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Australian & International Exploration & Evaluation of Mineral Properties

INDEPENDENT CONSULTING GEOLOGISTS' REPORT

ON

THE MINERAL EXPLORATION ASSETS

OF

DALEY RESOURCES PTY LTD

FOR

LATROBE RESOURCES LTD

23 October 2005

DRAFT

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1. FIGURES review and edit

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Australian & International Exploration & Evaluation of Mineral Properties

The Directors
Latrobe Resources Ltd
Address
Address

23rd October, 2005

Dear Sirs,

INDEPENDENT REPORT ON MINERAL ASSETS

1.0 SUMMARY

In a letter dated 10th September 2005, Latrobe Resources Ltd ("Latrobe") engaged Al Maynard and Associates ("AM&A") to prepare an independent geological report of its mineral assets which comprise the Latrobe, Tambellup and Mt Yates projects. Opinions are presented in accordance with the JORC Code (2004) and other regulations and guidelines that govern the preparation of such reports.

The Latrobe oil shale deposit is in Tasmania and contains an Indicated Resource of over xxx million tonnes of oil shale (Tasminities), approximately 8% of which is less than 20 metres below the surface and readily amenable to open cut mining. Relevant experts in their fields have calculated that this tonnage could produce as much as 59 million barrels of oil.

All the properties are 100% owned by Daley Resources Pty Ltd ("Daley") which is a wholly owned subsidiary of Latrobe.

2.0 BACKGROUND

This independent geological report was prepared by geologists, B.J.Varndell, who is a Fellow of the AusIMM and A.J. Maynard, Member of the AIG and the AusIMM. The writers are qualified to provide such reports for the purpose of inclusion in public company prospectuses. The purpose of this report is to provide an “Independent Geologists’ Report on the Mineral Assets of Latrobe Resources Ltd” for inclusion in a prospectus to be issued on or about the 15th October seeking to raise A$X million by the issue of Y milllion shares.

This report has been prepared in accordance with the relevant requirements of the Listing Rules of the Australian Stock Exchange Limited, Australian Securities and Investment Commission (“ASIC”) Practice Notes 42 and 43 and the Guidelines for Assessment and Valuation of Mineral Assets and Mineral Securities for Independent Expert reports (the Valmin Code) which is binding on members of the Australasian Institute of Mining and Metallurgy (“AusIMM”).

AM&A is an independent geological consultancy established 24 years ago and which has operated continuously since then. Neither AM&A nor any of its directors, employees or associates have any material interest either direct, indirect or contingent in Latrobe nor in any of the mineral properties included in this report nor in any other asset of Latrobe nor has such interest existed in the past. This report has been prepared by AM&A strictly in the role of an independent expert.

Latrobe, through Daley holds a 100% interest in three exploration properties; the Latrobe oil shale deposit, These projects are in various stages of exploration ranging from encouraging results from surface and sub-surface sampling to containing Indicated and Inferred Resources. All the projects have potential to host their target commodities as described hereunder and warrant the exploration and testing programmes as set out.

In the course of the preparation of this report, access has been provided to all relevant data held by Latrobe and various other technical reports and information quoted in the bibliography. We have made all reasonable endeavours to verify the accuracy and relevance of the database. Latrobe has warranted to AM&A that full disclosure has been made of all material in its possession and that information is complete accurate and true. None of the information provided by Latrobe has been specified as being confidential and not to be disclosed in our report.

Professional fees payable for the preparation of this report constitute our only commercial interest in Latrobe. Payment of fees is in no way contingent upon the conclusions of these documents.

We are of the opinion that Latrobe has satisfactorily and clearly defined exploration and expenditure programs which are reasonable, having regard to the stated objectives of the company and sufficient exploration work has taken place to justify the budgeted exploration and expenditure.

It is our opinion that the properties described below warrant the proposed exploration and testing programmes for each respective project. It should be noted that the proposed programmes may be subject to change according to results yielded as work is carried out.

3.0 QUALIFICATIONS AND EXPERIENCE

4.0 LATROBE OIL SHALE DEPOSIT

Sedimentary hydrocarbon deposits are renowned for their homogeneity over large areas. The Tasmanite Oil Shale horizon in Tasmania has already produced 1.13M litres of oil from underground mining operations. Several drilling campaigns completed 280 holes that confirm extension of the underground grades and have demonstrated continuity of the deposit over a large area. It is accordingly reasonable to accept the findings of all the previous workers that led to a Feasibility study by the Tasmanian Hydro-Electric Commission. That study accepted a total resource of at least 72Mt of oil shale yielding 130 litres oil per tonne for a potential 14,820 megalitres equivalent to 13.8 Mt of crude or more than 59 million barrels of oil.

Dr. K.Brendow at the Symposium on Oil Shale in 2002 stated :

“Crude Oil prices above US$25 per barrel appear to render shale oil production viable”.

4.1 INTRODUCTION

The Latrobe oil shale deposit is located between Latrobe and Railton in northern Tasmania, 10 kilometres south west of the port of Devonport in Tasmania (refer Figure 1). Road and port access are excellent. The deposit is within the Launceston 1:250,000, Railton 1:25,000 and Latrobe 1:25,000 map sheets. Average annual rainfall in the area is 924mm.

4.1.1 Tenure

Granted to Daley Resources Proprietary Limited on 21 December 2004 Exploration Licence EL20/2004 secures an area of 61 square kilometres and is valid until 26 November 2009 with no reduction of area required. Expenditure requirements for Category 2 – Fuel Minerals during the first two years are $45,750; thereafter they are $1000, $2000 and $5000 per sq km for the third, fourth and fifth years respectively. A security deposit bond for $7000 is in place to cover Performance and Private Land Deposits.

There are three areas of exclusion listed in the licence being;

A) 227Ha Warrawee Forest Reserve

B) 39Ha Henry Somerset Orchid Private Sanctuary

C) Part of the Gas pipeline corridor

Other areas that may be excluded and covered by the blanket licence statements are land owned or leased by the Commonwealth, crown land reservations of 5Ha or less, municipal reserves or roadways and areas of private land which have been or are in the process of being purchased by the crown for forestry purposes.

INSERT TENEMENT LOCATION PLAN

Figure 1

EL20/2004 incorporates all the known tasmanite oil shale occurrences of the Latrobe – Railton district including those areas referred to in previous literature as Goliath Mine, Tasmanite Mine at the 'Great Bend', China Flat, Mersey River, Oliver's Block, Blankhorn Quarry, Knights, 'Knight-Churchill' and 'Latrobe-Sassafras'. The oil shale resources within EL20/2004 are referred to below by their location number (I-VI), as determined by Clementson 1982 and Sofoulis 1988 and detailed in Figure 2.

Figure 2 (10 ex Rm).

The deposit was discovered in the 19th century and is well documented. It has previously been mined and up until the 1930s produced 1.13 million litres of oil. It has been defined by drilling and contains an Indicated Resource of 42 million tonnes ("Mt") of which 6Mt are amenable to open cut mining operations. There is an additional Inferred Resource of 30Mt at depth. This is equivalent to 93 million barrels of crude oil.

The deposit is different from other Australian oil shales in that it occurs in tasmanite oil shale, a variety that is unique to Tasmania. The shale is also unique among world oil shales in that its kerogen arises principally from its content of fossil oil spores. Tasmanite has the advantage over other oil shales in that the spores containing the oil may be physically separated from the waste material. Tasmanite can therefore be beneficiated by relatively cheap physical processes such as froth flotation. Tasmanite also has the great advantage over other Australian oil shales in that it can be used as a source of bitumen as well as oil.

4.2 HISTORY

The deposit was discovered in the 19th century and was worked intermittently into the 1930s by which time it had produced 1.13 million litres of oil. This production was from the 'Great Bend' area of the Mersey River (Areas II and III) and 'China Flat (Area V). During that period, extensive exploration was carried out by the operators and also the Tasmanian Government, who produced three reports from 1911 to 1934 (Clementson 1981).

The deposit was first documented by Twelvetrees, 1911. Following a detailed report to the government in 1932 by the Tasmanian Shale Oil Investigation Committee, all the existing owners and lessees, except one, amalgamated to form the Tasmanite Shale Oil Company Limited. A testing campaign involving mining, retorting and refining was made at the 'Great Bend' location (Mooney, 1975). This operation was presumably not a success, but this may have been as a result of other factors including the great depression and World War II.

Laboratory research and pilot plant processing established that the oil spores containing the oil could be extracted from the crushed shale by froth flotation to produce a concentrate that could be converted into bitumen or oil products (Mooney 1975).

The deposit has been tested by several drilling campaigns in 1925, 1928, 1930, 1933 1941, 1975, 1981 and 1982. Henderson, 1941, records the 1940-1941 campaign completed by the Tasmanian government. Endeavour Oil Company NL drilled 44 holes and CRA drilled 135 holes in 1981-1982.

The area was drilled by the Australian Shale Oil Corporation in 1925 which completed 25 holes. It was drilled again in 1928 by Tasmanite Shale Oil Company which completed 12 holes. Further investigations were completed in 1930 by Latrobe Shale Oil Company which drilled 18 holes.

The area was investigated by the Tasmanian Mines Department in 1933 when they drilled 16 holes and again in 1940-1941 when they drilled 26 holes. The results of the investigations from 1925 to 1982 are available in the data package and collar locations are shown on Figure 3.

add holes and change EL boundary

Figure 3 collars Update ex RM 9

Recently (1974-1989), the deposit was investigated by Endeavour Oil Company NL (later Endeavour Resources Ltd) and CRAE. Endeavour drilled 44 holes totalling 1,041 metres using a Mayhew 1000 rig with mud or water injection. Open hole drilling was carried out with a tungsten tipped blade bit. This was replaced by a roller bit in the harder conglomerate horizons. When oil shale was encountered, the drill was withdrawn and a parallel hole was drilled alongside down to the oil shale horizon. A solid core was then made of the total oil shale section using a core barrel.

CRA completed a 135 hole, 5,051m drilling programme to assess the potential for open cut mining. This drilling was completed with an Ingersoll Rand TH60 rig and used rotary air, rotary mud and percussion hammer techniques depending on ground conditions. Coring was accomplished using a HQ triple tube core barrel. Most of the holes were geophysically logged using a Century Geophysics wireline logging system (Clementson 1981). In 1983 an additional 5 holes at 4 sites for 145m of open hole and 2.6m of core drilling at the nearby Nook deposit was completed by CRAE.

Tasmanite core intersections were geologically logged and subdivided into sample intervals on the basis of spore content. The core was then sawn into equal halves and one half of each intersection submitted for analysis to AMDEL. Proximate analyses were carried out on an as received basis and also a moisture free basis. Oil yields were determined using the Fischer method. Various authors have commented that the Fischer analysis method is at best an indicator of yield and that at several operations output has often exceeded the assay estimate (Dyni JR 2003 – p196).

Endeavour also commissioned technical research with the CSIRO and other agencies into the bitumen producing potential.

4.3 GEOLOGY AND MINERALISATION

The oldest rocks in the area are an isolated nuclei of Precambrian quartzite and amphibolite varying from relatively unmetamorphosed to strongly metamorphosed garnet amphibolite grade. These rocks exhibit unconformable contact with a cyclic Cambrian sequence of marine siltstone greywacke, conglomerate and basic and acid volcanics, including tuffs, generated by the intervening Pengein Orogeny. This sequence is unconformably overlain by a generally shallow-water Ordovician sequence, consisting of up to several thousand metres of siliceous conglomerate, passing upward into interbedded grits, slates and fossiliferous sandstone topped by 1,500 metres of massive bluish grey shelly Gordon Limestone. The Silurian-Lower Devonian sandstone and mudstone cap the Ordovician.

A series of north-northwest to northwest trending folds, with superimposed thrust and wrench faults, were produced in these Lower Palaeozoic and Proterozoic rocks during the mid Devonian Tabberabbereran Orogeny, followed by the intrusion of granitic batholiths and stocks. The horizontal to gently dipping Permian sediments were laid down in the regional synclinoria resulting from this Tabberabbereran event.

The Permian sequence commences with a siliceous quartz sand matrix Basal Conglomerate with granitic and gneissic glacial erratics and interbedded sandstone, and is overlain by the thick predominantly mudstone sequence of the Lower Karine age Speyton Beds. These are succeeded by the Mersey Coal Measures, including terrestrial, coastal plain, quartz sandstone and siltstone and carbonaceous siltstone and coal, followed by Upper Marine partly fossiliferous mudstone, siltstone and sandstone beds. Tertiary clay, sand and conglomerate and Quaternary talus and residual gravels are the only post-Palaeozoic sediments preserved to a significant extent in the area. The Permian beds are intruded extensively by Jurassic dolerite dykes and sills and cut off by Tertiary basalt flows (Mooney 1975).

Faulting, sometimes associated with this igneous activity, is widespread, varying from large scale dislocations to intricate networks of minor faults with displacements varying up to hundreds of metres.

Most of the rock units described above crop out in the Latrobe-Railton district. The main exception is the Cambrian and Silurian sequences and Devonian granite. A belt of Precambrian quartz-sericite and mica schist, possibly an outlier of the Forth Nucleus, extends along the course of the Mersey River for 12 kilometres from Bonney's Creek to Hogg's Bridge. This belt is bordered to the east and west by Permian beds containing a number of oil shale areas and separated by faulting into a number of more or less separate blocks at different altitudes.

The Permian beds east of 'great Bend' unconformably overly Precambrian schist to the west and extend eastwards under the tertiary basalt of Sassafras plateau and contain the oil shale prospect area of Knight-Churchill also known as Latrobe-Sassafras and referred to as Area I. Area I extends eastward under the Tertiary basalt on Saggers Hill and Oppenheim Hill. It is limited to the north by a major east north east trending fault, which is associated with dolerite and basalt and to the south by outcropping basal Permian conglomerate.

West of the 'Great Bend', another northwest trending belt of lower Permian beds contains the China Flat (referred to as Area V) and Oliver's Block (referred to as Area III) oil shale deposits. These beds are faulted against Precambrian rocks to the east and underlain to the west by Ordovician Sandstone and conglomerate, where they overlie a belt of Railton Limestone, which is the Gordon Limestone equivalent, exposed in the Goliath and Blankhorn quarries.

To the north, the Permian beds are separated from the shale area west of the 'Great Bend' by a major north east trending fault, again associated with dolerite and basalt. Another major fault, of similar orientation and with a downthrow south east, passes through China Flat (Area V).

The Permian outcropping in the above areas consists mainly of Lower Marine Spreyton Beds comprised of about 200 metres of bluish grey mudstone, consisting of sandy fossiliferous and pebbly mudstone and minor sandstone with thin sandstone-conglomerate interbeds and a basal conglomerate unit of about 20 metres. This conglomerate unit generally consists of sub-angular to rounded pebbles, predominantly of quartz, pinkish-red quartzitic sandstone and grey quartzite in a bluish-grey mudstone matrix.

EL boundary change

Figure 4

Add Geol map ex RM fig 2a and legend 2b

The tasmanite oil shale is of lower Permian age and occurs within the upper part of the marine Spreyton Beds. The lower part of the Spreyton Beds is a basal siliceous conglomerate, which because of the transgressive nature of the unit is not always present. This is followed by a thin tillitic mudstone unit then a succession of argillitic conglomerates which are believed to be quiet water marine mudstones and siltstones into which floating tree roots and/or icebergs dropped their debris load. Overlying the tillites is the thick Quamby Formation of up to 150 metres of mudstones and siltstones also with occasional dropstone clasts. The tasmanite bed occurs 10 – 15m above the base of this formation. Overlying the Quamby Formation are the Mersey Coal Measures and the Kelcey Tier Beds (Clementson 1981). There are portions of the licence area where extraction of coal seams may be possible.

The tasmanite horizon was deposited in relatively shallow water adjacent to basement highs on the Permo-Carboniferous shoreline away from the coal forming swamps. The drilling has confirmed that the tasmanite is older than the Mersey Coal Measures and not therefore a facies variant of the coals. Coal and tasmanite are therefore not mutually exclusive; consequently tasmanite could exist below many areas of younger Permian coals previously neglected in past exploration. Variations in quality of the Tasmanite horizon are unlikely to be any different to those experienced in most of the economic Australian coal deposits.

The present near surface distribution of the tasmanite is largely a result of post depositional events. Faulting and igneous intrusion have broken up the originally continuous bed into a series of fault, basement, dolerite and basalt separate blocks. The majority of these blocks occur within the Railton-Latrobe district, but the sub-surface distribution could be very much more extensive.

4.3.1 Characteristics of Tasmanite Oil Shale

The tasmanite oil shale is a flat dipping Carbo-Permian siltstone horizon with widths that average 1.5m and reach a maximum up to 2 m. It is generally subdivided by one and occasionally two thin 10-20cm bands of fossil poor silty mudstone horizons. These low grade partings generally have sharp lower contacts and gradational upper contacts. Taken as a whole, the Tasmanite horizon generally has gradational contact with the enveloping mudstones. Pyrite is present in both the high and low grade portions of the horizon, often concentrated in and around the approximately 1cm arenite and argillite clasts that occur up to 5% within the Tasmanite.

This Late Carboniferous Tasmanite oil shale is rich in *tasmanities puncatus,* a fossil with a discoidal spore case 0.3-0.5 millimetres in diameter. The spore cases are amber to red in colour and are composed of kerogen that yields a variety of oils when heated. They are set in a matrix of bluish–grey mudstone, varying in nature from soft and clayey to moderately hard and sandy. Predominantly siliceous pebbles are sporadically distributed throughout as is minor pyrite and marcasite and the occasional marine shelly fossil. The amber to red colour of these spore cases give a characteristic light brown colour to the richer sections of the shale, which, owing to the fact that the spore cases are flattened parallel to the bedding and welded together in overlapping layers, is also finely laminated and very fissile. The shale breaks unevenly and with great difficulty across the bedding plane (Mooney 1975).

The Tasmanities spores can be readily separated from the shale by crushing and simple floatation. The shale is unique among world oil shales in that its kerogen is derived principally from its content of fossil oil spores, thus it is unlike other Australian oil shales. It differs in composition in that the oil yield is dependent on the relative abundance of spore cases of the fossil Tasmanities punctates. Crude oil produced from this unique shale is bituminous, and is marked by its rank smell - a nauseating odour principally due to basic nitrogen compounds, more than the sulphur content of the shale.

The kerogen (spore) content of the richer parts of the seam can be up to 45 percent whilst that of the low grade partings is around 5 percent. Oil yields vary greatly but the rich kerogen shales may yield up to 300 litres/tonne (l/t) while the poor kerogen shales may yield only 20 l/t. Historical overall mined average oil yield for the total Tasmanite horizon based on the 1930's results is between 90-120 l/t. Exposure to weathering is reported to have negligible effect on the oil yield from the oil shale. The specific gravity of the shale, as a result of the low kerogen content is about 2.1 gm/cc for the entire Tasmanite horizon. In subsequent work involving drill cores the specific gravity of whole seam raw material was accepted as 2.25 and the conservative average oil yield was stated to be 130 l/t.

With regard to beneficiation tasmanite is unique amongst world oil shales. It is this feature which provides great promise for the commercial utilization of tasmanite. Tasmanite kerogen is the remains of a spherical alga and the organic matter is discrete, of large particle size (200-500 microns*),* and the kerogen is easily separated. Previous investigation by the Laboratories of the Tasmanian Department of Mines carried out tests on the concentration of tasmanite by flotation. CSIRO conducted further tests on these concentrates on behalf of Endeavour Oil NL where simple crushing and floatation techniques further upgraded potential hydrogenation feedstock to about only 25% ash. CSIRO also completed a detailed evaluation of the chemistry, petrology, pyrolysis and utilization study of the tasmanite. This confirmed the elemental composition of tasmanite kerogen as 82.3% carbon, 11.0% hydrogen, 4.0% sulphur, 2.0% oxygen and 0.7% nitrogen.

Clementson (1981) quoted the CSIRO study that concluded the tasmanite oil shale could be readily upgraded by physical methods as opposed to other more expensive chemical methods. CSIRO states:-'*Fortunately tasmanite, unlike most other oil shales, is amenable to relatively simple methods of physical upgrading. Techniques based on density differences, although not tested in the present research, would almost certainly be effective. However, probably froth flotation will prove to be the most satisfactory'.*

Additional definitive test-work is required.

4.3.2 Sampling

The Fischer assay method does not necessarily indicate the maximum amount of oil that can be produced by a given oil shale. Some retorting methods, such as the Tosco II process, are known to yield in excess of 100 % of the yield reported by Fischer assay. In fact, special methods of retorting, such as the Hytort process, can increase oil yields of some oil shales by as much as 300 to 400 % of the Fischer assay yield. (Dyni J.R. 2003 p196). At best, the Fischer assay method only approximates the energy potential of an oil-shale deposit. No extra allowance for this phenomenon is made in any of the resource or yield estimates.

In the areas of the Goliath and Tasmanite Mines the oil shale has been extensively sampled (Blake, 1931). The oil shale horizon consists of three bands; the upper and lower bands of shale separated by a middle band of silty mudstone. All three bands contain spores of the *Tasmanities* bodies, but the quantity of spores varies between the three bands. The middle mudstone band contains the fewest number of *Tasmanities* bodies and consequently has the lowest oil yield. The top shale band contains more spores than the bottom shale, and has the highest oil yield.

Early operators give these seams an average thickness of 1.57m on the workable part of the field. Selective mining was practiced, and as a result early operators assessed the effective thickness as 1.22m when developing tonnages for reserves.

Table 1 Analysis of Oil Shale Bacon 1986

	Moisture (%)	Volatiles (%)	Fixed Carbon (%)	Sulphur (%)	Ash (%)	Crude Oil Yield (l/t)
1	2.16	20.41	5.50	0.73	71. 20	
2	2.30	36.51			61.19	
3						245.67
4						44.37
5						122.30
6						150.61
7	0.8	30.84	5.86	2.56	62.50	192.36
8	1.0	30.00	6.20	1.92	62.80	183.31
9	1.9	16.28	8.50	1.26	73.32	
10	1.3	22.86	5.84	1.65	70.00	130.04
11				2.61		117.29
12				2.65		148.96
13				2.77		130.26
14				2.90		172.22
15		17.42	3.80		79.70	139.00
16		16.33	1.95		81.70	151.00

1. sample from Mersey Valley, 1850 (Penny, 1855)
2. sample from Mersey Valley tested at Museum of Practical Geology, London, 1862 (Twelvetrees, 1911).

3,4,5 sections (top, middle, bottom bands) worked by Latrobe Shale Oil Company (sent to Pumpherston Oil Works, Scotland) (DOH CorrespondenceFiles).

6. average oil yield of seam worked by Latrobe Shale Oil Company
7. average of samples from Latrobe (Blake, 1928).
8. average of samples from Railton (Blake, 1928).
9. sample from Nook (Blake, 1928).
10. sample from Sarnett Creek (Slake, 1928).
11. whole seam average, Goliath Mine (Slake, 1931).
12. top and bottom shale average, Goliath Mine (Blake, 1931).
13. whole seam average, Tasmanite Mine (Slake, 1931).
14. top and bottom shale average, Tasmanite Mine {Slake, 1931}.
15. average of samples from North China Flat (Clementson, 1981).
16. average of samples from South China Flat (Clementson, 1981).

Table 2. Sampling Results of Tasmanite Seams, Bacon 1986.

Source	Thickness (m)	Specific gravity	Sulphur (%)	0il yield average *(litresIt)*

Tasmanite Mine				
top shale	0.58	1.9		198.16
middle band	0.41	2.45		38.47
bottom shale	0.55	2.03		146.27
average	1.54	2.09	2.77	172.22
Goliath Mine				
top shale	0.61	2.0		162.38
middle band	0.37	2.5		32.21
average	1.59	2.15	2.61	148.96
Whole field			2.65 - 2.69	153.74

Over the Latrobe-Railton field the oil yield of the whole seam is around 153-165 l/t (34-37 gallons/ton) of crude oil. The seam is about 1.53m thick with the poorly yielding middle band being 0.30 m thick. The overall sulphur content is 2% and the shale has a specific gravity of 2.0 (Slake. 1931). Analyses from more recent exploration in 1981 gave a range of oil yields from 109 to 177l/t with an average yield of 143 l/t (Clementson. 1982)

The table below shows a typical controlled run on underground material, imperial gallons and long tons provides an average yield of about 100 l/t.

Retorted Tons	**Recovery: gals oil/ton**
8.3	30.3
12.3	24.0
13.1	25.0
13.1	21.4
13.1	21.4
12.9	24.2
13.4	20.8
4.4	17.4
8.9	17.4
13.6	22.8
13.6	18.4
11.2	*30.4*
12.6	22.4
13.0	22.7
10.4	23.4
4.1	20.2

7.3	20.2
12.4	19.2
	(av. 22.2)

TABLE 3. From Hunt 1975

Crozier Retorting whole Seam Shale Test Run 3A – June 1932
Note: The average, 22.2gal/ton, represents 86% recovery on the mine assays.
Metallurgical work in 1940 used specific gravity whole seam 2.0 and organic matter 1.

An important aspect of previous research is the relationship between yield, specific gravity and ash content. This has important implications regarding cost of assay to any potential future drilling campaigns – it also provides a quick, effective estimate on the drill rig for the quality of an intersection and would assist in decisions of where to place new drill sites.

Ash %	**Specfic Gravity**	**Oil Gal /ton**	**l/t**
61.9	1.71	65.0	295
66.5	1.87	52.6	239
68.3	1.90	45.4	206
70.0	1.94	44.0	200
71.6	1.94	46.2	210
75.3	2.04	35.9	163
71.5	2.12	*30.0*	*136*
79.9	2.14	23.6	107
80.2	2.17	27.4	124
81.7	2.25	22.8	104
84.4	2.24	16.2	74

84.5	2.29	16.5	75
89.3	2.48	9.6	44
89.8	2.56	7.5	34
91.1	2.48	6.4	29
93.5	2.65	2.7	12

TABLE 4. From Hunt 1975

Relationship between Oil Yield and Ash from Kurth,E.E.1932 (MinRes No8 Vol II)
Notes:
1) Oil yields may be estimated from ash content, but these are to be regarded as maximums.
2) The SG of the dry shale bears close relationship to the oil yield, and the oil yield may be inferred to within 2 or 3gal/ton from simple determination of SG.

During the CRAE drilling campaign, sample analysis was undertaken by Australian Mineral Development Laboratories (AMDEL). Proximate analyses were carried out on an "as received" and a moisture free basis and the oil yield of the Tasmanite samples was determined by Fischer estimate. The results of these analyses plus a summary of the sample intervals and composite oil yields are summarised in Table 5. The subdivision of the Tasmanite horizon by spore content is reflected in the analyses, the high oil yields generally reflecting high spore content in upper and lower "rich" zones separated by spore deficient zones which produce little oil. (Extract from CRAE Report No. 11047 by I.M. Clementson, December 25, 1981).

TABLE 5. Oil Yields from Fisher Estimates.

Area	Zone	No. cored holes	Proximate Analysis (Dry) - CRAE Results only			
			Volatiles %	Fixed carbon %	Ash %	Oil yield l/t
I		-	-	-	-	-
II		3	19.22	1.28	79.5	127
III		5	20.25	0.96	78.8	167

IV		-	-	-	-	-
V	North China flat	4	17 42	3.80	79.7	139
V	South China flat	4	16. 33	1.95	81.7	151
V	South extension	-	-	-	-	-

Testing of the tasmanite by CSIRO yielded the following proximate analysis results on an air dried basis (all results as percentages):-

Table 6. Average Proximate analysis results.

Sample	H_2O %	Ash %	Vol %	Fixed Carbon %
Float concentrate	3.5	32.6	60.2	3.7
Demineralised float concentrate	4.6	7.0	82.4	6.0
Demineralised oil shale Area V	1.0	24.7	67.4	6.9
Barren Shale	2.0	93.3	3.7	1.0

Testing of the tasmanite by CSIRO yielded the following Gray-King analysis results on an air dried basis (all results as percentages):-

Table 7. Gray- King analysis results.

Sample	Flotation concentrate	Demineralized flotation concentrate	Demineralized oil shale from area V
'coke'	41.9	14.1	39.4
Tar & water	50.9	77.9	48.3
Gas	7.2	8.0	12.3

Testing of the tasmanite by CSIRO yielded the following Fischer assay results on an air dried basis (all results as percentages):-

Table 8. Fischer analysis results.

Sample	Flotation concentrate	Demineralized flotation concentrate	Demineralized oil shale from area V	Barren shale
'coke'	43.9	19.7	40.1	96.4
Tar & water	40.1 & 7.5	70.9	47.1	0.3 & 3.0
Gas	8.3	9.3	12.8	0.3

In summary the overall average oil yield for the total Tasmanite horizon is
a) 90-120l/t according to 1950 report by Tasmanian Department of Mines.
b) Approximately 143 l/t based on results of CRAE drilling and weighting by resource tonnage for each area (Note: CRAE results are based on significantly less number of samples than those of the Tasmanian Department of Mines).

The above figures make no allowance for dilution from the hanging-wall or footwall but do include the middle band of low kerogen content.

Other workers including Bujtor et al, 1982 used an SG of 2.25 to establish tonnage for whole seam grades and to be conservative estimated oil yields of 130l/t.

4.4 RESOURCES

Historical reports indicate a slow, steady increase in the resource base, fundamentally building on the underground experience. The present estimated in-situ mineralisation at Railton is shown in Table 9. The figures are those calculated by CRAE with verification of the tonnage estimates by Bujtor et al (1982).

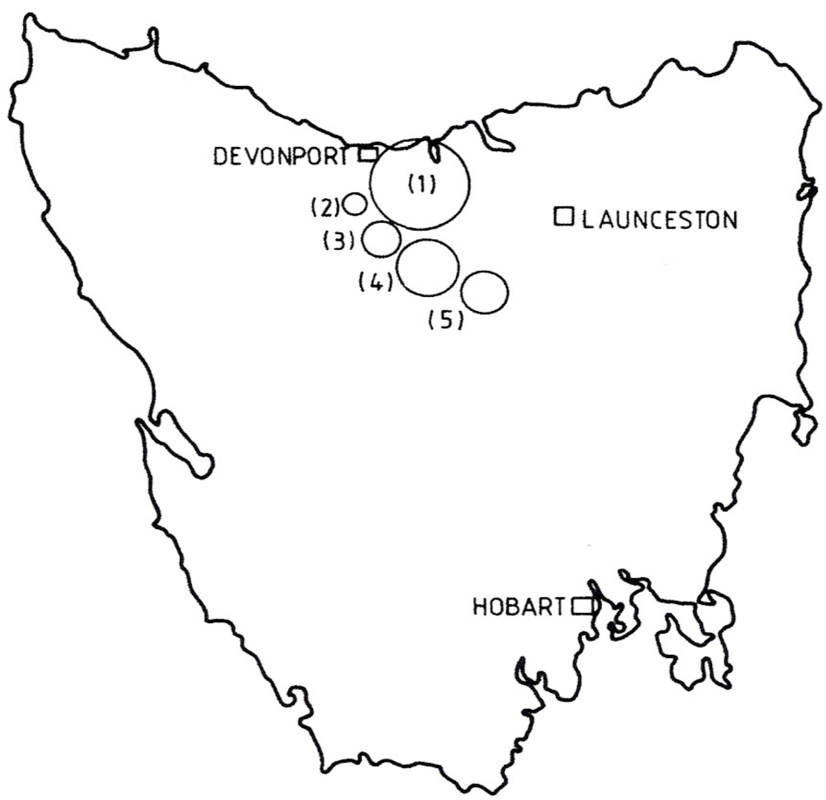
At best, the estimates can only be regarded as potentially economic mineralisation and merely serve to give an impression of the order of magnitude of the Tasmanite resource of the area. The subsequent Feasibility study was based on these estimates.

Of the areas drilled, mineralisation is greatest in Areas I, II and III and accounts for approximately 75% of the total potential mineralisation.

The total potentially economic mineralisation is in the order of 42Mt of Tasmanite in eight separate deposit locations. Of this 42Mt perhaps 6.0Mt in five separate areas occurs at depths shallower than 20m metres (refer Table 9).

OIL SHALE RESOURCES OF TASMANIA

FIGURE A1.1



(1)	LATROBE - RAILTON - KIMBERLEY	17 895 000	TON
(2)	NOOK	1 050 000	TON
(3)	BEULAH	2 346 700	TON
(4)	CHUDLEIGH	6 000 000	TON
(5)	QUAMBY BLUFF	3 750 000	TON

SOURCE TASMANIAN DEPARTMENT OF MINES 1967

Figure 5. 1967 Oil Shale Resources of Tasmania.
Table 9 Tasmanite Resources Based on CRAE 1981

Area	Tasmanite (million tonnes) CRAE	1981
I		6.8
U	Up to	14.0
III	Up to	11.0
IV	Untested, probably not significant	
V	North China Flat South China Flat	2.2 0.7
VI	South Extension	3.5 (tentative) 5.0 (verv tentative)
	Total	43.2

(Average thickness of total Tasmanite horizon taken as 1.5m; average density 2gm/cc).

CRAE concluded that the total indicated Tasmanite resource of approximately 42 million tonnes included only some 6 million tonnes of Tasmanite at less than 20 metres depth. The potential for increasing the total resource within the area is great, however the vast majority of any increase would be of Tasmanite at depths in excess of 100 m. Localities which offer such potential are to the north and east of Area I, to the north and west of Areas II and III respectively and to the south of Area V. In addition to these areas, which are prospective by virtue of their contiguity with known Tasmanite occurrences, there are several, often large areas that have been mapped as Upper Permian. These areas are potentially Tasmanite bearing, although any Tasmanite present would be at great depth.

There is also potential to identify some hydrocarbon resources as coal within the Mersey Coal Measures. Two of the CRAE holes intersected coal that was unfortunately not assayed. The two holes are RD81MR35 from13-14m and RD82MR116 from 33-34m. In Endeavour hole 37 a 30cm coal seam was also intersected.
For shallow Tasmanite the Area X to the north of Nook has 5 holes, and the only prospective areas untested are to the south of Area V, to the east of Area VI and a small area north west of Railton. The total potential within these, and possibly a

few other very small areas, is not great, probably less than 3 million tonnes of Tasmanite in total.

Table 10. Insitu Potential Economic Mineralisation At Railton

(Bujtor 1982)

Area	Depth to Oil Shale m	Thickness m	No. of CRAE holes intersecting oil shale	No. of Endeavour holes intersecting oil shale	Waste:ore ratio	Mt <20m depth	Mt >20m depth	Note Number
I	6->65	1.6		5	3->40:1	0.5	4.0	
II	56	1.7	5		20->50:1		14.0	1
III	70	1.3	10		2.29	1.0	9.0	2
IV	36	1.2			?			3
V N China flat	15	1.3	4	3	0.50	2.0		4
V S China flat	6	1.3	4	2	0.21	0.7	3.0	5
V S extension	70	1.8	2	1	1.67		5.0	6
VI	54	1.2	1		1.88	0.5		
All areas		1.4	26	11		4.7	35.0	7

Notes

1-Most oil shale >75m. S part contains 3mt at average depth 35m. All Crown Land.

2- Henry Somerset Conservation Reserve traverses part of this area. Remainder owned by APPM.

3-Drill hole failed to penetrate Basalt.

4-Faulting & dolerite intrusions common. HT power line crosses this area that is currently planted with 60cm pines.

5-A number of houses are sited in the area.

6-Faulting common. Extensive drilling required to prove area.

7-Holes drilled adjacent to each other taken as one hole.

Bujtor reduced the CRAE estimate to the rounded order of 40 million tonnes of Tasmanite, of which possibly 5-6 million tonnes is at less than 20 metres depth.

The potential resource, which is as yet not fully tested, may be increased to over 72Mt by additional drilling. Bujtor concurred with CRAE's areas of deep potential as:

a) North of Area I (Saggers Hill) - at depths greater than 50m;
b) North of Area 2 - at depths greater than 90-100m;
c) North and West of Area 3 - at depths greater than 50-l00m;

d) North of Area 4 - at depths greater than 50m. (refer Figure 2)

Table 11. Tasmania's Oil Shale Resources after Sofoulis 1988.

Oil Shale Resources	**Million Tonnes**
La Trobe-Railton area	
Indicated Resources	42
Inferred resources at depth	30
Total	**72**
Oil Content by Fischer Assay	**Litres/tonne**
From drill core samples	
Minimum	5
Maximum	300
Average	**130**
In situ content	
Indicated Resources	5460 M-litres
Inferred Resources	**3900 M-litres**
Total	**9,360** M-litres

The Indicated and Inferred Resources (refer Figure 2) are determined from drilling (Sofoulis quoting CRAE 1988).

Table 12. Total Resource potential.

Locality (after Sofoulis, Appendix I)	**Indicated Resource open cut <20m (Mt)**	**Indicated Resource deep >20m (Mt)**	**Inferred Resource deep >20m (Mt)**
I	0.6	6.7	9.3
II	0.7	11.6	7.0
III	0.7	13.8	10.0
IV	N/A	N/A	N/A
V	3.5	2.0	2.8?
VI	0.6	1.9	0.9
TOTAL	**6.0**	**36.0**	**30**
Contained oil***	5 million barrels	29 million barrels	25 million barrels

**Average oil content by Fischer method: 130l/t.

*** I US barrel =159 litres.
(Note: the above Inferred Resource was referred to by Sofoulis, 1988 and Clementson, 1982 as 'potential' resource. This has been amended here to 'Inferred' Resource to comply with current resource nomenclature).

4.5 Feasibility study considerations

(Refer to Appendix I)

4.6 CONCLUSIONS AND RECOMMENDATIONS

According to the in-depth study by the Planning and Public affairs Group of the Hydro-Electric Commission of Tasmania, September 1987: *'Processes exist which would enable the oil shale to be mined and retorted to yield shale oil which could be hydrotreated to yield a petroleum equivalent which could then be refined to yield the full range of transport fuels required by Tasmania'* (Sofoulis 1988).

The deposit could either be used as a source of fuel oil or bitumen for road making or both.

The indicated reserves and additional potential resources of oil shale in Tasmania are of sufficient magnitude to allow shale to be extracted at the rate of 2 million tonnes each year for a period of at least 20 years.

Processes exist which would allow Tasmanian oil shale to be mined then retorted to yield shale oil, the shale oil to be hydrotreated to yield a petroleum equivalent, and the hydrotreated oil to be refined to yield the full range of transport fuels required by Tasmania. The transport fuel yield from 2 million tonnes of oil shale would be about 286 megalitres, or more than 33% of Tasmania's 1986 annual requirements.

The project devised and described by the HEC would involve an initial capital outlay of $805 million and employ in excess of 900 people. The project works would be located in the general proximity of Devonport, Latrobe, Railton and Spreyton and it was assumed employees would be housed in these towns. The indirect employment likely to be generated in the area has not been quantified, but employment multipliers provided by the Centre for Regional Economic Analysis suggest that the total of direct and indirect employment provided would be about 2 500 people.

The cost of product from the project described was estimated to range from 66 cents/litre if produced by a statutory authority with access to Government secured capital funds, rising to 95 cents/litre if produced by a company using 100% equity capital and subject to company taxation. These figures were at 1 January 1986 cost levels. At that time the maximum wholesale price of motor spirit in Tasmania was 51.2 cents/litre.

Oil grades for the CRAE cores assayed from less than 5 to 300l/t with an accepted average oil grade of 130 l/t. HEC stated the deposit contains an Indicated Resource of 42Mt of which 6Mt is amenable to open cut mining methods. The deposit contains at least an additional Inferred Resource of 30Mt. For the purpose of their report a resource of 72 million tonnes of 130l/t in-situ shale was considered. For the 42 million tonnes of oil shale indicated, the resource is about 5500 ML. Using bord and pillar underground mining techniques with an extraction of 60%, a twenty year mine life at 2.0 million tonnes per year was considered, corresponding to 260 ML/year of raw shale oil to be processed into refinery products.

The deposit has previously been mined successfully and 1.13 million litres of oil extracted.

Investigations by CSIRO have confirmed that the tasmanite oil shale is readily upgradeable by physical beneficiation such as froth flotation.

Processes exist for the processing of the oil shale to oil and/or bitumen.

Sufficient drilling has been completed to delineate a resource potentially mineable by open cut methods.

It is recommended that further test work be completed on the oil shale to determine the most feasible fraction to be produced. It is anticipated that this will require approximately a 20-50 tonne bulk sample. It is recommended that this be obtained from location VI near Railton.

It is recommended that, depending on the results of the bulk sampling, a pilot plant be established at Railton.

Table 13. PROPOSED EXPLORATION BUDGET

Item	Estimated 5 Year costs $
Access, legal costs, planning	25,000
Extraction of bulk sample	100,000
Transport and testing of bulk sample	65,000
Evaluation of results	10,000
Pilot plant design	20,000
Pilot plant construction	260,000
Administration and contingencies	60,000
TOTAL	**540,000**

Yours faithfully,

Allen J. Maynard   Brian J. Varndell

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8.0 GLOSSARY

Adamellite: a variety of granitic rock, rich in mica

Alluvial: Matter deposited from flowing water

Alluvial Diamond: Diamond associated with alluvial material (a secondary source)

Alluvium: A general term for unconsolidated material deposited during comparatively recent geologic time by a stream or other form of running water

Anomaly: A physical feature or measured value different to the expected norm

Anticline: Upward arching fold of rock strata

Archaean: The earlier period of the Pre-Cambrian era

Basement: Rocks underlying a rock sequence of interest; often used to describe the igneous rocks of the Earth's crust

Basic (rock): Descriptive of an igneous rock with low silica content

Basin: See sedimentary basin

Cretaceous: The time period following the Jurassic

Diamond: High pressure crystalline form of carbon

Dolerite: Medium grained basic igneous rock

Erosion: the wearing away and general lowering of the Earth's surface

Fault: A fracture in the Earth along which relative displacement of the sides has taken Place

Granite: Coarse grain silica rich igneous rock

Igneous: Said of a rock or mineral that solidified from molten magma

In-situ: In its original place

Jurassic: A time period following Triassic

Kaolin: A rock compose essentially of clay minerals of the kaolinite group

Kaolinite: a common clay mineral

Kerogen: The solid bituminous mineral substance in oil shale which yields oil when the shale undergoes destructive distillation

Kimberlite: A silica poor intrusive igneous rock rich in olivine and calcite generally generated from the Earth's mantle

Lamproite: A silica poor intrusive igneous rock rich in potassium and magnesium minerals with similar characteristics to kimberlite. I.e. it is generated from the mantle and can contain diamond

Mafic: Descriptive of dark coloured igneous rock caused by high concentration of magnesium and iron

Mica: a group of multi element silicate minerals forming platy crystals

Oil shale: A shale with a high content of contained hydrocarbons, capable of yielding oil on slow distillation

Paleo-: A prefix indicative of relatively great age

Permian: a time period preceding Triassic

Proterozoic: the younger of the two geological periods in the Precambrian era

Puy: a dissected volcanic cone

Shale: A fine grain sedimentary rock formed from the lithification of clay, silt and mud

Syncline: Downward arching fold of rock strata

Tasmanite: A variety of oil shale rich in kerogen and found only in Tasmania

Volcanic: pertaining to the activities, structures or rock types of a volcano

APPENDIX ONE

Feasibility study considerations

Geological factors that influence resource to reserve conversion and parameters for a full feasibility study are discussed below.

A) Geology

Successive layers of the oil shale have different oil yields and other different characteristics. Outcrop shale may have a similar oil yield to an underground shale, yet have different reaction in flotation. For some unexplained reason orange-coloured spores behave differently to lemon-coloured spores and metallurgical test work on core could perhaps delineate variation in oil shale zones, and also possibly indicate areas where improved shale to yield ratios may exist. This could impact on future feasibility cost estimates.

As previously noted the cost of oil yield analysis may be avoided to some degree due to the relationship between ash content and oil yield whereby yield could be estimated from ash analysis or specific gravity.

Where potential open pit excavation is likely core drilling should be undertaken to establish the nature and extent of any thin, high-yield layers above the easily recognisable "normal" horizon, as they may be selectively extractable. This should include some holes to investigate the Mersey Coal Measures in the area.

The possibility that the small 0.3-0.6m scale faulting previously noted, that poses problems for underground mining operations, may be widespread. Small scale faulting was reported as a major difficulty in the early mining operations. Drilling to date has been too widely spread to allow estimates of the frequency, preferred orientation or average displacement of such small scale faulting to be made. Major faulting up to 75m displacement does not present as many problems as it has already been recognised from wide spaced drilling.

The clast content of the Tasmanite seam which includes rock types such as quartz, quartzite, schist, granite, gabbro and dolerite occur erratically distributed throughout the oil shale and may present a problem to continuous mining machinery in an underground operation. However, average clast size is small (approx. 1 cm) and the frequency of clasts rarely exceeds 5% mainly at the margins of the seam. Those clasts within the body of the seam are not very tightly held by the fabric of the oil shale and may be "plucked out" with little damage or increase in wear to mining equipment. In places the underlying mudstones project into the lower portion of the seam (as evidenced in the old workings).

During the CRAE drilling programme, conducted during summer when the regional water table was at a minimum, it was noticed that the siltstones immediately above the Tasmanite act as an aquifer. It appears that the relatively impermeable Tasmanite seam is acting as the base for a perched water table. This may cause problems in an underground mining operation.

The oil shale is either horizontal or dips at low angles. The dip in the different areas and even in the same area can vary in direction and amount but generally does not exceed around 1 in 10 (5 - 6°).

"

The Tasmanite horizon is up to 2m in thickness but averages around 1.4m. The horizon usually consists of three bands but there is occasionally a second siltstone parting, these siltstones bands have low spore/kerogen content and low oil yields. Both the upper and lower contacts are gradational and do not necessarily coincide with the hanging and footwall partings that average 15cm beyond the main seam.

Dolerite intrusives are common in the area and in many cases are thought to have been intruded along faults. Some of the holes drilled by CRAE were abandoned in dolerites and basalts. Better definition of dolerite occurrence is required.

B) Mining

Some features of the Tasmanite occurrences which may affect exploitation of the resource warrant mention. The following factors are considered to have a significant bearing on the choice of mining method and ease of extraction of the oil shale:

Depth of oil shale horizon
Faulting
Intrusives
Presence of pebbles/boulders
Dilution of the oil shale horizon

Since the Tasmanite oil shale occurs as a horizontal or gently dipping horizon averaging 1.4m in thickness, the problems of mining the oil shale are similar to those encountered when mining horizontal or gently dipping coal seams.

Choice of mining methods and associated costs should therefore be restricted to those applicable to conventional open cut and underground coal mining methods. In previous studies, all oil shales at a depth shallower than 20 metres were considered to be suitable for open cut mining with deeper oil shales considered suitable for mining by underground methods.

Factors that could affect or impact on the choice of underground mining methods focussed on conventional drilling and blasting and the use of continuous miners. Of major concern are small faults, clasts, variable dip, partings, uneven floors and intrusives.

Many of the factors deemed problematical for underground mining were thought to only have a "nuisance" impact on surface mining operations. Excessive dilution and/or possible loss of part of the oil shale horizon is a real possibility in opencut mining. The very thin nature of the oil shale horizon will mean whole seam mining, and will necessitate careful monitoring of the base of the overburden and the oil shale horizon.

A trial seismic survey indicated that only minor rippable overburden exists and that blasting will be required. This virtually eliminates the possibility of using scrapers as the sole means of overburden removal.

In the major report by the Tasmanian Hydro-Electric Commission (HEC) that contains a Feasibility study the choice of mining methods are summarised. For oil shales less than 20m depth a conventional truck and shovel operation was selected as the most appropriate method of mining the oil shales. However, the economics of a viable operation depended on sufficient reserves for a life of about 20 years. Possible mineralisation in this category defined to date is less than *6* mt with little potential to significantly increase this figure.

HEC assumed that for an operation producing 50,000 tonnes of bitumen per annum, opencut production would need to average around 315,000 tonnes oil shale per year (assuming 6.3t oil shale produces 1 tonne bitumen). For a 20 year mine life, a minimum, of *6.5* mt of mineable reserves would be required, whilst a 30 year mine life needs around 10 mt of mineable reserves.

The presently defined possible mineralisation at a depth less than 20m is thus insufficient to support a 20 year operation.

For oil shales greater than 20m depth, underground mining methods are the only means of extracting the oil shale since overburden stripping ratios become prohibitive. HEC concluded that the majority of the presently defined mineralisation is therefore only mineable by underground means.

Depending on the hardness and pebbly nature of the oil shale horizon, either continuous miners or conventional drilling and blasting on a room and pillar method (or the like) would be the most appropriate underground mining method. Longwall and shortwall mining methods are virtually precluded because of the abundance of faults and intrusives.

HEC assumed that with 60% extraction from room and pillar operations the present underground mineralisation of more than 35mt at greater than 20m depth is more than sufficient for an operation producing *50,000* tonnes per annum bitumen over a 20-30 year mine life.

C) Processing

The oil yield on distillation depends upon the kerogen (spore) content in the shale. In the richer parts of the Tasmanite oil shale horizon, kerogen content can be as high as 45% with yields up to 300 litres/tonne. For the poorer siltstone parts, kerogen content can be as low as 7% yielding only 20 litres/tonne. Average oil yield for the total seam comprising the oil shale horizon including middle siltstone is 140 litres/tonne based on CRAE drilling results only. Any beneficiation would allow processing of only a portion of the mined total and thereby reduce plant capital expenditure and subsequent processing costs. HEC also concluded that the Tasmanite oil shale is potentially profitable for its bitumen content since the crude oil produced from it has good bituminous characteristics.

A sample of tasmanite concentrate (742551) was taken for examination and possible upgrading from a pile in a shed at the remains of the old pilot plant near Latrobe. This examination was undertaken to obtain information for the Endeavour Oil Co. N.L. who were exploring the shale deposits.

A head sample was cut from the bulk samples for assay purposes and a number of samples were cut for sizing flotation tests. A screen analysis was conducted on one of the samples taken from the bulk sample and the screen fractions were assayed for ash. Further floatation using dispersing agents and multi-stage cleaning yielded a product assaying 25.9% ash. Grinding of a sample reduced the ash further to 12.6%.

This crude test that had significantly reduced the ash content from run of mine feedstock indicates that additional test work on primary material is justified.

D) Hydrogenation

Oil shale consists of rather hard dense rock with solid organic matter called kerogen distributed through it. The kerogen may be broken down by heating the shale in the absence of air to produce a shale oil of vaporised oil, water vapour and other minor gaseous constituents. The oil, known as shale oil, is recovered by condensation and can be converted into a synthetic crude oil directly comparable with petroleum by the process of hydrotreating. When hydrotreated shale oil is refined, it yields the full range of fuels normally derived from petroleum.

The shale oil extracted from the shale by retorting is not suitable for direct feed to conventional oil refineries. It is deficient in hydrogen, and contains substances which adversely affect the refinery processes. Further, it deteriorates in quality when stored for any length of time.

Retorting and hydrotreating are most efficiently undertaken in a single plant and for this reason production of a crude oil for refining in a distant processing facility may not be an attractive option.

The basic approaches for extracting oil from oil shale are surface retorting and in-situ retorting, neither of which are wholly applicable here. Tasmanite shale has an advantage in that the oil spores are physically separable from the sandy shale by flotation as successfully demonstrated by Manson and Walker in 1937. The oil produced from Tasmanite shale is unusual for its high bitumen content, the only known Australian bitumen source, and the nature of the 1937 process is such that an end product asphalt could be varied by metallurgical control. No product specification has been written for this unique asphalt. It is clear that if written, that the specification would control plant design if the asphalt route was selected. The alternative selection is to produce a crude oil. Only after the desired processing route is selected can plant and operating costs be properly ascertained beyond current crude estimates.

Cane 1984 stated that there has been extensive experimentation on oil shale pyrolysis using hydrogenation techniques. The foremost of these is by the Institute of Gas Technology in Chicago with the Hytort process. Its associate the Hycrude Corporation, expressed an interest in testing tasmanite and samples were submitted to them. Discussions with I.G.T. indicated that the process is very capital intensive, demands high throughputs and may not be appropriate because of the lack of natural gas for hydrogen production. I.G.T. admitted that the Hytort process is designed for low grade shale oils so did not give much improvement for shales richer than 25 g/t. Nevertheless IGT undertook to evaluate tasmanite in the Hytort process and send the results to Australia.

The Colorado School of Mines has experimented with the direct hydrogenation of oil shale under autoclave conditions for a hydrothermal extraction process. The advantages of hydrothermal extraction, rather than "dry" retorting for the production of shale oil is that, as cracking conditions are relatively gentle, the decomposition gives a better carbon conversion of 85% compared to 65% maximum with retorting, and a greater selectivity of 90% to oil. Additionally the product oil contains about 50% condensed aromatic structures and about 25% olefins compared with normal crude oil. In other words, the shale oil from thermal extraction rather than retorting has a much better "chemistry", in that it shows less coking and is a better feed for up-grading for use as a petroleum feed-stock. The disadvantages are that hydrothermal extraction is a pressure process with high cost capital equipment and it also requires a copious hydrogen supply that is expensive and demands natural gas or equivalent.

The Colorado School of Mines was anxious to evaluate their hydrothermal extraction process on the tasmanite concentrate and samples were also supplied to them. No further reference to any of this test work was seen.

E) General

Additional information regarding the shale resource and its processing to liquid fuels would be required to determine the technical and economic feasibility and the social and environmental implications of its exploitation.

Areas requiring further study are:
Infill drilling to define reserves more closely.
Detailed geological description of the shale deposit.
Extended shale sampling and assays.
Evaluation of mining methods including possible trial mining.
Test beneficiation processes for R.O.M. shale.
Retorting technology evaluation, pilot plant processing, Hydrotreating and refining process evaluation.
Pilot testing waste management studies.
Infrastructure definition.
Environmental data collection and impact study.
Economic evaluation.

In a study completed in 1984 by the Japan Australia Oil Shale Corporation, a joint venture with Southern Pacific Petroleum and Central Pacific Minerals (SSP/CPM) $US23 million was spent leading to a capital estimate of $US2,332 million for the open-cut mining and processing of the Condor oil shale deposit in Queensland to produce 4,200 ML/year hydrotreated crude. Even at this level of expenditure, capital and operating cost estimates were accurate to only 25%.

Exploration drilling to define the resource followed by a project feasibility study would take the first three of eight years required from commencement of the project to commissioning of the erected plant. A year would be required for a review of the study results, negotiation of project capital funding and approval of all submissions to statutory authorities and government departments.