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Rept. Bk. No. 63/94
G.S. No. 3571

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

EXPLORATION SERVICES DIVISION

REPORT ON

RESISTIVITY GROUNDWATER SURVEY

STREAKY BAY

by

J. J. Hussin
Assistant Senior Geophysicist
EXPLORATION GEOPHYSICS SECTION

63/94

26th October, 1966.

D.M. 1896/65

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PLANS

Plan No.	Title	Scale
S5486	Locality Plan	1" = 75 miles
S5049	Wenner and Schlumberger Electrode Configurations	
66-814	Streaky Bay Survey Area	1" = 1.75 miles
66-815	Resistivity Profiles	1cm = 2500 feet
66-816	Electrical Soundings and Interpretation.	

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REPORT ON RESISTIVITY GROUNDWATER SURVEY

STREAKY BAY

ABSTRACT

A geophysical groundwater survey consisting of 75 miles of resistivity profiling and 26 electrical soundings was carried out in the Robinson Basin near the town of Streaky Bay on western Eyre Peninsula from 20th June to 8th July 1966. The investigations revealed very heterogeneous hydrogeological conditions in the basin, and six drill hole sites have been recommended to provide information on the permeabilities and porosities of the various sedimentary formations and the salinities of the groundwaters.

INTRODUCTION

The South Australian Engineering and Water Supply Department is concerned in increasing the Streaky Bay town water and irrigation supply which has its origin in groundwater of the Robinson Basin. The extent and thickness of the aquifer in this basin are not very well known, and the Hydrogeology Section of the Department of Mines considered that geological and geophysical surveys of the area should be made so that the development of an adequate supply could be based on sufficient information. A request for a resistivity survey over the whole of the basin was therefore made, and a reconnaissance programme accordingly planned by the Exploration Geophysics Section to form the first phase of the investigation.

The reconnaissance resistivity groundwater survey was performed between the 20th June and 8th July 1966, and included 75 miles of resistivity profiling and 26 electrical soundings.

PREVIOUS GEOPHYSICAL WORK

Virtually all of Eyre Peninsula is covered by published one mile aeromagnetic maps. Subsequent ground magnetic and gravity work in 1959, was performed to investigate an aeromagnetic anomaly situated in the hundred of Ripon. Two of the three drill holes put down as a result of this investigation bottomed on gabbro. Refer to Whitten, 1963.

GEOLOGY

Physiography

The general surface features of the country south of Streaky Bay are gently undulating, consisting of low calcreted aeolianite ridges and occasional old fixed sand dunes. Small swamps fill many of the depressions formed between the ridges. The major portion of Gibson's Peninsula is high country underlain by calcreted aeolianite and sandstone with sandhills bordering the coast. A low east-west ridge extends from Streaky Bay into the Hundred of Forrest. Several wells sunk into this high country have bottomed upon granite rocks. Refer to Plan 66-814.

The surface features of the eastern part of the Hundred of Forrest and the major portion of the Hundred of Campbell, are undulating, consisting principally of low calcrete covered ridges, with the country having a general rise in an easterly direction.

Prominent sandhills border the shores of Sceales Bay and the northern coast of Searcy Bay.

There are no well defined surface drainage channels or water courses present in the region. Rain percolates down to the greundwater table, through the highly jointed travertine limestone.

The principal timber covering the high portions of the

region consists of low stunted mallee, while the well drained flats and depressions between the undulations (except the swamps) generally carry sheoak and occasional mallee.

Rock Types

Pleistocene to Recent

The sediments of this age are aeolian and marine, the former being chiefly windblown sand with small particles of shelly material; while the sand dunes and ridges which form a prominent fringe border the coast. Older sand dunes which have drifted some distance inland, and have become fixed by vegetation, are also regarded as being Pleistocene to Recent in age. The marine sediments consist of unconsolidated fossiliferous sands, and partly consolidated fine, even grained sandstone, containing numerous small shell fragments and fossil shells.

Tertiary to Pleistocene

The formations of this age consist principally of sands with shelly fragments, which are in part unconsolidated; and fossiliferous limestones. Where these beds occur near the surface, they are usually capped by calcrete forming a superficial crust which follows the undulations of the surface of the land. The calcrete ranges in thickness from 4 feet to 12 feet, and may be tabular in form with a reddish soil filling the interstices and hollows in the formation.

Cliffs along the coastline range up to 100 feet in height. The sediments are partly consolidated ferruginous and calcareous sandstone, with occasional fossil shells, and numerous shell fragments, which rest unconformably upon an old peneplaned

surface of granite and gneissic rocks.

Precambrian

Formations of this age are represented by banded and augen gneisses and by granites and porphyries. Gabbro has been intersected in drilling but does not outcrop.

EQUIPMENT

The Department operates a two ampere, square wave, Geoscience transmitter for sending a stabilized current through the ground via the current electrodes.

A Hewlett-Packard voltmeter with filter is used to measure the resultant potential drop across the potential electrodes. This high impedance voltmeter measures one millivolt full scale deflection on its lowest voltage range.

Half-inch diameter steel electrodes eighteen inches long are hammered half-way into the ground and are watered with salt solution. This electrode system usually allows 0.5 to 1.0 amperes to flow through the ground without increasing the voltage above 400 volts.

METHODS

The two basic methods utilized in this survey are resistivity profiling and electrical soundings. Plan S5049 illustrates the Wenner and Schlumberger electrode configurations which are used for profiling and electrical soundings respectively. Refer to Kunetz, 1965, for an elementary discussion on the theory and application of resistivity surveying.

Resistivity Profiling

Resistivity profiling has had numerous applications sinc

the advent of electrical prospecting and will continue to be useful on a large scale. Its principal advantages lie in the ease of making field measurements and in the simplicity of a qualitative interpretation of the results. In relation to electrical soundings, there is the advantage of permitting continuous coverage which makes profiling preferable for detailed surveys of such features as steeply dipping faults, basin boundaries and salt water- fresh water interfaces.

The possibilities of resistivity profiling are fairly lim ited when it comes to defining precisely the nature and form of structures but this is not a major inconvenience in reconnaissance surveys where the object is to reveal anomalous areas to be studied in detail by other methods.

Electrical Soundings

Electrical soundings find their greatest application on surveys for broad structures in which the beds are horizontal or nearly horizontal. Such conditions often exist in hydrological or civil engineering problems. However, even under the most favourable conditions, i.e., those in which the beds are horizontal and the resistivity is a function of depth only, the relationship between the true resistivity and the apparent resistivity is complex. Thus it is rarely possible to arrive at a quantitative interpretation only from the data obtained by isolated electrical soundings. Such soundings, too isolated from each other to permit following continuously changes of the earth's characteristics, can furnish only qualitative information concerning the nature of the beds. They might indicate for example, the comparative magnitude of resistivity contrasts, the presence of thick conductive or resistant beds, as well as an order of magnitude of depths and resistivities. Especially in reconnaissance work, such information can be very useful for judging the advisability of using electrical

methods and to help choose the best field methods.

It is only through a comparative study of the common characteristics and the progressive changes of a nearly continuous set of electrical soundings that it becomes possible to draw precise conclusions. Even when one cannot determine the depths and true resistivities exactly, one can at least deduce the trend of variations.

The determination of absolute values depends on other favourable circumstances such as drill holes or outcrops. For example, adequately logged drill holes to a sufficient depth can be used, to calibrate the electrical soundings so that the variation of resistivity and depths can be determined fairly accurately in the space between individual holes. Another possible source of calibration would be an outcrop, or the recognized presence, at very shallow depths, of the most important beds.

Since, in every case, various resistivity distributions quite different from each other can lead to similar electrical soundings, every interpretation must be based on the integration of all geological and geophysical information available on the region.

RESULTS

Resistivity Profiling

Refer to Plan 66-814 for the location of the 75 miles of resistivity profiling traverses and to Plan 66-815 for the resistivity profiles themselves.

A Wenner electrode system with a 500 feet electrode separation was suggested for this survey on the following basis. The simplified geological section consisting of dry sediments, saturated sediments, and granitic basement presents an intermediate - low - high resistivity pattern of electrical sounding.

From such a pattern it is comparatively easy to determine the longitudinal conductance of the sediments at large electrode separations. The 500 feet separation of the Wenner configuration was considered large enough to produce a predominantly horizontal current flow in the sediments and hence give an indication of the longitudinal conductance of the sediments. Since the longitudinal conductance of the sediments equals the sum of the ratios of bed thickness divided by bed resistivity, it is readily appreciated that saline water saturated sediments have a relatively large effect on the total longitudinal conductance. In the absence of saline waters, fresh water saturated sediments and weathered bedrock would be the major factor. And finally, in the absence of a water table, the thickness of dry/ damp sediments overlying the bedrock would be the controlling factor affecting the longitudinal conductance value and hence the resistivity profile.

As a rough quantitative guide, values of less than ten ohm-metres on the resistivity profile indicate a layer of at least 50 feet of saline water situated between the surface and bedrock. In zones such as these, the presence or absence of a fresh water layer cannot be determined from the profile. Values of 30 to 100 ohm metres on the resistivity profile indicate little or no saline water, mainly fresh water. Values of over 100 ohm metres indicate that very little groundwater, either saline or fresh, lies below the surface.

Refer to Plan 66-815 for the location of highly saline areas and for the relatively dry areas. These profiles will be more fully discussed in the section "Combined Analysis".

Electrical Soundings

Five electrical soundings (ES 1, 2, 3, 4, 5) were made in the Engineering and Water Supply Reserve four miles southeast

of Streaky Bay for the purpose of confirming the applicability of the 500 feet Wenner electrode separation to be used in the resistivity profiling and to gain an insight into the hydrogeological conditions of the Reserve with the possibility of providing a site for a future water supply trench. Plan 66-814 gives the location of the five electrical soundings. Refer to Plan 66-816 for the electrical sounding graphs and the resultant interpretation. Keep in mind that the subsurface geological and hydrogeological conditions below these soundings are relatively unknown so that the physical interpretations given in Plan 66-816 are made within the bounds of the principles of equivalence and suppression (Kunetz, 1966).

Electrical soundings 1, 2, 3, 4 and 5 indicate a very resistant dry surface layer six to twenty feet thick overlying at least 120 feet of saline water overlying a resistant bedrock which is indicated by the 45 degree rise at the tail end of the electrical sounding curves. Between the surface layer and the saline water saturated sediments is an intermediate layer indicated by the abnormally decreasing slopes of the electrical sounding curves. Due to the principle of suppression, the resistivity and thickness of this zone cannot be determined. However, it is known to be caused, at least partially by the layer of fresh water overlying the saline water saturated sediments. It is from this layer of fresh water that the township of Streaky Bay gets its supply. Since the lower limit of the fresh water layer cannot be calculated, it would be misleading to add it to the electrical sounding interpretation.

The remaining electrical soundings will be discussed in the following section.

Combined Analysis

Refer to traverse A on Plan 66-815. Electrical soundings

6, 7, 8 and 9 were made in an uplifted area containing granitic sands. As was expected, electrical soundings 7 and 8 show deeper weathering profiles than electrical soundings 6 and 9 respectively. An old abandoned dry well was situated less than 500 feet from electrical sounding 9. The results of electrical sounding 10 and 11 strengthened the indication of a thick saline water saturated zone above bedrock as shown on the resistivity profile. Electrical soundings 13, 14 and 18 show a low resistivity layer indicated by 3 ohm metres that is absent from electrical soundings 12, 15, 16, and 17. Such rapid changes in sediments and/ or groundwater salinities present many possibilities of interpretation.

The northwest portion of traverse B indicates another area containing much saline groundwater. Analysis of electrical soundings 24, 25 and 26 indicates very similar subsurface conditions. However, electrical sounding 19 shows a startling change in subsurface conditions, indicating a general sedimentary resistivity of 150 ohm metres as compared with 3 ohm metres in the former three electrical soundings. The southeast portion of traverse B shows rising resistivity values in the area of the granitic outcrops.

The section of traverse C to the west of its intersection with traverse A again indicates an area containing much saline groundwater which is confirmed in the analysis of electrical soundings 22 and 23. To the east of the intersection of traverses A and C, the resistivity profile indicates variations in the granitic bedrock underlying the area, as exemplified in the analysis of electrical soundings 20 and 21.

Traverse D indicates very heterogeneous subsurface conditions, however, saline zones are known to exist from bores near the indicated saline zone of the resistivity profile and dry wells exist to the north of this area. The hydrogeological factors influencing these conditions are not known.

CONCLUSIONS AND RECOMMENDATIONS

Definite indications of high salinity zones and subsurface valleys are evident from this survey. However, quantitative answers can only be given after accurate information regarding subsurface permeabilities and groundwater salinities has been obtained. To this end, six preliminary borehole sites have been suggested and are shown on traverse B on Plan 66-815.

The borehole information should then be correlated with the total resistivity results to help determine the hydrogeological conditions of the Robinson Basin.

J. J. Hussin

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EXPLORATION GEOPHYSICS SECTION

JJH:DLH
26/10/1966

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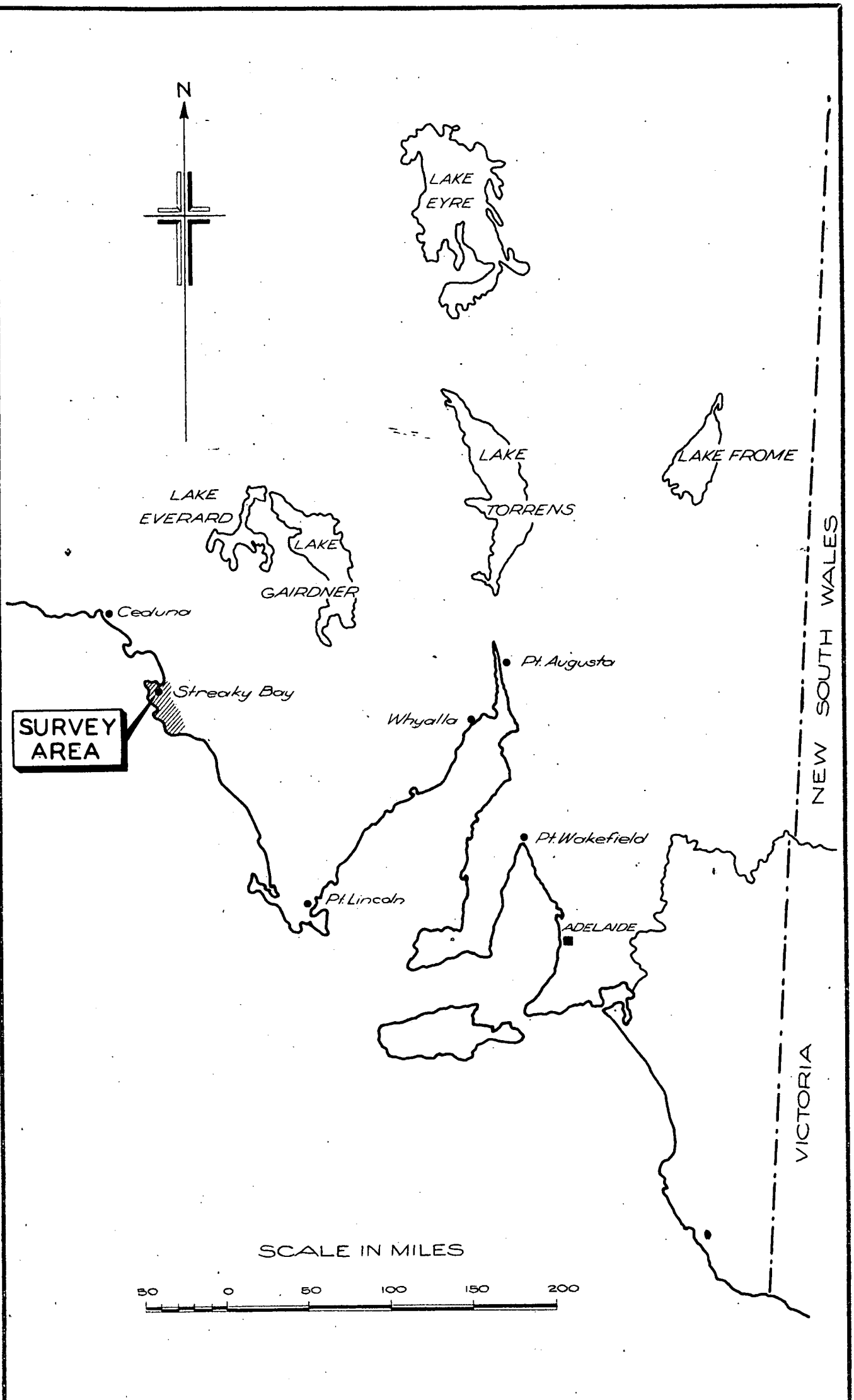
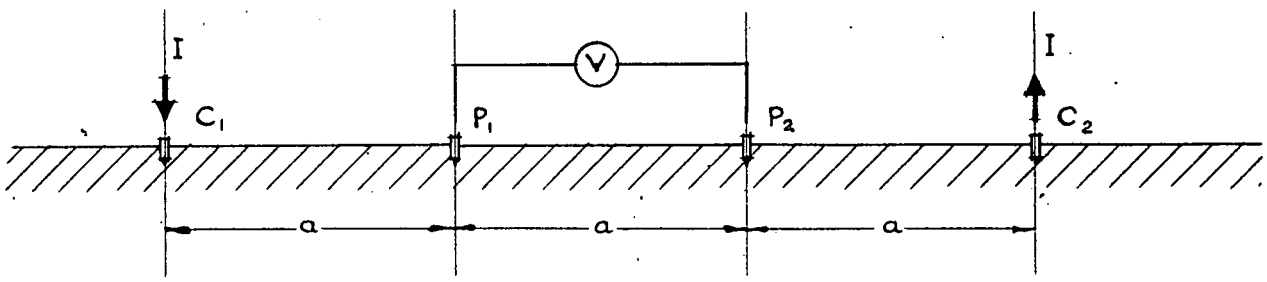
WHITTEN, G.F., 1963. Investigation of Aeromagnetic Anomalies, Hundreds Carina, Chandada and Ripon, Western Eyre Peninsula, Report of Investigation 23, S.A. Department of Mines.



DEPARTMENT OF MINES — SOUTH AUSTRALIA

	Drn. J.V.H	RESISTIVITY GROUNDWATER SURVEY	SCALE: As shown
	Tcd. T.R.S	LOCALITY MAP	S 5486
	Ckd. L.V.W	STREAKY BAY	Dg 5 + 10/11 + 16/19
	Exd.		DATE: 6 - 9 - 66

WENNER CONFIGURATION.



$$\rho a = 1.915\, a \frac{V}{I}$$

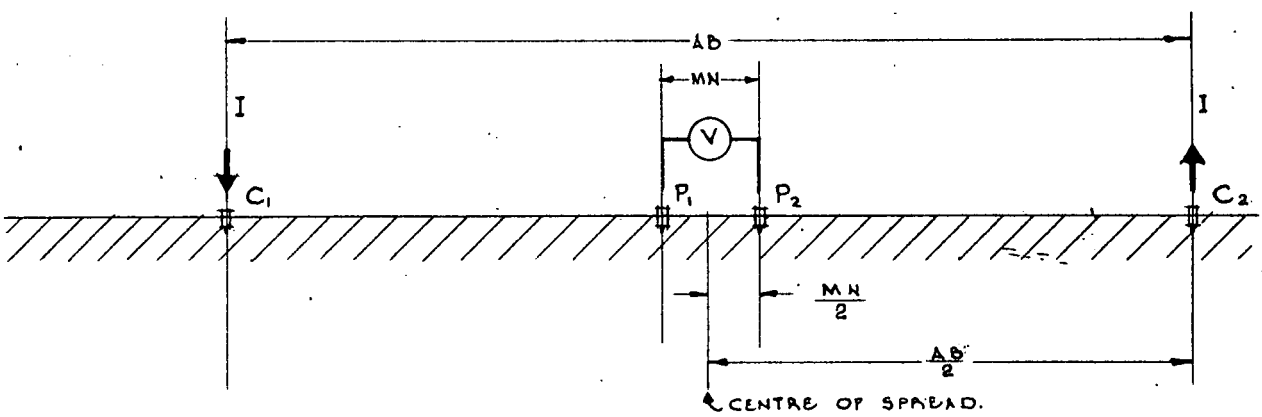
ρa = ohm·metres.

a = feet.

v = volts.

I = amperes.

SCHLUMBERGER CONFIGURATION.



$$\rho a = 0.957 \frac{V}{I} \left[\frac{(AB/2 + MN/2)(AB/2 - MN/2)}{MN} \right]$$

ρa = ohm·metres.

AB = feet.

MN = feet.

V = volts.

I = amperes.

To accompany report by J.J. HUSSIN.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

	Drn.J.J.H	WENNER AND SCHLUMBERGER ELECTRODE CONFIGURATIONS	SCALE:
	Tcd.SCW.		S 5049
	Ckd.L.V.W.		M.G.I.
	Exd.		DATE: 7 · 2 · 66

HD. MURRAY

HD. SCOTT

HD. CAMPBELL

HD. FORREST

HD. ROUNSEVELL

HD. WRENFORDSLEY

HD. RIPON

HD. DUDLEY

TRAVERSE A

TRAVERSE B

TRAVERSE C

TRAVERSE D

TRAVERSE E

WATERWORKS RESERVE

HIGH

Mt. Hall

Coca Hill

ANXIOUS BAY

BEARDS BAY

SEARCY BAY

SCEALES BAY

SLADE POINT

STREAKY BAY

BLANCHE PORT

GIBSONS PENINSULA

CORVISART BAY

POINT WESTALL

SCALE

0 1 2 3 4 5 6 7 8 MILES

LEGEND

- Boundary of Robinson Fresh Water Basin.
- Pleistocene – Recent Sand Hills.
- Pleistocene Calcareous Aeolianite.
- Archaean Granite, Granite-Porphyry.
- Resistivity Traverse.
- Electrical Sounding.
- Swamp

N

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RESISTIVITY GROUND WATER SURVEY

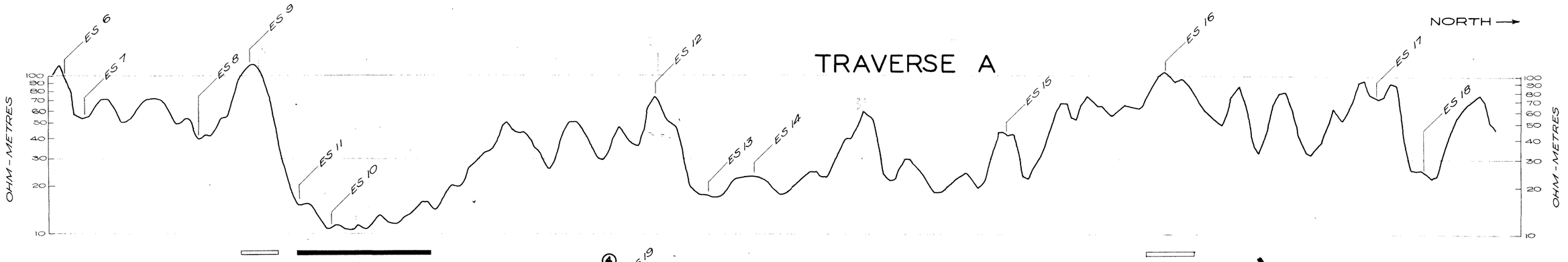
SURVEY AREA

STREAKY BAY

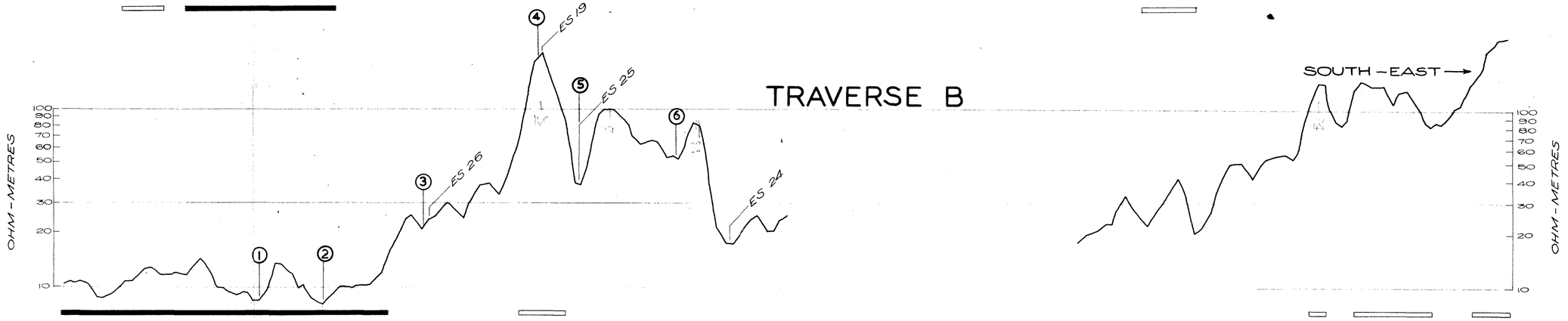
C3/64

		Drn. J.V.H.	SCALE: As shown
		Tcd. T.P.S.	66-814
		Ckd. L.V.W.	Dgs 10/11 + 16/19
Director of Mines		Exd.	DATE: 12 - 9 - 66

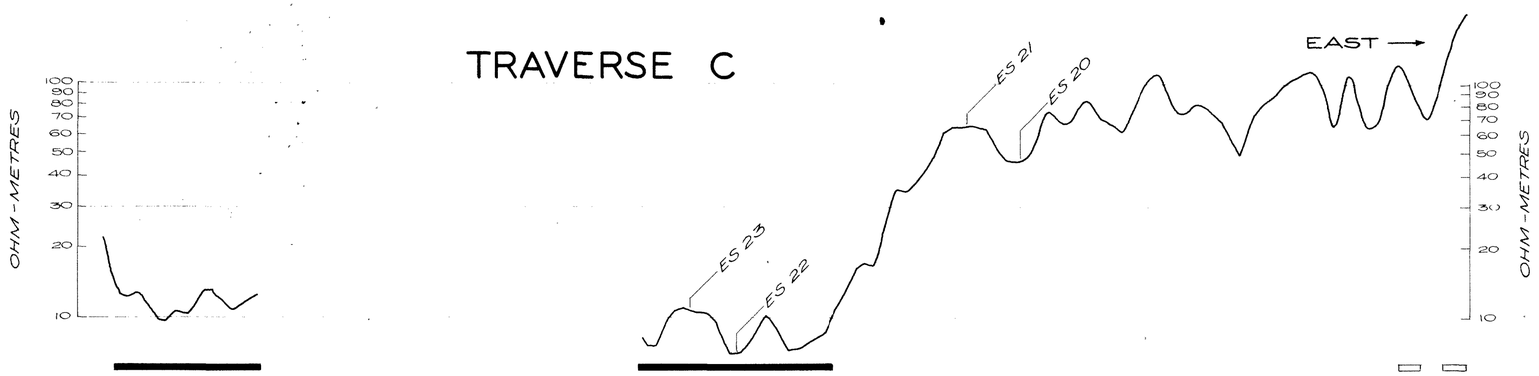
TRAVERSE A



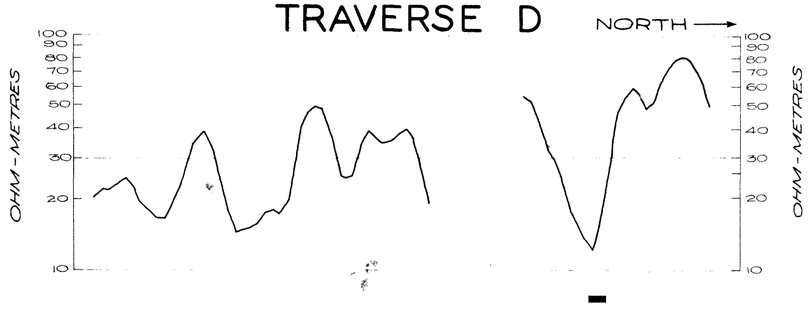
TRAVERSE B



TRAVERSE C



TRAVERSE D



② Suggested drill sites.

Areas containing very little groundwater.

Areas containing more than 50 feet thickness of highly saline groundwater. Thickness of overlying fresh water unspecified.

For location see plan 66-814

DEPARTMENT OF MINES — SOUTH AUSTRALIA

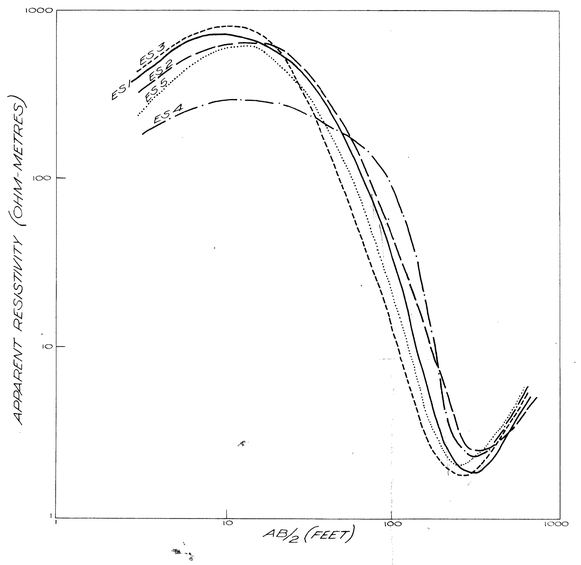
RESISTIVITY GROUND WATER SURVEY

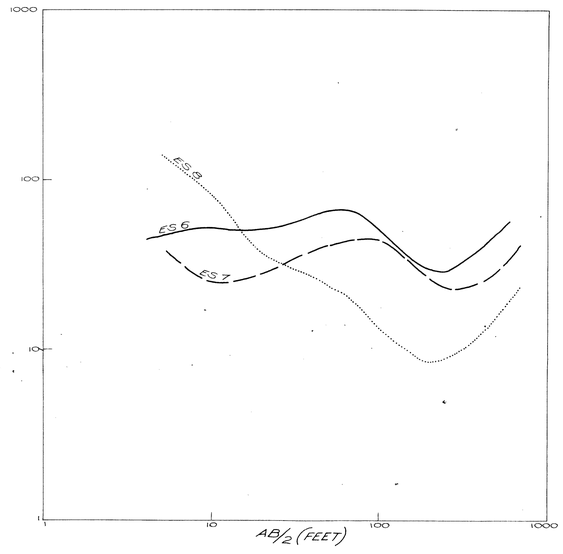
RESISTIVITY PROFILES

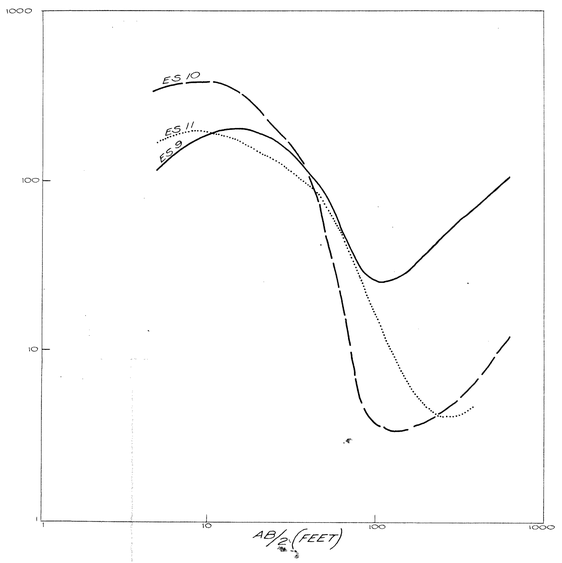
STREAKY BAY

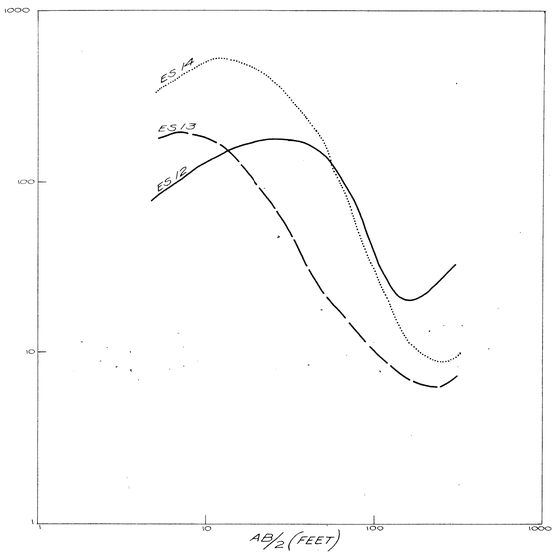
		Drn. J.J.H.	SCALE: 1cm = 2500ft.
		Tcd. T.P.S.	66-815
		Ckd. L.V.W.	Dg 5 + 10/11 + 16/19
Director of Mines		Exd.	DATE: 14-9-66

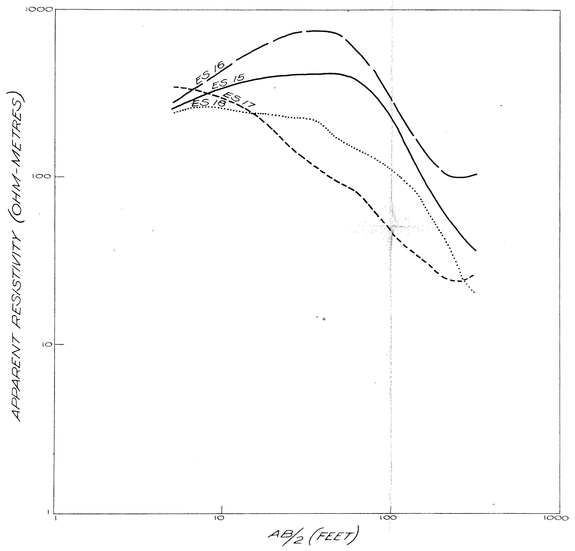
ELECTRICAL SOUNDINGS

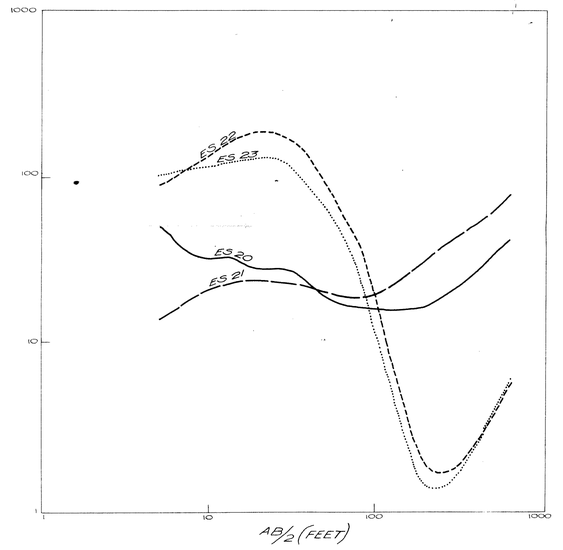


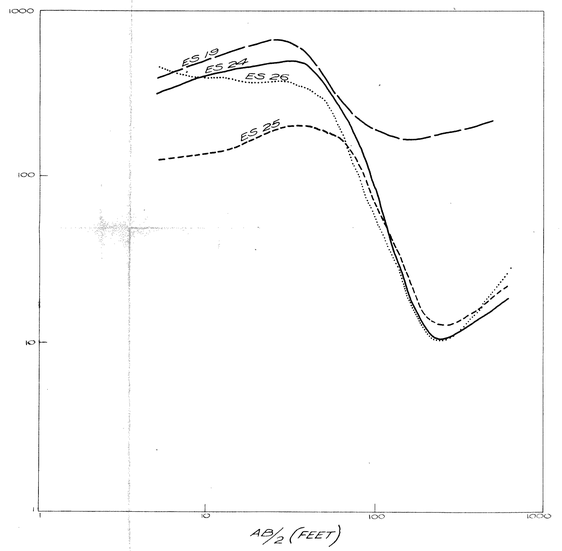




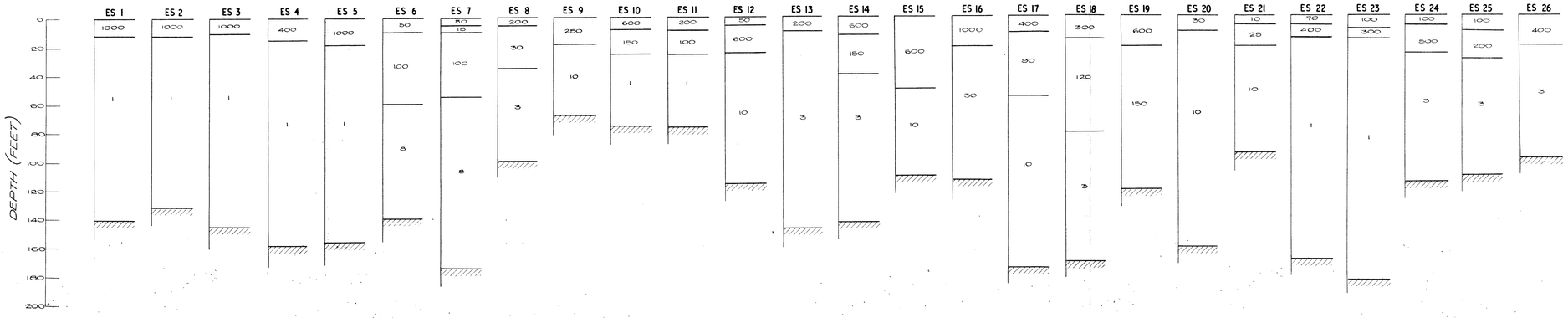








ELECTRICAL SOUNDING INTERPRETATION



200 Resistivity value in ohm-metres.

High Resistivity Layer.

For location see plan 66-814

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RESISTIVITY GROUND WATER SURVEY ELECTRICAL SOUNDINGS AND INTERPRETATION STREAKY BAY 63/94			
		Drn. J.J.H	SCALE: As shown
		Tcd. T.P.S.	66-816
		Ckd. L.V.W.	Dgs. 10/11 + 18/19
Director of Mines		Exd.	DATE: 19-9-66