DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

REPORT BOOK 93/11

ARTIFICIAL RECHARGE POTENTIAL AT PRECINCT 1 NORTHFIELD RESIDENTIAL DEVELOPMENT, ADELAIDE SOUTH AUSTRALIA.

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and

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S R HOWLES, N Z GERGES and
S DODDS

Hydrogeological investigations of the Tertiary Sand and the Basement aquifer underlying Sections 789 and 873 Hundred of Yatala South Australia, indicate that only the Basement Aquifer has the potential to store storm water for subsequent reuse. Well equations to describe the behaviour of a well completed in this aquifer under discharge,drainage and injection have been developed.These show that the well can be pumped at a rate of 24 L/s for 10,000 minutes.A drainage rate of 13 L/s for a period of 10,000 minutes is possible.An injection rate of 23 L/s (2 ML/day) would result in 13 m of head above ground at 10,000 minutes.A cautious estimate of 20 m would result at 100,000 minutes. The salinity of the native groundwater in the Basement Aquifer is approximately 2600 mg/L.

INTRODUCTION

Precinct 1 Northfield residential development site includes Sections 789 and 873 Hundred of Yatala (Figure 1).One of important requirements imposed on the development is the limiting of peak stormwater runoff from the Site. Northfield Joint Venture partners proposed the use of a retention basin in conjunction with artificial recharge to deal with the problem. The total runoff was estimated to be of the order of 100 ML/year. Benefits of this approach are the reuse of the recharged water for irrigation.

In November of 1992 the South Australian Department of Mines and Energy (SADME) was contracted by the Northfield Joint Venture partners to investigate the potential for artificial recharge on Precinct 1 Northfield residential development.The objectives of the investigation program were to define the hydrogeology and assess the artificial recharge potential of both a shallow Tertiary Sand and underlying Basement aquifer.

PRELIMINARY WORK - HYDROGEOLOGY

A preliminary desktop study by Gerges indicated that Precinct 1 Northfield residential development

site is underlain by the following hydrogeological sequence.

Quaternary to Recent clays

Highly reactive clay confining bed varies from 2 - 5 m thickness through the area.

Tertiary Sand

This formation is expected to occur at depths of 2 - 5 m below surface,and is of unknown thickness.Material is expected to be sand - fine gravel. This formation is possibly dry,drainage is possibly in the south or southwest direction with implications for existing housing outside the area of investigation.

Weathered Bedrock

Plastic grey clay confining bed is expected to occur at a depth of 25 - 50 m.

Basement Aquifer

Basement may contain minor or major fractures capable of acting jointly as an aquifer. This aquifer is expected to occur at a depth of 35 - 60 m. It is expected to have a yield of 2.5 L/s and contain groundwater with an average salinity of 4000 mg/L.

PHASE 1 - INVESTIGATION PROGRAM

The following investigation program was defined on 25/11/92 at a meeting between SADME personnel,the Northfield Joint Venture project manager, and their engineering consultants.

Assessment of Basement Aquifer

Establish a 100 m deep scout hole,lined with approximately 65 m of 150 mm diameter steel casing,using rotary drilling methods.

Subject to adequate air lifted yield, undertake test pumping operations consisting of pumping development,step drawdown testing and a 6 hour constant discharge test.

Subject to positive results and water availability,undertake a 3 day injection test.

Assessment of Tertiary Sand

Conduct a full scale PROTEM geophysical survey (totaling approximately 3 km of traverses) to assess the areal extent and geometry of the sand layer.

Establish a cable tool drilled well to fully penetrate the Tertiary sequence (approximately 30 m),the well to be lined with 150 mm diameter PVC casing and sand screen.

Subject to adequate saturated thickness of sand, undertake test pumping and injection operations as per deep well.

PHASE 1 - RESULTS AND DISCUSSION

Assessment of Basement Aquifer

Drilling

Well 6628-16185 was drilled under permit 28272 and completed on 5/12/92 (Figure 1). The well was mud drilled to 45.5 (into Basement),155 mm internal diameter steel casing was set and pressure cemented. The final depth of 80.5 m was achieved with rotary air hammer drilling at a diameter of 152 mm. The well was left as an open hole completion within the Basement Aquifer.

During drilling strata samples were collected and following well completion geophysical logs were run.Composite well logs are given in Appendix A.

The hydrogeological sequence superposing the Basement can be summarised as follows:

0 - 2 m black soil

2 - 8 m clay

8 - 10 m fine gravel (Tertiary Sand sequence)

10 - 12 m clay and fine gravel

12 - 44 m clay (including weathered basement)

44 - 68 m slate

68 - 80.5 m quartzite

The Basement was intersected at 44 m as a grey fine grained slate, fractures were intersected at 53 and 60 m.A multi - fractured quartzite was intersected at 68 m. Yield increased significantly in the quartzite between 68 and 80.5 m. A final air lifted yield of 15 - 20 L/s was estimated, considerably higher than expected.The quartzite shows a clear signature on the geophysical logs.

Salinity data given in Appendix B Table B1 indicate that the salinity increased from 1384 mg/L at 53 m to 2488 mg/L at 80 m.

A final standing water level of 14 m was recorded.

Discharge Testing

Following the better than expected yield a constant discharge test was conducted on 16/12/92 with SADME's mobile submersible pump at a rate of 8 L/s for a period of 480 minutes. The test data is plotted in Figure 2,and is given in Appendix C. Test data allows calculation of a specific capacity at 100 minutes of 1.9 (L/s)/m of drawdown,and an initial estimation of the aquifer transmissivity of 50 m2/d.

In this situation the quartzite will be operating as the dominant aquifer with a small contribution from the upper fractures.It should be noted that the thickness,extent and orientation (geometry) of the quartzite is unknown.

Note: Step discharge testing was not conducted at this time but incorporated in the comprehensive suite of tests recommended for Phase 2 of the investigation.

Assessment of Tertiary Sand

Drilling

Well 6628-16186 was drilled under permit 28273 and completed on 10/12/92 (Figure 1). The well was drilled by cable tool to 35 m,80 mm internal diameter PVC casing was set with slots between 6 - 10 m and 26 - 35 m, monitoring the Tertiary Sand sequence.

During drilling strata samples were collected and following well completion geophysical logs were run.Composite well logs are given in Appendix A.

The hydrogeological sequence intersected can be summarised as follows:

0 - 2 m black soil

2 - 6 m sandy clay

6 - 8 m sandstone, Tertiary Sand sequence

8 - 10 m coarse sand - fine gravel, Tertiary sand sequence.

10 - 35 m clays and clayey sand

The Tertiary Sand was thought to be dry during the drilling but was found later to be seeping a small amount of water.

Due to the extremely variable nature of the Tertiary Sand Aquifer indicated from the both wells, and the possible drainage problems and effects on the reactive Quaternary clays,it was decided to abandon further investigation and concentrate only on the Basement Aquifer.

Geophysical survey

The geophysical survey was supervised and interpreted by A.R. Dodds (SADME). The results and discussion are given in full in Appendix D. The following summary was prepared by A.R. Dodds. Two Transient Electromagnetic traverses were done,at the locations shown in Figure 1. The results show a basement high 50 m west of the wells,dropping away steeply to the west and north but more slowly to the east. A shallow resistor between 3 and 30 m varies in thickness and resistivity, and appears to be a clayey-sand of variable proportions,the more permeable parts being more resistive.A conductor between this resistive feature and basement is also variable in thickness and intensity,and is expected to be caused by a combination of high clay content and more saline groundwater.

No attempt has been made to detect the basement fractures yielding low salinity groundwater that were found in well 6628-16185. These would be hard to detect at this depth in this environment,

as the low salinity and low clay content would make for a very weak conductor.

PHASE 1 - CONCLUSION

Due to the favourable results from the discharge tests conducted on the Basement Aquifer it was concluded that a comprehensive suite of well and aquifer discharge and injection tests be conducted at higher rates than were achievable with the mobile pump.This would allow an accurate assessment of the long term recharge potential.

PHASE 2 - INVESTIGATION PROGRAM

In view of the positive results from Phase 1 a more comprehensive second stage of investigation was initiated in order to:

- Determine the impact of injection on well efficiency and aquifer properties.
- Determine the effect of injected water on the salinity of the native groundwater.

PHASE 2 - RESULTS AND DISCUSSION

Details of the well and aquifer discharge and injection tests are given in Table 1,all test data is provided in Appendix C.

Table 1. Details of well and aquifer discharge and injection tests

Test	Date	Rate(L/s)	Duration (mins)
Pre Injection			
constant discharge	5/1/93	19.6	600
recovery			7920
step drawdown			
step 1	11/1/93	6.5	100
step 2	11/1/93	10.8	100
step 3	11/1/93	15.3	100
step 4	11/1/93	25.2	60
Injection			
constant injection	15/1/93	22 - 23	3930
recovery			9990
Post injection			
constant discharge	3/2/93	8.0	360
constant discharge	9/2/93	8.0	600

Well Test Data

In theory equations should be able to be developed for the well after testing. A simple form of the well equation (1) relates drawdown, discharge rate and time.

$$St = B\ Q \log t + C\ Q^2 \qquad (1)$$

where:

St = drawdown (m)

Q = discharge/recharge rate (L/s)

t = time (mins)

B = constant related to aquifer loss (well loss) for laminar flow

C = constant related to well loss (aquifer loss) for turbulent flow

The well equation allows calculation of the long term yield, drainage/injection and the non - linear head loss associated with the operating well.The following assumptions are inherrant.

1. The aquifer is homogeneous, isotropic, of uniform thickness, and of infinite areal extent.
2. Before pumping/recharge the piezometric surface is horizontal.
3. The well is operated at a constant rate.
4. The well penetrates the entire aquifer, and flow is everywhere horizontal within the aquifer from/to the well.
5. The well diameter is infinitesimal so that storage within the well can be neglected.
6. Pressure effect of water moving out of/into storage occurs instantaneously.

These assumptions can be assumed to be adequately met except number 1, ie the geometry of the quartzite (the major aquifer) is unknown.

Aquifer Test Data

Constant discharge test data from a pumped well is used to calculate the aquifer transmissivity using equation-2.

$$T = \frac{0.183\ Q}{ds} \qquad (2)$$

where:

T = transmissivity (m^2/d)

Q = discharge rate (m^3/d)

ds = drawdown per log cycle (m)

Pre Injection Discharge Tests

Aquifer Testing

The constant discharge test data is plotted in Figure 3, and is given in Appendix C.This test was conducted on 5/1/93 at a rate of 19.6 L/s for 600 minutes,recovery measurements were made over a period of 7929 minutes.

Figure 3 indicates that no boundaries have been intersected during the period of the test.

Test data allows calculation of a specific capacity at 100 minutes of 1.6 (L/s)/m of drawdown, and an aquifer transmissivity of 70 m^2/d.

Well Testing

The step drawdown test data is plotted in Figure 4 along with the constant discharge test data.The data is given in Appendix C. Three 100 minute

steps and a fourth 60 minute step were conducted on 11/1/93 at rates of 6.5, 10.8, 15.3, 25.2 L/s.

The simple form of the well equation (1) has proven to be useful in the Basement Aquifer environment (fractured rock) in which well 6628-16185 is completed.

The drawdowns at t = 10 and 100 minutes from Figure 4 are plotted on Figure 5, (calculated cumulatively for steps 2 - 4).The constants for well equation-1 are calculated to be B = 0.224 and C = 0.008.When used in equation-1,equation-3 is defined which generates data points which fit the observed step test data extremely well. The constant discharge test can be reproduced with extreme accuracy.

$$St = 0.224\ Q \log t + 0.008\ Q^2 \qquad (3)$$

A long term yield for a period of 100,000 minutes of 23 L/s can be calculated using the available drawdown of 30 m (casing depth - depth to water).It should be noted that the maximum depth to water should be used for this calculation during summer and this may be slightly less than the current value due to the extremely wet winter of 1992.

Salinity

Salinity data given in Appendix B Table B2 indicate that the salinity increased during the main test from 2448 mg/L to 2669 mg/L.During the step draw down test the salinity increased from 2086 mg/L to 2596 mg/L.Evidently water moving to the well during discharge is of a salinity possible higher than 2700 mg/L and may increase with time.The injection test and subsequent pumping out give some indication that injected water will remain localised thus reducing salinity. A full analysis is given in Appendix B.

Injection Tests

Well - Aquifer Testing

The constant injection test was conducted with mains water at mains pressure on 15/1/93.The salinity of the mains water was approximately 360 mg/L, a total of 5.4 ML was injected.

The constant injection test data is plotted in Figure 6.and given in Appendix C. This test was conducted at a rate of 21.9 L/s to 1300 minutes at which time the pressure in the mains increased flow to 23 L/s which persisted until the end of the test at 3960 minutes.Recovery measurements were made over a period of 9990 minutes.

Figure 6 indicates that the test should be viewed as three segments, (possibly indicating some boundaries) t = 1 - 40 minutes, t = 40 - 1000 minutes, t > 1000 minutes.Following injection the waterlevel recovered more quickly indicating the existance of a permeable boundary to the quartzite aquifer. Due to the length of the test and the existance of boundaries well equation-3 defined above will not accurately generate the injection curve.

Mr D.Armstrong of this Department has determined the following complex family of well equations (4 - 6) which accurately describe the injection curve. A knowledge of the behaviour of the well under injection/drainage is what is ideally required.

t = 1 - 40 minutes:

$St = 0.0113\ Q^2 + (\log t * 0.1644\ Q)$ (4)

t = 40 - 1000 minutes:

$St = 0.0113\ Q^2 + 0.2634\ Q + (\log t - 1.602) * 0.2283\ Q$ (5)

t > 1000 minutes:

$St = 0.0113\ Q^2 + 0.5825\ Q + (\log t - 3) * 0.3174\ Q$ (6)

It is expected that the well would behave in a similar manner under discharge for long times.

A further 0.6 ML was injected in a test conducted on 25/1/92 at a rate of 17 L/s.The head measured in this test was affected by the initial starting conditions and the resultant data is not considered to be an accurate representaion of the well behaviour. This data is not included in this report.

Post - Injection Tests

Well - Aquifer Testing

The well was tested after injection with two separate constant discharge tests in order to simply check the behaviour of the well after the injection and to check the salinity during pumping.

Data is given in Appendix C. Simple testing only was conducted due to time and money contraints.

Constant discharge tests were conducted on 3/2/93 and 9/2/93 at a rate of 8 L/s for periods of 360 and 600 minutes respectively. Recovery measurements were not made. The constant discharge test data is plotted in Figure 7 along with data points generated from equation-5. The plots indicate that the the test data matches the data generated from equation-5 quite accurately.This indicates that the well efficiency and aquifer properties have not been affected by the injection test.

Salinity

Salinity data are given in Appendix B Table B3,and are plotted on Figure 8. The mains water had remained in the aquifer for a period of approximately 17 days prior to any extraction.

On 3/2/93 the first water pumped had a salinity of 772 mg/L almost double that of the mains water of 360 mg/L.At the end of the test the salinity had risen to 882 mg/L.Evidently some mixing had occured,this would be expected as only 6.0 ML of mains water was injected in total.

On 9/2/93 the salinity had again risen,to 882 mg/L indicating more mixing. At the end of the test the salinity had risen to 1233 mg/L.It is not possible to accurately predict the pumping time required to regain the salinity of the native groundwater. The SADME will pump the well for 2 hours per week for March and April of 1993 to further monitor salinity changes.

A total of 0.5 ML was extracted in the two tests,approximately 8% of the volume injected.

It can be expected that the large volume of 100 ML expected to be drained/injected would have a long term improvement on the native groundwater salinity.

Well Performance

Using the family of equations (equations 4-6) developed for injection and applying them to discharge/drainage and injection the long term well behaviour can be estimated.Due to the length of the test (3960 minutes) the equations can be used with reasonable safety to estimate the behaviour of the well up to 10,000 minutes.

Using an available drawdown of 29 m a discharge rate of 24 L/s for a period of 10,000 minutes can be calculated.

Using the available head of approximately 14 m (ie depth to water) a drainage rate for a period of 10,000 minutes of 13 L/s can be calculated.

If additional head above surface is provided by injection then an injection rate of 23 L/s (2 ML/day) would result in 13 m of head above ground at 10,000 minutes.A cautious estimate of 20 m would result at 100,000 minutes.

The drawdowns at t = 100 and 1000 minutes from all individual stages of discharge and injection tests are plotted in Figure 9, along with values generated from equations (5) and (6). There is a good fit between the observed and generated data for t = 100 minutes. There is only one observed value at t = 1000 minutes. These curves allow the estimation of well performance for times of 100, 1000 and 10,000 minutes.

PHASE-2 CONCLUSION AND RECOMMENDATIONS

Well and aquifer discharge and injection testing indicate that well 6628-16185 is capable of operating efficiently as either a production, drainage or injection well at rates in excess of 10 L/s. This exceeds the expected operational rate of 5 L/s.Well efficiency and aquifer properties are not expected to be affected if silt free water is drained/injected.It is also expected that the salinity of the native groundwater will be significantly reduced after artificial recharge.

The drilling of an additional production well at a distance of 10 - 50 m from well 6628-16185 is recommended in order to:

- Provide a standby

production/drainage/injection well.

- Allow monitoring of waterlevels.

The further drilling of 1 - 2 observation wells is recommended in order to:

- Better define the geometry of the quartzite aquifer.

- To determine the gradient of the water table and the extent and geometry of the drainage/injection mound.

- It is recommended that regular sampling to monitor water quality be undertaken once the scheme is operational. Waterlevels should also be regularly monitored.It is recommended that the SADME be contacted at this time for advice.

AKNOWLEGMENTS

Acknowlegment is made of the technical support of Mr D. Armstrong of SADME in interpreting well and aquifer data.

APPENDICES

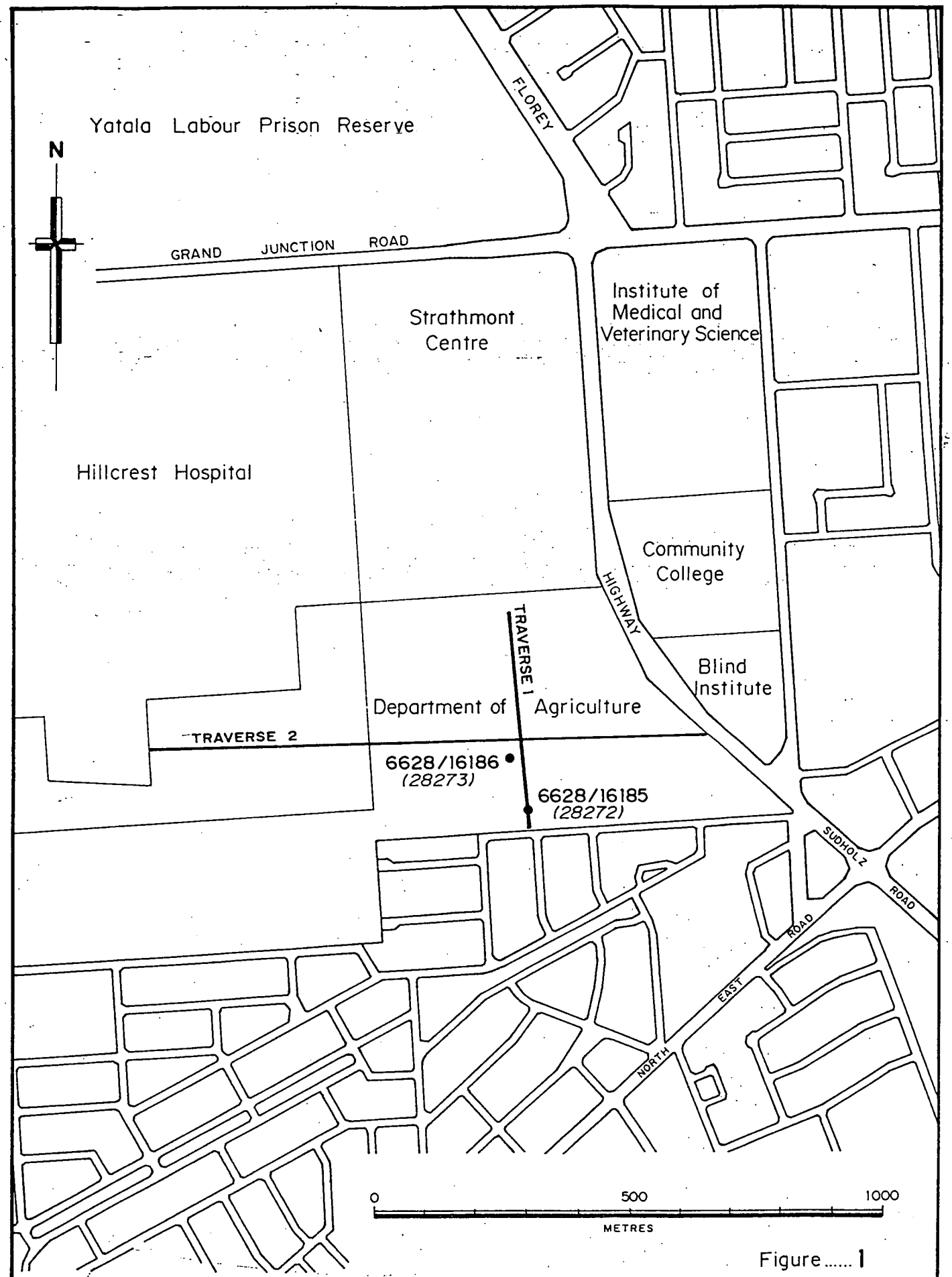
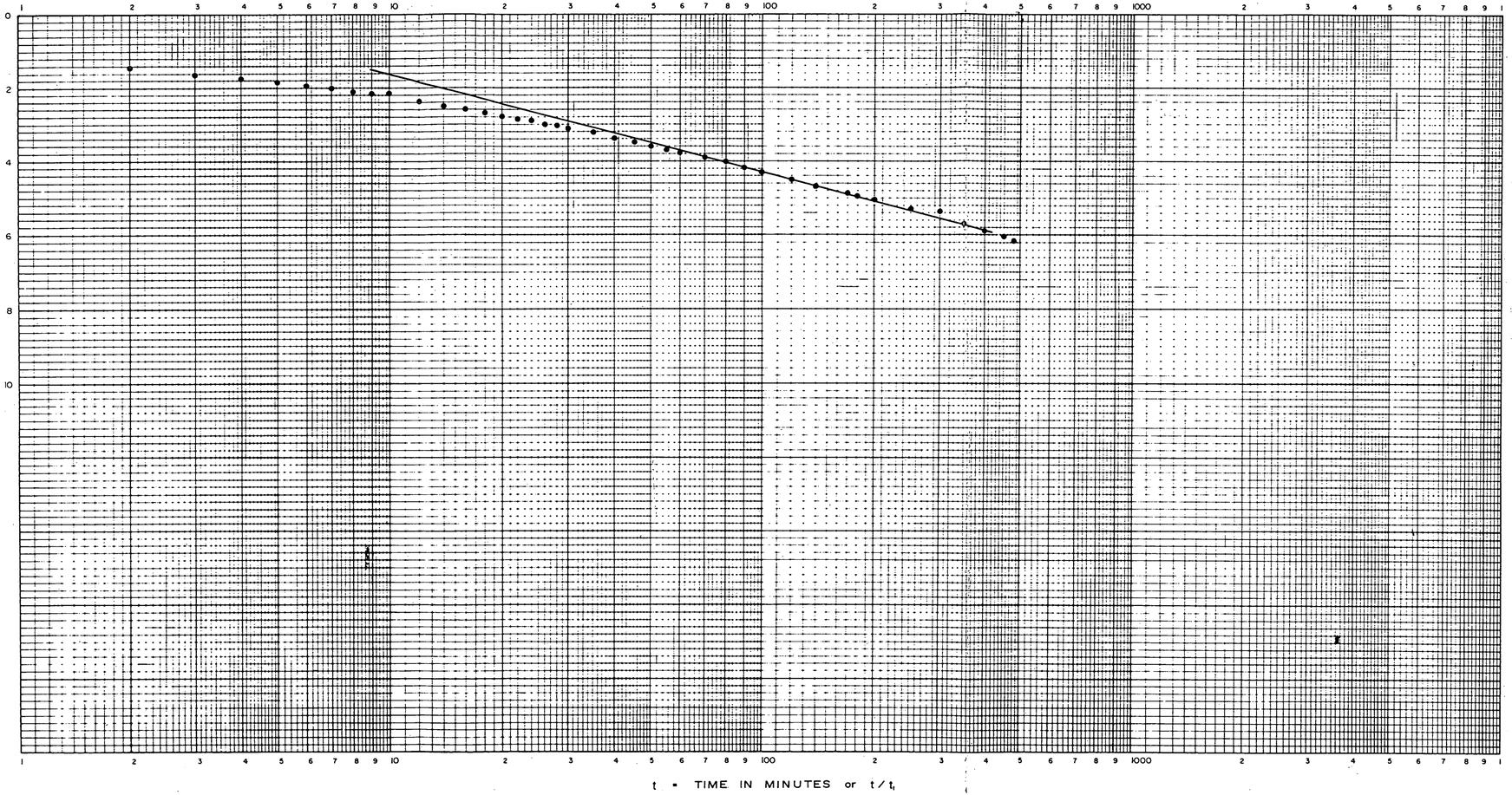


Figure..... 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O. DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1	DRAWN R. Bird	SCALE As shown
LOCALITY PLAN	DATE February 1993 CHECKED	PLAN NUMBER 93-134

5770



WELL UNIT No. 6628/16185

REFERENCE POINT ..... m above ground

AQUIFER from 45·5 to 80·5 m

INTERVAL TESTED from 45·5 to 80·5 m

DISCHARGE RATE 8 L/s

TYPE OF PUMP MOBILE SUBMERSIBLE

LENGTH OF TEST 480 minutes

DEPTH PUMP INTAKE — m

DEPTH WATER LEVEL AT START OF TEST 14·35 m

AVAILABLE DRAWDOWN 29 m

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 (m^3/day/m)
Q = Pumping rate (m^3/day)
$\Delta\Delta$ = Drawdown per log cycle (m)
S = Storage Coefficient
t_o = Zero drawdown time (mins.)
r = Distance to observation well (m)

1 day = $8{\cdot}64 \times 10^4$ secs

DATA

Q	$\Delta\Delta$	t_o	r
8 L/s	2·65 m	—	—

= 691 m^3/day

CALCULATIONS

$$T = \frac{0{\cdot}183 \times Q}{\Delta\Delta} \qquad SC_{100} = \frac{Q}{\Delta_{100}}$$

$$T = \frac{0{\cdot}183 \times 691}{2{\cdot}65} \qquad SC_{100} = \frac{8}{4{\cdot}3}$$

$T = 50\ m^2$/day $\qquad SC_{100} = 1{\cdot}9$ (L/s)/m drawdown

Figure 2

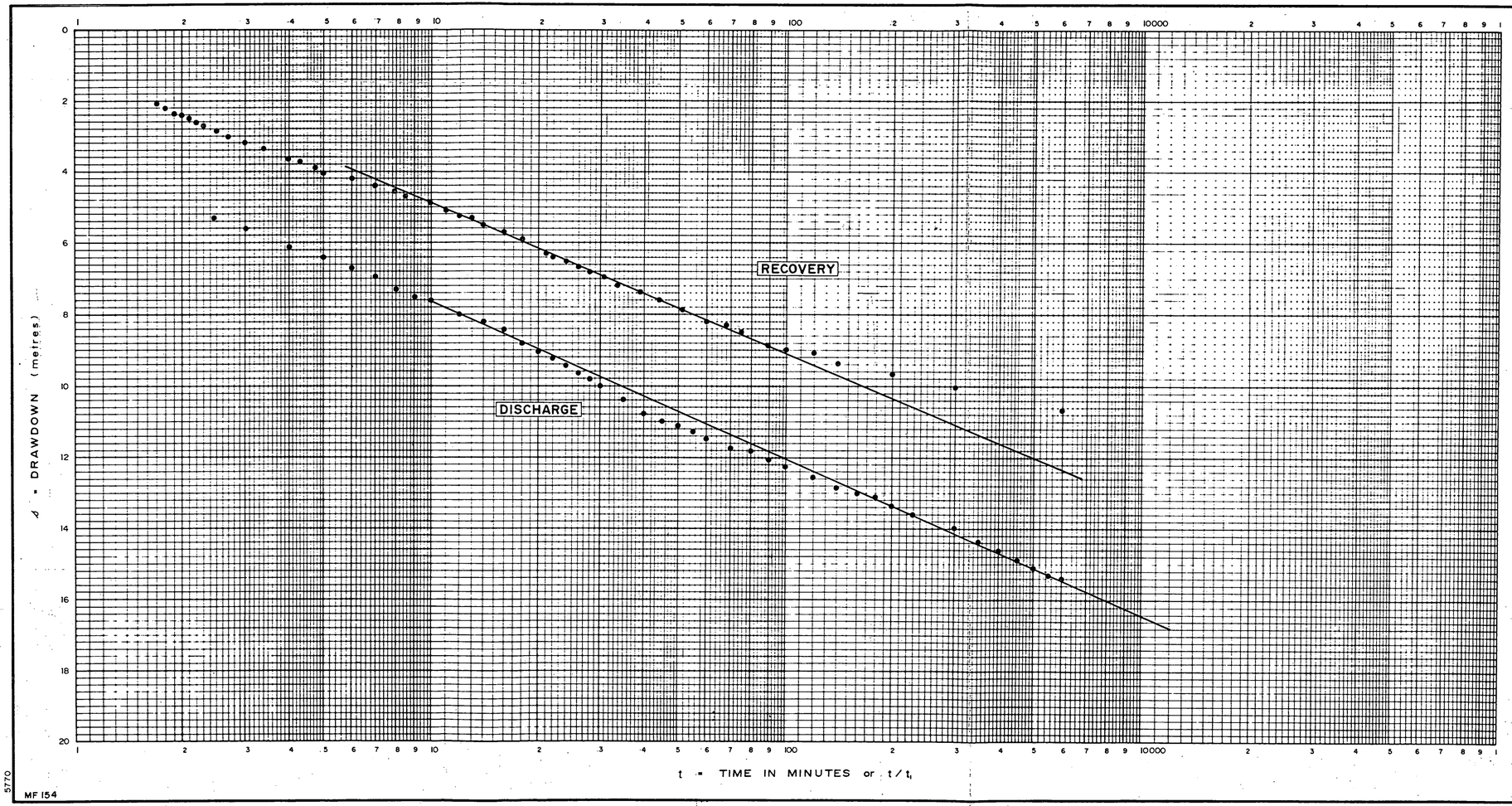
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHFIELD RESIDENTIAL DEVELOPMENT
ARTIFICIAL RECHARGE POTENTIAL-PRECINCT 1
WELL 6628390WW16185
CONSTANT DISCHARGE TEST (16/12/92)

COMPILED S. Howles	C D O DATE
DRAWN R. Bird	SCALE As shown
DATE February 1993	PLAN NUMBER 93-135
CHECKED	

5770

MF 154



WELL UNIT No. 6628/16185

REFERENCE POINT – m above ground

AQUIFER from 45·5 to 80·5 m

INTERVAL TESTED from 45·5 to 80·5 m

DISCHARGE RATE 19·6 L/s

TYPE OF PUMP POMONA

LENGTH OF TEST 600 minutes

DEPTH PUMP INTAKE 45·1 m

DEPTH WATER LEVEL AT START OF TEST 14·17 m

AVAILABLE DRAWDOWN 30 m

EQUATIONS

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

In which

T = Transmissivity (m^3/day/m)
Q = Pumping rate (m^3/day)
Δd = Drawdown per log cycle (m)
S = Storage Coefficient
t_o = Zero drawdown time (mins.)
r = Distance to observation well (m)

1 day = $8{\cdot}64 \times 10^4$ secs

DATA - (RECOVERY)

Q	Δd	t_o	r
19·6 L/s	4·4m		–

= 1695 m^3/day

CALCULATIONS

$$T = \frac{0{\cdot}183 \times Q}{\Delta d}$$

$$T = \frac{0{\cdot}183 \times 1695}{4{\cdot}4}$$

$$T = 70{\cdot}5\ m^2/day$$

Figure 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHFIELD RESIDENTIAL DEVELOPMENT
ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1
WELL 6628390WW16185
CONSTANT DISCHARGE TEST (5/1/93)

COMPILED	C.D.O.	DATE
S. Howles		
DRAWN	SCALE	
R. Bird	As shown	
DATE	PLAN NUMBER	
February 1993	93-136	
CHECKED		

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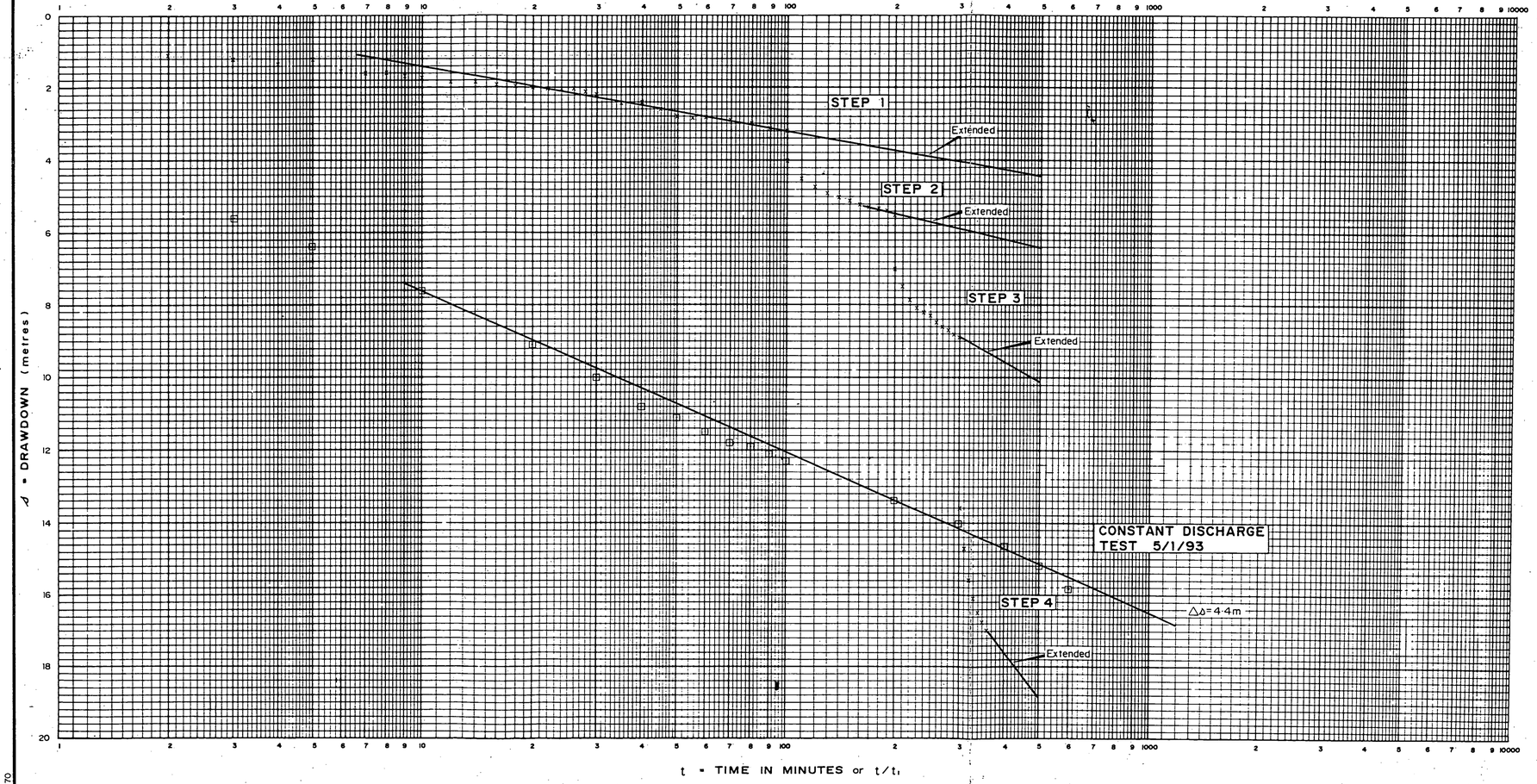


WELL UNIT No. 6628/16185

REFERENCE POINT ..... m above ground

AQUIFER from 45·5 to 80·5 m

INTERVAL TESTED from 45·5 to 80·5 m

TYPE OF PUMP POMONA

DURATION OF TEST 360 minutes

DEPTH PUMP INTAKE 45·1 m

DEPTH WATER LEVEL AT START OF TEST 14·42 m.

AVAILABLE DRAWDOWN 30 m

STEP DRAWDOWN TEST	Q (L/s)	t = 10	t = 100	Δs	Δs/Q
STEP 1	6·5	1·71	3·18	1·8	0·277
STEP 2	10·8	3·01	5·08	-	-
STEP 3	15·3	5·01	8·08	-	-
STEP 4	25·2	10·81	16·68	-	-
CONSTANT DISCHARGE TEST	19·6	7·59	12·3	4·4	0·224

at t = 100,000 minutes
and Δt = 30 m

$\Delta t = 0{\cdot}224 \log_{10} tQ + 0{\cdot}008 Q^2$

$30 = 0{\cdot}224 \log_{10} 100{,}000 Q + 0{\cdot}008 Q^2$

$Q = 23$ L/s

Figure 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHFIELD RESIDENTIAL DEVELOPMENT
ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1
WELL 6628390WW16185
STEP DRAWDOWN TEST (11/1/93)

COMPILED S. Howles	C.D.O. DATE
DRAWN R. Bird	SCALE As shown
DATE February 1993	PLAN NUMBER 93-137
CHECKED	

5770

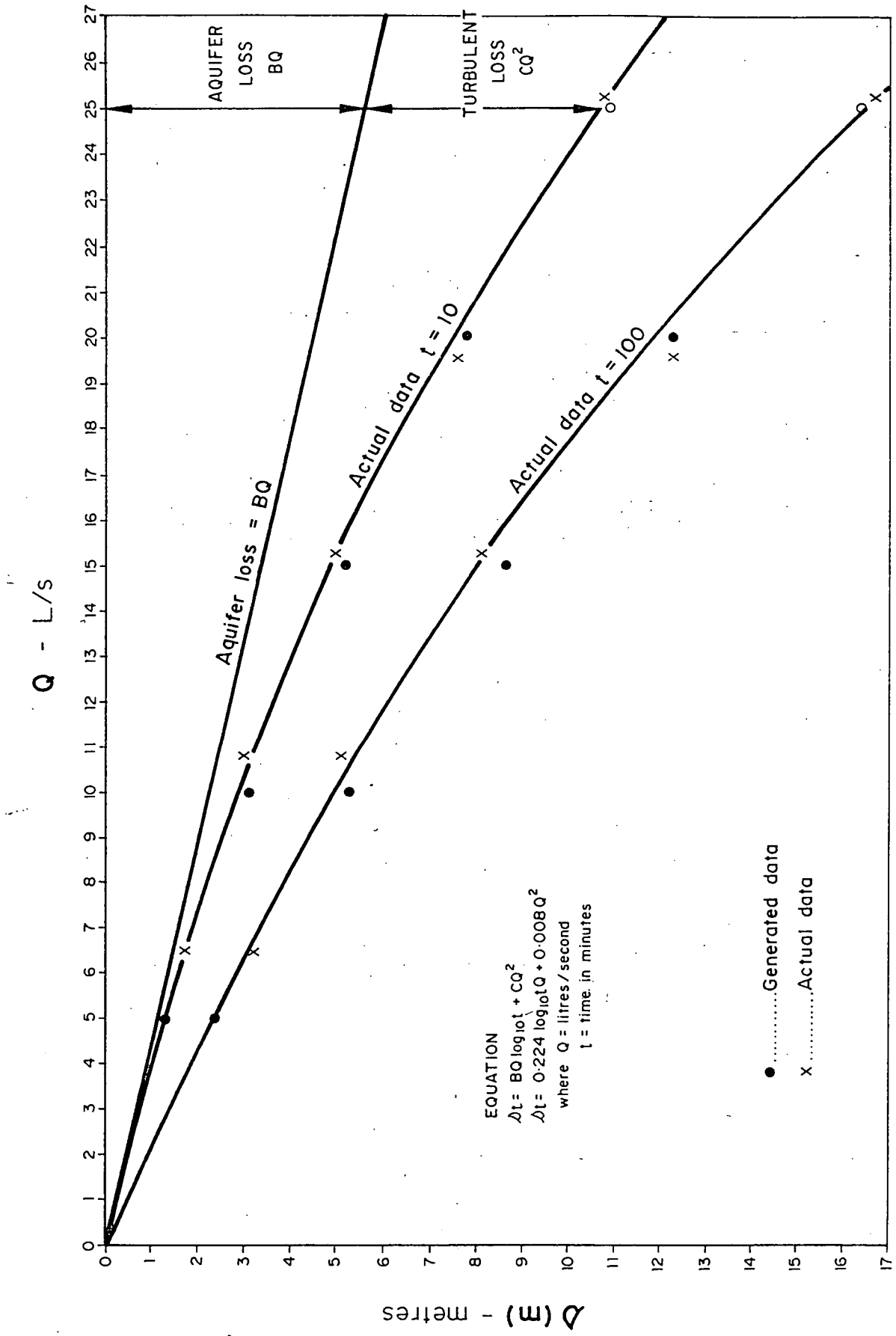
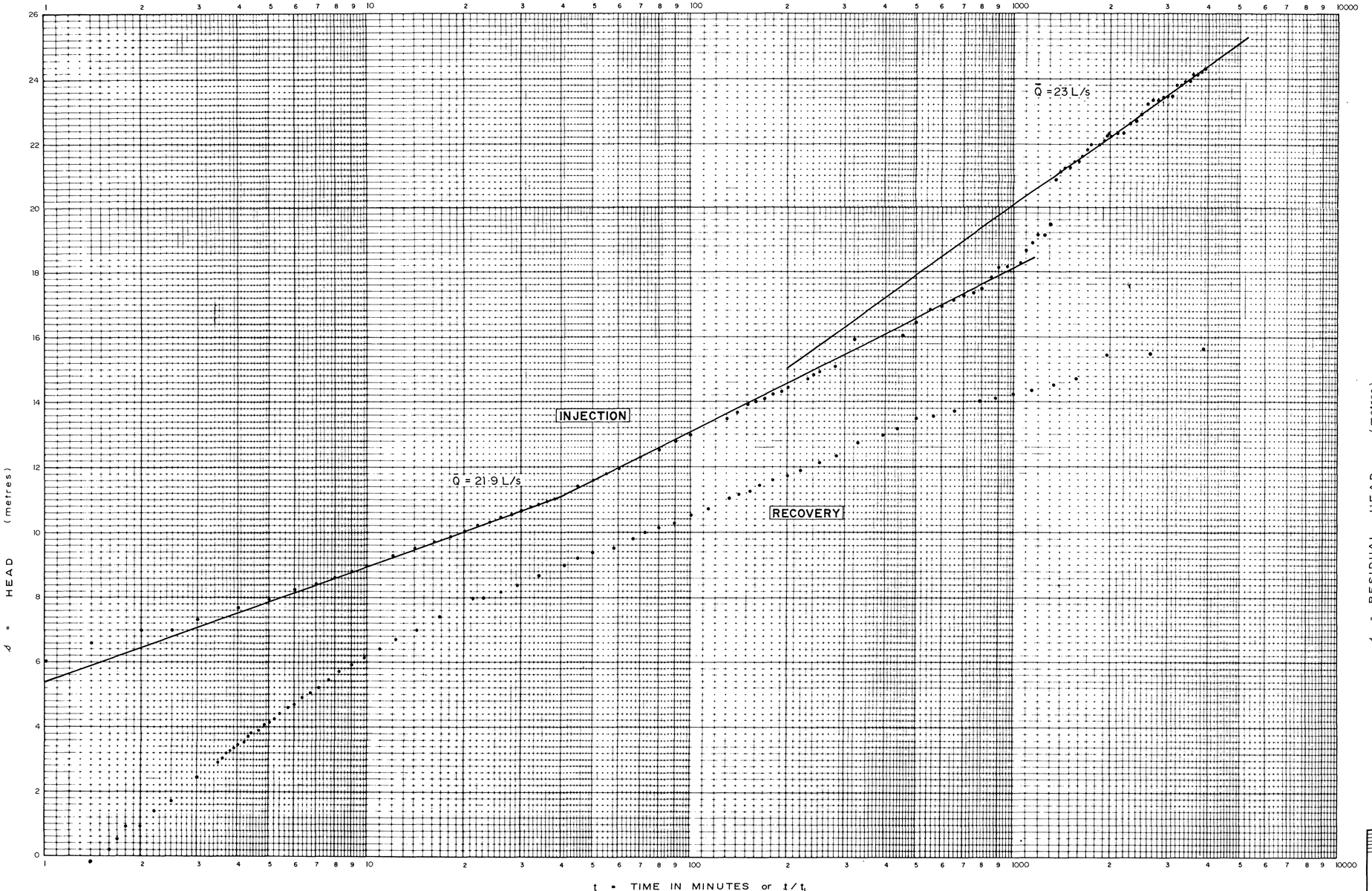


Figure.....5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O. DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1	DRAWN R. Bird	SCALE As shown
SPECIFIC CAPACITY PLOT	DATE February 1993	PLAN NUMBER 93-138
	CHECKED	

5770



WELL UNIT No. 6628/16185 TYPE OF PUMP —

REFERENCE POINT 1·3 m above ground LENGTH OF TEST 3960 minutes

AQUIFER from 45·5 to 80·5 m DEPTH PUMP INTAKE — m

INTERVAL TESTED from ..... to ..... m DEPTH WATER LEVEL AT START OF TEST 15·14 m

INJECTION RATE ~21·9 L/s AVAILABLE DRAWDOWN ..... m

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 (m^3/day/m) S = Storage Coefficient

Q = Pumping rate (m^3/day) t_o = Zero drawdown time (mins.)

$\Delta\Delta$ = Drawdown per log cycle (m) r = Distance to observation well (m)

1 day = $8{\cdot}64 \times 10^4$ secs

DATA

Q $\Delta\Delta$ t_o r

CALCULATIONS

Figure 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHFIELD RESIDENTIAL DEVELOPMENT

ARTIFICIAL RECHARGE POTENTIAL-PRECINCT 1

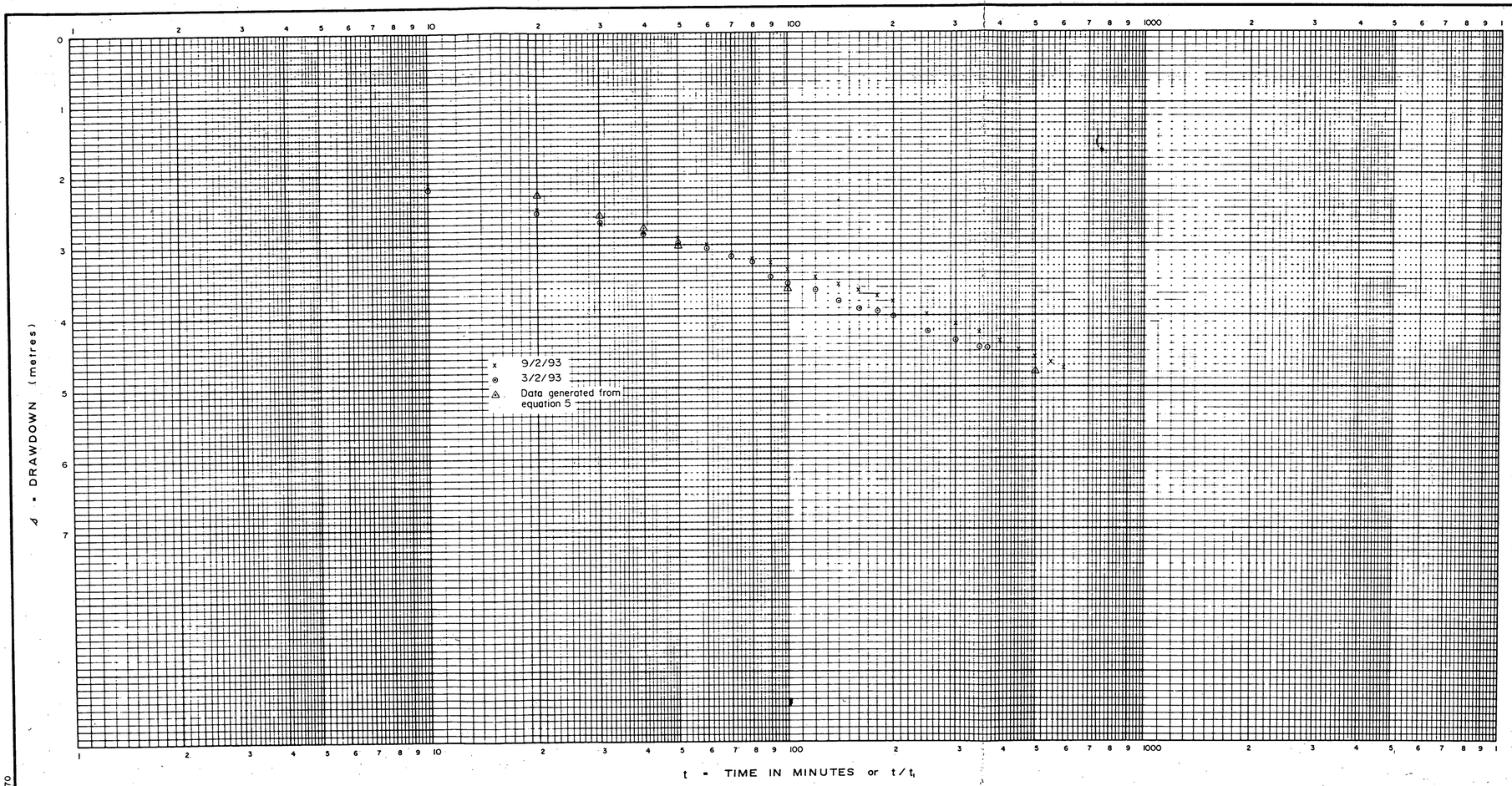
WELL 6628390WW16185

CONSTANT INJECTION TEST (15/1/93)

COMPILED	S. Howles	C.D.O.	DATE
DRAWN	R. Bird	SCALE	As shown
DATE	February 1993	PLAN NUMBER	93-139
CHECKED			

5770

MF 154



s - RESIDUAL DRAWDOWN (metres)

WELL UNIT No. 6628/16185

REFERENCE POINT ..... m above ground

AQUIFER from 45·5 to 80·5 m

INTERVAL TESTED, from 45·5 to 80·5 m

TYPE OF PUMP MOBILE SUBMERSIBLE

LENGTH OF TEST 360/600 minutes

DEPTH PUMP INTAKE 25 m

DEPTH WATER LEVEL AT START OF TEST – m

AVAILABLE DRAWDOWN 19 m

EQUATIONS

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

In which

T = Transmissivity (m^3/day/m)
Q = Pumping rate (m^3/day)
Δs = Drawdown per log cycle (m)
S = Storage Coefficient
t_o = Zero drawdown time (mins.)
r = Distance to observation well (m)

1 day = $8{\cdot}64 \times 10^4$ secs

DATA

Q Δs t_o r

CALCULATIONS

Figure 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHFIELD RESIDENTIAL DEVELOPMENT
ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1
WELL 6628390WW16185
CONSTANT DISCHARGE TEST (3,9/2/93)

COMPILED S. Howles		C D O	DATE
DRAWN R. Bird	SCALE As shown		
DATE February 1993	PLAN NUMBER 93-140		
CHECKED			

MF 154

5770

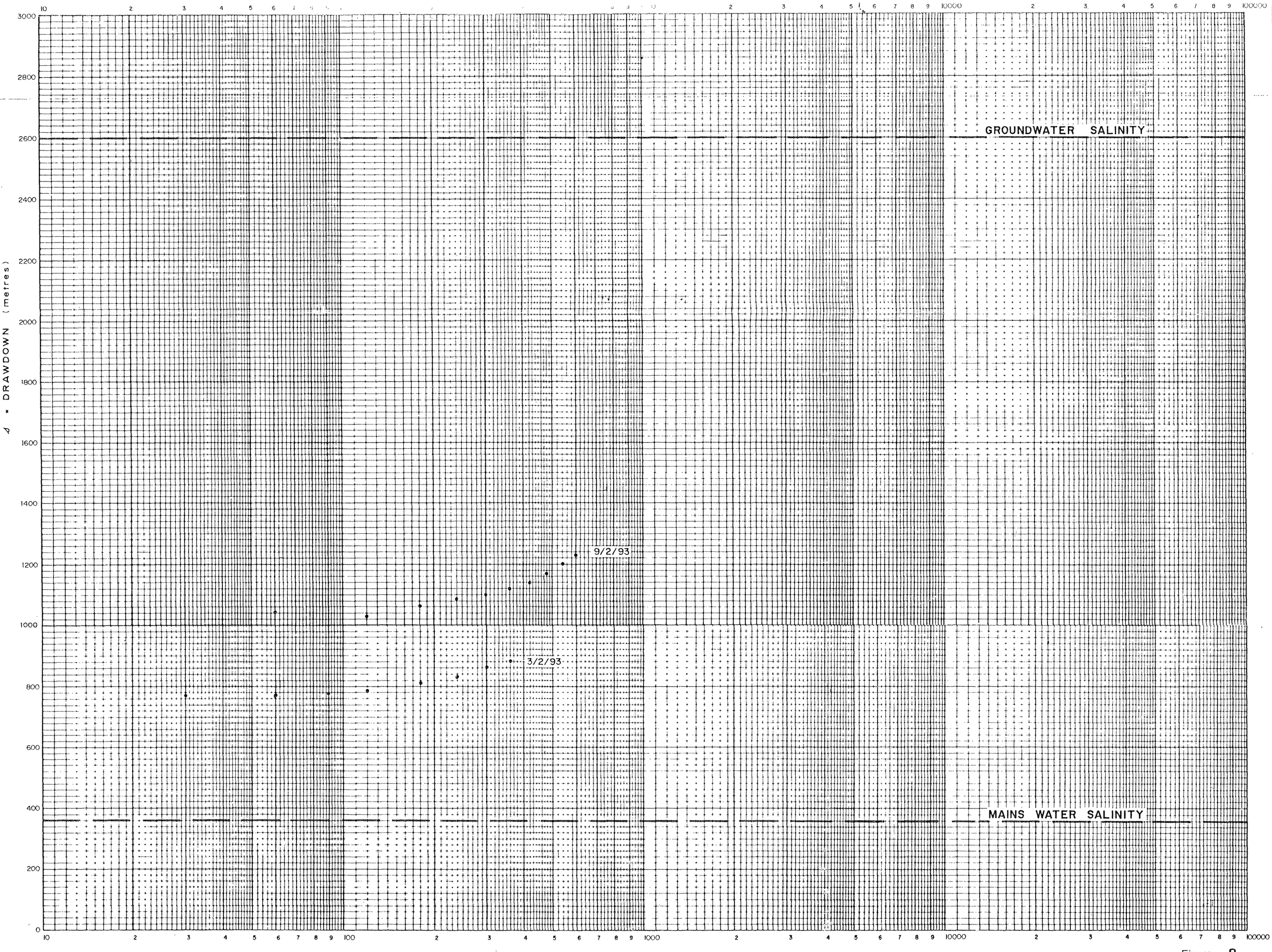
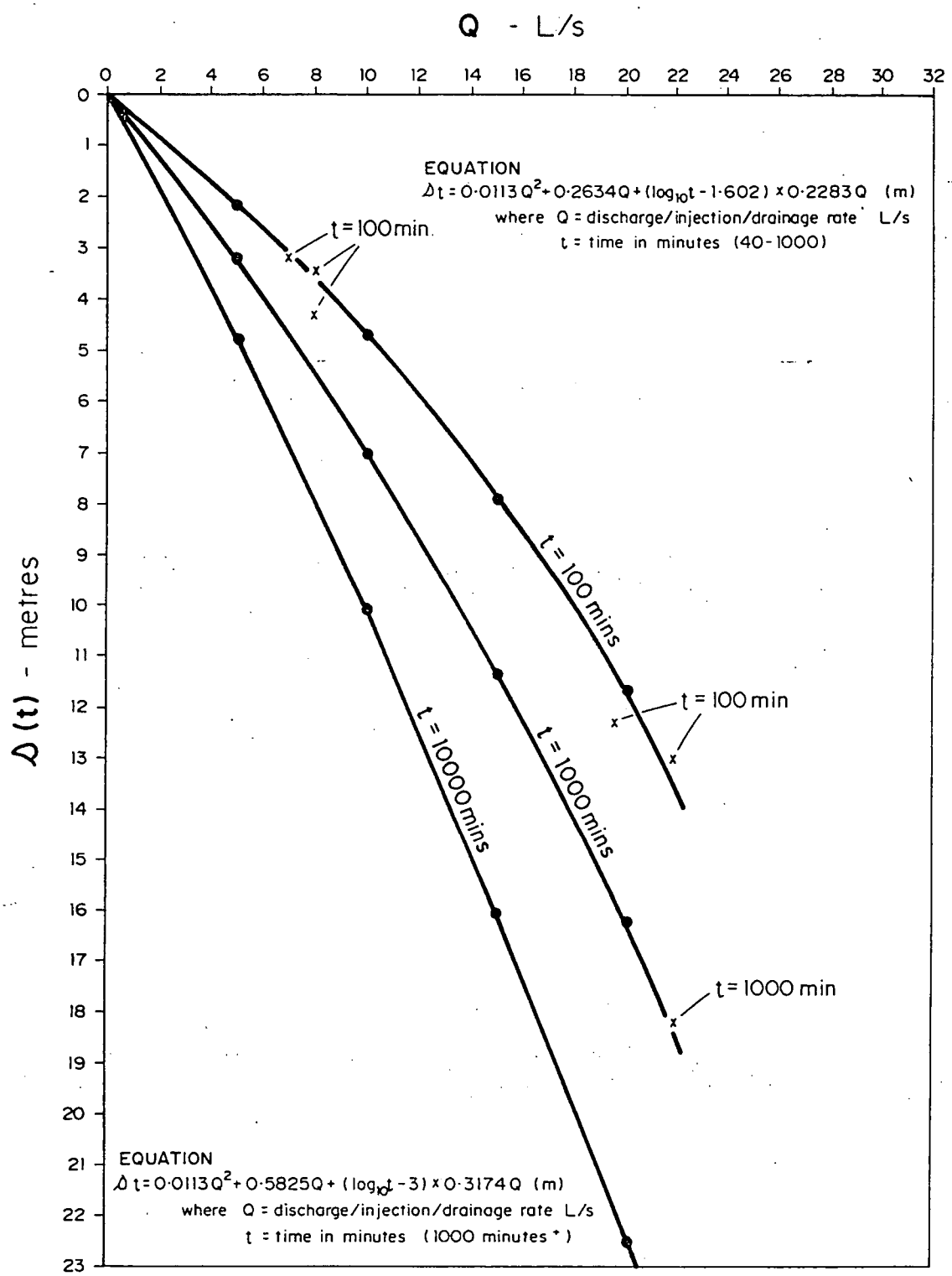


Figure.....8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O. DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1 SALINITY VS TIME INJECTED WATER PUMPED OUT	DRAWN R. Bird	SCALE As shown
	DATE February 1993	PLAN NUMBER 93-141
	CHECKED	

5770



LEGEND

●.....Data generated from Equation

x.....Actual data from individual stages

Figure.....9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O. DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1 SPECIFIC CAPACITY PLOT BEHAVIOUR GENERATED FROM INJECTION EQTNS.	DRAWN R. Bird	SCALE As shown
	DATE February 1993	PLAN NUMBER 93-142
	CHECKED	

5770

APPENDIX A - LITHOLOGICAL AND GEOPHYSICAL LOGS

5770

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENGINEERING SECTION

PLAN No. 93-143

COMPOSITE WELL LOG - GROUNDWATER

CONSTRUCTION DETAILS

DRILLING METHOD . . . ROTARY
CIRCULATION . . . MUD/AIR
MUD RESISTIVITY/TYPE
START . . . 2/12/92 . . . FINISH . . . 5/12/92 . . .
TOTAL DEPTH . . . 80.5 . . . m

	mm	From (m)	To (m)
HOLE DIAMETER	247	0	3
	193	3	45·5
	152	45·5	80·5
CASING DIAMETER (Cemented)	205	0	3
	155	0	45·5
CASING DIAMETER (Uncemented)			
SCREEN DETAILS OPEN HOLE	152	45,5	80,5

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO S.W.L. (m)	YIELD L/s	YIELD Method of Test	TOTAL DISSOLVED SOLIDS mg/litre	TOTAL DISSOLVED SOLIDS Analyses W. No.
53		3	AIR LIFT		
60		5	AIR LIFT		
69		8	AIR LIFT		

REMARKS

PROJECT . . . NORTHFIELD RESIDENTIAL DEVELOPMENT
ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1
FIELD No. . . . . UNIT No. . . 6628390WW16185 PERMIT No. . . 28272 . . .
LOCATION . . . . SECTION 873, HUNDRED OF YATALA
(NORTHFIELD, ADELAIDE)
REF. ELEV. . . . . m SURFACE ELEV. . . . . m DATUM . . . . .
LOGGED BY . . . S. HOWLES DATE . . . 5/12/92 . . . .

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	S.P.	CALIPER	BULK DENSITY	POINT RESIST.		
DATE OF RUN								
FIRST READING (m)	78	80	79	78	80	79		
LAST READING (m)	0	2	43	1	3	43		
RECORDED BY								

WELL SYMBOLS

- Casing seal
- Casing shoe
- Wire wound screen
- Slotted casing
- Cemented interval
- Gravel packed interval

CONSTRUCTION LOG | WATER CUT AND LEVEL | HYDRO DATA | AGE | UNIT | LITHOLOGY DESCRIPTION | LITHO. LOG | DEPTH (m)

0–2m BLACK TOP SOIL

2–8m CLAY yellow-brown, red, mottled. Stiff, minor interbeds of medium gravel.

8–10m GRAVEL fine–medium, 2–20mm, predominantly 3–4mm. Quartz, clean.
10–18m CLAY AND GRAVEL Clay white, yellow-brown, orange and sticky. Gravel fine–medium, 2–20mm, quartz, ironstone,interbeds (?).

18–38m CLAYS white, brown, pink, grey, sticky.

38–44m CLAY Green, sticky, pure.

44–69m SLATE grey fine grained slate. Includes quartz bands between 63 and 69m.

69–80.5m QUARTZITE white grey.

GAMMA 0–150 CPS | SPON. POTENTIAL 150–350 mV | POINT RESIST. 45–95 OHM
NEUTRON 0–2000 CPS | BULK DENSITY 19000–6000 CPS | CALIPER 100–200 mm

-967.443
-647.458
-82

5770

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA
GROUNDWATER AND ENGINEERING SECTION

PLAN No. 93-144

COMPOSITE WELL LOG - GROUNDWATER

CONSTRUCTION DETAILS

DRILLING METHOD . . CABLE TOOL . . . . . .
CIRCULATION . . . WATER. . . . . .
MUD RESISTIVITY/TYPE . . . . . .
START . . . . 7/12/92 . . . FINISH . . . 10/12/92. . .
TOTAL DEPTH . . . 35. . . m

	mm	From (m)	To (m)
HOLE DIAMETER	200	0	35
CASING DIAMETER (Cemented)	80	0	35
CASING DIAMETER (Uncemented)			
SCREEN DETAILS SLOTTED CASING	80	6	10
		28	35

GROUNDWATER ANALYSES

DEPTH TO WATER CUT (m)	DEPTH TO S.W.L. (m)	YIELD		TOTAL DISSOLVED SOLIDS	
		m³/day	Method of Test	mg/ltre	Analyses W. No.
12			SEE PAGE		

REMARKS . . . . . .

NORTHFIELD RESIDENTIAL DEVELOPMENT
PROJECT . ARTIFICIAL RECHARGE POTENTIAL – PRECINCT 1 . . . . . .
FIELD No. . . . . UNIT No. . 6628390WW16186 . PERMIT No. . . 28273 . . .
LOCATION . . . . SECTION 873, HUNDRED OF YATALA . . . . . .
. . . . . (NORTHFIELD, ADELAIDE) . . . . . .
REF. ELEV. . . . . m SURFACE ELEV. . . . . m DATUM . . . . . .
LOGGED BY. S. HOWLES . . DATE. . . . 10/12/92 . . .

GEOPHYSICS

TYPE OF LOG	GAMMA	NEUTRON	S.P.	CALIPER	DENSITY	TEMP.		
DATE OF RUN								
FIRST READING (m)	0	1						
LAST READING (m)	34	35						
RECORDED BY								

WELL SYMBOLS

. . . . Casing seal
. . . . Casing shoe
. . . . Wire wound screen
. . . Slotted casing
. . . Cemented interval
. . . Gravel packed interval

CONSTRUCTION LOG | WATER CUT AND LEVEL | HYDRO DATA | AGE | UNIT | LITHOLOGY – DESCRIPTION | LITHO. LOG | DEPTH (m)

0–2m BLACK TOP SOIL grey-red brown, stiff.

2–6m SANDY CLAY mottled grey and green-grey red-brown, stiff, 50% medium sand.

6–10m SANDSTONE Quartz, solid, grading to coarse sand-fine gravel and clay at base.

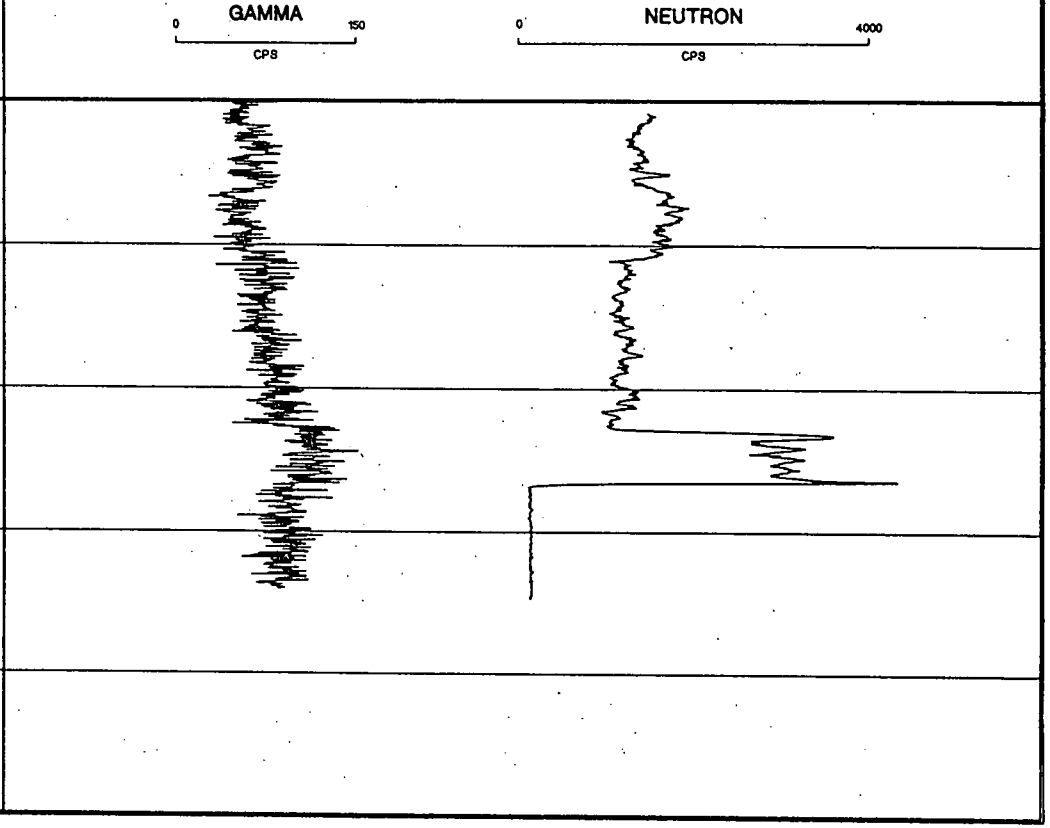
10–12m CLAYEY SAND fine.

12–22m CLAY white, minor brown-red ferruginous mottling, very stiff. Includes 10% coarse gravel or fine sand.

22–24m SAND AND CLAY fine sand.

24–30m CLAY green-yellow laminated, ferruginous bands, stiff, coarse gravel bands.

30–35m CLAY green, grey, orange, yellow mottled, stiff, coarse gravel bands.



APPENDIX B - SALINITY DATA AND FULL ANALYSIS

Table B1. Salinity data during drilling of well 6628-16185

Depth(m)	Date	salinity(mg/L)	pH	W No
53	5/12/92	1384	7.79	W5658/92
60	5/12/92	1389	8.24	W5659/92
69	5/12/92	1563	7.97	W5660/92
75	5/12/92	2114	7.88	W5661/92
80	5/12/92	2488	7.95	W5662/92

Table B2. Salinity data during pre - injection discharge tests on well 6628-16185

Time (mins)	Date	salinity(mg/L)	pH	W No
constant discharge test				
180	5/1/93	2448	7.25	W2706/93
300	5/1/93	2527	7.25	W2707/93
350	5/1/93	2573	7.28	W2708/93
400	5/1/93	2613	7.45	W2709/93
450	5/1/93	2641	7.45	W2710/93
500	5/1/93	2652	7.34	W2711/93
550	5/1/93	2669	7.42	W2712/93
600	5/1/93	2669	7.35	W2713/93
step drawdown test				
Step 1				
5	11/1/93	1714	7.20	W2725/93
60	11/1/93	2086	7.23	W2726/93
100	11/1/93	2227	7.38	W2727/93
Step 2				
80	11/1/93	2391	7.24	W2728/93
Step 3				
30	11/1/93	2476	7.26	W2729/93
100	11/1/93	2556	7.21	W2730/93
Step 4				
10	11/1/93	2567	7.28	W2731/93
30	11/1/93	2596	7.32	W2732/93

Table B3. Salinity data during post - injection discharge tests on well 6628-16185

Time (mins)	Date	salinity(mg/L)	pH	W No
constant discharge test 3/2/93				
0	3/2/93	385	7.88	W2915/93
30	3/2/93	772	7.01	W2916/93
60	3/2/93	772	7.04	W2917/93
90	3/2/93	777	6.90	W2918/93
120	3/2/93	783	7.05	W2919/93
180	3/2/93	810	6.90	W2920/93
240	3/2/93	832	7.06	W2921/93
300	3/2/93	860	6.91	W2922/93
360	3/2/93	882	6.94	W2393/93
constant discharge test 9/2/93				
0	9/2/93	1044	6.87	W2960/93
60	9/2/93	1044	6.96	W2961/93
120	9/2/93	1032	6.93	W2962/93
180	9/2/93	1066	7.03	W2963/93
240	9/2/93	1088	7.03	W2964/93
300	9/3/93	1105	7.01	W2965/93
360	9/3/93	1121	6.99	W2966/93
420	9/2/93	1144	6.99	W2967/93
480	9/2/93	1172	7.04	W2968/93
540	9/2/93	1199	7.08	W2969/93
600	9/2/93	1233	7.13	W2970/93

amdel

Water Analysis Report Job No. 3AD0187 Method WAT 2 Page W1

Sample ID. W2714/93

		Chemical Composition mg/L	me/L
Cations			
Calcium	(Ca)	33.6	1.68
Magnesium	(Mg)	60.9	5.01
Sodium	(Na)	833.0	36.23
Potassium	(K)	15.0	0.38
Anions			
Hydroxide	(OH)		
Carbonate	(CO3)		
Bi-Carbonate	(HCO3)	363.6	5.96
Sulphate	(SO4)	316.0	6.58
Chloride	(Cl)	1210	34.09
Nitrate	(NO3)	<0.1	

Other Analyses

Reaction - pH	6.9
Conductivity (E.C) (micro -S/cm at 25°C)	4720
Resistivity Ohm.M at 25°C	2.12

Derived Data

	mg/L
Total Dissolved Solids	
A. Based on E.C.	2744
B. Calculated (HCO3=CO3)	2650
Total Hardness	334
Carbonate Hardness	298
Non-Carbonate Hardness	36
Total Alkalinity (Each as CaCO3)	298

Totals and Balance

Cations (me/L)	43.3	Diff=	3.32
Anions (me/L)	46.6	Sum =	89.94

ION BALANCE (Diff*100/Sum) = 3.70%

Sodium / Total Cation Ratio 83.7%

Remarks

600mins. IMBALANCE UNKNOWN.

Note: mg/L = Milligrams per litre
me/L = MilliEqivs.per litre

Name: Ms S.TYRTEOS
Address: DEPARTMENT OF MINES & ENERGY
191 GREENHILL ROAD
PARKSIDE S.A

Date Collected 5-1-93
Date Received 21-1-93
Collected by KJD

Formation
Type
Point
Time
Interval
Geologist
Depth 45M

NB: CONSTANT DISCHARGE TEST 5/1/93 - 600 mins.

APPENDIX C - WELL AND AQUIFER DISCHARGE AND INJECTION DATA

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL 0.58 (m)
WATER LEVEL BELOW TOC AT START 14.35 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT ..... ON 16/12/92
STOPPED AT ..... ON ../../.....

Note: Use black ball pen and fill in form completely.

CONSTANT DISCHARGE TEST

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
1	1.25			8 L/S	
2	1.45				
3	1.65				
4	1.75				
5	1.85				
6	1.95				
7	2.04				
8	2.14				
9	2.18				
10	2.15				
12	2.40				
14	2.52				
16	2.61				
18	2.70				
20	2.79				
22	2.85				
24	2.92				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/S~~LOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL 0.58 (m)
WATER LEVEL BELOW TOC AT START 4.35 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT ..... ON 6/12/92
STOPPED AT ..... ON ../../.....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
26	3.00				
28	3.05				
30	3.12				
35	3.26				
40	3.38				
45	3.50				
50	3.60				
55	3.69				
60	3.77				
70	3.93				
80	4.07				
90	4.20				
100	4.32				
120	4.49				
140	4.67				
170	4.85				
180	4.92				

Test performed by ..... Analysed by .....

Sheet 2 of 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628 -16 185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 ...(m)

TOP OF CASING (TOC) ABOVE GL 0.58 ..(m)
WATER LEVEL BELOW TOC AT START 14.35 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT ..... ON 16/12/92 ....
STOPPED AT ..... ON ../../.....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
200	5.04				
250	5.31			8 L/s	
300	5.33			8 L/s	
350	5.72				
400	5.91				
450	6.06				
480	6.15				
END TEST					

Test performed by ..... Analysed by .....

Sheet 3 of 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-1685
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED~~/~~SCREENED~~
From 45.5 to 80.2 (m)

TOP OF CASING (TOC) ABOVE GL..... (m)
WATER LEVEL BELOW TOC AT START 14.172 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT 1.30 pm. ON 5/1/93
STOPPED AT 10.30 pm. ON 5/1/93

Note: Use black ball pen and fill in form completely.

CONSTANT DISCHARGE TEST

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00			19.94 l/s	
1	—				
2	—				
2.5	5.350				
3	5.570				
4	6.125				
5	6.410				
6	6.705				
7	6.940				
8	7.280				
9	7.455				
10	7.585			19.99 l/s	
12	7.990				
14	8.200				
16	8.445			20.15 l/s	
18	8.810				
20	9.070				
22	9.250				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No...6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~80.5~~...(m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START ~~8.172~~(m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT ~~1:30pm~~.ON 5/1/93....
STOPPED AT ~~10:30pm~~.ON 5/1/93....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m or ~~Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
24	9.450			19.99 L/S	
26	9.660				
28	9.830				
30	10.010			20.10 L/S	
35	10.385				
40	10.790			20.06 L/S	
45	10.970			19.97 L/S	
55	11.305				
60	11.470				
70	11.770				
80	11.920				
90	12.105				
100	12.300				
120	12.580				
140	12.835				
160	13.025				
180	13.166				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER:

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED~~/~~SCREENED~~
From ~~45.5~~ to ~~50.5~~ (m)

TOP OF CASING (TOC) ABOVE GL..... (m)
WATER LEVEL BELOW TOC AT START ~~19.72~~ (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT 1.30 pm. ON 5/1/93....
STOPPED AT ~~10.30~~ pm. ON 5/1/93....

Note: Use black ball pen and fill in form completely.

TIME (Mins after Start)	DRAWDOWN (m or ~~Kpa~~)	DISCHARGE			
		Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
200	13.370			20.35	
230	13.605			19.65	
300	14.035			19.63	
350	14.390			19.63	
400	14.650			19.52	
450	14.925			19.63	
500	15.160			19.68	
550	15.370			19.36	
600	15.585			19.70	
END	TEST				
			$\bar{Q}$ =	19.63 l/s	av last 400 mins.

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING AND MECHANICAL BRANCH

Well No. 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL RECOVERY TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

TEST TYPE: Pump/Air-Lift/
Bailer

STAGE NO.:

AVERAGE PUMPING RATE ..... 19.63 L/S ~~x1/hr~~
PUMP STOPPED AT 10:30 AM ON 5.1.1.93

RECOVERY MEASUREMENTS
STOPPED AT 10:30 AM ON 3.11.1.93

Note: Use black ball pen and fill in form completely.

RECOVERY

Minutes after pump		$\frac{t}{t_1}$	RESIDUAL DRAWDOWN	Minutes after pump		$\frac{t}{t_1}$	RESIDUAL DRAWDOWN
Start(t)	Stop(t)			Start(t)	Stop(t)		
601	1	601	10.670	645	45	14	5.520
602	2	301	10.050	650	50	13	5.310
603	3	201	9.700	655	55	12	5.230
604	4	151	9.395	660	60	11	5.105
605	5	121	9.090	670	70	10	4.865
606	6	101	8.900	680	80	8.5	4.690
607	7	87	8.670	690	90	8	4.555
608	8	76	8.500	700	100	7	4.390
609	9	68	8.320	720	120	6	4.200
610	10	61	8.160	740	140	5.3	4.030
612	12	51	7.860	760	160	4.8	3.870
614	14	44	7.570	780	180	4.3	3.720
616	16	39	7.370	800	200	4.0	3.620
618	18	34	7.175	850	250	3.4	3.350
620	20	31	6.950	900	300	3.0	3.180
622	22	28	6.790	950	350	2.7	2.985
624	24	26	6.640	1000	400	2.5	2.855
620	26	24	6.510	1050	450	2.3	2.735
628	28	22	6.390	1100	500	2.2	2.630
630	30	21	6.270	1150	550	2.1	2.525
635	35	18	5.930	1200	600	2.0	2.440
640	40	16	5.710	1250	650	1.9	2.357

Performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING AND MECHANICAL BRANCH

Well No. 6628-1685
PRODUCTION/~~OBSERVATION~~

WATER WELL RECOVERY TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

TEST TYPE: Pump/Air-Lift/ Bailer
STAGE NO.:

AVERAGE PUMPING RATE 19.63 L/S ~~kl/hr~~
PUMP STOPPED AT 10:30 ~~AM~~ ON 5.1.93.

RECOVERY MEASUREMENTS
STOPPED AT 10:30 AM ON 11.1.93

Note: Use black ball pen and fill in form completely.

Minutes after pump		$\frac{t}{t_1}$	RESIDUAL DRAWDOWN	Minutes after pump		$\frac{t}{t_1}$	RESIDUAL DRAWDOWN
Start(t)	Stop(t)			Start(t)	Stop(t)		
1300	700	1.85	2.290				
1350	750	1.80	2.210				
1400	800	1.75	2.140				
1450	850	1.70	2.065				
1500	900	1.66	2.000				
1890	1290	1.46	1.545				
2610	2010	1.29	1.150				
3330	2730	1.22	0.915				
4050	3450	1.17	0.760				
4770	4170	1.14	0.595				
5490	4890	1.12	0.535				
6990	6390	1.09	0.400				
8520	7920	1.08	0.310				
	END RECOVERY						

Sheet 5 of 5

Performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to ~~50.5~~ (m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START ~~14.42~~ (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 11 ~~AM~~ ON 11/1/93
STOPPED AT 5 ~~PM~~ ON 11/1/93

Note: Use black ball pen and fill in form completely.

STEP DRAWDOWN TEST

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
1	1.015			6.5 l/s	STEP 1
2	1.095				
3	1.200				
4	1.335				
5	1.415				
6	1.490				
7	1.555				
8	1.615				
9	1.665				
10	1.705			6.5 l/s	
12	1.775				
14	1.830				
16	1.910				
18	1.955				
20	2.000			6.5 l/s	
22	2.030				
24	2.050				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 ...(m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START 4.42 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 11 am ON 11/1/93
STOPPED AT 5 pm ON 11/1/93

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
26	2.120				
28	2.145				
30	2.170				
35	2.415			6.5 l/s	
40	2.415				
45	2.620				
50	2.795				
55	2.825				
60	2.860				
70	2.925				
80	3.030				
90	3.095				
100	3.180			6.5 l/s	
101/1	4.025			10.8 l/s	STEP 2
102/2	4.085				
103/3	4.170				
104/4	4.235				

Test performed by ..... Analysed by .....

Sheet 2 of 7

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628 - 16685
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/S~~LOTTED/SCREEN~~ED
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START 4.42 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 11 am ON 11/1/93
STOPPED AT 5 pm ON 11/1/93

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
105/5	4.270				
106/6	4.345				
107/7	4.360				
108/8	4.420				
109/9	4.440				
110/10	4.475			10.8 L/S	
112/12	4.540				
114/14	4.580				
116/16	4.675				
118/18	4.680				
120/20	4.730			10.8 L/S	
122/22	4.730				
124/24	4.815				
126/26	4.835				
128/28	4.850				
130/30	4.855				
135/35	4.900				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/S~~LOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START 14.42 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT. 11 a.m. ON 11/1/83
STOPPED AT. 5 p.m. ON 11/1/83

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
140/40	4.985			10.8 L/S	
145/45	5.035				
150/50	5.105				
155/55	5.155				
160/60	5.185			10.8 L/S	
170/70	5.280				
180/80	5.330				
190/90	5.385				
200/100	5.485			10.8 L/S	
201/1	—			15.3 L/S	STEP 3
202/2	7.070				
203/3	7.145				
204/4	7.200				
205/5	7.255				
206/6	7.33				
207/7	7.39				
208/8	7.40				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED~~/~~SCREENED~~
From ~~45.5~~ to ~~80.5~~ (m)

TOP OF CASING (TOC) ABOVE GL..... (m)
WATER LEVEL BELOW TOC AT START ~~7.42~~ (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT. ~~11 AM~~ ..ON ~~11~~/~~1~~/~~83~~ ....
STOPPED AT. ~~5 PM~~ ..ON ~~11~~/~~1~~/~~83~~ ....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
209/9	7.485				
210/10	7.495			15.3 L/s	
212/12	—				
214/14	7.670				
216/16	7.730				
218/18	7.770				
220/20	7.855				
222/22	7.880				
224/24	7.955				
226/26	8.005				
228/28	8.035				
230/30	8.075			15.3 L/s	
235/35	8.155				
240/40	8.215				
245/45	8.265				
250/50	8.355				
255/55	8.450				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START 14.42 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 11 AM ON 11/1/93
STOPPED AT 5 pm ON 11/1/93

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
260/60	8.510			15.3 L/S	
270/70	8.595				
280/80	8.715				
290/90	8.835				
300/100	8.915			15.3 L/S	
301/1	—			25.2 L/S	STEP 4
302/2	—				
303/3	13.635				
304/4	13.980				
305/5	14.080				
306/6	14.245				
307/7	14.150				
308/8	14.550				
309/9	14.630				
310/10	14.745			25.1 L/S	
312/12	15.000				
314/14	15.175				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-1618S
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 50.5 (m)

TOP OF CASING (TOC) ABOVE GL.....(m)
WATER LEVEL BELOW TOC AT START 4.42 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 11 AM ON 11/1/93
STOPPED AT 5 pm ON 11/1/93

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m or ~~kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
316/16	15.305				
318/18	15.50				
320/20	15.585				
322/22	15.755				
324/24	15.860				
326/26	15.990				
328/28	16.090				
330/30	16.120			25.24/s	
335/35	16.360				
340/40	16.520				
345/45	—				
350/50	16.835				
355/55	—				
360/60	17.035			25.24/s	
END	TEST.				

Test performed by ..... Analysed by .....

Sheet 1 of 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-1685
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~80.5~~ ...(m)

TOP OF CASING (TOC) ABOVE GL ..1.3..(m)
WATER LEVEL BELOW TOC AT START 15.4(m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT 5.30 pm ON 15/1/93
STOPPED AT 11.30 AM ON 16/1/93

Note: Use black ball pen and fill in form completely.

INJECTION TEST

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
1	5.97			22.5 L/S	mains head 15m
1.5	6.61				
2	6.99				
2.5	6.99				
3	7.30				
3.5	7.49				
4	7.64				
4.5	7.82				
5	7.92			22.5 L/S	mains head 15m
5.5	8.07				
6	8.21				
6.5	8.32				
7	8.41				
7.5	8.49				
8	8.62				
8.5	8.71				
9	8.80				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL 1.3 (m)
WATER LEVEL BELOW TOC AT START 15.14 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT 5.30 pm ON 15/1/93
STOPPED AT 1.30 AM ON 18/1/93

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
9.5	8.90				
10	8.97			22.5 L/s	Mains head 15m
11	9.11				
12	9.27				
13	9.38				
14	9.50				
15	9.60				
16	9.72				
17	9.81				
18	9.89				
20	10.06			22.5 L/s	mains head 15m
22	10.21				
24	10.33				
26	10.44				
28	10.56				
30	10.66				
32	10.74				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-1685
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~50.5~~...(m)

TOP OF CASING (TOC) ABOVE GL.....1.3.....(m)
WATER LEVEL BELOW TOC AT START ~~15.14~~(m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT ~~5:30~~ PM ON 5/1/93....
STOPPED AT 11:30AM ON 18/1/93....

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m or ~~Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
34	10.84				
36	10.93				
38	11.02				
40	11.14	[redacted]		22.5 l/s	mans head 15m
45	11.39			22.5 l/s	mans head 15m
50	11.59				
55	11.79				
60	11.95				
70	12.30				
80	12.53	[redacted]		22.5 l/s	
90	12.79				
100	12.97			22.15	
130	13.51			22.13	mans head 17m
140	13.72				
150	13.87			22.10	
160	14.03				
170	14.14			22.07	mans head 19m

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ .. to ~~80.5~~ ..(m)

TOP OF CASING (TOC) ABOVE GL..1.5..(m)
WATER LEVEL BELOW TOC AT START 15.14 (m)
PUMP SETTING BELOW TOC .....(m)
PUMP STARTED AT. 5.30 pm ON 15/.1./.93.....
STOPPED AT. 1.30 Am ON 18/1./.93.....

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
180	14.22				
190	14.35				
200	14.44				
230	14.76				
240	14.85				
250	14.95			22.07 L/s	mains head 19m
280	15.14			22.07 L/s	mains head 19m
420	15.94			22.07 L/s	mains head 19m
450	16.04			22.0 L/s	
500	16.44			22.0 L/s	mains head 20m
550	16.74			22.0 L/s	
600	16.94			21.96 L/s	mains head 20m
650	17.14			22.0 L/s	
700	17.24			21.96 L/s	
750	17.34			21.96 L/s	
800	17.64			21.96 L/s	
850	18.04			22.0 L/s	mains head 21m

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL 1.3 (m)
WATER LEVEL BELOW TOC AT START 5.14 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT 5.30 pm ON 15/1/93
STOPPED AT 11.30 AM ON 18/1/93

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m or Kpa)	Meter Readings	Difference	Rate in ~~l/hr~~ l/s	Renmarks
00	00				
900	18.14			21.96 l/s	
950	18.14			21.90 l/s	
1000	18.14			21.68 l/s	Mans head 21m
1050	18.24			21.77 l/s	
1100	18.64			21.73 l/s	Mans head 21m
1150	18.89			21.68 l/s	Mans head 21.5m
1200	19.14			21.77 l/s	Mans head 21.5m
1250	19.14			21.64 l/s	Mans head 21.75m
1300	19.44		Jump ↓ 1L/s	21.94 l/s	Mans head 22m
1350	20.89			23.4 l/s	Mans head 26m
1400	21.14			23.4 l/s	Mans head 26.5m
1450	21.24			23.3 l/s	Mans head 26.5m
1500	21.24			23.2 l/s	Mans head 26.5m
1550	21.44			23.18 l/s	Mans head 26m
1600	21.44			23.1 l/s	Mans head 26m
1650	21.64			23.3 l/s	Mans head 26.5m
1700	21.84			23.35 l/s	Mans head 26.5m

$\bar{Q}$ = 21.94 l/s

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-6618S
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL. 1.3 (m)
WATER LEVEL BELOW TOC AT START 15.14 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT ~~5.30PM~~ ON 15/1/93
STOPPED AT ~~11.30AM~~ ON 18/1/93

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
1750	22.04			23.40 L/s	Mans head 26.5m
1800	22.04			23.46 L/s	Mans head 27m
1850	22.04			23.4 L/s	Mans head 27m
1900	22.14			23.34 L/s	Mans head 27m
1950	22.24			23.31 L/s	Mans head 27m
2000	22.34			23.32 L/s	Mans head 27.5m
2100	22.34			23.44 L/s	Mans head 27.5m
2200	22.39			23.45 L/s	Mans head 27.5m
2300	22.64			23.44 L/s	Mans head 27.5m
2400	22.74			23.34 L/s	Mans head 27.5m
2500	22.94			23.25 L/s	Mans head 28m
2600	23.24			23.3 L/s	Mans head 28m
2700	23.34			23.24 L/s	Mans head 28m
2800	23.34			23.26 L/s	Mans head 28m
2900	23.44			23.2 L/s	Mans head 28m
3000	23.44			23.04 L/s	Mans head 27.5m
3100	23.64			23.2 L/s	Mans head 28m

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL. 1.3 (m)
WATER LEVEL BELOW TOC AT START 15.14 (m)
PUMP SETTING BELOW TOC ..... (m)
PUMP STARTED AT 5:30 pm ON 15/1/93
STOPPED AT 11:30 am ON 18/1/93

Note: Use black ball pen and fill in form completely.

TIME	~~DRAWDOWN~~ HEAD	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
3200	23.84			23.25 L/s	Mns head 28.5m
3300	23.84			23.25 L/s	Mns head 28.5m
3400	23.94			23.25 L/s	Mns head 28.5m
3500	23.94			23.35 L/s	Mns head 28.5m
3600	24.14			23.35 L/s	Mns head 29m
3700	24.14			23.3 L/s	Mns head 29m
3800	24.24			23.15 L/s	Mns head 29m
3900	24.34			23.15 L/s	Mns head 29m
3930	24.34			23.02 L/s	Mns head 29m $\bar{Q}$=23 L/s
END	TEST. at	3960			

Test performed by ..... Analysed by .....

Sheet 7 of 9

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING AND MECHANICAL BRANCH

Well No. 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL RECOVERY TEST

PROJECT/OWNER: NORTH FEED DEVELOPMENT

TEST TYPE: Pump/Air-Lift/
Bailer
STAGE NO.:

AVERAGE PUMPING RATE ..... kl/hr
PUMP STOPPED AT 11.30 Am ...ON 18/1/93.

RECOVERY MEASUREMENTS
STOPPED AT 10 Am ... ON 25/1/93..

Note: Use black ball pen and fill in form completely.

RECOVERY

Minutes after pump		$\frac{t}{t_1}$	RESIDUAL HEAD (m) ~~DRAWDOWN~~	Minutes after pump		$\frac{t}{t_1}$	RESIDUAL HEAD (m) ~~DRAWDOWN~~
Start(t)	Stop(t)			Start(t)	Stop(t)		
3960.5	0.5	7921	16.64	3982	22	181	11.56
3961	1.0	3961	15.64	3984	24	166	11.44
3961.5	1.5	2641	15.54	3986	26	153.3	11.315
3962	2.0	1981	15.44	3988	28	142.4	11.170
3962.5	2.5	1585	14.74	3990	30	133	11.06
3963	3.0	1321	14.54	3995	35	114.1	10.75
3963.5	3.5	1132.4	14.38	4000	40	100	10.55
3964	4.0	991	14.25	4005	45	89	10.25
3964.5	4.5	881	14.15	4010	50	80.2	10.16
3965	5.0	793	14.00	4015	55	73	9.99
3966	6	661	13.75	4020	60	67	9.81
3967	7	566.7	13.63	4030	70	57.6	9.55
				4040	80	50.5	9.365
				4050	90	45	9.19
3968	8	496	13.315	4060	100	40.6	9.00
3969	9	441	13.17	4080	120	34	8.695
3970	10	397	12.96	4100	140	29.3	8.405
3972	12	331	12.655	4120	160	25.8	8.205
3974	14	283.9	12.370	4140	180	23	8.00
3976	16	248.5	12.135	4160	200	20.8	7.79
3978	18	221.	11.96	4210	250	16.8	7.375
3980	20	199	11.77	4260	300	14.2	7.020

Performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING AND MECHANICAL BRANCH

Well No. 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL RECOVERY TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

TEST TYPE: Pump/Air-Lift/ Bailer
STAGE NO.:

AVERAGE PUMPING RATE ..... kl/hr
PUMP STOPPED AT 11.30 AM ON 18/1/93

RECOVERY MEASUREMENTS
STOPPED AT 10 AM ON 25/1/93

Note: Use black ball pen and fill in form completely.

Minutes after pump		$\frac{t}{t_1}$	RESIDUAL HEAD (m) ~~DRAWDOWN~~	Minutes after pump		$\frac{t}{t_1}$	RESIDUAL HEAD (m) ~~DRAWDOWN~~
Start(t)	Stop(t)			Start(t)	Stop(t)		
4310	350	12.3	6.70	5410	1450	3.7	3.16
4360	400	10.9	6.41	5460	1500	3.6	3.085
4410	450	9.8	6.145	5510	1550	3.6	2.925
4460	500	8.9	5.88	5560	1600	3.5	2.905
4510	550	8.2	5.655	5940	1980	3.0	2.415
4560	600	7.6	5.43	6690	2730	2.5	1.665
4610	650	7.1	5.21	7230	3270	2.2	1.38
4660	700	6.7	5.05	8100	4140	2.0	0.93
4710	750	6.3	4.87	8640	4680	1.8	0.885
4760	800	6.0	4.705	9500	5540	1.7	0.430
4810	850	5.7	4.56	10980	7020	1.6	0.130
4860	900	5.4	4.41	12420	8460	1.5	-0.030
4910	950	5.2	4.265	13950	9990	1.4	-0.245
4960	1000	5.0	4.16				
5010	1050	4.8	4.05				
5060	1100	4.6	3.92				
5110	1150	4.4	3.78				
5160	1200	4.3	3.675				
5210	1250	4.2	3.55				
5260	1300	4.0	3.44				
5310	1350	3.9	3.35				
5360	1400	3.8	3.25				

Performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-1685
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~80.5~~ ...(m)

TOP OF CASING (TOC) ABOVE GL. 0.9 (m)
WATER LEVEL BELOW TOC AT START 15.49 (m)
PUMP SETTING BELOW TOC ..... 21 (m)
PUMP STARTED AT 9.45 AM ON 3/2/93
STOPPED AT 3.45 PM ON 3/2/93

Note: Use black ball pen and fill in form completely.

CONSTANT DISCHARGE TEST

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
1	1.505			8 L/S	
2	1.630				
3	1.750				
4	1.845				
5	1.945				
6	1.995				
7	2.050				
8	2.110				
9	2.170				
10	2.215			8 L/S	
12	2.280				
14	2.355				
16	2.405				
18	2.455				
20	2.520			8 L/S	
22	2.560				
24	2.610				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No 6628 - 16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~80.5~~ (m)

TOP OF CASING (TOC) ABOVE GL. 0.9 (m)
WATER LEVEL BELOW TOC AT START ~~15.99~~ (m)
PUMP SETTING BELOW TOC ..... 25 (m)
PUMP STARTED AT ~~9.45 AM~~ ON ~~3~~/2/92
STOPPED AT ~~3.45 pm~~ ON ~~3~~/2/92

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m or ~~Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
26	2.660				
28	2.690				
30	2.705			8 L/s	
35	2.775				
40	2.850			8 L/s	
45	2.900				
50	2.950			8 L/s	
55	3.005				
60	3.035			8 L/s	
70	3.160			8 L/s	
80	3.235				
90	3.470			8L/s	
100	3.545			8L/s	
120	3.665				
140	3.790				
160	3.890				
180	3.960				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/S~~LOTTED/SCREENED~~
From 95.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL. 0.9 (m)
WATER LEVEL BELOW TOC AT START 15.99 (m)
PUMP SETTING BELOW TOC ..... 25 (m)
PUMP STARTED AT 9.45 AM ON 3/2/82....
STOPPED AT 3.45 pm ON 3/2/82....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
200	4.045				
250	4.230				
300	4.345				
350	4.445				
360	4.475				
END TEST.					

Test performed by ..... Analysed by .....

Sheet 3 of 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628 - 16785
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~45.5~~ to ~~80.4~~...(m)

TOP OF CASING (TOC) ABOVE GL..~~0.?~~.(m)
WATER LEVEL BELOW TOC AT START~~5.74~~.(m)
PUMP SETTING BELOW TOC .....~~25~~..(m)
PUMP STARTED AT ~~7.50 am~~..ON ~~9~~./~~2~~./~~93~~.....
STOPPED AT ~~5.50 pm~~..ON ~~9~~./~~2~~./~~93~~.....

Note: Use black ball pen and fill in form completely.

CONSTANT DISCHARGE TEST

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ l/s	Renmarks
00	00				
1	1.420			8 l/s	
2	1.655				
3	1.730				
4	1.800				
5	1.880				
6	1.950				
7	2.015				
8	2.070				
9	2.110				
10	2.160			8/l/s	
12	2.240				
14	2.320				
16	2.365				
18	2.435				
20	2.485			8l/s	
22	2.535				
24	2.580				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628-16185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTHFIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From ~~85.5~~ to ~~80.5~~ ...(m)

TOP OF CASING (TOC) ABOVE GL. 0.9 ..(m)
WATER LEVEL BELOW TOC AT START 15.7~~6~~(m)
PUMP SETTING BELOW TOC .....25.(m)
PUMP STARTED AT 7.50 AM. ON. 9/.2/.93....
STOPPED AT 5.50 PM. ON. 9/.2/.93....

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/s	Renmarks
00	00				
26	2.620				
28	2.650				
30	2.705			8 L/S	
35	2.765				
40	2.820			8 L/S	
45	2.875				
50	2.930				
55	3.000				
60	3.055			8 L/S	
70	3.125				
80	3.205				
90	3.270			8 L/S	
100	3.360				
120	3.460			8 L/S	
140	3.570				
160	3.650			8 L/S	
180	3.740				

Test performed by ..... Analysed by .....

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

DRILLING & MECHANICAL BRANCH

Well No. 6628:16.185
PRODUCTION/~~OBSERVATION~~

WATER WELL PRODUCTION TEST

PROJECT/OWNER: NORTH FIELD DEVELOPMENT

HUNDRED .....
SECTION .....
WELL OPEN/~~SLOTTED/SCREENED~~
From 45.5 to 80.5 (m)

TOP OF CASING (TOC) ABOVE GL. 0.9 (m)
WATER LEVEL BELOW TOC AT START 5.74 (m)
PUMP SETTING BELOW TOC ..... 25 (m)
PUMP STARTED AT 7.50 AM. ON. 9/2/93
STOPPED AT 5.50 p.m. ON. 9/2/93

Note: Use black ball pen and fill in form completely.

TIME	DRAWDOWN	DISCHARGE			
(Mins after Start)	(m ~~or Kpa~~)	Meter Readings	Difference	Rate in ~~kl/hr~~ L/S	Renmarks
00	00				
200	3.810			8 L/S	
250	3.990				
300	4.145			8 L/S	
350	4.270				
400	4.385			8 L/S	
450	4.505				
500	4.585			8 L/S	
550	4.680				
600	4.760			8 L/S	
END TEST.					

Test performed by ..... Analysed by .....

Sheet 3 of 3

APPENDIX D - GEOPHYSICAL SURVEY DISCUSSION

A.R. DODDS

Report on Geophysical Surveys at Northfield, S.A.

Introduction

As part of a project to investigate drainage and recharge problems at Northfield, two PROTEM traverses were done to test basement topography and the characteristics of overlying sediments. Fieldwork was done on 26 November and 4 December 1992, concurrently with the drilling of two test bores.

Survey Details

The instrument used for this survey was a PROTEM 47S which is a Transient Electromagnetic (TEM) device designed to detect variations in ground conductivity in the top 50 metres below surface. A 50 metre square transmitter loop was used, with the receiver coil centred within it. Readings were taken at 50 metre intervals along two orthogonal lines, as shown in Fig. 1, for a total of 30 soundings.

The results were transferred to a computer and inverted to yield a section of ground resistivity variation with depth at each reading point. The inversions were generally fair to good, with a few failures, giving high confidence in the general features of the sections but lower confidence in some of the detail features.

Results

The results are presented as resistivity contour sections in Figs. D1 and D2. In general high resitivities, over 100 ohm-metres, indicate basement or dry sediments while low resistivities indicate higher water content and higher salinities. Clays can also yield low resistivities.

Traverse 1 (Fig. D1) shows high resistivities below 20 metres depth at the south end of the line, near Bristol Terrace, which the bore in this location confirms to be quartzite basement. Above this are three layers, with conductors (clays) at surface and between 10 and 20 metres and a resistor between 3 and 10 metres which may be related partly to the dry sand layer of interest. This is discussed further below. The gradual increase in resistivity between 20 and 40 metres reflects the weathering profile.

Basement evidently drops away quite sharply to the north, dropping below 50 metres by 650N. The near surface resistor thickens to 25 metres at 750N, and extends, thinning, to the end of the traverse, underlain by thicker conductive material. The resistor was originally interpreted as indicating the sandy

aquifer, but drilling indicates that the clay content is quite high, and it appears that the water table may be the controlling feature here. Thus this material would have a low enough clay content that water is not held in any great quantity.

A metre or two of near-surface conductor (clay) exists throughout the traverse.

Traverses 1 and 2 cross at about the bore location - 400W on Traverse 2 and 600N on Traverse 1. Shallow basement in this area is shown, on Traverse 2, to drop away very sharply to the west, being over 50 metres below surface west of 500W. To the east, towards Sudholtz Road, it drops away more gently, and weathered basement probably exists within 35 metres at the east end of the traverse. Basement appears to be shallowest at 450W, about 50 metres west of the bores. Further west again there is little likelihood of fresh basement in the top 50 metres, but some weathered basement may be this shallow.

The shallow resistor, between 3 and 20 metres, is present over most of this traverse, and is most prominent between the bores and Sudholtz Road. Resistivities here exceed 1000 ohm-metres, and may well indicate that the clayey sands in the area of the bores is cleaner to the east. This layer peters out where basement is shallowest, occurring again further west but with lower intensity. This would indicate clayey-sand similar to that encountered in well 6628-16186. In this area the layer does not extend below 15 metres.

The conductor below this layer, between 15 and 30 metres depth, varies from highly conductive (less than 10 ohm-metres between 750W and 900W) to only mildly conductive at the east end. Whether this is caused by clay content or salinity is uncertain, probably a bit of both.

There is a possibility, geophysically speaking, that basement is very shallow between the bores and Sudholtz Road, and that the weak conductor between 15 and 30 metres is a wide fracture zone dipping to the east. While this is not considered likely, the possibility should be kept in mind.

Summary

The TEM survey has detected a basement high 50 metres west of the bores, dropping away steeply to the west and north but more slowly to the east. A shallow resistor between 3 and 30 metres varies in thickness and in resistivity, and appears to be a clayey-sand of variable proportions, the more permeable parts being more resistive. A conductor between this and basement is also variable in

thickness and intensity, and is expected to be caused by a combination of high clay content and more saline groundwater.

No attempt has been made to detect the basement fractures yielding low salinity groundwater that were found in well 6628-16185. These would be hard to detect at this depth in this environment, as the low salinity and low clay content would make a very weak conductor.

Bristol Terrace

Strathmont

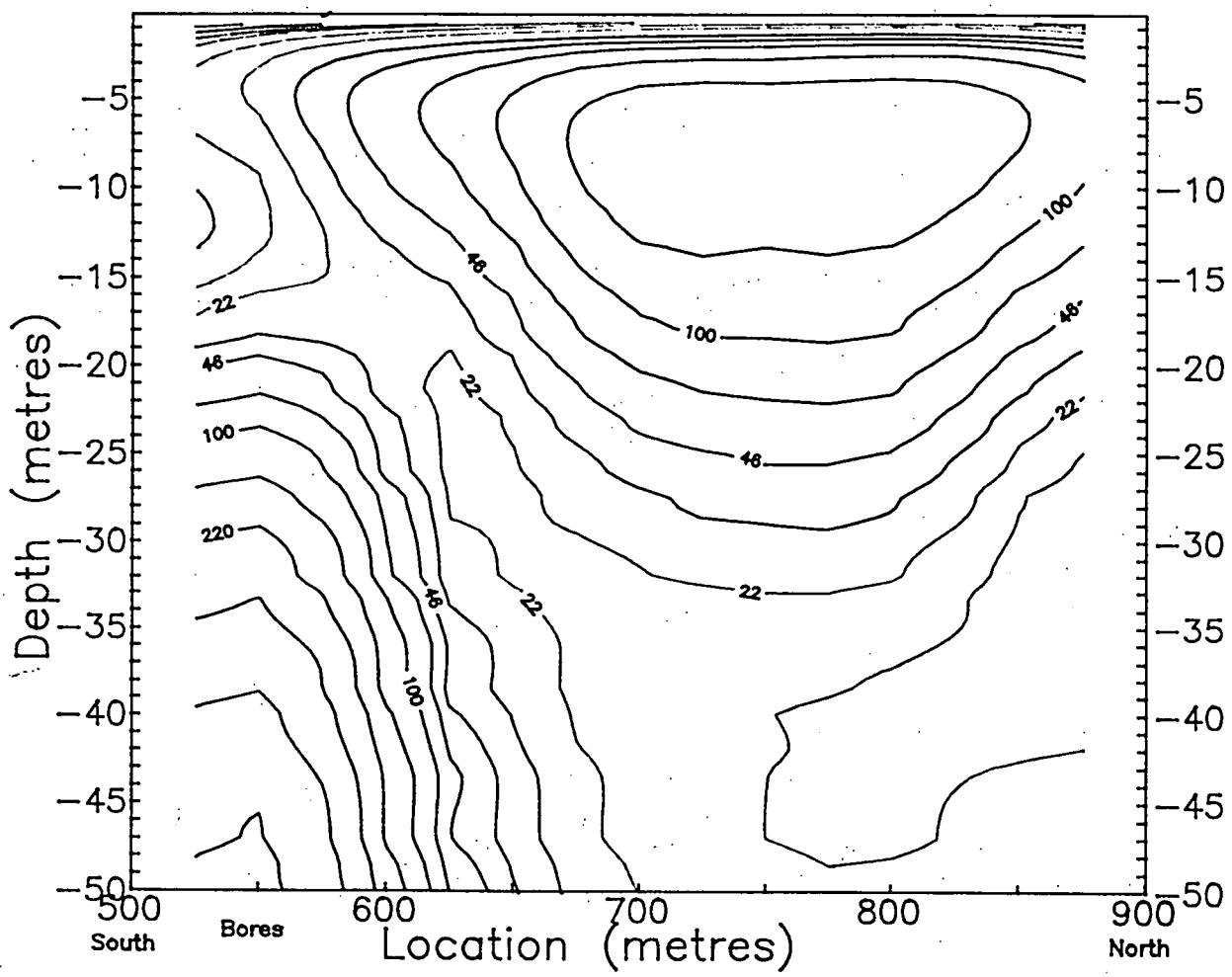


Figure.....D1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O.	DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1 RESISTIVITY SECTION FROM INVERSION TRAVERSE 1	DRAWN R. Bird	SCALE As shown	
	DATE March 1993	PLAN NUMBER 93-159	
	CHECKED		

5770

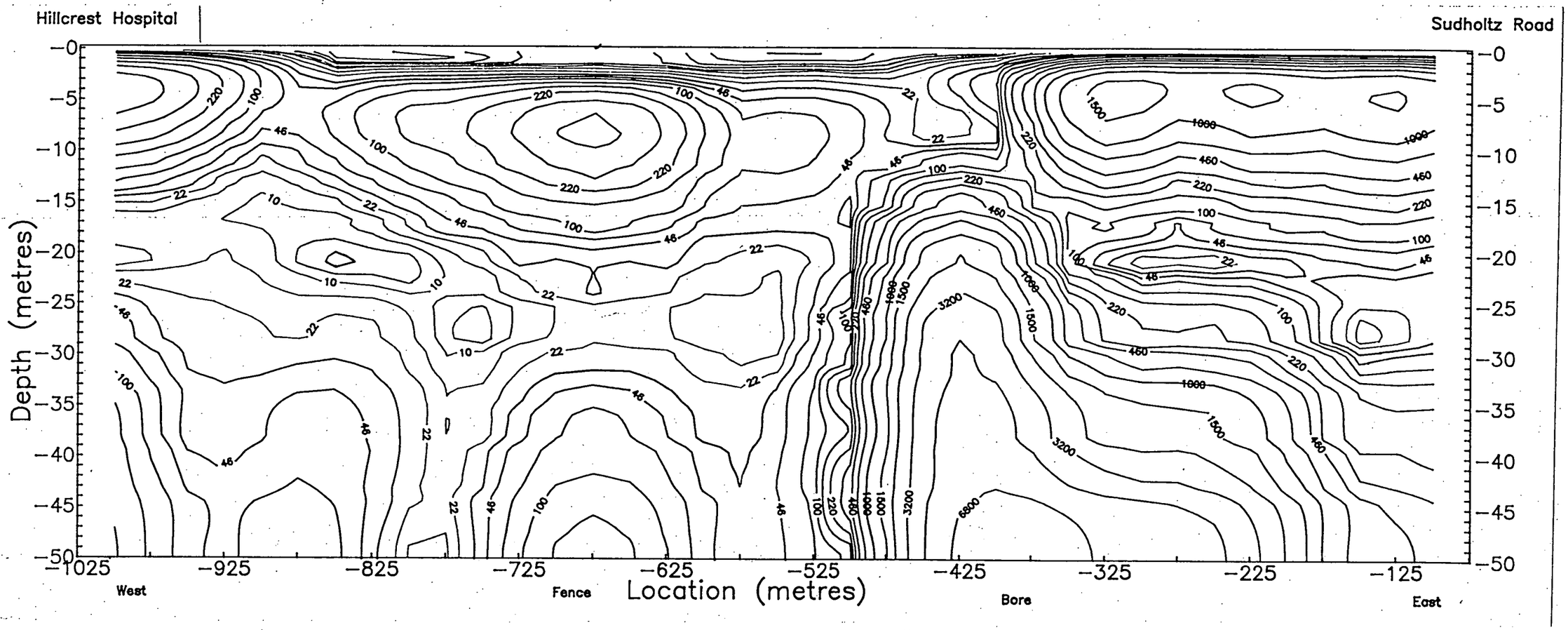


Figure.....D2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Howles	C.D.O. DATE
NORTHFIELD RESIDENTIAL DEVELOPMENT ARTIFICIAL RECHARGE POTENTIAL - PRECINCT 1 RESISTIVITY SECTION FROM INVERSION TRAVERSE 2	DRAWN R. Bird	SCALE As shown
	DATE March 1993	PLAN NUMBER 93-160
	CHECKED	

5770