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REPORT

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ON THE

FINANCIAL POSITION, REQUIREMENTS AND PROSPECTS

OF THE

RAILTON-LATROBE SHALE OIL COMPANY

BY

ARTHUR WADE, D.Sc., A.R.C.Sc., ASSOC. MEMB. I.M.M. F.G.S.

Presented to both Houses of Parliament by His Excellency's Command.

[Estimated cost of printing (325)—£14 8s. 9d.]



Tasmania:

JOHN VAIL, GOVERNMENT PRINTER, HOBART

1916

B68473

AMG REFERENCE POINTS ADDED

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Hobart, 8th December, 1915.

SIR,

I HAVE the honour to submit herewith my report on the Railton-Latrobe Shale Oil Company.

The fact that such a specialised industry as that which concerns itself with petroleum is in such an embryonic stage in Australia, and the present disturbed condition of the markets, make extreme accuracy of figures difficult to obtain; but I believe those contained herein to represent the facts as closely as careful investigation and close consideration can make them.

I have consulted with Mr. Griffin, the Company's present manager, with regard to every item of plant referred to, and I have no doubt that he will be able to secure, to fit up, and to work anything that may be required.

I have laid some stress on the necessity for obtaining a capable organic chemist with previous experience of this kind of work, because success will largely depend on his investigations and ability.

I have the honour to remain,

Sir,

Yours truly,

ARTHUR WADE, D.Sc., &c.

The Hon. J. EARLE, Premier of Tasmania.

No.	Description	Quantity	Value	Remarks
1	Oil	100	1000	
2	Gas	50	500	
3	Water	1000	1000	
4	Steam	1000	1000	
5	Electricity	1000	1000	
6	Coal	1000	1000	
7	Wood	1000	1000	
8	Iron	1000	1000	
9	Steel	1000	1000	
10	Copper	1000	1000	
11	Lead	1000	1000	
12	Zinc	1000	1000	
13	Aluminum	1000	1000	
14	Flux	1000	1000	
15	Welding	1000	1000	
16	Paint	1000	1000	
17	Oil	1000	1000	
18	Gas	1000	1000	
19	Water	1000	1000	
20	Steam	1000	1000	
21	Electricity	1000	1000	
22	Coal	1000	1000	
23	Wood	1000	1000	
24	Iron	1000	1000	
25	Steel	1000	1000	
26	Copper	1000	1000	
27	Lead	1000	1000	
28	Zinc	1000	1000	
29	Aluminum	1000	1000	
30	Flux	1000	1000	
31	Welding	1000	1000	
32	Paint	1000	1000	
33	Oil	1000	1000	
34	Gas	1000	1000	
35	Water	1000	1000	
36	Steam	1000	1000	
37	Electricity	1000	1000	
38	Coal	1000	1000	
39	Wood	1000	1000	
40	Iron	1000	1000	
41	Steel	1000	1000	
42	Copper	1000	1000	
43	Lead	1000	1000	
44	Zinc	1000	1000	
45	Aluminum	1000	1000	
46	Flux	1000	1000	
47	Welding	1000	1000	
48	Paint	1000	1000	
49	Oil	1000	1000	
50	Gas	1000	1000	
51	Water	1000	1000	
52	Steam	1000	1000	
53	Electricity	1000	1000	
54	Coal	1000	1000	
55	Wood	1000	1000	
56	Iron	1000	1000	
57	Steel	1000	1000	
58	Copper	1000	1000	
59	Lead	1000	1000	
60	Zinc	1000	1000	
61	Aluminum	1000	1000	
62	Flux	1000	1000	
63	Welding	1000	1000	
64	Paint	1000	1000	
65	Oil	1000	1000	
66	Gas	1000	1000	
67	Water	1000	1000	
68	Steam	1000	1000	
69	Electricity	1000	1000	
70	Coal	1000	1000	
71	Wood	1000	1000	
72	Iron	1000	1000	
73	Steel	1000	1000	
74	Copper	1000	1000	
75	Lead	1000	1000	
76	Zinc	1000	1000	
77	Aluminum	1000	1000	
78	Flux	1000	1000	
79	Welding	1000	1000	
80	Paint	1000	1000	
81	Oil	1000	1000	
82	Gas	1000	1000	
83	Water	1000	1000	
84	Steam	1000	1000	
85	Electricity	1000	1000	
86	Coal	1000	1000	
87	Wood	1000	1000	
88	Iron	1000	1000	
89	Steel	1000	1000	
90	Copper	1000	1000	
91	Lead	1000	1000	
92	Zinc	1000	1000	
93	Aluminum	1000	1000	
94	Flux	1000	1000	
95	Welding	1000	1000	
96	Paint	1000	1000	
97	Oil	1000	1000	
98	Gas	1000	1000	
99	Water	1000	1000	
100	Steam	1000	1000	

(No. 1.)



REPORT ON THE FINANCIAL POSITION, REQUIREMENTS AND PROSPECTS OF THE RAILTON-LATROBE SHALE OIL COMPANY: BY ARTHUR WADE, D.Sc., &c.

I.—INTRODUCTORY.

In response to a request made by the Government of Tasmania, I paid a second visit to the properties of the Railton-Latrobe Shale Oil Company in November, 1915, for the purpose of preparing the following report:—

II.—GENERAL AND DESCRIPTIVE.

General descriptions of the Tasmanite Shale Fields of the Mersey area and of the properties held by the Railton-Latrobe Shale Oil Company—the largest holder, and the only one engaged in active development—have already been given by Mr. Twelvetrees, the Government Geologist, in his admirable report on the district,* and by myself, in a report issued privately by the Company mentioned.† It may be advisable to briefly recapitulate the main points so far as they concern the Railton-Latrobe Company.

The Company holds 1482 acres of land carrying oil shales, under a consolidated lease, in the vicinity of the town of Latrobe, and the township of Railton, both situated on the Mersey River, between 7 and 10 miles south of the port of Devonport. Of the 1482 acres held, 930 acres are believed to be underlain by workable shale, varying in thickness between 1 ft. 8 in. and 7 ft. The average thickness of the seam may be taken as 4 feet. Deducting between a quarter and one-third of this for loss during working, we can take this as representing 1500 tons of shale per acre per foot of seam, or over 5½ million tons of shale available. These estimates may be considered as a minimum, rather than a maximum, on the data at present available.

The shale is a tough, brown, laminated material, rich in carbonaceous matter, which is capable of being converted into petroleum products by distillation. The variety is peculiar to Tasmania, and is, therefore, appropriately known as "Tasmanite." Without going again into the detailed figures of analyses, the average yield of the three primary petroleum products obtained by distillation in the Company's own retorts is:—

1. Over 40 gallons of crude oil per ton of shale.
2. Over 7 gallons of petroleum spirit per ton of shale.
3. 2500 cubic feet of combustible gas per ton of shale.

Since my first visit the Company has installed a bench and four new retorts, which are working very efficiently. The observed yield was in excess of that given above, reaching 43 gallons of crude oil per ton of shale, and about 7½ gallons of spirit; in all, over 50 gallons of marketable liquids per ton, a quantity which compares very favourably with the results obtained from the distillation of oil shales in other parts of the world. The petroleum so obtained contains about 1 per cent. of chemically-combined sulphur. This is below the maximum fixed by the British Admiralty, which is now 3 per cent.

The crude oil is a heavy, dark olive-green liquid, with a specific gravity varying between .940 and .950. It is essentially a fuel oil. It burns readily, with a strong luminous flame, which, owing to the high carbon content, deposits much soot when not under proper regulation. The calorific value is remarkably high, as is shown by the following table:—

Tasmanite Crude.	Scotch Shale Oil.	Californian Crudes.	Burma Crude.	Borneo Crude.
22,000 B.T.U.	18,000	18,000 to 19,800	19,500	18,600

This comparison shows the Tasmanian product to be one of the best fuel oils in existence. This has been confirmed recently by trials in Melbourne at Hornsby & Co.'s depot, where the Tasmanian oil gave better results in a Hornsby crude oil engine than had ever been obtained from other fuel oils. The oil contains little paraffin, hence it deposits little sediment when cooled to 20° F., at which temperature it still remains liquid enough to flow readily. Tests carried out by myself and

* "The Tasmanite Shale Fields of the Mersey District," Geol. Surv. Bull. No. 11, Hobart, 1912.

† "Report on the Properties of the Railton-Latrobe Shale Oil Co.," Launceston, 1915.

Mr. Griffin (manager), in the Company's own laboratory, showed that the oil did not lose its liquid character until it was cooled to the neighbourhood of 30° F. below freezing point. These facts become important when the question of carrying the oil by means of a pipe-line is considered. The oil should flow freely in pipes at any temperature likely to be encountered in this part of Tasmania, and should not clog the pipes by depositing paraffin or other solid matter during wintry weather. It is difficult to make the advantages of these properties sufficiently prominent in a country where oil pipe-lines are as yet unknown. It will suffice to say that in some countries it is necessary to keep the oil above 100° F. throughout its course through the pipe-line, and heating stations have to be installed at intervals, as well as at the central storage where the pipe-line originates. Besides saving these large expenses, the absence of much deposit will remove many troubles connected with keeping the pipes clean and free, enable smaller-diameter pipes to be used at a saving of some thousands of pounds, and ensure regular supplies at all seasons.

The crude spirit is a light-brown liquid, with a specific gravity of .750. The colour is readily removed by the usual methods of treatment, leaving a colourless liquid of the motor spirit type, possessing a sharp and somewhat unpleasant odour, due to the presence of sulphur compounds. This defect can also be removed by suitable treatment; in fact, the impurity may possibly be turned to profit.

The gas is colourless, and possesses an odour somewhat similar to that of the spirit. It burns with a faint bluish flame, giving off intense heat. Like the natural gas produced on oilfields, it consists chiefly of methane (CH_4). It is capable of being employed in firing furnaces and retorts, the ease with which the supply can be regulated, as well as its cheapness, making it superior to other forms of heating for such purposes. It should also supply ample motive power, since it is capable of being utilised to advantage in engines of the suction gas type.

III.—DESCRIPTION OF PRESENT WORKINGS.

The following brief description of the plant in use at present is necessary, in order to make clear the alterations, additions, and economies suggested later. The works may be divided into three sections:—

1. The mine.
2. The retorting plant.
3. The refining plant, with which we must associate the laboratory.

1. *The Mine.*—The shale is at present mined by means of adits driven into the hillside about $\frac{3}{4}$ -mile to the west of the Company's works, 2 miles south of Latrobe. The seam here reaches 5 feet in thickness. The drives are well-timbered, and the main headings are laid with iron rails. The development is against the dip, so that the trucks run to the mouth of the mine by gravitation. From the mine the shale is carried in trucks by cable haulage over a wooden tramway to the breakers. The shale is broken by a cone-breaker, and passed into a large wooden "bin," with a capacity of 400 tons.

The bin is situated on the hillside above the retorting plant, so that the broken shale gravitates into trucks which feed to the tops of the retorts.

2. *Retorting Plant.*—There is at present working one bench of four vertical retorts, oval in shape, 18 feet high, each with a capacity of $1\frac{1}{2}$ tons, together with four horizontal retorts, which are only used for the fine material. These are not in constant use, since they are not so efficient as the former. The additional four vertical retorts mentioned in my previous report are now dismantled, owing to faulty casting. The whole bench is encased in brickwork, containing flues, by means of which the heat from the furnaces is suitably distributed around the retorts. Wood fires are now in use, timber being plentiful on the property. The shale falls directly from the trucks into the feeding-hoppers, situated above each retort. The shale gradually works its way down the retort, and gives off dense yellowish-green gases under the influence of the furnace heats. The spent shale gravitates into a chamber at the base of each retort, from which it can be removed from time to time by means of an arrangement of plates and levers.

Each retort discharges independently, the spent material falling directly into trucks, by which it is conveyed to a dump or "bing." This discharging arrangement is one of the improvements installed by Mr. Griffin, and does away with the dirty, and not altogether efficient, water seal which encumbered the base of the old retorts. It is important to prevent air from reaching the gases in the retorts, since oxidation of the products, with consequent loss and deterioration, would ensue. In the present case the spent shale itself forms the seal, and the little air which may enter combines with some of the free carbon remaining in this, and so assists the furnace heats in distilling the "green" shale above.

The gases produced pass out through pipes situated below the top of each retort. These communicate with a main, which carries away the whole of the gas produced. The generation of the gas and its passage away through the main is assisted by passing a limited quantity of steam into the interior of each retort. This is a further improvement installed by Mr. Griffin, and the results are distinctly satisfactory. It is unnecessary to give the full details of the improved process here.

The gases are partly condensed into crude oil and water in the cooler parts of the main, the products of condensation being immediately recovered and separated. The uncondensed gases pass through a series of vertical pipes, which present a large cooling surface to the air, and a further supply of crude oil and water is obtained and separated.

There still remains uncondensed gases, and from this the spirit can be obtained by compression and cooling, or by passing through scrubbing towers, through which crude oil is being pumped and sprayed. The heavier oil absorbs the remaining spirit from the gas, and this can be obtained again by distillation. There still remains the uncondensable gas, chiefly methane (CH_4), previously mentioned.

The retorting plant is kept working continuously night and day throughout the week, and is now producing about 250 gallons of heavy crude oil per day, together with about 40 gallons of spirit, neglecting the further quantity of spirit obtainable from the crude oil itself.

3. *Refining Plant.*—In order to remove the colour and certain chemical impurities from the crude spirit obtained in the primary distillation, it is necessary to treat the liquid with strong sulphuric acid. This is added to the oil, and thoroughly mixed by means of mechanical agitators. During this process a certain amount of tar is liberated, and sinks to the bottom of the lighter liquid, from which it is separated. The acid admixture is then neutralised by treatment with caustic soda. It is then necessary to again distil off the spirit, and it is recovered as a bright-looking, colourless liquid, utilisable as motor spirit.

A further amount of spirit is obtainable from the crude oil by similar distillation and treatment. There are, therefore, on the properties, stills and agitating tanks for the crude spirit and for the crude oil. The temperatures required for these distillations are low, being below 300° F., the heat being obtained from steam generated in the boiler plant.

All the mechanical operations, such as haulage from the mine, breakers, compressing, pumping, and agitating, are performed by steam power, which is also used to generate sufficient electricity to light the works and office.

4. *Storage.*—The oil is at present stored in a number of old Cornish boilers, each being about 5000 gallons capacity. These are quite sufficient for such comparatively small quantities.

5. *Laboratory.*—It is necessary to exercise constant supervision over the crude product in order to obtain continuous production of liquids of uniform value, and to measure the daily efficiency of the work being done by the plant. For this purpose each of the Company's products is tested daily in the laboratory, and the results carefully recorded.

IV.—SUGGESTED EXTENSIONS OF PLANT FOR INCREASED OUTPUT.

Having thus briefly described the plant and processes as they are at present, it now remains to consider the equipment of the properties with a view to possibilities of extension and improvement leading to greater development and profit. In the preparation of this part of the report, the Company's manager (Mr. D. Griffin) and myself have gone carefully into every question of economy and expenditure which presented itself to us, and have prepared detailed estimates in connection with every branch of the undertaking. As far as possible, we have endeavoured to give place to Australian productions; but, I think I shall not be misunderstood if I point out that some difficulty arises here owing to there being no petroleum industry as yet in Australia. Some plant may have to be obtained abroad, preferably in England. Some of our estimates may be slightly inaccurate, owing to the fact that we are making new calls on local resources, and some of the preliminary work may be considered experimental, owing to our endeavour to adapt ourselves to Tasmanian conditions. In the main, however, we have allowed liberally for such exigencies, and our feeling is that the actual total costs will be less than those stated.

The local demand for oils of various grades and economy in initial expenditure are the two chief questions affecting the preparation of estimates for extended development. Since the two are largely in opposition, it is necessary to compromise somewhat. With this in view, I have considered an annual production of 7000 tons, or 1,652,000 gallons of fuel oil per annum, to be sufficient for present calculations. To this must be added about 500,000 gallons of spirit and several million cubic feet of combustible gas.

1. *Mining Plant.*—To obtain this it will be necessary to mine 41,400 tons of shale per annum, or an average of 115 tons per day, allowing 360 days to the year. This means a considerable extension of the present mine, and much up-to-date equipment will have to be installed. Eventually it will mean that the centre of operations will have to be moved, probably necessitating the sinking of a shaft to work extensions of the shale seam, and some light boring and prospecting will have to be done to prepare for this.

In the present workings the cost of extending the main drives, installing electric rotary drills, and generally equipping for work on a greater scale will be about

£ s. d. £ s. d.

2000 0 0

For haulage, 10 tons of steel rails, 14 lb. per foot, will be required. These, with crossings, fittings, and sleepers, will cost

250 0 0

This haulage will equip the extended workings underground, and be sufficient to carry the shale over the surface to a new retorting site (shown on accompanying map), which will be more conveniently situated with regard to the mine. Later, more rails will be required, but this need not be considered at present. It should be possible to effect economy by buying this material second-hand locally. The power plant at present in use for haulage should be sufficient, and does not require adding to. The cost of laying the tramway from the mine to the new works' site, with proper approaches

150 0 0

The "Breaker" at present in use for the shale is insufficient, and a new breaking plant, consisting of pairs of solid revolving steel cylinders, fitted with short, strong teeth, as used on the Scottish fields, will have to be installed, at a cost of

250 0 0

For prospecting purposes, including small bores, with a view to selecting a main shaft for future workings

1000 0 0

Total expenditure required immediately for mining operations

3650 0 0

Required later for sinking main shaft, developing and equipping for new mining operations

7000 0 0

Total eventually required for mining operations

£10,560 0 0

2. *Retorting Plant.*—This will need greatly enlarging, in order to cope with 115 tons of shale per day. Sixty additional retorts will be required. These will be erected in benches of four retorts; each bench being separated from the next by brickwork, so that one bench can be put out of action and cleaned without being unduly affected by the heat from neighbouring retorts. It is not likely that all the benches will be working at once. Cleaning and repairs will be necessary from time to time, so that 60 retorts, in addition to those at present working, will not be too many. These retorts will be erected on a new site, as shown on the accompanying map. The present retorts are situated $\frac{3}{4}$ -mile from the mining area, and the tramline between the two has to cross a hill 250 feet high, by very steep grades. To save this long line and to economise haulage power it is proposed to shift the retort works to the new site shown. This will be within $\frac{1}{4}$ -mile of the present mine, and probably still nearer to the site chosen for the shaft for more extended mining operations. Again the new site will be higher and more roomy; is convenient for the erection of storage tanks; and will give sufficient head for a pipe-line running to Devonport, so as to do away with the necessity of installing pumps in that connection.

The new retorts will be of improved pattern, probably 25 to 30 feet high, circular in shape instead of oval, and with a capacity of over 2 tons each, as compared with $1\frac{1}{2}$ at present. The additional height will give a greater efficiency in the production of oil.

In addition it is proposed to effect further improvements in the shale hoppers at the top of the retorts and in the discharging apparatus at the base. The former will have a greater capacity for "green" shale, which will act as an air seal at the top, as well as assist in the condensation of the gas rising in the retorts. The latter will allow of a continuous discharge of the spent shale. Both improvements will provide greater efficiency, with greater economy in working. It is possible to make this side of the operations almost automatic, and the improvements are a step towards this.

	£	s.	d.
The cost of erecting 15 benches of retorts, at £1000 per bench, is	15,000	0	0
Apparatus for continuous discharge, at £50 per retort	3000	0	0
Condensers for greater production of gas, including galvanised iron pipe and fittings, materials, and construction	2000	0	0
Two gas engines, 35 to 40 h.p. each, adapted to use waste gas from retorts, at £250 each	500	0	0
Compression plant for recovery of spirit—Cost, including fittings—			
1 large cheap compressor	150	0	0
1 multi-stage compressor, compressing up to 600 atmospheres	450	0	0
Bricks for building retorts and other purposes—These have been made efficiently and cheaply on the properties, there being an abundance of fire-clay available; 50,000 bricks are required to each bench of retorts. In all, about 750,000 bricks will be required. It has been proved possible to manufacture 20,000 bricks a day on the property, at 20s. per 1000	750	0	0

3. *Storage.*—It will be necessary to store a considerable quantity of crude oil and spirit on the properties for several reasons—(1) To ensure regular and steady flow through the pipe-line. (2) For defence purposes it does not appear to me to be advisable to have all the available oil stored at Devonport, where it is liable to destruction by some enemy at sea. At present second-hand boilers, holding 5000 gallons each, are in use, and are efficient for smaller quantities. They cost from £25 to £60 each, according to condition and transport. With a pipe-line in contemplation, I think it will be cheaper in the long run, as well as more efficient, to have one storage tank erected on modern lines, and capable of holding 40,000 gallons.

The specifications for this are as follows:—

Diameter of tank, 30 feet.			
Height of tank, 8 feet.			
Number of rings in shell, 2.			
Thickness of first ring (Birmingham gauge), No. 7.			
Thickness of second ring (Birmingham gauge), No. 8.			
Thickness of bottom plates (Birmingham gauge), No. 7.			
Thickness of sketch plates (Birmingham gauge), No. 7.			
Size of bottom angle iron (in inches), $2\frac{1}{2} \times 2\frac{1}{2} \times 5/16$.			
Size of top angle iron (in inches) $2 \times 2 \times \frac{1}{4}$.			
Thickness of sheets for tight-riveted roof, No. 12; or			
Thickness of sheets for light-nailed roof, No. 20.			
Cost about	1000	0	0
A small gasometer will also be needed in order to store and regulate both supply and composition of the waste gases before supplying to the gas engines. This should not cost more than	150	0	0
A new high-pressure boiler required for supplying steam to compressor, &c.	400	0	0
Total cost of retorting plant required	£23,400	0	0

4. *Refinery.*—The chief products of the Company's plant are fuel, oil, and crude oil spirit. It will be most economical to concentrate on these for the present, and to develop other branches later from time to time as opportunity arises. It has been already shown that the crude spirit is obtained from two sources, primarily by the condensation of the gas from the retorts left over after the fuel oil has been removed, and secondarily by a distillation of the fuel oil itself, by means of which a further fraction of the spirit is obtained. Now, with improved retorting, it is hoped to recover the whole of the spirit directly, so that little will remain for extraction from the fuel oil. If this be accomplished, it will save one process of refining. At first it will be cheaper to effect the

necessary refining near the retorting plant, where fuel, steam, and motive power will fulfil all early requirements. Later, as this branch of the business develops, I believe it would be best to transfer it to a site at Devonport. This would save the cartage of the refined products to the port. Moreover, with a large refinery, it would be cheaper to use coal for raising power than to use wood. Wood costs 5s. per ton to get on the Company's areas, and would cost 8s. or 9s. at Devonport. Coal possesses more than three times its efficiency, and should be obtainable at Devonport per boat from Newcastle at something like 13s. a ton. The Company's own liquid fuel might be used for raising heat in the furnace, but the prices obtainable from its products make it more profitable to sell it for other purposes than to use it for firing. The objection to this scheme at present is that it would require a second pipe-line, smaller in diameter than that required for the fuel oil, to carry the crude spirit from the works to a refinery at Devonport. This cost might well be saved at the outset, and considered later.

It will also be cheaper to have the whole of the works in one place at present, and so cheapen the cost of management and upkeep by centralisation. A large refinery will require separate management, and will be a more or less self-contained concern. For present needs the refinery requires:—

	£	s.	d.
1 still, capacity 1000 gallons, for crude oil	100	0	0
1 still, capacity 1000 gallons, for crude spirit	100	0	0
The prices include erection, and the stills can be made out of old boilers.			
1 rectifying still	150	0	0
1 lubricating oil still	500	0	0
The latter plant should be made by experts, and should be of up-to-date type, in order to obtain a product that will compete with oils already on the market.			
The plant would preferably be of the continuous distillation type, and since it will be run night and day, a small one of about 1000 gallons capacity will suffice:—			
1 mechanical agitator for acid	50	0	0
1 mechanical agitator for soda	50	0	0
1 small desulphurising plant for spirit, capacity about 300 gallons per day	250	0	0
This plant must also include the latest refinements in method. It will probably be necessary to send samples of the spirit to the firm tendering for the plant, and after testing, the plant should be furnished complete, with a guarantee of efficiency.			
If, as will be recommended later, a research chemist be appointed, he should instal any further plant and improvements necessary. In a similar case known to me, a research chemist not only improved the plant, but turned the substance vitiating the oil into more profitable material than the oil itself.			
1 canning plant for preparing motor spirit and kerosene for market	300	0	0
2 boilers (second-hand low-pressure boilers)	200	0	0
Electrical plant, dynamos and generators	350	0	0
Copper cables for distributing current	150	0	0
5 small centrifugal pumps, at £10 each	50	0	0
Total cost of refining plant	£2250	0	0

5. *Laboratory.*—Although the petroleum industry has made great strides of recent years, it is remarkable how little is accurately known with regard to its chemistry. In a refinery works, as described above, the presence of a well-trained organic chemist, with special knowledge of the petroleum series of compounds, is an absolute necessity. The number of products and by-products obtainable is almost infinite, but as the chemical composition of almost every individual oil presents differences, so each presents its own chemical problems. The work of a good chemist may mean much to the financial success of the industry. Besides discovering new marketable commodities, he should also keep a check on the composition and character of the fundamental product, be familiar with all the processes involved in manufacture, and should be able to suggest improvements where chemical processes are at work in production. With the works increasing in size and working night and day throughout the year, it is obvious that some assistance must be given to the general manager. The works' chemist should be able to render such assistance in the capacity of works' manager.

For the purpose of research the laboratory would have to be equipped with all the standard apparatus for testing the physical and chemical properties of the oil. The viscosity flash point, calorific value, specific gravity, require special instruments. A recording pyrometer is needed to observe and regulate retort temperatures. The present equipment, in the way of chemicals and apparatus, will require greatly augmenting. For this a sum should be set aside of at least £1000.

6. *Pipe-lines.*—Experience has proved that the best way of transporting oil for any distance is by means of lines of pipes. It will be necessary to lay such a pipe-line from the works to Devonport, in order to transport the oil to steamers for shipment as crude. The ideal route for such a pipe would be straight, with just sufficient gradual fall to produce a steady flow from the storage at the works to the storage tanks at the port terminus. Bends decrease the speed of flow, and depressions in the line act as traps which catch any sediment which may be present, thus causing stoppages. Owing to the fact that oil will escape through joints that are tight to water, special joints are necessary. The expansion of the pipes in hot weather is taken up either by means of loops placed at intervals or by means of special expansion joints, by means of which the expansion is taken up by a sort of telescopic action.

The pipe is of wrought iron, which may be galvanised to prevent external rusting, or specially covered for the same purpose, and to counteract to some extent the loss of heat in cold weather. Considering the amount of oil it is proposed to transport, the distance it has to be carried and its viscosity, and the low temperature at which it will flow, I am of opinion that pipes with 4 inches

internal diameter will do for the purpose between the works and Devonport. The cost of this will be, approximately, £1000 per mile, which makes it essential to select the most direct route available. To save the expense of royalties for carrying the pipe across private properties it will be necessary to lay it along one of the means of communication already in existence; of these, there are five:—

- (1) By main road on the western bank of the Mersey.
- (2) By main road on the eastern bank of the Mersey.
- (3) By the narrow by-road running close to the Mersey on the eastern side.
- (4) By the railway line.
- (5) By the river. (See map.)

The storage site at the locality suggested for the new works is 180 feet above sea-level, thus giving plenty of head for a gradual fall to the port, and sufficient to overcome small undulations on the surface.

Routes 1 and 4 provide a gradual fall, but, owing to wide bends the length of pipe required would be over 2 miles above that required by other routes available.

Route 2 is more direct, but in one place it reaches an elevation of about 250 feet above sea-level, and this would require the expense of a pumping station.

A combination of 3 and 5 is the most direct and convenient. From the storage site the pipe would go by a gentle fall to the old Deloraine-road, shown on the map, running through the Company's properties, to the river. It would keep along the river bank, above flood-level, down to the point at which road and railway cross the river at the northern end of Latrobe town. Here it would follow the by-road by as direct a route as possible until it reached a terminus in Devonport. This route provides a steady fall to the river at first, and then a course with very little rise or fall to the end. The distance would be about 7 miles, and the total cost of pipe, fittings, and laying, about £7000.

The following figures give a general idea of the cost of laying a 6-inch pipe in America:—

	Per foot.
	s. d.
Pipe	2 10
Fittings	0 2½
Hauling	0 1¼
Stringing	0 0½
Painting	0 2¼
Ditching	0 3¼
Laying	0 2½
Extra Labour	0 0½
	3 10¾

Or £1028 10s. per mile.

Reckoning for the smaller diameter of pipe and fittings, and the increased cost of materials and labour in Tasmania, the cost of the 4-inch pipe-line proposed will not be less than the figure quoted.

There seems, however, to be a possible alternative. Locally-made wood-pipe can be obtained in Australia at a much cheaper cost per foot than the above. Wood-pipe has received little attention from petroleum engineers for one or two obvious reasons. The strains imposed when oil has to be pumped under high and quickly-varying pressures, where the head is very high, and where grades are steep, have been considered too high for anything but the best wrought piping. Again, the danger from fire and the difficulty of efficiently safeguarding lines which may run to hundreds of miles in length is too great. I can see no difficulty which cannot be overcome, however, for short lengths of line, providing that adequate precautions are taken and proper supervision exercised.

The first iron pipes failed on account of leakages at joints, and I am quite sure that the joints provided on wooden pipe-lines used for water-carriage would not be suitable for an oil pipe-line. If, however, the manufacturing company can overcome this, one of the greatest difficulties is mastered. Besides the saving in cost the wooden line would be easier to handle and to lay; would retain heat longer in winter, and would not be so liable to freeze up; would present a more suitable surface for the flow of oil, and thus allow of more rapid transport, with less liability to stoppage by sedimentation; would not be liable to breakages by expansion, nor deterioration by rust. I think it would be best to allow the Company to experiment with the oil in their pipes, and if they are confident they can handle it they should be asked to contract to supply and lay the line under guarantees. A 4-inch, or even 5-inch line should not cost more than £4000.

7. *Port Storage.*—The Naval Department will, if satisfactory arrangements are made, erect their own storage at the pipe-line terminus at Devonport. It will be necessary, however, to store any excess over their requirements for other sales. For this purpose a tank holding 1000 tons of oil fuel should be ample. This tank, together with others before mentioned, could be erected by contract on standard specifications. They should be provided with manholes, hatches, swing-pipes, and preferably with water-gauges protected in locked boxes, so that the amount of accumulated water can readily be observed.

The specification for 1000-ton tank would be:—

- Diameter of tank, 66 feet.
- Height of tank, 25 feet.
- Number of rings in shell, 6.
- Thickness of 1st ring (Birmingham gauge, No. 3.
- Thickness of 2nd ring (Birmingham gauge), No. 3.
- Thickness of 3rd ring (Birmingham gauge), No. 4.

Thickness of 4th ring (Birmingham gauge), No. 5.
 Thickness of 5th ring (Birmingham gauge), No. 6.
 Thickness of 6th ring (Birmingham gauge), No. 7.
 Thickness of bottom plates (Birmingham gauge), No. 6.
 Thickness of shield (Birmingham gauge), No. 6.
 Size of the bottom angle iron inside, $3 \times 3 \times \frac{1}{2}$.
 Size of the top angle iron inside, $2 \times 2 \times \frac{1}{4}$.
 Thickness of sheets for tight-riveted roof, No. 12.
 Thickness of sheets for light-nailed roof, No. 20.

The cost should not exceed £2500.

8. *Buildings*.—In addition to the above, a number of buildings will be necessary for the canning operations and for storage, as well as for the housing of some of the machinery. It may be advisable also to consider the construction of a residence for the manager on the property itself. With work going on night and day, the nearer he is to operations the more effective the supervision he can exercise. In any case, the sum allocated for buildings should not be less than £2000.

V.—SUMMARY OF COSTS.

Summarising the expenditure immediately required we get:—

	£	s.	d.	£	s.	d.
<i>Mining</i> —						
General immediate equipment	2000	0	0			
<i>Tramlines</i> —						
Material, &c.	250	0	0			
Laying and approaches.....	150	0	0			
Breaker	250	0	0			
Prospecting and boring, immediate	1000	0	0			
Total				£3650	0	0
<i>Retorting Plant</i> .—						
15 benches of 4 retorts each	15,000	0	0			
Apparatus for continuous discharge of same	3000	0	0			
Condensers—Material and construction	2000	0	0			
2 35 to 40 h.p. gas engines	500	0	0			
2 compressors (1 simple, 1 multi stage)	600	0	0			
750,000 bricks—Cost of making on properties	750	0	0			
Storage tank, 40,000 gallons	1000	0	0			
Small gasometer	150	0	0			
New high-pressure boiler	400	0	0			
Total				23,400	0	0
<i>Refinery</i> .—						
2 1000-gallon stills for crude oil and crude spirit	200	0	0			
1 rectifying still	150	0	0			
1 lubricating oil still	500	0	0			
2 mechanical agitators (acid and soda)	100	0	0			
1 small desulphurising plant	250	0	0			
1 canning plant	300	0	0			
2 second-hand low-pressure boilers	200	0	0			
Electric plant, dynamo, and generator	350	0	0			
Copper cables for current	150	0	0			
5 small centrifugal pumps, at £10 each	50	0	0			
Total				2250	0	0
Equipment of laboratory for testing and research				1000	0	0
Pipe-line, 4-inch—						
Wrought iron				7000	0	0
or						
Wood-pipe				4000	0	0
<i>Port Storage</i> —						
1 1000-ton tank				2500	0	0
<i>Buildings</i>				2200	0	0
Sundry expenses (unforeseen)				2500	0	0
Total cost of immediate equipment with iron pipe ...				44,500	0	0
Or						
With wood pipe				41,500	0	0
Necessary to set aside for less immediate mining operations				7000	0	0
Total expenditure in sight				£51,500	0	0
Or						
... ..				£48,500	0	0

It must be noted that these figures are only intended for the development of the shale areas in the immediate vicinity of the works. It will probably be many years before it is necessary to exploit the more outlying properties, such as those near Railton. These may be regarded as the Company's reserves, and need not now be considered. Developments in method and other circumstances may affect decisions at a later date.

Considerable savings may be effected in connection with some of the items in the estimates by judicious letting of contracts and by the shrewd buying of second-hand mining and power plant of suitable good quality, which is almost always available in Australia.

Negotiations for the wood pipe should be with The Australian Wood Pipe Co. Ltd., Booth's Wharf, Balmain, Sydney, or their agents in Tasmania, A. E. Evershed & Co., of Hobart and Launceston.

The desulphurising plant, lubricating oil plant, gasometer and storage tanks, may be referred to W. J. Fraser & Co. Ltd., Dagenham, Romford, Essex, England, who might quote contract prices. They have an agent in Melbourne, whose address I am unable to find at the time of writing.

VI.—LABOUR.

The number of men likely to be employed on the works is an important item. The following is a summary:—

<i>Mine.</i> —		Men.
Hewing shale, &c.		45
Surface work		5
Breaking plant		2
Total		52
<i>Retorting.</i> —The work will proceed night and day in three 8-hour shifts, each shift will require 5 men and 1 foreman.		
Total		Men. 18
<i>Refining</i>		5
Total permanent		75

For the temporary work during the time of construction the most permanent men will be those required for brickmaking. This will require—

Men in pit	5
Enginedriver	1
Feeders	2
Carrying and stacking	8
Total	16

For less permanent work about 100 men will be employed, such as mechanics, carpenters, navvies, bricklayers, and so forth; but it is likely that they will be required in something like rotation, so that the works will find permanent employment for 75 men, and temporary work for 116. The wages range from 8s. a day for labourers, to 12s. a day for foremen, and should average about 9s. a day for all classes of workmen. In addition, will be required the present General Manager; a good chemist, experienced in the chemistry of the petroleum compounds, who could assist the manager in the capacity of works' manager; a clerk who would act as accountant, time-keeper, &c.

VII.—FINANCIAL STATEMENT.

In considering the financial position arising from the proposed improvement and extension of the Company's workings, I have taken a conservative point of view, and have neglected anything but the primary products, which must be got rid of profitably in the first place, if the financial success of the undertaking is to rest on a secure basis. The by-products will be considered later, and will provide profits which are not considered in this fundamental statement. It is obvious that if the primary products can be made to pay the Company will not embark on any scheme for the development of the by-products unless they are absolutely assured of its success. If, therefore, adequate returns can be obtained from the sale of the fuel oil and the motor spirit, we can safely assume the financial success of the whole of the working, for the by-products will simply mean additions to surplus. Figures are based on the quantities allowed for in the preparation of the estimates.

<i>Charges.</i> —	£	s.	d.	£	s.	d.
(1) <i>Cost of Production.</i> —						
(a) Cost of mining and handling 41,400 tons from mine to breakers, at 6s. per ton	12,420	0	0			
(b) Cost of crushing and retorting to produce fuel oil, at 2s. per ton	4140	0	0			

(c) Cost of refining 1000 gallons of spirit a day—

10 gallons sulphuric acid, at 1s. 6d. a gallon	£0 15 0
30 lb. caustic soda, at 3d. a lb.....	0 7 6
5 men, at 10s. a day	2 10 0
Total cost per day	£3 12 6

Or

1d. per gallon per day for a year of 360 days	1500 0 0
Cost of canning—Plant, labour, and materials, at 3d. per gallon	4500 0 0
Cost of producing refined spirit	6000 0 0
Total cost of producing fuel, oil, and refined spirit...	£22,560 0 0

(2) Interest on Capital.—

Assuming £125,000 as price paid to vendors, in 4½ per cent. debentures	5625 0 0
£50,000, borrowed at 5 per cent.	2500 0 0
Total interest	£8125 0 0

Total annual charges on returns..... 30,685 0 0

Returns.—

Sale of 360,000 gallons spirit, at 1s. 6d. per gallon	27,000 0 0
7000 tons of fuel oil, at £3 15s. a ton	26,250 0 0
Total returns	53,250 0 0
Gross profits	£22,565 0 0

(3) Deductions.—

	£	s.	d.	£	s.	d.
Depreciation, at 10 per cent. on £50,000, which is actual capital outlay on machinery, &c.	5000	0	0			
Cost of management and office expenses	2500	0	0			
Rents, rates, taxes, &c.	500	0	0			
Insurance, general upkeep, and accident reserve	1000	0	0			
Total deductions				9000	0	0
Net profits				£13,565	0	0

This represents 7½ per cent. interest, or 13 years' purchase.

If the fuel oil be sold at £3 10s. a ton it will fetch	24,500 0 0
Total returns will be reduced to	51,500 0 0
Gross profits to	20,815 0 0
Net profits to	11,815 0 0

Representing 6½ per cent. interest, or 15 years' purchase.

It will be observed that all deductions have been liberally made on the one hand, and the bases on which profits are calculated minimised as far as possible, so that the net profits shown above are as low as they can be stated fairly. Actual results should be better than this. Moreover, we have still the by-products to consider, so that a considerable addition should be made to the above.

The returns show that an original debt of £175,000 should be paid off in from 13 to 15 years, which is a fair rate of purchase for a mining property. Looking at it in another way, from borrowed capital on which interest amounting to £8125 per annum is paid, a return of £13,565 per annum is obtained, giving a profit per annum of £5440.

VIII.—PRICES.

The fuel oil should sell at anything between £3 10s. and £5 a ton wholesale, to provide satisfactory returns. I note that in 1913 contracts made by the Naval Department reached £4 5s. and £4 10s. a ton. Recent quotations in Australia have been as high as £7 a ton. The calorific value of the Railton-Latrobe oil is higher than that of any crude I know of which is available to the Australian market. This is a factor which enters into consideration in the fixing of prices, and should place the oil in question in a good position. Motor spirit is being marketed at the rate of 1s. 9d. a gallon wholesale, but we may have to face a drop in prices, and consequent smaller returns. I doubt whether any permanent cutting of prices can be kept up by producing companies without affecting the world's markets elsewhere, so that the estimated price of 1s. 6d. a gallon should average out well.

The Railton-Latrobe Shale Oil Company is the successor to two other companies working the same area. Altogether, in retorting plant, engines, boilers, condensers, storage, mine equipment and development, buildings, lines of rail and haulage plant, electric lighting, sawmill, general labour, and management, nearly £40,000 has already been spent. So that the price asked for the properties, for a concern which has been considerably developed with some measure of success and future promise, and includes all the assets of the company available, is not excessive. The present Company has solved the problem of the distillation of the shale, and has considerably improved on the methods hitherto employed.

IX.—BY-PRODUCTS.

The first object of the Company should be to get the production of its fundamental products already dealt with on a sound and extended basis. When this is accomplished it will be time to consider the question of by-products.

At present there are two classes of material which the Company can market profitably—

1. Spray oil—Used locally by orchardists, and made from crude oil.
2. Land-dressing—Also used by orchardists, and made from the spent shale.

The first is made according to the Company's own formula, and sells readily and very profitably. Moreover, orchardists who have tried it say that it compares very favourably with imported spray oils. The spent shale has been spoken well of as a land dressing. Analysis, however, would seem to indicate that it required additions to it to form an effective manure. The ammoniacal liquor from the condensers can be run over it, and will add to the quality by increasing the available nitrogenous matter. Similarly, additions of bone-meal and phosphatic material could be made so that the resulting product would be of very high quality, and would command high prices as a manure and dressing. Both of the abovementioned materials can be made cheaply, and require no expensive apparatus. In addition to the by-products already marketed, it is possible to produce—

- | | |
|-----------------------------------|------------------------------|
| (1) Turpentine substitute. | (4) Gas oil. |
| (2) Rubber solvent. | (5) Lighting or burning oil. |
| (3) Lubricating oils and greases— | (6) Road-dressing. |
| (a) Light. | (7) Chemicals. |
| (b) Medium. | (8) Dyes. |
| (c) Heavy. | |

With regard to the production of Items Nos. 1 to 5, Mr. Twelvetrees gives three tables embodying results or researches made by Dr. Black and Mr. Thomas Esdaile. Two of these are sufficiently important to quote again here.

	Refined Oil recovered. ozs.	Gallons per ton of average Shale.	Same with 5% allowance added for smearing loss in manipulation	Estimated Cost of Production per Gallon.	Sp. gr. of Oil.
Petroleum Spirit ("Benzine")	21	5·626	5·907	d. 6½	·776
No. 1 Lighting Oil (Photogene).....	25	5·754	6·042	6½	·819
No. 2 ditto (Lighthouse Oil)	15½	3·335	3·501	6½	·858
Light Lubricating Oil, No. 1	9½	1·979	2·078	7½	·882
ditto No. 2	22½	4·705	4·940	7½	·897
Medium Lubricating Oil, No. 1	22½	4·552	4·779	8 to 12	·927
ditto No. 2	15	3·005	3·155	8 to 12	·937
ditto No. 3.....	15	3·200	3·360	8 to 12	·951
Heavy Lubricating Oil, No. 1.....	12	2·349	2·466	10 to 15	·958
ditto No. 2.....	11	2·135	2·242	12 to 24	·967
Total	168½	36·640	38·470	...	...
% of original weight	56·2	...	...	...	...
% of original volume .....	...	60·86	63·9	...	...

In 1902 Dr. Black gave a statement of oil products obtained by Esdaile's No. 2 method from 144 oz. crude oil, or about 39½ lb. of good shale:—

	Weight.	Fraction of gallon of product.	Temperature of steam distillation.	Sp. Gr. at 20° C.	Flashing temperature. Degrees F.	Firing temperature. Degrees F.	Gallons per ton.
Gasolene or Heavy "Benzine" ..	12·390	·1128	Up to 115°C	·779	Fires at once	Ord. temp.	6·429
Light Burning Oil (Photogene)...	13·270	·1115	Up to 140°C	·834	88° F	120° F	6·355
Heavy Burning or Lighthouse Oil	6·60	·0496	140° to 160°C	·846	140° F	161° F	2·827
No. 1 Light Lubricating Oil	8·70	·0642	160° to 180°C	·870	180° F	225° F	3·659
No. 2 ditto	11·36	·0882	180° to 200°C	·914	250° F	272° F	5·027
No. 3 ditto	3·31	·0230	200° to 220°C	·900	260° F	283° F	1·311
No. 1 Medium Lubricating Oil ...	11·25	·0855	220° to 240°C	·924	272° F	290° F	4·873
No. 2 ditto	6·00	·0433	240° to 270°C	·947	310° F	351° F	2·468
No. 3 ditto	6·00	·0429	300°C	·966	371° F	398° F	2·445
Total	78·88	·6210					35·394

The methods consist merely of fractionating the crude at suitable temperatures in stills made of boiler sheeting, and treating the fractions with sulphuric acid and caustic soda. It will be seen that the estimated cost of production of the lubricating oils runs from 7½d. to 2s. a gallon. Motor lubricants sell wholesale at over 4s. a gallon in Australia, while a rise in prices of over 50 per cent. is expected. Lubricating oils could be made and sold very profitably at the present moment.

The turpentine substitute and rubber solvent are cheaply prepared by refining crude spirit (already dealt with), and should find a ready sale in connection with the growing rubber industry in Australia.

The cost quoted above for the manufacture of lighting or burning oils is 6½d. a gallon. This is excessive for a properly-equipped plant. In 1911 samples of the shale were tested, and reported at the Pumpherson works in Scotland, and the following extract shows the costs and returns expected there:—

“Refining the crude oil and disposing of the refined products—

	Per 100 galls.
Value of naphtha, 1·53 per cent., at 3·63d., equals	5·36d.
Value of burning oil, 10·50 per cent., at 2·52d., equals	26·46d.
Value of total fuel oil, 30·15 per cent., at 1·96d., equals	59·09d.
Value of heavy grease oil, 25·10 per cent., at 1·50d., equals	37·65d.
	128·83d.
Total value of refined products	1·288d. per gallon of crude oil.
Cost of manufacturing and refining	0·916d. per gallon of crude oil.
Difference	0·372d.

“It will be seen that there is here a surplus of only 0·372d. per gallon.”

But the total value of refined products, at 1·288d., is far too low, when prices ruling in Australia to-day are considered. The cost of manufacturing and refining, it will be seen, is less than 1d. a gallon. It is obvious that with higher prices obtained locally, the surplus of 0·372d., or less than ½d. a gallon, will be considerably exceeded here in spite, perhaps, of the higher demands for labour. If the cost of refining can be kept anywhere near the figures quoted by the Pumpherson expert, burning oils and lubricants can be made profitably at the Railton-Latrobe Company's refinery.

Crude oil, used as a dressing for roads in towns and suburbs, increases the life of the road and removes the dust nuisance. For this purpose unrefined crude or tarry residues will suffice. It has been found necessary to spray from 7 to 15 tons of oil over each mile of road in California. The fine roads in San Francisco are prepared in this manner.

The question of the preparation of chemicals and dyes as by-products will be one for any chemist appointed to the works. Ichtyol has already been successfully prepared from the crude oil. This preparation has hitherto been made in Germany, and is used for skin affections and in medicated soap. Whether it will pay to manufacture on a small scale, and whether there is sufficient demand for it, must be decided later. Carbolic acid and other organic disinfectants can also be made if there is any demand. Cyanides could be made, as well as azo-colouring compounds and aniline dyes; but this opens up a wide field for chemical investigation, which may be left to the future.

In addition to the more familiar uses to which oil is put, it is now being used extensively in America for—

Gasmaking—Being sprayed in with coal gas to increase illuminating power. I am of opinion that the Railton-Latrobe crude would do for this with little or no preparation.
Copper-smelting.
Glass-making.
For pile protection.

With the equipment allowed for in this report, spray oil, turpentine substitute, and rubber solvent, lubricating oils and greases, gas oil and road-dressing oil, can be prepared without trouble. For the two latter there may be no present demand until the advantages to be derived from their use are made known and kept before the public. There is abundant scope for research in connection with these by-products, and successful production will depend very largely on the man who may be appointed as chemist to the concern, as well as on pushful management.

ARTHUR WADE, D.Sc., &c.

