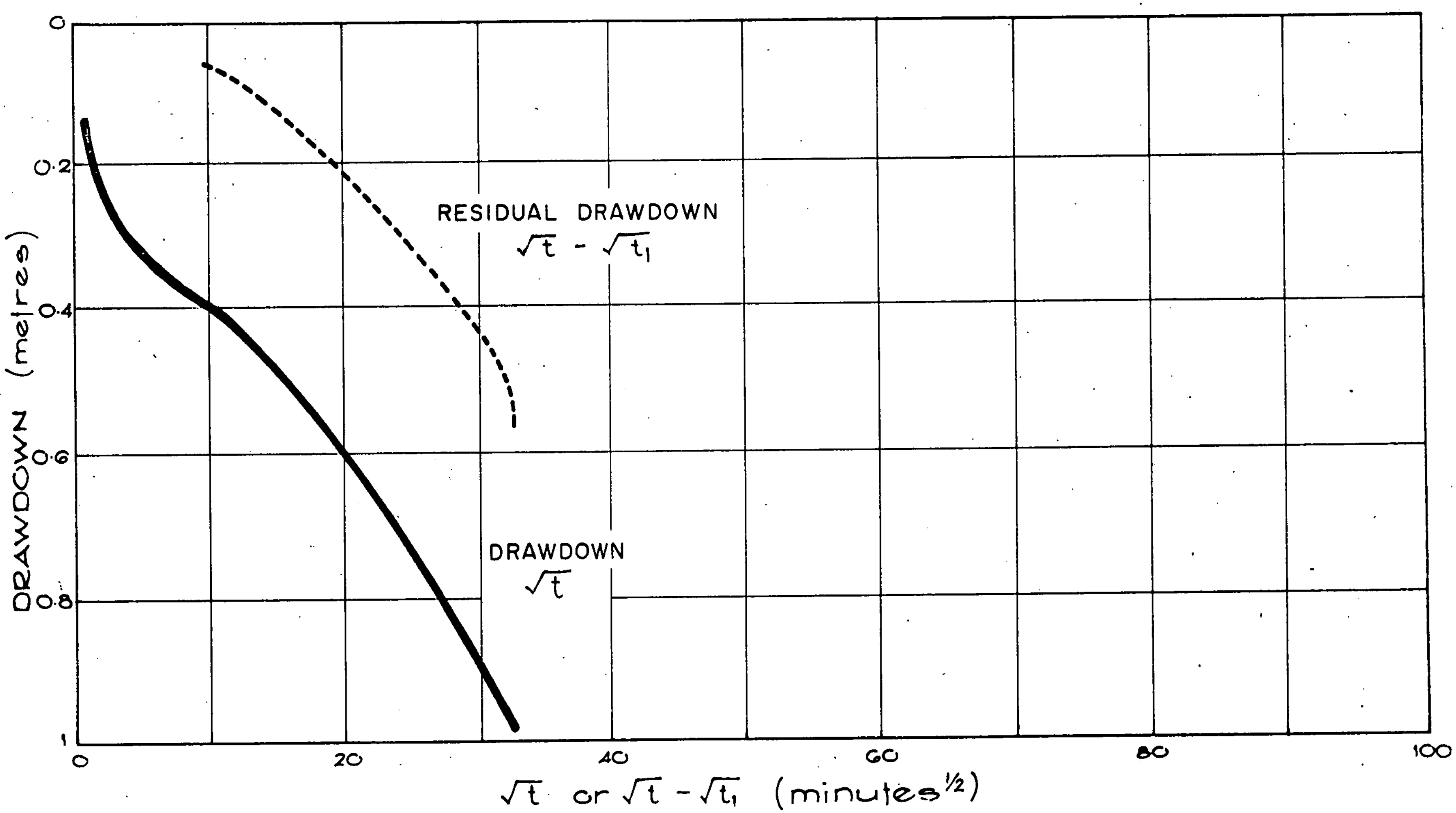


FIG. A-14

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00048
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	C.D.O. WC	DATE 20.11.85
DRAWN E.C.	SCALE	
DATE Aug. '85	PLAN NUMBER	
CHECKED	S 18370	

3885

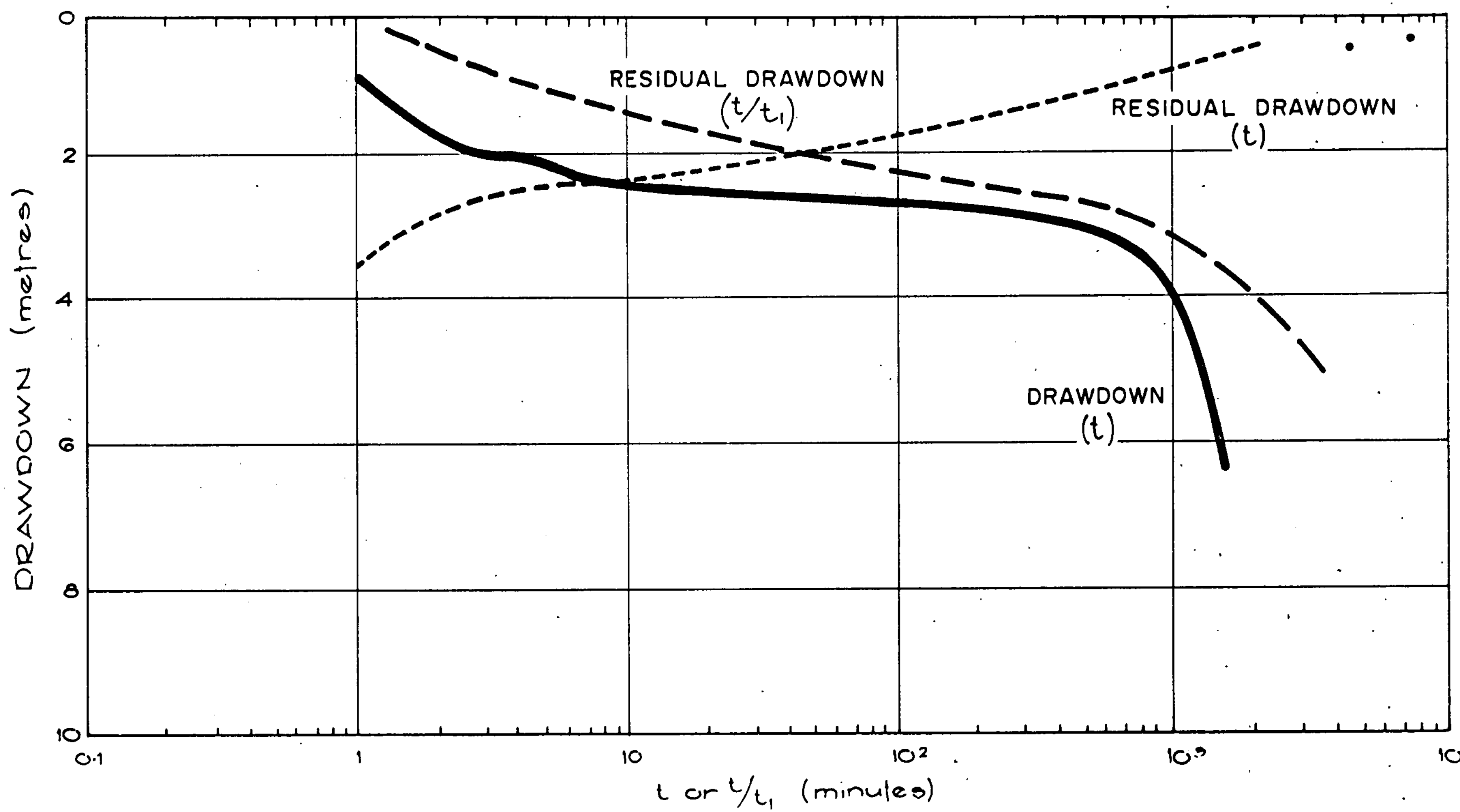


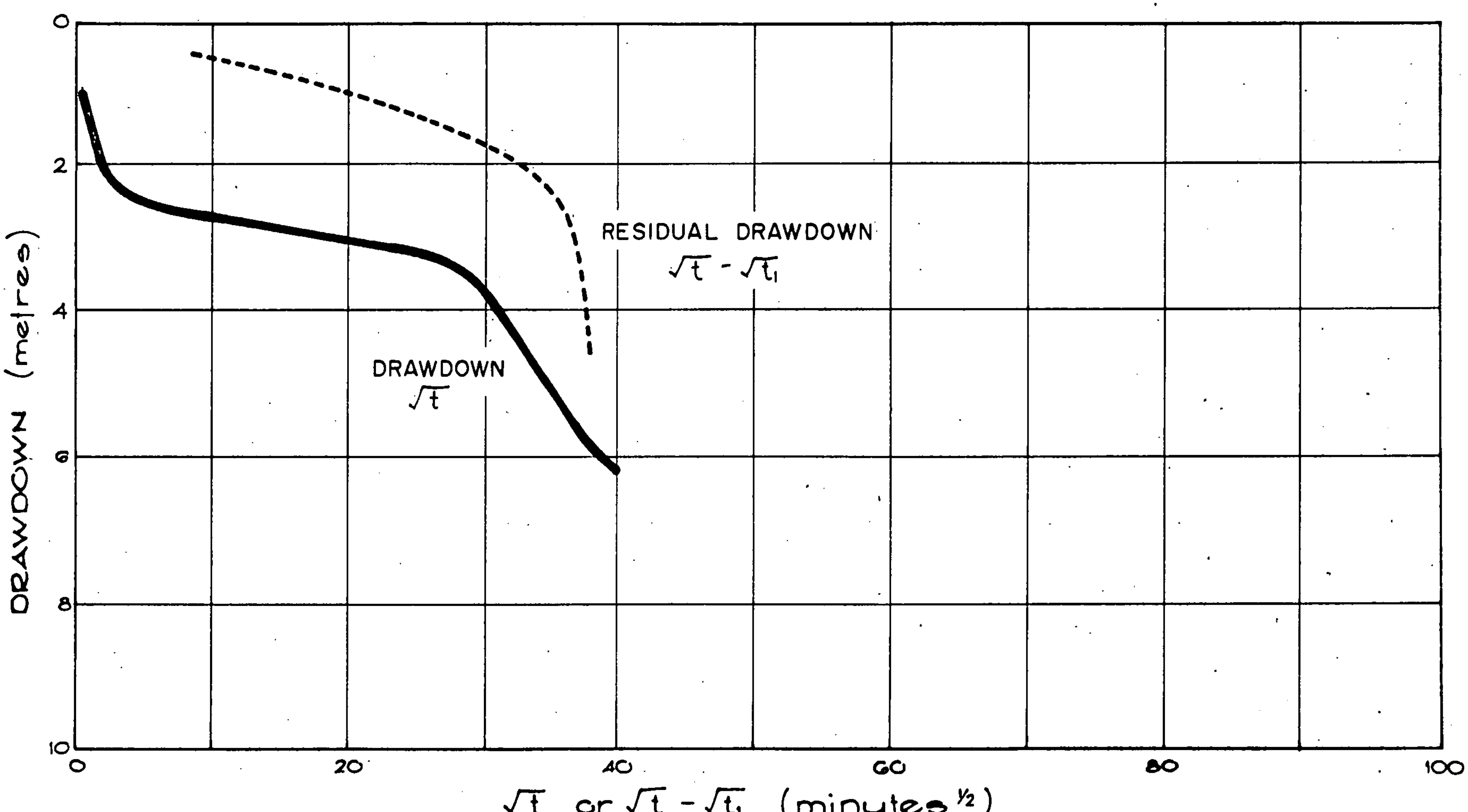
FIG. A-15

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00058
WELL DRAWDOWNS (SEMI-LOG)

COMPILED R. Read	C.D.O.	DATE 20·11·85
DRAWN E.C.	SCALE	
DATE Aug. '85	PLAN NUMBER	S 18371
CHECKED		

5885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY

MARLA TO NORTHERN TERRITORY BORDER SECTION

WELL No. 5545000WW00058

WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED: R. Read	C.D.O: [signature]	DATE: 20.11.85
DRAWN: E.C.	SCALE	
DATE: Aug '85	PLAN NUMBER: S 18372	
CHECKED		

FIG. A-16

3885

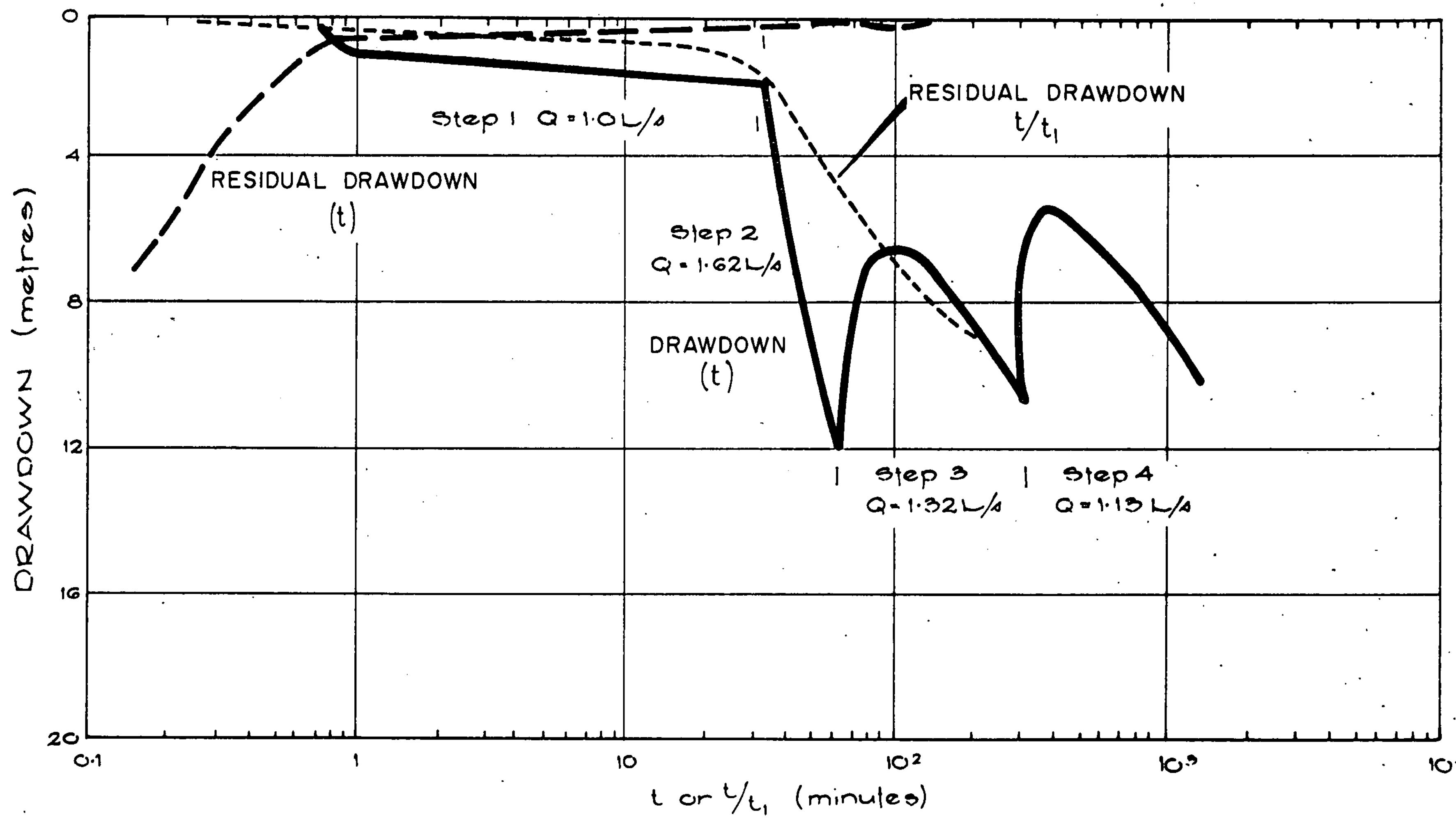


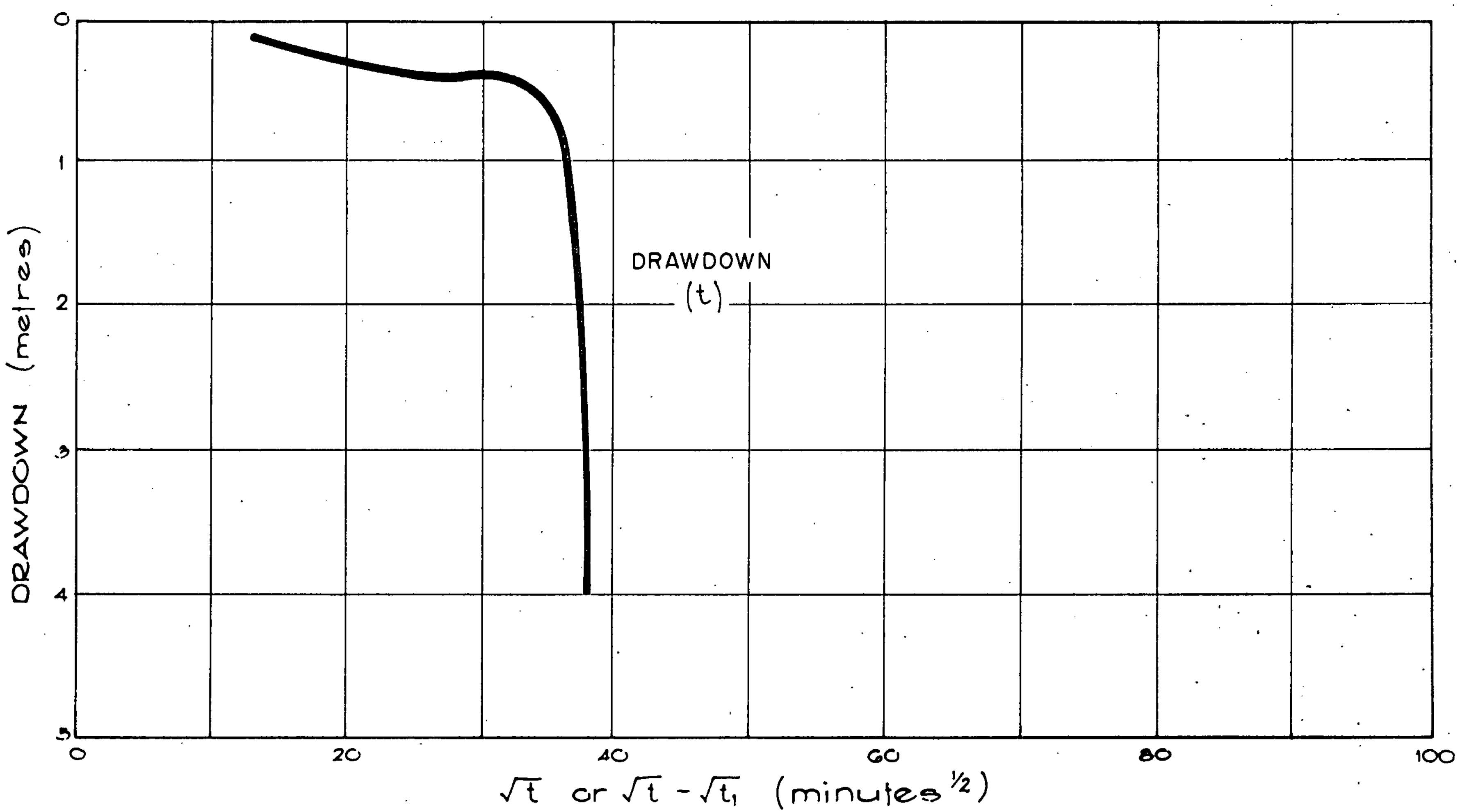
FIG. A-17

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00060
WELL DRAWDOWNS (SEMI-LOG)

COMPILED R.Read	CDO	DATE 20.11.85
DRAWN E.C.	SCALE	
DATE Aug.'85	PLAN NUMBER	S 18373
CHECKED		

3885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00060
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

FIG. A-18

COMPILED	R. Read	C.D.O.	DATE 20·11·85
DRAWN	E.C.	SCALE	
DATE	Aug. '85	PLAN NUMBER	S 18374
CHECKED			

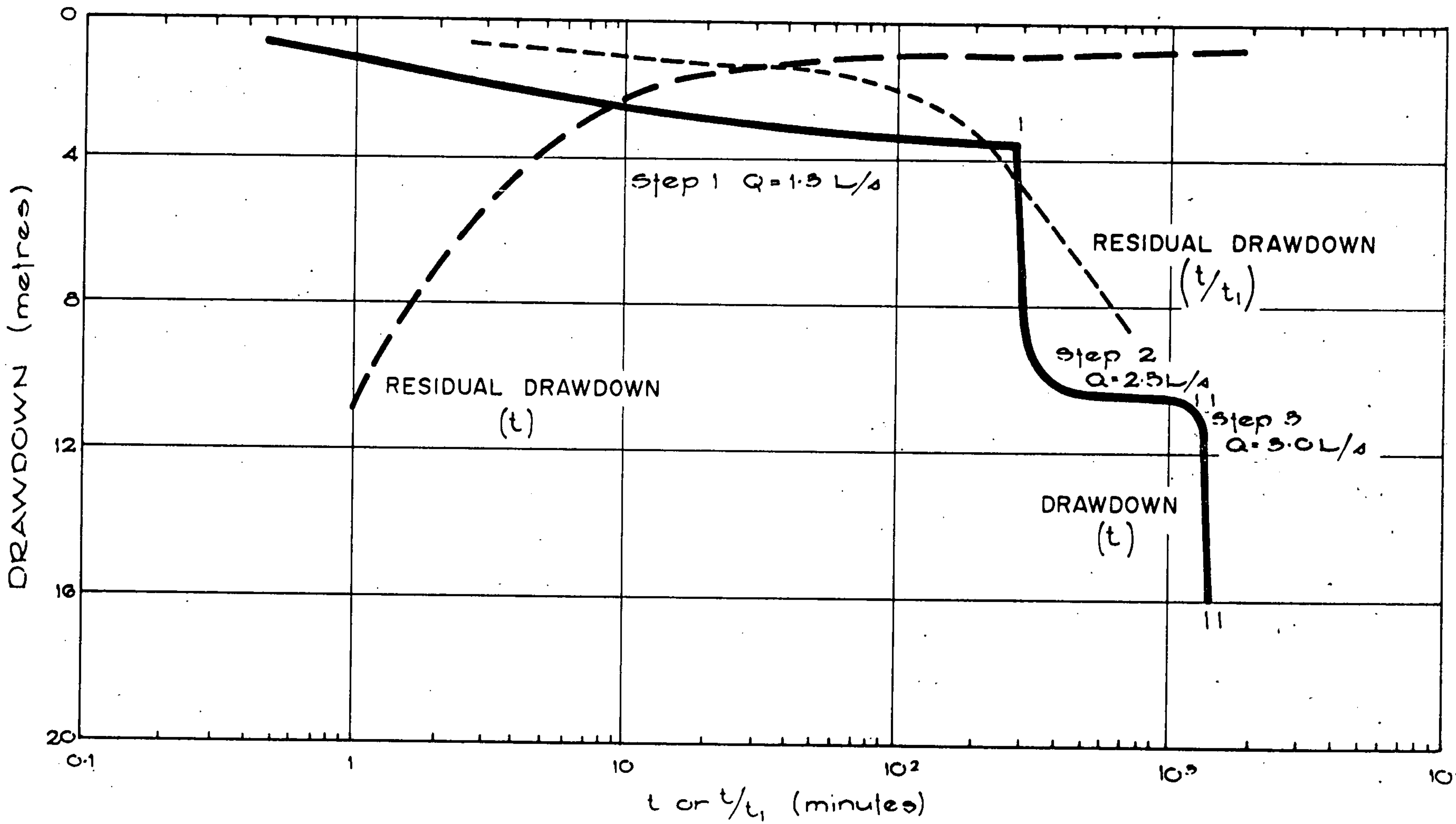
3885

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00059
WELL DRAWDOWNS (SEMI-LOG)

COMPILED	R. Read	C.D.O.	DATE 20.11.85
DRAWN	E.C.	SCALE	
DATE	Aug. '85	PLAN NUMBER	S 18375
CHECKED			

FIG. A-19



3885

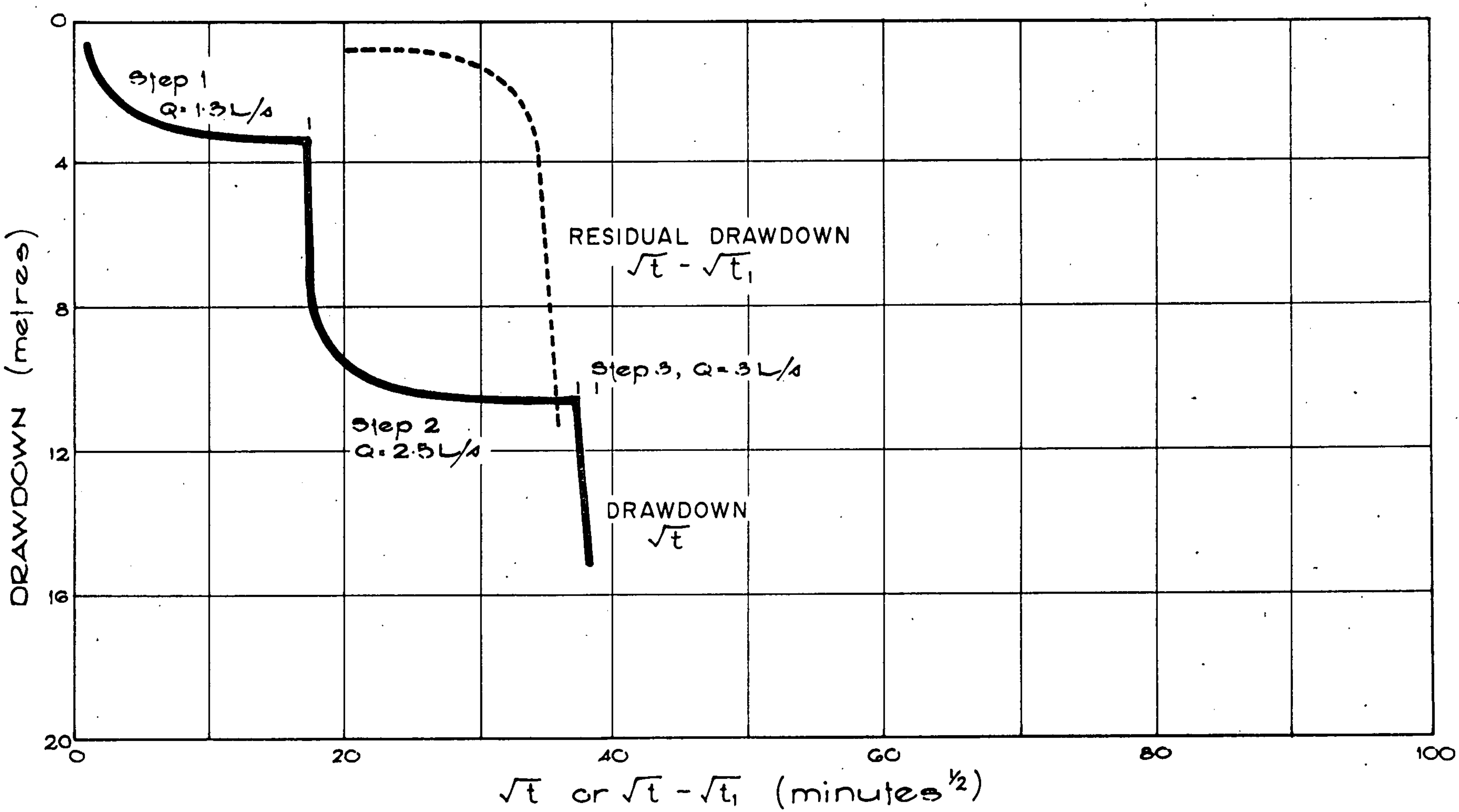


FIG. A-20

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00059
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R.Read	C D O 20.11.85 DATE
DRAWN E.C.	SCALE
DATE Aug.'85 CHECKED	PLAN NUMBER S 18376

3885

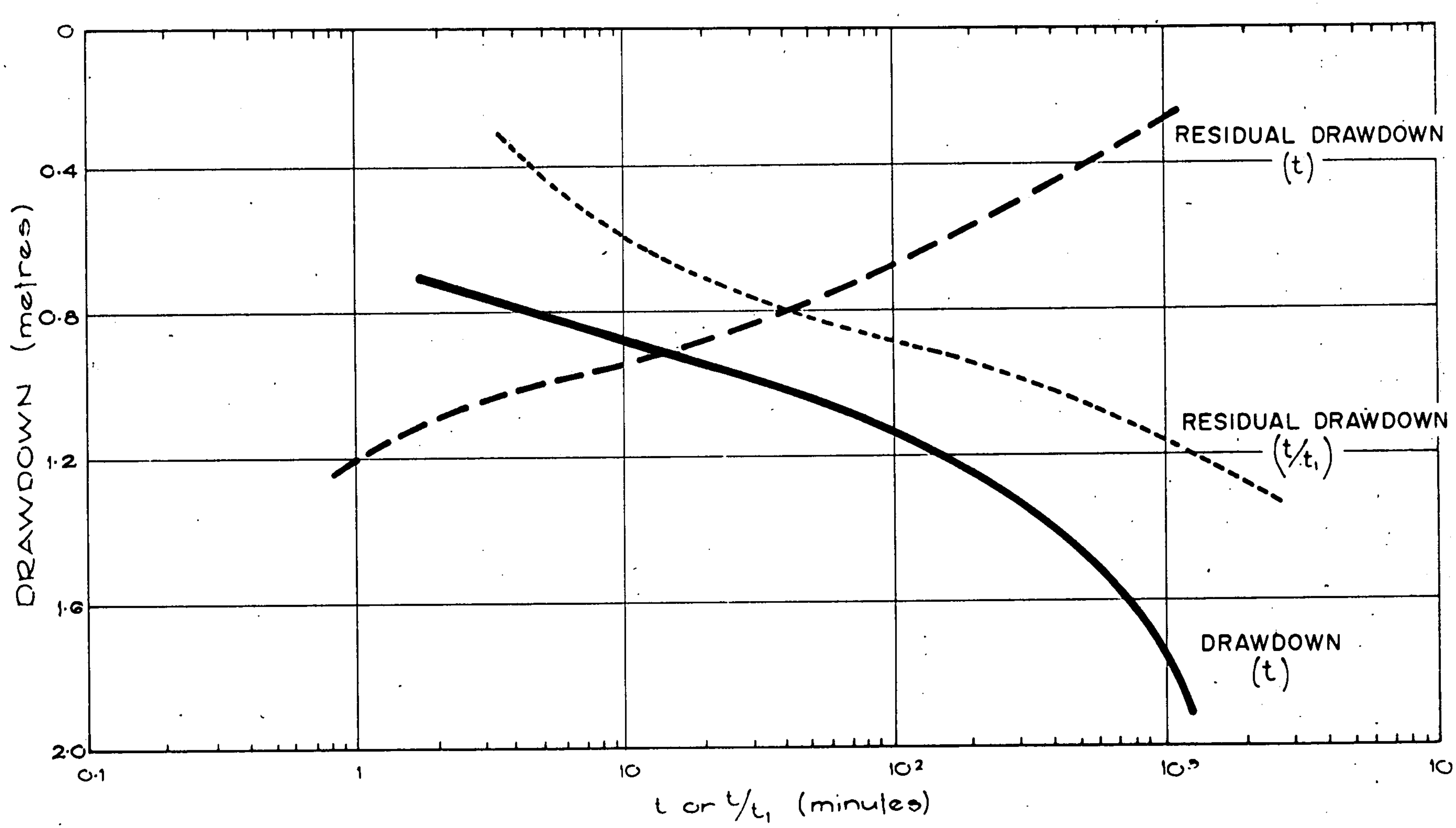


FIG. A-21

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5544000WW00140
WELL DRAWDOWNS (SEMI - LOG)

COMPILED	R. Read	C.D.O.	DATE 20.11.85
DRAWN	E.C.	SCALE	
DATE	Aug.'85	PLAN NUMBER	
CHECKED		S 18377	

3885

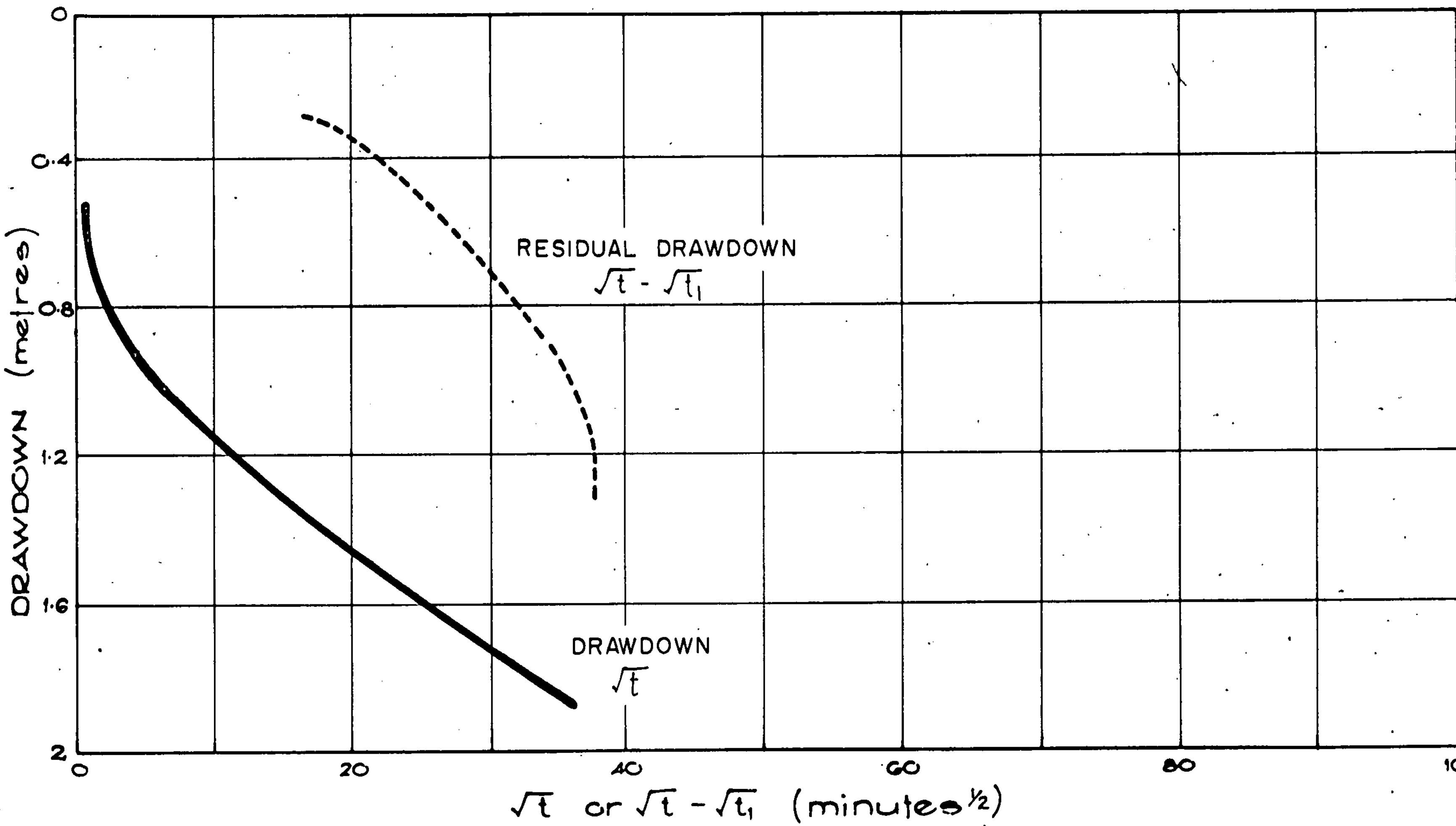


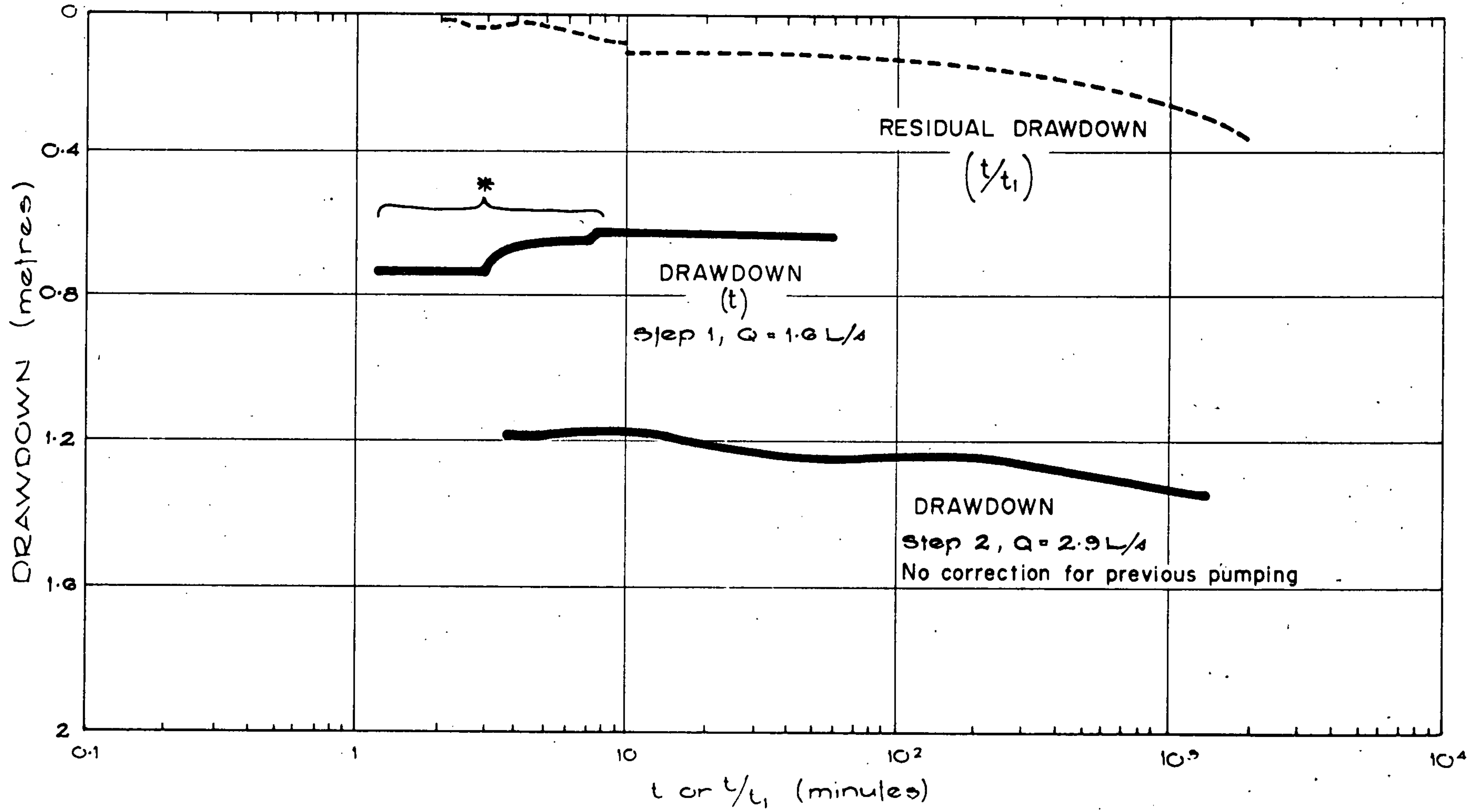
FIG. A-22

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5544000WW00140
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	C.D.O.	DATE 20.11.85
DRAWN E.C.	SCALE	
DATE Aug '85	PLAN NUMBER	
CHECKED	S 18378	

3885



* Varying Pump Rate

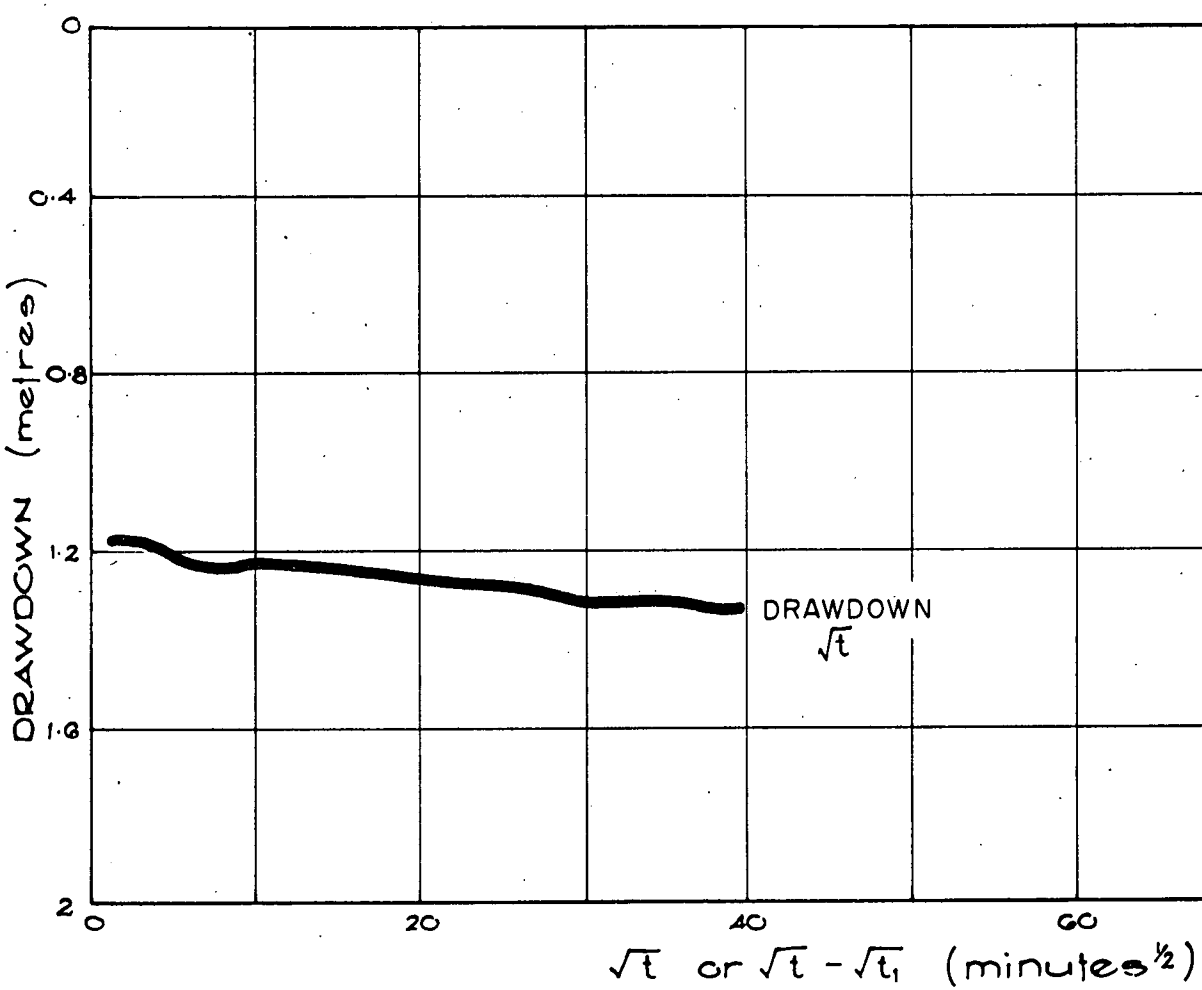
FIG. A-23

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00050
WELL DRAWDOWNS (SEMI-LOG)

COMPILED	R.Read
DRAWN	E.C.
DATE	Aug '85
CHECKED	
SCALE	
PLAN NUMBER	S18379

3885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL No. 5545000WW00050
WELL DRAWDOWNS (SQUARE ROOT OF TIME)

COMPILED R. Read	DRAWN E.C.	DATE Aug '85	CHECKED
C.D.O.	DATE 20-11-85	SCALE	PLAN NUMBER S 18380

FIG. A-24

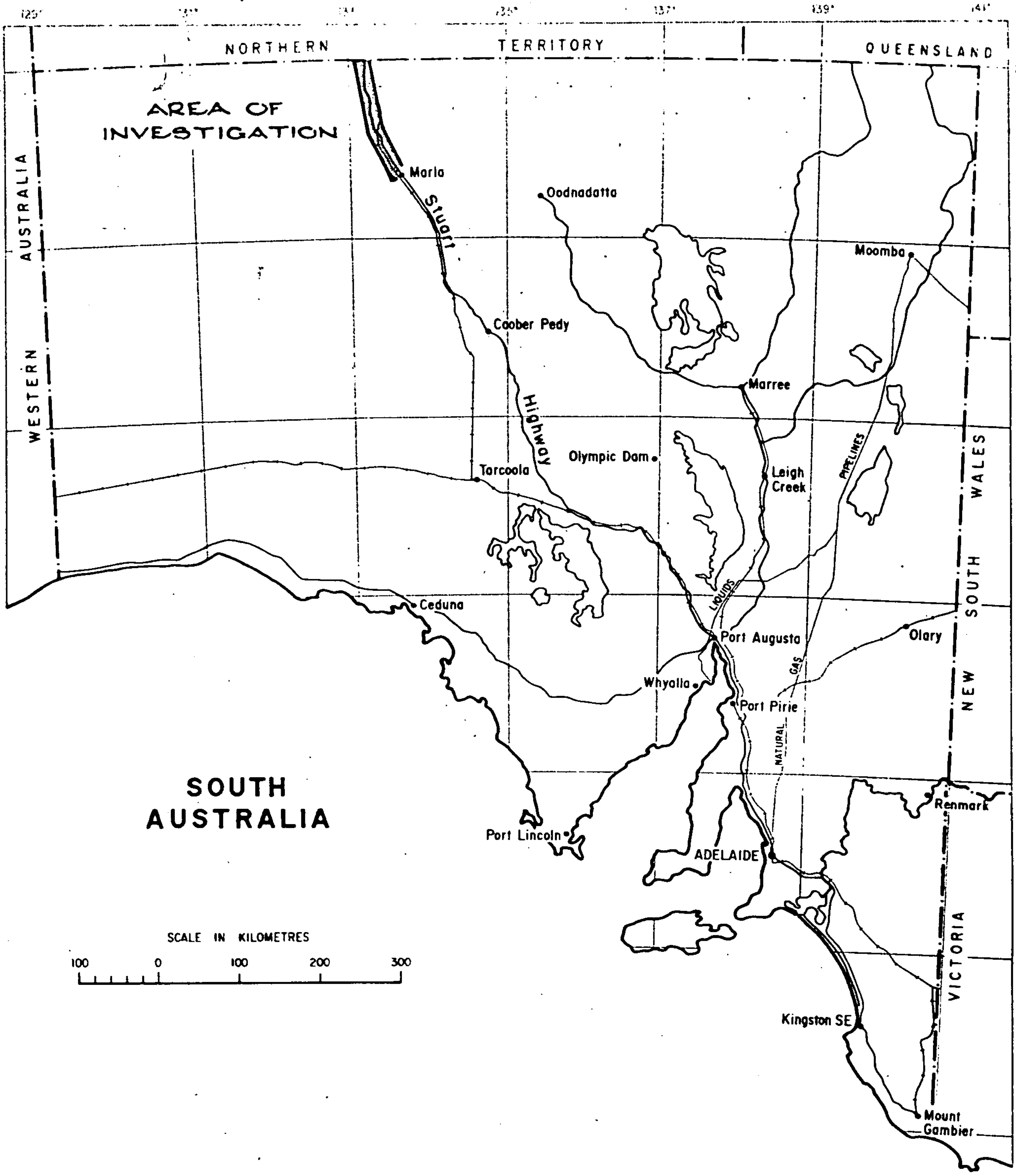
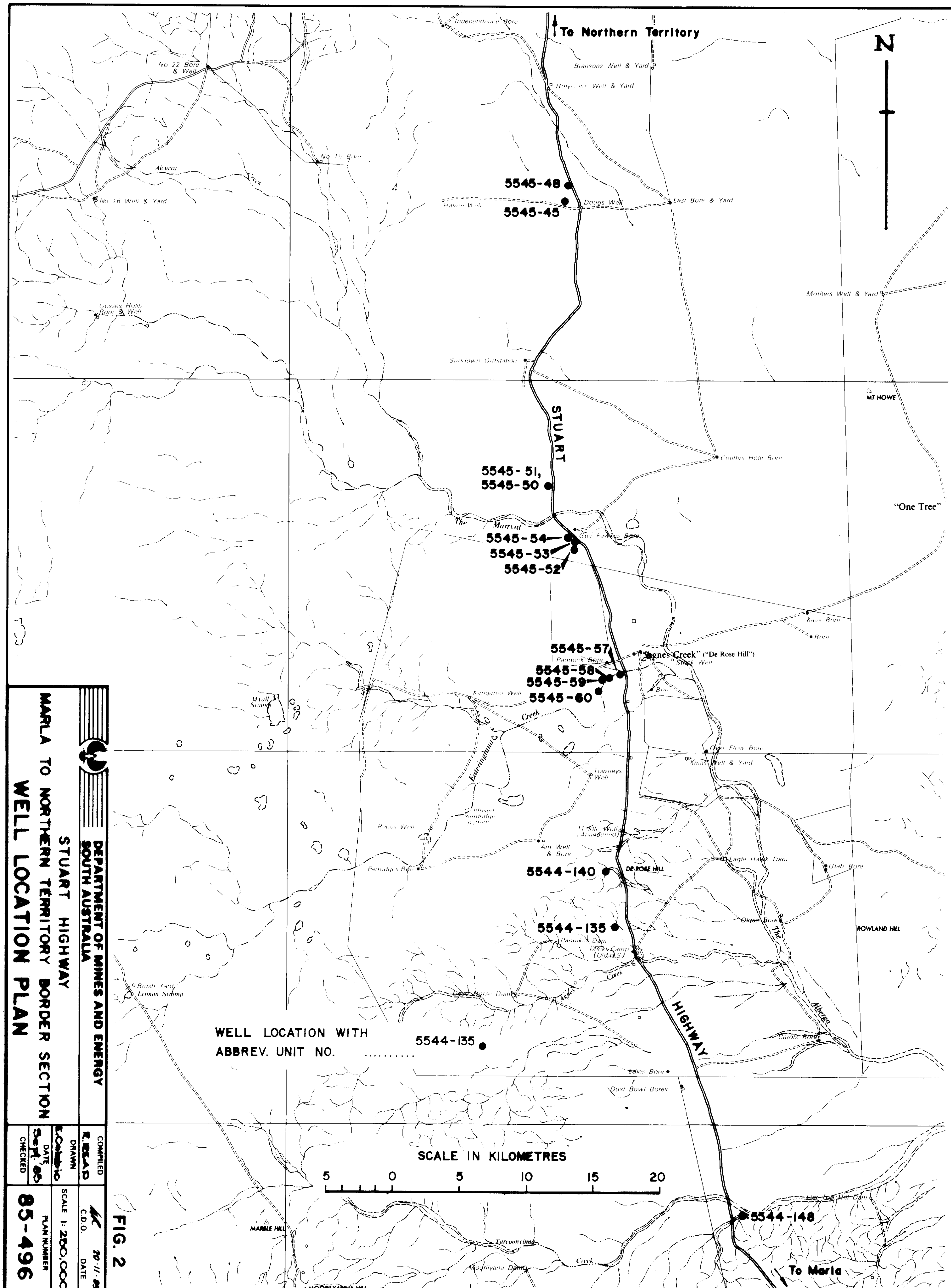


FIG. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.READ	C.D.O.	DATE 20·11·85
STUART HIGHWAY MARLA TO NORTHERN TERRITORY BORDER SECTION LOCALITY PLAN	DRAWN E.Colobio	SCALE As shown	
	DATE Sept.'85	PLAN NUMBER S 18356	
	CHECKED		

3885



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA
STUART HIGHWAY
MARLA TO NORTHERN TERRITORY BORDER SECTION
WELL LOCATION PLAN
COMPILED R. READ
DRAWN E. Calabio
DATE Sept. 85
CHECKED
C.D.O.
DATE 20.11.85
SCALE 1: 250,000
PLAN NUMBER 85-496
FIG. 2
N
To Northern Territory
To Marla
STUART
HIGHWAY
5545-48
5545-45
5545-51,
5545-50
5545-54
5545-53
5545-52
5545-57
5545-58
5545-59
5545-60
5544-140
5544-135
5544-148
WELL LOCATION WITH
ABBREV. UNIT NO. 5544-135
SCALE IN KILOMETRES
5 0 5 10 15 20
Independence Bore
Bransons Well & Yard
No 22 Bore & Well
No 15 Bore
No 16 Well & Yard
Alcurra
Creek
Havers Well
Dougs Well
East Bore & Yard
Gosses Hole Bore & Well
Mothers Well & Yard
Sundown Outstation
MT HOWE
Coultys Hole Bore
"One Tree"
The Marryat
Guy Fawkes Bore
Kays Bore
"Agnes Creek" ("De Rose Hill")
Paddock Bore
Stock Well
Myall Swamp
Kanggaroo Well
Creek
Townleys Well
Over Flow Bore
Xmas Well & Yard
Rileys Well
Ant Well & Bore
DE ROSE HILL
Eagle Hawk Dam
Utah Bore
Olgas Bore
ROWLAND HILL
Paradays Bore
Micks Camp (Old H.S.)
Brush Yard Lennon Swamp
Carols Bore
Alberga
Edies Bore
Dust Bowl Bores
MARBLE HILL
Tarcoonyinna
Creek
Moorilyana Dam
MOORILYANNA HILL