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DEPARTMENT OF MINES
SOUTH AUSTRALIA

AN APPRAISAL OF THE LOW GRADE IRON ORE DEPOSITS ON EYRE PENINSULA.

by

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ABSTRACT:

This report is an economic appraisal of the low grade deposits of iron ore in the Warramboo area (including Kopi and Kyancutta) and at Greenpatch. The former is located in Central Eyre Peninsula 123 miles by railway from Port Lincoln and the latter is in the uplands 15 miles by railway from Port Lincoln.

The basis of the estimate is the preparation of an annual quantity of 500,000 tons of high grade pellets containing 64% Fe for overseas shipment.

The appraisal must be considered as preliminary because ofincomplete knowledge of the nature of the orebodies. A critical factor will be the provision of an adequate water supply. An F.O.B. price of A£5.17.0 per ton of pellets grade 64% Fe. is adopted.

Based on preliminary metallurgical test work leading to an 85% recovery from Greenpatch ore using flotation and a 60% recovery from Warramboo ore using magnetic separation and on other assumptions considered to be reasonable, the conclusion is reached that a 20 year operation at Greenpatch on a scale of 1,300,000 tons per annum grade 30% Fe with a capital outlay £9,300,000 should break even.

It is also concluded that an operation at Warramboo utilizing ore of any grade could not be payable unless there were a substantial increase in pellet price or a decrease in costs - e.g. railage which has been estimated to amount to 36/6 per ton of pellets; or unless the operation at Warramboo followed one at Greenpatch and capital charges were levied only on the additional money needed to move and rehabilitate plant and buildings. In this case a scale of operation 1,300,000 tons per annum grade 42% might break even. Additional capital required would amount to £4,500,000

Details of the estimates with relevant tables, figures and a map are appended.

1. INTRODUCTION

During the past few years the Department of Mines has carried out extensive geological mapping and aeromagnetic geophyaical surveys followed by ground magnetic and gravimetric work and over 17,000 feet of drilling in the vicinity of Warramboo, Kopi and Kyancutta in Central Eyre Peninsula and at Greenpatch in the uplands near Port Lincoln.

Metallurgical work has been undertaken on a sample

of drill core from Warramboo and on a sample taken from a surface outcrop at Greenpatch. Drilling is currently proceeding at Greenpatch, and splits from the core will be used for further investigations.

The work to date is encouraging in that there are indications of the existence of ore deposits in excess of 20 million tons in both areas with grade in the range 24% to 48% Fe. The metallurgical work suggests that the sample of Greenpatch ore tested could be upgraded to a 65% Fe concentrate with recovery of 85% of the iron using a flotation process and that the sample of Warramboo ore could be upgraded to a concentrate of the same grade with recovery of 60% of the iron by magnetic separation.

There is at present an excellent though competitive market for iron ore and pellets, with experts to Japan moving from the U.S.A., Canada, South America, India, Malaya, Philippines, South Africa; while, in addition, contracts have recently been negotiated for high grade ore from Western Australia.

Japan has now replaced Germany as 3rd largest steel producer in the world and its capacity is expected to increase 13% to 42m. tons p.a. in the three years to 1965. The present trend is towards using pellets as raw material for the production of steel and a premium of 5 cents per unit (equal to 28/6 per ton grade 64%) is said to be attracted to pellets.

The current interest in the deposits on Eyre Peninsula arises from the possibility of their exploitation for the production of pellets. The overall plan would be to establish a beneficiating plant at the mine and rail concentrates to a pelletizing plant situated adjacent to a suitable wharf which will have to be provided near Port Lincoln.

The mine at Greenpatch would be 15 miles by rail from the wharf and Warramboo, 123 miles. There will be problems associated with establishing an industry and community at the

mine and the required services of housing, railway, power and water; also with the construction of a wharf at Pt. Lincoln. However, of these, the most critical will be that of water supply, and while it is known that underground water exists, a prerequisite to the spending of substantial funds on ore exploration and development or on buildings construction would be the proving of an adequate and permanent supply of water.

This assessment of the various factors involved in the establishment of an iron ore exporting industry is based on an annual output of 500,000 tons of pellets grade 64% Fe. It is being made to assist exploration by determining the limits of tonnage and ore grade which would be required for a profitable undertaking and also as a guide in negotiations with prospective interested parties.

2. PREVIOUS REPORTS:

Warramboo:	Summary	Whitten	1962
	No. 1	"	1962
	No. 2	Heath	1962
	No. 3	Heath & Whitten	1963
	Water Supply	Shepherd	1962
	Beneficiation	A.M.D.L.	1963
Kopi:	No. 1	Whitten	1963
	Geophysics	Risely	1963
Kyancutta:	No. 1	Shackleton	1963
Greenpatch:	No. 1	"	1963
	No. 2	Whitten	1964
	Geophysics	Risely	1963
	Beneficiation	A.M.D.L.	1963
General:	Policy	Whitten	1960
	Prospecting Programme	"	1963
	Billeroo, beneficiation	A.M.D.L.	1963

3. GEOLOGY:

The following brief notes on the geology of the areas have been prepared by Mr. G.F. Whitten.

WARRAMBOO.

The Warrambeo Aeromagnetic Anomaly is caused by 2 main beds of iron formation trending E-W for approx. 15 miles. The main surface features are sand dunes several miles long, 200'-300' wide and 50' high. There are no basement outcrops; cover varies from a few feet to 110'; depth of weathering averages 30'.

Drilling intersected metasediments of presumably Archaean age. The two dominant mineral associations of the iron-rich beds are quartz-felspar-magnetite-biotite and garnet-magnetite.with lesser quartz-biotite-sillimanite-felspar. The I.F. beds approximate 1000' wide and dip 30°-60°S. Iron formation has been intersected in the majority of "on anomaly" holes.

KOPI.

The Kopi Aeromagnetic Anomaly south of Warrambee is also caused by Iron Formation here in complex zones over a length of up to 21 miles. There are no basement outcrops, surface conditions being similar to Warrambee. Cover varies from 21ft. to as much as 220ft., where Tertiary Basins occur.

Rock types and metamorphism are similar to Warrambee but as there has been less testing nothing is known about structure and width of the iron formation.

KYANCUTTA:

Five scattered outcrops of coarse grained granulitic metajaspilite occur. The outcrops are small, trends are difficult to assess and dips have not been determined except for No. 2 (vertical). Detailed magnetic and gravity surveys have been proposed.

GREENPATCH.

At Greenpatch the major structure is probably an overturned north-plunging anticline made up of 2 or 3 beds of iron formation each 200-400' thick. These iron formations are either typical jaspilites or alternately bedded magnetite-marbles. Dips vary from 45-75°W or NW and the beds outcrop.

Ground magnetic and Gravity anomalies are related to synclinal folds on the N.W. limb of the major structure.

4. BASIS OF THE ESTIMATE:

The estimate must be regarded as preliminary at this stage because of the factors set out below. Details of the costs used in arriving at the conclusions are given in the appendices.

(a) There is insufficient knowledge of the nature, size, shape and setting of the ore deposits and of the distribution of the iron minerals to allow of more than a rough assessment being made of mineable grade, the outline of ore extraction limits or the ratio of overburden to ore. These factors very materially affect the mining cost.

(b) Metallurgical work to date has been confined to samples taken from a diamond drill hole at Warramboo and surface outcrops at Greenpatch. A reasonably representative sample of the ore body as a whole is required for preliminary experimental work and this must be followed by satisfactory testing on pilot plant scale before substantial funds are expended on buildings and plant. The results of the work on the early samples indicate that Greenpatch ore can be beneficiated to a concentrate assaying 65% Fe. with 85% recovery of the iron content of the ore using a

flotation process, while Warramboo ore can be beneficiated to the same grade with 60% recovery using magnetic separation.

(c) The cost of establishing a community will depend on the number of employees and the locality. An allowance is made for the recovery of some of the outlay by way of rent.

(d) One of the major items of cost is rail freight. An estimate has been made which is 67% of the normal "Miscellaneous" rate applying to ores. The Railways Department will be in a position to make a closer estimate when the terminal facilities and loading and unloading arrangements are known. These will depend very largely on the physical properties of concentrate. An allowance has been made for the capital cost of additional track and rolling stock.

An alternative of aerial ropeway transport for 4 miles from Greenpatch to the coast has not been developed because although possibly cheaper for Greenpatch ore, it would require an extra transfer when concentrate is being moved from Warramboo. The method is worth further investigation when more accurate costing is undertaken.

(e) Perhaps the most indefinite capital cost at this stage is that of water supply. It could range from £25,000 for water available locally to £3,000,000 for water from Morgan. Bores in the general area are producing 2,000 gall. per hour; although the water is saline, tests indicate that it will be satisfactory for beneficiation purposes. Clearly, drilling will be required to establish the source of an adequate supply of suitable water at a very early stage in the investigation.

(f) Preproduction testing includes geological and geophysical work, drilling, metallurgical testing, mine sampling and preliminary development to delineate ore reserves. A figure of approx. 5%-6% of total capital has been allowed.

(g) An allowance of 2% of total capital has been made for,acquiring properties and raising finance, and of 2 months operating costs for Working Capital.

(h) Capital charges are a high proportion of the total cost. These have been based on 10% per annum of the capital outlay.

(i) Product price will have a major influence on results. The price of £5.17.0 per ton of pellets grade 64% F.O.B. Port Lincoln is based on present knowledge of current Japanese C.I.F. contracts and on assumed ocean freights using 60,000 ton ore carriers.

(j) The A.M.D.L. report on the Warramboo work developes costs on the separate bases of ore grades 12%, 24%, 36% and 48%, all leading to the production of 500,000 tons of concentrates, grade 65%, p.a. for subsequent pelletizing to pellets, grade 64%. In this report the analysis is made on the basis of tons of ore mined per year (at various grades) to produce 500,000 tons of pellets, grade 64%, per annum.

5. PRICE OF PRODUCT:

The ore price will very largely be determined on the basis of C.I.F. Japan. Following a study of the available information, a price of C.I.F. £7.7.0 per ton of pellets grade 64% Fe with a range £6.15.0 to £7.17.0 for a range in grade 60%-67.5% Fe has been adopted in this report. Further details of the way these figures have been calculated are given in Appendix D.

It is apparent that ocean freights will have a marked influence on F.O.B. prices. The freight rates under current Japanese contracts appear to range between A£-2.0.0 and A£3.8.0. per ton. However, these rates undoubtedly apply to small boats and it is anticipated that rates as low as £1.10.0 or even £1.5.0 may be realised using 60,000 ton ore carriers for which provision is being made in this report.

The F.O.B. price adopted is £5.17.0 per ton for pellets grade 64% Fe with the range £5.5.0 for 60% Fe to £6.7.0 for 67.5% Fe.

6. CAPITAL REQUIREMENT SUMMARY:

The estimated capital cost for operations at Greenpatch and Warramboo for an annual throughput of 1.0m., 2.5m and 4.0m tons of ore at the appropriate grades from which 500,000 tons of pellets grade 64% Fe can be produced at Pt. Lincoln are set out below. Notes on the derivation of these costs appear in the Appendix B. The capital requirement is depicted in graphical form in Figure 4.

	GREENPATCH			WARRAMBOO		
T.P.A.(millions)	1.0	2.5	4.0	1.0	2.5	4.0
Grade (% Fe)	38.3	33.3	9.6	34.3	21.7	13.6
Beneficiation £m.	2.00	3.30	4.60	2.00	3.30	4.60
Mining	1.20	2.40	3.60	1.20	2.40	3.60
Pelletising	2.00	2.00	2.00	2.00	2.00	2.00
Community	0.80	1.20	1.56	0.80	1.20	1.56
Wharf etc.	0.90	0.90	0.90	0.90	0.90	0.90
Preprod.testing	.42	0.68	0.94	0.44	0.71	0.97
Railway	0.30	.30	.30	1.30	1.30	1.30
Roads	.02	.02	.02	.03	.03	.03
Water	.22	.28	.34	.30	.38	.50
Power	.04	.04	.05	.30	.30	.35
Finance	.16	.23	.29	.19	.25	.32
Working	.31	.46	.59	.40	.50	.58
Total £m.	8.57	12.01	15.39	9.86	13.27	16.71

£ per ton ore per year	£8.6	£4.8	£3.9	£10.0	£5.3	£4.2
£ per ton pellets per year	£17.1	£24.0	£30.8	£19.7	£26.5	£33.4

2. OPERATING COST SUMMARY:

The estimated operating costs per ton of pellets associated with the annual throughputs of 1.0, 2.5 and 4.0 million t tons of ore per annum at Greenpatch and Warramboo for the production of 500,000 tons of pellets grade 64% Fe are set out in the table below. The mining and beneficiating costs are per ton of ore. Details of the derivation of the costs appear in Appendix C. The results have been plotted in Fig. 2 and 3.

	GREENPATCH			WARRAMBOO		
Tons of pellets pa.(m)	0.5	0.5	0.5	0.5	0.5	0.5
Tons of ore pa.(m)	1.0	2.5	4.0	1.0	2.5	4.0
Tons per hour (milling)	127	317	508	127	317	508
" per day (mining)	4000	10000	16000	400	10000	16000
Mining	7/6	5/0	4/0	7/6	5/0	4/0
Beneficiation	10/0	8/9	8/3	6/0	4/9	4/3
	17/6	13/9	12/3	13/6	9/9	8/3
x R (ratio of concn)	35/-	68/9	98/-	27/-	48/9	66/-
Railage	8/-	8/-	8/-	36/6	36/6	36/6
Pelletizing	19/-	19/-	19/-	19/-	19/-	19/-
Loading, Wharfage etc.	4/6	4/6	4/6	4/6	4/6	4/6
Royalty	2/-	2/-	2/-	2/-	2/-	2/-
Administration	5/6	7/9	9/6	7/-	8/3	10/-
	74/-	110/-	141/-	96/-	119/-	138/-
Capital Charges	35/-	48/-	62/-	40/-	54/-	67/-
TOTAL	109/-	158/-	203/-	136/-	173/-	205/-
Revenue: pellets	117/-	117/-	117/-	117/-	117/-	117/-
other	2/-	3/-	4/-	2/-	3/-	4/-
Total	119/-	120/-	121/-	119/-	120/-	121/-
Excess p.t.pellets pa	10/-					
Deficit " " "		38/-	82/-	17/-	53/-	84/-

8. CAPITAL AND OPERATING COSTS - WARRAMBOO FOLLOWING GREENPATCH:

The direct operating costs would be the same as for Warramboo (disregarding changes that may take place during the next 10-20 years) but the capital charges would be reduced by reason of the transfer of buildings, plant and equipment from Greenpatch.

Assuming that Greenpatch had been operating on the scale of 1.3m tons per year and that it would cost ½ of the original cost to move and rehabilitate these capital items, the additional funds required for Warramboo to produce 1.2m tons p.a. grade 45% Fe, 1.55m t.p.a. grade 35% Fe and 2.2m t.p.a. grade 25% Fe might be expected to amount to the figures shown in the following table. Notes on these costs appear in Appendix E, and the final operating cost figures are shown in Fig. 3.

	If all new plant			Greenpatch	Additional to Greenpatch		
£.p.a.(millions)	1.2	1.55	2.2	1.3	1.2	1.55	2.2
Beneficiation	2.20	2.50	3.00	2.30	1.00	1.30	1.80
Mining	1.40	1.70	2.20	1.50	0.70	1.00	1.50
Pelletizing	2.00	2.00	2.00	2.00	-	-	-
Community	0.90	1.00	1.10	0.90	0.30	0.40	0.50
Wharf	0.90	0.90	0.90	0.90	-	-	-
Preproduction testing	.47	.51	.63	.47	.40	.50	.60
Railway	1.30	1.30	1.30	0.50	1.10	1.10	1.10
Roads	.03	.03	.03	0.02	.02	.02	.02
Water	.31	.33	.37	0.23	.25	.27	.31
Power	.30	.30	.30	.04	.30	.30	.30
Finance	.20	.21	.24	.17	.08	.10	.12
Working	.41	.43	.47	.34	.07	.09	.13
Total Capital	10.42	11.21	12.54	9.37	4.22	5.08	6.38
Capital Charges	42/-	45/-	50/-	38/-	17/-	20/-	26/-
Direct operating	99/-	104/-	114/-	81/-	100/-	105/-	114/-
Total operating	141/-	149/-	164/-	119/-	117/-	125/-	140/-

9. CONCLUSIONS:

The results for the three scales of operation at Greenpatch and Warramboo, and for an operation at Warramboo following the working out of Greenpatch are shown in Figs 2, 3 and 4. In all cases the output is assumed to be 500,000 tons of pellets assaying 64% Fe per year.

The break even point for Greenpatch is 1.3 m tons p.a. grade 30% Fe. with Capital £9.3m.

The graphs show that if revenue increases by 10/- per ton, the break even point becomes 1.6m t.p.a. grade 25%; if the revenue decreases by 10/- per ton (or costs increase by this amount) the break even point becomes 1.0m t.p.a. grade 38%. It follows that within the range in ore grade 25% - 40% Fe, a variation in price or working cost of 10/- per ton of pellets is approximately equivalent to 6% in ore grade.

It also follows from the variation of 3/- per ton in the price of pellets for changes of 1% in pellet grade that a 1% improvement in pellet grade (at no extra cost) is equivalent to 2% in ore grade.

The conclusion regarding Warramboo is that an operation based solely on deposits in this area cannot break even at any grade using the costs adopted in the report. If the costs fell by 20/- per ton (or the price increased by this amount) the mining of 1.2m t.p.a. grade 45% would have a chance of breaking even. The capital required would be approx. £10.4m. In this connection it should be noted that a rail freight of 33/- per ton of concentrates (equal to 36/6 per ton of pellets) has been used in arriving at this conclusion.

If Warramboo were held until after Greenpatch had been worked out, and the plant, buildings and equipment then transferred to Warramboo at a cost of half the original price paid, and if capital charges were allowed only on this additional expense, the operation at Warramboo might break even on a scale of 1.3m t.p.a. grade 42%. Extra Capital funds amounting to £4.5m would be required.

Under these conditions, a reduction in working cost (or increase in price) of 10/- per ton of pellets would see breakeven at 1.7m t.p.a. grade 32%; or a reduction of 20/-, break even at 2.2m t.p.a. grade 25%. Within the range in ore grade 25% - 40%, 10/- per ton of pellets is equivalent to 8% in head grade. It will also be seen that an increase of 1% in pellet grade would result in lowering of minimum ore grade by 2½%.

10. ACKNOWLEDGEMENTS:

Discussions on various aspects were held with Messrs. Campbell (E. & W.S.), Sainsbury (Harbors), Huddlestone and Ramsay (Electricity Trust), Fargher (Railways), Hosking and Henderson (AMDL) and Whitten, Stapleton and Shepherd (Geological Survey). The help of these gentlemen is acknowledged with thanks.

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APPENDIX A

NOTES ON PRODUCTION DATA

PRODUCTION DATA:

All of the estimates are based on an annual output of 500,000 tons of pellets grade 64% Fe.

The figures in the AMDL report on Warramboo are based on ores of grades 12%, 24%, 36% and 48%, and the beneficiation process there adopted is magnetic separation giving an overall recovery of 60% of the iron content. The estimates in the AMDL report on Billeroo are based on ore of grade 49% Fe; the process is flotation, and the recovery 81%. The AMDL preliminary report on Greenpatch with ore of grade 40% indicated a recovery of 85% using a flotation process for beneficiation.

In this appraisal, a recovery of 60% is assumed for Warramboo ores using magnetic separation, and a recovery of 85% for Greenpatch ores using flotation. The figures provided in the AMDL reports have been used in part to compile the following operating data for annual tonnages milled ranging from 1.0m to 4.5m.

Milling hours are calculated on the basis of 90% of the full year = 7880 hours.

Tons of ore mined per day are on the basis of 2 shifts of 8 hours for 5 days per week and 50 weeks per year.

The figures in the table below are shown in Fig. 1 and Fig. 5.

Pellets-Tons per year (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ratio of concentration	1	2	3	4	5	6	7	8	9
Ore-tons per yr.(m)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Greenpatch-grade	76.5	38.3	25.5	19.1	15.3	12.8	10.9	9.6	8.5
Warramboo-grade	108	54.3	36.2	27.1	21.7	18.1	15.5	13.6	12.0
Milling-tons per hr.	127	190	254	317	381	444	508	571	
- " " day	3050	4570	6100	7620	9140	10660	12200	13700	
Mining- " " "	4000	6000	8000	10000	12000	14000	16000	18000	
- " " hour	250	375	500	625	750	875	1000	1125	
Employees-mill	58	58	64	64	74	84	94	106	
pellet	39	39	39	39	39	39	39	39	
mine	80	120	160	200	240	280	320	360	

Employees-services (mine)	100	130	150	170	190	210	230	250
" (general)	100	100	100	100	100	100	100	100
Total	377	447	513	573	643	713	783	855
say: at mine	250	320	390	450	510	570	630	700
at Port Lincoln	150	150	150	150	150	150	150	150
Total	400	470	540	600	660	720	780	850

APPENDIX B

NOTES ON CAPITAL COSTS

BENEFICIATION PLANT:

The AMDL reports provided the following estimates for plants at Warramboo and Billeroo. The feed tonnages to give ½ million tons pellets p.a. have been calculated and added.

	Warramboo(magnetic separation)				Billeroo(flotation
Grade (% Fe)	12	24	36	48	
Ore(M.t.p.a.)	4.5	2.25	1.5	1.125	0.8
Cost (£m)	5.0	3.0	2.5	2.0	2.0

By interpolation, the costs for plants treating 1.0, 2.5 and 4.0m t.p.a. will be approximately £2.0, £3.3m and £4.6m See Fig. 4.

Mining

Cost of mining plant has been subdivided as follows:-

Ore - m.t.p.a.	1.0m	2.5	4.0
Building - £per t.p.d.	50	40	37½
Plant -	100	80	75
Equipment-	150	120	112½
Total -	300	240	225
Total (£m)	1.2	2.4	3.6

See Fig. 4.

PELLETIZING PLANT:

The AMDL figure of £2m for a plant producing ½m tons of pellets per annum has been adopted.

COMMUNITY:

A community cost covering housing, single men's quarters, messing, recreation rooms, stores etc. totalling £2,000 per

employee has been assumed.

WHARF, STORAGE, LOADING FACILITIES:

Provision is being made for 60,000 ton ore carriers:-

a. 90,000 ton pellet storage.

b. Conveyor belt, loading rate 1,000 t.p.h.

c. Jetty to support conveyor belt and dolphins.

d. Loading towers.

Total capital outlay estimated to be £900,000.

PREPRODUCTION TESTING:

a. Geological, engineering, water supply, metallurgical

say £100,000 for Greenpatch (1.0m.t.p.a.)

£150,000 Warrambee (2.5m.t.p.a.)

b. Diamond & Percussion drilling

Greenpatch 50,000' @ £4 per ft.

Warrambee 100,000' @ £4 per ft.

c. Development (for bulk sampling)

Greenpatch 5,000 ft. @ £20 per ft.

Warrambee 10,000 ft. @ £20 per ft.

d. Totals

These figures total £400,000 in the case of Greenpatch (1.0 m.t.p.a.) and £750,000 in the case of Warrambee (2.5m.t.p.a.)

Convenient ratios to use will be 10% of the capital cost of mining and milling plant plus 2% of the balance of the capital.

RAILWAY:

The AMDL report quotes £1.3m capital cost plus a rate of 33/- per ton of concentrate moved from Warrambee to Port Lincoln.

An approximate breakdown of this cost might be:

5 miles new track	£150,000
118 miles recondition	350,000
rolling stock	800,000
	£1,300,000

The capital cost for Greenpatch is estimated to be £600,000 made up of:-

5 miles new track	£150,000
10 miles recondition	50,000
Rolling stock	400,000
	£600,000

ROADS:

Allow £3,000 per mile:

Greenpatch	£14,000
Warrambee	£24,000
Pellet plant	£6,000

WATER SUPPLY:	Tons Ore per year (m)		
	1.0	2.5	4.0
Port Lincoln			
Employees		150	
Tons per hour pellets		63	
Water for employees (g.p.h.)		900	
Water for pellet plant etc.		1200	
		2100	
Size of pipe		4"	
Cost, say 10 miles @ 15/- per foot £m		.04	
Greenpatch			
Employees	250	450	630
Milling - tons p.h.	127	317	508
Water for employees	1500	2700	3780
Water for milling @ 90 g.p.t.	11430	28530	45700
Water for mine etc. @ 10	2500	6250	10000
Total	15400	37500	59500
Size of pipe	8"	10"	12"
Cost of pipe (£ per mile)	8000	11000	14000
Cost for, say, 20 miles £m	0.16	0.22	0.28

Warrambee

Water for employees	1,500	2,700	3,780
Milling @ 56 g.p.t.	6,350	15,800	25,400
Mining etc.	2,500	6,250	10,000
Total	10,400	24,800	39,200
Size of pipe	6"	8"	10"
Cost of pipe (£ per mile)	6,000	8,000	11,000
Cost for, say, 40 miles £m	0.24	0.32	0.44

POWER SUPPLY:

	Tons p.a. (m).		
	1.0	2.5	4.0
Power Consumption			
Mine 5 KWH per ton	1250	3130	5620
Mill 15 } 20 KWH p.t.	2540	6350	11400
Misc. 5 }			
Total at mine	3800	9500	17000
Pellet plant 30KWH p.t.	1900	1900	1900
Misc. 5	300	300	300
Total Pt. Lincoln	2200	2200	2200
Cost of line (£ per mile)	4000	4000	5000
- Greenpatch 8 miles £m	.04	.04	.05
Warrambee 70 miles £m	.30	.30	.35

FINANCE

2% of capital is allowed to cover acquiring title, finance etc.

WORKING CAPITAL

Two months finance, i.e. 1/6 of the annual direct operating costs, is allowed to cover the period between payment of wages and stores accounts and receiving returns from sales.

TOTAL CAPITAL REQUIREMENT:

The capital costs are depicted in Fig. 4.

The total capital required to mine and upgrade ore, produce pellets and load into ships according to these estimates is seen to be:-

		Greenpatch			Warrambee		
		1.0	2.5	4.0	1.0	2.5	4.0
£ per t.p.a.	Ore	£8.6	£4.8	£3.9	£10.0	£5.3	£4.2
	Pellets	£17.1	£24.0	£30.8	£19.7	£26.5	£33.4

With these figures can be compared the commonly accepted range of $30 - $50 per ton of pellets p.a. (which reduce to £13.5 - £22.5) and the following costs which have been gleaned from the literature and newspapers. As the make up of these figures is not known in detail no more than a very broad comparison can be drawn.

Mt. Isa including smelting and refining	£18 p.t.p.a.	Ore
" " concentrator only (2mtpa)	£4 p.t.p.a.	Ore
Moura coal (3mtpa)	£5 "	Coal
Leigh Creek coal (1mtpa)	£7 "	"
Koolan (no beneficiation) (2m.t.p.a.)	£4 "	Ore
Mt. Goldsworthy (1 m.t.p.a.)	£6 - 10 "	"
" " (incl. beneficiation & pelletizing)	£20 - 24 "	"
Hamersley (1-5 m.t.p.a.)	£6 "	"
" (incl. beneficiation)	£10 "	"
British Columbia (incl.beneficiation)	£5-10 "	"
Savage River (2m.t.p.a.)	£14 "	Pellets
Erie Mining Co. (7 m.t.p.a.)	£24 "	"
Hilton Mine (1 m.t.p.a.)	£10 "	"
Wabush Mine (3 m.t.p.a.)	£27 "	"

APPENDIX C

NOTES ON OPERATING COSTS

MINING:

The mining costs will depend on the size, shape and nature of the orebody (in particular on its irregularity and hardness) and on the ratio of overburden to ore. In the absence of adequate knowledge of these factors the scale of 7/6, 5/- to 4/- per ton for annual outputs of 1m., 2.5m, to 4.0m tons will be used. See Fig. 6.

BENEFICIATING:

This cost depends on the process and fineness of grinding. Major items will be labour, power, grinding. Major items will be labour, power, grinding balls and reagents.

Magnetic separation of Warramboo ore has been estimated by AMDL to cost 38/- per ton pellets for 12% head grade, 21/- for 24%, 16/- for 36%, 13/- for 48%. These costs have been converted to the following corresponding figures for annual production of ore: 4.2/- for 4.3 mtpa. to 5.9/- for 1.1 mtpa These results are shown in Fig. 6.

Flotation of the Billeroo ore has been estimated to cost 12/6 per ton for a throughput of 800,000 t.p.a. For Greenpatch the cost, by interpolation, has been calculated to be 10/- per ton for 1.0 m.t.p.a. with a reduction in cost for increase in throughput equal to that which applies to Warramboo. The results are shown in Fig. 6.

RATIO OF CONCENTRATION:

The mining and beneficiation costs per ton of ore have to be multiplied by the ratio of concentration, i.e. tons of ore required to produce 1 ton of concentrate, to provide the figure for cost per ton of pellets which is the basis on which the subsequent costs are presented.

RAILAGE:

AMDL reports 33/- per ton for the 123 miles haul from Warramboo. The rate for the 15 miles from Greenpatch will be about 7/-. In both cases, these rates are approximately $^{2}/_{3}$ of the "miscellaneous" rate normally applying to ores and both are less than the rate for wheat.

These rates must be regarded as tentative at this stage. The actual rates will depend on loading and unloading facilities and on train loading and annual tonnage carried.

The rates given apply to the gross tons of wet concentrate. The equivalent cost per ton of pellets is 36/6 in the case of Warramboo and 8/- in the case of Greenpatch.

PELLETIZING:

The figure of 19/- per ton of pellets as estimated by AMDL will be used.

HANDLING AND WHARFAGE:

An allowance is made, for loading ships, of 2/6 per ton and, for other handling, 1/- per ton. Wharfage and other port charges for this private wharf will be approximately 1/- per ton.

Sub total: 4/6 per ton of pellets.

RENTS AND ROYALTIES:

The BHP Co. Ltd. pays a royalty of 1/6 per ton of high grade ore or beneficiated concentrate and an annual rental of 1/- per acre for approx. 4840 acres plus an annual lump sum of £12,000.

In the case of Warramboo and Greenpatch an allowance is made for royalty at the rate of 1/6 per ton of concentrate and a rent on 5,000 acres at the rate of 1/- per acre. The latter, amounting to £250 is negligible when reduced to a cost per ton. However, an allowance of 6d. per ton is made to cover other charges which may be levied.

Sub total: 2/- per ton.

ADMINISTRATION:

A charge of 7½% of all other direct operating costs is allowed for general office and administration.

CAPITAL CHARGES:

A round figure capital charge of 10% is made to cover return of capital and a reasonable interest (e.g. 3% S.F. @ 5% over 20 years and 7% interest).

TOTAL OPERATING COSTS:

The various costs detailed above are listed and totalled in the table in Section 7.

They are shown in Figures 2 and 3.

APPENDIX D

NOTES ON REVENUE

Revenue is divided into 2 parts "sale of pellets" and "other".

PRICE OF PELLETS:

W.M.C. - Hanna-Homestake at Koolanooka have arranged a contract with price 21.0 c per unit CIF Japan. This reduces to £5.13.0. per ton of ore grade 60% Fe or £6.1.0 per ton grade 64% Fe.

Another potential Australian producer expects to receive a price CIF Japan of 26 c per unit for pellets grade 67.5%. This reduces to £7.18.0. per ton grade 67.5%; £7.10.0 per ton, 64%; or, £7.0.0 per ton grade 60%.

Other people are working on a price of 25 c per unit for pellets base grade 60% Fe. This reduces to £6.15.0 per ton grade 60% or £7.4.0 per ton grade 64%.

The premium for pellets is said to be 5c per unit i.e. ≠ 3 per ton at grade 60% (27/-) or 29/- per ton grade 64% Fe. This amount checks with the difference in price for Koolanooka ore compared with pellets.

Recent Japanese contracts for ore are as follows:-

U.S.A.	23.9 c.p.u.	for 57% Fe equiv. to	£6.17.0 for 64% ore
Canada	23.6	61	6.16.0
Malaya	21.8 - 23.9	58-60	6.11.0
India	20.9 - 25.7	58-62	6.15.0
	28.8	65	6.19.0
Chile	25.6	65	7. 8.0
Brazil	24.9 - 27.3	64-68.5	7.11.0

The average for 57-62% ores reduced to 64% is £6.14.0

64-68½ " " " " " £7. 6.0.

It is evident that a substantial premium is paid for the higher grade ores out of proportion to the extra iron content. In fact, the price ranges from 20.9 c.p.u. to 28.8 c.p.u. for a range in grade from 57% to 68.5% i.e. approximately 6/- per unit compared with a norm of 2/2 per unit.

It might reasonably be expected that the price for Australian pellets should equal £7.0.0. plus the premium for pelletizing i.e. £1.9.0 making a total of £8.9.0. per ton of pellets grade 64%.

However, in view of the price being adopted by potential producers of Australian pellets the figure of £7.7.0 per ton of pellets grade 64% will be used in this report with a range £6.13.0. for 60% to £7.17.0. for 67.5% grade i.e. 3/- per unit.

Ocean freights under recent Japanese contracts with various countries of the world range between A£2.0.0 and £3.8.0 per gross ton, while the freight on Koolanooka ores is expected to be £1.17.6. per ton. Some parties anticipate freight rates as low as £1.10.0 when using 40,000 to 60,000 ton ore carriers while others are working on rates of £1.5.0 per ton for 60,000 ton ore carriers.

The size of the ships transporting ores under the recent Japanese contracts is not known but those carrying Koolanooka ores will probably be restricted to 20,000 tons until major alterations are made to the port.

In this report a freight rate of £1.8.0 per gross ton or £1.10.0 per net long ton will be adopted.

F.O.B. prices used will thus be £5.17.0 per ton of pellets grade 64% ranging between £5.5.0 for 60% grade to £6.7.0 for 67½% grade.

OTHER REVENUE:

The only other source of revenue that can be envisaged at this juncture is rent and water rates. A reasonable figure may be 6 ^{2}/3% of capital outlay on community i.e. £54,000 for an output 1.0m. t.p.a., £80,000 for 2.5 m.t.p.a. and £104,000 for 4.0m.t.p.a. the corresponding charges per ton of pellets being 2.2/-, 3.2/- and 4.2/-.

Total revenue thus becomes £5.19.0 to £6.1.0 which are the figures used in Figs. 2 and 3.

APPENDIX E

NOTES ON AN OPERATION AT WARRAMBOO FOLLOWING CESSATION OF MINING AT GREENPATCH

It is clear from the operating costs set out in the summary table in section 7 that the low grade - high output operations need little further consideration. Consequently the scale of operations selected for investigation at Warramboo, following the break even operation at Greenpatch based on 1.3m t.p.a., are in the range 1.2, 1.55 and 2.2m t.p.a. corresponding with grades 45% Fe, 35% Fe and 25% Fe.

The capital costs will in general be pro rata those for Warramboo on its own.

The results are shown graphically in Fig. 3.

The capital charge in operating costs is based on the additional capital only. This follows from the assumption that the capital represented in buildings, plant, and equipment at Greenpatch has been completely written off or paid back to the shareholders. Actually, if all these items are to be used again for the operation at Warramboo they must still have considerable asset value.

FIGURE 3
SUMMARY of OPERATING COSTS - WARRAMBOO ALONE, WARRAMBOO AFTER GREENPATCH

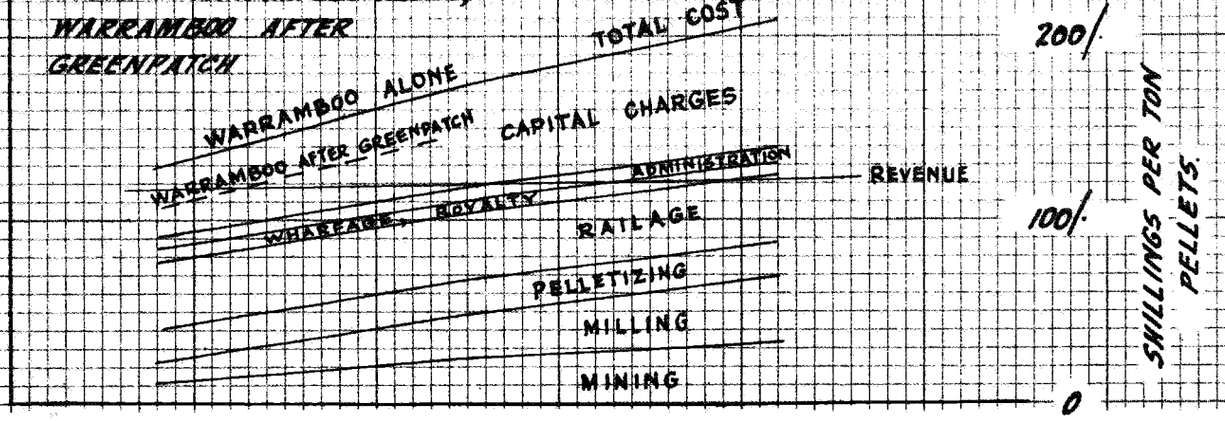


FIGURE 2
SUMMARY of OPERATING COSTS - GREENPATCH

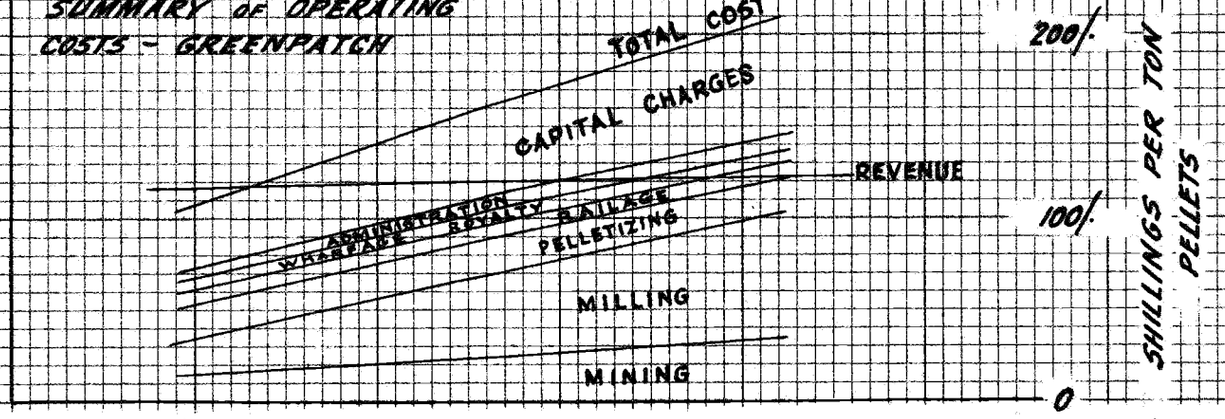
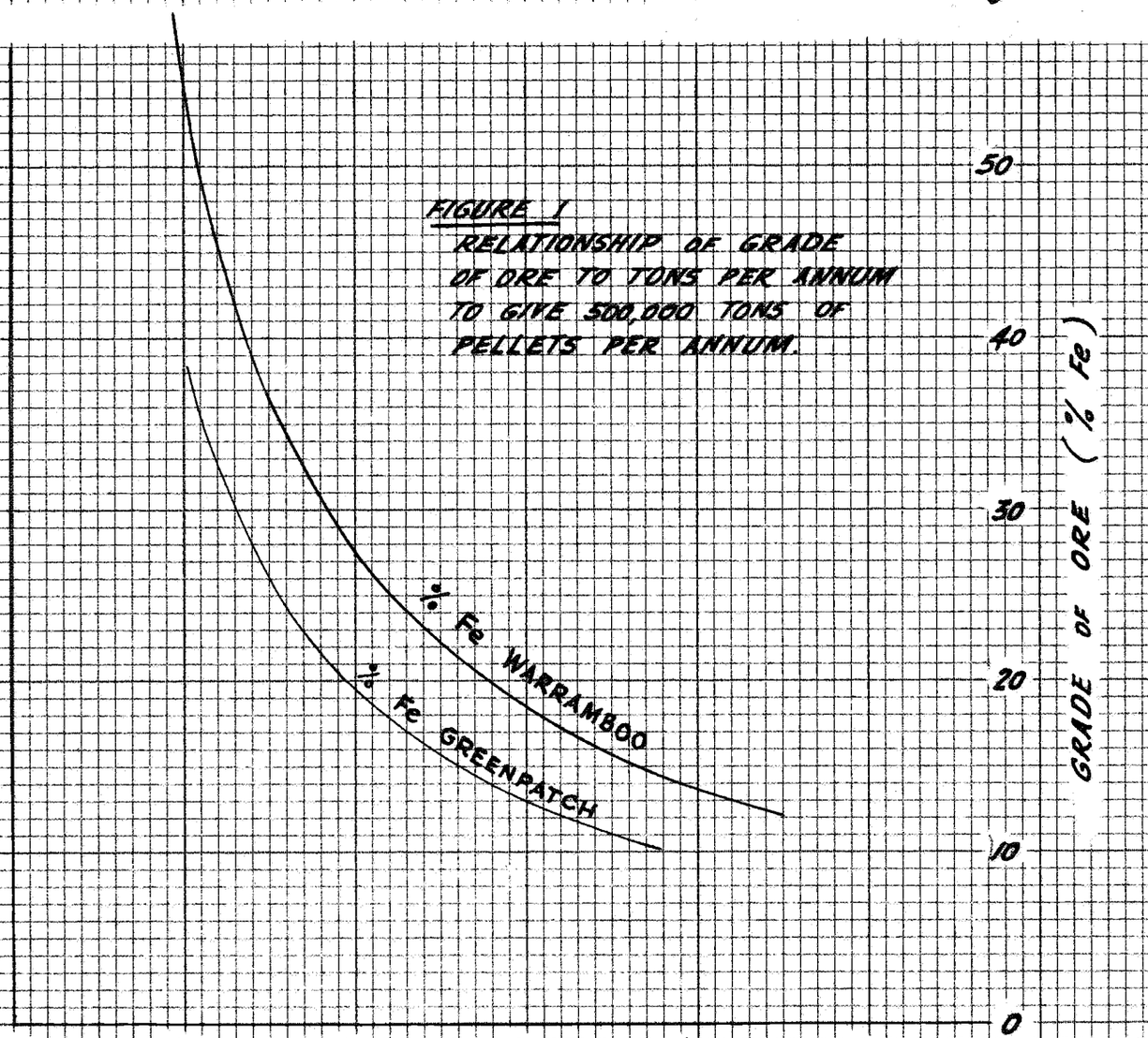


FIGURE 1
RELATIONSHIP of GRADE of ORE to TONS PER ANNUM to GIVE 500,000 TONS of PELLETS PER ANNUM.



S·3577
DH+m

To accompany report by A. H. Dutton.

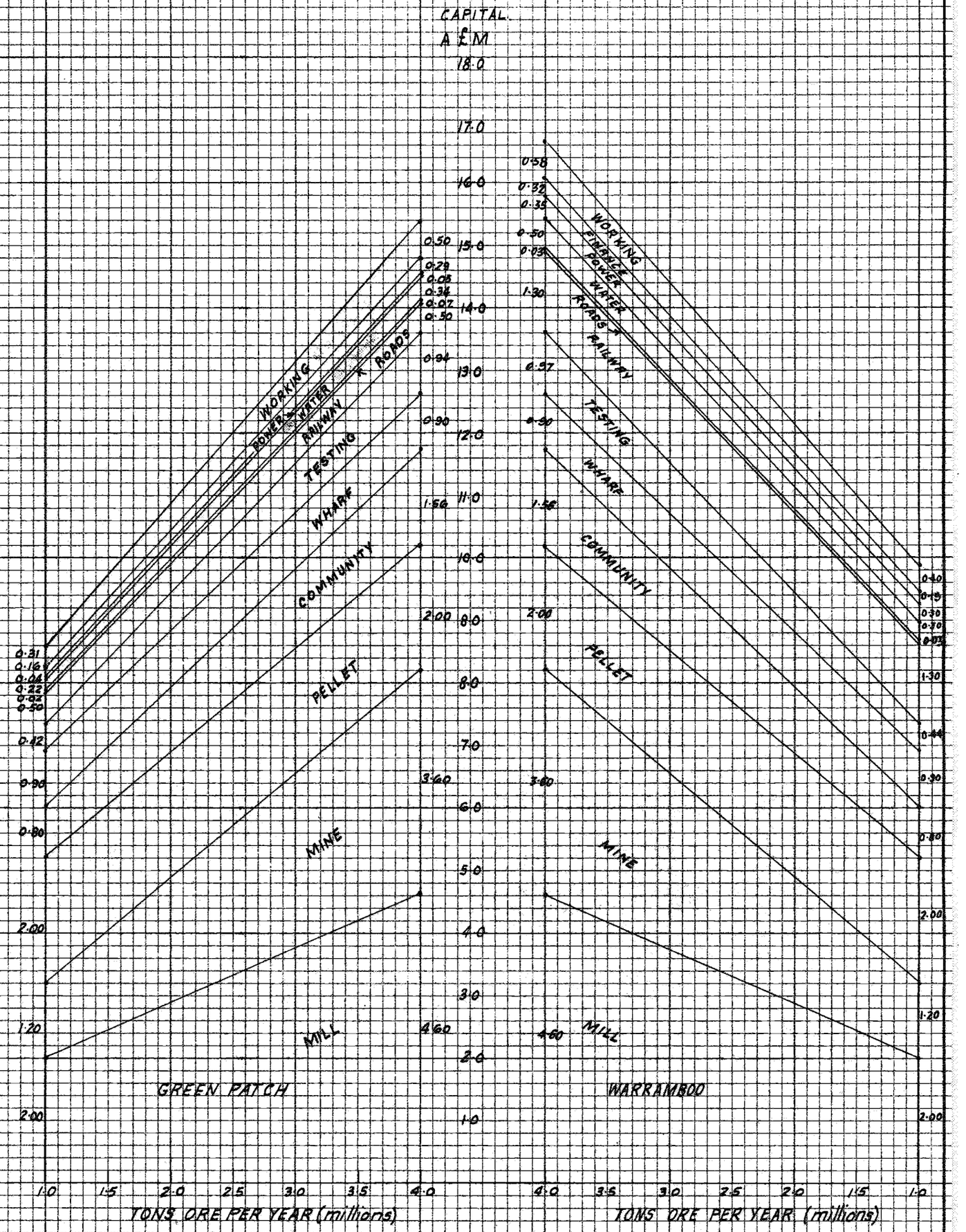


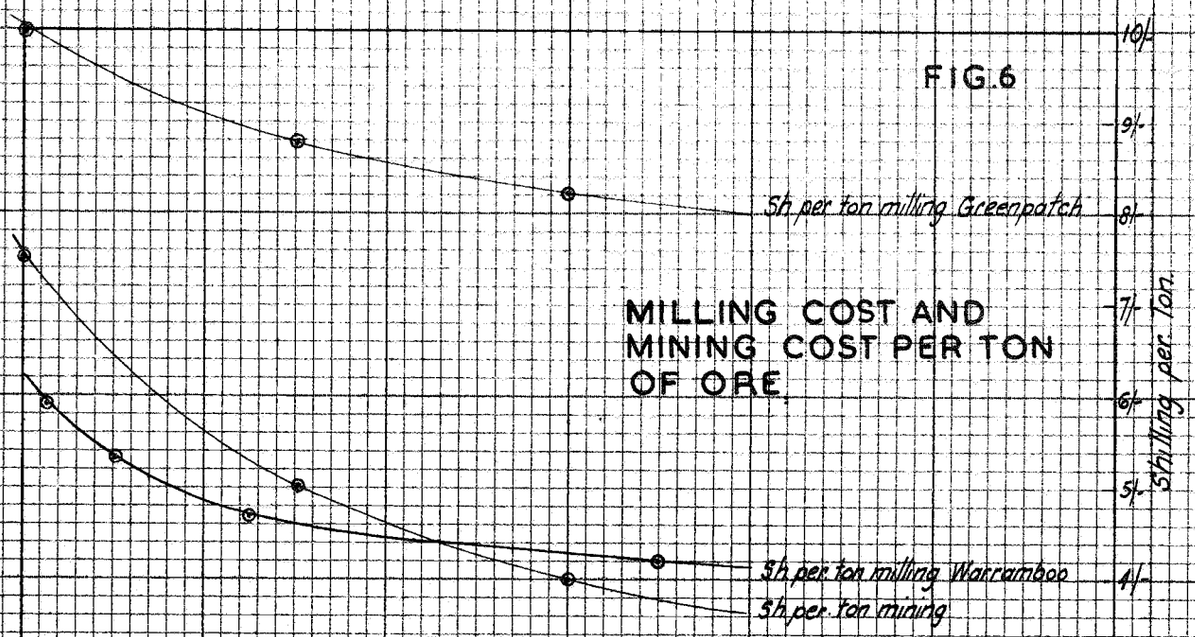
FIG. 4

S.A. DEPT. OF MINES
WARRAMBOO AND GREEN PATCH
SUMMARY OF CAPITAL REQUIRED

S3575
DH +n

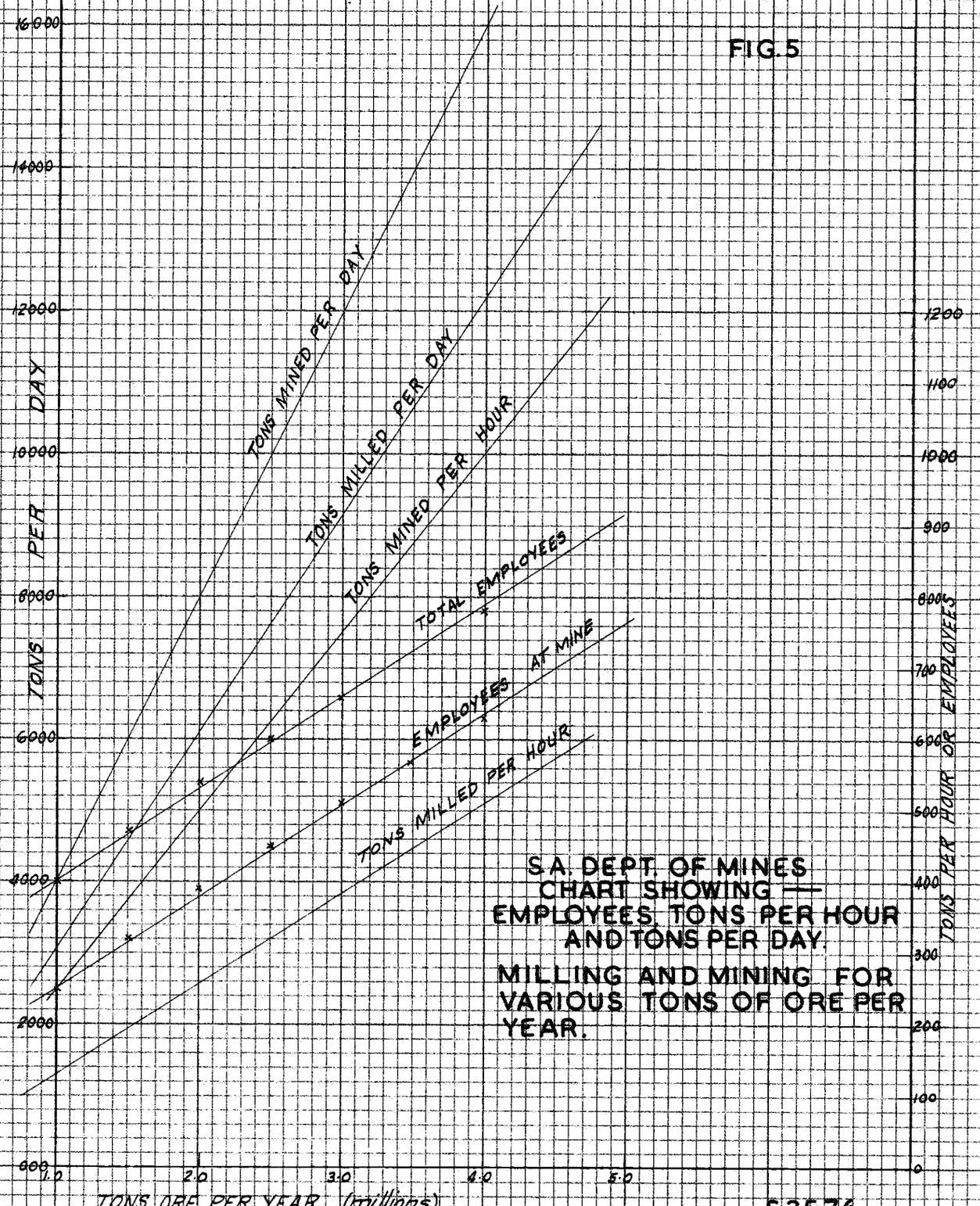
To accompany report by A.H. Dutton 6-2-64

FIG.6



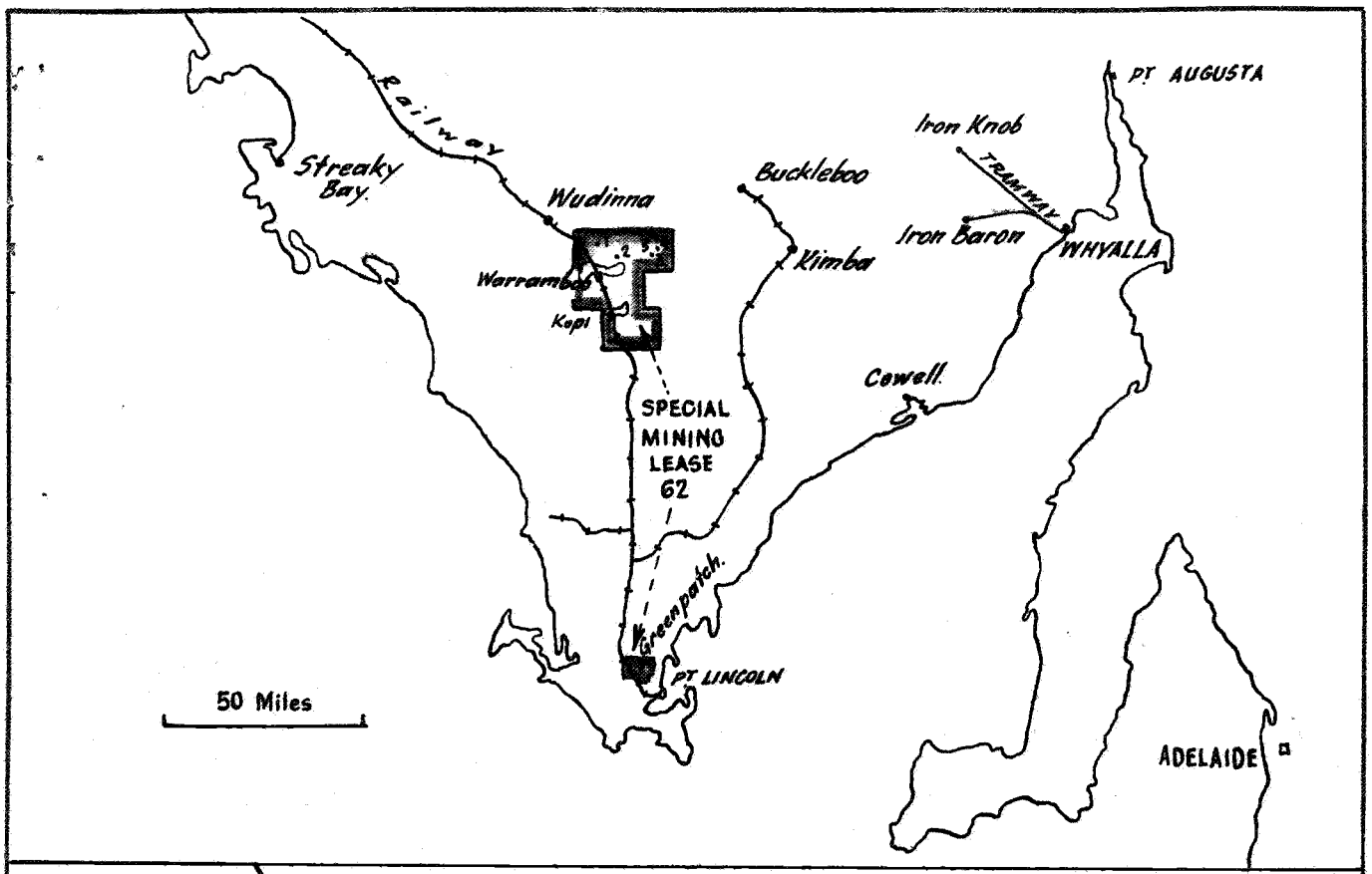
MILLING COST AND MINING COST PER TON OF ORE.

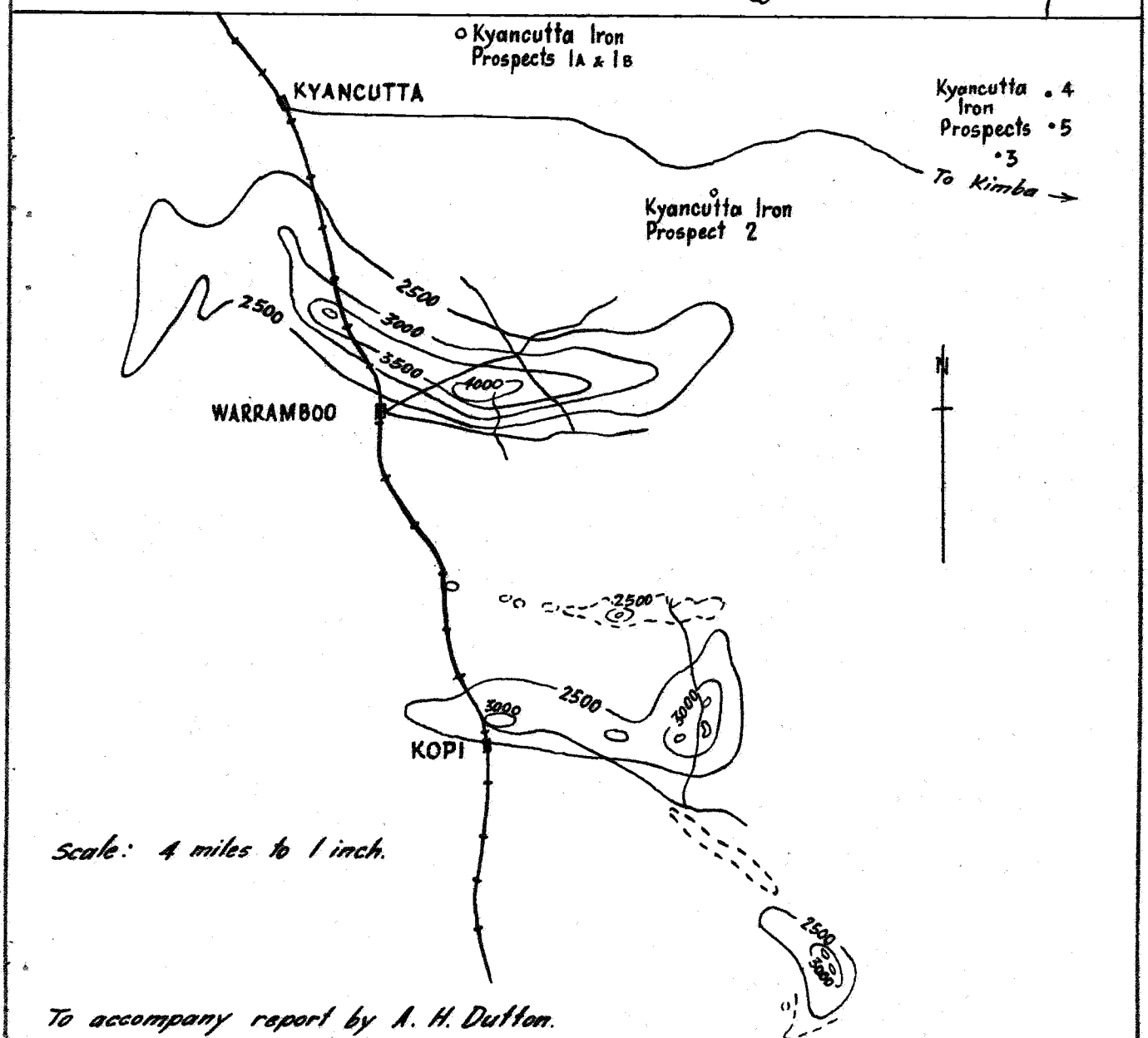
FIG.5



S.A. DEPT. OF MINES
CHART SHOWING —
EMPLOYEES, TONS PER HOUR AND TONS PER DAY.
MILLING AND MINING FOR VARIOUS TONS OF ORE PER YEAR.

S3576
To accompany report by A.H. Dutton Dh+m 6-2-64





To accompany report by A. H. Dutton.

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	LOW GRADE DEPOSITS OF IRON ORE ON EYRE PENINSULA	D.M.	Scale as shown.
		Tcd.		Req.	S.3578
		Ckd.			
Director		Exd.			Date 7.2.64 Dhm

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