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INVESTIGATION OF NOORA EVAPORATION BASIN, UPPER MURRAY SOUTH AUSTRALIA

Also: 76/16

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

INVESTIGATION OF NOORA EVAPORATION BASIN, UPPER MURRAY SOUTH AUSTRALIA

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03.1

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Locality

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DISPOSAL	IRRIGATION	DRAINAGE
WATER	SALINE	GROUNDWATER
MOVEMENT		

05.1

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INVESTIGATION OF NOORA EVAPORATION BASIN, UPPER MURRAY SOUTH AUSTRALIA

ABSTRACT

Further drilling and pump testing between the proposed Noora evaporation basin and the River Murray has provided data for determining aquifer parameters. Using the Boulton delayed yield method a transmissivity of 100 m^2/day was obtained for one pumping test in the Loxton Sand aquifer. Data from all pump tests are to be reviewed on the basis of delayed yield.

For this transmissivity value it has been estimated that first effects on the river would occur in about 40 years. At final equilibrium, estimated to be in about 100 years, the quantity of salt entering the river would be approximately 20 tonnes per day.

INTRODUCTION

Progress Report No. 1 (Williams, 1974) outlines the problem of irrigation drainage and its disposal in the Upper Murray region of South Australia. Current practice of disposal using evaporation ponds within the river valley is undesirable and therefore several potential sites away from the river were examined. The most suitable site - a depression and natural evaporation basin, was located in the Noora-Taldra area (Fig. 1).

Work which included drilling and pump testing was recommended to further appraise the suitability of the proposed site (Williams, 1974). This work was apportioned to both the Mines and Engineering and Water Supply Departments.

AQUIFER TEST SITES AND PROCEDURES

Three sites between the proposed Noora evaporation basin and the River Murray were selected. These were at sites of existing observations bores namely CTL7, CTL9, CTL10 (Fig. 1). Three pump bores (200 mm diameter) and five observation bores were drilled. Each pump bore was gravel packed, screened, developed and tested.

AQUIFER TESTING SUMMARY

Pumping tests were made at three sites in the Loxton Sand aquifer and results analysed by the Jacob (semi-log) method gave the following results.

Observation Bore	T m^2/day	S
CTL10	1 210	10^{-2}
"	1 250	10^{-2}
"	1 915	
CTL10B	180	
	430	
	1 610	
	257	
	750	
	310	
	750	
CTL9	30	$2x10^{-3}$
	23	
CTL9B	12	$5x10^{-4}$
	10	

PUMPING BORE	T m^2/day
CTL10A	144
"	133
"	146
"	400
CTL7A	134

Observation Bore	T m^2/day	S
CTL7D	1 230 1 450	
CTL7C	1 450	

Subsequently, data from bore CTL10D was analysed using Boulton Delayed Yield type curves. The two values of T obtained were 92 and 101 m^2/day and S was 1.[illegible] x 10^{-3}.

DISCUSSION

Pumping test data were plotted on semi-log paper to obtain aquifer parameters. Certain assumptions are necessary regarding the aquifer in this approach and these are listed in Kruseman and De Ridder (1970, pp.46, 107).

There is, however, an important aspect which may lead to erroneous results if neglected. This is the effect of delayed yield on an unconfined aquifer.

Where delayed yield occurs, the time-drawdown curve can be divided into three distinct segments.

The first segment covers a short period, possibly only a few minutes after pumping commences when gravity drainage of the aquifer has not commenced. The second segment shows a decrease in slope resulting from replenishment by gravity drainage from the interstices above the cone of depression. Both these segments are clearly shown in the drawdown curve of bore CTL10D. The third segment which was apparently not reached in any of the pumping tests again conforms closely to the Theis type curve. This is reached when there is equilibrium between gravity drainage and the rate of fall of the water table.

The values of transmissivity obtained for several observation bores in the later stages of drawdown are very high (approx. 1 200 m^2/day) and are not considered to represent the real situation. In pumping bores where drawdown is relatively rapid the first segment, as discussed above, has a longer duration. This is because the cone of drawdown falls more quickly than gravity drainage. Apart from one anomalous result the average transmissivity as calculated on pumping bore data is 140 m^2/day, using the Jacob semi-log plot. Plotting of data from observation bore CTL10B on log-log paper and using type curves developed by Boulton to allow for delayed yield, calculations of transmissivity were 92 and 101 m^2/day.

For purposes of calculating groundwater movement the transmissivity is considered to be 100 m^2/day.

EFFECT OF BASIN ON GROUNDWATER INFLOW TO THE RIVER

In a previous report (Williams, 1974) a graphical presentation of the time of flow to reach the river was presented. The estimated time required for 10% and 90% of the disturbance created by the recharge to the groundwater to reach the river is summarised below.

STORAGE COEFFICIENT S	TRANSMISSIVITY T (m^2/day)	t10 (years)	t90 (years)
0.1	16	100	900
0.2	16	200	1 000
0.2	200	20	80
0.2	1 000	3	15

Transmissivity of the Loxton Sand is considered to be about 100 m^2/day allowing for the effects of delayed yield. If correct then the value of t_{10} would be approximately 30 years. This assumes a value of 0.2 for Storage Coefficient which is reasonable for an unconfined sand aquifer. Although lower values were obtained from pumping tests further examination of the data are required using delayed yield methods.

In estimating the time taken for salt to reach the river it has been assumed that water is maintained continuously in Noora evaporation basin. However, it is understood that this will not be the case. Water level in the basin is expected to reach a peak in November-December when the average depth will be about 0.5 metre. The basin will probably dry out completely by late summer and there is expected to be little or no "recharge" of the groundwater for several months. Wetting of the profile down to the water table is also assumed to take place instantaneously, but some delay can be expected. In addition evaporation from the water table, which may be considerable when the basin has dried out, has also been neglected. When all these conditions are known it seems that they would increase the value of t_{10} by possibly 20-30%. If so, this would increase the time of travel to approximately 40 years.

On the same basis it is estimated that the time taken for 90% of the disturbance to reach the river would be approximately 100 years, which may be regarded as the time when equilibrium is reached.

The assumption is made that average transmissivity is 100 m^2/day, based on this value and a final groundwater gradient to the river of 1 in 1 550 the volume of water entering the river can be calculated as follows:-

$Q = TiL$

where Q = discharge in m^3/day

T = Transmissivity = 100 m^2/day

i = gradient $= \frac{21 - 13}{12\ 500} = \frac{1}{1\ 550}$

L = Width of discharge zone, estimated to be 10 kilometres

thus $Q = 100 \times \frac{1}{1\ 550} \times 10\ 000$ m^3/day

$= 645$ m^3/day

If the average salinity of groundwater entering the river is 30 000 mg/l then the quantity of salt would amount to 19.4 tonnes per day.

The gradient is based on the fact that groundwater table at Noora is 1-2 metres below the surface (18 metres above sea level) and the river at Pike River-Mundic Creek is approximately 13 m above sea level. Flooding of the basin is expected to add a maximum of 3 m head to the water table.

CONCLUSIONS AND RECOMMENDATIONS

The Noora evaporation site is unlikely to cause significant additions of salt to the Murray River and first effects of flooding the basin are not expected at the river for about 40 years. This assumes that the Transmissivity as used in the calculations is of the right order. To the present only one set of data has been subjected to the Boulton delayed yield method. The value obtained is of the same order as was obtained for pumping bores using the Jacob method.

It is recommended that all data be subjected to the Boulton method to obtain transmissivity and storage coefficients leading to the best estimates of groundwater flow towards the river.

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22nd October, 1975
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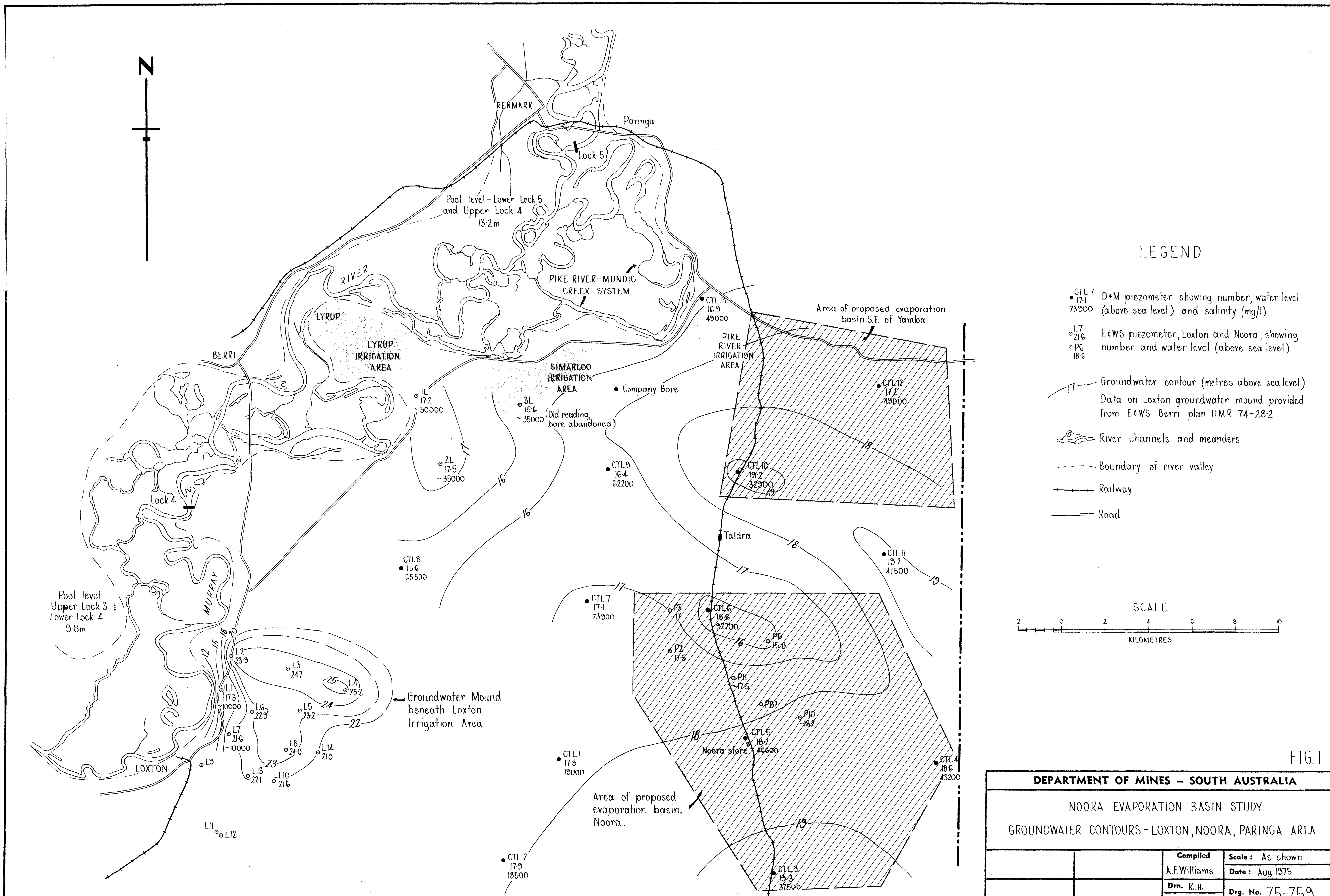

N
RENMARK
Paringa
Lock 5
Pool level - Lower Lock 5 and Upper Lock 4 13·2m
RIVER
PIKE RIVER-MUNDIC CREEK SYSTEM
LYRUP
LYRUP IRRIGATION AREA
BERRI
SIMARLOO IRRIGATION AREA
Company Bore
PIKE RIVER IRRIGATION AREA
Area of proposed evaporation basin S.E. of Yamba
CTL13 16·9 49000
1L 17·2 ~50000
3L 15·6 ~35000 (Old reading, bore abandoned)
2L 17·5 ~35000
CTL9 16·4 62200
CTL12 17·2 49000
CTL10 19·2 32900
Lock 4
Taldra
CTL11 19·2 41500
CTL8 15·6 65500
MURRAY
Pool level Upper Lock 3 & Lower Lock 4 9·8m
CTL7 17·1 73900
P3 ~17
CTL6 15·6 92700
P6 15·8
P2 17·5
P11 ~17·5
P8?
P10 ~18·2
CTL5 18·2 46600
Noora store
L2 23·9
L3 24·7
L4 25·2
L1 17·3 ~10000
L6 22·5
L5 23·2
L7 21·6 ~10000
L8 24·0
L14 21·9
L13 22·1
L10 21·6
L9
L11
L12
LOXTON
Groundwater Mound beneath Loxton Irrigation Area
CTL1 17·8 19000
Area of proposed evaporation basin, Noora.
CTL4 18·6 43200
CTL2 17·9 18500
CTL3 19·3 37500
LEGEND
CTL7 17·1 73900 D&M piezometer showing number, water level (above sea level) and salinity (mg/l)
L7 21·6 P6 18·6 E&WS piezometer, Loxton and Noora, showing number and water level (above sea level)
17 Groundwater contour (metres above sea level)
Data on Loxton groundwater mound provided from E&WS Berri plan UMR 74-28-2
River channels and meanders
Boundary of river valley
Railway
Road
SCALE
2 0 2 4 6 8 10
KILOMETRES
FIG. 1
DEPARTMENT OF MINES – SOUTH AUSTRALIA
NOORA EVAPORATION BASIN STUDY
GROUNDWATER CONTOURS - LOXTON, NOORA, PARINGA AREA
Compiled A.F. Williams
Drn. R.H.
Ckd.
Director of Mines
Scale: As shown
Date: Aug 1975
Drg. No. 75-759
7029-II + III