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Tasmania

DEPARTMENT OF MINES

---

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Report of Tasmanian Shale  
Oil Investigation  
Committee

ISSUED UNDER THE AUTHORITY OF  
THE HONOURABLE CLAUDE E. JAMES,  
MINISTER FOR MINES FOR TASMANIA



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# Tasmanian Shale Oil Investigation Committee

Hobart, 5th November, 1932.

The Hon. the Minister for Development,  
Canberra, F.C.T.

SIR,

THE Committee set up by the Commonwealth Government to report upon the Shale Oil Industry in Tasmania has the honour to submit the following report:—

The Committee was constituted as follows:

Hon. CLAUDE JAMES, M.H.A., Minister for Mines for Tasmania, Chairman.	} Nominated by Common- wealth Government.
MR. H. W. GEPP,	
MR. A. AIKENHEAD,	}
MR. J. B. SCOTT, State Mining Engineer,	
MR. P. B. NYE, Government Geologist,	} Nominated by Tasmanian Government.
MR. S. S. B. PURVES, Goliath Portland Cement Company Limited,	
MR. C. O. CHAMBERS, Australian Shale Oil Corporation Limited,	
MR. T. M. JUDE, representing Australian Workers' Union.	
MR. H. W. REES, representing Coal and Shale Miners' Federation of Australia.	

## REFERENCE.

The Committee was requested to report as to the obstacles in the way of the development of the industry, and to state whether these obstacles could be overcome, and, if so, what means should be employed for the purpose.

The first meeting was held at Hobart, on 15th January, 1931. The Hon. A. Blakeley, Minister for Home Affairs, attended the meeting, and outlined the Commonwealth Government's attitude towards the development of the industry. The Committee held six full committee and a number of sub-committee meetings. Members visited the works in the Railton-Latrobe area, and inspected the plant of the companies operating there.

The Committee had the advice and reports of technical officers as regards the mining, retorting, and economic side of the industry.

The Committee, after inspecting the Railton-Latrobe area and fully discussing the position, was of the opinion that an amalgamation of the interests operating in the area would materially assist in the development of the industry; a recommendation to this effect was submitted to those concerned, and an agreement has been completed whereby the following have amalgamated with the Tasmanite Shale Oil Company Limited:—

The Railton-Latrobe Shale Oil Company No Liability.

The Goliath Portland Cement Company Limited.  
Mineral Oils Extraction Limited.

Frank Richards and  
Robert Henry Crozier.

The other company operating in the area, viz., the Shale Oil Demonstrating Company Limited, decided to operate independently.

#### NECESSARY STEPS TO ESTABLISH THE POSSIBILITIES OF THE INDUSTRY.

The general knowledge of the deposits; the past experience in mining, retorting, and refining; the production of marketable products; and the deliberations of the Committee—have tended to show that certain steps are desirable in order to establish

the possibilities of the industry. The main points are included in the following list:—

(1) Prospecting of the deposits to prove their extent, and, if possible, the quality of the shale in the different areas. This would necessitate the putting down of a considerable number of bore-holes, or, where conditions are suitable, the sinking of shafts.

(2) Location of the existence or not of large faults in each area. This is necessary in order that mine workings could be laid out to advantage. The prospecting in (1) would achieve the greater part of this work, but closer drilling might be necessary in areas where faults likely to affect mining operations are present.

(3) *Retorting*.—It has been shown that the Tasmanite shale can be retorted efficiently in the 12-ton Crozier retort for the production of crude oil. This retort has operated continuously during the last nine months, and accurate records and figures kept. (See Mr. Walker's report: Appendix 5.) Further work should be done in order to confirm or otherwise—

(a) The actual efficiency under normal operating conditions over long periods of working. This would necessitate accurate records being kept of throughput, assay value of shale, recovery of crude oil, &c.

(b) The *operating* and *total* costs of retorting under larger scale conditions.

It has been stated that a Pumpherson retort has treated a few hundred tons of Tasmanite shale, but figures have not been made available to the Committee as to the results, and in the absence of

figures no comparison can be made between the Crozier and Pumpherson retorts.

(4) *Refining*.—Although it is known from experience that the crude oil yields petrol, kerosene, diesel oil, fuel oil, and bitumen, there is still scope for much more work on refining methods, and yields of the products.

(5) *Testing the Marketable Products*.—The petrol and kerosene contain a relatively large percentage of sulphur. These products can be, and have been, used in internal combustion engines, without any apparent ill-effects on the engines. It is, however, desirable that observations be made either in laboratory engines or others to determine if any effects are apparent after prolonged use of the shale oil products.

(6) *Wages*.—The question of wage rates make an important difference to all costs in the shale industry, but particularly that of mining. Any agreement on this matter would therefore enable the future possibility of the industry to be more accurately determined.

(7) *Accurate Records and Estimates*.—Investigation of the above six factors, but particularly (3), (4), and (6), would enable reliable figures to be obtained for the costs of retorting, refining, and mining, and thus permit of the preparation of reliable costs for the various parts of the shale oil industry. Moreover, the investigations in accordance with (4) and (5) would enable the amount and nature of the products to be determined, and thus permit of the probable income being calculated. With both sets of figures available, the possibilities of the industry could then be properly investigated.

## RECOMMENDATIONS.

The Committee recommends—

That of the sum of £100,000 set aside by the Federal Government for the rehabilitation of unemployed miners—which sum was subsequently vested in the Shale Oil Development Committee Limited—£25,000 be allotted as Tasmania's share for the development of the shale oil industry in this State.

That the first expenditure be incurred on a thorough drilling of the properties of the Tasmanite Shale Oil Company in the Railton-Latrobe area to determine the quantity and quality of the shale there, and that a sum of £2000 be made available immediately to cover the cost of this drilling.

In support of these recommendations, and in explanation of the conclusions herein set out, the Committee submits herewith detailed information under the following headings:—

Tasmanite Shale Fields.

History of Attempts to Establish the Shale Industry in This State.

Mining.

Retorting of Tasmanite Oil Shale.

Refining of Tasmanite Shale Oil.

Marketable Products.

Marketing and Economic.

The Committee acknowledges the help of those who supplied information and technical data, and appreciates the courtesy of the Council of the University in making available the services of Messrs. T. Hytten, M.A., Professor of Economics, and E. E. Kurth, B.Sc., Lecturer in Chemistry; the Broken Hill Proprietary Collieries Limited, for the assistance of Mr. G. M. Hindmarsh; and the Cornwall Coal Company, for the services of Mr. C. F. S. Hood. The various shale oil companies were also good enough to afford all necessary information regard-

ing their operations. As Minister for Mines, I record with appreciation the work of Mr. P. B. Nye, M.Sc., B.M.E., Government Geologist, who gave attention to various technical matters coming within the scope of the enquiry. Mr. E. Boyes, M.C., of the Chief Secretary's Department, also assisted the Committee throughout the enquiry, and discharged his duties of Secretary in a competent and satisfactory manner.

I have the honour to be,

Sir,

Your obedient Servant,

CLAUDE JAMES,

Minister for Mines, Chairman.

# The Oil Shale Deposits of Tasmania.

## I.—INTRODUCTION.

THE oil shale fields of Tasmania occur in the north, central, and north-western parts of the State, and the various fields are shown on the attached map of the State. (Appendix 1.)

Two distinct types of oil shale occur, viz., the Tasmanite oil shale, and the black "oil shales" of Preolenna and Barn Bluff (pelionite). Of these the Tasmanite shale is by far the more important, as it—

- (1) Has by far the greatest known extent.
- (2) Occurs in a seam which, being approximately 5 feet in thickness, is of workable dimensions.
- (3) Yields sufficient crude oil on distillation to render its treatment a possible economic success.
- (4) Has been subjected to a large amount of testing.

The "kerosene shale" of Preolenna and the "pelionite" of Barn Bluff yield a higher amount of oil on distillation, but the seams are extremely thin and of limited extent, as they occur as lenticular beds in seams of coal. They therefore offer no possibilities of economic exploitation, and need not be further considered in this report.

## II.—THE TASMANITE SHALE FIELDS.

### A.—GEOLOGY.

The bed of Tasmanite shale occurs at the horizon of the Greta series of the Permo-Carboniferous system, being interbedded between the Lower Marine and Upper Marine series.

The rocks of this system are horizontal or dip at low angles. Folding is absent, but faulting on a large scale is prevalent. The system has been intruded on an extensive scale by dolerite (diabase), and much of the faulting is associated with these intru-

sions. As a result of this geological structure, the Permo-Carboniferous rocks (and the contained Tasmanite shale, when present) occur as a number of more or less separate blocks at different altitudes, the blocks being separated from the neighbouring ones by faults or dolerite intrusions.

The Tasmanite shale bed does not occur throughout the Greta series, but at certain localities only. At other localities its place is taken by a coal seam.

#### B.—DISTRIBUTION. (See Appendix 2.)

The Tasmanite shale fields are restricted to the north, central, and north-western districts. They occur mainly in the Latrobe-Quamby Bluff region, with an outlying field in the vicinity of Oonah, some 40 miles to the west. In the Latrobe-Quamby Bluff region the shale occurs in 13 separate fields or areas, over a length of 27 miles and a width of 7 miles. Eight areas occur between Latrobe and Merseylea, and represent the most closely spaced portion of this region. Outlying areas occur at Nook, Beulah, Kimberley, Chudleigh, and Quamby Bluff. Of the above eight areas, six occur between Latrobe and Railton, and attention has been restricted mainly to these in the past attempts to establish a shale oil industry.

The 13 fields or areas are shown on the attached plan (Appendix 2), and numbered from I. to XIII., in accordance with the following list:—

#### Area.

- |                              |   |                                 |
|------------------------------|---|---------------------------------|
| Latrobe-<br>Railton<br>Field | } | I.—Northern Area.               |
|                              |   | II.—North of Great Bend.        |
|                              |   | III.—West of Great Bend.        |
|                              |   | IV.—South of Great Bend.        |
|                              |   | V.—China Flat or Railton Area.  |
|                              |   | VI.—Parramatta Area.            |
|                              |   | VII.—Native Plain Area.         |
|                              |   | VIII.—Merseylea-Kimberley Area. |
|                              |   | IX.—Kimberley-Moltema Area.     |
|                              |   | X.—Nook Area.                   |
|                              |   | XI.—Beulah Area.                |
|                              |   | XII.—Chudleigh Area.            |
|                              |   | XIII.—Quamby Brook Area.        |

### C.—THICKNESS AND SECTION OF THE SHALE SEAM.

The seam of shale has a thickness ranging up to 6 feet, but it generally does not exceed 5 feet, and in some of the areas it appears to be less. General information for the areas is given in Table No. I., while definite figures for the seam in the Tasmanite and Goliath Mines are given in Table No. III. The latter table shows that the average thickness in the Tasmanite Mine is 5 feet 0·62 inches, and that in the Goliath Mine is 5 feet 2·5 inches.

The seam usually consists of three distinct portions, viz., top shale, middle band, and bottom shale. At a few places another thin bed of shale may occur above or below the seam, but this occurrence is exceptional, and it can generally be disregarded. Each section of the seam has a considerable range in thickness, but in general the top shale is the thickest, and the middle band is the thinnest. The only definite figures available for the thicknesses of the section are those obtained during the sampling campaign, the average figures for which are given in Table II., for the Tasmanite and Goliath Mines, viz.—

	Top Shale.		Middle Band.		Bottom Shale.	
	ft.	in.	ft.	in.	ft.	in.
Goliath	2	2·99	1	2·55	1	8·95
Tasmanite	1	10·93	1	4·20	1	9·48

For general purposes, in the Goliath and Tasmanite Mines and adjacent areas it can be assumed that the shale seam has a thickness of 5 feet, made up of 4 feet of shale and 1 foot of middle band.

Number of Area.	DEVELOPMENT.			Workings.	Thickness of Shale (Feet).	Known Depth to Shale (Feet)
	Outcrops.	Shafts in Shale.	Bore-holes in Shale			
I.	3	1	Nil	Nil	4 ft. assumed (without band)	18 ft. in shaft
II.	Numerous along bank of River Mersey	Nil	6	2 (Main)	3.5 ft. to 6 ft. 5 ft. shale (with 1 ft. band)	Max. 286 ft.
III.	Nil	Several	27	1	Average 6 ft. with 1.5 ft. band (assumed 4 ft. without band)	Max. 273 ft.
IV.	Nil	Nil	Nil	Nil	Not known	Not known
V.	1	8	10	2 quarries	Ranged up to 4.5 ft. (general average, 3 ft. to 3.5 ft.)	Max. 153 ft.
VI.	Nil	Nil	3	Nil	1 ft. to 2.6 ft. (average 1.6 ft.)	103 ft. to 177 ft.
VII.	Nil	Nil	3	Nil	Average 2.33 ft. (including 1 ft. band)	160 ft. to 596 ft.
VIII.	Nil	Nil	Nil	Nil	Not known	Probably more than 500 ft.
IX.	Nil	Nil	Nil	Nil	Not known	Not known
X.	1	Several	Nil	Nil	4 ft. to 6 ft.	ditto
XI.	2	Nil	Nil	Nil	4 ft. (assumed)	ditto
XII.	1	Nil	Nil	Nil	Not known	ditto
XIII.	2	Several	2 (?)	Nil	5 ft. (exclusive of 1 ft. band)	ditto

## Shale Fields.

Shale-Bearing Tracts.				Total Tonnage,	Life of Mine in Producing Tons per Day.			
Partly Proved.		Possible Extensions.			338	6	1352	2704
Area.	Tons.	Area.	Tons.					
Acres.		Acres						
...	Small	...	3,000,000	3,000,000	32.8	16.4	8.2	4.1
320	2,400,000	270	2,025,000	4,425,000	48.4	24.2	12.1	6.0
225	1,887,500	217	1,627,500	3,515,000	38.4	19.2	9.6	4.8
...	No	Data	...	...	...	...	...	...
776	4,365,000	...	...	4,365,000	46.2	23.1	11.5	5.8
...	Small	140	420,000	420,000	4.6	2.3	1.1	0.5
...	...	620	2,170,000	2,170,000	23.6	11.8	5.9	2.9
...	No	Data	...	...	...	...	...	...
...	No	Data	...	...	...	...	...	...
...	...	140	1,050,000	1,050,000	11.4	5.7	2.8	1.4
64.5	484,250	248	1,862,500	2,346,750	25.6	12.8	6.4	3.2
...	No	Data	...	...	...	...	...	...
...	Small	500	3,750,000	3,750,000	40.0	20.0	10.0	5.0
				25,041,750	271.0	135.5	67.6	33.7

## D.—DIP OF THE SEAM.

The shale seam is either horizontal or dipping at low angles. The dip in the different areas, and even in different portions of the same area, varies in direction and amount. In the block opened up by the boundary tunnel at the Tasmanite Mine, the dip is to the north at 1 in 10. In the Goliath Mine the dip is to the north-west at 1 in 10. In the Shale Oil Demonstrating Company's mine the dip at the outcrop is to the west, but the boring has suggested a basin-like structure. In the Railton area (V.) a similar basin-like structure appears to be present. In other areas the dip is in different directions, but in amount it does not exceed about 1 in 10.

## E.—NATURE OF THE SHALE.

The Tasmanite shale is light-grey to light-brown in colour, and has the general appearance of an ordinary shale or impure sandstone. The kerogen or oil-producing substance consists of numerous small discs of resinous material (the origin of which need not be discussed here) distributed throughout the shale. The discs are yellow to reddish-brown in colour, and do not exceed 1/32 inch in diameter, their thickness being much less.

The matrix in which the discs are embedded consists of a very fine mixture of quartz sand or silt and clayey material. Detailed analysis of the shale ash (representing the matrix) are given in Table II.

The discs have a specific gravity of approximately 1.1, and the shale as a whole has one ranging from 1.76 for the richest shale to 2.62 for the poorest band. Average figures are given in Table III., and for general purposes the figure for top and bottom shale may be taken as 2.0, and that for the whole seam as 2.1.

The oil yield on distillation depends upon the number of the disc-like bodies in the shale. In the richest shale (59.2 gallons per ton) the amount of kerogen reaches a maximum of 35.9 per cent., while the poorest band (3.6 gallons per ton) contains not more than 7 per cent. of kerogen. The richer shale usually has a laminated structure.

Waterworn pebbles of hard rock types, such as quartz, quartzite, schist, granite, gabbro, dolerite, &c., occur erratically distributed throughout the Tasmanite shale.

TABLE II.  
*Analyses of Composite Samples of Tasmanite Shale.*

	Top Shale.		Middle Band.		Bottom Shale.	
	Goliath Mine. 1C-33C.	Tasmanite Mine. 34C-48C.	Goliath Mine. 1B-33B.	Tasmanite Mine. 34B-48A.	Goliath Mine. 1A-33A.	Tasmanite Mine. 34A-48A.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Registered number.....	1657	1658	1655	1656	1653	1654
Moisture.....	0.13	0.19	0.19	0.36	0.58	0.25
Volatile combustible matter....	24.91	26.45	9.67	8.60	22.15	20.82
Fixed carbon.....	1.54	2.99	0.18	2.02	1.07	3.35
Ash.....	73.42	70.37	89.96	89.02	76.20	75.58
Sulphur.....	2.45	2.82	2.35	2.28	2.80	2.92
Arsenic.....	Trace	Trace	Trace	Trace	Trace	Trace
Antimony.....	Nil	Nil	Nil	Nil	Nil	Nil
Selenium.....	Nil	Nil	Nil	Nil	Nil	Nil
Tellurium.....	Nil	Nil	Nil	Nil	Nil	Nil
Water-soluble lime (CaO)....	0.29	0.05	0.08	0.30	0.47	0.15
Water-soluble sulphates (SO <sub>4</sub> )	0.45	0.37	0.30	0.59	0.74	0.57
Water-soluble potash (K <sub>2</sub> O)...	...	...	0.074	...	...	...
Water-soluble phosphate (P <sub>2</sub> O <sub>5</sub> ).....	...	...	0.002	...	...	...

*Analyses of Shale Ash of Composite Samples of Tasmanite Shale.*

SiO <sub>2</sub> .....	70.11	72.13	70.62	75.12	68.06	72.50
Fe <sub>2</sub> O <sub>3</sub> .....	6.64	6.20	7.00	7.00	7.20	7.46
Al <sub>2</sub> O <sub>3</sub> .....	13.63	16.07	13.00	13.80	12.46	15.30
TiO <sub>2</sub> .....	0.31	0.58	0.34	0.38	0.74	0.30
MnO.....	N.D.	N.D.	N.D.	N.D.	0.03	N.D.
P <sub>2</sub> O <sub>5</sub> .....	0.05	0.05	0.07	0.05	0.16	0.05
CaO.....	2.84	0.42	2.47	0.44	3.98	0.52
Mg <sup>(t)</sup> .....	2.88	1.69	2.20	1.62	2.99	1.47
K <sub>2</sub> O.....	2.48	3.13	2.79	2.31	3.04	3.09
Na <sub>2</sub> O.....	0.86	0.48	0.65	0.65	0.50	0.57
SO <sub>3</sub> .....	1.39	0.44	1.70	0.38	1.78	0.54

## F.—OIL YIELD ON DISTILLATION.

Until the last year or two it was generally assumed that the shale seam (excluding middle band) had an average oil yield of 40 gallons per ton. This figure had been arrived at as a result of the testing of a small number of samples in the laboratory, and such small-scale and large-scale operating tests that had been carried out chiefly on shale from the Tasmanite (old Railton-Latrobe) Mine. More recently the operations of the Crozier retort on the shale from the Goliath Mine appeared to indicate an oil yield of approximately 33 gallons per ton.

In order to determine satisfactorily the oil yield for the information and purposes of this Committee, it was arranged that the Mines Department undertake a systematic sampling campaign.

This was carried out during May and June, 1931, in the Goliath and Tasmanite Mines, the remaining mine (that of the Shale Oil Demonstrating Company) being not available for sampling, as it was filled with water. The seam was sampled at 48 places, 33 samples being taken in the Goliath and 15 in the Tasmanite Mine. The seam was sampled in three sections at each place, viz., top shale, middle band, and bottom shale, making a total of 144 samples. In addition, three samples at six of the places were taken to determine the moisture content. The samples were tested in the Mines Department laboratory, Launceston, and the ash content, specific gravity, and sulphur content of the 144 samples were determined. The oil yield was determined from the ash content by means of a graph prepared by Mr. E. E. Kurth, of the University of Tasmania, as a result of his research on Tasmanite shale during the past five years. Where necessary Mr. Kurth determined the oil yield on distillation of particular samples representing points on his graph not previously tested by him.

The complete details of the samples are given in the reports thereon (Appendices 3A-3D), while a brief summary of the average values is shown in Table III.

TABLE III.

Section of Seam.	Mine.	Sulphur.	Specific Gravity.	Thickness		Oil Yield in Gallons per Ton.
		Per Cent.	Per Cent.	ft.	in.	
Top shale.....	Goliath	2.54	2.00	2	2.99	36.3
	Tasmanite	2.78	1.90	1	10.93	44.3
Middle band.....	Goliath	2.52	2.50	1	2.55	7.2
	Tasmanite	2.54	2.45	1	4.20	8.6
Bottom shale.....	Goliath	2.77	2.10	1	8.95	29.65
	Tasmanite	3.01	2.03	1	9.48	32.7
Top and bottom shale .....	Goliath	2.65	2.04	3	11.95	33.3
	Tasmanite	2.20	1.96	3	8.41	38.5
Whole seam.....	Goliath	2.61	2.15	5	2.50	26.22
	Tasmanite	2.77	2.09	5	0.62	29.12

The average values of each section of the seam for each mine are given in this table. It will be noted that the top and bottom shale (representing that usually retorted) had total oil yields on distillation of 33.3 gallons per ton for the Goliath and 38.5 for the Tasmanite mine. The figures show the difference in oil yield from the two mines, while the individual samples in the tables (Appendix 3D) show an even greater range in values from place to place.

It was therefore proved conclusively that the formerly assumed figure of 40 gallons per ton had to be abandoned (though the figure for the Tasmanite Mine, viz., 38.5, approached it), and that the oil yield would be different at different parts of the shale deposits, and would have to be determined accordingly.

Since the above sampling campaign the Tasmanite Shale Oil Company has carried out in the Crozier retort a number of tests on different sections of the shale from both the Goliath and Tasmanite Mines. These results are shown in the following table, representing a summary of the operations:—

TABLE IV.

	Mine.	Section of Seam.	Tons Treated.	Gallons of Crude Oil.	Average Yield.		Mines Department Sampling Results.
					Run of Mine Shale.	Dry Shale.	
Prior to --							
Test Run 1.....	Goliath	Top and bottom shale	1823	44,265	24.28	...	Partly
Test Run 1 ... ..	Goliath	ditto	1562	32,059	20.46	...	34.8
Test Run 2.....	Tasmanite	ditto	334	10,833	32.43	33.7	38.5
Test Run 3. ....	Tasmanite	ditto	327.6	9,983	...	35.12	38.5
Test Run 3A.....	Goliath	Whole seam	189.4	4,201	22.2	22.7	26.22
Test Run 3B.....	Goliath	Top and bottom shale	139.2	4,091	29.4	...	33.3

It will be readily seen from the above figures that Test Runs 2, 3, 3A, and 3B generally confirm the sampling figures (allowing for a recovery in the Crozier retort of approximately 85 per cent.).

It is obvious, therefore, that no general figure can be arrived at for the oil yield of the shale, but that it will have to be determined for each area, and even different portions of the same area.

#### G.—RESERVES.

In the past the estimates of reserves have been made largely on geological evidence, assisted by such drilling and developmental works that had been carried out. However, the latter were not important factors, and so geological data had to be relied on. While such methods have their greatest application and accuracy in the case of bedded deposits such as coal and shale, they cannot be regarded as establishing "proved" reserves, but rather as indicating the extent of the seam. Nor can such methods be regarded as establishing reserves possibly suitable for economic exploitation, as thinning of the seam, low oil yield, &c., might render them unprofitable to mine and retort.

The position to-day is much the same as regards prospecting, drilling, and development, so that calculation of "proved" reserves is still impossible. For this reason the reserves in the reports for the Mining Sub-Committee were described as "partly proved" and "possible extensions." The "partly proved" includes all reserves in which mine openings, outcrops, bore-holes, and shafts assist in the determination of same. The "possible extensions" include the reserves in areas in which there is reason to believe, from geological evidence, that the shale exists, but which have not been prospected.

All the available information is contained in Table I. It will be noted that some of the areas have either not been prospected at all, e.g., Chudleigh (XII.), or to only a slight extent, e.g., Areas I., IV., VII.-XIII. If thoroughly prospected and tested, these fields would add considerably to the total reserves. At the same time such development might in some areas prove that the seam is too thin

to mine economically, or that the oil content was too low to enable the shale to be mined and treated profitably, which would reduce the proved economic reserves.

From Table I. it will be seen that in the Latrobe-Quamby Bluff district the "partly proved" reserves are 9,136,750 tons, and the "possible extensions" 15,905,000 tons, making a total of 25,041,750 tons. In the Oonah district the shale has a possible extent equivalent to 6,000,000 tons. These figures are calculated upon the basis that 1 acre-foot of shale contains 1875 tons, the specific gravity being taken as 2 and 25 per cent. allowance made for losses.

#### H.—MOST FAVOURABLE AREAS IN WHICH TO START OPERATIONS.

The factors determining the most favourable areas in which operations could be started are numerous, and include amount of development work, reserves, thickness of seam, oil content of seam, and the spacing of the areas.

As already noted above, the shale areas are most closely spaced in the Latrobe-Railton district, six areas being included in this district. It will be noted from Table I. that this district includes Areas II., III., and V., in which the "partly proved" reserves are greatest, as more developmental work has been carried out. Also, these areas have shale of workable thickness, and with an oil yield which may enable the shale oil industry to be profitably conducted. Thus, from every point of view, these three areas are the most favourable ones in which to start operations. Further, Area I. is in close proximity to these areas, and has a large "possible extension," and thus affords other possible reserves in the Latrobe-Railton district.

#### III.—BRIEF HISTORY OF ATTEMPTS TO ESTABLISH THE SHALE OIL INDUSTRY IN TASMANIA.

The first attempt to establish the shale oil industry was made in 1901, when the Tasmanian Shale and Oil Syndicate of Adelaide had its shale-bearing lands

examined by Dr. Black and Mr. Esdaile. The following year the Tasmanian Shale and Oil Company No Liability was formed, and the above two investigators carried out extensive laboratory tests as to amount of oil to be obtained from the shale and the products to be derived from the crude oil.

A further important step was taken in 1910, when another company of the same name as the above began operations. This company erected the first retorts, which were four in number, and of a type similar to those patented by the manager, W. J. Hall, and erected by him in New South Wales. While the retorts were being erected, laboratory tests were carried out in Launceston. The retorts were designed to treat 4 or 5 tons of shale daily, and it is stated that 20 tons of oil were produced.

In the same year the Latrobe Shale Oil Company No Liability was formed, and while an important drilling campaign and mining operations were carried out, no retorts were erected. At the end of the year Admiral Sir Reginald Henderson, who was reporting upon the defence of Australia, visited the field and plant to ascertain their importance and advantages from the defence point of view.

The operations of the Hall retort do not appear to have been successful, and in 1912 a new company—Railton-Latrobe Shale Oil Company No Liability—was formed, and took over the property. A new retort was tested, and stated to be satisfactory, and the old retorts were scrapped. By 1914 there were four vertical and two horizontal retorts with condensing and refining plant, the capacity being 250-300 gallons of crude oil per day. In 1915 it was reported that 24,000 gallons of crude oil was produced from 600 tons of shale.

During 1915 a proposal was made that the State Government should purchase the property and interests of the Railton-Latrobe Shale Oil Company, with the object of carrying on the shale oil industry. The proposal was referred to the Parliamentary Standing Committee on Public Works for investigation and report. At the same time Dr. Arthur Wade was called in to report on the "Financial Position, Requirements, and Pros-

pects of the Railton-Latrobe Company." The question of acquiring the property and interests was discussed in Parliament, and defeated in the Legislative Council. Interest in the industry generally lapsed during the remainder of the war period, but revived some time after the war.

The drilling for liquid petroleum by the Mersey Valley Oil Company and the Adelaide Oil Exploration Company intersected the shale bed in numerous localities, and added greatly to the information in connection therewith.

The Southern Cross Motor Fuel Proprietary Limited was formed in 1922, and began experiments with a retort of the Schultz type. The company underwent reconstruction about 1925, and experiments continued with the MacPherson type of retort. These tests continued until 1928, but apparently without success. The property was then taken over by the Tasmanite Shale Oil Company Limited, and trials carried out in a Long retort for two years. This retort was not successful, and the MacPherson type was reverted to. A quantity of crude oil was produced, but no refining carried out.

The Tasmanian Cement Company was formed in 1922, and in addition to cement became interested in the oil shale. Experiments were carried out in a retort designed by Mr. Stone, the manager, but were not successful. In 1928 the company was reconstructed as the Goliath Cement Company, and arrangements were made with Mineral Oils Extraction Limited to test the shale in the Crozier retort.

In 1925 the Australian Shale Oil Corporation became interested in the Tasmanian shale deposits. An agreement was entered into with the State Government whereby certain parts of the shale areas were reserved to the company, which had, in turn, to erect a plant and undertake retorting, &c. The company erected Bronder retorts, and began operations near Latrobe. Large-scale units were erected, and during 1927 60,000 gallons of crude oil were produced. Difficulties arose, and operations ceased. Later arrangements were made whereby L. & N. (Tas.) Limited, an offshoot of L. & N. Brown Coal Company Limited, of England,

would test their retort. One retort was erected, but operations were suspended. Still later the property was taken over by the Shale Oil Demonstrating Company, which has during the present year erected a Scotch (Pumpherstons) retort, and treated several hundred tons of shale in it.

As a result of the recommendation of this Committee, all the existing companies and individuals (shale owners and lessees, operating companies, &c.), with one exception (the Shale Oil Demonstrating Company), have amalgamated as the Tasmanite Shale Oil Company Limited. This company has continued its testing campaign with the retorting of shale in the Crozier retort, and the refining of the crude oil. Since its installation until 7th October, 1932, the Crozier retort has treated 5417 tons of shale from two mines and different sections of the seam, and has produced 119,314 gallons of crude oil.

The present position is that the Tasmanite Shale Oil Company Limited is retorting shale in the Crozier retort, while the Shale Oil Demonstrating Company has a Scotch retort erected, but is not operating same.

The total amount of crude oil obtained is shown in the following table (based on available records in the Mines Department and information supplied by the companies) :—

Year.	Company.	Gallons.
1910.	Tasmanite Shale and Oil Company	4,800
1915.	Railton-Latrobe Shale Oil Company	
	No Liability .....	24,000
1927-28.	Australian Shale Oil Corporation .....	65,000
1930.	Goliath Portland Cement Company .....	20,101
1930.	Tasmanite Shale Oil Company Limited	35,000
1931.	Goliath Portland Cement Company .....	15,876
1931.	Tasmanite Shale Oil Company .....	17,611
1932.	Tasmanite Shale Oil Company .....	65,726
	(to 7th Oct.).	
		248,114

## IV.—MINING.

## A.—GENERAL.

From the above descriptions it will be noted that the Tasmanite shale occurs as a seam dipping at angles not exceeding 1 in 10. The problems of mining are therefore analogous to those of coal-mining.

The shale seam outcrops in a number of the areas, but on account of its dip and the topography it attains a depth ranging up to several hundred feet. Open-cut mining would therefore not be capable of general application, and it is also reasonably certain that, even along the outcrops, areas of sufficient extent do not exist to enable open-cut mining to be carried out on an economic basis.

As the shale outcrops in many of the areas, the facilities are therefore favourable for mining from adits. This method has been adopted in all the existing workings, and, where possible, mining has been carried on from "strike" adits; but in other cases mining from "dip" adits has been resorted to. If extensive mining operations are attempted, however, from adits, the main openings in practically every case will have to be "dip" adits. Adit-mining could be carried out wholly or partly in Areas I., II., III., V., VI., X., XI., XII., and XIII.

In certain areas (VII., VIII., and IX.), and probably in parts of other areas, mining from shafts would have to be resorted to.

As regards the actual underground methods, the "bord and pillar" method would be applicable under all circumstances. The presence of faults and the probable inapplicability of cutting machines limit the possibilities of using longwall methods, particularly "longwall advancing" ones. When, however, any large area of shale was thoroughly developed by adits, drives, &c., the possibility of applying a "longwall retreating" method could then be considered.

The presence of numerous pebbles of hard rock-types (quartz, quartzite, granite, &c.), distributed irregularly throughout the shale, roof, and floor prohibit the use of coal-cutting machines.

## B.—COSTS.

The mining costs represent the most important factor in the development of the shale oil industry.

All mining up till the present has been on a relatively small scale, and the costs thereof give only a general idea of those likely to be attained in larger scale mining. This is due to two main factors, which have opposite effects on the costs. The most important of these is that mining has been carried on under almost ideal conditions near the outcrop, with little or no expenditure for drainage, haulage, ventilation, &c., and consequent low costs. On the other hand, the small-scale mining causes the proportion of certain overhead charges to be high, and generally does not permit of cheap methods of mining, transport, &c. The exact costs are not known, but generally ranged from 8s. to 10s. per ton of shale. Estimates of total costs given by the companies for mining on a larger scale range from 9s. to 10s. 9d. per ton.

Detailed estimates of costs for mining 680 tons of shale per day are given in the attached report of the Mining Sub-Committee (Appendix IV.). The estimates were prepared by Mr. G. M. Hindmarsh, Manager, Elrington Colliery, N.S.W., and generally approved of by Mr. C. F. S. Hood, Manager, Cornwall Coal Mine, Tasmania. Two estimates are given, according to whether the middle band (which has to be mined) is to be retorted or left in the mine. The wages used in estimating are the ruling rates under the existing Coal and Shale Miners' Federation Award. It must be pointed out, however, that the present rates being paid at Latrobe are considerably lower than the above rates, and that if such were used the costs would be considerably reduced.

The estimates are—

- (1) When middle band is retorted, 7s. 10d. per ton.
- (2) When middle band is left in mine, 9s. 6d. per ton.

The hewing rate for the whole seam is estimated as 3s. 9d. per ton, but when the band is left in the mine the cost has to be applied to a less tonnage,

thus increasing the hewing rate for shale, while it would probably also be necessary to pay slightly higher hewing rates to ensure that the band would be picked out.

### C.—PROBLEM OF THE MIDDLE BAND.

Reference has already been made to this problem as regards the cost of mining. The sampling campaign proved that the middle band was not valueless, as previously thought, but that in the Goliath Mine it yielded 7·2 gallons per ton, and in the Tasmanite Mine 8·6 gallons per ton. Seeing that by retorting the band it will reduce the mining costs 1s. 8d. per ton, and will yield 7 to 8 gallons of oil per ton, it appears worthy of consideration as to whether the band should be retorted or not. If the middle band is retorted, the oil yield per ton will be reduced about 7 gallons, and the retorting cost per gallon of oil increased. The ultimate test is the cost per gallon of crude oil by both methods as determined by the mining and retorting costs.

	Retorting Middle Band.	Leaving Band in Mine.
	s. d.	s. d.
Mining cost per ton .....	7 10	9 6
Retorting cost per ton (say) .....	5 0	5 0
Total costs per ton .....	12 10	14 6
	Gals. per ton.	
Total oil content .....	27·01	34·66
Oil yield (85 per cent. recovery) .....	22·96	29·46
	d.	
Cost per gallon .....	6·7	5·9

The above figures show that it would not be economical to retort the middle band. It is assumed, however, that all the band has been kept separate from the shale. This could not be attained in practice, and some, if not all, of the finer material of the band, when broken, would be mixed with the shale, and sent to the retort. This would bring the above costs closer to one another, and warrant an extensive test in practice.

## D.—FAULTING.

The faulting of the shale seam has to be considered in connection with the mining. The small faults with a few feet of a displacement do not seriously inconvenience the mining of the shale, unless they happen to be very closely spaced, which, however, is exceptional. The larger faults have a greater effect, and in many cases will require different mine openings or levels for each faulted block.

In order to lay out the mines to advantage, particularly for large-scale mining, it is essential that—

- (1) Drilling be carried out in each area or shale field, in order to generally locate the larger faults, and thus outline the different blocks in which the shale occurs at different levels. The number of mine openings and general scheme of mining can then be decided.
- (2) The main headings, or a drive corresponding to same, be driven right to the boundary of each block. This will reveal most of the minor faults, and any changes of dip, and will enable the general scheme of underground mining to be determined with advantage.

V.—RETORTING OF TASMANITE OIL  
SHALE.

## A.—GENERAL.

(By E. E. Kurth.)

The information gained by the sampling of the accessible exposures of shale and the testing of the samples obtained has definitely shown (see Appendix 3) the Latrobe deposit to be a low-grade one, i. e., very few samples contain less than 65 per cent. ash, and the average of the top and bottom seams (excluding the middle band) is approximately 74 per cent. ash. The shale is thus a mixture of, roughly, three parts of mineral matter with one part of organic oil-producing material. Now while from a commercial and national point of view this is unfortunate, yet it makes the retorting of Tasmanite a simple proposition compared with many rich oil shales

which fuse on distillation to a liquid mass, leaving a dense coke-like residue of great hardness. Such rich shales are very difficult to retort. In the Tasmanite shale this dilution with inert mineral matter prevents the caking together of the shale to any great extent and enables retorting to be carried out without serious difficulty. It has been demonstrated during the past several years that, provided sufficient technical ability was applied in the design and management of the retort, the extraction of the oil with a commercial efficiency was quite possible.

#### B.—GENERAL SUMMARY OF RESEARCH.

(By E. E. Kurth.)

While the latter work has been going on, research into oil shale retorting has been carried on at the Hobart Technical College by myself, and a standard method of assay or distillation developed, using a charge of 1120 grams, or slightly under  $2\frac{1}{2}$  lb. With this apparatus the influence of the following factors in distillation has been determined by prolonged study on the one standard sample.

The factors investigated were—

- (a) Size of particle, i.e., minimum dimension of particle.
- (b) Rate of rise of temperature of charge.
- (c) Time of contact of oil vapour and heated residue and surfaces.
- (d) Effect of steam, carbon dioxide, and hydrogen on distillation.
- (e) Effect of other solid substances in the charge, such as limestone and quicklime.
- (f) Thickness of charge in the retort.
- (g) Maximum temperature of distillation.
- (h) Pressure under which retorting takes place.
- (i) Variable efficiency of conversion of kerogen into oil with varying richness of shale.

Space hardly permits to say much about these various headings, but a few brief remarks will indicate the general results:—

- (a) and (b) The greatest amount of oil for any sample of shale is obtained by distilling particles

or pieces of shale not exceeding  $\frac{1}{4}$ -inch in minimum dimension at a fairly fast rate—much faster than commercial distillation—i.e., with the temperature rising 150° C. per hour. Any variation of these conditions, such as slower distillation or using smaller particles or larger lumps, results in a lower oil yield.

(c) The unsaturated character of Tasmanite shale oil makes it very sensitive to decomposition by heat. Contact with hot shale residue at 700° C. for 2 seconds will destroy more than half of the oil. Retort design should therefore avoid anything of this kind.

(d) The effect of carbon dioxide is not favourable to distillation, and hydrogen shows no appreciable advantage. Distillation in steam is of no use in fast laboratory distillations, but for slow distillation at commercial speed of retorting, in which 10 per cent. less oil is recovered compared with optimum conditions [see note under (a) and (b)], the use of ample steam will recover about half of the difference.

(e) The addition of other solid substances to the charge is of no advantage.

(f) Thickness of charge in retort is very important, explaining why commercial yields fall below laboratory yields. The shale is a relatively poor conductor of heat, and in order to supply the heat to volatilise the oil the temperature of the outer layers of shale in the retort must reach a fairly high figure in a commercial retort, so that the oil vapours coming in contact with the hot walls and outer layers of residue are destructively cracked, depositing carbon and making gas. This is the "carbonisation" trouble of which so much has been made. In order to diminish this wasteful cracking, the only cure is to have retorts of comparatively narrow dimensions, and to accelerate the passage of gas from the retort by ample steam.

(g) The maximum temperature of distillation necessary is, in general, not over 480° C.

(h) Retorting under reduced pressure will show somewhat better results than retorting at ordinary pressure, but practically the same results can be secured by using steam to lower the partial pressure

of the oil vapours, and then air leakage, &c., and the other troubles (of reduced pressure distillation) are obviated.

(i) Variable efficiency of conversion of kerogen into oil with varying richness of shale.

At the risk of labouring this point, it is instructive to take account of the way efficiency of distillation falls off with increasing ash content, or, expressed in other words, an appreciable percentage of the non-mineral matter in the shale produces no oil on distillation.

The following table shows the distillation results on a number of samples. Included in the table are the ash content of the shale, specific gravity of the shale, oil yield in gallons per ton, kerogen percentage in shale, and distillation index. The latter figure is the efficiency index of distillation, and is obtained by dividing the oil yield in gallons per ton by the kerogen percentage.

The samples are given in descending order of richness.

TABLE V.

Distillation No.	Description of Sample.	Ash.	Sp. Gr.	Oil Yield in Gals. per Ton.	Kerogen.	Distillation Index
54	Concentrate	24.3	n.d.	136.0	75.7	1.80
38	Top seam	61.9	1.71	65.0	38.1	1.70
15	Top seam	66.5	7.87	52.6	33.5	1.57
37	Top seam	68.3	1.90	45.4	31.7	1.43
41	Top seam	70.0	1.94	44.0	30.0	1.47
51	Top seam	71.3	n.d.	45.9	28.7	1.60
47	Top seam	71.6	1.94	46.2	28.4	1.63
56	Top seam	71.7	n.d.	43.5	28.3	1.53
42	Bottom seam	75.3	2.04	36.0	24.7	1.45
44	Bottom seam	77.5	2.12	30.0	22.5	1.33
34	Unknown	79.9	2.14	23.6	20.1	1.17
48	Bottom	80.2	2.17	27.4	19.8	1.38
58	Whole seam	80.4	n.d.	25.5	19.6	1.30
43	Bottom seam	81.7	2.25	22.8	18.3	1.25
39	Bottom seam	83.5	2.24	16.2	16.5	0.98
40A	Middle band	84.5	2.29	16.5	15.5	1.06
57	Spore free res.	85.5	n.d.	13.5	14.5	0.93
45	Middle band	89.3	2.48	9.6	10.7	0.90
46	Middle band	89.8	2.56	7.5	10.2	0.73
35	Middle band	91.1	2.48	6.4	8.9	0.72
36	Middle band	93.5	2.65	2.7	6.5	0.41

In passing, it may be noted that the grade of shale is, in spite of the possible variation in the ash constituents, very closely related to the specific gravity of the dried shale, and determination of this alone will indicate within a gallon or two per ton the yield of the shale.

The oil yields given above are under the optimum conditions, and represent, except where the samples were unavoidably finely crushed, maximum laboratory yields. If oil yields and distillation indices are plotted against ash content, the former relation is almost a straight line, but intersects the ash axis at about 94 per cent. ash. Poor shales are thus poorer than they apparently are, since 6 per cent. of the weight of the dried shale in addition to the ash is ineffective as regards oil production. The remaining kerogen, after deduction of the 6 per cent., produces oil at the rate of approximately 1.9 gallons per ton per 1 per cent. kerogen. For example—

(1) Shale 66.5 per cent. ash, kerogen 33.5,  
effective kerogen 27.5:

$$27.5 \times 1.9 = 52 \text{ gallons per ton.}$$

(2) Shale 75.3 per cent. ash, kerogen 24.7,  
effective kerogen 18.7:

$$18.7 \times 1.9 = 35.6 \text{ gallons per ton.}$$

As the shale contains at least two kinds of organic material, it is not surprising that this relation should be subject to small variations, but the relation will give the maximum oil yield to within 5 per cent., or closer, in all cases.

When the efficiency of distillation as expressed by the distillation index is considered, this shows only a small decrease from the rich spore case material concentrate of 24 per cent. ash to the richest available shale of 62 per cent. ash. From then on the drop in efficiency is large, with increasing ash content. So that, calculated on the whole kerogen content, distillation efficiency falls off markedly with increasing poorness or ash content of the shale. Thus, instead of a shale of 80 per cent. ash yielding twice as much oil as a 90 per cent. ash shale, it will yield three to four times as much, owing to the poor yield of the 90 per cent. ash shale.

The relation of possible oil yield to the kerogen content of a shale, and the decreasing efficiency of conversion with increase in ash content, has not to my knowledge been appreciated before this work was put in hand, and it is felt that in this one point a definitely valuable contribution to the knowledge of Tasmanite has been made.

C.—RELATION OF COMMERCIAL RETORTING YIELDS TO THE OPTIMUM YIELDS IN THE LABORATORY.

(By E. E. Kurth.)

Work has been carried out on several samples representing steady running conditions in the Crozier retort at Latrobe to obtain the correlating factor between commercial distillation in the Crozier retort and in the laboratory retort. Approximately the same relation holds as between commercial low temperature carbonisation plant and the Gray-King standard assay.

When the Crozier retort is being operated at a throughput within, or at least not above, its capacity, and without using a great deal of steam, a yield of 85 per cent. of the laboratory yield may be looked on as a fair average. By using steam up to the quantity used in the Pumpherston retort possibly 90 per cent. of the assay yields could be obtained. Whether this extra gain of extraction would pay for the extra steam used, extra condensing plant, and other disadvantages would have to be rather closely looked into.

It does not seem possible to duplicate the laboratory results on a large scale, and about 90 per cent., or perhaps a little more, of the laboratory figure represents the commercial maximum.

An irretrievable source of loss is that necessarily caused by the slower heating in a commercial retort. When retort dimensions are increased to a commercial size, the depth to which heat must penetrate is increased, and this of itself entails slower heating. Slow heating has been shown to produce changes in the kerogen material which (on subsequent distillation) reduce the oil yield and increase the proportion of the kerogen left in the retort residue.

The other main source of loss in a commercial retort is vapour phase cracking of the oil vapours by hot retort residue and walls. This effect is greater in a commercial retort than in a laboratory retort. The free use of steam to accelerate flow in the retort will reduce to a small quantity the vapour phase cracking which takes place outside the shale lumps, but has little effect on the cracking which takes place as the vapours diffuse through the lump and pass through zones heated necessarily considerably above  $480^{\circ}$  C. This latter temperature must be reached in the interior of the lump to finish the oil extraction, and the external layers must be much hotter than this in order to transfer heat inwards at a suitable rate.

Distillation in steam cannot, therefore, in commercial retorts equal the laboratory yields on suitably crushed shale heated at the optimum rates. The inter-particle vapour phase cracking can be reduced greatly by its use, but the intra-particle cracking, and necessarily the constitutional changes in the kerogen, are unaffected.

In the survey carried out last year (1931) it must be understood that these yields are laboratory maxima, and that commercial retorting in a well-designed retort cannot, owing to the reasons given, produce much more than 90 per cent. of the assay values. Ordinarily good commercial retorting will produce 85 per cent. of the assay values, and by careless running or lack of knowledge of the shale much poorer yields may be obtained.

The Long retort towards the end of the campaign was producing approximately 65 per cent. of the oil yield obtainable under optimum conditions in the laboratory. This serves to show that retorting of Tasmanite, however well intentioned, can be very inefficient under certain conditions. A shale retort is not like certain other types of plant, such as an iron blast furnace, where efficiency is gained by increasing the size. Even a retort of the size of the Crozier retort now erected at Latrobe appears to be, if anything, over the optimum size in its smallest dimension. The depth to which heat can penetrate without injury to the external walls of the retort by running them at too high a temperature limits the

internal minima dimension to approximately 16 inches. If increased much over this figure, very little, if anything, is gained, and while the retort will hold more shale the tonnage throughput is not increased, whereas the longer time that the shale takes to heat up and is in the retort tends to reduce perceptibly oil yield.

It is possible that retorts could be built which would more closely approximate the conditions under which maximum oil yield is obtained, but the advantages are easily appreciated, while the disadvantages and operating difficulties make themselves fully known only on commercial testing out. As a basis for calculating possible returns from the shale, it appears much safer to accept the 85 per cent. figure obtained under known operating conditions than to consider a higher extraction to be possible by variations in retort design or operation.

#### D.—CROZIER RETORT.

A brief description of the Crozier retort is given in the "Chemical Engineering and Mining Review," Vol. XXIII, No. 266, 1930. It is a vertical retort, with external heating, and through which the shale passes by gravity. The retort proper is a flat-sided metal cylinder with semicircular ends. It is surrounded by brickwork, constructed so as to form the external flue for heating. The flue is divided into horizontal compartments by fire-tile partitions. Internal metal flues cross the retort diagonally from side to side, and connect with the external flues. A series of gas-burners is provided at alternate horizontal flues, and a furnace is provided adjacent to the bottom of the retort.

A Crozier retort has been in operation at Latrobe for the past two and a half years. A detailed report of the operation, particularly between October, 1931, and June, 1932, is given in Mr. A. Walker's report (Appendix 5). During the period covered by the report 4375 tons were retorted, for 105,442 gallons of crude oil. In all, the retort has operated for 56 weeks, during which 5417 tons of shale were treated, yielding 127,592 gallons of crude oil.

The first operations were directed to endeavouring to obtain the oil yield per ton (40 gallons) which the shale was supposed to give, and a throughput anticipated as a result of work in London. Later the trial runs were directed to verifying the oil contents of the different sections of the seam and of the shale from the two mines, as indicated by the sampling campaign (Appendices 3A-3D), and also to establishing the maximum yield of oil obtainable and the most economic yield in relation to the throughput.

As a result of these tests, it has been proved that the Crozier retort has a daily throughput of 12 tons, and that the percentage recovery under the conditions was 85. (As indicated above, Mr. Kurth considers it likely that this would be raised to 90, if steam was used in a greater quantity commensurate with that used in the Scotch retort.)

The retort has been found to operate smoothly, and to require only a minimum of supervision. It is understood that alterations are to be made in the construction of any new retorts that are erected.

#### E.—PUMPHERSTON RETORT.

The Pumpherston retort is too well known to need description here, and descriptions are available in the following publications:—

“Joint Report on the Bituminous or Oil Shales of New Brunswick and Nova Scotia, and also on the Oil Shale Industry of Scotland” (Canadian Mines Branch Publications Nos. 56 and 1107, 1910).

“The Oil Shales of the Lothians” (H.M. Stationery Office).

A Pumpherston retort was erected by the Shale Oil Demonstrating Company in 1932, and was operated for some two months, during which time several hundred tons of shale were retorted.

#### F.—PRODUCTS OF THE TASMANITE SHALE ON RETORTING.

When retorted the Tasmanite shale yields a residue, crude oil (and water), and vapours and gases.

The residue consists mainly of the inert mineral matter of the shale, together with such carbon as is produced from the distillation of the kerogen material in the shale and a small amount of oil and gas. The amount of carbon present ranges from 5 to 15 per cent., and has an average of 10 to 12 per cent., while the Crozier retort figures (excluding oil and gas) are slightly under 6 per cent.

The crude oil is described generally under refining (see page 35). The amount of crude oil has already been discussed in connection with the oil yield of the shale (see page 14) and the retorting of the shale (see page 25 and Appendix 5).

The vapours and gases are treated in condensing and scrubbing plants to remove the "light spirit," which amounts to 2 to 3 gallons per ton of shale (based upon Crozier retort figures). The volume of gas produced has a considerable range, as shown by the Crozier retort figures (1144 cubic feet per ton for Run No. 3A to 1875 cubic feet per ton for Run No. 2).

Of the above products, the crude oil is the most valuable, and is further treated by refining for the production of marketable products. The residue has little or no use. It has been used to spread on agricultural land, and is said to have given good results. It has no manurial properties, and may act as a soil fumigant or a soil activator. There is also the possibility of making use of the combustible matter in the residue to provide a further supply of gas for assisting in the retorting. The gas, after stripping, is used to heat the retorts.

#### G.—COSTS.

For the Crozier retort Mr. Walker (Appendix 5) estimates the weekly operating costs on a 50-ton-a-day plant as—

Crushing, £11 1s. = 7·5d. per ton.

Retorting, £52 4s. 6d. = 3s. per ton.

The crushing costs include labour, power, and stores, and the retorting costs include labour, fire-wood, power and light, stores, and steam. The only provision for maintenance in the above figures is that for stores and maintenance (crushing £1,

retorting £2). As the estimates of cost of retorting plant alone are somewhere between £15,000 and £20,000, it is necessary that some greater provision should be made.

It appears, therefore, that the total costs of retorting and crushing should be provisionally put down at a figure of at least 5s. per ton, the increase over the above estimate being due to further provision for maintenance, contingencies, &c.

No figures are available for the cost of retorting in a Pumpherson retort operating under Tasmanian conditions. In general, however, they will be similar to the above.

## VI.—REFINING OF TASMANITE SHALE OIL.

### A.—SUMMARY OF RESEARCH.

(By E. E. Kurth.)

Most of the work carried out has been on fractions of shale oil obtained from crude oil supplied by the Tasmanite Shale Oil Company. These crude oils were somewhat deficient in the lighter fractions, and were possibly a shade more difficult to refine than average Tasmanite shale oil. The difference is not so great as to impair the results.

The general character of Tasmanite shale oil is that it is a relatively high gravity, unsaturated, asphaltic base oil, and of moderate calorific value, since its hydrogen content is on the low side.

The crude oil has a very penetrating odour, which is principally a blend of hydrogen sulphide, more complex sulphides (such as allyl-propyl sulphide), mercaptans, creosote, and nitrogenous basic oils like pyridine, &c. The nitrogenous constituents are responsible for the clinging nature of the smell, while hydrogen and other sulphides contribute most to the offensiveness of the oil to anyone who is unaccustomed to it.

On separation into fractions, the fraction coming over between 150° C. and 200° C. has the highest sulphur content, the lighter fractions and the heavier fractions being lower in sulphur.

In the refining work carried out, commercial lines were not adopted altogether, as the constitution of the oils was the chief object of the work.

*Soda Washing*—Washing of the fractions with sodium hydroxide solution readily removes the hydrogen sulphide, and with it the oxygenated oils, which are acidic in character.

The refining loss increases with the boiling point of the oil, being less the lower the boiling point of the fraction. Over the petrol and kerosene ranges, say up to 275° C., it is approximately 5 per cent. of the oil volume, or, say, 2 per cent. of the original crude distilled.

On acidification of the washings, a creosote separates about equal to 1 per cent. on the original crude.

The sulphur content is reduced by this caustic soda treatment, being most pronounced in those fractions which contain the most hydrogen sulphide.

*Dilute Acid Washing*.—Washing with dilute sulphuric acid—10 per cent.—is effective in removing basic oils. The refining losses even with this dilute acid are considerable, being on the average one and a half times as great as in the soda washing, and, taking the petrol and kerosene fractions together, would be 7 to 8 per cent. of the original fractions, or, say, 3 per cent. of the original crude oil.

These are largely recoverable by making the washing liquor alkaline.

The crude fractions now are free from creosote and basic oils, and are much less unpleasant in smell. The removal of basic oils causes a slight increase in sulphur content.

*Sulphur Removal by Strong Sulphuric Acid*.—The creosote-free and basic-free oil was treated with varying amounts of 1.84 sp. gr. sulphuric acid, in order to determine the relative ease of removal of the comparatively large sulphur content. Sulphur removal by acid of this strength is disappointing, as the oils contain such a relatively large content of unsaturated hydrocarbons. In the case of both petrol and power kerosene fractions the sulphuric acid removed two and a half times its volume of oil, so that with five successive 1 per cent. by volume treatments the oil lost 12 per cent. of its bulk. The actual sulphur elimination was of the order 25 to

30 per cent. of that present before strong acid treatment, but as that remaining was spread over a smaller oil volume the reduction in sulphur content was rather disappointing.

Strong sulphuric acid washing to the extent of 5 per cent. by volume in five successive treatments, following on the soda washing and dilute acid washing, will result in the disappearance of 20 to 25 per cent. of the crude light oil fraction that was originally started with. With scrubber spirit or light petrol a lower refining loss would be obtained, but with a lighting kerosene a much higher loss would hold.

Even though this refining loss of 20 to 25 per cent. takes place, the remaining sulphur content of the oil is large—say 2 per cent. for the petrol fraction, and somewhat higher for the kerosene fractions.

I understand that more success with sulphur removal has attended the use of oleum in place of ordinary concentrated sulphuric acid, but I am not entitled to speak on this point from my own experience. In general, it may be accepted that the bulk of the sulphur in the lighter fractions of Tasmanite shale oil cannot be removed by a moderate amount of sulphuric acid treatment as in the case of most well petroleum.

*Hypochlorite Purification.*—Carefully conducted hypochlorite purification on fractions distilling over below 275° C. were carried out. The fraction treated contained comparatively little spirit boiling below 100° C. The difficulties found in hypochlorite treatment were chiefly that, in spite of carefully controlled alkalinity, chlorination of the unsaturated hydrocarbons was very rapid, absorbing large amounts of hypochlorite, and that the oxidised compounds were too oil soluble in this fraction to be readily removed. Although refining losses were approximately 10 per cent., very little reduction of sulphur content was made, but the smell of the oil was changed for the better owing to the chlorination. The actual sulphur elimination was equal to the refining loss, showing that on the kerosene fractions hypochlorite purification was hopeless.

More hypochlorite purifications on fractions distilled over below 175° C., and from a different lot of

oil, showed somewhat better elimination of sulphur—on the average, 23 per cent. of that contained in the original oil fraction. Refining losses were not over 5 per cent. of the original fraction, so that some reduction of sulphur content was made. Chlorination of the unsaturated hydrocarbons was impossible to avoid, in spite of well-controlled alkalinity. Hypochlorite purification, both on Tasmanite and on New South Wales shale oil fractions, appears unsuitable, owing to the ease of chlorination of the unsaturated hydrocarbons, which make up so large a portion even of the petrol fraction.

The originators of the hypochlorite process claim that it will deal with any type of sulphur compound except thiophen and its homologues, so that the presence of these compounds in Tasmanite shale oil would make the hypochlorite process ineffective.

*Identification of the Difficultly Removable Sulphur Compounds.*—The failure of the hypochlorite process to remove much more than 25 per cent. of the sulphur in a petrol fraction gave strong indication that the oil was particularly high in thiophenic sulphur.

Repeated fractionation of a quantity of shale petrol from which creosote and basics had been removed gave, after twenty series of fractionations, fractions of high sulphur content in the boiling ranges of methyl-thiophen, di-methyl thiophen, trimethyl thiophen. It would appear, also, that in addition to these there are also other homologues of thiophen. The actual separation of the thiophen homologues in a pure state has not been done, but tests for their presence have been made, and fractions containing 5 per cent. of sulphur without colour or offensive smell have been prepared.

The presence of the bulk of the sulphur in thiophenic form in the shale petrol would account for the slow removal by sulphuric acid, as these compounds are only sulphinated slowly, especially in the presence of the unsaturated hydrocarbons, on which the acid has a selective action.

*Atmospheric Pressure Hydrogenation of Shale Petrol.*—Work was carried out by a research man working at the college on sulphur removal by treatment of the petrol vapour with hydrogen in the pres-

ence of various catalysts at their correct working temperatures.

While the forms of sulphur compounds in which the sulphur atom is relatively loosely attached are readily decomposed by this method—and this was checked by making up the sulphur content of "Imperial" petrol with prepared sulphur compounds, such as di-ethyl sulphide—no appreciable reduction of the sulphur content of refined shale petrol of 2.08 per cent. sulphur was found. The desulphurisation of "Imperial" doped up to 1 per cent. sulphur was practically quantitative, but with the shale petrol the slight loss of more volatile compounds fully offset the sulphur elimination. The smell of the shale petrol was considerably improved, but sulphur elimination amounted to only a few per cent. This petrol had, of course, the easily removable sulphur compounds corresponding to those in well petroleum already removed, so that practically all the sulphur would be thiophenic. Thiophenic sulphur is not amenable to low-pressure hydrogenation, as the sulphur is too securely combined in the molecule. High-pressure hydrogenation is probably more effective on thiophenic sulphur, but in this connection no detailed information seems available, though it may be possessed by the proprietors of the hydrogenation process.

*Sulphur Removal by Activated Clay or Bauxite.*—A little work was done without much success. It seems that the high content of sulphur-containing compounds would necessitate huge amounts of absorption body, and would seem to be rather impracticable in the case of the Tasmanite shale oils.

*Fuel Oil.*—The fuel oil has not a large sulphur content compared with the lighter fractions, as with increasing molecular weight the sulphur atom becomes relatively of less importance in the molecule. Shale residuum that has been distilled to 300° C. is fluid, even at quite low temperatures, owing to the comparative absence of paraffin hydrocarbons. It is thus a good fuel oil, and the objectionable smell, &c.,

of crude shale oil is not present in the residium. It is therefore well suited to any uses as fuel oil, except for Diesel engines. The asphaltic matter and highly unsaturated character make it quite unsuitable for compression-ignition engines, although to the eye it looks very similar to other oils which give excellent performance in this type of engine. For Diesel work on shale oil a distillate is essential, and shale distillates of comparatively low boiling point will give eminently satisfactory running when a saturated oil of the same boiling range would be impossible to use in this type of engine.

*Bitumen.*—No laboratory work has been done on the shale oil bitumen in this laboratory, though it is understood that a good quantity has been used in actual road-construction in the north-west of Tasmania.

*General.*—In conclusion, it must be admitted that the Tasmanite shale oil is an unusually difficult oil to refine by standard methods. Even when rather excessive refining (compared with well petroleum) is used, with its accompanying high costs, it is impossible in some cases to produce products of standard quality, e.g., petrol and lighting kerosene. In all cases relatively high sulphur content products result, which in practice may or may not result in damage to engines, &c. While, for example, high sulphur kerosene may be used in open conditions, as in a farm tractor, the nature of the product provides a ready weapon in the hands of the large established oil companies should expansion take place in the shale industry and arouse their commercial antagonism. It would be shutting one's eyes to the truth to think of Tasmanite shale oil as equal to average well petroleum, as it appears to be inferior to the great majority of well petroleum, in that neither the sulphuric acid process nor the hypochlorite process will produce standard quality products as at present sold in Australia. Unless the shale products can be turned out comparatively cheaply, so as to be sold in competition with a somewhat better article imported, or made from imported oils, there seems to be little hope for the establishment of the industry.

## B.—TASMANITE SHALE OIL COMPANY.

Refining has been carried out in conjunction with the operations of the Crozier retort. After preliminary laboratory work a small refining plant was installed, which was later replaced by a larger one, which, in turn, was superseded by a still larger one. The last plant consisted of a crude oil still of 2000 gallons capacity, an intermediate still of 500 gallons capacity, a finishing still of 300 gallons, a chemical treatment plant with washers of 800 and 300 gallons capacity respectively, and a small steam bubble tower still for recovering the light motor-spirit wash from the gas in the scrubber towers on the retorting plant.

Details of results of refining with different treatment are given in Appendix 5. From the crude oil the following products were obtained:—Petrol, kerosene, tractor oil, diesel and fuel oil, and bitumen. The proportions of each product are shown in the following table, representing a modified form of that shown in Appendix 5.

TABLE VI.

(Based on 100 gallons of crude oil.)

Product	Figures Realised at Plant	Figures Based on Assumption that Practical Refining Difficulties are Overcome
	Gallons	Gallons
Petrol .....	6·35	16·95
Kerosene .....	13·25	14·36
Diesel Oil .....	48·70	37·50
Tractor Oil.....	8·92	11·93
Bitumen .....	12·63	10·80
	89·85	91·54
Lcss.....	10·15	8·46
	100·00	100·00

The following notes have been prepared by Mr. A. Walker:—

“In the case of bitumen, diesel, and fuel oils, satisfactory products, up to standard specification and giving excellent results in practice, can be obtained without difficulty from the refinery.

“Motor-spirit and kerosene have been produced, and have given satisfactory results in practice, in some cases over a period of two years. These oils are up to standard grade, except in respect to odour and sulphur content, and have given better returns per gallon to the consumer than the imported oils. Many unsolicited testimonials to this effect have been received from customers, and have been filed at the office of the company.

“Owing to limited resources, these oils have been obtained by simple and rather out-of-date methods, but this should not be over-stressed in respect to the two disabilities mentioned above. Although the relatively high sulphur content has not adversely affected the engines using the oils, the matter is sufficiently in doubt to emphasise the need for further research, either chemically, to bring the sulphur within known safe limits, or mechanically, to prove beyond doubt that the present oils can be guaranteed safe.

“Apart from the refining method in use on the plant, involving caustic soda, sulphuric acid, and sodium plumbite, the following methods have been tried experimentally at the works, unfortunately only with a view to general results, and not with a close and reliable check on sulphur content, except where shown in the report:—

- (1) Methods using oleum.
- (2) Oxidation methods using potassium permanganate.
- (3) Oxidation methods involving chlorine, as used by the Anglo-Persian Oil Company.
- (4) Physico-chemical methods, by absorption in bauxite, animal charcoal, various local clays, and shale ash.
- (5) Distillation over various metals and metallic salts.

"The products obtained by the above methods exhibit considerable variations in odour, and further work, under better conditions of control than were available at the works, might be carried out with profit along the above lines, and others indicated by more recent technical advances, e.g., along the lines of modified hydrogenation.

"Commercial de-odorants have been tried, but, as the odour objection is more from the sulphur dioxide in the exhaust gases than from the oils themselves, they are of doubtful value.

"Some experimental work in cracking the heavy fractions to light oils has been carried out. In the case of the refined spirit obtained, the odour was more akin to ordinary grades of imported petrol. No work was carried out on the sulphur content, since the cracking method adopted was experimental and not parallel to available commercial practice.

"Large-scale cracking tests should be carried out in conjunction with the commercial organisations controlling such processes, and reliable reports should be obtained on the quality of the resulting products. For this work the oils required could be obtained from the existing plant, but in view of the present general public interest in the shale products, it would be preferable to supply from the proposed plant, so that marketing investigations would not be interrupted."

#### C.—COSTS.

The weekly costs of refining the crude oil from the Crozier retort (50 tons per day) are given by Mr. Walker (Appendix 5) as follows:—

Scrubbing, £16 8s. 9d.

Refining, £61 6s.

These costs are equivalent to approximately 1.75d. per gallon. In order to provide for depreciation, contingencies, &c., it would be preferable to use the general figure of 2d. per gallon. This is higher than the costs of refining petroleum, but would be necessitated by the more difficult nature of the processes for shale oil.

## VII.—MARKETABLE PRODUCTS.

## A.—GENERAL.

(By E. E. Kurth.)

To market a large number of products needs usually a large organisation, both in manufacturing and in selling, and in general it is only possible on a large output.

While a great diversity of products may undoubtedly be made from shale oil, those which can be relied on for revenue are practically all in the fuel category. The outstanding products which can most simply be made without resorting to cracking are—

- (1) Petrol.
- (2) Power kerosene.
- (3) Diesel oil.
- (4) Fuel oil.
- (5) Bitumen.

It is necessary to make all these to dispose of the whole output, but no hard-and-fast line of demarcation exists between (2) and (3) and between (3) and (4).

The manufacture of lighting kerosene would seem to be quite out of the question, and the manufacture of lubricants needs complete investigation, as practically no information exists as to whether they could be worked up from the oil.

It is possible that a marketable creosote could be turned out with little trouble from the soda tar, and with a further expense the nitrogenous basic oils could be recovered from the acid tars along with the sulphonated hydrocarbons, &c. The value of this material as a spray oil for orchards would need proper investigation.

If cracking were resorted to, the same products would need to be sold, although the proportion of petrol would be largely increased. If petrol produced by cracking proved the most remunerative, all oil residues which did not pay to recycle would naturally be sold as fuel or gas oil.

The quality of these various products has been discussed in the preceding section on refining. In general, with proper works control, bitumen, fuel

oil, and diesel oil may be turned out to comply with standard specifications. As regards lighting kerosene, it would be futile to attempt to market the product, owing to the need for practically complete saturation and freedom from sulphur. The difficulty of attaining these in the shale oils of correct boiling range makes the production quite uneconomic.

As regards the volatile fuels, the power kerosene and petrol are difficult to reduce to a low sulphur content, but could undoubtedly be sold, as in the past, provided the price was attractive. It does not seem possible to realise on a larger output the same price as for imported petrol, as the smell of shale petrol is objectionable to many people, both as vapour and in the exhaust. The extra mileage and antiknock quality of shale petrol is obtained, as far as my experience goes, with a petrol not so highly refined, and further refining to make a petrol more like those at present sold results in reducing the actual performance on the road.

A good proportion of the output of petrol has in the past been sold in the district where it has been produced, and a patriotic spirit no doubt helps to overlook any small disadvantages. As with other products, the public judges a thing on its value as found by continued use, and if shale products can be sold at a price not greater than their actual worth in service, then the production of shale products is solely a question of economics.

#### B.—EXPERIENCE OF THE TASMANITE SHALE OIL COMPANY.

The question of marketable products has been partly discussed under refining, and the following notes deal more with the actual marketing of the products. A summary of the sales to date is shown below. The figures given are actual sales, and do not include oils consumed in the work of the company. These include fuel oil used at the retort, petrol used by the staff of the company and in our motor-lorry for transport, and kerosene (amount-

ing to 298 gallons) used in the Government drilling plant. No account is included of free samples, nor of oils used in obtaining experimental information, such as in road tests on petrol.

It will be seen from the figures that the products have been given a reasonable trial on the open market, and there is ample evidence that they have given satisfactory performance, in the majority of cases the results in work done being superior to that for imported oils. Despite this, owing to the disabilities of odour and sulphur, the light oils are at present sold as second-grade products. This will be necessary until improvements in refining are obtained.

A considerable amount of work has been done, in co-operation with our agents and the farmers, in experimenting with a cheap fuel for tractors. We understand that many tractors of the John Deere type are idle owing to the high cost of kerosene. Recently successful tests were completed on a tractor fuel which could be supplied at an economic price, and a promising market was opened up. Unfortunately our production is on too small a scale to carry this work forward, and we have had to turn down orders for this fuel.

The petrol is used generally in private cars, commercial vehicles, marine motor-engines, and motor-cycles, and has given winning results in hill-climbing competitions and speed tests. The mileage obtained in tests allowing adjustment has shown an improvement over the imported petrol, the usual figures being from 10 per cent. to 20 per cent.

The kerosene is used in stationary engines and in tractors at work on the land. Tests have been carried out by the Mount Lyell Mining Company with satisfactory mechanical results, but the odour was considered unsatisfactory under its conditions of use.

The fuel oil is sold under contract to the Tasmanian Government Railways and to the Mount Lyell Company. The contracts amount to 5500 gallons monthly.

The bitumen is used by the local councils, both on main roads and in secondary roads in the townships. The performance is comparing favourably

with that of the imported article, which has been laid alongside in some cases for comparative tests.

Although comparatively little attention has been given to spray oils for orchardists, a growing demand exists, and some of the local orchardists have used no other oilspray for years. The results obtained are excellent, and good prices are received.

Sundry quantities of by-product tar from the refinery have been sold locally for destroying weeds and blackberries. No attempt has been made to develop this market.

This also applies to the shale ash, for which a local demand exists from orchardists and farmers. Apparently the material has some beneficial mechanical action. At present the ash is supplied gratis, and we are watching results.

To sum up the marketing position, the present demand for the products of the company exceeds the supply, and orders are repeatedly being turned down, despite the fact that the company spends nothing on advertising.

#### *Summary of Sales to October, 1932.*

Product.	Quantity Sold.	Value.		
	Gals.	£	s.	d.
Petrol .....	2,992	285	16	9
Kerosene .....	16,964	1,058	6	8
Tractor oil .....	2,213	99	7	9
Diesel fuel .....	68,708	1,717	15	6
Bitumen .....	15,763	564	3	2
Spray oils .....	—	236	4	4
<b>Total</b> .....		<b>£4,001</b>	<b>14</b>	<b>2</b>

### VIII.—MARKETING AND ECONOMIC.

#### A.—MARKETING.

It is difficult to come to any really valid conclusion on the marketing of shale oil products from the Tasmanite shale until the possibilities of marketing the higher outputs are tested. This question, and that of prices, has already been briefly dis-

cussed under "Marketable Products." It is fairly certain that the prices now realised on the output of the one retort cannot be expected once a large plant is installed. These prices, according to the report of the Manager of the Tasmanite Shale Oil Company Limited, are—

	Per Gallon.	
	s.	d.
Petrol .....	1	10½
Kerosene .....	1	3
Diesel oil .....	0	6
Tractor oil .....	0	8
Bitumen .....	0	9

On actual recoveries at the plant, this would give a price of 8·2d. per gallon of crude oil, but he estimates that if practical refining difficulties are overcome to allow for full possible recovery of the lighter fractions, the return per gallon would be just a fraction over 9d. per gallon. This higher return would be almost entirely due to the higher recovery of petrol. The return on petrol and diesel oil together would, in any case, dominate the position, and the probable price of these two commodities is therefore important.

There has evidently been no difficulty in getting these prices for the present output, and they might be substantially maintained with a 50 tons per day output, but they would fall rapidly once higher production was attempted. The report of the Shale Oil Investigation Committee on the New South Wales deposits takes 9d. per gallon as the price of petrol, and allows 3d. per gallon for fuel oil. Possibly these prices are low. The report of the committee investigating petrol prices stated that the Vacuum Oil Company gave its c.i.f. cost of petrol at 6·805d., and the Shell Company gave the c.i.f. prices of first and second grades as 8·393d. and 7·520d. respectively; but these prices included profit. It therefore seems that landed cost, exclusive of duty, may be somewhere in the neighbourhood of 7·5d. or 8d.; and with a protection of 3d. per gallon, this would give a price of 10½d. or 11d.

For the present another 2d. per gallon might be added for exchange. The price of fuel oil landed in Melbourne appears to be slightly above 3d. per gallon.

This seems to indicate that once the field gets into full production, the bulk of the output of petrol must be sold at something less than 1s. per gallon. The extent to which this would affect the average price obtained would depend on the amount it would be possible to market locally. It is almost impossible to arrive at any definite conclusion, except that the prices now obtained would not hold once production is increased to any great extent.

The figures used in the above discussion do not include any cost for distribution from the works to retailers. If the operating company undertook such distribution, the prices received for the products would be increased accordingly.

#### B.—ECONOMICS OF THE INDUSTRY.

In the previous pages figures have been given as to the costs of mining, retorting, and refining. These are estimates based upon general knowledge and experience, and are figures which might be closely realised in actual practice, especially in the case of mining. If these figures were used in attempting to decide the economic possibilities of the industry, it would probably be decided that the industry has no chance of success. However, in practice, it might be found that sufficient differences, though small, would exist between the estimates and actual costs as to materially affect the possibilities of the industry. At the same time, the information concerning the nature and amount of, and the prices obtainable for, the various products is not finally determined, and the final determination of these factors might indicate that the commercial possibility of the industry is more favourable than at present appears.

It seems, therefore, that there are as yet too many unknown factors to make a very direct statement on the economic possibilities of the industry.

Turning from the general aspect to actual experience gained by operating companies, the report of

the Tasmanite Shale Oil Company Limited (Appendix 5) yields valuable information as to the costs of production, and the revenue derived from their present plant. Further estimates based upon this experience are given in the report for a 50 tons a day retorting plant.

Mr. Walker, in his report, has taken an average return per gallon of 8·9d. as a basis for his balance-sheet (Appendix V.). The second alternative in that balance-sheet is based on a 50-ton throughput of top and bottom shale on the low-grade part of the field, giving 28 gallons per ton. This would give a total weekly return of £364 1s. The weekly costs calculated by Mr. Walker total £205 16s. 9d., leaving a balance of £158 4s. 3d., or 9s. 0½d. per ton for costs which he has not taken into consideration. These costs are (1) extra provision in the retorting costs for maintenance and contingencies as outlined above, (2) mining costs, and (3) return on capital.

The extra provision for maintenance and contingencies required is set out above as about 1s. 4½d. per ton. This would leave 7s. 8d. per ton, which is not sufficient, on present figures, to cover the cost of mining, and would therefore leave nothing for return on capital. The actual cost per ton is evidently about 9s., and the estimate of the Mining Sub-Committee for a larger output 9s. 6d. But, as pointed out previously, this latter figure was based on wages at a much higher level than those at present being paid at Latrobe. Wages form an extremely important factor in the mining costs, and much would depend on the rate to be paid. One may say that on present rates it is unlikely that an output of 50 tons per day could be mined for 7s. 8d. per ton, but that larger scale operations at the same rates of wages may bring a lower cost per ton.

The third alternative in that balance-sheet is based upon top and bottom shale from the high-grade part of the field giving 35 gallons per ton. The figure of 13s. 9d. for the unprovided costs would cover the extra provision for the retorting costs and the mining costs, and leave a surplus.

The average grade of the shale throughout the field would be between the above two figures. The

results of the working would be between those outlined above, and might provide for all working costs, without any surplus for return on capital.

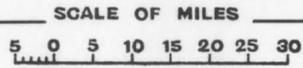
The prospects of the industry in the immediate future do not look particularly alluring. But there are factors, both economic and non-economic, which may make further research on a larger scale important to Australia. There is no need for us to elaborate on these factors, which, no doubt, have had the full consideration of the Commonwealth Shale Oil Development Committee. Our chief object is to point out that, before large-scale production can be thought of, the industry in Tasmania has to go through an intermediate stage, at which profitable production probably cannot be expected.

As stated above, there are at present too many unknown factors to make a more definite statement, and our recommendations are made with a view to determining these factors.

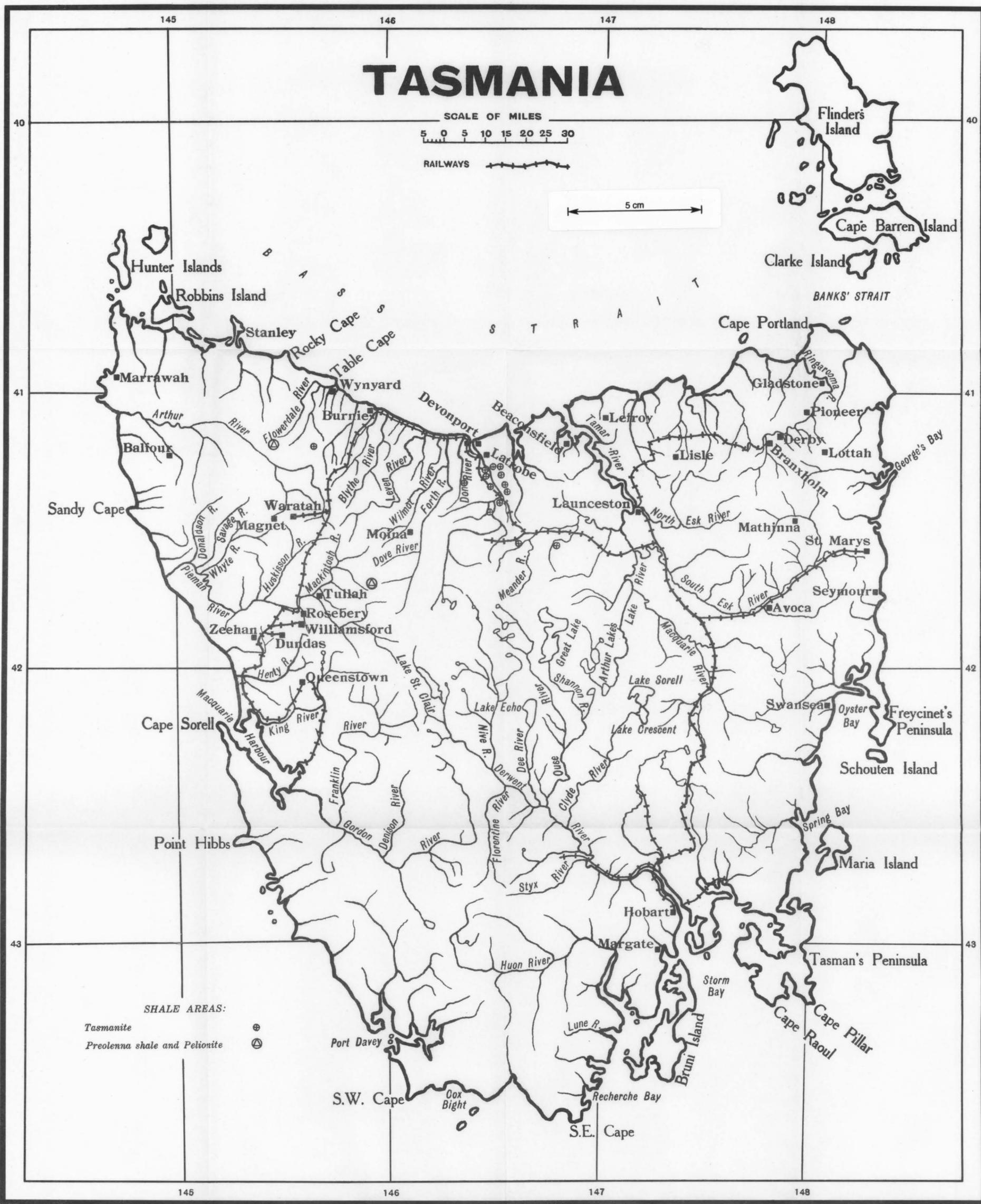
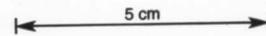
## APPENDICES.

1. Map of Tasmania.
2. Map of Latrobe-Quamby Bluff Shale Oil Fields.
3. Reports on—
  - (a) Sampling, by Mr. F. Blake.
  - (b) Methods of Analyses, by Mr. D. H. Bath.
  - (c) Distillation of Oil Shale Samples, by Mr. E. E. Kurth, B.Sc.
  - (d) Results of Sampling, by Mr. P. B. Nye, M.Sc., B.M.E.
- 4.—
  - (A) First Report of Mining Sub-Committee.
  - (B) Final Report of Mining Sub-Committee.
  - (C) Report on Shale-bearing Areas Nos. 2 and 5, near Latrobe, by Mr. G. M. Hindmarsh.
  - (D) Copies of Letters from Messrs. G. M. Hindmarsh and C. F. S. Hood.
5. Report on the Crozier Retort, by Mr. A. Walker.

# TASMANIA



RAILWAYS



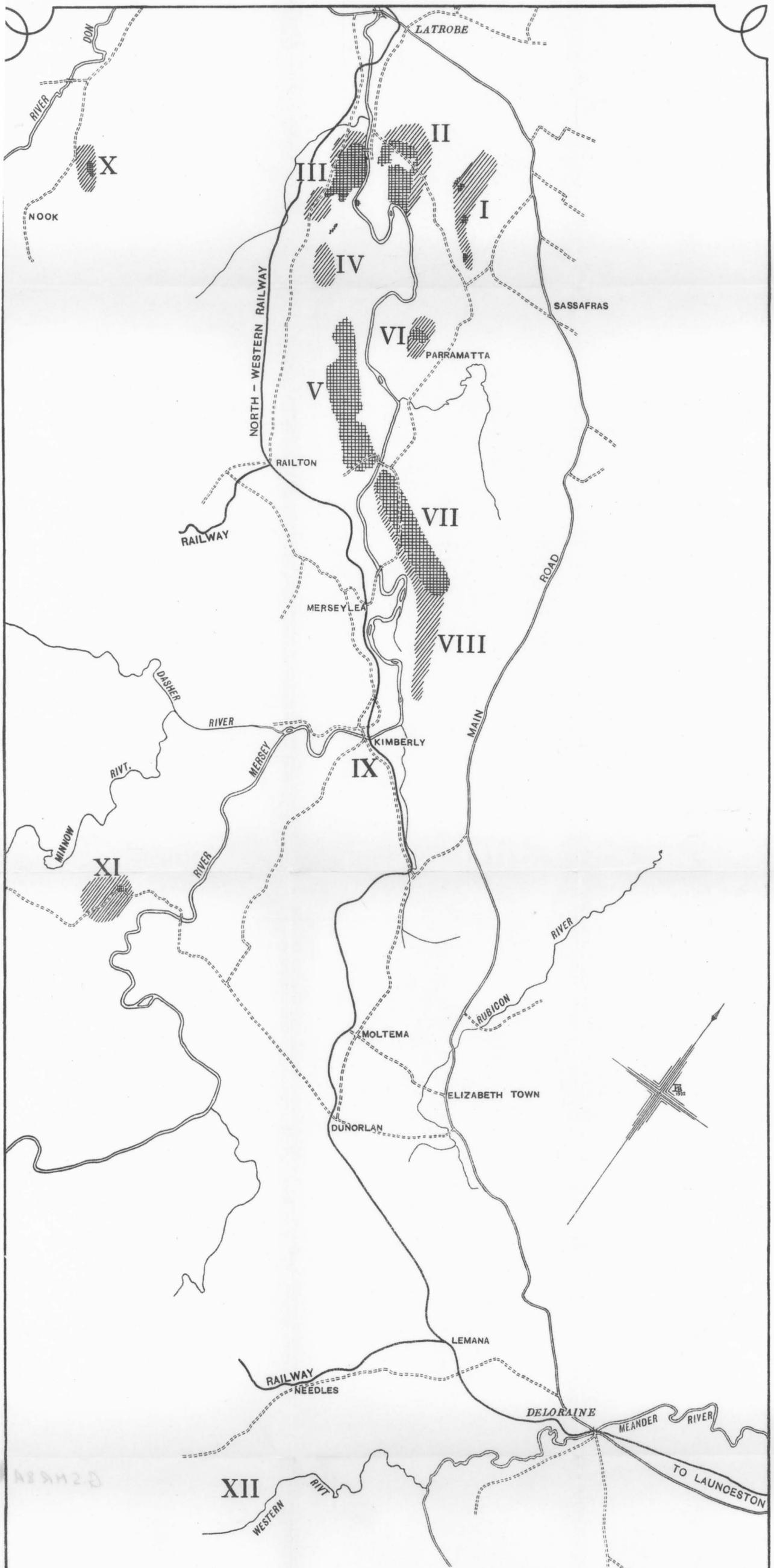
SHALE AREAS:

Tasmanite

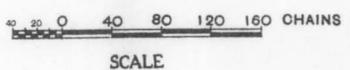
Preolenna shale and Pelionite



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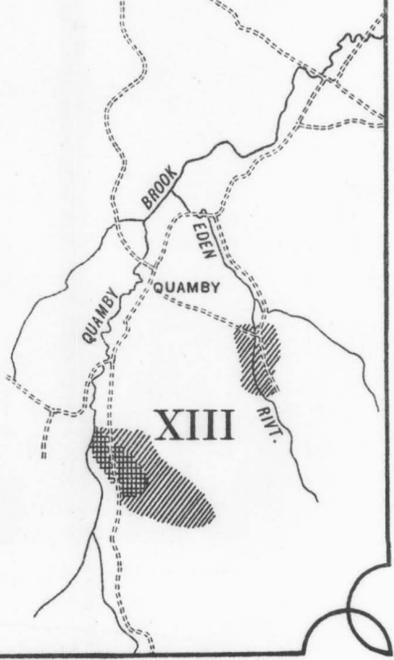
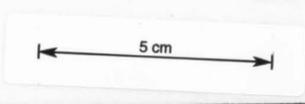
SKETCH MAP OF  
**THE LATROBE-QUAMBY  
 DISTRICT**



SCALE

**SHALE AREAS**

- Partly Proved 
- Possible Extension 



## Appendix 3a.

## SAMPLING OF TASMANITE SHALE OF LATROBE DISTRICT.

All the sampling was carried out underground in the workings of the Goliath Cement Company and Tasmanite Shale Oil Company. The positions of the samples were determined, with the idea of spreading them throughout the mines as far as possible, with particular regard to the newer workings. Some of the older workings were either waterlogged, fallen in, or filled up with mullock, and in these sampling could not be undertaken.

(1) *Characteristics of the Seam.*

Generally, it may be said that the Tasmanite shale seam is made up of three bands or beds, the upper and lower ones of which are shale, while the middle band is more in the nature of a mudstone. The three bands contain Tasmanite spores, but the quantity of spores in each section varies. The top shale is the richest in spores, and therefore in oil yield, while the middle mudstone band is by far the poorest.

The two shale bands, which are somewhat arenaceous, proved remarkably tough to break when dry, thus differing from the mudstone band, which is harder and slightly brittle. Distributed sporadically through the seam, small waterworn pebbles of quartzite are occasionally found. These are usually up to 3 inches in diameter, but often are 6 inches, and occasionally are of the dimensions of boulders, the largest of which was 30 inches in diameter. In places, particularly towards the top of the seam or immediately above it, the pebbles become more concentrated, and the rock assumes the nature of a conglomerate.

Partings, along which the shale breaks away, generally occur at the top and the bottom of the seam respectively. At times the positions of the partings differ slightly from the above, and it is then found that they may be a few inches above or below the top and/or the bottom of the seam. For instance, in the Tasmanite Shale Oil Company's Mine portion of the lower shale has been extracted from a parting now represented by the mine floor. Below the floor some 3 to 6 inches of poor shale has been left, and this gradually merges into the underlying mudstone. Other partings separate the middle band from the two shale bands.

The dip of the seam is generally even and gradual, but here and there some of the underlying mudstone projects into the lower portion of the seam, thus producing an uneven floor in these places when mined.

Many small faults and several larger ones traverse the seam.

The latter introduce displacements from 1 foot up to 20 feet, thereby adding to the difficulty of working.

The following table shows the average thickness of the seam in each mine, together with those of its component parts:—

Goliath Cement Company's Mine.

Bottom Shale.		Middle Band.		Top Shale.		Top and Bottom Shale Combined.		Top and Bottom Shale Combined with Middle Band.	
ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
1	8.95	1	2.59	2	3	3	11.95	5	2.54

Tasmanite Shale Oil Company's Mine.

ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
1	9.48	1	4.2	1	10.9	3	8.4	5	0.6

(2) *Method of Sampling.*

Positions were picked along the walls of drives, pillars, and boards where the surfaces were most even, and where full vertical sections of the seam could be obtained. When practicable, places where the floor was driest were resorted to. The sampling was performed by cutting a vertical channel from floor to roof of the seam.

Each sample of the seam was taken in three sections, and each section given a letter for identification purposes, viz., Bottom Shale A, Middle Band B, Top Shale C.

The width of the sample was 6 inches, and the average depth 2 inches.

Sampling was commenced by cleaning the face from roof to floor by picking and brushing, until clean, unweathered shale was encountered. During the process the tops and bottoms of the several sections were ascertained, and these were then marked out with chalk, together with the sample width.

Bags were then placed on the floor of the mine, and the bottom section (A) taken out with the pick. The sample thus obtained was broken, mixed, and quartered, on a clean sheet of iron, until approximately seven pounds of the material remained. This was placed in a numbered and lettered calico bag, and tied, to be forwarded for analysis.

Sections B and C were then treated in a similar manner. In this way 48 samples, each consisting of three sections, in different parts of the mines, were secured for treatment. In addition, four representative samples of each section were taken, and placed in sealed glass containers for the purpose of determining the moisture content.

F. BLAKE, Field Geologist.

Hobart, 22nd September, 1931.

**Appendix 3b.**

Laboratory, Launceston,

9th October, 1931.

**OIL SHALE SAMPLES RECEIVED FROM THE  
LATROBE AREA FOR DETERMINATION OF THE  
ASH, SULPHUR, AND SPECIFIC GRAVITY.**

The samples on arrival were crushed approximately half (1) to a quarter (1) inch size by a Braun Chipmunk "W" crusher, and after quartering down to about three pounds (3 lb.) were dried at 100° C., in order to facilitate finer grinding in the Braun pulveriser. The shale was ground to pass a 70-mesh sieve. It was not considered advisable to crush the material finer, owing to the nature of the shale. A portion of the sample was then taken, and dried at 105° C. for two hours in a hot-air oven, then placed in a desiccator to cool.

*Ash.*

The ash content was determined by placing 1 gram of the shale in a porcelain or platinum crucible, and heating it over a meker burner, slowly at first, and gradually increasing the temperature until no particles of carbon were left. A few of the samples were checked by the Emerson bomb calorimeter, and the results were practically identical.

*Sulphur.*

The sulphur was determined by the well-known Eschka method, and checked by sodium peroxide and sodium carbonate fusion methods, the results of which compared well.

*Specific Gravity.*

The specific gravity was determined by using ground shale and weighing by displacement in kerosene, the variation of temperature being very carefully noted. Some 150 odd samples were received, and the complete results will be found accompanying the report of the Government Geologist (P. B. Nye).

L. H. BATH,

Government Chemist and Assayer.

## Appendix 3c.

REPORT ON DISTILLATION OF OIL SHALE  
SURVEY SAMPLES.

During the past three years or so I have been engaged in research on the Latrobe Tasmanite shale. In the course of this work I had occasion to study the various factors in retorting, and for this purpose developed a large-scale assay, in which a charge of 1120 grams of shale was retorted under closely controlled conditions, especially with regard to rate of heating. This work had already been done at the time the first meetings of the investigation committees, in April of this year, took place. This work, included among others, study of the influence of the following factors on oil yield:—

- (1) Rate of heating.
- (2) Size of particle of shale retorted.
- (3) Pressure of retorting.
- (4) Presence of other gases, such as hydrogen, steam, carbon dioxide, &c.
- (5) Richness of shale or ash percentage.

The latter provided some interesting results, and there was obtained clear evidence that there was a fairly definite relationship existing between the ash content and the efficiency of conversion of the kerogen into oil. This relationship was expressed by the term "distillation index," and is defined as that factor which, multiplied by the percentage of kerogen in the shale dried to constant weight at 100° C., gives the yield in gallons per ton. The distillation index has thus a very practical significance, and practically reduces the determination of the oil yield to an ash determination on the dried shale.

Shale of 95 per cent. ash yields no oil on distillation, but only gas, so that the distillation index is zero, while for the richest shale examined, i.e., 65 gallons per ton, the distillation index is 1.7. Between these limits there is continuous variation.

If the efficiency of conversion of kerogen into oil were constant for all grades of shale, the oil yield plotted against ash would yield a straight line, but owing to increase of efficiency of conversion with increasing richness of shale the oil yield plotted against ash yields a distinct curve.

Prior to this question of a survey of the field, work had been done on a number of samples, and an oil yield ash curve drawn. In this work the shale was retorted under conditions of particle size and rate of heating which were found to give the maximum oil production.

In order to give greater confirmation of the correctness of the curve, ten additional samples obtained in the survey were retorted, and substantially confirmed the previous curve.

It is to be expected that such a composite material as oil shale will yield variations in some cases, and it is confidently thought that the curve expresses the relation of oil yield to ash content very closely for 90 per cent. of the samples, and would strike a good average for the remainder.

For the purposes of determining oil yield, simple retorting at atmospheric pressure was adopted. The size of particle was not under control, as crushing and quartering of the original samples were necessary to determine the ash content.

The maximum size of particle was very close to that regarded as the optimum size, but there was rather too much fine material as a result of the sampling crushing. With the richer samples it is estimated that the yields would be about a gallon per ton higher with less crushing of the shale.

The rate of heating adopted was approximately 100° C. per hour, as this rate or a little higher rate, gives the maximum oil production.

The oil yields thus estimated from the ash content may therefore, in general, be regarded as a maximum, since any oil left in the residue in commercial retorting, any oil uncondensed, and any further cracking as occurs during slow commercial retorting—all would tend to reduce the commercial oil yield. It is therefore probable that any retort now operating would produce distinctly less than the figures given, unless rapid distillation in a vigorous current of steam was carried out, when a little greater yield of oil may be obtained; but even then it is doubtful whether steam distillation would balance other unavoidable commercial losses.

#### *Experimental Details.*

A few details of the experimental retort may prove of interest.

The internal dimensions are 3½ inches by 15 inches, providing sufficient space to take 1120 grams of the richest shale. For poor shales 1.5 times this charge was taken. One gallon per ton is thus represented by 5 c.c. and 7.5 c.c. respectively. As the oil volume could be obtained by weighing the oil and determining its specific gravity, as well as by direct volume measurement to approximately .55 c.c., the determination of the oil yield could be made to .1 gall. per ton.

The retort actually consisted of 3½-inch steam-pipe, capped at each end. One end cap carried a thin, solid, drawn steel tube of ½-inch internal diameter, into which a thermocouple was inserted. The external wall temperature was obtained by another couple pined into the wall, and lagged with asbestos to prevent direct radiation reaching it. In this way the microammeter, with a two-way switch, gave both the wall temperature of the retort and the temperature of the centre of the charge.

No casual condensing arrangement will serve to give consistent results, so that a triplex condenser was used.

The ¾-inch copper pipe leading from the retort was water-jacketed for 12 inches, and delivered into a measuring cylinder. Most of the condensation was effected in this

pipe. The gases and vapours then ascended 2 feet of  $\frac{1}{2}$ -inch diameter glass tubing, water-jacketed, and were thus cooled to water temperature, and any oil condensed could run back to the first cylinder. Following this was a water-jacketed glass worm of  $\frac{1}{4}$ -inch tubing of ten turns of  $1\frac{1}{4}$  to  $1\frac{1}{2}$ -inch diameter, which acted principally as a centrifugal separator, as the gas was already cold entering the worm. Following this system were two measuring cylinders containing Mobiloil E motor-cylinder oil, with gas inlet tube arranged to bubble the gas through about 6 inches of oil.

All of the above condensing apparatus is absolutely essential in order to get consistent results with all the rates of gas flow experienced in retorting. No doubt a little more spirit could be obtained by compression of the gas, but this possible yield was neglected. The gases were then passed through two caustic soda scrubbers to absorb sulphuretted hydrogen, and finally through a capillary gas meter to measure the gas production by integration of the time-flow curve.

Heating of the retort was carried out in an electric furnace made by winding a clay tube 4 inches in diameter with nichrome wire. A rheostat in series could be used to control rate of heating.

After the run was complete as shown by absence of further distillate, the two lots of oil condensed (with poor shales the gas flow was insufficient to carry any oil mist into the worm) were mixed, settled overnight, and the volume of oil and water measured, and also weighed. The oil then was carefully pipetted off without disturbance of the water. When practically all the oil was taken off petrol would be added to dilute the remaining 1 c.c. or so, a measured amount of dilute acid added to acidify the water-layer and break any emulsion, and after settlement the water measured, allowing for the added acid. By subtraction the volume of the oil could be obtained. By deducting the weight of the water the weight of the oil could also be obtained, and the specific gravity of the oil accurately determined. In this way the oil volume could be computed, and this method was found much more accurate, as the errors of measuring cylinders were eliminated, as well as those involved in reading the troublesome oil meniscus, which offers its own peculiar difficulties in reading with dark-coloured oil. In addition to the condensed oil, the increase in volume of the oil scrubber, usually not exceeding 1 gallon per ton, and sometimes much less, was added to the measured oil to give the total oil production. With high rates of gas flow, up to 3 gallons per ton may be found in the oil scrubbers, but this would indicate the condensing system to be overloaded. This only occurs with exceedingly rapid distillation of rich shales, and does not enter into present considerations.

The residue in the retort was removed, weighed, and sampled. From its proximate analysis the ash content of the original shale could be determined with greater accuracy than is the case with the raw shale, owing to its heterogeneous nature.

The following table shows the relation of the oil yield to ash:—

Dist. No.	Ash.	Spec. Grav.	Oil.	Kerogen.	Dist. Index.
	Per Cent.		Gals. per Ton.		
38	61·9	1·71	65·0	38·1	1·70
15	66·5	1·87	52·6	33·5	1·57
37	68·3	1·90	45·4	31·7	1·43
41	70·0	1·94	44·0	30·0	1·47
47	71·6	1·94	46·2	28·4	1·63
42	75·3	2·04	35·9	24·7	1·45
44	77·5	2·12	30·0	22·5	1·33
34	79·9	2·14	23·6	20·1	1·17
48	80·2	2·17	27·4	19·8	1·38
43	81·7	2·25	22·8	18·3	1·25
39	84·4	2·24	16·2	15·6	1·04
40A	84·5	2·29	16·5	15·5	1·06
45	89·3	2·48	9·6	10·7	·90
46	89·8	2·56	7·5	10·2	·73
35	91·1	2·48	6·4	8·9	·72
36	93·5	2·65	2·7	6·5	·41

It will be observed that the distillation index decreases steadily with increasing ash, and Nos. 47 and 48 are the most marked departures, both exceeding the average distillation index for their particular ash content. These are top seam samples, and in general the top seam seems to produce slightly more oil (1 to 2 gallons per ton) in some cases than the curve would show, but on the other hand one or two of the top seam samples yielded less. The curve from which the assaying values of the 144 samples were computed may be accepted as representing closely the average results to be obtained in retorting.

The moisture content of the shale in the face is low, varying from about 1·9 to 7·5 per cent. All specific gravities and oil yields are for dried shale, so that the oil yields for shale direct from the mine would be subject to a reduction of a few per cent. As, however, the specific gravities were determined on the dried shale, the tonnage of shale available calculated from the specific gravities would not be affected by the moisture in the shale.

Apart from oil yield, the distillations performed gave additional information on several points. They are as follows:—

#### *Sulphur Content of Oil.*

This proved again remarkably constant within certain limits. The crude oil in the various distillations varied from 2·12 per cent. to 2·50 per cent. The top seam samples averaged higher than any other part, exceeding somewhat the middle band oils in this regard. These latter oils were, in turn, slightly higher (·1 per cent.) in sulphur than the oils from the bottom seam.

*Oil From Middle Band.*

This oil is not materially different from oil produced from other parts of the seam in general properties. It is not as sulphurous as that from the top seam, and in one case, where the band assayed 3.57 per cent. (only exceeded by one band sample), and would be expected to produce an oil high in sulphur, this latter assayed 2.36 per cent., which is less than that of the richer portions of the top seam. The band is moderately constant in grade, and as its oil content is appreciable, the question of discarding the band needs fresh consideration in the light of the information obtained in this survey.

*Conclusion.*

The sulphur content of the shale samples very rarely fell below 2 per cent., and the great majority fell within the limits 2 per cent. to 3 per cent. Only part of this sulphur is combined in the organic oil-yielding material, and it is my opinion that the intrinsic sulphur bears a fairly constant ratio to the kerogen, and that the higher assays for sulphur are due to excessive pyritisation of the shale. The amount of sulphuretted hydrogen produced in distillation varies a good deal, and it is, no doubt, produced by reaction of hydrocarbons with the pyritic sulphur. On the other hand, the sulphur content of the oil, especially when stripped of dissolved sulphuretted hydrogen, is very nearly constant, averaging 2.1 per cent. to 2.2 per cent. In the poorer shales rich in sulphur, very little of the sulphur is found in the oil, the bulk remaining in the residue, while approximately one-quarter is given off as sulphuretted hydrogen.

This constancy in sulphur content of the oil suggests that the cracking of the pyrobitumen into oil is, to a large extent, independent of the production of sulphuretted hydrogen, which latter seems to be a secondary reaction between the pyritic matter and the hydrocarbons present.

There are certain portions of the top seam which are certainly richer in intrinsic sulphur, and these produce oils somewhat exceeding 2.5 per cent. sulphur. On the whole, however, this work indicates that 2.5 per cent. S. is about the upper limit of sulphur content likely to be met with in oil from the Latrobe area.

The specific gravity of the dried shale bears a very close relationship to the oil yield. This, of course, only applies while the mineral matter is approximately constant in specific gravity, but, with the exception of a few band samples, the oil yield may be inferred to within 2 or 3 gallons per ton from a simple determination of the specific gravity.

It is hoped that the foregoing report will serve to explain the basis adopted for determining the oil yields in the survey carried out, and it is felt that computation from the curve is more accurate than the distillations frequently carried out with comparatively crude retorts and still cruder condensing arrangements.

E. E. KURTH.

### Appendix 3d.

## REPORT ON THE RESULTS OF THE SAMPLING OF THE TASMANITE SHALE AT LATROBE.

### *Introduction.*

At the meeting of the Tasmanian Shale Oil Inquiry Committee held at Launceston on 17th April discussion revealed that there was considerable diversity of opinion as to the oil yield of the Tasmanite shale, and that the information regarding this subject was not as complete and definite as could be desired. It was therefore arranged that the Mines Department should undertake the sampling of the shale deposits.

### *Sampling Campaign.*

The sampling campaign was planned by the Geological Survey, and carried out under the supervision of Mr. F. Blake, Field Geologist. A report by Mr. Blake is attached, and describes the method of sampling, observed characteristics of the seam, thickness of seam, &c. The plans attached to the report show the position and numbers of the samples. The sampling was restricted to the mines of the Goliath Portland Cement Company and the Tasmanite Shale Oil Company, which were the only accessible underground workings.

### *Shale Analysis.*

The samples were forwarded to the Mines Department Laboratory, Launceston, where the analyses were made under the direction of Mr. L. H. Bath, Government Chemist and Assayer.

In each sample, the content of ash and sulphur, and the specific gravity, were determined by methods outlined in the report by Mr. Bath.

The moisture was determined in twelve special samples taken for that purpose, having been put in sealed and stoppered bottles for transport.

### *Determination of the Oil Yield of the Shale.*

The oil yield of the samples was deduced from the ash content of the shale by means of a graph prepared by Mr. E. E. Kurth, B.Sc., of the Hobart Technical College. This graph represents the results of many years' research work by Mr. Kurth, and is dealt with in the attached report by him.

### *Results of the Sampling and Analyses.*

The results of the sampling, analysis, and deduced oil yield for each sample are shown in Table I.

This table also contains the average figures for the sulphur, specific gravity, and oil yield, and the total thickness for the top and bottom shale, and also for the whole of the seam, including the middle band. The averages are not the arithmetical means, but true averages calculated in accordance with the thicknesses and specific gravities of each sample. This applies also to the averages in Tables II. and III.

Table II. contains the averages of each section of the seam—top shale, middle band, and bottom shale—and also of the top and bottom sections combined, and of the seam as a whole.

Table III. shows the averages of the top and bottom shale combined, and of the whole seam worked out for the shale deposits by three methods. It will be realised that Samples 1 to 33 represent the shale in the Goliath Mine, and Nos. 34 to 48 that in the Tasmanite Mine, the mines being 60 chains apart. In the first place, the mines may be taken as of equal weight, and the averages calculated in accordance with those of the two mines (Line I.). Secondly, the mines may be considered to have "weights" in proportion to the number of samples taken in each mine (33 in the Goliath and 15 in the Tasmanite), and the averages calculated accordingly (Line II.). Thirdly, and the most correct way, is to give the mines "weights" corresponding to the areas of shale represented by the sampling, which by measurement gives a proportion of 2.5 for the Goliath against 1 for the Tasmanite (Line III.). It must be remembered, however, that none of these figures actually represents the average of the shale for the fields, but that they give approximations obtained from the available information. (If the samples had been equally spaced in both mines, the results of Lines II. and III. would have been the same.)

### *The Shale Seam.*

It will be noted that the shale seam consists of three parts, which have been termed the top shale, middle band, and bottom shale, these three divisions being always present throughout the Latrobe field. Each of these parts, as well as the whole seam, has a considerable range in thickness, and also in specific gravity, sulphur content, and oil yield. These factors are important from the point of view of quantity of shale, its oil-yielding capacity, and the quality of the shale and the oil produced therefrom. A brief description of each of these factors is given below. Their range is indicated in Tables I., II., and III.

### *Thickness.*

The average thicknesses indicate that the top shale is the thickest part of the seam, and the middle band is the thinnest, the bottom shale being intermediate. The average

thickness of the various parts of the seam are given in the following table:—

	Goliath Mine.		Tasmanite Mine.		Latrobe Field.	
	ft.	in.	ft.	in.	ft.	in.
Top shale .....	2	3	1	11	...	...
Middle band.....	1	2.5	1	4.2	...	...
Bottom Shale.....	1	8.9	1	9.5	...	...
Top and bottom shale.....	4	0	3	8.4	3	10.2
					to	
					3	10.9
Whole seam .....	5	2.5	5	0.6	5	1.6
					to	
					5	2.0

It must be pointed out that in the mine workings the thickness may appear somewhat less than these figures or the thicknesses given for individual samples as shown in Table I. This is due to the fact that if a convenient parting occurs a few inches above the bottom of the shale, the shale may be broken from above this parting, leaving several inches of shale on the floor of the workings.

In previous reports and calculations it was generally assumed that the shale seam was 5 feet thick, with 1 foot of middle band. From the tables it will be realised that the shale seam has an average thickness of 5 feet 1 inch to 5 feet 2 inches, with the middle band 1 foot 3 inches in thickness. The figures used previously were therefore fairly accurate, but slightly underestimated the thickness of the whole seam and the middle band, and overestimated the top and bottom shale.

#### *Specific Gravity.*

The specific gravity of any sample of shale or band is, in a general way, directly proportional to the mineral matter and inversely proportional to the kerogen content. Thus, the greater the amount of mineral matter and the smaller the amount of kerogen, the higher is the specific gravity, and *vice versa*. The specific gravity of the mineral matter apparently ranges from 2.5 to 2.7, the higher figures being due largely to greater content of pyrite. The specific gravity of the kerogen is approximately 1.1. The specific gravity of a shale or band sample, therefore, lies between these limits. There is a further limitation, in that the samples yielding the greatest amount of oil contain approximately 35 per cent. of kerogen. The specific gravity of such shales is, by measurement, 1.76 to 1.77. On the other hand, the poorest band had a specific gravity of 2.42, while a somewhat richer one gave the greatest measured specific gravity (2.62), due probably to a greater content of pyrite.

The specific gravity of the band is naturally greater than that of the top or bottom shale, the top shale having the lowest figure. The average specific gravity of the various parts of the seam are shown in the following table:—

	Goliath Mine.	Tasmanite Mine.	Latrobe Field.
	Per Cent.	Per Cent.	Per Cent.
Top shale .....	2·00	1·90	...
Middle band .....	2·50	2·45	...
Bottom shale.....	2·10	2·03	...
Top and bottom shale .....	2·04	1·96	2·00 to 2·02
Whole seam .....	2·15	2·09	2·12 to 2·13

In previous reports and calculations of reserves the specific gravity of the top and bottom shale was assumed to be 1·6, while from the above it is seen that the figure is 2·00. As a result of the sampling campaign, therefore, reserves of top and bottom shale will be increased by 25 per cent.

#### *Sulphur.*

Sulphur is present in the shale in two main forms:

- (1) As part of the composition of the kerogen.

An analysis of Church gives the sulphur content of the kerogen or Tasmanite as 5·28 per cent.

- (2) As pyrite in the mineral matter of the shale.

The pyrite occurs as—

- (a) Infillings of the Tasmanite sacs.  
 (b) Nodules in the shale.  
 (c) Veins and impregnations in the shale.

Further, it may occur to a small extent as sulphates (gypsum, &c.).

The following table gives the average sulphur content of the seam and different parts thereof:—

	Goliath Mine.	Tasmanite Mine.	Latrobe Field.
	Per Cent.	Per Cent.	Per Cent.
Top shale .....	2·54	2·78	...
Middle band .....	2·52	2·54	...
Bottom shale.....	2·77	3·01	...
Top and bottom shale.....	2·65	2·90	2·72 to 2·77
Whole seam .....	2·61	2·77	2·65 to 2·69

The middle band contains the least, and the bottom shale the most, sulphur. This proves that the view that the band contained more sulphur than the shale is erroneous. The whole seam contains less sulphur than does the top and bottom shale. These remarks apply, of course, to the average content, and do not preclude the possibility that in individual samples the middle band may contain more sulphur than either the top or bottom shale.

The above figures appear, therefore, to override the objection to retorting the whole of the seam because the middle band was considered to contain more sulphur. It must be remembered, however, that in treating the whole of the seam less oil is produced (to the extent of 22 per cent.), while the total sulphur in the material is only reduced 2.5 per cent., and it might be assumed that the oil will have a greater sulphur content. However, this does not appear to be the case, and the researches of Mr. E. E. Kurth prove that the sulphur content of the crude oil is fairly constant, no matter what the nature of the retorted shale.

#### Oil Yield.

The oil yield of the shale is the most important factor in connection with the economic exploitation of the shale, and the determination of it was the principal objective of the sampling campaign. As a result of the sampling and analyses the following averages (expressed in gallons per ton) have been calculated for the oil yield of the various parts of the seam:—

	Goliath Mine.	Tasmanite Mine.	Latrobe Field.
	Per Cent.	Per Cent.	Per Cent.
Top shale .....	36.3	44.3	....
Middle band .....	7.2	8.6	....
Bottom shale .....	29.65	32.7	....
Top and bottom shale ..	33.3	38.5	34.6 to 35.7
Whole seam .....	26.2	29.1	27.0 to 27.6

Of the three sections of the seam, the top shale is the richest (36.3 and 44.3), while the bottom shale is of lower grade (29.65 and 32.7), and the middle band is poorest (7.2 and 8.6).

In individual samples, owing to the range in the oil yield, the bottom shale may be richer than the top shale, e.g., Sample 42, where the bottom shale has an oil yield of 39.5 and the top shale a yield of 29.6. The oil content of the middle band does not in any sample exceed that of either the top or bottom shale, though in Sample No. 8 it (14.8) approaches that of the bottom shale (16.2).

It is to be noted that the oil yield of each section of the shale seam is greater for the Tasmanite Mine than for the Goliath Mine, particularly in the case of the top shale. This is also evident in the averages for the top and bottom shale (38.5 for the Tasmanite and 33.3 for the Goliath) and for the whole seam (29.1 for the Tasmanite against 26.2 for the Goliath). The former figures (38.5 and 33.3) really confirm those quoted for the oil yield at the last Committee meeting in Launceston. It must be remembered that until 1923 the only shale mine was the Railton-Latrobe one (now the Tasmanite), and most of the sampling and treatment of shale was of top and bottom shale from this mine. The figure of 40 gallons per ton was assumed to be the average oil yield as a result of the sampling and treatment, which figure is generally confirmed by the above one of 38.5 gallons per ton. In the Goliath Mine, opened first in 1923, it was claimed that the treatment in the Crozier retort gave an oil yield of approximately 33 gallons per ton for the top and bottom shale, which figure is almost identical with the 33.3 arrived at by sampling. It was, therefore, the fact that results from different mines, the shale in which gave different oil yields, were quoted that led to the differences of opinion as regards the oil yields.

The sampling has shown that the middle band has an average oil content of 7.2 to 8.6 gallons per ton. This content raises the question as to whether, seeing that the band has to be mined, it should be retorted instead of being rejected. By not having to pick it out from the shale, the cost of mining per ton of material delivered to the retorts would be decreased. Against this the oil yield of material retorted would be reduced from 33.3 to 26.2, or from 38.5 to 29.1 gallons per ton.

The averaging of the results from the two mines suggests that the oil yield from the Latrobe field will be for the top and bottom shale approximately 34.6 to 35.7 gallons per ton, and for the whole seam 27.0 to 27.6 gallons per ton.

P. B. NYE, Government Geologist.

Mines Department,  
Hobart, 31st October, 1931.

TABLE I.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	1C	837	70.10	2.35	1.90	2 0	44.8
Middle band .....	1B	759	91.00	2.64	2.49	1 2	6.3
Bottom shale .....	1A	814	79.40	2.86	2.21	2 0	25.4
Top and bottom shale ..	....	....	....	2.62	2.06	4 0	34.4
Whole seam .....	....	....	....	2.63	2.15	5 2	27.0
Top shale .....	2C	768	73.76	2.70	1.95	2 2	36.7
Middle band .....	2B	760	92.76	2.59	2.42	0 11.25	3.6
Bottom shale .....	2A	751	75.70	2.91	2.04	1 9.5	32.6
Top and bottom shale ..	....	....	....	2.80	1.99	3 11.5	34.8
Whole seam .....	....	....	....	2.75	2.07	4 10.75	27.8
Top shale .....	3C	838	72.48	2.24	1.95	1 11.5	39.5
Middle band .....	3B	761	90.74	3.28	2.41	1 1	6.6
Bottom shale .....	3A	752	75.80	3.08	2.04	1 11.5	32.4
Top and bottom shale ..	....	....	....	2.67	2.00	3 11	35.9
Whole seam .....	....	....	....	2.82	2.08	5 0	28.5
Top shale .....	4C	769	76.42	2.51	2.06	2 7	31.4
Middle band .....	4B	762	90.94	2.70	2.35	1 6	6.4
Bottom shale .....	4A	753	75.10	2.86	2.04	1 8	34.0
Top and bottom shale ..	....	....	....	2.65	2.05	4 3	32.4
Whole seam .....	....	....	....	2.66	2.13	5 9	24.9

TABLE I.—*continued.*

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	5C	770	76·80	2·48	2·04	2 6·5	30·4
Middle band .....	5B	763	89·86	2·66	2·47	1 7·5	8·0
Bottom shale .....	5A	754	77·70	2·88	2·07	1 9·5	28·4
				Eschka	2	.....	.....
				Fusion			
Top and bottom shale ..	.....	.....	.....	2·65	2·03	4 4·5	29·6
Whole seam .....	.....	.....	.....	2·72	2·17	5 11·5	22·9
Top shale .....	6C	771	72·80	2·28	1·94	1 11	38·9
Middle band .....	6B	764	92·16	2·44	2·52	1 2	4·6
Bottom shale .....	6A	755	77·70	2·95	2·10	1 9·5	28·4
Top and bottom shale ..	.....	.....	.....	2·62	2·02	3 8·5	33·6
Whole seam .....	.....	.....	.....	2·57	2·14	4 10·5	25·4
Top shale .....	7C	772	65·00	3·00	1·78	1 8	57·0
Middle band .....	7B	765	89·50	2·53	2·42	1 5	8·5
Bottom shale .....	7A	756	77·00	2·88	2·06	1 8	30·0
Top and bottom shale ..	.....	.....	.....	2·94	1·92	3 4	42·5
Whole seam .....	.....	.....	.....	2·79	2·07	4 9	30·6
Top shale .....	8C	773	71·50	2·61	1·94	2 1	41·9
Middle band .....	8B	766	85·36	2·82	2·29	0 11·25	14·8
Bottom shale .....	8A	757	84·62	2·69	2·24	2 0	16·2
Top and bottom shale ..	.....	.....	.....	2·65	2·09	4 1	28·4
Whole seam .....	.....	.....	.....	2·69	2·12	5 0·25	25·6

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	9C	774	65·20	2·47	1·83	1 6·5	56·5
Middle band .....	9B	767	89·00	2·58	2·45	1 7·5	9·3
Bottom shale .....	9A	758	76·60	2·80	2·02	1 8·5	30·9
Top and bottom shale ..	....	....	....	2·65	1·93	3 3	42·4
Whole seam .....	....	....	....	2·62	2·10	4 10·5	29·6
Top shale .....	10C	839	65·84	2·30	1·82	1 7·75	55·0
Middle band .....	10B	826	88·80	1·94	2·48	1 5·5	9·4
Bottom shale .....	10A	815	76·40	2·71	2·11	1 8	31·3
Top and bottom shale ..	....	....	....	2·52	1·97	3 3·75	42·2
Whole seam .....	....	....	....	2·31	2·12	4 9·25	30·5
Top shale .....	11C	840	76·20	2·44	2·07	2 11·5	31·7
Middle band .....	11B	827	90·10	2·81	2·56	1 0·5	7·6
Bottom shale .....	11A	816	75·60	2·77	2·09	1 8·75	32·9
Top and bottom shale ..	....	....	....	2·56	2·08	4 8·25	32·1
Whole seam .....	....	....	....	2·62	2·16	5 8·75	26·9
Top shale .....	12C	841	79·40	2·29	2·11	3 2·5	25·4
Middle band .....	12B	828	90·20	2·18	2·53	0 11	7·5
Bottom shale .....	12A	817	75·30	2·92	2·09	1 8·5	33·6
Top and bottom shale ..	....	....	....	2·51	2·10	4 11	28·2
Whole seam .....	....	....	....	2·44	2·17	5 10	24·4

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	13C	829	67.60	2.72	1.86	1 8.75	50.6
Middle band .....	13B	842	89.70	1.90	2.47	1 7	8.3
Bottom shale .....	13A	818	77.70	2.68	2.12	1 11	28.4
Top and bottom shale ..	....	....	....	2.70	2.00	3 7.75	38.2
Whole seam .....	....	....	....	2.42	2.14	5 2.75	27.7
Top shale .....	14C	843	74.40	2.14	2.00	2 0.25	35.5
Middle band .....	14B	830	91.70	1.87	2.59	1 4.5	5.2
Bottom shale .....	14A	819	81.00	2.84	2.25	2 3.25	22.3
Top and bottom shale ..	....	....	....	2.53	2.13	4 3.5	28.1
Whole seam .....	....	....	....	2.35	2.24	5 8	21.7
Top shale .....	15C	844	76.56	2.77	2.07	2 11.75	31.0
Middle band .....	15B	831	91.04	2.05	2.56	1 1	6.2
Bottom shale .....	15A	820	78.68	2.70	2.15	1 11.5	26.6
Top and bottom shale ..	....	....	....	2.74	2.10	4 11.25	29.2
Whole seam .....	....	....	....	2.60	2.18	6 0.25	24.4
Top shale .....	16C	845	76.36	2.22	2.05	2 8.25	31.5
Middle band .....	16B	832	90.90	2.10	2.53	0 10.25	6.5
Bottom shale .....	16A	821	80.62	3.44	2.26	0 8.25	23.0
Top and bottom shale ..	....	....	....	2.49	2.09	3 4.5	29.6
Whole seam .....	....	....	....	2.40	2.18	4 2.75	24.2

TABLE I.—*continued.*

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	17C	846	75.00	2.65	2.04	3 0.25	34.1
Middle band .....	17B	833	90.78	2.04	2.50	1 2	6.6
Bottom shale .....	17A	822	77.04	2.69	2.10	1 8.25	30.0
Top and bottom shale ..	....	....	....	2.66	2.06	4 8.5	32.6
Whole seam .....	....	....	....	2.52	2.15	5 10.5	26.5
Top shale .....	18C	871	78.54	2.22	2.11	2 10.5	27.0
Middle band .....	18B	834	89.70	2.73	2.50	1 5	8.3
Bottom shale .....	18A	823	78.30	2.66	2.12	1 10	27.5
Top and bottom shale ..	....	....	....	2.39	2.11	4 8.5	27.2
Whole seam .....	....	....	....	2.54	2.20	6 1.5	22.2
Top shale .....	19C	872	80.44	1.97	2.17	3 1	23.4
Middle band .....	19B	835	91.34	2.21	2.58	1 0.75	5.8
Bottom shale .....	19A	824	78.10	2.73	2.12	1 10	27.9
Top and bottom shale ..	....	....	....	2.25	2.15	4 11	25.0
Whole seam .....	....	....	....	2.24	2.23	5 11.75	21.1

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	20C	873	76.10	2.07	2.08	3 0.75	31.9
Middle band .....	20B	836	89.90	3.53	2.56	1 2	8.0
				Eschka 3.57	....	....	....
Bottom shale .....	20A	825	77.72	Peroxide 2.78	2.12	1 9	28.4
				Eschka 2.80	....	....	....
Top and bottom shale ..	....	....	....	2.34	2.09	4 9.75	30.7
Whole seam .....	....	....	....	2.62	2.18	5 11.75	25.4
Top shale .....	21C	908	69.90	2.91	1.89	1 9.5	45.1
Middle band .....	21B	891	89.30	3.10	2.53	1 3.75	8.8
Bottom shale .....	21A	874	75.24	2.53	2.05	1 10	33.8
Top and bottom shale ..	....	....	....	2.71	1.97	3 7.5	39.1
Whole seam .....	....	....	....	2.83	2.12	4 11.25	29.5
Top shale .....	22C	909	75.86	2.61	2.94	2 10	32.4
Middle band .....	22B	892	89.90	3.98	2.62	1 1.5	8.0
Bottom shale .....	22A	875	76.62	2.74	2.09	1 9	30.9
Top and bottom shale ..	....	....	....	2.66	2.06	4 7	31.8
Whole seam .....	....	....	....	2.97	2.17	5 8.5	26.1

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton
Top shale .....	23C	910	72.00	2.77	1.94	1 6.75	40.6
Middle band .....	23B	893	89.44	2.46	2.51	1 4	8.5
Bottom shale .....	23A	876	77.70	2.43	2.09	1 11	28.4
Top and bottom shale ..	.....	.....	.....	2.58	2.03	3 5.75	33.7
Whole seam .....	.....	.....	.....	2.54	2.16	4 9.75	25.5
Top shale .....	24C	911	73.38	2.23	1.97	2 1	37.8
Middle band .....	24B	894	91.62	2.27	2.56	1 0.5	5.3
Bottom shale .....	24A	877	77.00	2.50	2.10	1 9.75	30.0
Top and bottom shale ..	.....	.....	.....	2.36	2.02	3 10.75	34.0
Whole seam .....	.....	.....	.....	2.34	2.16	4 11.25	26.8
Top shale .....	25C	912	72.50	3.57	1.96	1 10.25	39.5
Middle band .....	25B	895	90.24	2.22	2.52	1 5.5	7.5
Bottom shale .....	25A	878	73.88	2.76	2.02	1 5	36.6
Top and bottom shale ..	.....	.....	.....	3.21	1.97	3 3.25	38.2
Whole seam .....	.....	.....	.....	2.85	2.15	4 8.75	27.1
Top shale .....	26C	913	72.84	3.57	1.98	2 1	38.9
Middle band .....	26B	896	91.34	2.25	2.55	1 2.25	5.8
Bottom shale .....	26A	879	74.90	2.51	2.05	1 3.75	34.3
Top and bottom shale ..	.....	.....	.....	3.15	2.01	3 4.75	37.1
Whole seam .....	.....	.....	.....	2.87	2.15	4 7	27.5

TABLE I.—*continued.*

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	27C	914	72.40	2.64	1.95	1 8.75	39.9
Middle band .....	27B	897	90.12	2.36	2.55	1 2	7.6
Bottom shale .....	27A	880	76.00	2.55	2.06	1 8.5	32.0
Top and bottom shale ..	....	....	....	2.59	2.00	3 5.25	35.8
Whole seam .....	....	....	....	2.52	2.14	4 7.25	27.3
Top shale .....	28C	916	77.58	2.66	2.10	2 9.5	28.9
Middle band .....	28B	915C	91.60	2.60	2.60	1 0.5	5.3
Bottom shale .....	28A	881	76.28	2.85	2.07	1 7.5	31.6
Top and bottom shale ..	....	....	....	2.73	2.09	4 5	29.9
Whole seam .....	....	....	....	2.70	2.19	5 5.5	24.3
Top shale .....	29C	917	70.40	2.95	1.92	1 9.75	44.10
Middle band .....	29B	899	90.18	2.24	2.50	1 6	7.55
Bottom shale .....	29A	882	75.10	2.91	1.92	1 7.25	34.0
Top and bottom shale ..	....	....	....	2.93	1.97	3 5	39.2
Whole seam .....	....	....	....	2.68	2.13	4 11	27.9
Top shale .....	30C	918	73.34	3.35	2.00	1 11.5	37.8
Middle band .....	30B	900	91.68	2.24	2.56	1 1.75	5.2
Bottom shale .....	30A	883	77.00	2.87	2.10	1 9	30.0
Top and bottom shale ..	....	....	....	3.12	2.05	3 8.5	34.0
Whole seam .....	....	....	....	2.87	2.17	4 10.25	26.0

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	31C	919A	73.40	2.23	1.99	2 3	37.6
Middle band .....	31B	901	91.30	2.72	2.56	0 11	5.8
Bottom shale .....	31A	884	76.70	2.69	2.09	1 10.75	30.6
Top and bottom shale ..	....	....	....	2.45	2.03	4 1.75	34.3
Whole seam .....	....	....	....	2.51	2.13	5 0.75	28.1
Top shale .....	32C	919	71.32	2.61	1.92	1 10.5	42.1
Middle band .....	32B	902	91.48	2.88	2.57	1 1	5.5
Bottom shale .....	32A	885	75.60	2.80	2.06	1 10	32.9
Top and bottom shale ..	....	....	....	2.71	1.99	3 8.5	37.4
Whole seam .....	....	....	....	2.75	2.12	4 9.5	28.6
Top shale .....	33C	920	70.60	2.74	1.88	1 10.75	43.8
Middle band .....	33B	903	90.90	2.38	2.52	1 1	6.5
Bottom shale .....	33A	886	76.68	2.78	2.10	1 9	30.6
Top and bottom shale ..	....	....	....	2.76	1.98	3 7.75	37.1
Whole seam .....	....	....	....	2.66	2.11	4 8.75	28.7
Top shale .....	34C	921	64.10	2.74	1.77	1 5.5	59.2
Middle band .....	34B	904	88.70	3.08	2.44	1 9	9.5
Bottom shale .....	34A	887	80.42	2.91	2.15	2 3.5	23.4
Top and bottom shale ..	....	....	....	2.85	2.00	3 9	35.7
Whole seam .....	....	....	....	2.93	2.14	5 6	26.2

TABLE I.—*continued.*

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	35C	922	71.00	2.74	1.90	2 1	42.9
Middle band .....	35B	905	90.32	2.66	2.51	1 1	7.3
Bottom shale .....	35A	888	75.58	3.58	2.06	1 10	32.9
Top and bottom shale ..	....	....	....	3.15	1.97	3 11	38.0
Whole seam .....	....	....	....	3.02	2.09	5 0	30.0
Top shale .....	36C	923	68.24	2.81	1.84	1 10.25	49.0
Middle band .....	36B	906	90.00	2.49	2.46	1 4.75	7.8
Bottom shale .....	36A	889	75.00	2.98	2.01	1 10	34.1
Top and bottom shale ..	....	....	....	2.90	1.92	3 8.25	41.3
Whole seam .....	....	....	....	2.77	2.07	5 1	30.3
Top shale .....	37C	924	72.18	2.63	1.93	2 0	40.2
Middle band .....	37B	907	91.52	2.40	2.53	1 0.25	5.4
Bottom shale .....	37A	890	76.90	3.21	2.08	1 10.5	30.2
Top and bottom shale ..	....	....	....	2.92	2.00	3 10.5	35.2
Whole seam .....	....	....	....	2.77	2.11	4 10.75	27.4
Top shale .....	38C	967	70.50	2.88	1.96	2 2.75	43.9
Middle band .....	38B	956	90.64	3.03	2.59	1 0	6.7
Bottom shale .....	38A	945	74.12	3.58	2.04	1 7.5	36.1
Top and bottom shale ..	....	....	....	3.18	1.99	3 10.25	40.5
Whole seam .....	....	....	....	3.20	2.12	4 10.25	32.0

TABLE I.—*continued.*

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	39C	968	65.10	3.57	1.76	1 10.75	56.7
Middle band .....	39B	957	88.86	3.34	2.47	1 10	9.4
Bottom shale .....	39A	946	76.20	3.17	2.07	1 8	31.7
Top and bottom shale ..	.....	.....	.....	3.37	1.90	3 6.75	44.0
Whole seam .....	.....	.....	.....	3.36	2.10	5 4.75	30.1
Top shale .....	40C	969	66.56	3.10	1.89	1 9	53.3
Middle band .....	40B	958	91.80	2.47	2.55	1 6	5.1
Bottom shale .....	40A	947	74.89	3.17	2.04	2 0	34.3
Top and bottom shale ..	.....	.....	.....	3.14	1.97	3 9	42.8
Whole seam .....	.....	.....	.....	2.91	2.13	5 3	29.9
Top shale .....	41C	970	64.56	2.79	1.77	1 4.5	58.2
Middle band .....	41B	959	86.30	2.47	2.32	1 11	13.5
Bottom shale .....	41A	948	74.82	4.36	2.06	1 5	34.5
Top and bottom shale ..	.....	.....	.....	3.65	1.92	2 9.5	45.3
Whole seam .....	.....	.....	.....	3.11	2.08	4 8.5	30.8
Top shale .....	42C	971	77.20	4.65	2.11	2 0	29.6
Middle band .....	42B	960	85.80	2.17	2.32	2 0	14.2
Bottom shale .....	42A	949	72.48	2.86	1.85	1 8.5	39.5
Top and bottom shale ..	.....	.....	.....	3.88	1.99	3 8.5	33.8
Whole seam .....	.....	.....	.....	3.22	2.10	5 8.5	26.2

TABLE I.—continued.

Section of Seam.	Sample No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	43C	972	81·86	2·33	2·18	1 0	20·7
Middle band .....	43B	961	91·16	2·06	2·49	1 4·75	7·5
Bottom shale .....	43A	950	78·90	2·53	2·10	1 11	26·2
Top and bottom shale ..	....	....	....	2·46	2·13	2 11	24·2
Whole seam .....	....	....	....	2·32	2·24	4 3·75	18·2
Top shale .....	44C	973	68·14	2·39	1·83	2 3·5	49·1
Middle band .....	44B	962	89·50	2·25	2·46	1 5	8·5
Bottom shale .....	44A	951	75·10	2·50	1·98	1 8·5	34·0
Top and bottom shale ..	....	....	....	2·44	1·89	4 0	42·4
Whole seam .....	....	....	....	2·38	2·04	5 5	31·7
Top shale .....	45C	974	73·36	2·58	1·94	2 0	37·8
Middle band .....	45B	963	89·80	2·72	2·47	0 11	8·1
Bottom shale .....	45A	952	73·32	3·06	1·97	1 8·5	37·8
Top and bottom shale ..	....	....	....	2·80	1·95	3 8·5	37·8
Whole seam .....	....	....	....	2·78	2·06	4 7·5	30·7
Top shale .....	46C	975	71·70	2·22	1·89	2 6	41·2
Middle band .....	46B	964	90·58	1·44	2·43	1 0	6·9
				Eschka			
				1·50			
				Fusion			
Bottom shale .....	46A	953	74·48	2·40	2·00	1 9·25	35·4
Top and bottom shale ..	....	....	....	2·30	1·93	4 3·25	38·7
Whole seam .....	....	....	....	2·12	2·03	5 3·25	31·5

TABLE I.—continued.

Section of Seam.	Sampl. No.	Reg. No.	Ash.	Sulphur.	Specific Gravity.	Thickness.	Oil Yield (deduced from Ash Content).
			Per cent.	Per cent.		ft. in.	Gals. per ton.
Top shale .....	47C	976	67.40	2.47	1.78	2 0.5	51.0
Middle band .....	47B	965	90.24	2.13	2.46	1 1	7.5
Bottom shale .....	47A	954	75.76	2.13	2.01	1 10.5	32.5
Top and bottom shale ..	....	....	....	2.30	1.89	3 11	41.6
Whole seam .....	....	....	....	2.25	2.01	5 0	32.6
Top shale .....	48C	977	73.34	1.84	1.95	2 2.25	37.8
Middle band .....	48B	966	91.20	2.33	2.48	0 11.25	6.0
Bottom shale .....	48A	955	75.20	3.02	2.03	1 7.5	33.8
Top and bottom shale ..	....	....	....	2.35	1.98	3 9.75	36.0
Whole seam .....	....	....	....	2.35	2.08	4 9	29.0

TABLE II.

Section of Seam	Mine		Sulphur	Specific Gravity	Thickness		Oil Yield
			Per Cent.		ft. ins.	ft. ins.	Gallons Per Ton.
Top shale .....	Goliath	Range Average	1.97 to 3.57 2.54	1.78 to 2.17 2.00	1 6.5 to 3 2.5 2 2.99	23.4 to 57.0 36.3	
	Tasmanite	Range Average	1.84 to 4.65 2.78	1.76 to 2.18 1.90	1 0 to 2 6 1 10.93	20.7 to 59.2 44.3	
Middle band ..	Goliath	Range Average	1.87 to 3.98 2.52	2.29 to 2.62 2.50	0 10.25 to 1 7.5 1 2.55	3.6 to 14.8 7.2	
	Tasmanite	Range Average	1.44 to 3.34 2.54	2.32 to 2.59 2.45	0 11 to 2 0 1 4.20	5.1 to 14.2 8.6	
Bottom shale ..	Goliath	Range Average	2.43 to 3.44 2.77	2.02 to 2.26 2.10	0 8.25 to 2 3.25 1 8.95	16.2 to 36.6 29.65	
	Tasmanite	Range Average	2.13 to 4.36 3.01	1.85 to 2.15 2.03	1 5 to 2 3.5 1 9.48	23.4 to 39.5 32.7	
Top and bot- tom shale ..	Goliath	Range Average	2.25 to 3.21 2.65	1.92 to 2.15 2.04	3 3.0 to 4 11.25 3 11.95	25.0 to 42.5 33.3	
	Tasmanite	Range Average	2.30 to 3.88 2.90	1.89 to 2.13 1.96	2 9.5 to 4 3.25 3 8.41	24.2 to 45.3 38.5	
Whole seam ..	Goliath	Range Average	2.24 to 2.97 2.61	2.07 to 2.24 2.15	4 2.75 to 6 1.5 5 2.50	21.1 to 30.6 26.22	
	Tasmanite	Range Average	2.12 to 3.36 2.77	2.01 to 2.24 2.09	4 3.75 to 5 8.5 5 0.62	18.2 to 32.6 29.12	

TABLE III.

Section of Seam.		Sulphur.	Specific Gravity.	Thickness.	Oil Yield.
		Per Cent.		ft. ins.	Gals. per Ton.
Top and bottom shale	I. ....	2.77	2.00	3 10.18	35.74
	II. ....	2.72	2.02	3 10.84	34.79
	III. ....	2.72	2.02	3 10.94	34.66
Whole seam	I. Each mine of equal "weight"	2.69	2.12	5 1.61	27.63
	II. Weighted according to number of samples (33 : 15) ..	2.66	2.13	5 1.91	27.09
	III. Weighted according to areas represented by the sampling (2.5 : 1) ....	2.65	2.13	5 1.96	27.01

SUPPLEMENTARY REPORT ON THE RESULTS OF THE SAMPLING  
OF THE TASMANITE SHALE AT LATROBE.

In the report on the results of the sampling campaign the results of moisture determinations were accidentally omitted, and are therefore being included in this supplementary report.

Owing to the necessity of transporting samples for moisture determination in airtight containers, and the necessity and cost of providing same, it was decided not to attempt to determine the moisture on all representative samples (144 in number) taken during the campaign. Samples were taken at the same places as four of the representative samples (2, 15, 31, and 35), making 12 samples in all, and these were forwarded to Launceston in corked and sealed pickle-bottles.

The moisture content was determined in the Mines Department, Launceston, with the following results:—

Sample No.	Top Shale. C	Middle Band. B	Bottom Shale. A
	Per Cent.	Per Cent.	Per Cent.
2	5.30	6.90	7.50
15	2.20	1.93	1.90
31	2.70	1.98	2.58
35	4.85	6.98	6.65

Samples 2, 15, and 31 were from the Goliath Mine, and sample number 35 was from the Tasmanite Mine. Sample number 2 was taken from a place where the shale was somewhat damp, due to percolating water. Samples Nos. 15 and 31 were taken from the typical dry places in the mine. Sample number 35 represents the typical shale in the Tasmanite Mine away from seepages of water. Both mines are no great depth from the surfaces, and the samples must therefore be regarded as coming from shallow depths. From an inspection of the mines the Tasmanite appears to be wetter than the Goliath, and it is anticipated that the shale from the former will contain a greater moisture content.

The averages calculated from the above results are—

Sample No.	Top and Bottom Shale.	Whole Seam.
	Per Cent.	Per Cent.
2	6.48	6.57
15	2.02	2.00
31	2.64	2.49
35	5.77	6.09

The above figures show that the moisture content has a considerable range. Samples 2 and 35 have similar contents of approximately 6.5 per cent and 6.0 per cent respectively, while numbers 15 and 31 also have similar contents of approximately 2.0 per cent and 2.5 per cent respectively, which are much lower than those of numbers 2 and 35. These differences are due to the fact that numbers 2 and 35 represent wet or damp shale, while numbers 15 and 31 represent the normal dry shale of the Goliath Mine.

The above do not serve to give the average moisture content of the shale, as a large number of samples would be necessary for this purpose. However, they serve to give some idea of the moisture content, and it may be assumed that the content of the dry shale in the Tasmanite Mine is 2.0 to 2.5 per cent approximately, and that of the damp or wet shale in both mines is 6.0 to 6.5 per cent approximately. The average in mines such as those now opened up would be between the above figures, but in dry mines it would be nearer to the lower figure (2.0 per cent to 2.5 per cent), and in wet mines it would approach the higher figures (6.0 per cent to 6.5 per cent).

P. B. NYE, Government Geologist.

Mines Department,

Hobart, 19th December, 1931.

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TASMANIAN SHALE OIL INVESTIGATION: MINING  
SUB-COMMITTEES' REPORT.

Public Buildings,

Launceston, 16th April, 1931.

To Chairman,

Tasmanian Shale Oil Investigation Committee.

SIR,

At the meeting of the Tasmanian Shale Oil Committee held at Latrobe on 12th and 13th February, 1931, it was resolved to form a sub-committee, entitled "The Mining Sub-Committee," to investigate the mining problems as per the following resolutions:—

A. *Mining Sub-Committee.*—Resolved, That Messrs, Rees, Nye, and Scott, together with Messrs. Hindmarsh and Hood, whose services were to be co-opted, form a Mining Sub-Committee to investigate and report on the probable costs of mining 150, 250, 500, and 1000 tons of shale per day. It was

also recommended that this Sub-Committee consult with the Chief Inspector of Mines. Mr. P. B. Nye to act as Chairman of the Sub-Committee.

*B. Output of Shale.*—Resolved, That the Mining Sub-Committee report on the possibility of an output of shale on the basis of 500, 1000, and 2000 tons per day.

All available information in the Mines Department relating to the shale deposits of Tasmania was collated and issued to all members of the Sub-Committee as a report entitled "The Oil Shale Resources of Tasmania." This was followed by a circular entitled "Preliminary Notes for the Guidance of the Mining Sub-Committee."

A visit was made to Latrobe by Messrs. Hindmarsh and Hood, the co-opted members of the Sub-Committee, and the mine workings inspected. With the exception of Mr. Jude, all members of the Sub-Committee have thus inspected the shale workings.

The Sub-Committee met in Launceston on 15th April, there being present Mr. P. B. Nye (in the chair), Messrs. Hindmarsh, Hood, Scott, Jude, and Rees. Professor Hytten also attended the meeting.

The resolution (B) covering the output of shale was dealt with first, and after discussion it was resolved that in view of the information available it would not be possible to mine on an economic basis more than 1000 tons of shale per day, and that the output at the beginning be limited to a quantity sufficient to supply a retorting plant treating 500 tons per day. Further, that the mining should be carried out in the shale-bearing area east of the River Mersey and north of the Great Bend.

Dealing with Resolution A, a general discussion on methods of mining ensued, and the following decisions were arrived at:—

- (1) *Bord and Pillar Method.*—This method would be applicable under all conditions known to occur in the shale fields. The Committee considers that the costs, viz., 10s. 4d., plus an allowance of 1s. for contingencies, per ton, submitted by Messrs. Hindmarsh and Hood, to be a reasonable estimate for the mining of 500 tons per day under the above method. This estimate does not include provision for depreciation or interest, and is based on the present thickness of the seam (4 feet 6 inches to 5 feet) and the rates applicable to the Coalminers' Award (Australian Coal and Shale Employees' Federation). The corresponding costs for 250 tons per day would be 11s. 9d. per ton.

The Sub-Committee is of the opinion that it would not be economic to mine less than 250 tons per day, and so estimated cost for 150 tons per day is not given.

(2) *Longwall Method.*—The conditions in the shale fields are such that longwall methods could be applied, except for—

- (a) The presence of faults. Providing these faults were outlined by boring and development work, this disadvantage would be minimised, except in so far as they may cause the faces to be carried at an angle not satisfactory for other working conditions and economic extraction.
- (b) The presence of pebbles in the shale prohibits the use of chain or bar cutting machines, so that the rate of advancement of the face would be reduced. The faces could, however, be worked by other, but slower, methods.
- (c) The soft material in the fault and fracture planes would materially retard the workings of the longwall system.

The Sub-Committee recommends that advancing longwall methods would not be suitable, and any longwall method would need to be of the retreating type.

The Sub-Committee considers that the cost, viz., 9s. 4d. per ton, plus 1s. per ton for contingencies, submitted by Messrs. Hindmarsh and Hood, to be a reasonable estimate for the mining of 500 tons per day under a retreating longwall method. These costs are subject to the same provisions as for the bord and pillar method.

The Sub-Committee recommends that the shale deposits should be worked by bord and pillar method in the early stages of mining operations, and that the development headings should be driven to the boundaries of the shale area. The possibility of longwall mining could then be considered in view of the information obtained by such development work.

The Chief Inspector of Mines was consulted, and in a letter to the Chairman of the Sub-Committee advises that, in his opinion, the advanced longwall method would not be applicable, but as developments may show different conditions the most economical method would be acceptable.

Yours faithfully,

P. B. NYE,

Chairman, Mining Sub-Committee.

**Appendix 4b.****FINAL REPORT OF MINING SUB-COMMITTEE ON  
OIL SHALE IN TASMANIA.**

The oil shales are described in Appendix A, "The Oil Shale Resources of Tasmania," attached to this report. Further information is also available in "Mineral Resources No. 8A."

The shales include the Tasmanite shale, the "kerosene shale" of Preolenna, and the pelionite of Barn Bluff. From the point of view of immediate development of the oil shale industry, the Tasmanite shale is the most important, as it has the greatest extent and reserves of shale; a thickness suitable for economic mining; and an oil content which may permit of economic retorting; and has been subject to testing in many ways.

*Tasmanite Shale Fields.*

The Tasmanite shale fields are restricted to the north-western districts. They occur mainly in the Latrobe-Quamby Bluff region, with an outlying field in the vicinity of Oonah, some 40 miles to the west. In the Latrobe-Quamby Bluff region the shale occurs in 13 separate fields or areas, over a length of 27 miles and a width of 7 miles. Eight areas occur between Latrobe and Merseylea, and represent the most closely spaced portion of this region. Outlying areas occur at Nook, Beulah, Kimberley, Chudleigh, and Quamby Bluff. Of the above eight areas, six occur between Latrobe and Railton, and attention has been restricted mainly to these in the past attempts to establish a shale oil industry.

From several viewpoints, including thickness, extent, amount of prospecting and drilling, known reserve, &c., Areas II. (north of Great Bend), III. (west of Great Bend), and V. (China Flat) are the most important. These points are more fully discussed in Appendix B.

*Reserves.*

This question was discussed in the "Oil Shale Resources" (Appendix A) and "Preliminary Notes" (Appendix B). The figures given in these reports were based upon a specific gravity of the shale of 1.6, but have been altered in this report and the table attached to Appendix II. in conformity with the specific gravity of 2.0 determined by systematic sampling and testing (1 acre-foot of shale equals 1875 tons).

*Total Reserves.*

In the past the estimates of reserves have been made largely upon geological evidence, and this method of estimating was forced upon the investigators by the general lack of testing and developmental work. While such methods

have their greatest application in the case of bedded deposits, such as coal, shale, &c., they should, however, be regarded as rather indicating the possible areal extent of the deposit than as actual estimates of tonnages. This would apply particularly to the Tasmanite shale deposits, where, though the shale may extend over the area indicated, a thinning of the seam may cause part of the area to be regarded as containing no *economic* reserves, i.e., those which can be economically mined. Further, other factors, such as faulting, poor quality of shale (due, possibly, to increase in thickness of band affecting the quality), as well as thickness of shale, &c., might affect the amount of *economic* reserves.

The position to-day is much the same as regards prospecting and development of the different areas, so that calculation of reserves is still somewhat uncertain. It is for this reason that in the report on the oil shale resources, and also in the attached table, they may have been put under headings of "partly proved" and "possible extensions." The "partly proved" includes all reserves in which mine openings, outcrops, bore-holes, and shaft assist in the determination of same. The "possible extensions" include the reserves in areas in which there is every reason to believe from geological evidence that the shale exists, but which have not been prospected.

From the figures in the table it will be seen that in the Latrobe-Railton field there is a partly proved reserve of 8,652,500 tons and a possible extension of 7,072,500 tons, or a total of 15,725,000 tons. In the remaining areas in the Latrobe Quamby-Brook district, only a small "partly proved" reserve can be considered to exist, while the total of this and the possible extensions amounts to 9,316,750 tons. Developmental work in these latter areas would probably prove this reserve and possibly add considerably to the amount.

In the present state of our knowledge of our deposits it would appear that the total tonnage of "partly proved" and "possible extensions" is 25,041,750 tons. From this figure there would need to be deducted the reserves from those areas in which prospecting and developmental work proves the shale seam to be too thin for economic mining. Such areas might include VI. (Parramatta) and VII. (Native Plains).

#### *Maximum Output of Shale.*

Owing to the limited size of the areas, it is not possible to mine shale on a larger scale than necessary to maintain an industry retorting 1000 tons per day, and this would have to be done by mining two areas. The Sub-Committee, however, recommends that the output at the beginning should be limited to a quantity sufficient to provide for the retorting of 500 tons per day, and that this should be drawn from Area II. (north of Great Bend).

*Results of Sampling Campaign.*

The results of the systematic sampling campaign undertaken by the Department are shown in the following table:—

Section of Seam.	Mine.	Sulphur.	Specific Gravity.	Thickness.		Oil Yield.
		Per Cent	Per Cent	ft.	in.	Gals. per Ton.
Top Shale .. .. .	Goliath	2.54	2.00	2	2.99	36.3
	Tasmanite	2.78	1.90	1	10.93	44.3
Middle Band ..	Goliath	2.52	2.50	1	2.55	7.2
	Tasmanite	2.54	2.45	1	4.20	8.6
Bottom Shale	Goliath	2.77	2.10	1	8.95	29.65
	Tasmanite	3.01	2.03	1	9.48	32.7
Top and Bottom Shale ..	Goliath	2.65	2.04	3	11.95	33.3
	Tasmanite	2.20	1.96	3	8.41	38.5
Whole Seam ..	Goliath	2.61	2.15	5	2.50	26.22
	Tasmanite	2.77	2.09	5	0.62	29.12

The following remarks on Power-supply, Method of Working, Coal-cutting Machines, Loading Machines, Electric Locomotives, Skips, Band in Seam, Method of Handling Coal, and Estimated Capital Expenditure are extracted from Mr. Hindmarsh's report of 22nd June, 1931 (Appendix 4c), with which Mr. Hood was in agreement.

*Power-Supply.*

There are two possible sources of power-supply, viz.:—

- (1) Generation of power at mine, involving the purchase and erection of boilers, turbines, generators, &c.
- (2) Purchase of electricity from the Hydro-Electric Commission, whose mains are at present within easy distance of the properties.

It would appear that if power can be purchased at a reasonable cost, say at 1 penny to 1.5 pence per unit, that this would be the most favourable proposition.

In this case the whole of the plant should be electrified.

### *Method of Working.*

There are three general methods of working which may be adopted in mining, viz.:—

- (1) Bord and Pillar.
- (2) Longwall Advancing.
- (3) Longwall Retreating.

(1) *Bord and Pillar*.—This system could be adopted under any conditions which are likely to be met with, and is the one I recommend be started.

(2) *Longwall Advancing*.—Owing to the faulting and fissures filled with clay which are known to exist, from the meagre information available, I cannot conceive of this system being successfully worked on these areas, as I understand that the fault planes are erratic in direction, and the possibilities are that you would be continually opening up new faces, entailing heavy expense and loss of output.

(3) *Longwall Retreating*.—I have little doubt that when the area has been more extensively proved by means of developmental headings that a longwall retreating system will be feasible.

I am submitting a plan of Areas Nos. 2 and 5, with workings projected thereon. This shows a number of different methods of working panels, and gives my views generally on how the areas should be opened up, but, of course may be subject to considerable modification in view of the information that will be gained in the developmental places.

### *Coal-Cutting Machines.*

Owing to the presence of quartz pebbles, which are interspersed throughout the seam, I consider it is not feasible to work the chain or bar coal-cutting machines, as immediately the picks struck these pebbles it would be necessary to change same, and from indications showing at the face at the time of our visit, a great amount of the machine-men's time would be taken up in changing picks.

A percussive machine could be used, but it is doubtful in my mind as to whether these would be an advantage over shooting out of the solid or "grunching."

Mr. Hood is of the opinion that the trial of percussive machines is worthy of consideration, seeing that compressed air is already being supplied to the mine.

### *Loading Machines.*

With the bord and pillar system without the use of coal-cutting machines, the output per 8 yards place would be so small that in my opinion the use of loading machines would not be justified.

If it is found later that a longwall retreating system can be applied, then scraper loaders or conveyors, or perhaps both, may be found economical, but I cannot at this stage make a definite recommendation.

*Electric Locomotives.*

These may be found economical along the main levels, but so much depends on the grades and faulting that I cannot recommend their use at the present, and it would appear that a small rope haulage, such as main and tail, would be the best proposition until a considerably larger area has been opened up.

All main roads should be properly laid, fish-plated, and sleepers, so that locomotives can be used at a later date, if necessary, without any heavy road-laying costs.

*Skips.*

These should be as large as possible, taking into consideration the height of the seam and grades, but I would suggest that a skip carrying at least 25 cwt. of shale be used, the height of the skip to be kept down to a minimum to conserve the energy of the filler.

*Band in Seam.*

One very bad feature of the seam is that a band of very low grade shale, approximately 12 inches thick, runs somewhere about the middle of the seam.

The band is not clearly defined, and the consensus of opinion among the retorting experts I discussed it with is that it is practically worthless. However, in view of the value determined by sampling being 7.2 to 8.6 gallons per ton, the question of retorting the band is worthy of consideration. This practice would lower the mining costs, but would increase the retorting costs (per gallon of crude oil).

It will certainly be very difficult to pick this band out in the mine, and if the miner is paid per ton of shale, then the inducement will be there for him to fill it into the skip.

The only other method of dealing with it is to fill everything into the skip, and clean out the band on the surface, but this will add materially to the plant on the surface, besides putting from 3d. to 6d. per ton on the surface cost, depending on the contour of the surface within easy distance of the mine for disposal of the refuse.

With this method the haulage and screening arrangements would have to handle 25 per cent more material than if the band were not brought to the surface, and I think it should be left in the mine, but it would then be necessary to have a dirt scale, so that the miners would be penalised for filling over specified amounts of band.

*Method of Handling Shale on Surface.*

Seeing that it is contemplated to work the two areas simultaneously, the shale to be delivered to one central crushing and retorting plant, some track will be necessary, and I have been asked to assume a distance of 3 miles.

As it is not yet known where the retorting plant will be placed, I do not know whether the 3 miles will cover sidings, nor do I know the extent of excavation and filling that will be necessary, but am basing my estimate on £5000 per mile of track, which may have to be considerably modified.

I have assumed that the shale from the mine will be tipped into a hopper holding, say, 5000 tons, while that from the other mine will be tipped into wagons and railed to the crushing plant, which I presume will be close to the above hopper.

The number of wagons required should be sufficient to hold at least a day's output from the No. 2 Mine, which, if the carrying capacity of the wagons is 10 tons, will mean 68 wagons.

An alternative scheme is to run a light line from one mine to the other, and convey the mine skips on this line, the whole of the output from both mines being tipped direct into the 5000-ton storage hopper.

So much depends on the relative positions of the crushing and retorting plant and the two mine entrances that it is impracticable to state definitely which would be the better scheme until these points are fixed.

*Estimated Capital Expenditure Required to Mine 680 Tons Per Day From Each of Two Mines and Deliver Same to a Central Crushing Plant.*

	£
Railway, assumed 3 miles at £5000 per mile .....	15,000
Storage hopper to carry 5000 tons (say) .....	10,000
Wagons, 68, at £250 each .....	17,000
Mine skips .....	8,000
Switchgear, transformers, cables, &c. ....	15,000
Engines, motors, compressors, &c., and foundations	15,000
Fans, motors, drift, and foundation and housing .....	5,000
Workshop and shop tools (common to both mines)	2,000
Store-room and stores (common to both mines) .....	1,250
Telephone service (common to both mines) .....	250
Underground rails, ropes, pipes, sleepers, &c. ....	4,000
Stables .....	600
Horses .....	800
Magazines .....	200
Office and furniture (common to both mines) .....	1,000
Official cottages (1 manager, 2 under-managers, 1 engineer) .....	4,500
	£99,600
Plus 10 per cent for contingencies .....	9,960
	£109,560

*Estimated Cost of Mining.*

The following figures are estimates by Mr. Hindmarsh and apply to the cost of mining 680 tons per day from each of two mines, one situated on Area II. and the other on Area V., the shale being delivered into hopper or wagons:—

	s.	d.
Hewing .....	3	9
Wheeling .....	0	5
Shift work .....	0	4
Deputies .....	0	1·5
Rope haulage .....	0	1·5
Pit-top hands .....	0	2
Mechanics .....	0	3
Staff .....	0	2
<hr/>		
Total wages cost .....	5	4
Rents and royalties .....	0	3
Stores .....	0	6
Pit timber .....	0	1·5
Horse-feed and stable expenses .....	0	1·5
Miscellaneous .....	0	0·5
Compensation .....	0	3
Power (electric current) .....	0	6
Plus 10 per cent for contingencies .....	0	8·55
<hr/>		
Total .....	7	10·05

showing a saving of 2s. 10·45d.

If it is proposed not to retort the middle band, but to leave same in the mine, I estimate the cost per ton of marketable shale as 9s. 6d., showing a reduction of 1s. 2·5d. over the original estimate of 22nd June, 1931.

These costs are, of course, for a seam of a total thickness of approximately 5 feet, but in some parts of the areas this is reduced to 2·75 feet according to the latest information, and the above tonnage rate would not apply to this thickness, and, as a matter of fact, I do not consider that it would be economical to mine a seam 2 feet 9 inches in thickness at all under the bord and pillar method.

No provision has been made for interest, depreciation, Federal and State income taxes, directors' fees, head office expenses, &c.

P. B. NYE,  
Chairman, Mining Sub-Committee.

## APPENDIX A.

## THE OIL SHALE RESOURCES OF TASMANIA.

*I. Introduction.*

The oil shale fields of Tasmania are restricted to the north, central, and north-western parts of the State, and their positions will be readily ascertained from the attached map (Appendix I.).

Two distinct types of oil shale occur, viz., the Tasmanite oil shale and the black "shales," or cannel coals, of Preolenna ("kerosene shales") and Barn Bluff (pelionite). Of the fields formed by these shales, those containing the Tasmanite shale are the most important for many reasons, including the following:—

- (1) They have the greatest extent and shale reserves.
- (2) They contain a seam ranging in thickness up to 7 feet, and being usually 4 to 5 feet, which is therefore ore that can be worked economically.
- (3) The Tasmanite shale yields on distillation, a sufficient quantity of crude oil (giving on fractionation marketable products) to render its treatment a possible economic success.
- (4) The deposits and the shale have been made the subject of a considerable amount of testing.

Thus, while all the fields will be described, it must be realised that the Tasmanite fields are the most important, and the establishment of a shale oil industry in the immediate future depends upon the exploitation of certain of the Tasmanite shale fields.

*II. The Tasmanite Shale Fields.*

The following information, descriptions, &c., are taken from departmental publications (the two most important of which are given below), augmented by existing reports and information from companies, consulting specialists, &c.:—

Twelvetrees, W. H.: "The Tasmanite Shale Fields of the Mersey District," Tas. Geol. Surv. Bull. No. 11, 1911.

Reid, A. McIntosh: "The Oil Shale Resources of Tasmania," Tas. Geol. Surv. Min. Resources No. 8, Vol. 1, 1924.

These reports were prepared as the result of areal geological surveys by the two Government Geologists respectively. The assistance of the above reports made possible the compilation of the following, which presents the subject-matter in different form, and includes information that has become available since the issue of the above.

*Geology.*—The Tasmanite shale seam is interbedded with the rocks of the Permo-Carboniferous system, and occurs at the horizon of the Greta series, between the Lower and the

Upper Marine series. Generally this horizon is represented by fresh-water sediments, containing seams of coal or carbonaceous shale. When the Tasmanite shale seam is present, the sediments are marine, and it has been established that the Tasmanite seam fringes the shores of the land (mainland and islands) which rose above the level of the existing Permo-Carboniferous seas (the lands were composed of Proterozoic schists and lower Palæozoic conglomerates, sandstones, &c.). The relations between marine and fresh waters are not easily deciphered, but shale-bearing strata are found to give place within a short distance of coal-bearing or carbonaceous shale-bearing strata. At the Bott Gorge, A. M. Reid found a transitional stage between the above two extreme types of deposition.

The rocks of the Permo-Carboniferous system are either horizontally bedded or dipping at low angles. Folding is absent, but faulting is very common. The rocks have been intruded by Mesozoic diabase (dolerite) on an extensive scale, the intrusions being mainly transgressive, but also occur as both thick and thin sills. A large proportion of the faulting is associated with these intrusions.

As a result of these intrusions and faulting, combined with the subsequent denudation of overlying rocks, the Permo-Carboniferous rocks (and the Tasmanite shale seam, when present) occur in a number of more or less separate blocks at different altitudes, the blocks being separated, and bounded by diabase intrusions and faults respectively. The denudation has also re-exposed the ancient lands and islands, which further help to cause the occurrence of the Permo-Carboniferous rocks and shale seam in separate tracts.

The shale fields are thus found to occur as numerous separated areas. These have been numbered and shown on the attached map, and are also described separately below. It must be remembered that there is possibly some small amount of information not in the possession of the Department, although attempts have been made to obtain all available information.

*Area I. (Northern Area).*—This area is situated about 3 miles to the south-east of the township of Latrobe. It has a general trend from the north-east, being approximately  $1\frac{3}{4}$  miles in length, with a maximum width of half a mile.

It includes the northern part of the 533-acre block of the Special Mineral Lease 6641, and parts of the land blocks charted as follows:—R. Stone, 30 acres; T. Smith, 50 acres; A. F. Jarman, 18 acres; R. Sagers, 260 acres (southern portion); J. James, 500 acres (north-east portion); M. Bourke, 24 acres; M. Bourke, 50 acres; and P. Pettit, 57 acres (northern portion).

The western boundary is determined by the Proterozoic schists. The Permo-Carboniferous rocks pass under Recent sediments and Tertiary sediments and basalt to the east and north. The limits of the shale-bearing portion in these directions has, however, been roughly determined by the Mersey Valley Oil Company's Bores 1 to 6.

Within the shale-bearing region the shale outcrops at three localities. The only development in this area consists

of six shafts (including the Tasmanian Shale and Oil Company's Nos. 5 to 8). The No. 5 shaft and small pit were sunk to the west of, and the Mersey Valley No. 3 bore to the south-west of, the shale-bearing area. The shaft situated 20 chains north-north-west of the No. 3 bore was not sufficiently deep to intersect the shale, as was also the case with Nos. 7 and 8 shafts.

Thus three outcrops and one shaft give the only information as to thickness, dip, and extent, &c., of the shale seam. A thickness of 4 feet is assumed by both Twelvetrees and Reid. The dip, as obtained from the outcrops, is given as a low angle east of north.

The extent of the seam has been based upon geological evidence, assisted by the above. Twelvetrees showed a shale-bearing area of 379 acres, but only calculated a reserve from 330 acres. Reid considered an actual reserve as occurring on 290 acres, and a probable reserve on 220 acres. Generally, reviewing the above, it appears likely that the seam may extend over 400 acres. Assuming a 4-foot seam, the possible reserve of shale is 2,400,000 tons.

The only record of the depth of the seam below the surface is 18 feet in No. 6 shaft, but this should be deeper to the north and east.

*Area II. (North of Great Bend).*—This area is situated 2 to 3 miles south of Latrobe. It is roughly elliptical in shape, having a length of  $1\frac{1}{2}$  miles and a width of 1 mile, with the longer axis in a north-and-south direction.

It includes Mineral Leases 6641-M (256 and 533-acre blocks); 8822-M; and the land blocks charted in the names of J. James, 500 acres; M. Gray, 25 acres; W. Dyson, 49 acres; F. Wright, 65 acres; N. H. Gerrard 50 acres; T. Johnson, 100 acres; E. Haig, 100 acres; and J. Coope, 248 acres.

The southern, eastern and north-eastern boundaries are determined by the Proterozoic schists. To the west and north-west the Permo-Carboniferous strata are concealed below shallow superficial deposits but while it is known that the shale seam gives place to one of coal, the exact limits have not been defined.

Outcrops are numerous along the Mersey River in the southern part of the area. Two main workings (those of the Tasmanite Shale and Oil Company and of Goliath Portland Cement Company) exist in the southern part. Four bores (three sunk by the Cement Company and the No. 3M bore of the Mines Department) have proved the existence of the seam. The No. 4 shaft of the Latrobe Shale and Oil Company was not deep enough to cut the seam. The Nos. 1M and 2M bores were outside the shale-bearing country, while the results of the remaining bore (near the river) of the Cement Company are not known. The thickness of the seam is better known on this area than any other on account of the outcrops and mine workings. It ranges from 3.5 to 7 feet, and consists of top and bottom seam, with a band in the middle. Excluding the band, previous investigators have taken, for calculation purposes, 4 feet as a reliable thickness for the seam.

The dip in the workings and outcrops is generally in a north-easterly direction, at angles up to 10°, but in the present workings of the Goliath Company the dip is to the north-north-west. Such variation of dip is to be expected owing to faulting and diabase intrusions.

Twelvevrees considered 220 acres as existing on the western part of James' 500-acre block and the 256-acre block of 6641-M. In view of later work, Reid increased the actual shale-bearing area to 375 acres, and the probable to 314 acres, or a total of 689 acres. Later boring, &c., has slightly reduced the extent of the shale-bearing land, and it is probable that the extent does not exceed 590 acres. On the basis of a 4-foot seam, this would give a possible reserve of 3,540,000 tons.

A diabase dyke traverses this area almost centrally from south-west to north-east, and practically divides it into two sub-areas, that to the south-east extending 348 acres, and the other over 242 acres.

The greatest recorded depth of the seam is 286 feet in the bore-hole of 8822-M.

A number of faults have been revealed by the mine workings and difference in levels of outcrops. In the Goliath Portland Cement Company's workings three faults have been intersected with throws from 1½ to 4½ feet. Another fault is evident between the mouths of the adits of the Tasmanite Shale and Oil Company's workings, while others are apparent from the outcrops. Faults with throws of larger dimensions undoubtedly occur between this and Area III.

*Area III. (West of Great Bend).*—This area is situated on the west side of the Mersey River, some 3 miles south of Latrobe. It has a general elliptical shape, its long axis being three-quarters of a mile in a north-and-south direction, and its short axis being half a mile in length.

It includes the following mineral leases:—151P-M and 152P-M; and land blocks charted in the names of J. Lobley, 41 acres; and H. Desbrow, 50 acres.

The south-eastern boundary is determined by a diabase dyke. To the east and north-east the area has been separated from Area II. by the denudation of the River Mersey. There may be a possible extension of the area to the west and north-west.

This area is the most prospected of all, as, in addition to the workings of the Australian Shale Oil Corporation (and the L. and N. Company), 30 bore-holes and several shafts have been sunk on it. Only three bore-holes failed to intersect the seam.

According to the information supplied, the average thickness of the shale seam would be 6 feet, inclusive of the band, which has a thickness up to 18 inches. Thus 4 feet would be a safe figure to use in calculations.

The correlation of the bore-holes along the line of the main adit of the Australian Shale Oil Corporation suggested a basin-shaped structure for the seam. Later work in the adit has proved a number of small faults within the seam, which, according to reports, make the mining of the seam

very difficult. The exact structure of the area is somewhat uncertain, and the basin-shaped structure is probably due to faulting on a larger scale than that within the seam. The workings have revealed one such fault immediately north of No. 19 bore.

Twelvetrees did not consider any large tract of shale-bearing land to exist in this vicinity. Reid calculated a probable reserve of 1,260,000 tons, which would correspond to an area of 210 acres. (This being based on the assumption that one-third of the area of the upper mudstone series is shale-bearing.)

The later boring campaign has generally proved a shale-bearing area of 164 acres, with possible extensions to west and north-west. This would give a reserve of 820,000 tons.

The greatest depth to shale from the bore records was 273 feet.

*Area IV. (South of Great Bend).*—This area is immediately south of Area III., being 1 mile south of the Great Bend and 4 miles south-south-east of Latrobe.

It is roughly elliptical in shape, being 30 chains in length from north to south and 20 chains wide. It includes portions of Leases 3994-M, 4792-M, and 4791-M.

The north-eastern and south-western boundaries are defined by the Proterozoic schists and Cambrian sandstones respectively. There may be an extension to the south-east, but diabase occupies a considerable portion of this region. It is probable that there is an extension to the north-west beneath the basalt on the land blocks charted in the names of G. A. Wakeham and F. Riley, 49 acres; J. Oliver, 50 acres; E. Morse, 29 acres; and Lease 153P-M. The limit to the extension in this direction is the diabase dyke at the south end of Area III. (This extension has not been included in the area, because everything depends upon the thickness of the basalt as to whether the shale exists under it. It is to be noted that a long strip of shale outcrops along the eastern side of Oliver's block.)

Practically no prospecting work has been carried out on this area. Campbell's shaft (25 feet) gave inconclusive results, and probably is west of the shale-bearing tract. Three other shafts between this one and Lease 4627-M were sunk by Hedditch but no shale was reported, and their positions are not known. Another shaft in the north-western corner of Lease 3994-M was 25 feet deep, but the results were not conclusive, as it may not have been deep enough. The "H" line of the Latrobe Shale and Oil Company's bores proved no shale, and so definitely limits the shale land on the south-east side.

The presence and extent of the shale seam is therefore based entirely on geological evidence. Twelvetrees did not calculate any reserves of shale, but pointed out the possibilities. Reid assumed the shale to exist over one-third of the country occupied by the upper mudstones, and calculated a probable reserve of 1,296,000 tons, which equals a 4-foot

seam over 216 acres. (This included, however, Leases 4626-M, 2545-M, and 8954-M, which are in Area V. described below.) The area outlined on the plan covers 163 acres.

No figures for thickness, dip, or depth below surface are available.

*Area V. (China Flat Area).*—This area is situated 2 to 4 miles south of the Great Bend, or 6 miles south-south-east of Latrobe. It is in the form of a long and narrow strip from north-west to south-east, with a length of 220 chains and a width of 20 chains.

It includes portions of the following leases:—2545-M; 8954-M; part of Special Lease 6641, 699 acres; 4777-M; and land blocks—H. Weeks, 129 acres; A. Wells, 143 acres; C. M. Hogg, 48 acres; C. F. Oldaker, 35 acres; and A. A. Bennett, 49 acres.

The north-eastern limits of the area are determined by the Proterozoic schists, and the south-western by Cambrian sandstone and conglomerates. The north-western limit is determined by diabase, but there is a possible narrow extension to Area IV. The south-eastern limit is indefinite, and will probably be found to be determined by faulting and erosion of the seam. This area is probably continuous with Area VII., but in faulted relation thereto.

Only one outcrop is reported, but the seam is also exposed in a quarry near the "B" line, and in Richard's quarry on the "C" line. The area has, however, been prospected by a boring campaign. Four lines ("A" to "D") of bore-holes and shafts of the Latrobe Shale and Oil Company's testing campaign cross the area at well-spaced intervals. On these lines 19 bore-holes and shafts intersected the seam. Two shafts were sunk north and west (Hedditch No. 2) of the quarry on the "B" line, and cut the seam. Two bore-holes (Adelaide Oil Exploration Company's Nos. 1 and 2) were sunk at the south-eastern end, and serve to determine the boundary in that direction.

The thickness of the seam in the bore-holes ranged up to 4.5 feet, and the general average of the four lines would be 3 to 3.5 feet. In the quarry the thickness is reported as 5.5 feet, with a central 1-foot band of clay.

In Richard's quarry and Hedditch No. 2 shaft the thickness is given as 4 feet, inclusive of band.

Dips are not recorded, and owing to lack of information the results of the boring cannot be correlated to determine the geological structure of the area.

The greatest depth of the shale seam is 99 feet on the "B" line and 153 feet on "D" line. At several places, particularly near the "B" and "C" lines, the shale is within 20 feet of the surface, and open-cut mining might be possible. The tract of country on which this is possible would need investigation by prospecting and detailed surveys.

Faulting has not been proved to exist, but the depths to shale on "C" and "D" lines suggest a fault with downthrow to the south-east.

The extent and reserves have been calculated as follows. Twelvetrees estimated that the seam (4 feet) extended over 500 acres. Reid estimates:—

	Area.		Reserves.	
	Actual.	Probable.	Actual.	Probable.
6641-M .....	360	125	1,440,000	500,000
4777-M .....	40	70	200,000	350,000
			(On basis of 500 tons per acre)	
Land blocks east of 6641-M (50 per cent. considered shale-bearing) .....	.....	217.5	.....	1,305,000
North of 6641-M .....	.....	80-100	.....	.....

Taking all the information into consideration, it is probable that there are 776 acres of shale in this area, made up as follows:—

	Acres.
6641-M .....	380
4777-M .....	110
East of 6641-M .....	204
North of 6641-M .....	82

This would give, on the basis of a 3-foot seam, a possible reserve of 3,492,000 tons.

*Area VI. (Parramatta).*—This area is situated near the former settlement of Parramatta, on the old Latrobe-Delorraine road, and is 5½ miles south-east of Latrobe.

It is probably 30 chains long and 10 to 15 chains wide, being elliptical in shape. Portions of the following leases are contained in the shale-bearing tract:—4806-M, 4804-M, 4805-M, and 4807-M.

The south-western, western, and northern limits are determined by the Proterozoic schists. The Permo-Carboniferous strata continue to the east, and probably also to the north-east, below the basalt.

Two lines of bore-holes ("E" and "F") were sunk by the Latrobe Shale and Oil Company. The "E" line did not intersect any shale, and thus proved the southern limit of the area. Of the five bores (16 to 20) on the "F" line, three intersected shale (18 to 20), and proved the eastern and western limits of the area. There is a possible extension under the basalt to the north-east and north which might connect this area with the southern end of Area I.

The thickness ranged from 1 to 2.6 feet, and the depth at which the seam was cut 103 to 177 feet.

No dips have been obtained, and the geological structure is not known.

As regards extent, Twelvetrees considered it to be doubtful, and stated that it was below 200 acres, and the reserve below 1,000,000 tons. Reid gives an actual reserve of 22,250 tons and a probable one of 2,400,000 tons (on a basis of a 4-foot seam, these reserves would correspond to extents of 4.5 and 400 acres).

In the present state of our knowledge no more than 140 acres could be considered as possibly existing. As proved thicknesses are 1.0 to 2.6 feet, the calculation of reserves is somewhat doubtful, as such thicknesses could probably not be profitably mined.

*Area VII. (Native Plains).*—This area is situated on the east bank of the Mersey River, 2 to 3 miles east of Railton. It forms a long and narrow tract of country, with a general trend from north-west to south-east, being 180 chains in length and 20 to 30 chains in width.

It occupies portion of the former Native Plains estate, and the land blocks at present charted in the names of P. A. Roebuck, 567 acres; I. Hays, 395 acres; L. Guthrie, 363 acres; W. T. W. and J. Field, part of 451 acres; and W. D. Winspear, 322 acres.

The limits of this basin are very indefinite. Large tracts of Permo-Carboniferous strata occur to the east and south-east of Railton. To the south-west they pass beneath the basalt, while on Native Plains they are covered by Recent alluvium gravels. The north-eastern boundary is partly determined by the diabase of Long Hill. To the north-west the area is probably continuous with Area V., but with a faulted relation thereto.

The shale-bearing area has been proved by the Adelaide Oil Exploration Company's bore-holes Nos. 3, 4, and 10. On the south-western side three bore-holes (Native Plains Nos. 1 and 2 and one other) did not cut shale, but they were not sufficiently deep to cut any extension of shale in that direction. On the north-east side two bore-holes have been sunk, of which the Native Plains No. 3 did not cut shale (but may have been too shallow), and no information is available as to the other bore. The three bore-holes (Nos. 3, 4, and 10) were sunk in the flood plain of the Mersey River, and cut the shale at depths of 160, 305, and 596 feet respectively. The shale seam is therefore getting much deeper to the south-east, and a geological section along this line of bores suggests a basin-shaped structure, or alternately one with a uniform dip to the south-east and a fault between bore-holes 4 and 10 with the upthrow to the south-east.

The thicknesses of shale cut in these bore-holes were 2, 2.75, and 2.5 feet respectively, or an average of 2.33 feet.

Reid calculated an actual reserve of 3,000,000 tons and a probable one of 4,500,000 tons. From the evidence of the above three bore-holes it would appear that the seam may be expected to exist over 620 acres. With a thickness of 2½ feet, this would give a reserve of 1,736,000 tons. It is possible that the area is wider than shown, i.e., there is an extension to the south-west, which would, of course, increase these figures.

*Area VIII. (Merseylea-Kimberley).*—This area represents the south-eastern extension of Area VII. The Permo-Carboniferous strata extend throughout the area, but no proof (outcrops, bore-holes, shafts, &c.) exists of the presence of the seam. This is due, no doubt, to the depth of the seam beneath the surface.

Reid, in his description of this area (Merseylea), calculated a probable reserve of 4,500,000 tons. Though shown on the attached map (Appendix II.) as a possible extension of the Native Plains area, it is not considered that the calculation of a reserve is warranted.

*Area IX. (Kimberley-Moltema).*—No outcrops of shale occur in this area, nor have any shafts or bore-holes been put down to cut the seam. Reid, describing this area under the title of "Kimberley," states that a large portion of it is occupied by Permo-Carboniferous strata. He states "that there is every indication of the existence of the seam in the 450 acres of mudstone near Coiler Rivulet." An estimate of the probable reserve there seems justifiable. On the basis of a 3-foot seam, the quantity is put at—Actual, nil; probable, 2,025,000 tons.

This area is indicated on the attached map (Appendix II.), but no extent is shown.

*Area XI. (Beulah).*—This area occurs between the Minnow and Mersey Rivers, in the Minnow district, some 7 miles south-south-west of Kimberley.

The following land blocks comprise the tract considered to be shale-bearing:—W. Fair, 508 acres; W. Fair, 100 acres; A. M. Gregory, 97 acres; E. A. Sharman, 13 acres; W. Fair, 49 acres; F. Richards, 364 acres.

A considerable extent of Permo-Carboniferous rocks exists in this district, but no prospecting or development work has been carried out. Only two outcrops are known, one being in a road-cutting and the other in a creek-bed. The dip is to the east of north at a low angle, but the thickness of the seam has not been recorded.

Twelvetees considered the shale seam to extend possibly over 1 square mile, and, on a basis of 600 acres, calculated a reserve of 3,600,000 tons. Reid estimated the tonnage as 387,400 of actual, and 1,490,000 tons of probable reserve. While either of the above estimates may be ultimately proved to be correct, in view of the paucity of information these figures should be regarded as possible reserves only.

*Area XII. (Chudleigh).*—This area was not discovered until 1926, and no geological survey has been made. Tasmantite shale outcrops at Dairy Plains, to the south-east of Chudleigh, but no development work has been performed.

*Area X. (Nook).*—This area is situated in the Nook district, some 6 miles to the south-west of Latrobe. The known shale bearing land occurs on a land block of 102 acres, in the name of A. Bryan, and the adjacent portion of the 536 acres in the name of Alex. McNaughtan.

The shale seam outcrops in a creek running north-westerly through the above land blocks. In addition, several small shafts and pits have exposed the seam in the creek and on both sides of the dividing-fence between the two properties.

The dip of the seam is 5 degrees to the north-east, while the thickness ranges from 4 to 6 feet.

The shale-bearing tract is somewhat limited, as it gives place to coal-bearing land on the south-west and north-east sides, and probably also the north-west. The tract is practically confined to the two properties referred to above, with a possible extension to the south-east.

Twelvetrees stated that there was every reason to believe that the shale extended over 130 to 140 acres, with a reserve of 800,000 tons. Reid states that the seam undoubtedly extends over 100 acres, and probably will be found over an additional 470 acres. In calculating the reserves, however, he estimates an actual reserve of 260,000 tons (which corresponds to a 4 foot seam over 43 acres) and a probable reserve of 3,620,000 tons. The extent on the attached map (Appendix II.) is 140 acres, which was made to agree generally with the 130 acres of Twelvetrees and the 110 acres of Reid.

*Area XIII. (Quamby Brook).*—This area is situated  $7\frac{1}{2}$  miles south-east of Deloraine and 2 miles north-east of Quamby Bluff. Shale was first discovered in 1921, but little development work has been carried out.

The shale-bearing tract includes the adjoining land blocks charted in the names of Wm. Bakes, 300 acres; and C. Davis 100 acres—on the east side of Quamby Brook. Shale is also said to occur in the valley of the Eden Rivulet, to the north-east.

Permo-Carboniferous strata occur in the valleys of both the above streams, and is stated to exist continuously beneath the diabase hill that separates the two valleys. The shale-bearing tract is limited on the north-west side by older rocks, while to the west and south the shale gives place to coal or carbonaceous shale-bearing strata. The limits in the eastern and northern directions are not known.

The shale outcrops on the Bakes block and in the Quamby Brook (where it traverses the Davis block). The only development consists of a few shallow pits (10 to 28 feet deep) and two shallow bore-holes (one 63 feet) on the Bakes block.

The thickness of the seam is given as 5 feet, exclusive of a central 1-foot band.

The dip on the Bakes block is easterly at 5 to 10 degrees, while on the Davis block it is north-east. A fault parallel to the stream is the cause of the different dips, and also the difference in altitude on the two blocks.

In 1924 Reid considered the shale-bearing tract to be 50 acres, with a fairly large potential area, his estimates being—

	Actual. Tons.	Probable. Tons.
Bakes block .....	186,250	372,500
Davis block .....	25,000	111,750
Eden Rivulet .....	.....	558,750

In 1926 Reid considered the shale to occur over 300 acres, with a probable extension of 200 acres, the reserves (calculated on a 4-foot seam) being—Actual, 1,800,000 tons; probable, 1,200,000 tons.

*Area XIV. (Oonah).*—This area is situated in the Oonah district, 15 miles south of Wynyard. It includes the land blocks charted as follows:—Wm. Cross, 79 acres; E. Hodgetts, 198 acres; J. Martin, 150 acres; H. H. Lennox, 195 acres; Agricultural Bank, 95 acres; H. E. Miles, 160 acres; and a 197-acre block formerly held by C. C. Jubbs.

These blocks, with the exception of that of Wm. Cross, comprise a large tract near Oonah, while that of Wm. Cross forms a small outlying tract in the valley of the Cam River, 2 miles to the north.

This field was only discovered in 1923, and no development has taken place. Reid estimates a probable reserve of 6,000,000 tons, which probably corresponds to a 4-foot seam over 1000 acres, which is approximately the area of the above land blocks. In view of the lack of development, this reserve can only be considered as a possible one.

### III. *Preolenna Shale Fields.*

*Geology.*—The Preolenna shale is a black "kerosene shale," of the nature of a cannel coal, or torbanite, rather than a true oil shale. The shale does not occur in independent seams, but as lenticular bodies in the coal seams. The coal seams occur in the Greta series of the Permo-Carboniferous system, as does the Tasmanite shale in other districts.

The same general geological conditions apply as in the Tasmanite shale fields.

*Area XV.*—This area is restricted to the coalfield which exists around Preolenna. The coalfield is described in the following departmental publications:—

Tas. Geol. Surv. Bull. No. 13, by Loftus Hills, 1913.

Tas. Geol. Surv. Min. Res. No. 7, 1922, p. 231.

The development of the field consists of outcrops, prospecting shafts, trenches, mine workings, and bore-holes.

Four coal seams have been proved to exist, with the possibility of a fifth one. The seams range in thickness from 9 to 24 inches, the usual thickness being 15 to 24 inches.

In 1922 the probable reserve of coal was calculated as 5,000,000 tons. The shale reserve forms only a small proportion of this, and has not been estimated.

### IV. *Pelionite Fields.*

*Geology.*—Pelionite is the name given to the black "kerosene shale" of the Barn Bluff district. It is generally similar to the Preolenna shale, and occurs at the same horizon, viz., the Greta series of the Permo-Carboniferous system.

The pelionite does not occur as a separate seam, but as part of one which may be coal at one place, coal and pelionite at another, and apparently all pelionite at others.

The same general geological conditions apply as in the case of the Tasmanite and Preolenna shale fields.

*Area XVI. (Barn Bluff).*—The only known pelionite is that around the flanks of Barn Bluff. It has been described in the following departmental publications:—

Tas. Geo. Surv. Bull. No. 30, by A. M. Reid, 1919.

Tas. Geol. Surv. Min. Res. No. 7, 1922, p. 236.

The seam is only 8 inches thick, and very little, if any, development work has been carried out. The possible reserve is given in Min. Res. No. 7 as 1,600,000 tons.

P. B. NYE.

Chairman, Mining Sub-Committee.

Mines Department,

Hobart, 12th March, 1931.

LIST OF TESTING CAMPAIGNS, TASMANITE SHALE FIELDS.

*Government Bores.*—(1884.)

*Tasmanian Shale and Oil Company N.L.*—(Probably 1901 or 2.)

Shafts (Nos. 1 to 10) on what is now the present Lease 6641 (256 and 533 acre blocks).

*Latrobe Shale and Oil Company N.L.*—(1910.)

Bores and shafts on lines A to F, and H.

*Native Plain Estate.*—(Prior to 1911.)

Bores 1 to 4.

*Rubicon Area.*—(1910.)

Bores 1 to 4.

Shafts 1 to 5.

*Adelaide Oil Exploration Company.*—(1920 on.)

Bores 1 to 11, &c.

*Mersey Valley Oil Company.*—(1920 on.)

Bores 1 to 9.

*Tasmanian Cement Company.*—(Goliath Cement Company.) Leases and Properties (1922-24).

Bores 1 to 4.

*Australian Shale Oil Corporation.—(1925.)*

Government and company's bore-holes and shafts.

Bore-holes 1 to 30.

Shafts 1 to 6.

*Tasmanite Shale Oil Company.—(1929.)*

Government bores 1 to 3.

*Government Bore.—(Mines Department 1884. No. 2 Bore in Mineral Resources No. 8.)*

	ft. in.		ft. in.
Terrestrial deposits	Nil	to	56 9
Coal	56 9	to	58 9
Terrestrial deposits	58 3	to	264 9
Marine beds	264 9	to	370 0
Silurian limestone	370 0	to	400 6

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*Tasmanian Shale and Oil Company N.L.*

No. 1 Shaft: In south-west corner of 6641-M, above Mersey River.

0 - 22 Pebbly fossiliferous mudstone.

22 - 29 Tasmanite shale.

29 - 31 Pebbly mudstone.

No. 2 Shaft: 4 chains south-east of No. 1 and in north-west corner of 4163-M.

0 - 18 Loose ground.

18 - 20 Heavy shingle.

20 - 50 Upper bluish mudstones.

Abandoned owing to water trouble.

No. 3 Shaft: 6 chains south-east of No. 2.

0 - 10 Hill detritus.

Abandoned.

No. 4 shaft: 14 chains north 28 degrees west from mouth of main heading of Tasmanian Shale and Oil Company's working (on east side of 266-acre block of 6641-M).

0 - 83 feet. Upper mudstones.

Abandoned, due to water trouble.

No. 10 shaft: At mouth of main heading.

No particulars, except that the shale seam was 7 feet 5 inches thick.

No. 9 Shaft: 3 chains west of main heading.

The shale seam was reported to have been cut at 26 feet.

Hand-bore: North-west of main heading and north of tramway.

Sunk to 100 feet through loose sandy ground without cutting shale.

No. 5 Shaft: South of W. Barry, 25 acres.

Several feet deep and into schist.

No. 6 Shaft: 5 chains east of W. Barry, 25 acres. In 6641-M.

Sunk 18 feet. Cut shale.

No. 7 Shaft: 12 to 15 chains east of No. 6.

30 feet deep in bluish mudstone.

*Results of Boring Campaign on Latrobe Shale and Oil Company's Leases.*—(Now Railton-Latrobe Shale Oil Company N.L.)

"A" Line of Bores:

Commencing at (or near) the south-west corner of Mineral Lease 4626-M, 116 acres, and trending in a north-easterly direction to 2545-M.

Datum.

Number of		Chainage.	Shale Cut at (Feet)	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
.....	6	20	.....	.....	54	Unsuccessful
.....	7	30	70.5 - 74.0	3.5	77	
.....	8	40	21.0 - 23.5	2.5	31.3	
.....	9	50	.....	.....	26.5	
						Unsuccessful: bot- tomed on conglom- erate

" B " Line of Bores and Shafts:

45 chains south of " A " line and trending in a north-easterly direction from the north-west corner of Mineral Lease 2542-M (now on western boundary of 6641-M, about 5 chains north of H. Cooper, 25 acres).

Number of		Chainage.	Shale Cut at (Feet)--	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
3	....	5	....	....	15.5	
5	....	9	9 - 12.5	3.5	12.5	
2	....	10.5	15.5 - 19.25	3.75	19.25	
....	1	S.W. end	42.5 - 47.0	4.5	36	
....	2	15	42.5 - 47.0	4.5	79	
....	3	30	71.0 - 75.5	4.5	99	
....	4	45	....	....	153	
....	5	40	14.5 - 15.2	0.7	47	Only 8-inch core obtained owing to softness of shale
1	....	40	13.5 - 16.5	3.00	16.5	No. 1 shaft proves 3 feet at same spot
4	....	42	16.0 - 19.75	3.75	19.75	
6	....	45	....	....	27	

"C" Line of Shafts:

78 chains south of "B" line, and trending in a south-westerly direction from the north-east corner of Section 4619-M to the south-east of Section 2546-M. (Now part of Special Lease 6641-M.)

Number of		Chainage.	Shale Cut at (Feet)—	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
3	.....	30	....	....	20	No shale
2	.....	25	....	....	26	No shale
4	.....	19	3 - 3.5	0.5	3.5	....
1	.....	15	23 - 27	4.0	27	....
5	.....	N.E. end	....	....	12	No shale

"D" Line of Bores:

Trending in a north-easterly direction across Section 4777-M, the first bore 10 chains from south-west corner, and the last being within 6 chain of the northern boundary.  
Datum. South-west corner of 4777-M.

Number of		Chainage.	Shale Cut at (Feet)—	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
1	10	S.E. end	....	....	50	37 feet mudstone, 13 ancient conglomerate
2	11	5	....	....	47	47 feet mudstone (ancient conglomerate)
3	12	20	72 - 75.5 76.5	3.5 4.5	102	18 feet soil, 18 to 54 mudstone, 72 to 75.5 shale, 75.5 to 79.5 p.c. conglomerate, 79.5 to 101 pebbly mudstone, 101 to 102 ancient conglomerate
4	13	30	149 - 151	2.0	153	34 feet alluvial and clay, 34 to 149 mudstone, 149 to 151 shale, 151 to 151.5 mudstone, 151.5 to 153.5 conglomerate (ancient)

"D" Line of Bores—*continued.*

Number of		Chainage.	Shale Cut at (Feet)—	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
5	14	40	120 - 122	2-0	133	28 feet clay and alluvial, 28 to 61 mudstone, 61 to 120 mudstone and sandstone, 120 to 122 shale, 122 to 133 ancient conglomerate
6	15	50	130 - 135	50	146	26 feet clay and alluvial, 26 to 75 mudstone, 75 to 130 mudstone and sandstone, 130 to 135 shale, 135 to 136 mudstone, 136 to 143 sandstone, 143 to 146 conglomerate

"E" Line of Bores:

East and west line across centre of 4807-M and 4805-M.

Datum. East Line of 4805-M.

Number of		Chainage.	Shale Cut at (Feet)—	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
1	21	5 from "E" bound- ary	....	....	70	14 to 64 feet mud- stone, 64 to 70 fos- siliferous sand- stone
2	11(?)	5 from "E" bound- ary	....	....	87	24 feet clay, 24 to 85 sandy mud- stone, 85 to 87 schist drift
2	22(?)	....	....	....	38	15 feet clay, 15 to 38 mudstone country (broken)

"F" Line of Bores and Shafts:

East-west line through the centre of 4806-M and 4804-M.

Datum.

Number of		Chainage.	Shale Cut at (Feet)--	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
....	16	25	....	....	155	
....	17	12	....	....	257	
....	18	37	103 - 104.25	1.25	109	
....	19	47	177 - 179.60	2.60	196	
....	20	60	174 - 175	1.00	184	

"H" Line of Bores and Shaft:

Near conglomerate and schist floor on 4627-M.

Datum.

Number of		Chainage.	Shale Cut at (Feet)—	Thickness (Feet).	Depth of Bore (Feet).	Remarks.
Shafts.	Bores.					
Line No.	Serial No.					
....	1	....	....	....	27	8 to 24 feet mudstone, 24 to 27 conglomerate
....	2	10 ch. N.E. from No. 1	....	....	31	24 to 31 feet conglomerate
....	3	20 ch. N.E. from No. 1	....	....	53	14 to 49 feet mudstone 49 to 53 conglomerate
1	....	....	....	....	38	15 feet clay, 15 to 38 mudstone, apparently disturbed, highly inclined

Shafts sunk between "D" and "H" lines show apparent faults with bands of limestone.

*Native Plains Bore-holes.*—(Figures in brackets are those given in Mineral Resources No. 8.)

N.P. No. 1 (No. 10), 33 chains south-south-east from Hogg's bridge and 15 chains east of the Mersey River:

0 - 6 Loam  
6 - 2 Shingle  
Mudstone

N.P. No. 2 (No. 9), 46 chains south-east of No. 1, and near the Merseylea Bridge, north-east bank of Mersey:

Feet.

2 Loam  
7 Sand  
9½ Alluvial  
51½ Mudstone  
63 Sandstone, with layers of calcareous mudstone

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N.P. No. 3 (No. 7), 35 chains east-south-east of Hogg's Bridge: First passed through heavy shingle, and then into mudstone (lower division of system?).

N.P. No. 4 (No. 8), west side of old Latrobe-Railton road, 70 chains east of Hogg's Bridge:

Feet.

38 Sandstone  
17 Pebbly sandstone, with thin layers of conglomerate  
12 Conglomerate  
11 Mudstone and clayey sandstone

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*Rubicon Leases.*

Five shafts on a north-west-south-east line, west of the old Deloraine-road on Section 4850-M:

Shafts—

- No. 1.—34 feet, in dark fossiliferous mudstone
- No. 2.—6 feet soil, 19 feet buff beds, bottomed in hard blue mudstone
- No. 3.—4 feet buff pebbly clay and 33 feet of blue fossiliferous mudstone and buff conglomerate clay
- No. 4.—10 to 15 feet buff clay and about 25 to 30 feet bluish mudstone
- No. 5.—30 feet soft white sandstone, 8 feet buff rock, and into 2 feet bluish mudstone

Bores (The numbers in brackets are those used by A. M. Reid in Mineral Resources No. 8):

- No. 3 (19)— 0 - 16 White and yellow sand  
                  16 - 70 Dark sandy clay or mudstone; struck harder rock, and bore abandoned
- No. 4 (20)— 0 - 10 Surface material  
                  10 - 50 Dark bluish clay or mudstone

*Adelaide Oil Exploration Company.*—(The numbers in brackets are those used by A. M. Reid in Mineral Resources No. 8. For further details of the logs see Mineral Resources No. 8, pp. 81-85.)

Bore No. 1 (12): About centre of 4777-M. This bore-hole was 565 feet deep, having reached bedrock of quartzite at 485 feet. It started below the horizon of the shale seam.

Bore No. 2 (13): Near and on south side of Hogg's Bridge, on the west bank of the Mersey River, Native Plain.

	Feet.
Shale cut at .....	160
Thickness of shale .....	2
Depth of bedrock .....	268
Depth of bore-hole .....	294

*Adelaide Exporation Company—continued.*

Bore No. 3 (14): 20 chains south-east from Hogg's Bridge, Native Plain.

	Feet.
Shale cut at .....	305
Thickness of shale .....	2.75
Depth of bedrock .....	508
Depth of bore-hole .....	520

Bore No. 4 (15): 40 chains south-east from No. 3 bore Native Plains.

	Feet.
Shale cut at .....	596
Thickness of shale .....	2.5
Depth of bedrock .....	708
Depth of bore-hole .....	830

Bore No. 10 (27): East of Merseylea Bridge.

	Feet.
Shale cut at .....	913
Thickness of shale .....	3
Depth of bedrock .....	916
Depth of bore-hole .....	945

*Mersey Valley Oil Company.*—(Numbers in brackets are those used by A. M. Reid in Mineral Resources No. 8.)

Bores—

- No. 1 (21): 8 chains south-south-east of the north-west corner of R. Driscoll's 35-acre block. Drilled to 300 feet. No shale.
- No. 2 (23): 7 chains east-south-east of the north-west corner of A. E. Walpole's 65-acre block. Drilled to 378 feet. No shale.
- No. 3 (22): 2 chains north-east of the south-west corner of M. Bourke's 24-acre block. Drilled to 795 feet. No shale.
- No. 4 (24): 10 chains south-east of the north-west corner of W. Dooley's purchase (152 acres). Drilled to 1000 feet. Coal at 337.2 to 338 feet. No shale.
- No. 5 (25): 16 chains south-west from the north-east corner of J. Thomas' purchase (160 acres). Drilled to 192 feet. No shale; bottomed on quartzite schist.
- No. 6 (26): 3 chains south-east from the north-west corner of H. Cherry's purchase (11 acres). Drilled to 1000 feet. Coal at 494 feet to 494.5 feet. Brown coaly shale at 494.5 feet to 496 feet. No shale.
- No. 7 (28?): On Haine's block,  $\frac{1}{2}$ -mile east of the junction of Latrobe-Devonport road with the Moriarty-road. Drilled to 286 feet. No shale.

*Bores on present Goliath Cement Company's Property.*—(Formerly Tasmanian Cement Company.)

Test bore in north-western corner of Section 8822-m. Cut seam at 256 feet. (No further particulars.)

Hand-drilled hole 75 feet in Cory's block near old Deloraine-road.

Near southern boundary of Lot 6858 a bore-hole passed through 5 feet of shale at a depth of 49.5 feet.

Near northern boundary, formed by old Deloraine-road, the seam was intersected at 104 feet.

*Australian Shale Oil Corporation Bore-Holes.*

Company's Number.	Number of Government Bore.	Shale Struck at (Feet)—	Thickness of Shale (Feet).	Depth of Bore (Feet).	Remarks.
1	1	221	7.0	231	
2	....	178	6.5	186	
3	2	28.5	6.5	38	
4	4	85	6.5	96	
5	....	14	4.0	18.5	Proved by Shaft No. 3
6	....	35	6.8	42	Proved by adit
7	5	128.5	?	139	Shale mudstone from 128.5
8	....	171.5	6	180.0	
9	....	....	....	....	Abandoned
10	6	188	Comp. 7 Govt. ?	Comp. 195.5 Govt. 200	11 feet of shale and mudstone
11	7	101	6.16	110	Proved by adit
12	....	170.5	6.75	179	
13	10	115	Comp. 7 Govt. ?	129.5	14.5 feet of shale and mudstone
14	9	75	Comp. 6.5 Govt. ?	33	8 feet shale and mudstone
15	....	33	6.5	39.5	
16	....	In clay or diabase			
17	....	103	6.0	109	
18	11	68	Comp. 6.5 Govt. ?	75.5	10.5 feet of mudstone and shale
19	....	86	1.5	87.5	Fault reported; proved by adit
20	....	87	6.2	93.2	Proved by adit

21	13	180	Comp. 7 Govt. ?	194	14 feet of mudstone and shale
22	....	39	6	45	
23	....	34-5	5	39-5	
24	....	267	1-6	268-6	
25	....	173	7	179	
26	12?	76	Comp. 7 Govt. ?	88-5	12-5 feet of mudstone and shale
27	....	No trace	....	....	
28	....	249	6	255	
29	....	273	7	280	
30	....	Abandoned	....	....	
....	3	....	....	14-5	In river wash only

*Mines Department Bores.*—On 256-acre block of Special Lease No. 6641-M (location on Departmental plan), Latrobe.

	ft.	ft.	
Bore No. 1M:	0 - 40	Clay	
	40 - 177	Basalt	
Bore No. 2M:	0 - 68	Clay	
	68 - 106	Schist	
Bore No. 3M:	0 - 21	Clay	
	21 - 134	Mudstone	
	134 - 139	Shale	
	139 - 148	Mudstone	

## APPENDIX B.

PRELIMINARY NOTES FOR THE GUIDANCE OF THE MINING  
SUB-COMMITTEE.

The report on the "Oil Shale Resources of Tasmania" contains all available information on the occurrence of oil shale.

It will be noted from the above report that, of the three types of oil shale, the deposits of the Tasmanite shale are the most important. It is the deposits of Tasmanite shale that must therefore be relied upon in any immediate development of the oil shale industry in Tasmania.

It will be further noted that the Tasmanite shale occurs in a number of separate fields or areas. All information likely to be useful from the mining point of view is given for each area in the attached table (Table I.).

With this information available, various aspects of the problems attendant on the mining of the Tasmanite shale will be discussed below.

*Number of Areas.*

From the abovementioned report it will be noted that the Tasmanite shale occurs in 14 separate areas. Of the 14 areas it is possible, but not likely, that two may be non-existent when testing is performed. It is also possible that one to three of the areas may be continuous with an adjacent one, but the result would not materially alter conditions, as long narrow areas would be formed, which would have to be, for mining purposes, regarded as two or more sub-areas. Thus under no circumstances is there likely to be less than 11 separate areas of Tasmanite shale.

*Distribution of the Areas and Problems Associated  
Therewith.*

The 14 areas of Tasmanite shale occur in two districts:

- (1) Latrobe-Quamby Brook district. Thirteen of the areas occur in this district.
- (2) Oonah district. This is an outlying district some 40 miles west of the other, but distant about 60 miles by road and rail from Latrobe. For the present this district need not be considered in the immediate development of the oil shale industry.

The Latrobe-Quamby Brook district has a general trend from north-west to south-east, the length being 27 miles and the width 7 miles. The areas group themselves into two parallel lines:

- (a) Latrobe-Quamby Brook, including Areas I., IX., and XIII.
- (b) Nook-Chudleigh, including Areas X., XI., and XII.

While this lineal arrangement is an expression of geological conditions in the case of the Latrobe-Quamby Brook areas, it cannot be said, in the present state of knowledge, to represent a similar expression in the Nook-Chudleigh areas.

In the Latrobe-Quamby Brook district the areas are most closely spaced in the Latrobe-Railton portion. Six areas are included in this field in a length of 6 miles and a width of 3 miles, while a seventh area occurs immediately to the south-east. It is therefore apparent that, other things being equal, this field should be the first exploited in any development of the oil shale industry. Moreover, this field has been prospected and tested almost to the exclusion of others, so that at present it has the greatest amount of partly proved reserves. It necessarily follows that some locality in this field would be selected for the site of a central retorting and refining plant in the immediate development of an oil shale industry.

#### *Relative Importance of the Areas.*

The present relative importance of the areas depends upon, among other things—

- (1) Amount of prospecting and development work.
- (2) Thickness of shale.
- (3) Extent of shale.
- (4) Quality of shale.
- (5) Faulting.

At present the amount of prospecting and development really determines the value of the areas, because without it the other factors cannot be determined. Of the various areas, the only ones that have been prospected and tested to any extent are II. (Great Bend), III. (west of Great Bend), and V. (China Flat).

The thickness of the shale seam has, of course, an important bearing upon the importance of an area, both as regards reserves and also facilities for economic mining. It is best known in Areas II. and III., in which mine openings, &c., occur, and it is also greater in these areas. Strangely enough, the bore-holes in adjacent areas prove a lesser thickness, but whether this is associated in any way with the methods of borings cannot be stated. It is certain, however, that the nature of the core (perfect or imperfect) in a core-producing plant would somewhat affect the question, while in a percussion plant the thickness could not be so accurately determined. It is to be noted that the smaller thickness in Area V. slightly reduces its importance, while in the case of Area VII. the thickness is such that it practically prohibits the economic mining of the shale in that area.

The extent of an area would, other things being generally equal, determine the importance of an area from the viewpoint of large-scale mining operations. In view, however, of the undeveloped nature of the areas, only Areas II., III., and V. can be considered as having any proved extent and reserves.

In addition to the above there are many factors, such as faulting, which will seriously affect the facilities for mining. Faulting is known to occur, and the occurrence of the shale at different altitudes in adjacent areas is due to this feature. Smaller faults are also present within each area, but generally the amount of development has not been sufficient to locate and determine these.

It is quite apparent from the above that the most important areas are II., III., and V. These are all situated in the Latrobe-Railton field, and thus stress the necessity of starting operations in this field.

*Possibility of Mining 500, 1000, and 2000 Tons Per Day.*

(NOTE.—The terms of reference to the Sub-Committee state that the possibilities of mining 500, 1000, and 2000 tons per day are to be considered. The Retorting and Refining Sub-Committee is, however, considering the treatment of 1000 tons per day. As retorting will be carried on continuously, and mining on six days per week only, the above tonnages per day will have to be increased to 583, 1166, and 2312.)

In considering the output from any mine, or, in this case, any shale area, it must be remembered that there is considerable expense involved in opening up and efficiently equipping the mine. In mining a product showing a large percentage of profit, this initial outlay need not necessarily be seriously considered, especially from the viewpoint of the cost it imposes upon the mining costs. In a case like the Tasmanite shale, where the profits would be small, i.e., a low-grade proposition, the initial expenditure and its effect upon mining costs has, however, to be seriously considered. Thus the plant installed and development work performed have to be utilised so as to give the best possible economic results. This utilisation probably consists of the working of the plant and mine for such period as will enable provision to be made out of the profits for an amortisation, or depreciation fund sufficient to replace the plant or render unnecessary the costly removal of the greater part, if not all, of the plant, &c. That is to say, it would probably not be economic to mine any shale area at a rate sufficient to exhaust its reserves in, say three years when another mine would have to be opened up and the plant and equipment moved thereto.

The question, then, is to decide what period would be considered economically sufficient to permit of the working out of the mine and provision of a fund to provide for expenditure on plant. It is suggested in this connection that a minimum life of 14 years should be adopted. This period enables a fund to be established by annual payments of 5 per cent. at compound interest, or 7 per cent. at simple interest, which figures, particularly the former, are practicable ones. The above is a minimum life, and if a longer period were adopted the annual provision could be reduced.

Using this figure in conjunction with the attached table (Table I.), the following results are obtained:—

*Possibility of Mining 2332 Tons Per Day.*

The maximum life of any of the areas under this scope of operations is 4.1 years in the case of Areas II. and V. None of the areas can therefore be considered suitable for mining at the above rate.

*Possibility of Mining 1166 tons Per Day.*

The maximum life of any of the areas is 8.2 years for Areas II. and V. under this rate.

*Possibility of Mining 583 Tons Per Day.*

The maximum life of Areas II. and V. is 16.5 and 16.4 years respectively, so that these could be economically mined at this rate.

*Possibility of Mining 291 Tons Per Day.*

At this rate Areas I. II., V., and VII. could be economically mined, while Area III., with any extensions of same, would probably also become available.

It is obvious from the above that the only economic arrangement in order to give any required daily output is to mine at the rate of 583 tons per day from Areas II. and V., and at the rate of 291 tons per day from Areas I., III., and VII.

In the above attention has been given only to the Latrobe-Railton field. As regards the outlying areas in the Latrobe-Quamby Brook district, they are not developed to any extent, and, moreover, they would, in the first place, not be considered, owing to cost of transport to a central plant in the Latrobe-Railton field.

*Total Reserves.*

In the past the estimates of reserves have been made largely upon geological evidence, and this method of estimating was forced upon the investigators by the general lack of treating and developmental work. While such methods have their greatest application in the case of bedded deposits, such as coal, shale, &c., they should, however, be regarded rather as indicating the possible areal extent of the deposit than as actual estimates of tonnages. This would apply particularly to the Tasmanite shale deposits, where, though the shale may extend over the area indicated, a thinning of the seam may cause part of the area to be regarded as containing no *economic* reserves, i.e., those which can be economically mined. Further, other factors, such as faulting, poor quality of shale (due possibly to increase in thickness of band affecting the quality), as well as thickness of shale, &c., might affect the amount of *economic* reserves.

The position to-day is much the same as regards prospecting and development of the different areas, so that calculation of reserves is still somewhat uncertain. It is for this reason that in the report on the oil shale resources, and also in the attached table (Table I.) they have been put under headings of "partly proved" and "possible extensions." The "partly proved" includes all reserves in which mine openings, outcrops, bore-holes, and shaft assist in the determination of same. The "possible extensions" include the reserves in areas in which there is every reason to believe from geological evidence that the shale exists, but which have not been prospected.

From the figures in the table it will be seen that in the Latrobe-Railton field there is a partly proved reserve of 6,232,000 tons and a possible extension of 4,356,000 tons, or a total of 10,588,000 tons. In the remaining areas in the Latrobe-Quamby Brook district only a small "partly proved" reserve can be considered to exist, while the total of this and the possible extensions amounts to 7,453,000 tons. Developmental work in these latter areas would probably prove this reserve, and possibly add considerably further to the amount.

In the present state of our knowledge of our deposits it would appear that the total tonnage of "partly proved" and "possible extensions" is 18,041,000 tons. From this figure there would need to be deducted the reserves from those areas in which prospecting and developmental work proves the shale seam to be too thin for economic mining. Such areas might include VI. (Parramatta) and VII. (Native Plains).

#### *Methods of Mining.*

*Open-Cut.*—As the shale outcrops and also has no great cover over portions of certain areas, it would be possible to mine same by open-cut methods. This applies particularly to Area V., and possibly to Area I. The extent over which this would be possible cannot be determined at present, but generally it would appear that there is not sufficient extent to warrant open-cut mining on an extensive scale. Thus, while open-cut mining may be carried out where the shale outcrops, it is improbable that it will form a very large factor in the mining of the shale.

*Underground Mining—From Adit Openings:* As the shale outcrops in many of the areas, and has a low dip (not exceeding 10 degrees), the conditions are generally suitable for working from adit openings. The only disadvantage arising from this method would be longer underground haulage in some cases, as compared with a centrally situated shaft. It is probable that Areas I. to VI., and X. to XIII., would be worked from adit openings.

*From Shafts:* Shaft mining would have to be resorted to in areas in which the shale is situated at depth. Such areas would include VII., VIII., and IX., if the shale extends into

the latter. As regards the other areas, the only advantage of shaft versus adit mining would be slightly reduced underground haulage in some cases.

*Bord and Pillar or Longwall Mining.*—At present the mines are being worked on a small scale only, and bord and pillar methods are in use. The question of the relative merits of the above two methods has, however, to be considered, particularly as regards the conditions under which the shale occurs and the requirements of an oil shale industry. The occurrence of the shale has already been discussed in the report on the oil shale resources. The requirements of an oil shale industry using Tasmanite shale are that the mining costs must be reduced to a minimum, and that a continuous supply of shale is required at the treatment plant. The reduction of mining costs involves mechanisation of the mining.

The principal conditions favourable to bord and pillar methods are—

- (1) A thick seam.
- (2) When the maintenance of the roof is necessary, due to buildings and plant on the surface, water in the overlying strata, &c.
- (3) When there is a difficulty in obtaining waste rock to fill the workings.
- (4) When there are numerous faults which prevent the maintenance of a proper line of longwall.

The principal conditions favourable to longwall methods are—

- (5) A thin seam.
- (6) A waste band is interbedded with the seam being worked.
- (7) Where the roof is such that it will not break at or near the face, but will break clean a moderate distance behind it.
- (8) Faults are not numerous.
- (9) When the seam is difficult to mine, due to the nature of the material.
- (10) When there is a steady and continuous output required.

Generally, it may be said that there is not much difference as regards the conditions favouring either of the methods for mining the Tasmanite shale. However, conditions 5, 6, 9, and 10 generally favour the use of longwall mining. Conditions 4 and 8 probably favour bord and pillar methods, while information is not available in connection with 7. Condition 2 does not have to be fulfilled, as the plant site can be chosen where required.

Generally, it would appear that the conditions are favourable for longwall mining, the only disadvantages being—

- (a) The presence of faults, which may affect the alignment of a longwall.

(b) The presence of vertical joints in the overlying shales, &c. This could be overcome by determining the general direction of such joints, and carrying the longwall at an angle to this direction. There is also the possibility that these joints, which have been detected by the mining at shallow depths, might not occur, or only to a less extent, at depth.

The longwall methods, if a suitable roof is present, certainly permit of greater mechanisation of the mining, by way of mechanical loaders, cutting-machines, &c. Other advantages of longwall mining are—

- (a) Less explosives.
- (b) Less timber.
- (c) Plentiful storage for waste rock.
- (d) Better ventilation.
- (e) Fewer roadways.
- (f) Fewer accidents from roof falls.
- (g) Better supervision.
- (h) Higher output per man.

P. B. NYE,  
Chairman, Mining Sub-Committee.

Hobart, 19th March, 1932.

## Appendix 4c.

REPORT ON SHALE-BEARING AREAS NOS. 2 AND  
5, NEAR LATROBE, TASMANIA.

Elrington Colliery,

P.O. Box 4, Weston, N.S.W.,

22nd June, 1931.

The Chairman, Mining Sub-Committee,  
Tasmanian Shale Oil Investigation Committee,  
Hobart.

DEAR SIR,

IN conformity with arrangements made between the Tasmanian Shale Oil Investigation Committee and the Directors of the B.H.P. Collieries Proprietary Limited, I left Elrington on 7th April, and caught the s.s. "Zealandia" from Sydney on 8th April, arriving in Hobart on the 10th.

In company with Professor Hytten (Chairman of the Economic and Marketing Sub-Committee) and yourself, I travelled from Hobart to Latrobe on 13th April.

The following day we were joined by Mr. Hood, Manager of the Cornwall Colliery, and Mr. Purvis, of the Goliath Cement Company, and together made an inspection of the Goliath Cement Company's shale mine, portion of the Tasmanite Shale Company's mine, and the surface plant of the Australian Shale Oil Company.

The workings of the latter company's mine, and portion of the Tasmanite Company's mine, were flooded at the time of our visit, and could not, therefore, be seen.

After the inspection at Latrobe we journeyed to Launceston the same night, and attended a meeting of the Mining Sub-Committee the following morning (the 15th April), a meeting of the Retorting and Refining Sub-Committee on the 16th, and a meeting of the Main Committee on the morning of the 17th, leaving Launceston for Melbourne on the afternoon of the same day, and arriving at Elrington on 20th April.

I would like to place on record my appreciation of the courtesy and assistance extended to me, while in Tasmania, by the President of the Main Committee, the Hon. the Minister for Mines (Mr. James), Mr. Gepp (Chairman of the Retorting and Refining Sub-Committee), Professor Hytten (Chairman of the Economic and Marketing Sub-Committee), your good self, as Chairman of the Mining Sub-Committee, and the various members of the Mining Sub-Committee and other committees.

REPORT ON SHALE-BEARING AREAS NOS. 2 AND 5, NEAR  
LATROBE, TASMANIA.

*Location.*

There are 13 areas lying within a radius of approximately 25 miles of Latrobe, but for the purpose of this report only two are considered, viz., Areas 2 and 5, as marked on the plan submitted to the members of the Mining Sub-Committee.

*Area.*

No. 2 Area has a possible shale-bearing area of some 590 acres. This has been partly proved by outcrops and boreholes, and it would appear as if the average thickness of shale (excluding 12-inch band) is approximately 4 feet.

The total tonnage of marketable shale in this area is given in a table supplied to members as 3,540,000, which, of course, is only very approximate, due to lack of reliable information; but I am of the opinion that with a specific gravity of 1.6 this estimate is on the conservative side.

In the same table the possible shale-bearing area and tonnage expected in Area No. 5 are given as 776 acres and 3,492,000 tons respectively and the same remarks as above apply also in this case.

*Output.*

The output required from each of the above areas is 500 tons for 365 days per year, as I understand this is the figure on which the Retorting and Refining Sub-Committee is basing its conclusions.

As it is customary for the mining industry to work only 11 days per fortnight, and as there are a number of public holidays, &c., on which mines do not work, I intend to base my figures on 270 working days per year.

This will mean that considerably more storage capacity will be required than when working on the assumption of the mines working 12 days per fortnight, but I consider this essential in any case, so as to guard against delays due to breakdown, strikes, and other unforeseen happenings.

Taking 500 tons per day for 365 days, we have an annual output of 182,500 tons, giving us, on a 270-working day year, an average daily output of approximately 680 tons, which would give a life of approximately 19 years for each area.

*Power-Supply.*

There are two possible sources of power-supply, viz.—

- (1) Generation of power at mine, involving the purchase and erection of boilers, turbines, generators, &c.
- (2) Purchase of electricity from the Hydro-Electric Commission, whose mains are at present within easy distance of the properties.

It would appear that if power can be purchased at a reasonable cost, say at one penny to 1·5 pence per unit, that this would be the most favourable proposition.

In this case the whole of the plant should be electrified.

#### *Method of Working.*

There are three general methods of working which may be adopted in mining, viz.—

- (1) Bord and pillar.
- (2) Longwall advancing.
- (3) Longwall retreating.

(1) *Bord and Pillar*.—This system could be adopted under any conditions which are likely to be met with, and is the one I recommend be started.

(2) *Longwall Advancing*.—Owing to the faulting and fissures filled with clay which are known to exist, from the meagre information available I cannot conceive of this system being successfully worked on these areas, as I understand that the fault planes are erratic in direction, and the possibilities are that you would be continually opening up new faces, entailing heavy expense and loss of output.

(3) *Longwall Retreating*.—I have little doubt that when the area has been more extensively proved by means of developmental headings that a longwall retreating system will be feasible.

I am submitting a plan of Areas Nos. 2 and 5, with workings projected thereon. This shows a number of different methods of working panels, and gives my views generally on how the areas should be opened up, but, of course, may be subject to considerable modification in view of the information that will be gained in the developmental places.

#### *Coal-Cutting Machines.*

Owing the presence of quartz pebbles, which are interspersed throughout the seam, I consider it not feasible to work the chain or bar coal-cutting machines, as immediately the picks struck these pebbles it would be necessary to change same, and, from indications showing at the face at the time of our visit, a great amount of the machine-men's time would be taken up in changing picks.

A percussive machine could be used, but it is doubtful, in my mind, as to whether these would be an advantage over shooting out of the solid or "grunching."

#### *Loading Machines.*

With the bord and pillar system without the use of coal-cutting machines, the output per 8 yards place would be so small that, in my opinion, the use of loading machines would not be justified.

If it is found later that a longwall retreating system can be applied, then scraper loaders or conveyors, or perhaps both, may be found economical; but I cannot at this stage make a definite recommendation.

#### *Electric Locomotives.*

These may be found economical along the main levels, but so much depends on the grades and faulting that I cannot recommend their use at the present, and it would appear that a small rope-haulage, such as main and tail, would be the best proposition until a considerably larger area has been opened up.

All main roads should be properly laid, fishplated, and sleepered, so that locomotives can be used at a later date, if necessary, without any heavy road-laying costs.

#### *Skips.*

These should be as large as possible, taking into consideration the height of the seam and grades, but I would suggest that a skip carrying at least 25 cwt. of shale be used, the height of the skip to be kept down to a minimum to conserve the energy of the filler.

#### *Band in Seam.*

One very bad feature of the seam is that a band of very low grade shale, approximately 12 inches thick, runs somewhere about the middle of the seam.

The band is not clearly defined, and the consensus of opinion among the retorting exports is that it is practically worthless.

It will certainly be very difficult to pick this band out in the mine, and if the miner is paid per ton of shale, then the inducement will be there for him to fill it into the skip.

The only other method of dealing with it is to fill everything into the skip, and clean out the band on the surface; but this will add materially to the plant on the surface, besides putting from 3d. to 6d. per ton on the surface cost, depending on the contour of the surface within easy distance of the mine, for disposal of the refuse.

With this method the haulage and screening arrangements would have to handle 25 per cent. more material than if the band were not brought to the surface, and I think it should be left in the mine, but it would then be necessary to have a dirt scale, so that the miners would be penalised for filling over-specified amounts of band.

#### *Method of Handling Shale on Surface.*

Seeing that it is contemplated to work the two areas simultaneously, the shale to be delivered to one central crushing and retorting plant, some track will be necessary, and I have been asked to assume a distance of 3 miles.

As it is not yet known where the retorting plant will be placed, I do not know whether the 3 miles will cover sidings, nor do I know the extent of excavation and filling that will be necessary, but am basing my estimate on £5000 per mile of track, which may have to be considerably modified.

I have assumed that the shale from one mine will be tipped into a hopper holding, say, 5000 tons, while that from the other mine will be tipped into wagons and railed to the crushing plant, which, I presume will be close to the above hopper.

The number of wagons required should be sufficient to hold at least a day's output from the No. 2 Mine, which, if the carrying capacity of the wagons is 10 tons, will mean 68 wagons.

An alternative scheme is to run a light line from one mine to the other, and convey the mine skips on this line, the whole of the output from both mines being tipped direct into the 5000-ton storage hopper.

So much depends on the relative positions of the crushing and retorting plant and the two mine entrances that it is impracticable to state definitely which would be the better scheme until these points are fixed.

*Estimated Capital Expenditure Required to Mine 680 Tons per Day from Each of Two Mines and Deliver Same to a Central Crushing Plant.*

	£
Railway, assumed 3 miles, at £5000 per mile .....	15,000
Storage hopper to carry 5000 tons (say) .....	10,000
Wagons, 68 at £250 each .....	17,000
Mine skips .....	8,000
Switchgear, transformers, cables, &c. ....	15,000
Engines, motors, compressors, &c., and foundations	15,000
Fans, motors, drift, and foundations and housing .....	5,000
Workshop and shop tools (common to both mines)	2,000
Storeroom and stores (common to both mines) .....	1,250
Telephone service (common to both mines) .....	250
Underground rails, ropes, pipes, sleepers, &c. ....	4,000
Stables .....	600
Horses .....	800
Magazines .....	200
Office and furniture (common to both mines) .....	1,000
Official cottages (1 manager, 2 u/managers, 1 engineer) .....	4,500
	99,600
Plus 10 per cent. for contingencies .....	9,960
	£109,560

*Estimated Cost into Hopper or Wagons of Mining 680 Tons  
Per Day from Each of Two Mines, One Situated on Area  
2 and the Other on Area 5.*

	s.	d.
Hewing .....	6	0
Wheeling .....	0	5
Shift work .....	0	6
Deputies .....	0	2
Rope-haulage .....	0	1-5
Pit-top hands .....	0	2
Mechanics .....	0	3
Staff .....	0	2
<hr/>		
Total wages cost .....	7	9-5
Rents and royalties (say) .....	0	3
Stores .....	0	6
Pit timber .....	0	2
Horse-feed and stable expenses .....	0	1-5
Miscellaneous .....	0	0-5
Compensation (say) .....	0	4
Power (electric current) .....	0	6
<hr/>		
	9	8-5
Plus 1s. per ton for contingencies .....	1	0
<hr/>		
	10	8-5
<hr/>		

No provision has been made for interest, depreciation, Federal and State income taxes, directors' fees, head office expenses, &c.

Yours faithfully,

G. M. HINDMARSH.

## Appendix 4d.

LETTERS FROM MESSRS. G. M. HINDMARSH AND  
C. S. F. HOOD.

Elrington Colliery,

P.O. Box 4, Weston, N.S.W.,

11th February, 1932.

The Chairman, Mining Sub-Committee,

Tasmanian Shale Oil Investigation Committee,

Hobart.

DEAR SIR,

I HAVE your report dated 31st October, 1931, giving the results obtained from a sampling campaign carried out in the Latrobe district, which gives much more definite information as to the height of seam and specific gravity of the Tasmanite shales, together with the oil yield from the top, middle, and bottom portions, and the total yield of the whole of the seam.

As suggested in your letter of the 26th January last, I am submitting herewith revised mining costs based on the later information.

In my original report of 22nd June, 1931, the specific gravity of the shale was taken as 1.6, whereas it is now shown in the revised tables as 2.12 for the whole seam. The height of seam was taken as 5 feet, including the 12-inch band about the middle of the seam, which had to be mined and thrown back into the goaf as unmarketable. The average wage of the miner was taken as 25s., after deducting explosives, and the quantity of marketable shale filled as 5 tons per miner.

Taking the specific gravity of 1.6, this meant that the miner had to mine 5.19 cubic yards, but he only filled, and was paid for, 4.15 cubic yards. Now, if the whole of the seam is filled away into skips, and the specific gravity is taken as 2.12, the miner still mining 5.19 cubic yards would be paid for 8½ tons approximately, which would bring the tonnage rate to 3s. 7.68d., say, 3s. 9d. In addition to this saving, approximately only two-thirds of the miners would be required for the same output, which would affect some of the other costs slightly. These are itemised hereunder:—

	s.	d.
Hewing	3	9
Wheeling	0	5
Shift work	0	4
Deputies	0	1.5
Rope-haulage	0	1.5
Pit-top hands	0	2
Mechanics	0	3
Staff	0	2
<b>Total wages cost</b>	<b>5</b>	<b>4</b>

	s.	d.
Brought forward (wages cost) .....	5	4
Rents and royalties .....	0	3
Stores .....	0	6
Pit timber .....	0	1-5
Horse-feed and stable expenses .....	0	1-5
Miscellaneous .....	0	0-5
Compensation .....	0	3
Power (electric current) .....	0	6
	7	1-5
Plus 10 per cent. for contingencies .....	0	8-55
Total .....	7	10-05

showing a saving of 2s. 10-45d.

If it is proposed not to retort the middle band, but to leave same in the mine, I estimate the cost per ton of marketable shale as 9s. 6d., showing a reduction of 1s. 2-5d. over the original estimate of 22nd June, 1931.

These costs are, of course, for a seam of a total thickness of approximately 5 feet, but in some parts of the areas this is reduced to 2-75 feet, according to the latest information, and the above tonnage rate would not apply to this thickness, and, as a matter of fact, I do not consider that it would be economical to mine a seam 2 feet 9 inches in thickness at all under bord and pillar method.

The same remarks regarding interest, depreciation, &c., made in the original report, apply equally in this case.

Yours faithfully,

G. M. HINDMARSH.

Cornwall Coal Company, N.L.,  
Cornwall, 9th November, 1931.

P. B. NYE, Esq.,

Chairman, Mining Sub-Committee,  
Tasmanite Shale Fields.

DEAR SIR,

I HAVE carefully checked the report of Mr. G. M. Hindmarsh on the working of Areas Nos. 2 and 5, and am of the opinion that the report is on the right lines. I quite agree that the first method to adopt is to obtain an output from developing headings to the boundary slightly to the rise, to facilitate drainage and bord and pillar system, until the boundary is reached by the headings, thence longwall retreat-ing method; meanwhile pillar extraction to follow the bord workings as closely as practicable. Owing to the presence of faults, which may alter the grade, either favourably or otherwise, it will probably be necessary to drive an adit to the surface dip from the main winnings. This should be winning shale most of the way, and will be more economical than pumping, as I anticipate a good deal of water in these areas. The cover, being shallow, when it becomes broken by working, will also allow a good deal of surface water to enter.

The estimated cost of working by Mr. Hindmarsh is near the mark, and the difference in cost, owing to the difference in specific gravity, as amended from 1s. 6d. to 2s., excluding the band, will be 3d. per ton less, while if the band is allowed to be filled by the miners direct from the face, it will bring the cost of production down by 1s. per ton.

Owing to the number of pebbles in the seam, I agree that the ordinary chain cutter machines will prove too troublesome for successful operation, but as compressed air is being supplied at present for the boring machines, I am of opinion that the trial of one of the percussive type of machines is well worthy of consideration.

If there is any other matter on which you desire any more information, I shall be cheerfully at your service.

I have forwarded Mr. Hindmarsh's plan under separate cover.

Yours faithfully,

C. S. F. HOOD.

*[Faint, illegible text, likely bleed-through from the reverse side of the page.]*

## Appendix 5.

## TASMANITE SHALE OIL COMPANY LIMITED.

Reference  
Nos. of  
Documents.

REPORT ON INVESTIGATIONAL WORK CARRIED OUT SINCE 1ST  
OCTOBER, 1931, TO 30TH JUNE, 1932.

A careful examination of developmental work on Tasmanite shale, in the light of our present knowledge, leads to the belief that the quoted estimates for the value of the field have been based either on insufficient information or on results coloured by personal opinion, not unmixed with self-interest. Unquestionable evidence as a basis for the estimates is very meagre, and it is desirable, in considering the following report, to eliminate any preconceived ideas of the value of the shale if based on assumptions from localised results. It will be seen that even genuine results obtained from local parts of the shale seam may be quite misleading when applied to the seam in general; but it seems reasonably certain that we have data on the approximate maximum and minimum values.

This report will deal with the subject under three main headings, viz. :—

- A. The Technical Side.
- B. The Commercial Aspect.
- C. A Recommendation for the Immediate Future of the Work.

*A.—The Technical Side.*

On the technical side, consideration should be given to three main branches—mining, retorting, and refining.

*Mining.*—The writer is not competent to discuss the technical aspects of the mining, but several features of the mining side affecting the general plant operations may be mentioned, since they form the source of much confusion in quoting values.

It has been shown definitely that the shale quality varies, not only across the seam but through the field, and it is from these variations that difficulty arises in placing a reliable average value on the shale field, since operations to date have been confined to relatively small localities.

The variation in value across the seam has been summed up in describing the seam as being composed of top, middle, and bottom bands, each widely differing from the others in value. The existence of these bands has led to a trial of selective mining to eliminate the low-grade centre band. Before a final decision can be reached on the economic aspect of selective mining, a careful examination should be made of the commercial values of the whole-seam shale as compared with selected shale, having regard to the relative running costs.

1. The present operating company has obtained reliable figures of the commercial oil yields from whole-seam mining,
2. in the low and high grade sections of the field, and corresponding figures for selective mining. This data will afford
3. an indication of the commercial values of the shale deposit.
- 4.

Some idea of the general trend of the values across the field will be obtained by extensive drilling and examination of the cores obtained. This work is at present being done.

Since the richer shale weighs less per unit volume than the poorer shale, it is possible, under parallel conditions, to obtain a higher weight throughput on the lower grade shale in each retort, without altering the volume of the shale charged. This is reflected in the tables showing the retort results. From the commercial point of view, a more accurate perspective of values is obtained by regarding the cubic yard of shale as the basic unit, rather than the ton. A still more drastic example of this variation is seen when comparing the value of the very light New South Wales shale with Tasmanite. It will then be seen that the oil content per foot depth of seam from the Tasmanite field is not far behind that of New South Wales, taking the latter seam at 2 feet.

These variations may be summarised in the fact that the richer the shale, the greater the volume that must be mined to make a ton, and the lower the retort throughput. Consequently a true commercial comparison cannot be obtained by simply comparing oil values per ton of varying shales.

*Retorting.*—The present retort at Latrobe was designed following experience gained from two smaller units of the same fundamental principles.

The first retort was a small unit erected in Burma, following extensive laboratory work on the Burma shale over a period of two years. The performance of this unit on a throughput of 2 tons per day was so promising that it was decided to extend its application by the erection of a larger unit in London to carry out general research on oil shales and coal distillation, under the control of the Mineral Oils Extraction Limited.

This retort behaved very satisfactorily with a wide variety of coals and oil shales from different parts of the world, including two test runs on Tasmanite shale and one on New South Wales torbanite. The throughput varied from 3½ tons to 10 tons per day, according to the material tested. Verdicts on the retort performance by men of high technical qualifications and reputation, and including a carefully controlled test by His Majesty's Fuel Research, are available.

Following the work on the Tasmanite shale, it was decided that the commercial prospects were sufficiently attractive to justify the company in carrying the work to a further stage by erecting a pilot plant on the Latrobe shale field to obtain an accurate idea of local conditions and any difficulties peculiar to the shale field. The writer was sent to Tasmania by the company to supervise the erection and operation of this plant.

The early operations of the retort were chiefly directed towards realising, if possible, the shale throughput and oil yield per ton predicted by analogy from experience with the London unit.

During this period 1823 tons of shale were retorted, yielding 44,265 gallons of crude oil. No steps were taken to recover the light motor-spirit from the gas except on a

Reference  
Nos. of  
Documents.

- 1.
- 2.
- 3.
- 4.

laboratory scale. For the work a new tunnel was opened into the shale seam. This tunnel proved of considerable value in exposing the variation of grade in the shale across the field.

Following the amalgamation of the shale interests in 1931, as recommended by the Shale Oil Development Committee, financial assistance was granted by the Committee as a contribution towards the expenses of a programme of investigation, involving a three months' run on the Crozier retort, following alterations of a mechanical nature to improve the system for discharging the spent shale. This programme was later modified, on the advice of the manager of the company, to one of a more comprehensive nature, arranged to obtain full and reliable information on the developed sections of the shale field, together with detailed figures which would reflect the commercial efficiency of the retort under conditions which would leave no room for doubt as to whether maximum results for the particular unit under review were being obtained.

This work involved an alteration to the heating system of the retort to provide conditions known to be sound and satisfactory for long continuous operation, and consequently to eliminate any question regarding throughput that might be attributed to unsatisfactory heating.

1. The first test run had for its objective mainly the obtaining of results which would be in accord with those deduced from the tests carried out in London.

5. Retorting commenced on 23rd November, 1931, and was maintained continuously to 24th January, 1932. During this period 1562 tons of shale were treated, with an oil yield of 32,059 gallons of oil. A plant for the recovery of the light scrubber spirit from the gas was brought into operation during this period. Figures for throughput of shale were obtained as high as 35 tons per day. It was found, however, that owing to the greater mean hydraulic depth of the Latrobe unit, and the smaller heating area per unit charge of shale as compared with the London unit, such results could only be obtained under conditions of temperature and oil yield that would be unsound for continuous commercial operations.

The reasons for the discrepancy between the performances of the two retorts having been ascertained, it was decided to discontinue the attempts to bring the two performances in line, standardise the conditions of retorting on a conservative basis for sound commercial operation, and proceed with the investigations into the retort efficiency under these conditions.

1. 2. In this, the second test of the series, attention was concentrated on a particular section of the shale field, and the retort was maintained in continuous operation for one month, commencing 25th February and ending 24th March, 1932, the work being directed towards obtaining the maximum possible yield of oil from this particular grade of shale.

6.

It should be remembered that high throughput figures may be obtained at the expense of oil yield, either through

incomplete treatment or by operating at temperatures sufficiently high to increase the decomposition of the oil to permanent gas, i.e., "cracking." A relatively high throughput of shale, with a lower oil yield, may, under certain conditions of running and retorting costs, be sound commercial practice. The method of operating with an indefinite oil yield depending on throughput makes it a difficult matter to obtain information of absolute retort efficiency. Since this was the immediate aim, it was decided to adopt complete treatment at as low a temperature as possible as the basis from which to work.

To assist in the compiling of the data from the tests, the company augmented its staff by employing two graduates in engineering from Tasmanian University. It was also arranged, through the courtesy of Mr. E. E. Kurth, Lecturer in Chemistry at the University, who had already carried out considerable research work of value on the shale and its products, that the testing of the samples representative of the shale fed to the retort should be cross-checked in the University laboratories.

An additional check on this work was obtained from a comprehensive sampling of all developed parts of the field by the Mines Department, acting under instructions from the Hon. Claude James, Chief Secretary and Minister for Mines, Tasmania. The work was carried by Mr. P. B. Nye, Government Geologist, assisted by Mr. J. Blake, Field Geologist, and included a careful sampling of the shale seam at regular intervals in all the present tunnels and bords on our leases. The samples of shale were examined as regards oil content, specific gravity, sulphur content, and seam width at position of sampling. The results are combined in detailed reports, copies of which may be obtained on application to the Mines Department, Hobart.

The reports referred to are as follows:—

1. Report on Distillation of Oil Shale Survey Samples, by E. E. Kurth, Lecturer in Applied Chemistry, Tasmania University.
2. Report on Sampling of Tasmanite Shale of Latrobe District, by J. Blake, Field Geologist, Tasmania, dated 22nd September, 1931.
3. Report on the Results of Sampling of the Tasmanite Shale at Latrobe, by P. B. Nye, Government Geologist, Tasmania, dated 31st October, 1931.
4. Supplementary Report on the Results of the Sampling of the Tasmanite Shale at Latrobe, by P. B. Nye, Government Geologist, Tasmania, dated 19th December, 1931.

The manner in which the results from these varying sources agree is very satisfactory, considering the variation in sampling methods and the different methods of analysis adopted.

In the second test 334 tons of shale were retorted, for an oil recovery of 10,833 gallons of crude oil. Excluding the starting-up period, when of necessity oil is lost to the residue while bringing the temperatures to standard conditions, an average recovery of 35.7 gallons per dry ton of

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shale was obtained, representing an 80 per cent. recovery of the assay result, and 98.1 per cent. of the oil-bearing matter in the shale fed to the retort was accounted for in the form of products of the retorting.

8. Following this test, the alteration to the heating system of the retort was made with the object of obtaining the figure for retort throughput under conservative conditions, and without adversely affecting the percentage yield and quality of the oil as indicated by the second test.

2. 3. In Test No. 3, commencing 12th May to 1st June, 1932, 327.5 tons of shale were retorted, with a yield of 9993 gallons of crude oil. The results showed an improvement on the second test, the oil recovery amounting to 86 per cent. of the yield from the plant assays, and to 80.7 per cent. of the assays from the University.
- 7.

An interesting feature is that, owing to the differing specific gravities of the oils, the percentage weight recovery of oil was 82 per cent. on the University assay and 84.9 per cent. on the plant laboratory assay. The products of retorting in this test totalled to 94.3 per cent. of the oil-bearing matter fed to the retort.

This figure having been obtained, attention was directed towards obtaining the oil yields under identical standard conditions from the known varying qualities of the shale in the field.

This work included tests of whole-seam mining and selective mining to eliminate the low-grade centre-band of shale and involved mining in two quite distinct and widely separated parts of the field, in one case remote from the retorting plant, and necessitating expensive and troublesome carting.

3. 3A. In the following test, 3A, the retort dealt with the shale taken from the whole seam in the lowest-grade section of the field. The test period lasted from 1st June, 1932, to 16th June, 1932. During the test 189.4 tons of shale were treated, with a recovery of 4201 gallons of crude oil, representing 22.2 gallons per ton, or 80.5 per cent. of the assay.
- 7a.

4. 3B. The low-grade centre band was then excluded, and during Test Run 3B, from 18th June, 1932, to 29th June, 1932, the top and bottom shale from the lower grade section of the field was retorted. During this period 139.2 tons of shale were treated, with an oil recovery of 4091 gallons, representing an average recovery of 29.4 gallons per ton.
- 7b.

In all, during these tests the total shale retorted amounted to 2552.1 tons, with a recovery of 61,177 gallons of crude oil. Since the erection of the retort the total tonnage put through amounts to 4375.1 tons, for a recovery of 105,442 gallons of crude oil.

- 1, 2, 3, 4, 5, 6, 7, 8. The details of these five test runs are given in the attached tables under the appropriate headings.

The method of reporting the results has been directed towards showing how the total organic or oil-bearing matter decomposes to form oil, gas, aqueous liquor, and carbon, and we have endeavoured, as far as conditions have permitted, to show the distribution in these products. For

comparative purposes the corresponding figures for the two laboratory methods are included, and the manner in which the course of the decomposition may vary with differing retorting conditions is clearly indicated.

The method is an adaptation of that used by His Majesty's Fuel Research Station in England, and, when carried out under proper control, it affords an excellent index of the efficiency of the plant under review. In this connection it cannot be too strongly emphasised that a laboratory or any small-scale test of the shale is of little value unless the apparatus is of standard design, or data on the relationship between the results and those from the standard apparatus are known. The accepted standard apparatus in England is the Gray-King arrangement as used at the Fuel Research Station. It is interesting to note that the results from this apparatus approximated to those obtained by Mr. Kurth as compared with those from the apparatus used at the plant. Based on the Gray-King apparatus, large-scale retorts usually returned oil yields varying from 60 per cent. to 75 per cent., and never, to date, in excess of 84 per cent. In Scottish shale practice the small-scale test is known as the "pipe test." This gives results in close agreement with the yields to be expected from the Scottish commercial plant. Before such a test can be used as a basis for comparative efficiency, it would be desirable to have careful comparative tests made with an apparatus such as that used in the laboratory of the University.

Owing to this variation of results according to retorting conditions employed, it is desirable, when valuing any shale field for commercial development, that the oil yields taken as probable should be based on full-scale practice with the particular type of plant to be employed. Where laboratory results only are available, they should be in agreement with those of a standard apparatus, and should be modified for estimate purposes by a factor showing their relationship to the yield from the large-scale plant in view. This factor must be obtained from practical tests on a sufficient scale.

An illustration of the variation in oil yields from the same sample of shale, according to retorting conditions employed, is shown in some research work on cracking carried out in London in 1928. By varying the conditions of treatment, a Tasmanite shale sample yielding normally 43 gallons of oil per ton gave 20 gallons per ton of a much lighter oil.

*Refinery.*—Experimental work on refining the crude oil produced has been carried on continuously since production commenced.

Preliminary laboratory work was followed by the erection of a 50-gallon still for the crude oil distillation, a 20-gallon steam still for the light oils, and a small washer for chemical treatment. The work at this period was chiefly concerned with obtaining a motor-spirit of satisfactory appearance for testing purposes. This work was followed by the erection of a 500-gallon still and a washer of 100 gallons capacity. With this plant several thousands of gallons of crude were refined and the products sold.

Reference  
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Documents.

The behaviour of the products was promising, but it was obvious that the refinery equipment was inadequate for fully satisfactory results. This plant was succeeded by a larger one incorporating a crude oil still of around 2000 gallons capacity, an intermediate still of 500 gallons capacity, and a finishing still of 300 gallons capacity. The chemical treatment plant was increased to a washer of 800 gallons capacity and one of 300 gallons.

A small steam bubble tower still was included for recovering the light motor-spirit wash from the gas in the scrubber towers on the retorting plant. Close control was maintained on the operations of the refinery plant by the laboratory. Where the laboratory facilities were inadequate for certain work, or where checks were desired, samples were sent to the University, the Mines Department, and the Goliath Portland Cement Company.

The Tasmanite Company much appreciates the valuable assistance from the above sources towards the accumulation of reliable data in connection with the industry.

13.

As compared with standard specifications, the present sulphur content of the oils is high. On the other hand, in actual practice, to judge from reports received from our customers, some of whom have used large quantities and are still keen buyers, the relatively high sulphur content does not appear to have any detrimental effect on the engine. The question calls for further research work on both the chemical side and the mechanical engineering side, but the important point is that we have oils of marketable quality with which to carry through the initial stages necessary to establish the industry. It must be remembered that research will be a necessary part of the plant routine, with the object of continuously improving the quality and variety of the products.

The present products, although retaining a characteristic odour, have been considerably improved in this respect since the present work commenced. It is important from the large-scale selling side that the petrol and kerosene be free from objectionable odour, and the present position in this respect is similar to that of the sulphur question.

9.

10.

All standard methods of refining have been tried. In some cases, results in the laboratory have been well within standard requirements on the points raised above, but the methods have not been adapted to the plant, either from reasons of expense or difficulty in obtaining chemicals. The present plant practice is straightforward, and although the refinery equipment is largely makeshift, the results correspond well with those obtained in the laboratory under similar treatments.

Mr. E. E. Kurth has carried out a considerable amount of research work on the refining of the oils. This work is still in progress, and may indicate where improved methods may be applied.

9.

10.

Tables showing yields under several conditions of treatments, and the distribution of sulphur in the products, are attached.

*B.—The Commercial Aspect.*Reference  
Nos. of  
Documents.

The winning of petroleum substitutes from shale constitutes a low-grade primary and manufacturing industry, because a large bulk of raw material is handled in the first instance at a cost relatively high compared with the value of the finished products, while these products form a comparatively small percentage of the material treated. The margin of profit or loss in operation depends, to a great extent, on the scale of operations, since there is an economic minimum to the quantity that can be handled by a given amount of labour and plant.

This is illustrated on the present plant, where a shale-crusher capable of handling 250 tons of shale in eight hours, is being operated to crush 90 tons per week, and one retort is being controlled by two men, who would be quite capable of looking after four.

Our present marketing information is summed up in the attached table, which gives our experience with the single-unit plant, from which over £3000 worth of oil has been produced and sold.

13.

The cost of production is naturally high, partly owing to the minimum scale of operations and partly to the experimental nature of the work, as outlined above. We have incorporated these results in the estimate attached, showing the probable results on a throughput of 50 tons per day. Despite the fact that the figures are based on conditions capable of general improvement in efficiency, the relationship between cost of production and value of products is very satisfactory considering the small scale of operations involved. The figures for power, fuel, water, chemicals, &c., have been obtained by actual measurement on the present plant.

The commercial returns are seen to be largely dependent on retort capacity, the oil yield per ton, and the refinery yields from the crude oil.

In the case of retort capacity, it may be found desirable to run the retorts at a relatively high throughput with a low percentage recovery. This would depend greatly on the mining costs. This point is illustrated in comparing the results of two runs on the same quality shale with the present retort: one at an average throughput of 25.3 tons per day, with an oil recovery of 19.3 gallons per ton, or a total of 488 gallons per day, and one at 11.7 tons per day, with a recovery of 34 gallons per ton, or 398 gallons per day. On these figures this method would be unsound, apart from the objection to throwing oil on the dump-heap.

It is a difficult matter to estimate the probable average value of the field with accuracy till the present drilling operations are complete, but the figure of 28 gallons per ton should be safe.

There is every room for improvement on the refinery results. The figures quoted are based on the results obtained from a makeshift plant, which provides a source of considerable loss from leaks alone. Such losses are included in our general refinery losses. With our present method of refinery we do not utilise the full quantity of petrol and

Reference  
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Documents.

kerosene shown to be present in the crude from the laboratory tests, because we are not, as yet, sure that the finished products would be as acceptable as the present ones. Again, the present method of refining results in the bulk of the oil being sold as fuel oil of low value. No allowance is made for the lubricating oil fractions present in the fuel oil, because we have not carried out the necessary work to prove the commercial value of these products. There are undoubtedly recoverable lubricants of light character in the oil, and we substitute a large proportion of our lubricant requirements on the plant with our heavy crude distillates. The results are very satisfactory. The recovery and examination of such oils should constitute a part of any future programme. No allowance has been made for side applications of the bitumen for paints, nor for by-products, such as spray oil for orchardists, phenyle, and cresylic acids, ichthyol, and the fuel value of the steamed acid tar. The possible by-products should be considered as a matter for further investigation, but the commercial prospects should be gauged solely on the value of the straight oil products.

It appears certain that a large-scale plant should include cracking equipment. The commercial outlook with a cracking process of treatment is quite transformed, and it is possible that the value of the oil may be increased by 50 per cent, over the figures quoted on the attached sheets. After allowing for the extra cost of cracking, this method remains the most attractive, particularly because it results in a high yield of motor-spirit, the product in greatest demand.

The data used in estimating for the intermediate scale plant are conservative, and based on actual information from three years' work on the field. No allowance is made for the improvement to be expected from a plant which will naturally incorporate the benefits of the developmental work. Experience with forecasting results on the shale field from theory has demonstrated how difficult it is to substantiate any other than proven facts.

*C.—Recommendation for the Future of the Industry.*

The attempt to establish a shale oil industry in Australia is somewhat analogous to the efforts in Britain to establish a coal distillation industry. In this connection a report by the Director of Fuel Research in London has offered as guidance the following stages through which developmental work should pass before a sound foundation can be laid for the industry:—

- (a) The suggested method must be investigated under laboratory conditions, where the varying factors involved can be subject to close control, and where relatively high accuracy of measurement can be obtained.
- (b) The process must then be carried to a stage further by erecting an intermediate scale unit, with a view to obtaining further designing data for a still larger unit. In this stage the plant will probably deal with several hundredweights per day.

- (c) Making use of the information yielded in Stage (b), a full-scale unit must now be erected and tried out. The size of this unit would depend upon the type of plant, but might range from, say, 5 tons to 100 tons daily capacity. It is essential that this unit should be capable of multiplication to the full size of the commercial unit without increase in scale.
- (d) A battery consisting of several units similar to those developed in Stage (c) would then be erected on the field, and the economic possibilities of the system examined in actual practice, and, if necessary, tested by commercial audit.

The present plant has now reached the completion of Stage (c). This stage has been worked out in greater detail than is allowed for in the recommendation, since two units of differing dimensions have been examined in Stage (c), following one in Stage (b), and the preliminary work of Stage (a).

On this basis the unit recommended for adoption in Stage (d) has been reached. This unit lies in dimensions between the two retorts tested on Tasmanite shale.

It is now proposed to incorporate the information obtained to date in the erection of a battery of four retorts. This plant will have a capacity of around 50 tons per day throughput, and would be regarded as supplying the information outlined in Stage (d).

11.

The scale recommended will be sufficiently large to provide under continuous operation for 12 months, an indication of the commercial possibilities of the field if the scale of operations were increased to full commercial magnitude. The quantity of oil produced will be sufficient to expose any unforeseen difficulties in marketing, and will permit of these being attended to without creating too difficult a storage problem at the plant. The operating period on such a plant will enable the mine development to be advanced to a stage where production on a large commercial scale will be in sight.

As explained in the refining section, there is need for further work on refining, particularly along the lines of cracking the heavy oils to motor-spirit. It would be desirable to obtain during this period the consulting advice of such a company as the Universal Oil Products of Chicago, U.S.A., or of Craig's, of Glasgow, who designed and erected the cracking plant in use on the Scottish shale fields, with a view to testing the oils and designing a cracking plant of suitable dimensions for a large layout. Preliminary work on cracking Tasmanite oil has already been carried out by the abovementioned American company. A table setting out details of cracking results is attached. It would also be essential to obtain satisfactory evidence that the finished motor-spirit was of first-grade marketable quality.

14.

The establishment of the proposed four-retort unit is recommended with the object of creating that public confidence in the soundness of the industry which will assist

this company in obtaining the capital necessary for the erection of a plant to treat a daily throughput of from 500 to 1000 tons of shale.

Expenditure on the necessary material for the proposed plant will be within Australia, and the plant itself will form part of a larger battery in the event of extension. The four-unit plant operating during the proposed operating period of 12 months will definitely determine the minimum daily quantity of shale required to be treated in order to place the industry on a profitable basis.

The company has a considerable amount of auxiliary gear, which would be suitable for a 50-ton layout. This includes crushing-plant, electric motors, transformers, gas-producer, charging bunkers, mine equipment, loading-gear, and Diesel engine.

The results of the investigational work to date indicate that the industry will provide reasonable returns on capital, provided the scale of operations is sufficiently large. Labour will be employed in a primary mining industry for the production of an essential source of power and an essential factor in national defence not otherwise obtainable in the Commonwealth.

Any proposal which may assist in the establishment of the industry should therefore be worthy of careful consideration by both Federal and State Governments, especially in view of the fact that such information as is given in this report has been obtained in such countries as Britain, Germany, Canada, and Japan from investigational work undertaken at the expense of the governments of these countries for reasons of national safety.

A. WALKER, Manager, B.Sc., A.I.C.

*List of Documents Attached.*

Ref. No.	Subject-matter.
1.	Summary of Test 2.
2.	Summary of Test 3.
3.	Summary of Test 3A.
4.	Summary of Test 3B.
5.	Details of Test 1.
6.	Details of Test 2.
7.	Details of Test 3.
7A.	Details of Test 3A.
7B.	Details of Test 3A.
8.	Comparison of Retort Performance Before and After Heating Alterations.
9.	Tables showing Results of Various Refining Tests.
10.	Analysis of Sulphur Distribution in the Products.
11.	Estimates for Plant of Four Retorts.
12.	Tables showing Variation of Oil Yield and Quality with Variation in Retorting Conditions.
13.	Summary of Sales of Products.
14.	Table showing How the Crude Oil Value Varies According to the Method of Refining Adopted.

## 1.

## TASMANITE SHALE OIL COMPANY LIMITED.

## Summary of Test Run No. 2 on Crozier Retort.

Period from 24th February to 25th March.

1/4/32.

Preliminary Warming-up Period, from 11th February to 24th February.

Period of Run Reviewed.	Duration Period (Days).	Total Shale Treated (Tons).	Throughput Per Day (Tons).	Total Oil Yield (Gals.).	Average Recovery Per Ton (Gals.).	Average Assay (Gals.).	Average Recovery (Per Cent. of Assay).
First week .....	8.2	107	13	2929	27.3	42.8	63.8
Second week .....	7	81.3	11.6	2594	31.9	43.4	73.7
Third week .....	7	70	10	2425	34.6	42.7	81.0
Fourth week .....	7.66	72.6	9.5	2427	33.9	42.2	80.3
Close-down period .....	....	4.5	....	483	Part of this oil was recovered from the condenser boxes, and should be credited to the first week's yield.		
Period of set conditions .....	27	290	10.7	9528	32.8	42.8	76.6
Total period .....	30.5	334	11	10,833	32.4	42.8	75.6

Test Run No. 2.—Analysis of Laboratory Assays.

8/4/32.

Period from 24th February to 25th March.

Shale Dried at 100°C. (University).			Run of Mine Shale (Plant Laboratory).			Plant Laboratory (Corrected for Moisture).		
Product.	Yields Per Ton (Gals.).	Percentage by Weight.	Product.	Yields Per Ton (Gals.).	Percentage by Weight.	Product.	Yields Per Ton (Gals.).	Percentage by Weight.
Crude oil ....	45.9	18.7	Crude oil ....	42.8	18	Crude oil ....	44.5	18.72
Liquor ....	2.6	1.1	Liquor ....	11.6	4.9	Liquor ....	2.6	1.10
Gas .....	1145	3.06	Gas .....	1249	3.35	Gas .....	1297	3.48
	c. ft.			c. ft.			c. ft.	
Volatiles in residue ....	77.2%	3.55	Volatiles in residue ....	75.1%	0.5	Volatiles in residue ....	77.57%	0.52
Fixed carbon in residue ....		2.32	Fixed carbon in residue ....		2.66	Fixed carbon in residue ....		2.76
Ash in residue ....		71.33	Ash in residue ....		71.94	Ash in residue ....		74.29

1. The first section of the table shows the results obtained by Mr. Kurth, Lecturer in Chemistry at the University of Tasmania, on a shale sample representing three days' run. The second section shows the average results over four weeks, obtained at the plant laboratory. The third section shows the plant results corrected for moisture, as outlined below in Note 2.

2. Mr. Kurth has based his analyses on shale dried to constant weight at 100° C. This is the desirable and correct procedure when the results are required as a standard. The plant results were primarily required as a check on the daily commercial retort yields, irrespective of weather conditions or moisture conditions at the mine. It will be preferable in future to calculate all results on the dried shale basis, and a check on the retort yield can be obtained by keeping daily figures on the moisture content of the shale charged. To obtain a better correlation of our results with those of Mr. Kurth, I have calculated them to the dry basis by assuming that the difference between the liquor yields is due to moisture in the shale. Reference may be made to pages 5 and 6 of Mr. Kurth's report to the Mines Department, on the recent assay work of the Department, to show that the moisture adjustment is reasonable. In the report the moisture content is given as varying from 1.9 per cent. to 7.5 per cent. The correction from our analyses is 3.84 per cent. This correction for the dried shale is given in the third section of the table.

3. Owing to the high finishing temperature of our laboratory retort, the volatile matter left in the residue is lower than in Mr. Kurth's. The later represents more closely a true low-temperature distillation. A further result of this relative difference in retorting conditions is the higher carbon content in our residue, presumably obtained partly from the distillation of the remaining 3 per cent. of volatiles in the residue. This is also reflected in our increased gas yield. It would be interesting to know how much of these effects was due to the more complete distillation, and how much to difference due to cracking during the distillation.

4. It will be noticed that the percentage figures do not total to 100. This is to be expected because of the variables used in the calculations. The discrepancy is more pronounced in our total, partly because of the large number of assays used in arriving at the average figures. Some of the assays were carried out on shale exposed to wet weather conditions.

5. Too much reliance cannot be placed on our ash figure, as insufficient proximate analyses were carried out to justify averaging the results over the total number of assays done.

6. The specific gravity of Mr. Kurth's oil is .913, as compared with our .941. This accounts for the percentage weights being approximately the same, despite the difference in volume.

7. The results show that there was no justification for serious questioning of the assay figures, particularly on the grounds that they were high. Mr. Kurth's figures will give a close approximation to the relative quantities of the yields for a particular sample of the shale. Reference to my letter to Mr. Kurth will show that we were obtaining results varying between 42 and 46 gallons per ton on the wet basis at the time this sample was taken.

8. I shall base our commercial results on the dry shale assay figure, and shall prepare one on Mr. Kurth's results, and one on our own. It should be remembered that the sample sent to Mr. Kurth represented only a short period of the run. On the other hand, the figure for the ash in ours is possibly high, and consequently that for the kerogen low.

In general, the results provide a close parallel, all variations being in the right direction.

*Test Run No. 2.—Basic Figures for Kerogen Quantity.*

8/4/32.

(Oil-bearing matter in shale.)

Source of Result.	Percentage of Shale Accounted for as Kerogen Products, Exclusive of Liquor.
University of Tasmania Laboratory— Results based on dried shale: Sample represented three days of the run	27.6 per cent.
Tasmanite Shale Oil Company Laboratory— Result based on dried shale: Average over four weeks	25.5 per cent.
Commercial Retort— Result A (calculated to dry shale basis)	27.08 per cent.
Commercial Retort— Result B (calculated to dry shale basis)	26.29 per cent.

8/4/32.

*Test Run No. 2.—Weight Balance on Kerogen Matter, Exclusive of Liquor, from Results with the Commercial Retort.*

A. Over period of 14·66 days, when retorting conditions were steady. Results are on shale as mined.

		Per Cent.
Crude oil .....	34·3 gals. per ton	14·15
Gas .....	1875 c. ft. per ton	5·00
Gas in residue .....	200 c. ft. per ton	0·54
Oil in residue .....	1·1 gals. per ton	0·45
Carbon in residue .....		5·90
		<hr/>
		26·04

B. Over total period of run, including starting up and closing down. Results are on shale as mined.

		Per Cent.
Crude oil .....	32·4 gals. per ton	13·38
Gas .....	1783 c. ft. per ton	4·78
Gas in residue .....	250 c. ft. per ton	0·67
Oil in residue .....	1·32 gals. per ton	0·55
Carbon in residue .....		5·90
		<hr/>
		25·28

8/4/32.

*Test Run No. 2.—Table Summarising Yields of Crude Oil Obtained From the Commercial Retort, and Comparison with the Assay Results.*

Source of Result.	Yield Per Ton.	Commercial Result as Percentage of University Figure.	Commercial Result as Percentage of Plant Laboratory Figure.
		Per Cent.	Per Cent.
University Laboratory, Tasmania	45.9	....	....
Plant Laboratory	44.5	....	....
Commercial Retort (Period A)	35.7	77.7	80.2
Commercial Retort (Period B)	33.7	73.4	75.7

NOTE.—All results in the above table are based on dry shale.

8/4/32.

*Test Run No. 2.—Notes on the Tables Showing the Relationship Between the Commercial Retort Figures and the Assays.*

1. The figures tracing the kerogen matter in the two laboratory retorting systems, and in the commercial retort are informative and interesting. It appears that we are very close to accounting for all the organic matter in the shale. The actual figure over half the operative period of the retort amounts to 98.1 per cent. of the University assay result.

2. The results for the total run appear to be satisfactory when the unavoidable losses in starting up are taken into account.

3. The oil recovery of the retort as compared with the assay result is seen to range between 73.4 per cent. and 80.2 per cent., according to the assay taken as most accurate, and the period of the test chosen. It is reasonable to base the figure on the more controlled period of the run. By taking Mr. Kurth's figure as accurately

representing the shale value, the conversion factor is 0.78. A safe figure at the present stage would be 0.75, based on the University apparatus. The factor compares favourably with the results obtained from low-temperature distillation plants in England.

4. With the bulk of the kerogen accounted for, attention can be given to further increasing the oil yield by decreasing the gas formed.

The effect of steaming should be tried, as suggested in one of my previous reports. Mr. Kurth also advocates this, despite his negative results with steam in the laboratory. The laboratory conditions are too dissimilar to provide reliable information in this respect. I am doubtful, however, if steaming will increase the oil yield considerably under our present low-temperature operating conditions.

Any further improvements are a matter of design. The yield already obtained is a reliable indication of the fundamental soundness of the present design. Our present information indicates that an increased oil yield will result from narrowing the cross-section slightly. A further improvement would be the use of the bottom experimental cracking-pipes as off-takes. These points are raised as matters of interest for the future.

1/4/32.

*Test Run No. 2.—Notes on Table of Retorting Results for Experimental Run—24/2/32 to 25/2/32.*

1. The low yield during the first period is due partly to unavoidable loss to residue, while bringing the setting to minimum retorting conditions. It is also partly accounted for by some of the oil going to fill the condensers and separators. This oil is recovered in the close-down period. Allowing an average of 33 gallons per ton for the 4.5 tons used during closing down, 235 gallons are seen to be obtained from the condensers and separators. This may be transferred to the first period, bringing the yield to 29.6 gallons per ton for this period. It is, I think, preferable to average it over the whole period.

2. Apparently we require about a fortnight after starting the run, to adjust for the best results.

3. Over the first three weeks the oil yield increased with decrease of throughput. This indicates incomplete treatment. This yield reached a maximum during the third week, at an average throughput of 10 tons per day, and slightly decreased with decrease of throughput during the fourth week. The variation over the last fortnight is small enough to be within experimental error. The yield obtained over this period can be taken as a safe maximum for the quality of the shale treated.

4. Since the breakdown of the scrubbing circuit on 14th March, 1932, the scrubber spirit has been allowed for by taking a safe percentage of the daily yields obtained previously. This amounts to 339 gallons over the last stage. This was an unfortunate occurrence, as it has been necessary to make a conservative theoretical allowance which is probably on the low side.

## TASMANITE SHALE OIL COMPANY LIMITED.

23/6/32

*Summary of Test Run No. 3 on Crozier Retort.*

Period from 12th May to 1st June.

Raw Material—Tasmanite shale from old workings, middle low-grade band excluded.

Period of Run Reviewed.	Duration Period (Days).	Total Shale Treated (Tons).	Throughput Per Day (Tons).	Crude Oil Yield (Gals.).	Average Recovery (Gals. Per Ton).	Average Assay.	Average Recovery (Per Cent. of Assay).
Preliminary warming-up .....	11-3	87	7-7	2494	28-65	.....	.....
First week .....	6-33	74-6	11-83	2505	33-57	42-0	79-75
Second week .....	7-0	80-9	11-56	2824	34-9	41-3	84-4
Third week .....	7-0	85-0	12-14	2723	32-1	38-4	83-6

## Summary:

Total shale treated .....	327-6 tons
Total condenser oil produced .....	9297 gals.
Total scrubber spirit produced .....	696 gals.
Total crude produced .....	9993 gals.

NOTE.—The scrubbing plant was not up to normal operating efficiency until 24th May. From the 12th to 24th May the average recovery figures include a scrubber yield obtained from averaging the yield from the remainder of the run.

24/6/32.

*Test Run No. 3.—Weight Balance on Kerogen Matter, Exclusive of Liquor, from Results with the Commercial Retort.*

Period from 12th May to 1st June.

Over period of 14 days when conditions were steady. Results are on shale calculated to dry basis.

		Per Cent.
Crude oil .....	35.12 gals. per ton	14.64
Gas .....	1455 c. ft. per ton	3.90
Gas in residue .....	421 c. ft. per ton	1.13
Oil in residue .....	.50 gals. per ton	0.21
Carbon in residue .....	5.68 per cent.	5.68

25.56

*Basic Figures for Kerogen Quantity.*

(Oil-bearing matter in shale.)

Source of Result.	Percentage of Shale Accounted for as Kerogen Products, Exclusive of Liquor.
University of Tasmania Laboratory .....	27.74 per cent.
Tasmanite Shale Oil Company Laboratory .....	26.50 per cent.
Commercial Retort .....	25.56 per cent.

Test Run No. 3.—Table Summarising Yields of Crude Oil Obtained from the Commercial Retort, and Comparison with the Assay Results.

Period from 12th May to 1st June.

Source of Result.	Yield Per Ton (Gals.).	Specific Gravity.	Yield Per Ton (Lbs.).	Commercial Result as Percentage of University Figure.		Commercial Result as Percentage of Plant Laboratory Assay.	
				Volume Basis.	Weight Basis.	Volume Basis.	Weight Basis.
Tasmania University .. .. .	43·5	0·919	399·77	....	....	....	....
Tasmanite Shale Oil Company Laboratory .. .. .	40·8	0·956	390·05	....	....	....	....
Commercial Retort .. .. .	35·12	0·934	328·02	80·7 per cent.	82·05 per cent.	86·08 per cent.	84·9 per cent.

*Test Run No. 3.—Analysis of Laboratory Assays.*

24/6/32.

Period from 12th May to 1st June.

Product.	University Yields Per Ton.	Percentage, by Weight, of Shale.	Plant Laboratory Yields Per Ton.	Percentage, by Weight, of Shale.		
Crude oil .....	43·5 gals.	17·84	40·8 gals.	17·41		
Liquor .....	2·6 gals.	1·16	2·6 gals.	1·16		
Gas .....	1182 c. ft.	3·16	1926 c. ft.	5·14		
Volatiles in residue .....	} 78·5 per cent.	{ 4·04	} 75·87 per cent.	{ 0·75		
Fixed carbon in residue .....					{ 2·70	{ 3·20
Ash in residue .....						

3.

## TASMANITE SHALE OIL COMPANY LIMITED.

Summary of Test Run No. 3A on Crozier Retort.

30/6/32

Period from 3rd June to 17th June.

Raw Material—Tasmanite shale from new workings—whole-seam shale taken.

Period of Run Reviewed.	Duration Period (Days).	Total Shale Treated (Tons).	Throughput Per Day (Tons).	Crude Oil Yield (Gals.).	Average Recovery (Gals. Per Ton).	Average Assay.	Average Recovery (Per Cent. of Assay).
Total run .....	15	189.4	12.6	4201	22.2	25.8	86 per cent.

## Summary:

Total shale treated .....	189.4 tons
Total condenser oil recovered .....	3,679 gals.
Total scrubber oil .....	522 gals.
Total crude .....	4,201 gals.

16/7/32.

*Test Run No. 3A on the Crozier Retort: 3/6/32 to 17/6/32.—Weight Balance on Kerogen Matter, Exclusive of Liquor, from the Results with the Commercial Retort.*

The results are based on dry shale. (Moisture in shale, 2.2 per cent.)

	Per Cent.
Crude oil .....	9.47
Gas .....	3.06
Gas in residue .....	1.47
Oil in residue .....	0.01
Carbon in residue .....	4.66
	18.67

*Basic Figures for Kerogen Quantity.*

(Oil-bearing matter in shale.)

Source of Result.	Percentage of Shale Accounted for by Kerogen Product, Exclusive of Liquor.
University of Tasmania Laboratory .....	18.69 per cent.
Tasmanite Shale Oil Company Limited Laboratory .....	17.93 per cent.
Commercial Retort .....	18.67 per cent.

16/7/32.

Test Run No. 3A on the Crozier Retort: 3/6/32 to 17/6/32—Analysis of Laboratory Assays.

Raw Material—Whole-seam shale from new workings.

Product.	University Yields Per Ton.	Percentage, by Weight, of Shale.	Plant Laboratory Yields Per Ton.	Percentage, by Weight, of Shale.
Crude oil .....	25.5 gals.	10.38	26.4 gals.	11.12
Liquor .....	2.4 gals.	1.08	5.2 gals.	2.32
Gas .....	878 c. ft.	2.35	1246 c. ft.	3.32
Volatile hydrocarbons in residue .....	} 86.4 per cent.	{ 4.49	} 82.79 per cent.	{ 0.84
Fixed carbon in residue .....		{ 1.47		{ 2.65
Ash in residue .....		{ 80.44		{ 79.30
Totals .....	....	100.21	....	99.55

16/7/32.

Test Run No. 3A on the Crozier Retort: 3/6/32 to 17/6/32.—Table Summarising Yields of Crude Oil Obtained from the Commercial Retort, and Comparison with the Assay Results.

Source of Result.	Yield per Ton (Gals.).	Specific Gravity.	Yield per Ton (Lbs.).	Commercial Result as Percentage of University Figure.		Commercial Result as Percentage of Plant Laboratory Assay.	
				Volume Basis.	Weight Basis.	Volume Basis.	Weight Basis.
Tasmania University .....	25.5	.912	232.6	....	....	....	....
Tasmanite Shale Oil Company Laboratory .....	26.4	.940	248.2	....	....	....	....
Commercial Retort .....	22.7	.934	212.0	89	91.1	86	85.5
				per cent.	per cent.	per cent.	per cent.

4.

## TASMANITE SHALE OIL COMPANY LIMITED.

30/6/32.

## Summary of Test Run No. 3B on Crozier Retort.

Raw Material—Shale from new tunnel, middle band discarded.

Period from 18th June to 29th June.

Period of Run Reviewed.	Duration Period (Days).	Total Shale Treated (Tons).	Throughput Per Day (Tons).	Crude Yield (Gals.).	Average Recovery (Gals. Per Ton).	Average Assay.	Average Recovery (Percentage of Assay).
Total run .....	12	139.2	11.6	4091	29.4	33.2	88.6 p.c.

## Summary—

Total shale treated .....	139.2 tons
Total condenser oil recovered .....	3,732 gals.
Total scrubber spirit .....	359 gals.
Total crude .....	<u>4,091 gals.</u>

## 5.

## TASMANITE SHALE OIL COMPANY LIMITED.

20/6/32.

## No. 1 Run.—Daily Retort Figures.

Top and Bottom Seams—Low-grade Part of Field.

Period ending 2nd December, 1931.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
Prelim. period to 23/11/31 .....	27	500	....	500	19	27	500	....	500
8 a.m.									
24/11 .....	13	400	....	400	31	40	500	....	900
25/11 .....	3·7	140	....	140	....	43·7	1040	....	1040
26/11 .....	17	303	....	303	18	60·7	1343	....	1343
27/11 .....	17	317	....	317	19	77·7	1660	....	1660
28/11 .....	22·5	448	....	448	20	100·2	2108	....	2108
29/11 .....	27·5	537	....	537	19	127·7	2645	....	2645
30/11 .....	25·5	395	....	395	15·5	153·2	3040	....	3040
1/12 .....	21	355	....	355	17	174·2	3395	....	3395
2/12 .....	21·5	430	....	430	20	195·7	3825	....	3825

## Summary—

Average throughput .....	18·1 tons per day
Average recovery .....	19·8 gals. per ton (as mined)
Average recovery (calculated to dry basis) .....	Not calculated
Average assay (calculated to dry basis) .....	Not calculated
Average assay .....	26·3 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.

Week commencing 8 a.m. on 3rd December and ending 9th December, 1931.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	195.7	3825	....	3825
3/12	21	390	....	390	19	216.7	4215	....	4215
4/12	19	343	....	343	18	235.7	4558	....	4558
5/12	20.5	408	....	408	20	256.2	4966	....	4966
6/12	24.5	486	....	486	20	280.7	5452	....	5452
7/12	24	478	....	478	20	304.7	5930	....	5930
8/12	22.5	285	....	285	13	326.2	6215	....	6215
9/12	32.5	455	....	455	14	358.7	6670	....	6670
To 4 p.m.	9	225	....	225	17	367.7	6895	....	6895
Adjustment	....	....	....	....	....	....	6530	....	6530

Summary—

Average throughput	24.7 tons per day
Average recovery	15.6 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	29.4 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.  
 Week commencing 8 a.m. on 10th December and ending 16th December, 1931.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	367.7	6530	....	6530
10/12	23	310	....	310	17	390.7	6840	....	6840
11/12	25	422	....	422	17	415.7	7262	....	7262
12/12	29	461	....	461	16	444.7	7723	....	7723
13/12	27	544	....	544	20	471.7	8267	....	8267
14/12	25.3	402	14	416	16	497	8683	14	8697
15/12	21.5	442	31	473	22	518.5	9156	45	9201
16/12	22.5	452	69	521	22	541	9608	114	9722
To 4 p.m.	8	113	37	150	19	549	9721	151	9872
Adjustment	....	....	....	....	....	....	9592	....	9743

Summary—

Average throughput	26 tons per day
Average recovery	17.7 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	27.1 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.

Week commencing 8 a.m. on 17th December and ending 23rd December, 1931.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	549	9592	151	9,743
17/12	18	323	63	386	21	567	9915	214	10,129
18/12	27	476	106	582	21	594	10,391	320	10,711
19/12	27	553	70	623	23	621	10,944	390	11,334
20/12	27	460	64	524	19	648	11,404	454	11,858
21/12	28	383	70	453	16	676	11,787	524	12,311
22/12	23	420	85	505	22	699	12,207	609	12,816
23/12	27	535	95	630	23	726	12,742	704	13,446
24/12	10	190	28	218	22	736	12,932	732	13,664
Adjustment	....	....	....	....	....	....	12,892	....	13,624

Summary—

Average throughput	26.7 tons per day
Average recovery	20.8 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	31.1 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.

Week commencing 8 a.m. on 24th December and ending 30th December, 1931.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	736	12,892	732	13,624
24/12	17	344	58	402	24	753	13,236	790	14,026
25/12	25	415	59	474	19	778	13,651	849	14,500
26/12	26	333	63	396	15	804	13,984	912	14,896
27/12	25	625	66	691	28	829	14,609	978	15,587
28/12	26	480	63	543	21	855	15,089	1041	16,130
29/12	26	445	50	495	19	881	15,534	1091	16,625
30/12	28	527	68	595	21	909	16,061	1159	17,220
To 4 p.m.	9	115	36	151	18	918	16,176	1195	17,371
Adjustment							16,039		17,234

Summary—

Average throughput	26 tons per day
Average recovery	19.8 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	29.1 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.

Week commencing 8 a.m. on 31st December, 1931, and ending 6th January, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	918	16,039	1195	17,234
31/12	19	350	27	377	18	937	16,389	1222	17,611
1/1	29	462	87	549	19	966	16,851	1309	18,160
2/1	27	470	103	573	21	993	17,321	1412	18,733
3/1	30	520	107	627	21	1023	17,841	1519	19,360
4/1	29	670	110	780	27	1052	18,511	1629	20,140
5/1	36	638	90	718	20	1088	19,149	1719	20,868
6/1	31	500	102	602	19	1119	19,649	1821	21,470
To 4 p.m.	10	216	33	249	23	1129	19,865	1854	21,719
Adjustment							19,804		21,658

Summary—

Average throughput	30 tons per day
Average recovery	21 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	32.6 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Top and Bottom Seams—Low-grade Part of Field.

Week commencing 8 a.m. on 7th January and ending 13th January, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	1129	19,804	1854	21,658
7/1	17	295	62	357	21	1146	20,099	1916	22,015
8/1	28	518	95	613	22	1174	20,617	2011	22,628
9/1	34	595	73	668	20	1208	21,212	2084	23,296
10/1	25	390	65	455	18	1233	21,602	2149	23,751
11/1	20	420	59	479	23	1253	22,022	2208	24,230
12/1	24	410	62	472	19	1277	22,432	2270	24,702
13/1	19	390	56	446	23	1296	22,822	2326	25,148
To 4 p.m.	9	150	20	170	19	1305	22,972	2346	25,318
Adjustment	....	....	....	....	....	....	22,887	....	25,233

Summary—

Average throughput	25.1 tons per day
Average recovery	20.2 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated
Average assay	32.5 gals. per ton (as mined)

No. 1 Run.—Daily Retort Figures.

20/6/32.

Introduction of High-grade Shale—19/1/32 to 24/1/32.

Week commencing 8 a.m. on 14th January and ending 20th January, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	1305	22,887	2346	25,233
14/1	18	460	45	505	28	1323	23,347	2391	25,738
15/1	29	499	69	568	19	1352	23,846	2460	26,306
16/1	23	365	70	435	19	1375	24,211	2530	26,741
17/1	24	400	73	473	19	1399	24,611	2603	27,214
18/1	26	428	63	491	19	1425	25,039	2666	27,705
19/1	26	631	58	689	26	1451	25,670	2724	28,394
20/1	28	801	81	882	31	1479	26,471	2805	29,276
To 4 p.m.	9	267	23	290	32	1488	26,738	2828	29,566
Adjustment							26,910	.....	29,738

Summary—

Average throughput	26.1 tons per day
Average recovery	24.6 gals. per ton (as mined)
Average recovery (calculated to dry basis)	Not calculated
Average assay (calculated to dry basis)	Not calculated

Assays were discontinued during this period pending the erection of a small crushing plant and the carrying out of tests to correlate the relationship between the skip weight and the assay value of the shale.

No. 1 Run.—Daily Retort Figures.

20/6/32.

Temporary Suspension of Operations on 24th January, 1932.  
 Period commencing 8 a.m. on 21st January and ending 24th January, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	1488	26,910	2828	29,738
21/1	19	555	48	603	32	1508	27,465	2876	30,341
22/1	29	700	80	780	27	1537	28,165	2956	31,121
23/1	25	845	33	878	35	1562	29,010	2989	31,999
24/1	....	45	15	....	....	1562	29,055	3004	32,059

## 6.

## TASMANITE SHALE OIL COMPANY LIMITED.

3/3/32.

## No. 2 Run.—Daily Retort Figures.

Week commencing 8 a.m. on 25th February and ending 2nd March, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	10	223	....	....
25/2	12.5	300	....	300	23	22.5	523	....	523
26/2	16.5	297	17	314	19	39	820	17	837
27/2	12.2	300	56	356	29	51.2	1120	73	1193
28/2	11.7	390	45	435	37	62.9	1510	118	1628
29/2	12.1	342	25	367	30	75	1852	143	1995
1/3	11.9	378	18	396	33	86.9	2230	161	2391
2/3	14.1	385	32	417	30	101	2615	193	2808
To 4 p.m.	6.0	173	15	188	31	107	2788	208	2996
Adjustment	....	....	....	....	....	....	2714	215	2929

## Summary—

Average throughput	13 tons per day
Average recovery	28 gals. per ton (as mined)
Average recovery (calculated to dry basis)	29.01 gals. per ton
Average assay (calculated to dry basis)	42 gals. per ton

No. 2 Run.—Daily Retort Figures.

11/3/32.

Week commencing 8 a.m. on 3rd March and ending 9th March, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	107	2714	215	2929
3/3	8.7	217	21	238	27	115.7	2931	236	3167
4/3	12.5	348	45	393	31	128.2	3279	281	3560
5/3	10.9	322	42	364	33	139.1	3601	323	3924
6/3	10.5	330	28	358	34	149.6	3931	351	4282
7/3	11.4	320	32	352	31	161	4251	383	4634
8/3	11.8	360	29	389	33	172.8	4611	412	5023
9/3	11.9	355	39	394	33	184.7	4966	451	5417
To 4 p.m.	3.6	95	11	106	34	188.3	5061	462	5523

Summary—

Average throughput	11.5 tons per day
Average recovery	32 gals. per ton (as mined)
Average recovery (calculated to dry basis)	33.2 gals. per ton
Average assay (calculated to dry basis)	43.4 gals. per ton

No. 2 Run.—Daily Retort Figures.

18/3/32.

Week commencing 8 a.m. on 10th March and ending 16th March, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	188.3	5061	462	5523
10/3	7.2	243	21	264	34	195.8	5304	483	5787
11/3	9.4	297	31	328	35	205.2	5601	514	6115
12/3	10.0	300	38	338	34	215.2	5901	552	6453
13/3	10.4	300	33	333	32	225.6	6201	585	6786
14/3	9.2	285	12+19*	316	34	234.8	6486	597	7083
15/3	9.3	280	31*	311	33	244.1	6766	597	7363
16/3	10.3	325	31*	356	34	254.4	7091	597	7688
To 4 p.m.	3.8	114	10*	124	32	258.2	7205	597	7802
Adjustment	....	....	....	....	....	....	7260	597	7857

\* Theoretical scrubber yield.

Summary—

Average throughput	9.9 tons per day
Average recovery (inc. *)	33.5 gals. per ton (as mined)
Average recovery (inc. *) (calculated to dry basis)	34.7 gals. per ton
Average assay (calculated to dry basis)	42.7 gals. per ton

No. 2 Run.—Daily Retort Figures.

24/3/32.

Week commencing 8 a.m. on 17th March and ending 24th March, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	258.2	7260	597	7857
17/3	6.0	170	21*	191	32	264.2	7430	597	8027
18/3	9.6	297	31*	328	34	273.8	7727	597	8324
19/3	9.7	293	31*	324	33	283.5	8020	597	8617
20/3	9.3	315	31*	346	37	292.8	8335	597	8932
21/3	9.8	275	31*	306	31	302.6	8610	597	9207
22/3	9.3	288	19+12*	319	34	311.9	8898	616	9514
23/3	8.8	282	8+18*	308	35	320.7	9180	632	9812
24/3	9.1	274	31*	305	33	329.8	9454	632	10,086
25/3	4.5	483	....	....	....	334	9937	....	10,569
Adjustment	....	....	264	....	....	....	....	896	10,833

\* Theoretical scrubber yield.

Summary—

Average throughput	9.2 tons per day
Average recovery (inc. *)	33.9 gals. per ton (as mined)
Average recovery (inc. *) (calculated to dry basis)	35.1 gals. per ton
Average assay (calculated to dry basis)	42.2 gals. per ton

## 7.

## TASMANITE SHALE OIL COMPANY LIMITED.

19/5/32.

## No. 3 Run.—Daily Retort Figures.

Week commencing 8 a.m. on 12th May and ending 18th May, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
Prelim. period to 8 a.m.									
12/5	87.0	2200	....	....	....	87	2200	....	2200
13/5	12.2	328	....	328	26.9	99.2	2528	....	2528
14/5	11.7	355	....	355	30.0	110.9	2883	....	2883
15/5	11.7	350	....	350	30.0	122.6	3233	....	3233
16/5	12.8	340	....	340	26.5	135.4	3573	....	3573
17/5	11.0	326	....	326	29.7	146.4	3899	....	3899
18/5	11.3	378	....	378	33.4	157.7	4277	....	4277
To 4 p.m.	3.9	132	....	132	31.9	161.6	4409	....	4409

## Summary—

Average throughput	11.8 tons per day
Average recovery	29.8 gals. per ton (as mined)
Average recovery (calculated to dry basis)	30.5 gals. per ton
Average assay (calculated to dry basis)	42 gals. per ton

No. 3 Run.—Daily Retort Figures.

27/5/32.

Week commencing 8 a.m. on 19th March and ending 25th May, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.				
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.	
8 a.m.					Forward	161.6	4409	Total to date	4409	
19/5	7.9	245	....	245	31.9	169.5	4654		4654	
20/5	11.8	325	....	325	27.5	181.3	4979		4979	
21/5	12.0	370	....	370	30.8	193.3	5349		5349	
22/5	10.3	310	....	310	30.1	203.6	5659		5659	
23/5	11.4	340	....	340	29.8	215.0	5999		5999	
24/5	11.2	405	....	405	36.1	226.2	6404		294	6698
25/5	11.8	385	66	451	38.2	238.0	6789		360	7149
To 4 p.m.	4.5	123	11	134	30.6	242.5	6912		371	7283

Summary—

Average throughput	11.5 tons per day
Average recovery (excluding scrubber spirit)	30.8 gals. per ton (as mined)
Average recovery (calculated to dry basis)	31.8 gals. per ton
Average assay (calculated to dry basis)	41.3 gals. per ton

No. 3 Run.—Daily Retort Figures.

3/6/32.

Week commencing 8 a.m. on 26th May and ending 1st June 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	242.5	6912	371	7283
26/5	8.2	227	28	255	30.6	250.7	7139	399	7538
27/5	12.1	345	42	387	32.0	262.8	7484	441	7725
28/5	12.0	382	41	423	35.2	274.8	7866	482	8348
29/5	11.7	330	51	381	32.6	286.5	8196	533	8729
30/5	12.6	310	43	353	28.0	299.1	8506	576	9082
31/5	11.9	354	51	405	34.0	311.0	8860	627	9487
1/6	12.4	355	53	408	32.7	323.4	9215	680	9895
To 4 p.m.	4.1	122	16	138	30.3	327.5	9337	696	10,033
Adjustment	....	....	....	....	....	....	9297	....	9993

Summary—

Average throughput	12.1 tons per day
Average recovery	31.9 gals. per ton (as mined)
Average recovery (calculated to dry basis)	32.3 gals. per ton
Average assay (calculated to dry basis)	38.4 gals. per ton

7a.

## TASMANITE SHALE OIL COMPANY LIMITED.

10/6/32.

No. 3A Run.—Daily Retort Figures.

Whole Seam Run, Commencing 3/6/32.

Week commencing 8 a.m. on 2nd June and ending 8th June 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward	327.5	9297	696	9993
2/6	8.3	193	29	222	30.3	335.8	9490	725	10,215
3/6	12.3	250	45	295	24.0	348.1	9740	770	10,510
4/6	13.1	290	38	328	25.0	361.2	10,030	808	10,838
5/6	13.1	250	31	281	21.4	374.3	10,280	839	11,119
6/6	13.1	245	35	280	21.4	387.4	10,525	874	11,399
7/6	12.9	280	33	313	24.2	400.3	10,805	907	11,712
8/6	13.4	240	39	279	20.8	413.7	11,045	946	11,991
To 4 p.m.	4.4	65	15	80	17.4	418.1	11,110	961	12,071

## Summary—

Average throughput	12.9 tons per day
Average recovery	23.1 gals. per ton (as mined)
Average recovery (calculated to dry basis)	23.7 gals. per ton
Average assay (calculated to dry basis)	25.8 gals. per ton

No. 3A Run.— Daily Retorting Figures.

12/6/32.

Whole-Seam Retorting for Full Period.

Period commencing on 9th June and ending 17th June, 1932.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
8 a.m.					Forward				
9/6	8.9	135	16	151	17.4	418.1	11,110	961	12,071
10/6	13.6	283	28	311	22.8	427.0	11,245	977	12,222
11/6	13.6	222	29	251	18.4	440.6	11,528	1005	12,533
12/6	11.2	310	31	341	30.4	454.2	11,750	1034	12,784
13/6	12.6	242	40	282	22.4	465.4	12,060	1065	13,125
14/6	13.0	258	38	296	22.7	478.0	12,302	1105	13,407
15/6	10.4	205	39	244	23.4	491.0	12,560	1143	13,703
To 4 p.m.	4.1	65	9	74	20.2	501.4	12,765	1182	13,947
16/6	7.3	136	21	157	20.2	505.5	12,830	1191	14,021
17/6	12.4	203	35	238	19.2	512.8	12,966	1212	14,178
						525.2	13,169	1247	14,416

Summary—

Average throughput	12.5 tons per day
Average recovery	22.2 gals. per ton
Average recovery (calculated to dry basis)	23.0 gals. per ton
Average assay (calculated to dry basis)	27.6 gals. per ton

7b.

TASMANITE SHALE OIL COMPANY LIMITED.

24/6/32.

No. 3B Run.—Daily Retort Figures.

Top and Bottom Shale Retorting—Low-grade Part of Field.  
 Period from 18th June to 29th June.

Date.	Tons Fed.	Crude Yield.	Scrubber Yield.	Daily Total.	Recovery (Gals. Per Ton).	Progressive.			
						Tons Fed.	Crude Yield.	Scrubber Yield.	Total.
					Forward				
18/6	10.1	257	25	282	27.9	525.2	13,169	1247	14,416
19/6	11.0	345	28	373	33.9	535.3	13,426	1272	14,698
20/6	11.7	375	33	408	34.9	546.3	13,771	1300	15,071
21/6	11.7	360	38	398	34.0	558.0	14,146	1333	15,479
22/6	11.6	325	33	358	30.8	569.7	14,506	1371	15,877
To 4 p.m.	4.3	105	8	113	26.2	581.3	14,831	1404	16,235
23/6	8.5	200	23	223	26.2	585.6	14,936	1412	16,348
24/6	11.7	330	33	363	31.0	594.1	15,136	1435	16,571
25/6	11.3	288	25	313	27.7	605.8	15,466	1468	16,934
26/6	12.0	287	28	315	26.2	617.1	15,754	1493	17,247
27/6	12.7	285	34	319	25.1	629.1	16,041	1521	17,562
28/6	11.6	295	23	318	27.4	641.8	16,326	1555	17,881
29/6	11.0	280	28	308	27.9	653.4	16,621	1578	18,199
To 4 p.m.	4.2	95	9	104	23.5	664.4	16,901	1606	18,507
Adjustment	....	....	....	....	....	668.6	16,996	1615	18,611
						....	16,982	....	18,597

8.

TASMANITE SHALE OIL COMPANY LIMITED.

27/5/32.

*Notes on Table Showing Comparison Between Retort Performance Before and After the Alteration to the Heating System.*

1. The table has been prepared to give a true reflection of the effect of the alterations by showing the effect of the incidental variation in shale quality.
2. The retort is at present running under parallel conditions to second period of last run, as can be seen by the oil recovery figures. The comparison should therefore be made with this period, which represents approximately, the last fortnight of the last run.
3. It will be seen that the daily volume of shale retorted has increased from 13·8 yards to 15·95 yards, an increase of 15·6 per cent. The increase is directly due to the new conditions.
4. It will be seen that, alongside this increase, there is an increase in oil recovery of 0·8 gallons per cubic yard.
5. Consideration of the weight figure will show how difficult it is to keep parallel results with a variable raw material like Tasmanite. Incidentally, it is obvious that the often quoted figure of 40 gallons per ton could quite easily have been given in good faith if the shale was calculated by volume, and some arbitrary figure taken for weight per cubic yard.
6. By actual weight the throughput has increased from 9·47 tons to 11·65 tons, a rise of 23 per cent.; but the difference between the 23 per cent. and the 15·6 per cent., i.e., 7·4 per cent., has been solely due to the heavier shale.
7. The heavier skip weights are corroborated by the assays, which show a slight decrease.
8. With regard to the heavier shale, I understand from Mr. Anderson that, latterly, he was encountering less soft shale in the bottom seam, resulting in less being discarded. The heavier shale is therefore more representative of this part of the field. This is further borne out by the fact that the assays are approaching the Mines Department figure of 38·5 gallons per ton.

9. Despite the lower quality of the shale the recovery figure shows a slight increase. This can only be attributed to either more complete treatment or better treating conditions, presumably the latter, since we were running, on an average, just as complete treatment towards the end of last run.

10. The present throughput figure for the plant is slightly higher than the average figure shown in the table, the throughput being around 16.2 cubic yards per day, an increase of 17.4 per cent., the tonnage increase being 25 per cent.

11. As a matter of interest, I have included in the table tonnage figures for the present run, based on the same quality of shale as last run. This brings the tons throughput to 10.95, an increase of 15.6 per cent., in line, of course, with the volume increase, but the oil yield per ton is still further increased.

12. The only figures that matter commercially are the volume of shale sent to the retort, and the oil recovered per unit of that volume. With heavier shale the retort will put through a greater tonnage, but the yield per ton will be lower. With the lighter shale the retort throughput in tons will be lower, but the yield per ton higher. The present programme will provide interesting information on the total effect of this variation.

13. It should be noted that the oil figures do not include scrubber spirit. I have excluded these, because the yield depends on the efficiency of the scrubber plant, and inclusion would introduce an undesirable variable.

14. The above sums up the effect of the heating alteration to date on the actual yields, but it cannot be too strongly stressed that the effects of the alteration on the operation and control of the plant far outweigh the above effects. We have, undoubtedly, the basis of a satisfactory system in the event of extension, and there is no comparison of the labour involved in control. The retort is satisfactorily heated, and (although I am disappointed in the increase gained) it has shown, to my satisfaction, that for any subsequent improvement we must pay more attention to the heat penetration factor. The present is the maximum for the existing retort under proper heating conditions. Under these conditions a depreciation figure of 10 per cent. on a new plant would, I believe, be sound.

27/5/32.

Table Showing Comparison Between Retort Performance Before and After the Alteration to the Heating System.

Period Considered.	Average Volume of Throughput. (Cubic Yards per Day).	Average Oil Yield per Cubic Yard (Excluding Scrubber Spirit).	Average Weight of Shale Treated (Tons per Cubic Yard, Broken to Retorting Size).	Average Throughput per Day in Tons.	Average Oil Yield per Weighed Ton (Excluding Scrubber Spirit). (Gals.)
Total run before alteration, exclusive of preliminary period .....	16.23	19.7	.686	11.14	28.6
Period of maximum oil recovery before alteration .....	13.80	21.0	.686	9.47	30.5
Present run to 26/5/32, exclusive of preliminary period .....	15.95	21.8	a .686	10.95	31.9
			b .73	11.65	30.84

Results of Various Laboratory and Plant Refinery Circuits.

TREATMENT No. 1.  
Crude Light: 100 c.c.  
Treated.

Total Loss, 6.6 c.c.  
(6.6 p.c. of Crude Light)

Recovered Stock, 93.4 c.c.  
(93.4 p.c. of Crude Light)

Treatment: 1 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Fairly satisfactory.

TREATMENT No. 2.  
Crude Light: 100 c.c.  
Treated.

Total Loss, 14 c.c.  
(14 p.c. of Crude Light)

Recovered Stock, 86 c.c.  
(86 p.c. of Crude Light)

Treatment: 5 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Very good.  
Sulphur: 0.37 per cent.

TREATMENT No. 3.  
Crude Light: 100 c.c.  
Treated.

Total Loss, 14.6 c.c.  
(14.6 p.c. of Crude Light)

Loss to Acid, 12 c.c.  
(12 p.c. of Crude Light)

Recovered Stock, 85.4 c.c.  
(85 p.c. of Crude Light)

Treatment: 4 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Very good.

TREATMENT No. 4.  
Crude Light: 100 gals.  
First Treatment.

Total Loss, 7 gals.  
(7 p.c. of Crude Light)

Recovered Stock, 93 gals.  
(93 p.c. of Crude Light)

Distilled.

Residue, 11 gals.  
(11 p.c. of Crude Light)

Distillate, 82 gals.  
(82 p.c. of Crude Light)

Second Treatment.

Total Loss, 6 gals.  
(6 p.c. of Crude Light)

Recovered Stock, 76 gals.  
(76 p.c. of Crude Light)

Distilled.

Residue, 10 gals.  
(10 p.c. of Crude Light)

Petrol, 24 gals.  
(24 p.c. of Crude Light)

Finished Kerosene, 42 gals.  
(42 p.c. of Crude Light)

Distilled.

Residue, 4 gals.  
(4 p.c. of Crude Light)

Finished Petrol, 20 gals.  
(20 p.c. of Crude Light)

Treatment (first): 4 per cent. of 18 per cent. NaOH, plus water, plus 2 per cent. H<sub>2</sub>SO<sub>4</sub>, plus water, plus 5 per cent. of 10 per cent. of NaOH.

Treatment (second): 2 per cent. H<sub>2</sub>SO<sub>4</sub>, plus water, plus 5 per cent. of 10 per cent. NaOH.

Petrol—

Smell: Very good.  
Colour: Water-clear.  
Sulphur: 1.4 per cent.

Kerosene—

Smell: Fair.  
Colour: Pale straw colour.  
Sulphur: 2.19 per cent.

TASMANITE SHALE OIL COMPANY LIMITED.

TREATMENT No. 5.  
Crude Light: 100 gals.  
Treated.

—> Total Loss, 10 gals.  
(10 p.c. of Crude Light)

Recovered Stock, 90 gals. <—  
(90 p.c. of Crude Light)

Distilled to 147°C.

—> Residue, 45 gals.  
(45 p.c. of Crude Light)

Finished Petrol, 45 gals. <—  
(45 p.c. of Crude Light)

Treatment: 3 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Good.  
Sulphur: 0.86 per cent.

TREATMENT No. 6.  
Crude Light: 100 c.c.  
Treated.

—> Loss to Acid, 6 c.c.  
(6 p.c. of Crude Light)

—> Total Loss, 8 c.c.  
(8 p.c. of Crude Light)

Recovered Stock, 92 c.c. <—  
(92 p.c. of Crude Light)

Treatment: 2 per cent.  $H_2SO_4$ , plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Characteristic shale.

TREATMENT No. 7.  
Crude Light: 100 c.c.  
Treated.

—> Total Loss, 8.4 c.c.  
(8.4 p.c. of Crude Light)

Recovered Stock, 91.6 c.c. <—  
(91.6 p.c. of Crude Light)

Treatment: 2 per cent.  $H_2SO_4$ , plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Characteristic shale.

TREATMENT No. 8.  
Crude Light: 100 c.c.  
Treated.

—> Total Loss, 17 c.c.  
(17 p.c. of Crude Light)

Recovered Stock, 83 c.c. <—  
(83 p.c. of Crude Light)

Treatment: 7½ p.c. Oleum, plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
Colour: Water-clear.  
Smell: Very good.

TREATMENT No. 9.  
Crude Petrol: 100 c.c.  
Treated.

—> Loss, 12 c.c.  
(12 p.c. of Crude Petrol)

Recovered Stock, 88 c.c. <—  
(88 p.c. of Crude Petrol)

Distilled through heated clay.

—> Residue, 24 c.c.  
(24 p.c. of Crude Petrol)

Distillate, 64 c.c. <—  
(64 p.c. of Crude Petrol)  
[No. 1 Sample]

Distilled.

—> Residue, 4 c.c.  
(4 p.c. of Crude Petrol)

Petrol, 60 c.c. <—  
(60 p.c. of Crude Petrol)  
[No. 2 Sample]

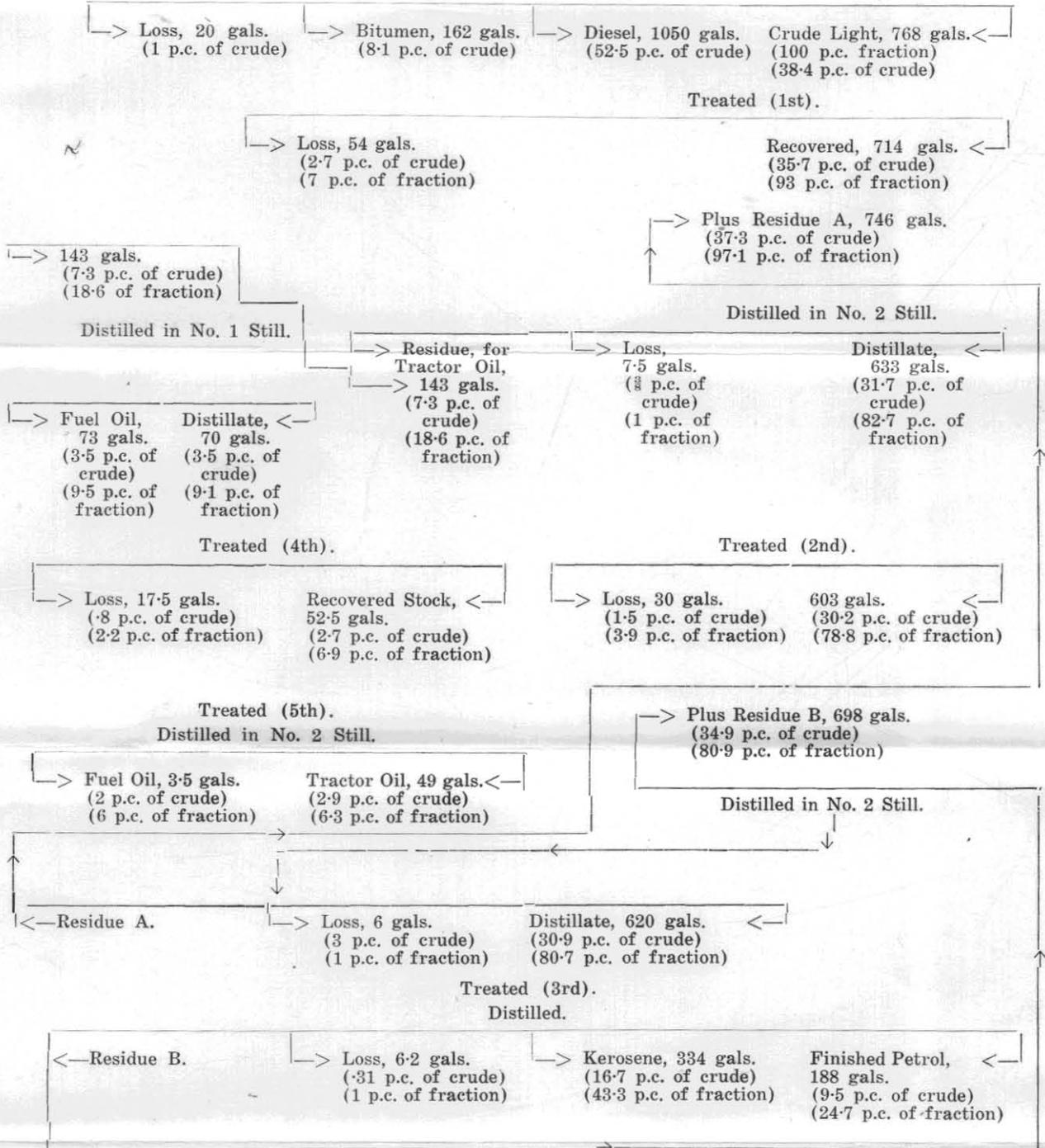
Treatment: 2 per cent.  $H_2SO_4$ , plus water, plus 5 per cent. of 10 per cent. Caustic Solution.  
No. 1 Sample: Sulphur, 2.11 per cent. No. 2 Sample: 1.95 per cent.

TASMANITE SHALE OIL COMPANY LIMITED.

TREATMENT No. 10.

Crude Oil: 2000 gals.

Distilled in No. 1 Still.



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Treatments, &c.—

- 1st: 20 lb. of NaOH in 12 gallons of water, plus water, plus 2 per cent. of H<sub>2</sub>SO<sub>4</sub>, plus water, plus 5 per cent. of 10 per cent. NaOH.
- 2nd: 2 per cent. H<sub>2</sub>SO<sub>4</sub>, plus water, plus 5 per cent. of 10 per cent. NaOH.
- 3rd: 10 per cent. Plumbite wash.
- 4th: 2 per cent. H<sub>2</sub>SO<sub>4</sub>, plus water, plus 5 per cent. of 10 per cent. of NaOH.
- 5th: 10 per cent. Plumbite wash.

**Total Loss**  
 10.9 per cent. of fraction.  
 4.2 per cent. of crude  
 (Refers to both charts)

**Petrol.**  
 188 gallons  
 24.7 per cent. of fraction  
 9.5 per cent. of crude  
 (Refers to both charts)

**Kerosene.**  
 334 gallons  
 43.3 per cent. of fraction  
 16.7 per cent. of crude  
 (Refers to this chart)

TASMANITE SHALE OIL COMPANY LIMITED.

TREATMENT No. 11.

Crude Oil, 2000 gals.

→ Loss	→ Bitumen	→ Diesel	Crude Light, 760 gals. ← (38 p.c. of crude) (100 p.c. of fraction)
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Treated (1st).

→ Total Loss, 110 gals. (5.5 p.c. of crude) (15.9 p.c. of fraction)	Recovered Stock, 650 gals. ← (32.5 p.c. of crude) (84.1 p.c. of fraction)
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Distilled in No. 2 Still.

→ Residue, 50 gals. (2.3 p.c. of crude) (5.1 p.c. of fraction)	Distillate, 600 gals. ← (30 p.c. of crude) (79 p.c. of fraction)
--	--

Treated (2nd).

→ Total Loss, 70 gals. (3.5 p.c. of crude) (9 p.c. of fraction)	Recovered, 530 gals. ← (26.4 p.c. of crude) (70 p.c. of fraction)
---	---

→ B, 265 gals. (13.3 p.c. of crude) (35 p.c. of fraction)	A, 265 gals. ← (13.3 p.c. of crude) (35 p.c. of fraction)
---	---

Distilled in No. 2 Still.

Treated (3rd).

→ Distillate 240 gals. (12.5 p.c. of crude) (33 p.c. of fraction)	Residue and Loss, 15 gals. ← (7.5 p.c. of crude) (2 p.c. of fraction)
---	---

Distilled.

Treated (3rd).

Distilled.

→ Residue, 35 gals. (1.8 p.c. of crude) (4 p.c. of fraction)	→ Finished Kerosene, 150 gals. (7.7 p.c. of crude) (20 p.c. of fraction)	→ Petrol, 80 gals. (4 p.c. of crude) (11 p.c. of fraction)	←
---	---	---	---

Distilled in No. 3 Still.

Distilled.

→ Finished Kerosene B, 125 gals. (6.3 p.c. of crude) (18 p.c. of fraction)	→ Finished Petrol B, 85 gals. (4.2 p.c. of crude) (11 p.c. of fraction)	Residue, 31 gals. (1.5 p.c. of crude) (4 p.c. of fraction)	←	→ Residue, 10 gals. (.5 p.c. of crude) (1.3 p.c. of fraction)	Finished Petrol, 70 gals. (3.5 p.c. of crude) (9.7 p.c. of fraction)	←
---	--	---	---	--	---	---

Treatments—

1st: 20 lb. NAOH in 12 gallons of water, plus water, plus 2 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. NAOH.

2nd: 2 per cent. Oleum, plus water, plus 5 per cent. of 10 per cent. NAOH.

3rd: Plumbite wash.

Petrol B—

Sulphur, 1.0 per cent.

Kerosene B—

Sulphur, 1.67 per cent.

Petrol A—

Sulphur, 1.06 per cent.

Kerosene A—

Sulphur, 1.93 per cent.

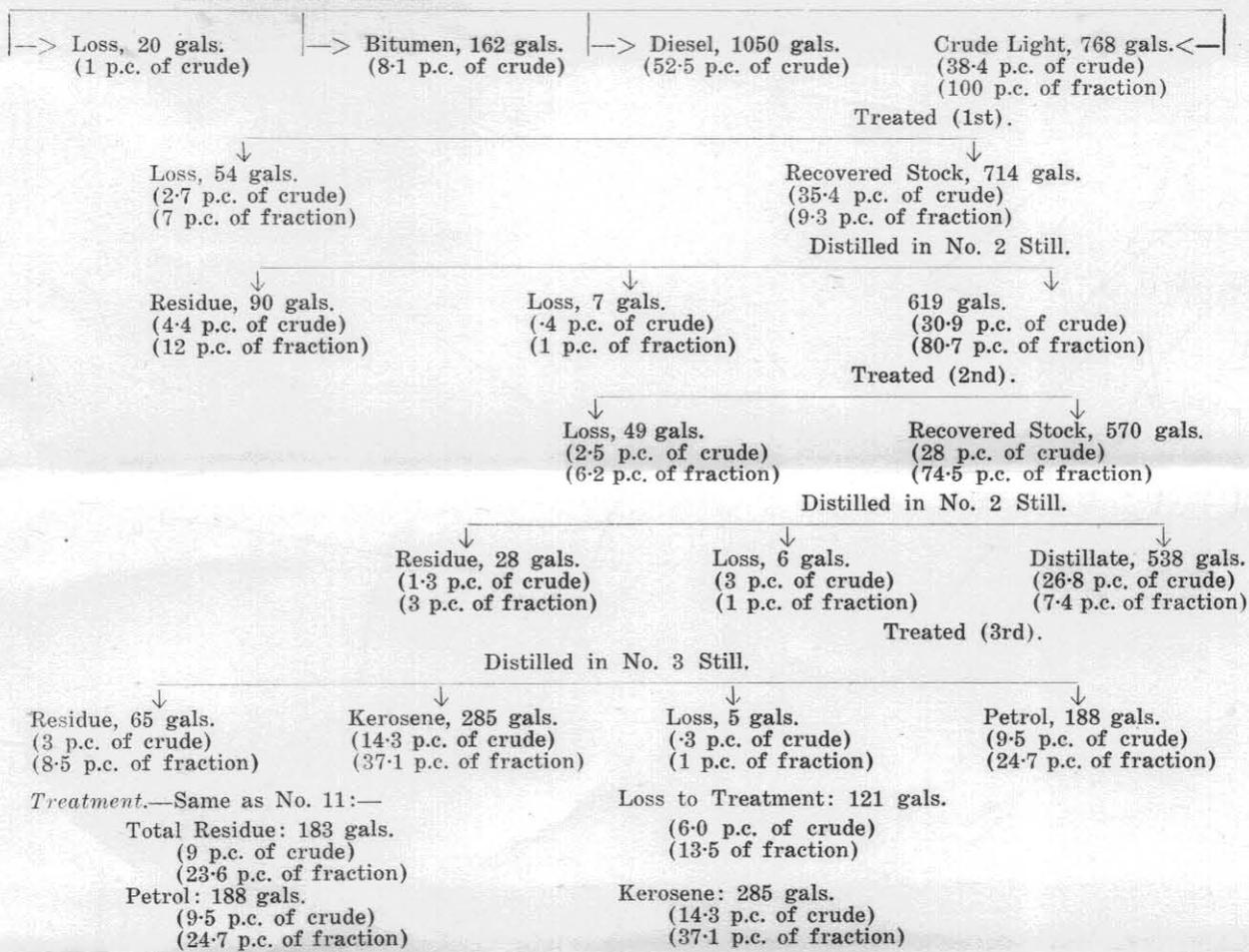
In this circuit the second treated stock, 530 gallons, was divided into two lots, A and B. For the full recovery of finished Petrol and Kerosene, based on the crude, the percentages given under A and B should be doubled, i.e.:

Finished Petrol A is 7 p.c. of crude.  
Finished Kerosene A is 15.4 p.c. of crude.  
Finished Petrol B is 8.4 p.c. of the crude.  
Finished Kerosene B is 12.6 p.c. of the crude.

TASMANITE SHALE OIL COMPANY LIMITED.

TREATMENT NO. 12.

Crude Oil, 2000 gals.  
Distilled in No. 1 Still.



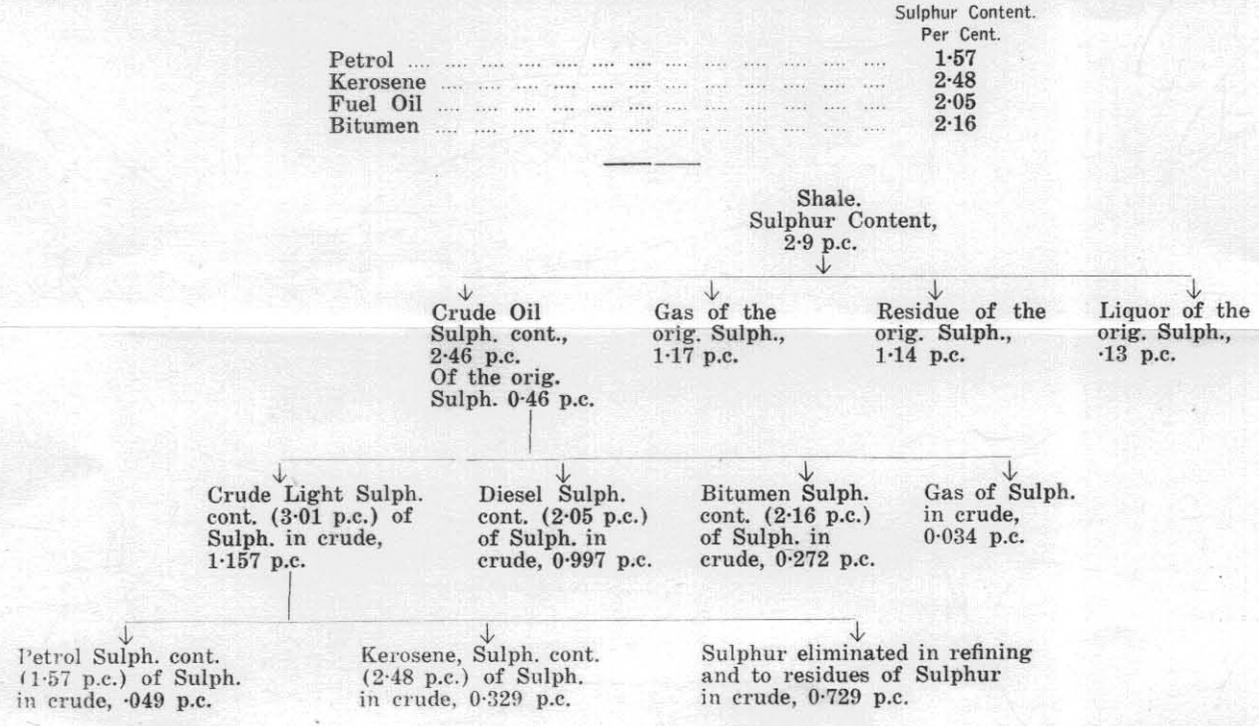
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10.

TASMANITE SHALE OIL COMPANY LIMITED.

23/4/32.

Sulphur Contents of Finished Products—Tree Showing Dispersion of Sulphur from Shale to Finished Oils.



## TASMANITE SHALE OIL COMPANY LIMITED.

17/6/32.

Summary of Weekly Costs and Returns (Costs are Exclusive of Mining).

Based on a 50-Tons-a-Day Throughput—Proposed New Plant.

1. Whole-Seam Mining—Lowest Known Grade Part of Field. (23 gals. per ton.)				2. Top and Bottom Shale—Low-Grade Part of Field. (28 gals. per ton.)				3. Top and Bottom Shale—High-Grade Part of Field. (35 gals. per ton.)			
Costs.		Returns.		Costs.		Returns.		Costs.		Returns.	
		(Sheet 8)				(Sheet 8)				(Sheet 8)	
Salaries—	£ s. d.	£ s. d.		Salaries—	£ s. d.	£ s. d.		Salaries—	£ s. d.	£ s. d.	
(Sheet 1) ..	26 10 0	299 0 0		(Sheet 1) ..	26 10 0	364 1 0		(Sheet 1) ..	26 10 0	455 7 0	
Retorting—				Retorting—				Retorting—			
(Sheet 2) ..	52 14 6			(Sheet 2) ..	52 14 6			(Sheet 2) ..	52 14 6		
Refining—				Refining—				Refining—			
(Sheet 3A) ..	54 5 0			(Sheet 3) ..	61 6 0			(Sheet 3c) ..	70 13 6		
Scrubbing—				Scrubbing—				Scrubbing—			
(Sheet 4) ..	16 8 9			(Sheet 4) ..	16 8 9			(Sheet 4) ..	16 8 9		
Yard—				Yard—				Yard—			
(Sheet 5) ..	17 16 6			(Sheet 5) ..	17 16 6			(Sheet 5) ..	17 16 6		
Crushing—				Crushing—				Crushing—			
(Sheet 6) ..	11 1 0			(Sheet 6) ..	11 1 0			(Sheet 6) ..	11 1 0		
Selling—				Selling—				Selling—			
(Sheet 7) ..	20 0 0			(Sheet 7) ..	20 0 0			(Sheet 7) ..	20 0 0		
	198 15 9				205 16 9				215 4 3		
Balance to mining ..	100 4 3			Balance to mining ..	158 4 3			Balance to mining ..	240 2 9		
	£299 0 0	£299 0 0			£364 1 0	£364 1 0			£455 7 0	£455 7 0	
Mining—5s. 9d. per ton (Inc. Mine Manager).				Mining—9s. 0½d. per ton (Inc. Mine Manager).				Mining—13s. 9d. per ton (Inc. Mine Manager).			

TASMANITE SHALE OIL COMPANY LIMITED.

17/6/32.

*Analysis of Weekly Running Costs.*

(Taking Base B, 28 gals. per ton, as typical.)

Section.	Wages.	Salaries.	Power.	Heat.	Water.	Chemicals.	Stores and Maintenance.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Retorting .....	23 5 6	7 0 0	5 0 0	22 9 0	.....	.....	2 0 0
Refining .....	18 6 0	6 0 0	1 8 8	13 1 4	0 10 0	26 0 0	2 0 0
Scrubbing .....	11 12 9	2 15 0	1 0 0	2 9 0	0 7 0	.....	1 0 0
Crushing .....	3 6 6	1 5 0	6 14 6	.....	.....	.....	1 0 0
Yard .....	12 16 6	1 10 0	.....	.....	.....	.....	5 0 0
Selling .....	20 0 0	8 0 0	.....	.....	.....	.....	.....
	£ 89 7 3	26 10 0	14 3 2	37 19 4	0 17 0	26 0 0	11 0 0

Men Employed (Exclusive of Mining).—Staff, 5 and 1 (boy); Plant, 18 and 3 (boys); Selling, 2;  
Totals, 25 and 4 (boys).

17/6/32.

## TASMANITE SHALE OIL COMPANY LIMITED.

*General Estimate for Outlying Plant and Materials.*

(Data to be revised when design details and layout are available.)

	£
Mining plant .....	2,000
Refinery (additional plant to cope with additional production on similar lines to present practice) .....	2,000
Scrubbing plant (additional plant) .....	500
Pyrometers .....	150
Exhauster .....	100
Laboratory equipment .....	150
Pumps .....	150
Storage-bin .....	600
Firebox fittings .....	40
Motors .....	50
Stacks .....	80
Discharge (belting, idlers, &c.) .....	760
Electric fittings .....	50
Pipes .....	1,000
Pipe fittings .....	400
Insulation .....	50
Transport .....	200
Stores and tools .....	500
Pulleys, shaftings, and belts .....	100
Water seal .....	200
Storage and drums .....	2,000
Timber .....	100
	<hr/>
Total .....	£11,180

*Estimated Capital Expenditure for Proposed New Plant.*

	£
Castings for four retorts .....	3,099
Four C.I. discharge hoppers .....	240
Discharge hoppers, gear, rollers, and chain .....	1,200
Top-plates .....	210
Base-plate .....	1,200
Preheating hoppers .....	80
Understructure .....	454
Sales tax, 6 per cent., covering above items .....	388
Red bricks .....	722
Fire bricks .....	434
Tiles .....	100
Sand .....	55
Cement .....	60
Fireclay .....	60
Foundations .....	450
Erection .....	3,000
Condensers, off-takes, &c. ....	1,500
	<hr/>
	£13,252

17/6/32.

Sheet 1.

*Operating Expenditure on Proposed New Plant.*

Salaries—	£	s.	d.
Manager .....	10	0	0
Engineer .....	5	0	0
Chemist .....	4	0	0
Office Staff .....	7	10	0
	<hr/>		
	£26	10	0

17/6/32.

Sheet 2.

*Operating Expenditure on Proposed New Plant.*

Retorting (Weekly)—	£	s.	d.
Seven men, at £3 6s. 6d. per week .....	23	5	6
Firewood .....	20	0	0
Power, light (50 h.p.) .....	5	0	0
Water (debit to refinery) .....			
Stores .....	2	0	0
Steam .....	2	9	0
	<hr/>		
	£52	14	6

17/6/32.

Sheet 3.

*Operating Expenditure on Proposed New Plant.*

Refinery Costs (Weekly)—	£	s.	d.
A. On 23 Gals. per Ton:			
Labour (one man per shift, plus boys) .....	18	6	0
Chemicals .....	21	8	0
Power (15 h.p.) .....	1	8	8
Water .....	0	8	4
Fuel .....	10	14	0
Stores .....	2	0	0
	<hr/>		
	£54	5	0
B. On 28 Gals. per Ton:			
Labour .....	18	6	0
Chemicals .....	26	0	0
Power (15 h.p.) .....	1	8	8
Water .....	0	10	0
Fuel .....	13	1	4
Stores .....	2	0	0
	<hr/>		
	£61	6	0

C. On 35 gals. per Ton:		£	s.	d.
Labour	.....	18	6	0
Chemicals	.....	32	10	0
Power (15 h.p.)	.....	1	8	8
Fuel	.....	16	6	4
Water	.....	0	12	6
Stores	.....	2	0	0
		<hr/>		
		£70	13	6

17/6/32.

Sheet 4.

*Operating Expenditure on Proposed New Plant.*

Scrubbing (Weekly)—		£	s.	d.
Labour (three men: 7 days)	.....	11	12	9
Power (10 h.p.)	.....	1	0	0
Steam	.....	2	9	0
Water	.....	0	7	0
Stores	.....	1	0	0
		<hr/>		
		£16	8	9

*Operating Expenditure on Proposed New Plant.*

17/6/32.

Sheet 5.

Yard (Weekly)—		£	s.	d.
One fitter	.....	4	10	0
One lorry-driver	.....	4	0	0
One yard-man	.....	3	6	6
One boy	.....	1	0	0
Stores	.....	5	0	0
		<hr/>		
		£17	16	6

17/6/32.

Sheet 6.

*Operating Expenditure on Proposed New Plant.*

Crushing (Weekly)—		£	s.	d.
Power (70 h.p.)	.....	6	14	6
Labour	.....	3	6	6
Stores	.....	1	0	0
		<hr/>		
		£11	1	0

17/6/32.

Sheet 7.

*Operating Expenditure on Proposed New Plant.*

	£	s.	d.
Selling (weekly) .....	20	0	0
	<u>£20</u>	<u>0</u>	<u>0</u>

17/6/32.

Sheet 8.

*Value of Products from Proposed New Plant.*

A. On 23 Gals. per Ton: (Weekly.)

	Per Cent.	Gals.	Per Gal.	£	s.	d.
			s. d.			
Petrol .....	11	886	at 1 10	81	4	0
Kerosene .....	15	1,208	at 1 3	75	10	0
Diesel & Fuel .....	42	3,380	at 0 6	84	12	0
Tractor Oil .....	8	645	at 0 8	21	10	0
Bitumen .....	12	966	at 0 9	36	4	0
Loss .....	12					
	<u>100</u>	<u>7,085</u>		<u>£299</u>	<u>0</u>	<u>0</u>

8-9d. per gal.

B. On 28 Gals. per Ton:

	Per Cent.	Gals.	Per Gal.	£	s.	d.
			s. d.			
Petrol .....	11	1,078	at 1 10	98	17	0
Kerosene .....	15	1,470	at 1 3	92	0	0
Diesel & Fuel .....	42	4,120	at 0 6	103	0	0
Tractor Oil .....	8	784	at 0 8	26	2	0
Bitumen .....	12	1,177	at 0 9	44	2	0
Loss .....	12					
	<u>100</u>	<u>8,629</u>		<u>£364</u>	<u>1</u>	<u>0</u>

8-9d. per gal.

C. On 35 Gals. per Ton.

	Per Cent.	Gals.	Per Gal.	£	s.	d.
			s. d.			
Petrol .....	11	1,349	at 1 10	123	15	0
Kerosene .....	15	1,840	at 1 3	115	0	0
Diesel & Fuel .....	42	5,150	at 0 6	128	14	0
Tractor Oil .....	8	981	at 0 8	32	14	0
Bitumen .....	12	1,470	at 0 9	55	4	0
Loss .....	12					
	<u>100</u>	<u>10,790</u>		<u>£455</u>	<u>7</u>	<u>0</u>

8-9d. per gal.

## TASMANITE SHALE OIL COMPANY LIMITED.

*Extracts from Laboratory Tests on Cracking Heavy Oil.*

Tasmanian Shale.

## A. Straight Distillation of Shale—

Oil Yield.	Specific Gravity.	Fractionation of Oil.
43 gallons per ton .....	0.9525	Per Cent.
		74 to 130° C. .... 3
		130 to 175° C. .... 6
		175 to 250° C. .... 12
		250 to 300° C. .... 11.2
Over 300° C. .... 67.8		

Motor Spirit, 3.87 gallons per ton.

Residual Oil, 39.13 gallons per ton.

B. Cracking Distillation of Shale Oil during retorting of shale, with subsequent cracking of residual oil after removal of spirit—

Oil Yield.	Specific Gravity.	Fractionation.	
37.6 gallons per ton	0.930	Per Cent.	
		65 to 130° C. ....	6.8
		130 to 175° C. ....	9.3
		Over 175° C. ....	83.9
		} Sp. gr. of spirit 0.736	

The Residual Oil (83.9 per cent.) was cracked under similar circumstances: New Crude Oil recovered—80 per cent. of stock—67.1 per cent of original Crude.

Fractionation of new Crude—

	Per Cent.	
70 to 130° C. ....	5.6	} 13.7 per cent. = 9.2 per cent of original Crude.
130 to 175° C. ....	8.1	

Summary of Results:

	Per Cent.	
Total Motor Spirit to 175° C. ....	25.3	= 9.5 gallons per ton.
Total Residual Oil ....	57.9	= 21.8 gallons per ton.
Total Loss ....	16.8	= 6.3 gallons per ton.

Additional loss in Crude Oil in original recovery: 5.4 gallons per ton.

1000	1000	1000
1000	1000	1000
1000	1000	1000

C. Retorting of Shale under Cracking Conditions slightly varying from B—

Oil Yield.	Specific Gravity.	Residue.
1. 20 gallons per ton	0.898	} 80.5 per cent.
2. 21 gallons per ton	0.905	
3. 28 gallons per ton	0.915	

Nos. 2 and 3 combined with average specific gravity 0.910.

No. 1 Motor Spirit = 9.8 per cent. } 20.3 per cent.  
 No. 2 Motor Spirit = 10.5 per cent. }

Motor Spirit, 5 gallons per ton.  
 Residual Oil, 19.5 gallons per ton.

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ANALYSIS OF PRODUCTS FROM DISTILLATION OF THE CRACKED RESIDUE

LANARKSHIRE SHALE OIL COMPANY LIMITED

1918

## TASMANITE SHALE OIL COMPANY LIMITED.

22/6/32.

*Actual Sales of Products from Various Trial Runs of the Crozier Retort.*

Product.	Quantity Sold.	Value of Products Sold.	Principal Customers.
	Gals.	£ s. d.	£ s. d.
Petrol .....	2,206	210 8 0	
Kerosene .....	13,881	867 5 11	E. E. Badcock Westbury ..... 53 8 4 D. W. Bowman, Deloraine ..... 44 19 10 E. C. Chilcott, Meander ..... 39 8 9 J. H. Davidson, Campbell Town ..... 38 10 0 C. Ingram, Sassafras ..... 33 4 4 A. M. Bowman, Deloraine ..... 28 0 10
Tractor Oil .....	1,993	90 0 9	L. D. Burbury, York Plains ..... 20 14 4 J. Davis, Tunbridge ..... 27 13 8
Diesel/Fuel Oil .....	52,560	1,314 1 6	Tas. Govt. Railways ..... 1,067 2 3 Mt. Lyell Co., Queenstown ..... 55 0 0 N.W. Freezing Co., Burnie ..... 47 18 4 Public Works Department, Hobart ..... 36 13 5 Emu Bay Council, Burnie ..... 28 13 2
Bitumen .....	11,693	414 3 2	Devonport Council ..... 158 6 8 Latrobe Council ..... 100 7 9 Emu Bay Council ..... 88 7 0
Spray Oils, Weed- killer, &c. ....	.....	146 6 6	
Total .....	82,333 gals.	£3,042 5 10	

## 14.

## TASMANITE SHALE OIL COMPANY LIMITED.

*Table Showing How the Crude Oil Value Varies According to the Method of Refining Adopted.*

(The results are based on 100 gallons of Crude Oil.)

Product.	Value Based on Actual Figures Realised at the Plant.	Value Based on the Assumption that Practical Refining Difficulties are Overcome to Allow for Full Possible Recovery of the Lighter Oil Fractions in Marketable Form.
	£ s. d.	£ s. d.
Petrol .....	6.35 gals., at 1s. 10½d. .... 0 11 11	16.95 gals., at 1s. 10½d. .... 1 11 9
Kerosene .....	13.25 gals., at 1s. 3d. .... 0 16 7	14.36 gals., at 1s. 3d. .... 0 17 11
Diesel Oil .....	48.7 gals., at 6d. .... 1 4 4	37.5 gals., at 6d. .... 0 18 9
Tractor Oil .....	8.92 gals., at 8d. .... 0 5 11	11.93 gals., at 8d. .... 0 7 1
Bitumen .....	12.63 gals., at 9d. .... 0 9 6	10.8 gals., at 9d. .... 0 8 2
	89.85 gals. £3 8 3	91.54 gals. £4 3 8
Loss .....	10.15 gals.	8.46 gals. (Loss)
	100.0 (or 8.2d. per gallon)	100.0 (or 9.04d. per gallon)

Table Showing Value of Crude Oil on Similar Lines to Table Above, But Using Cracking Methods.

Product.	Value Based on Figures Realised at the Plant (with Cracking Methods).	Higher Value, Making the Same Assumption in Refining as on Above Table.
	£ s. d.	£ s. d.
Petrol .....	45.2 gals., at 1s. 10½d. ....	50.15 gals., at 1s. 10½d. ....
Kerosene .....	13.3 gals., at 1s. 3d. ....	14.36 gals., at 1s. 3d. ....
Fuel Oil .....	7.1 gals., at 6d. ....	6.08 gals., at 6d. ....
	65.6 gals. £5 4 10	70.59 gals. £5 14 11
Loss .....	34.4 gals.	29.41 gals.
	100.0 (or 12.58d. per gallon)	100.0 (or 13.79d. per gallon)

The above figures take no account of the value of the coke or carbon residue obtained from the Cracking Plant.