DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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REPT.BK.NO. 86/44
INDULKANA WATER SUPPLY

GEOLOGICAL SURVEY

BY

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JULY, 1986

DME.437/77

CONTENTS

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 86/44
D.M.E. No. 437/77
Disk No. 123

INDULKANA WATER SUPPLY

ABSTRACT

Some 38 wells have been drilled around Indulkana over 18 years, testing three geological environments.

Firstly crystalline Precambrian rocks yield small supplies with salinity 15 000 to 20 000 mg/L.

Secondly Adelaidean slates and quartzites are capable of moderate yields, but salinity after extended pumping has risen to 7 000 mg/L.

Thirdly 2 Ordovician sandstone units were investigated.

Indulkana is currently being supplied from two wells in the Mount Chandler Sandstone. Past experience suggests that salinity in these wells may rise to about 5 000 mg/L.

Further drilling in the Mount Chandler Sandstone has been unsuccessful.

Two wells have been drilled in the overlying Blue Hills Sandstone, which appears to have generally better propects. Salinity is about 2 000 mg/L.

Because of the location of Indulkana it is not possible to provide the residents with a complete potable water supply except at high cost.

A dual water supply scheme using water of different qualities is now proposed. This appears to be the only realistic management option.

Every effort must be made to conserve the limited reserves of potable water.

Systematic water sampling to monitor the behaviour of the aquifers is essential.

INTRODUCTION

Indulkana is an Aboriginal community, in the Pitjantjatjara Homelands in the northwest of the State (Fig. 1).

Investigations for Indulkana Water Supply have been carried out intermittently since 1967. Results of some of the early work are included in Selby (1972a and b) and Stadter et al. (1978) document a more recent well.

This report documents results at all investigations up to the present.

HISTORY

A summarised history of the Indulkana water supply is in Table 1.

In 1967 Hillwood (1967) examined the area and assessed its potential for water supply.

His statement that "Drilling to locate potable groundwater in this area is highly speculative and will depend on locating areas where local recharge has been sufficient to freshen the generally brackish groundwater." has been proved correct by later experience.

Hillwood recommended testing firstly of the alluvium and weathered bedrock along Indulkana Creek, and then the Ordovician sandstones of the Mount Chandler Range.

Subsequent drilling showed that the area around Indulkana Creek contained saline water.

Well details are shown in Table 2 and locations (so far as known) in Figure 2.

Two wells were apparently drilled in the Mount Chandler Range. No salinity is recorded for 5544 WW 39, and 5544 WW 40 is recorded as having a salinity of 22 000 mg/L. This salinity is so much higher than any subsequently recorded in this area that the possibility that the sample attributed to the well actually came from one of the holes near Indulkana Creek cannot be discounted.

The drilling program was apparently conducted without on-site geological supervision.

TABLE 1

SUMMARIZED HISTORY OF INDULKANA WATER SUPPLY

Year	
1967	Area assessed by Hillwood
1967	First drilling programme to test weathered crystalline basement along the Indulkana Creek. Two wells in Mount Chandler Sandstone.
1970	Drilling programme directed at the Adelaidean. Subsequent development of some wells.
1974	Geophysical investigation.
1974	Further drilling of the Adelaidean plus one well in Blue Hills Sandstone.
1975	One well in Mount Chandler Sandstone (IND17D) (successful) and additional well in the Adelaidean.
1977	One well in Mount Chandler Sandstone.
1982	One well in Mount Chandler Sandstone
1983	One well in Blue Hills Sandstone.
1985	Three dry wells in Mount Chandler Sandstone.

TABLE 2

WELL DETAILS

Unit No.		Project No	Depth m	SWL m	Yield L/s	Salinity mg/L	Aquifer	Year Drilled	Comments
	19	-	-	-	-	1 640	-	-	Soak
	20	-	-	-	-	4 400?	Omb	-	Spring
5544 WW	37	1	15	10	.07	>15 000	pC	1967	
	38	2	52	19	small	50 000	pC	"	
	39	3	20	3	.3	?	Omc?	"	
	40	4	44	-	.3	22 000	Omc	"	
	41	5	10	-	small	15 000	pC	"	
	42	6	24	?	.03	15 000	pC	"	
	43	7	11	?	?	?	pC	"	
	44	8	24			15 000	pC	"	
	45	9	24			15 000	pC	"	
	46	9A	24	5	.04	?	pC	"	
	47	9B	5	5		15 000	pC	"	
	49	-	-	-	-	1 609			
						2 685		-	Spring equipped with windmill
	27	IND 1	17		.6	1 490	P	1970	
	28	IND 3A	6	-	-	-	P	"	Abandoned, hard drilling
	29	IND 3B	6	-	-		P	"	" " "
	30	IND 3C	42	11	.5	2 000	P	"	
5543 WW	19	IND 4	67	51	.4	2 700	P	"	
	20	IND 5	76	62	.15	745	P	"	
5544 WW	31	IND 6	33	7	2	2 300	P	"	
	50	IND 6A	56	7	.8	3 400	P	1975	
	65	IND 7	25	8	.01	>21 000	pC	1974	
	66	IND 8	49	11	.2	10 000	P	"	
	67	IND 9	38	8	.6	5 880	P	"	
	68	IND 10	68	18	3	2 700	P	"	
	69	IND 11	62	26	.2	1 100	P	"	
	70	IND 12	82	-	small	-	P	"	

TABLE 2 - continued

5543 WW	64	IND 13	64	37	.05	700	P	"	
5544 WW	72	IND 14	64	27	.04	1 300	P	"	
	73	IND 15	60	16	.4	3 000	P	"	
5543 WW	65	IND 16	65	-	"seep"	-	P	"	
5544 WW	75	IND 17D	50	18	.7	200 to 500	Omc	1975	Abandoned because of high salinity- 5 100 mg/L in 1985
	76	IND 18	40	.05	.6	1 480	Omb	1974	
	50	IND 6A	56	6.8	.6	3 440	P	1975	Pump tested
	101	IND 19	68	15.4	.44	334	Omc	1977	
	131	IND 20	30	5.5	2.5	1 980	Omb	1983	
	132	IND 19A	79	?	1.1	2 000	Omc	1982	Salinity was observed to increase markedly with depth.
	152	IND 22	72		Dry	-	Omc	1985	
	153	IND 23	46	-	very small	1 070	Omc	1985	
	154	IND 24	61	?	0.05	350	Omc	1985	

TABLE 3

DRILLING HISTORY OF INDULKANA*

Year	Unit** Drilled	No of Wells	No of*** Successes	Comments
1967	O m c	2	0	Wells stopped at shallow depth because of hard drilling. Highly saline water not typical of this area found.
	pC	9	0	Drilling in weathered crystalline basement along Indulkana Creek.
1970	P	8	4	Some of these successes have later been abandoned because of increasing salinity and declining yields.
1974	pC	1	0	Geophysical target
	Omb	1	1	Drilled alongside spring
	P	8	1?	None of these appear to have been equipped.
1975	P	1	1	Replacement well?
	Omc	1	1	Renewed interest in Indulkana Range. Well later abandoned because of excessive salinity.
1971	Omc	1	1	At this stage the Mount Chandler Sandstone appeared to be the solution to the water supply problem.
1982	Omc	1	1	
1983	Omb	1	1	
1985	Omc	3	0	Disastrous fall in success rate for Mount Chandler Sandstone.

* Wells abandoned at shallow depth because of hard drilling have been ignored.

** Omb, Blue Hills Sandstone
Omc, Mount Chandler Sandstone
P Adelaidean
pC Crystalline basement

*** The definition of a success is difficult as various standards have been applied at different times. Since this table is intended to show the evolution of water supply thinking with time a success has been taken to be a well considered successful at the time of drilling.

In 1970 there was a further round of drilling, this time in the Adelaidean (Selby, 1972(a)). This was more successful although salinities all exceeded the World Health Limit of 1 500 mg/L.

In 1974 geophysical work consisting of seismic refraction and resistivity traverses was carried out (Nelson, 1974). Predictably this did not improve the success rates of drilling.

Since 1974 attention has been directed at the Mount Chandler Range. The only report for this period (Stadter et al., 1978) merely documented the drilling of 5544 WW 101.

In 1982 a further successful well was drilled in the Mount Chandler Sandstone.

In 1985 Well 17 was cleaned out to ascertain why it had been abandoned and a further three wells were drilled in the Mount Chandler Sandstone.

Water airlifted from Well 17 was found to have a salinity of 5 000 mg/L and the new wells were almost dry. This dashed hopes of developing a reasonable supply in the Mount Chandler Sandstone.

Drilling history is summarised in Table 3.

PUMP-TESTING

Four wells drilled in 1970 were pump-tested (Selby, 1972(b)). The tests have not been re-analyzed as by this time their performance is well known from operating experience.

Other production wells in the Indulkana area have not been systematically pump-tested.

DRILLING METHODS

Prior to 1975 all drilling at Indulkana was by the rotary method using roller bits. Considerable difficulty was experienced in penetrating the hard formations as can be seen from the number of wells abandoned at shallow depth because of hard drilling.

More recently rotary percussion (down-hole hammer) methods have been used. This is a great improvement, although drilling rates are still relatively slow and bit wear excessive.

GEOLOGY

The area has been mapped by Sprigg et al (1955 and 1956) and Krieg (1972).

The geology of the area is shown in Figure 3. The most significant feature is the east-west trending Indulkana Syncline which contains Ordovician sedimentary rocks.

HYDROGEOLOGY

Aquifers around Indulkana occur in three distinct geological environments: the Precambrian crystalline basement, Adelaidean sediments and the Ordovician sediments of the Mount Chandler Range. All three have been extensively explored for water supplies. Their characteristics are summarized in Table 4.

Precambrian

Ten wells have been drilled in the area along Indulkana Creek. All supplies were small and salinities high.

This area has no potential for water supply.

Adelaidean

Following the poor results from drilling the Precambrian and initial poor results from the Indulkana Range attention was directed at the Adelaidean slates and quartzites.

Salinities were at best barely potable and have increased with pumping. Yields are small, 3 L/s and less.

More recent drilling in similar areas suggests that larger yields might be obtained from these rocks by deeper drilling. However salinities would be higher too.

Salinities of wells drilled in this area ranged from 300 mg/L to 6 000 mg/L when drilled, with the median value being 2 000 mg/L. Salinity is now about 7 000 mg/L.

TABLE 4

HYDROGEOLOGY

Hydrogeological Unit	Lithology	Groundwater
Precambrian	Gneisses, and schists, weathered near surface	Small supplies, generally in weathered zone. Salinity generally about 15 000 mg/L
Adelaidean	Slates & quartzites	Supplies up to 3 L/s. Yields decline with time. Salinity ranges 1 500 to 6 000 mg/L.
Mount Chandler Sandstone	Hard strongly-cemented Sandstone	Yields small, up to 1 L/s. Salinities erratic, from 200 mg/L to 5 000 mg/L.
Blue Hills Sandstone	Quartz sandstone, appears well-jointed.	Little drilling. Known yields up to 2.5 L/s. Large yields may be possible from deeper wells. Salinities 1 500 to 2 000 mg/L. Some chance of potable water.

Indulkana Range (Ordovician Aquifers)

The Indulkana Range consists of strongly outcropping sandstones folded into an east-west trending syncline (Fig. 3).

There are two sandstone units separated by the Indulkana Shale.

a. Mount Chandler Sandstone

Eight wells have been drilled in this sandstone over a length of 8 km. The overlying Indulkana Shale has been eroded to form a strike valley which provides relatively easy access.

The sandstone is silicified, making it difficult to drill even with a down-hole hammer and button bits. Penetration is slow and bit wear is excessive (commonly 1 bit per hole).

Where exposed this sandstone can be seen to be poorly jointed with few bedding plane partings. This is reflected in its relatively poor yields.

Water quality is variable and it appears that salinity increases with depth.

5544 WW 75 (IND 17D) produced water with salinity 200 mg/L when first drilled in 1975. By 1982 it had been abandoned because of excessive salinity.

5544 WW 40 is recorded as having had a salinity of 22 000 mg/L. This is much higher than any other wells in the area and the possibility of switched sample bottles cannot be discounted.

Well 17D produced low salinity water when first drilled, but salinity increased to 5 000 mg/L with pumping.

The potentiometric level in this aquifer is higher than in the nearby Adelaidean sediments, showing that it is recharged directly through nearby outcrops.

Water with salinity as low as 200 mg/L overlies waters with salinity at least as high as 5 000 mg/L.

These deeper saline waters are inevitably drawn up by pumping.

The density difference between the deep and shallow waters would be small, and recharge rates are low. Therefore it is not possible to skim off potable water for any length of time.

Relationship between Yield and Structure

It is often stated in the literature that better yields can be obtained from near the axes of synclines. Results from drilling in the Mount Chandler Sandstone do not support this.

b. Blue Hills Sandstone

Development of this unit has been restricted by the difficulty of access.

Two wells have been drilled in it, and the Indulkana Spring, which has been developed for water supply, discharges from it.

Well yields are 0.6 L/s and 2.5 L/s.

Outcrops of this sandstone are much better jointed than the Mount Chandler Sandstone below it.

The existence of the spring indicates the presence of layers of low permeability.

On the limited available evidence the lower part of the sandstone appears to have the best potential for water supply.

Information on wells in the Blue Hills Sandstone in the Officer Basin suggests that yields of 1 to 4 L/s should be obtainable.

While quality is poor, about 1 500 to 2 000 mg/L, there is no evidence of large increases in salinity with pumping from this aquifer.

There is still a reasonable chance that further exploration in this unit will discover potable (less than 1 500 mg/L) water which would provide an insurance against Wells 19 and 19A becoming too saline.

The high potentiometric levels show that the aquifer is recharged by the direct infiltration of rainfall through outcrop.

The total area of outcrop is roughly 20 km^2.

Indulkana's annual consumption of 40 ML is therefore equivalent to an annual infiltration of 2 mm over the area of outcrop. This is quite possible. In any case the volume in storage is so large that the water demand could be met for the foreseeable future.

PRESENT STATUS OF THE WATER SUPPLY SYSTEM

From information supplied by Mr D. Taylor, of the Department of Housing and Construction the present status of the Indulkana water supply is as follows:

Wells 19 and 19A are equipped and supplying water of about 900 mg/L.

Well 6A with 7 000 mg/L water is used when 19 and 19A cannot meet the demand.

Well 20 is to be equipped in the near future. This yields water of about 2 000 mg/L. It is then planned to use Well 20 to provide the bulk of the supply and use 19 & 19A for drinking water.

DISCUSSION

The area around Indulkana is characterized by saline to highly saline ground waters.

Although low salinity waters have been found experience shows that quality inevitably deteriorates with pumping as deeper more saline water is drawn up to replace the relatively thin 'cream' of lower salinity water. No obvious targets remain within reasonable distance of Indulkana.

During exploration for water supplies for the reconstruction of the Stuart Highway water with salinity 1280 mg/L (but an unacceptable nitrate level of 100 mg/L) was found in 5543WW68 about 20 km SE of Indulkana (Gerges, 1987).

The aquifer is a fault zone in Adelaidean slates close to a small creek. This is not a proven source of supply, but is a fair indication of the distance from Indulkana at which alternative water supplies might be expected.

About 20 km of pipeline costing 0.5 to 1 million dollars would be needed to develop this area for Indulkana water supply.

Further development of the Adelaidean sediments ('Eastern Range Area') is not warranted because operating experience shows that this area will only produce saline water.

The Blue Hills Sandstone in the central part of the Indulkana Range (Fig. 2) seems to provide the best chance for supplying water of moderate salinity, although probably above the World Health Limit of 1 500 mg/L. Bulldozing of access tracks will be needed for further development.

Wells 19 and 19A, which are now supplying more or less potable water cannot be relied on and will amost certainly become more saline with time.

Plans should be made for providing alternative sources of drinking water. Maximum use of rainwater, carting water and desalination should be considered.

WATER SAMPLING

Regular water sampling is necessary to permit long term trends in salinity to be recognised. Unfortunately in aquifers such as those at Indulkana where salinity changes markedly with depth, salinity will change in the few hours after the pump is turned on. This can easily mask long term trends.

To get worthwhile salinity records samples should be taken consistently after the pump has been running some time (say 6 to 24 hours). As much data as possible concerning pumping before sampling should be recorded.

CONCLUSIONS

1. There is little chance of developing sufficient supplies of potable groundwater near Indulkana to meet Indulkana's entire water supply needs.
2. By use of a dual water supply system and careful conservation of the potable water supplies it may be possible to supply potable water from Wells 19 and 19A for some years.
3. The Blue Hills Sandstone offers almost the only chance of finding additional supplies of potable water.
4. The Blue Hills Sandstone theoretically has the potential to supply adequate non-potable (1 500 mg/L to 2 500 mg/L) water.

5. Every effort must be made to conserve the limited supplies of potable water in Wells 19 and 19A.

RECOMMENDATIONS

1. The proposed dual water supply system should be installed as soon as possible.
2. Every effort should be made to conserve the limited supplies of potable water available from Wells 19 and 19A.
3. At least one well should be drilled in the Blue Hills Sandstone both to provide a standby for Well 20 and to explore for potable water.
4. Production wells should be sampled twice a year in order that changes in salinity can be monitored. A consistent method of sampling (say at the end of 8 hours pumping) should be adopted to reduce variations caused by sampling at different pumping times and allow long term trends to be detected.
5. Contingency plans should be made for the provision of potable water at short notice in the event of Wells 19 and 19A becoming too saline.
6. In the event of present potable water supplies becoming too saline the area around 5543WW68 20 km SE of Indulkana should be investigated as an alternative to desalination.

R.E. Read

RER:AM

R.E. READ
SENIOR GEOLOGIST

REFERENCES

Gerges, N.Z., (1987). Stuart Highway, Drilling for construction water, Marla to N.T. Border. S.A. Dept. Mines and Energy report, in prep.

Krieg, G.W., 1972. EVERARD map sheet, Geological Atlas of South Australia, 1:250 000 Series. Geol. Surv. S. Aust.

Hillwood, E.R., 1967. Report on Groundwater Prospects of the Proposed Indulkana Reserve. S.A. Department of Mines and Energy report Book 64/57 (unpublished).

Nelson, R.G., 1974. Geophysics in the search for groundwater, Indulkana Reserve. SA Department of Mines Report Book 74/93 (unpublished).

Selby, J., 1972(a). Northwest Aboriginal Reserve 1970/71 Drilling Programme. SA Department of Mines Report Book 72/128 (unpublished).

Selby, J., 1972(b). Northwest Aboriginal Reserve 1970/71 Drilling Programme. Aquifer Characteristics. SA Department of Mines Report Book 72/176 (unpublished).

Sprigg, R.C., Wilson, B. and Coats, R.P., 1955. Indulkana map sheet, Geological Atlas of South Australia, 1:63 360 series. Geol. Surv. S. Aust.

Sprigg, R.C., Wilson, B. and Coats, R.P., 1956. Chandler map sheet, Geological Atlas of South Australia, 1:63 360 series. Geol. Surv. S. Aust.

Stadter, M.H., Sibenaler, X.P. and Barnett, S.R., 1978. Northwest Aboriginal Reserves drilling programme November 1977 - January 1978. South Australian Department of Mines and Energy Report Book 78/37 (unpublished).

APPENDIX A

Geological Log of 5544WW154

PROJECT: INDULKANA WATER SUPPLY

MINES DEPARTMENT — SOUTH AUSTRALIA
ENGINEERING DIVISION

WATER WELL LOG

HOLE NO: 24

UNIT / STATE NO 5544WW154

LOCATION OR COORDS:

SEC. HD. Out of EL Surface m EL Ref. Point m Datum

DM

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	INTERVAL TESTED To:	SUPPLY ~~xxxxxxxxx~~*	Test Length (hrs)	Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No: W —
	54	-			0.05 L/s	Airlift while drilling	Eye	Conductivity 610 ECU	Field

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia(mm)	CASING From(m)	CASING To(m)
0	27		Shale	Brown weathered shale.	Indulkana Shale				
	27		Sandstone	White to pale brown fine-grained sandstone.	Chandler Sandstone				
27	36		Sandstone	Pale red-brown fine-grained sandstone.					
36	60		Sandstone	Light grey & red-brown hard fine-grained sandstone.					

REMARKS:

* NOTE: 110 kl / day = 1000gals / hr.

DRILL TYPE: Rotary Hammer

COMPLETED: 31/3/85

CIRCULATION: Air

LOGGED BY: R. Read

SHEET 1 OF 1

DATE: 31/3/85

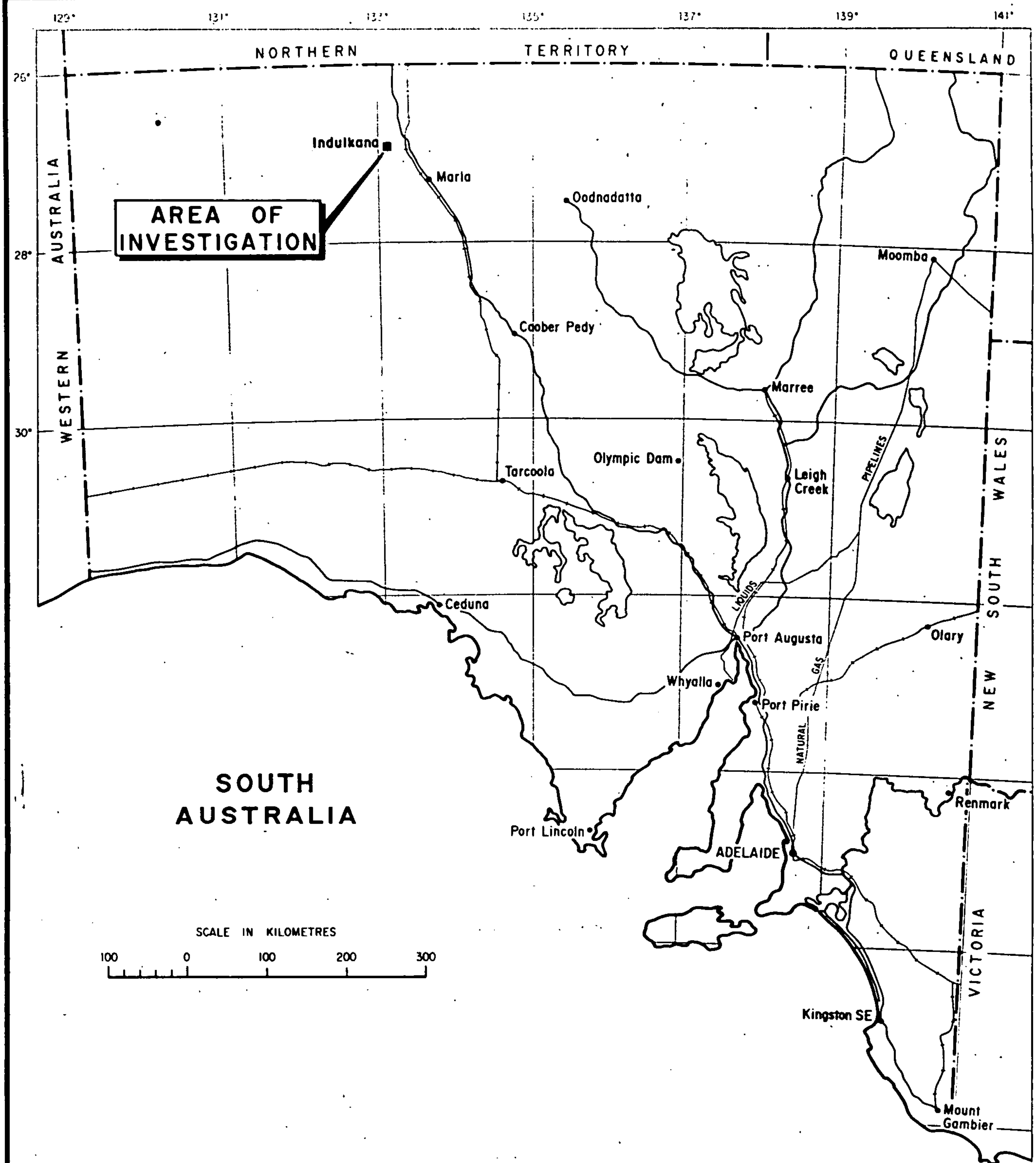
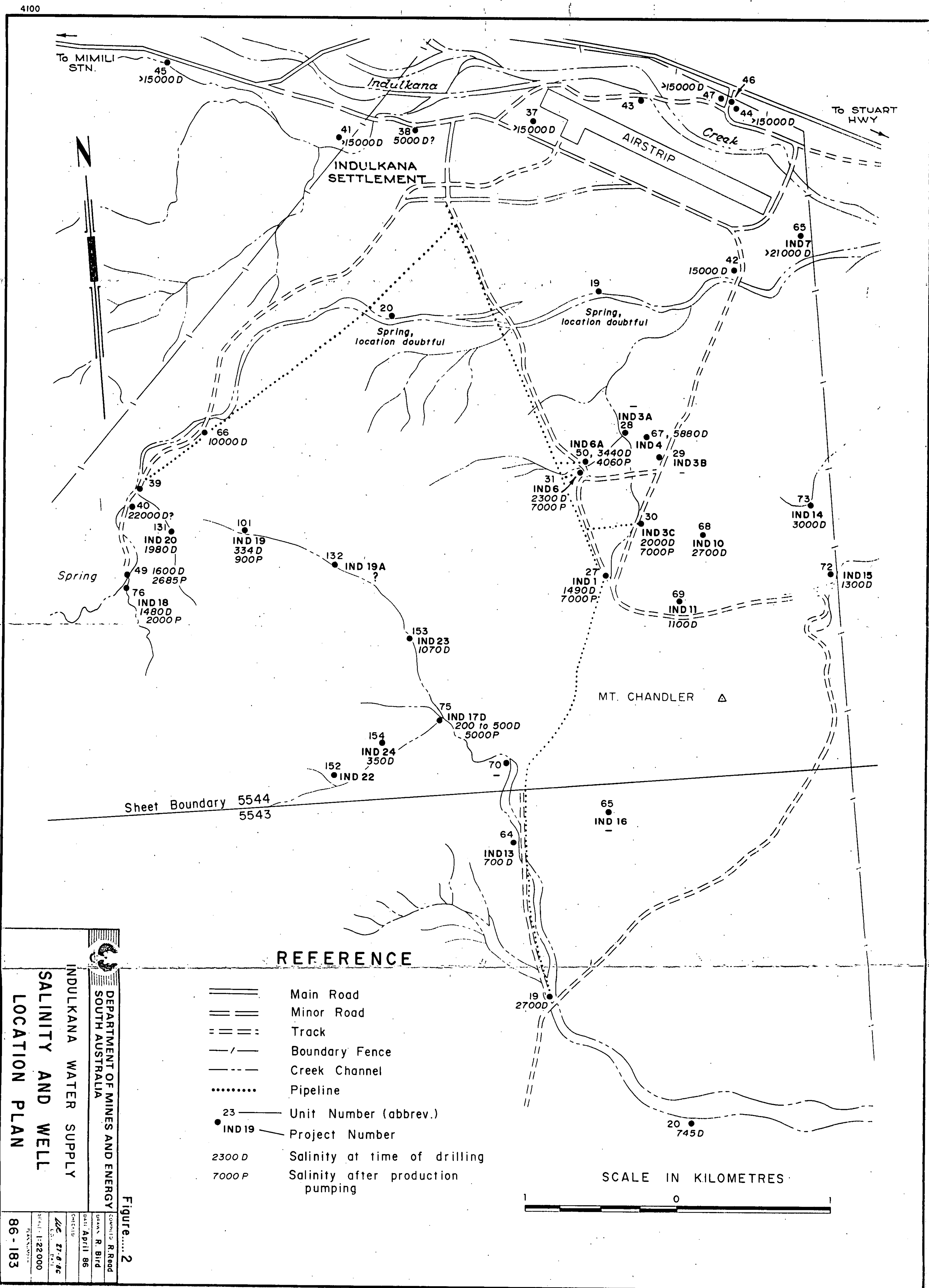


Figure..... 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. Read	C.D.O. 28·7·86 DATE
INDULKANA WATER SUPPLY	DRAWN R. Bird	SCALE As shown
LOCALITY PLAN	DATE April 86	PLAN NUMBER
	CHECKED	S18671

4100



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

INDULKANA WATER SUPPLY
SALINITY AND WELL
LOCATION PLAN

Figure....2

Compiled R. Read
Drawn R. Bird
Date April 86
Scale 1:22000

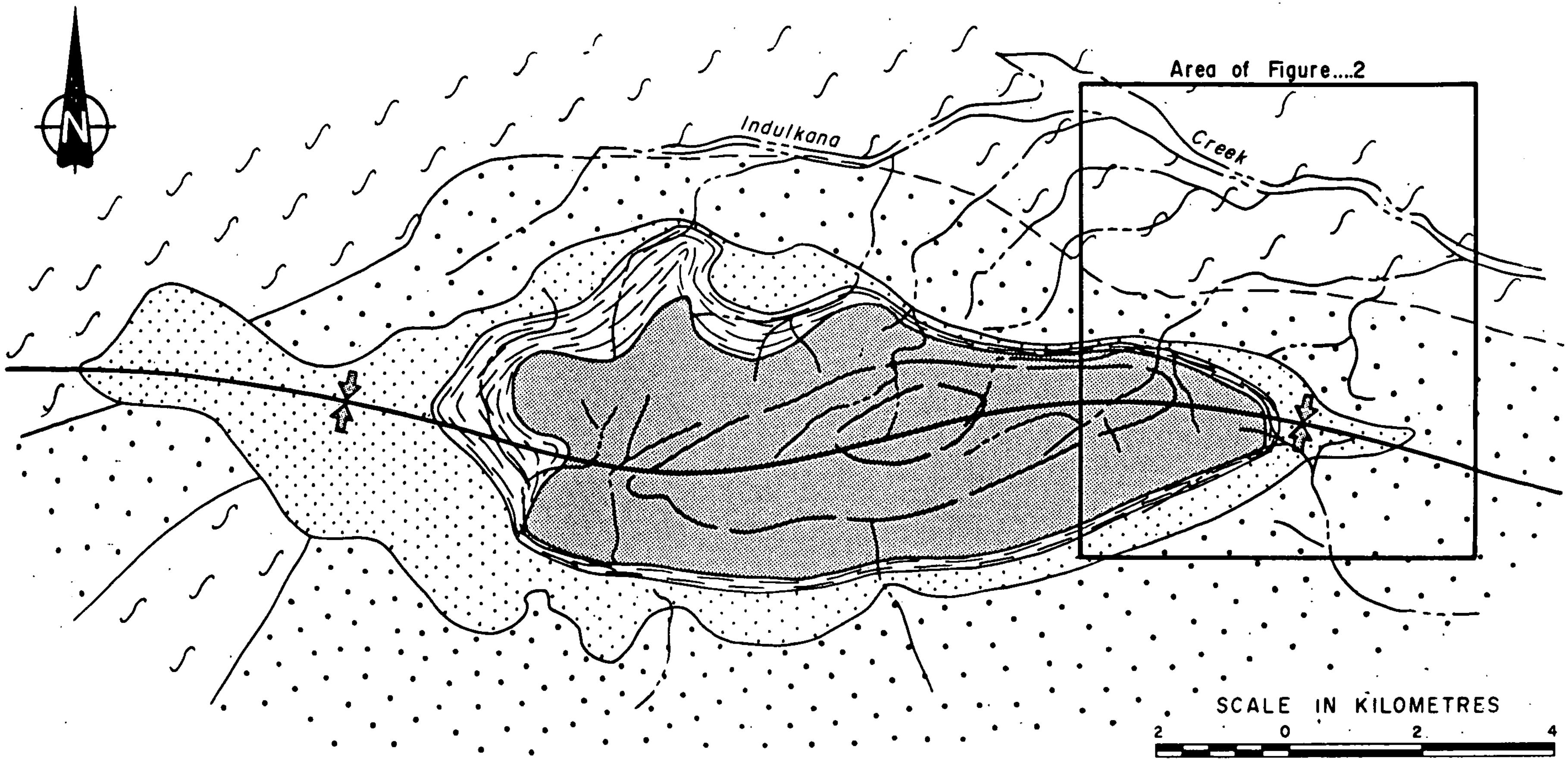
86-183

4100

SIMPLIFIED GEOLOGICAL MAP

INDULKANA WATER SUPPLY

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA



Geological boundary

Geological boundary (approximate)

Axis of syncline

Structure form line

Creek

Ordovician

BLUE HILLS SANDSTONE. Red brown weathering fine to medium grained quartz sandstone. Well jointed.

INDULKANA SHALE. Red and green shales.

MOUNT CHANDLER SANDSTONE. Hard silica-cemented brown and white quartz sandstone with wide spaced joints.

Adelaidean

States and quartzites

Precambrian

Gneisses

Figure.....3

COMPILED	R. Read
DRAWN	R. Bird
DATE	April 86
CHECKED	
C.D.O.	27. 8. 86
SCALE	1:100000
PLAN NUMBER	S18672