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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

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PROPOSALS FOR TESTING OF GROUNDWATER AT WARRABRI NATIVE SETTLEMENT NORTHERN TERRITORY

by

D. Woolley.

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C O N T E N T S

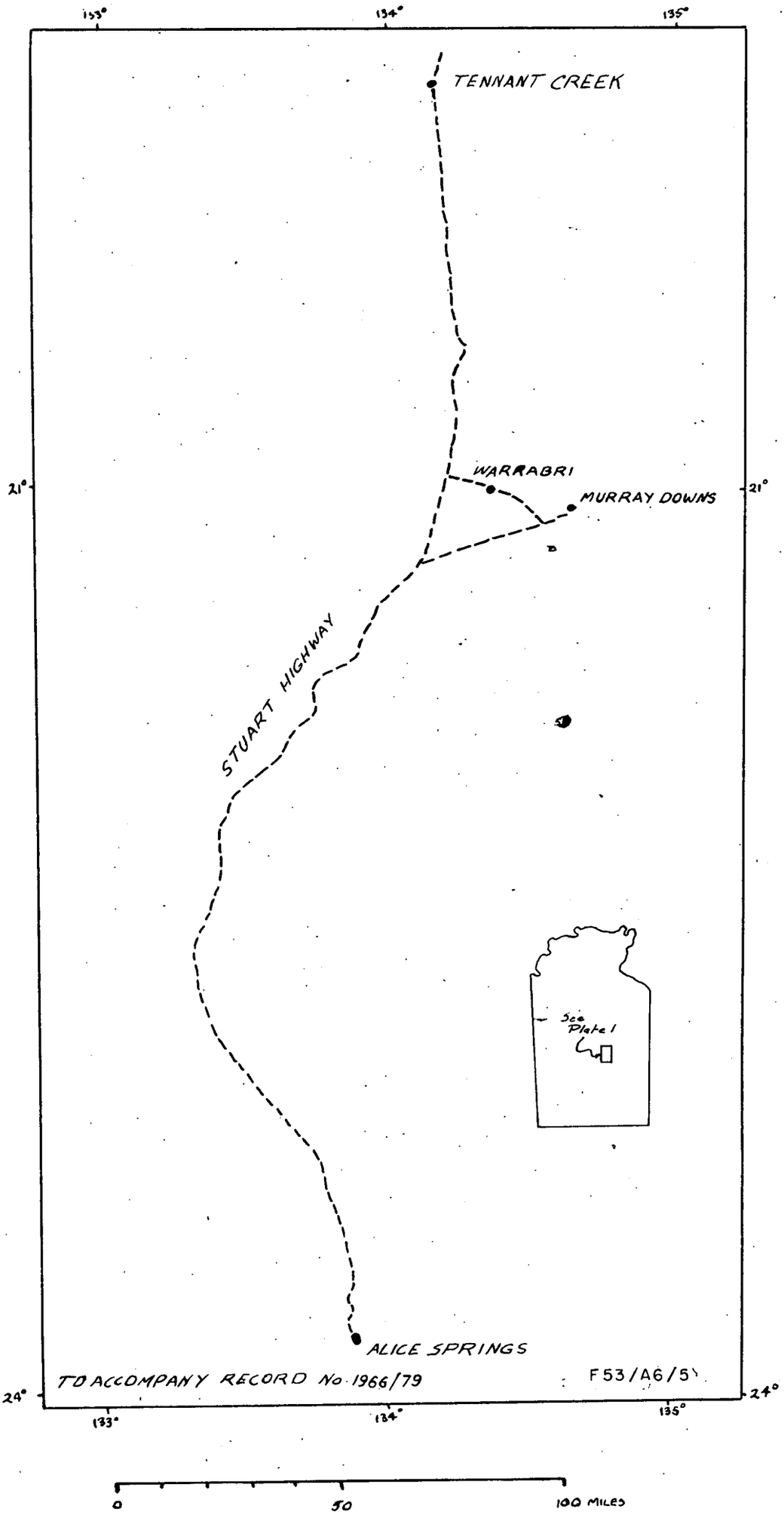


FIG. 1 LOCALITY PLAN

SUMMARY

Groundwater is stored in large quantities within unconsolidated deposits of Quaternary and/or, Tertiary age over a wide area south-west of the Davenport Range. Water supply for Warrabri Settlement is obtained by withdrawal from this groundwater reservoir. The water quality is generally suitable for agricultural and domestic purposes, and there is sufficient available for considerable future development. A drilling programme for Warrabri Reserve is suggested, in which about 15 holes totalling 2,500 to 3,000 feet, would be drilled to provide information on the amount and quality of water stored, and direction of water movement.

INTRODUCTION

This report has been prepared at the request of Water Resources Branch, Northern Territory Administration, to assist with a search for further supplies of groundwater for domestic and irrigation use at Warrabri Native settlement.

The Settlement is 190 miles north-north-east of Alice Springs, (Fig. 1) and access is via the Stuart Highway (about 215 miles) and graded earth road (about 215 miles). Water is required for domestic use for the several hundred people who live there, and for a small amount of irrigated agriculture. Groundwater is withdrawn from superficial sediments which extend over a very wide area. The scope of the report has been expanded to include a preliminary appraisal of the groundwater available in the whole basin.

TOPOGRAPHY

Warrabri Settlement is located on a very extensive sand-covered plain, in a shallow drainage depression just west of the floodout of Skinner Creek (Plate 1). From Warrabri, the downslope extension of the depression trends north-west, through Thring Swamp in the floodout areas of Wycliffe Creek. The sand plain is bounded to the north and east by outcrop areas of rocks of the Hatches Creek Group, which for extensive catchments draining in a south-west direction. To the south-east and south the boundary of the plain is less distinct, and continuity of the sand is broken by scattered outcrops of Lower Proterozoic and Palaeozoic rocks. Ridges of the Hatches Creek Group bound the plain to the south-west and the plain continues for many miles to the north-west. The area is thus a wide plain rising gently to the south-east, bounded on all sides except the north-west by rock outcrop, and has an overall north-west trending surface drainage.

GEOLOGY

Unconsolidated deposits of Quaternary and presumed Tertiary age overlie basement rocks of Lower Proterozoic and Lower Palaeozoic age.

Lower Proterozoic

The Hatches Creek Group, of Lower Proterozoic age, consists of quartzite with minor basic lavas. The Group forms the basement for the unconsolidated younger deposits on the north-east and south-west margine of the basin, and where exposed they form rugged terrain with steep relief.

The hills and ridges formed by the Hatches Creek Group are the main "hard" catchment areas in the Warrabri region, and run-off is high. The rocks of the Hatches Creek Group have no importance as a groundwater reservoir in the context of this report.

TABLE I

Bore Data

Bore Name	Number	T.D.	S.W.L.	Aquifer	Supply (g.p.h.)	Salinity (p.p.m.)
Wauchope Bore	F53/2-3	380'	200'	?Tertiary	750'	810'
Wycliffe Bore	F53/2-5	166'	31'	?	3,000	1158
Turn-off	F53/2-7					888
Conglomerate	F53/2-9	130'	?75'		2,000+	
Russell Well	F53/2-40		40			
Middle Well	F53/2-41		?85		600+	
Warrabri 1962/1	F53/2-42	89'	45'	?Tertiary	1,000	1043
Warrabri Piggery	F53/2-43	98'	39'		1,500	727
Emu	F53/6-6	228'	112'		1,500+	1,523
Spinifex	F53/6-10	190'	about 90'		3,000	1448
Murray Downs H.S.	F53/6-17				7,000+	
Shackle	F53/6-50	160'		?Tertiary		Good Stock
Warrabri No.1	F53/6-51	80'	43'	?Tertiary	1,500+	1,400
Warrabri No.2	F53/6-52	80'	35'	?Tertiary	1,500+	1,200
Warrabri No.3	F53/6-53	95'	41'	?Tertiary	1,400+	1,000
Warrabri No.4	F53/6-54	90'	?	?Tertiary	1,200	1,100
Warrabri No.4(Village)	F53/6-55	94'			2,000	
Billys	F53/6-66		?110'		2,000+	1,549
Jerries	F53/6-67	60'			2,000+	550
Bottom	F53/6-97	150+			2,000+	
Blubush	F53/6-98	194'	?115		2,000+	
Chabalowe	F53/6-901	83'			2,000+	
GRG 18	F53/6-	315	Dry	0-180' Quaternary 180-305' Tertiary 305-315' Cambrian		

Lower Palaeozoic

Sandstone of Upper Cambrian age crops out in several areas south-east of Warrabri (Plate 1). Its extent under the cover of unconsolidated deposits is unknown, but probably great. A Bureau of Mineral Resources stratigraphic hole, GRG 18, west of the Stuart Highway, penetrated 10 feet into fossiliferous Upper Cambrian dolomite below 305 feet of unconsolidated deposits, which indicates the probable widespread occurrence of Cambrian sediments concealed below younger deposits in the area of Plate 1.

Tertiary and Quaternary

Insufficient information is available to allow a general division to be made between Tertiary and Quaternary deposits in the area. Information is available from very few bores in the area (Table 1), and for all but two bores the only lithological logs available are drillers logs.

The BMR Hole GRG 18 encountered 180 feet of Quaternary sediments (brown sand and gravel), overlying 125 feet of white sandy clay presumed to be of Tertiary age. By extrapolation from this hole and by analogy with similar better known areas, it is considered that Tertiary sediments are widespread. The maximum known depth of unconsolidated sediments is also at GRG 18.

A bore drilled 5 miles north-west of Warrabri Settlement intersected 16 feet of clayey silt over 14 feet of travertine with opaline chalcedony, then passed into calcareous silt and siltstone to a depth of 90 feet. The sediments below 30 feet may be Tertiary. No obvious aquifer was noted in the log, but a moderate supply of water was obtained. The standing water level is below the travertine layer.

An analysis of the drillers logs of the Warrabri Settlement bores indicates that the section is generally:-

0-10/20	feet sand
10/20-30/40	feet travertine and opaline silica
30/40-45/50	feet brown clay
45/50-90	feet sand

One hole (No.3) intersected "rock" from 80-95', but this may not be bedrock, and could have been a hard tight clay or another travertine layer. The sand seems to be laterally continuous, and is the main aquifer known in the area to date.

HYDROLOGY

Availability of Groundwater

All successful bores in the area under consideration appear to have produced water from the superficial sediments. The shallow travertine layer probably is permeable but it is consistently above the piezometric surface. In the area of Warrabri Settlement, the sand occurring at 60 to 90 feet below surface is the major source of water for existing bores, but deeper aquifers may be present.

Supplies in excess of 2,000 gallons per hour (g.p.h.), and up to at least 7,000 g.p.h., have been obtained from bores drilled in the superficial deposits. Very few of them, however, have been adequately tested.

Groundwater can probably to obtained in considerable quantities from the Palaeozoic rocks which are inferred to occur widely beneath the superficial sediments. This possibility, however, cannot be evaluated as the nature of the Palaeozic rocks is largely unknown. To date drilling has generally ceased when a satisfactory supply has been obtained from the younger deposits.

TABLE II

U.S. Department of Agriculture Irrigation Water Classifications

Bore	Sodium Absorbtion Ratio	Salinity (ppm)	Conductivity	Classificatiom
Wauchope	4.0	810	1250	C3-S1
Wycliffe	4.0	1158	1750	C3-S1
Turnoff	1.8	913	1410	C3-S1
1962/1	2.1	1043	1520	C3-S1
Piggery	1.8	727	1120	C3-S1
Emu	6.6	1523	2300	C4-S2
Spinifex	5.6	1448	2200	C3-S2
Warrabri 1	6.3	1305	2000	C3-S2
Warrabri 2	5.8	1134	1750	C3-S2
Warrabri 3	5.6	1129	1750	C3-S2
Warrabri 4	6.5	1121	1730	C3-S2
Billys	4.9	1549	1900	C3-S1
Jerrys	0.6	550	860	C3-S1

TABLE III

Salinity of water from bores southwest of Davenport Range

Bore	rCa	rMg	rNa	rK	rCl	rSO_4	$rHCO_3$	rNO_3
Wauchope	3.74	0.82	5.96	0.92	5.22	1.56	4.54	0.23
Wycliffe	1.80	5.02	8.42	Ca1.03	8.35	3.19	6.07	0.50
Turnoff	3.14	5.18	3.7	1.13	5.08	1.21	7.25	0.29
1962/1	2.25	3.45	7.83	1.21	3.95	2.08	7.57	1.13
Piggery	1.60	3.37	3.05	1.54	1.69	0.33	7.75	0.29
Emu	3.09	5.51	13.7	0.87	14.10	4.87	3.20	1.87
Spinifex	3.19	4.93	11.30	1.54	13.40	3.33	5.35	0.65
Warrabri 1	1.65	3.87	10.65	1.49	6.06	2.10	8.20	1.67
Warrabri 2	1.40	3.29	9.05	1.41	4.23	1.79	7.80	1.42
Warrabri 3	1.40	3.37	8.70	1.41	4.51	1.79	7.51	1.58
Warrabri 4	1.55	3.37	10.22	1.36	6.35	2.46	4.97	1.06
Billys	4.54	6.58	11.74	1.43	14.25	3.41	5.31	0.93
Jerrys	0.95	3.78	0.91	1.41	0.39	0.15	5.63	0.68

Quality of Groundwater

The total dissolved solids (t.d.s.) content of water from the superficial sediments in the area shown in Plate 1 ranges between 550 parts per million (p.p.m.) and 1,550 p.p.m. (see Table 1). The chemical character of the water indicates that is is a mixture of water from two sources:-

(a) rechange water that has been in contact only with superficial sediments, e.g. Jerrys Bore, Fig. 2

(b) high sedium chloride water which has been in contact with Hatches Creek Group rocks for a long time, e.g. Hatches Creek Police Station bore, Fig. 2.

In three widely separated bores (Billys, Emu and Spinifex), water originating from the Hatches Creek Group aquifers appears to be present in large proportions, and is certainly sufficient to give the mixed water the same character as the Hatches Creek Group water (Fig.2).

The water from bores in the Warrabri reserve, and from Wycliffe Bore, shown a marked increase in sodium chloride content compared with water from Jerrys bore. This is presumably due, at least in part, to the introduction of some water from Hatches Creek Group aquifers, but not in sufficient quantity to change the groundwater to a sodium chloride water. (Fig 3

Water from bores in the area have been classified according to the U.S. Department of Agriculture classification shown in Fig.4 (Richards 1954) and the results are shown in Table II. Most of the water falls in Class C3-S1, in which the sodium hazard is low and the salinity is high. This type of water can be used for irrigation only on soils with good drainage, and requires special management for salinity control. Most of the other waters are classed as C3-S2, and besides the precautions necessary for C3-S1 waters they also require the use of coarse textured soils with low cation exchange capability so that a harmful build-up of sodium in the soil will not occur.

In the vicinity of Warrabri the better quality water both regard to t.d.s. and irrigation classification is to the north of the Settlement (Table 1 and Plate 1).

A feature of the chemical character of the water in these aquifers is the widespread occurrences of high nitrate and high potassium concentrations. High concentrations of both these ions do not occur in any one water sample (Table III). No explanation for their presence is offered at present. The nitrate level in some bores is high enough to render water partially unfit for domestic use; it is however, a valuable sources of nitrogen for irrigation purposes.

Water Levels, groundwater movement and recharge

Precise information on water levels is only available from a few holes (Table 1). In most cases standing water level is less than 50 feet below ground surface; several others are thought to be in the range 50-100 feet. A few have levels greater than 100 feet below surface.

Surface levels are only known at three localities where standing water level is known or can be inferred with any degree of confidence. These are Murray Downs Homestead, where the reduced level on the piezometric surface is about 1,300 feet above sea level, Spinifex Bore (1,150 feet) and Wycliffe Bore (1,140 feet). These levels indicate a generally north-westerly movement of groundwater, which is in accordance with the direction inferred from topographic and geological considerations.

Recharge to the aquifers in the superficial sediments is provided by run-off from the hilly areas surrounding the sand plain, particularly from the Davenport Range. Quinlan (1961) estimated that the area of the Davenport Range catchment draining to the south-west is 1,040 square miles. Hard

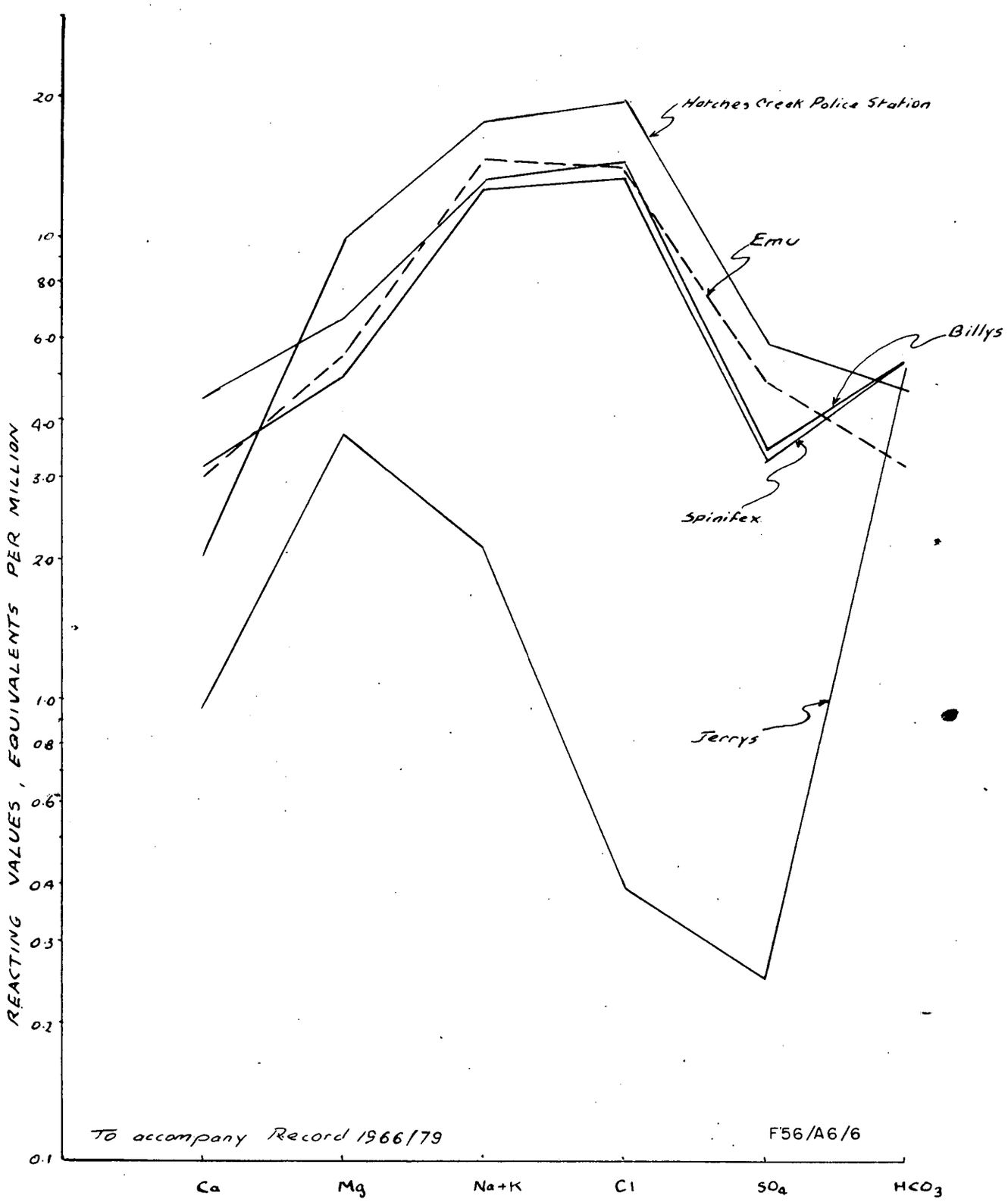


FIG. 2 GROUNDWATER SALINITIES

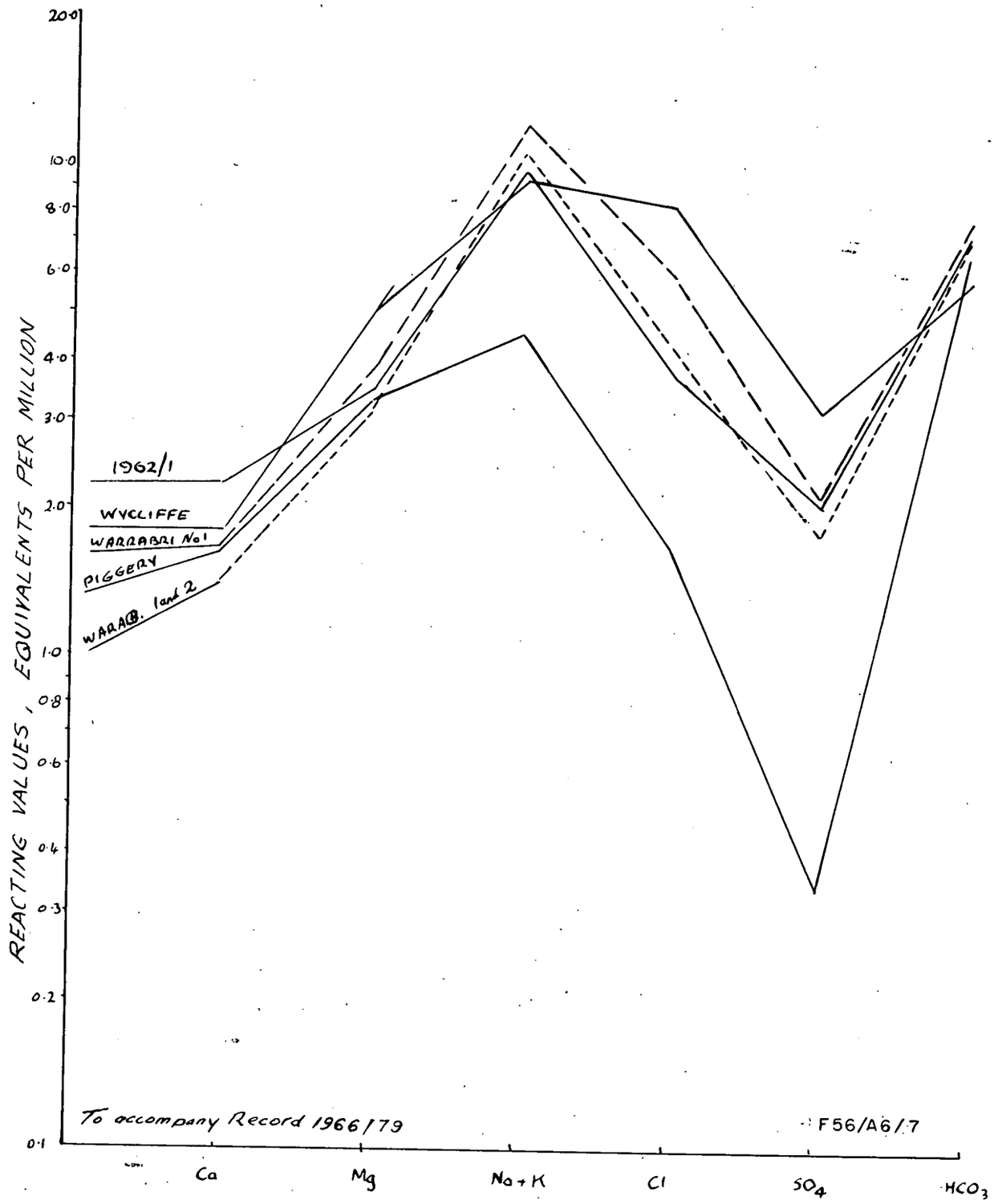
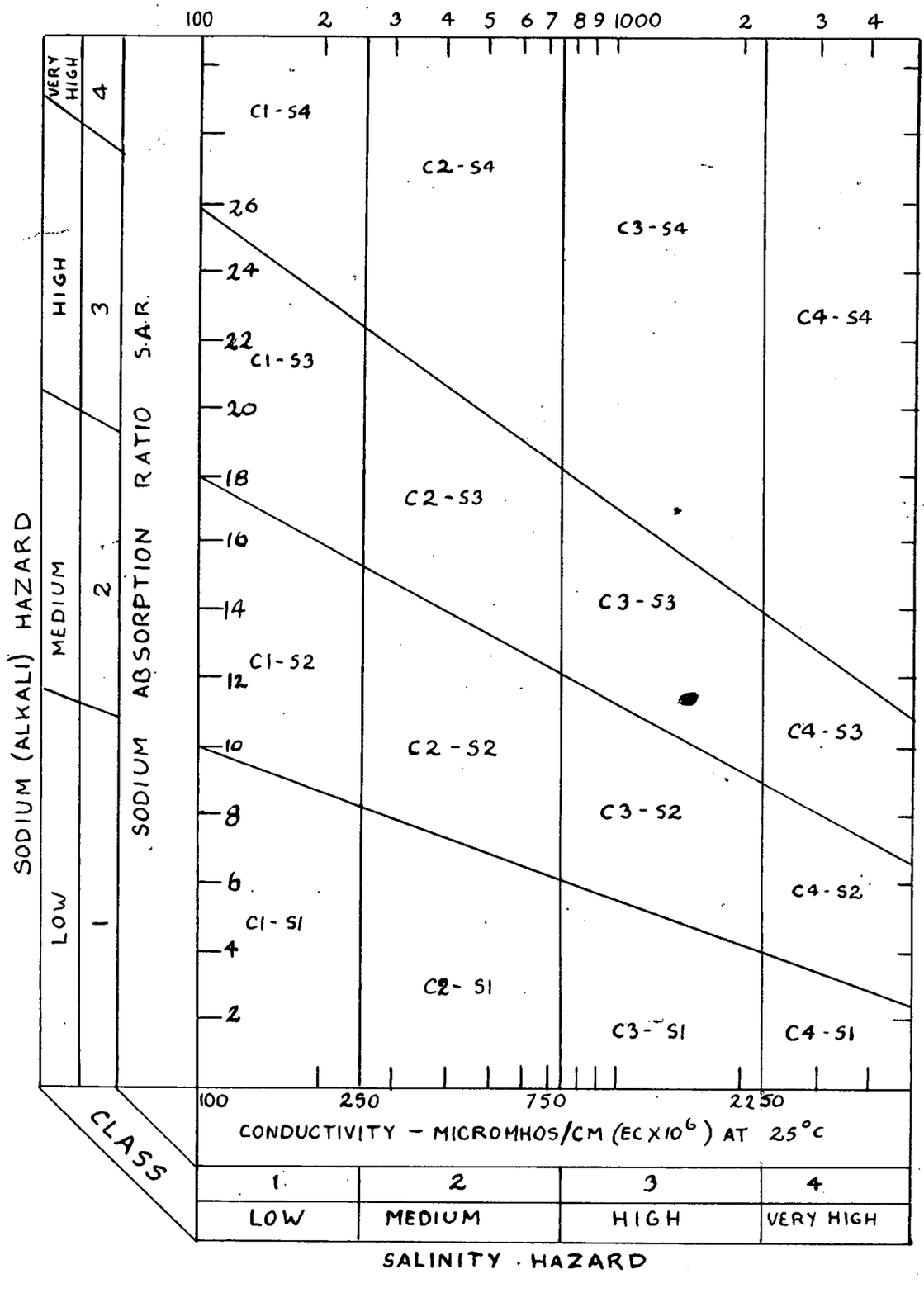


FIG. 3 GROUNDWATER SALINITIES

FIG 4 DIAGRAM FOR THE CLASSIFICATION OF IRRIGATION WATERS (AFTER U.S. DEPT. OF AGRICULTURE)



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catchment on the south-western side of the plain, and which drains to the north-east, amounts to about 450 square miles. Assuming that 1% of the mean annual rainfall of 10 inches is eventually added to groundwater storage, then 8,000 acre feet (2,000 million gallons) of water is added to storage. Most, but by no means all, of this would be added to storage east of the Stuart Highway.

Storage and Withdrawal of Groundwater

No attempt has been made to determine the volume of water stored, either in the basin as a whole or in the part of the basin which is accessible to Warrabri Bores. The volume stored is, however, clearly very large. Present withdrawal of groundwater from superficial depositseast of the Stuart Highway is probably of the order of 2,500,000 gallons per year, and this is very small compared to the amount stored, and the amount available for recharge.

CONCLUSIONS

A large volume of water, most of which is of suitable quality for irrigated agriculture, is stored in Tertiary and/or, Quaternary deposits which occur in an extensive area south-west of the Davenport Range. A considerable amount of recharge is available to aquifers in these deposits, and bores could be constructed on Warrabri Reserve to make use of much of this recharge. Some investigation drilling, spread over as large an area as possible, is required to determine the amount of groundwater sorted in and moving through the sediments on the reserve, and to establish a more accurate picture of the salinity pattern in the groundwater. Aquifers within the sediments appears to be quite sidespread and drilling, primarily designed to locate aquifers, is not warranted on a regional basis. Such drilling may be required, however, to provide suitable locations for production bores.

RECOMMENDATIONS

A drilling programme is recommended to provide the following information:-

(a) a semi-regional contour map of the piezometric surface

(b) a semi-regional assessment of groundwater quality

(c) details of the lithology of the superficial sediments

(d) details of bedrock depth and the bedrock surface configuration

(e) a suitable location for a production bore.

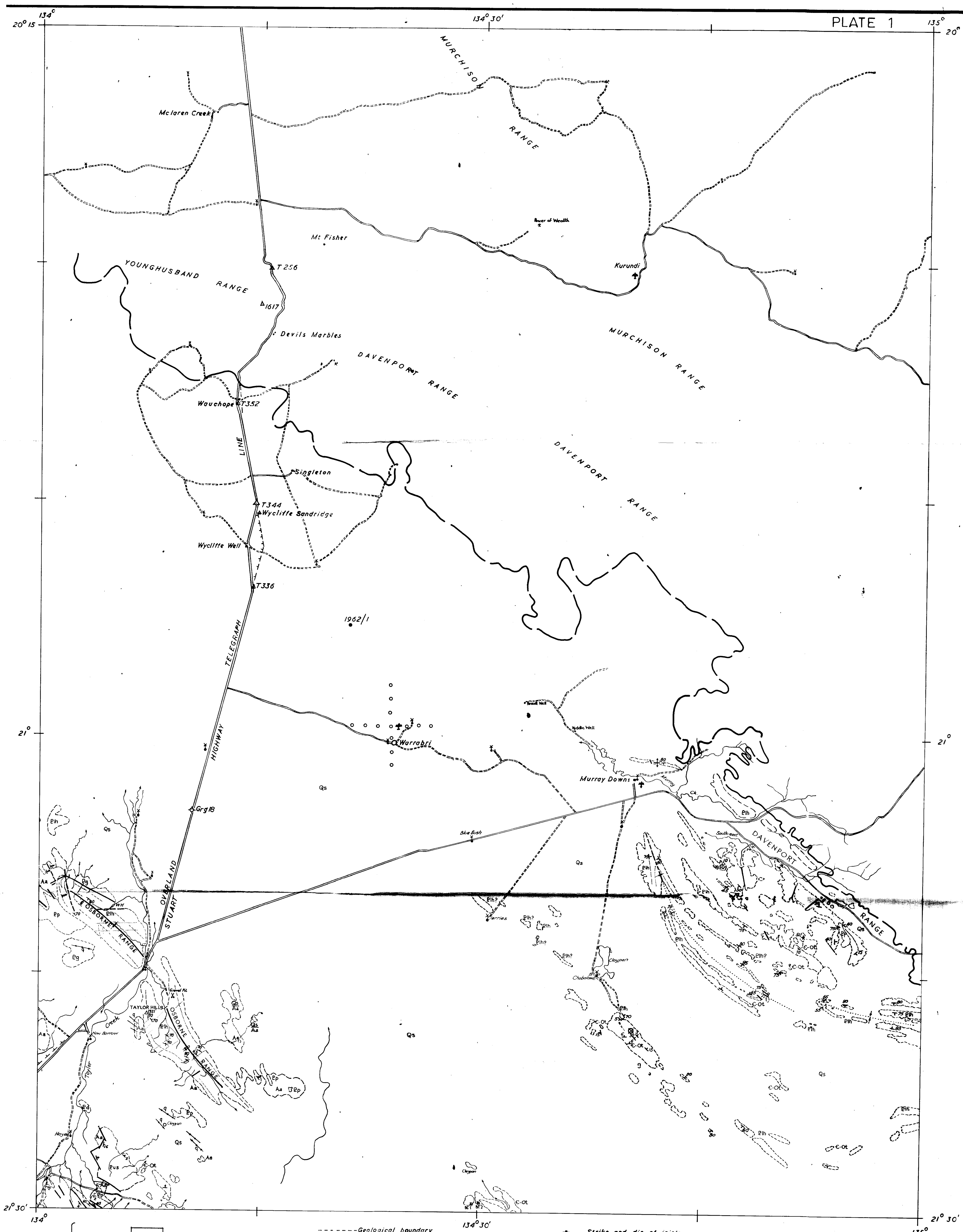
To do this, holes should be drilled to bedrock, at one mile spacing, along two lines at right angles crossing one mile north of the Settlement. One line should be in a north-south direction and one east-west (see Plate 1). At least three holes should be drilled in each direction from the intersection, including one to be drilled within the settlement itself to provide an authentic log. It is important that each hole be drilled to bedrock and that a water sample be obtained from each aquifer intersected. Additional holes may be required on the line at ½ mile and 1½ miles north from the settlement to define a location for the production bore which should be drilled in this vicinity. If possible, additional holes should be drilled along the line to the west, to extend knowledge of the geohydrology in that direction. At least 15 holes will be required, and the depths will probably be 150-200 feet.

Measurement of surface levels, and water levels, and collection of additional water samples, from existing bores in the area would also assist a regional interpretation of the area. Aquifer performance tests should be carried out on existing and,or, new production bores, to determine the aquifer characteristics.

REFERENCES

QUINLAN, T. 1961 -- Water Resources of Central Australia Bur. Min. Resour. Aust Rec. 1965/25.

RICHARDS, L.A. 1954 - Diagnosis and improvement of alkaline soils. United States Department of Agriculture Handbook No. 60.



CAINOZOIC	QUATERNARY	Qs	Red & brown aeolian sand.
		Qa	Alluvium, sand.
	TERTIARY ?	T	White silty limestone, chalcedony.
PALAEOZOIC	UPPER DEVONIAN — DULCIE SANDSTONE	Dud	Cream & brown quartz, sandstone, white siltstone, some pebble bands.
	UPPER CAMBRIAN TO LOWER ORDOVICIAN — TOMAHAWK BEDS	€-Ot	Brown silty sandstone, quartz sandstone, siltstone green silty limestone, blue oolitic limestone, brown dolomite, pebble & cobble conglomerate.
	UPPER PROTEROZOIC TO LOWER CAMBRIAN — GRANT BLUFF FORMATION	P€g	Glauconitic quartz sandstone, brown & white siltstone.
PRECAMBRIAN	UPPER PROTEROZOIC — CENTRAL MOUNT STUART BEDS	Pus	Red arkose, red quartz sandstone and greywacke, red siltstone, red dolomite, grey silty sandstone.
	LOWER PROTEROZOIC — BARROW CREEK GRANITE	Pgb	Tourmaline-muscovite-biotite granite.
	LOWER PROTEROZOIC	Pg	Muscovite-biotite granite
		Pp	Quartz-feldspar porphyry.
		Pd	Dolerite, gabbro.
	HATCHES CREEK GROUP	Plh	Quartz sandstone, siltstone, shale, greywacke. Acid & intermediate lavas.
	ARCHAEAN — ARUNTA COMPLEX	Aa	Mica schist, gneiss, amphibolite.

Geological boundary
Anticline, shewing plunge
Syncline
Syncline, overturned
Fault showing relative horizontal movement.
Where location of boundaries, folds, and faults is approximate, line is broken; where inferred, queried, where concealed, boundaries and folds are dotted, faults are shown by short dashes.
Strike and dip of strata.
Vertical strata.
Overturned strata.
Dip 15°
Dip 15° 45°
Dip 45°
Trend of bedding
Joints

Strike and dip of joints
Vertical joints
Strike and dip of foliation
Vertical foliation
Quartz vein or reef
Macrofossil locality
Rock specimen locality
Sample locality for age determination.
Stratigraphic hole; Georgina Basin; No 2.
Mine or prospect.
Alluvial workings
Cu Copper
Pb Lead
Sn Tin
Bore
Abandoned bore
Proposed investigation bore

Well
Windpump
Earth tank
Waterhole
Sand ridge
Road
Vehicle track
Fence
Telegraph line
"Stirling" Homestead
Yard
Landing ground
Astronomical station
Trigonometrical station
·1580 Height in feet instrument levelled; mean sea level.

GEOLOGICAL MAP OF AREA SURROUNDING

WARRABRI NATIVE SETTLEMENT

SCALE 1:250,000

TO ACCOMPANY RECORD 1966/79.

COMPILED BY RESIDENT GEOLOGICAL SECTION. DRAWN BY MINES BRANCH DRAUGHTING OFFICE, DARWIN, N.T. JUNE 1966.

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