AVAILABILITY OF COKING COAL IN WESTERN CANADA

FINAL REPORT

CALGARY, MAY 1974.

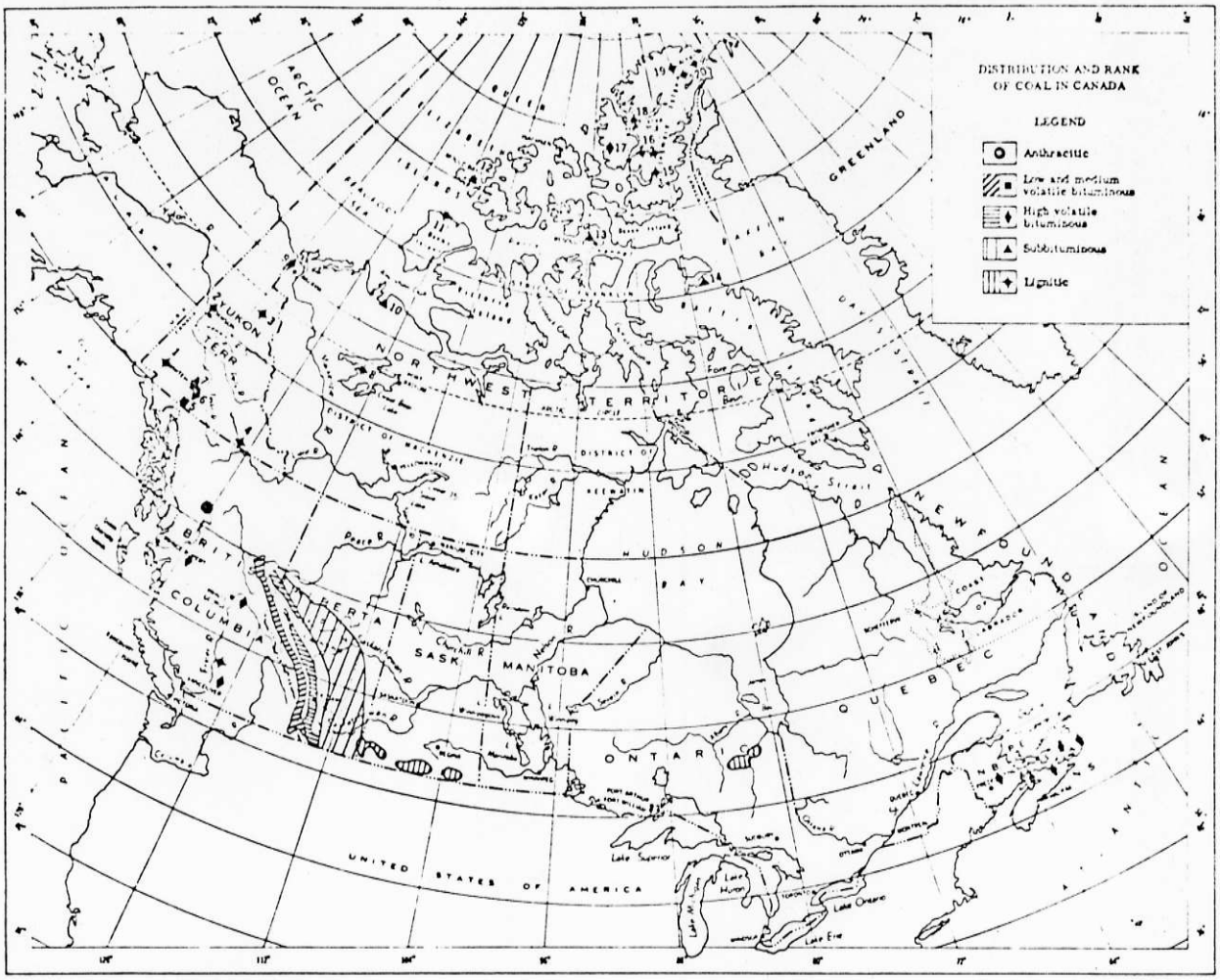

FIG. 1 : Coal Occurrences by Rank in Canada

FOR MISSING ANALYSIS DATA, REFER TO CONFIDENTIAL COAL ANALYSIS FILE.

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THE CANADIAN COAL RESOURCES (The following text is more or less copied from literature (1) and (2)).

The most comprehensive Canada - wide report was that prepared for the Royal Commission on Coal (1946) by Dr. B.R. MacKay of the Geological Survey of Canada. He used the following parameters for his calculations: All coal seams of less than 3 feet (with very few exceptions, notably in New Brunswick) were excluded from the calculations. For the depth limitation, a maximum of 4000 feet was adopted for Nova Scotia, 2500 feet for the bituminous mines of Alberta and British Columbia, and 500 feet for New Brunswick, Ontario (Onakawana), Manitoba and Saskatchewan.

With the use of these limiting parameters, MacKay arrived at estimates of MINEABLE Coal, constituting the tonnage of coal considered to exist in seams of mineable thickness (under existing technology) and lying within the required vertical distance below surface. His results by provinces were (Tab. 1).

Province	Probable	Possible	Total	Per Cent
Nova Scotia	1,197,000	1,147,000	2,344,000	2.4
New Brunswick	89,800	11,500	101,300	0.1
Ontario	100,000	50,000	150,000	0.2
Manitoba	33,600	67,200	100,800	0.1
Saskatchewan	13,126,000	11,004,000	24,130,000	24.6
Alberta	34,437,000	13,436,000	47,873,000	48.8
British Columbia	11,795,000	7,034,000	18,829,000	19.2
Yukon	434,000	1,449,000	1,883,000	1.9
Northwest Territories	140,000	2,489,000	2,629,000	2.7
Canada total.....	61,352,400	36,687,700	98,040,100	100.%

Tab. 1 : Mineable Coal in Canada (in thousands of tons)

The report indicated that Canada possessed about 61.35 billion tons of Probable plus about 36.69 billion tons of Possible for a total of 98 billion tons of MINEABLE Coal. Under this assessment, probable reserves mean coal which "by direct mining experience and by drilling, by continuity to existing workings and areas drilled, or by extensive geological data can be reasonably expected to exist." Possible reserves mean coal " the reasonable existance of which is based on limited geological data and limited prospecting", also coal "whose recovery is problematical due to its inferior quality and/or its relative inaccessibility".

The Mackay report then recognized that not all of this MINEABLE Coal in situ would actually be extracted and brought to surface as production. To allow for this, he adopted the reasonable average recovery rate at 50 per cent and, with use of this rate, arrived at the following estimate for RECOVERABLE Coal (Tab. 2).

Province	Probable	Possible	Total	Per Cent
Nova Scotia	983,000	573,600	1,556,600	3.1
New Brunswick	44,900	5,800	50,700	0.1
Ontario	50,000	25,000	75,000	0.2
Manitoba	16,800	33,600	50,400	0.1
Saskatchewan	6,563,000	5,502,000	12,065,000	24.4
Alberta	17,218,000	6,718,300	23,936,300	48.4
British Columbia	5,897,000	3,517,200	9,414,200	19.0
Yukon	217,000	724,900	941,900	1.9
Northwest Territories	70,000	1,244,900	1,314,900	2.7
Canada total.....	31,059,700	18,345,300	49,405,000	100.%

Tab. 2: Recoverable Coal in Canada (in thousands of tons)

With respect to the rank of the Canadian Coals, MacKay reported RECOVERABLE Coal as follows:

By Rank	Probable	Possible	Total	Per Cent
Bituminous-Low Volatile	4,882,900	2,703,900	7,586,800	15
Bituminous-Medium Volatile	11,152,300	4,032,700	15,185,000	31
Bituminous-High Volatile	4,951,900	3,482,800	8,434,700	17
Sub-bituminous	3,122,600	1,155,300	4,277,900	9
Lignite	6,950,000	6,970,700	13,923,500	28
Total, all ranks.....	31,059,700	18,345,400	49,405,000	100

Tab. 3 : Recoverable Coal According to Rank in Canada (in thousands of tons)

The location of the above ranks by provinces are:

Bituminous-Low Volatile	--	In British Columbia and Alberta
Bituminous-Med Volatile	--	In British Columbia and Alberta
Bituminous-High Volatile	--	In British Columbia, Alberta and the Maritimes
Sub-bituminous	--	Plains of Alberta
Lignite Coal	--	Saskatchewan, other western provinces, the Arctic and Ontario

In 1970, a re-assessment of the measured coal reserves of Western Canada was made by Mr. Latour and Mr. L. P. Chrismas of the Department of Energy, Mines and Resources. This report categorized the coal resources of Saskatchewan, Alberta and British Columbia under the following headings:

Measured or Proven Resources
Indicated or Probable Resources
Inferred or Possible Resources

As defined in this 1970 report, MEASURED RESOURCES mean coal about which so much is known that it can firmly be expected to exist and for which calculations are judged to be accurate, say, 20 per cent. The terms INDICATED AND INFERRED correspond respectively to the probable and possible reserves of the MacKay report. The 1970 re-assessment indicated as follows:

Province	Measured	Indicated	Inferred	Total
British Columbia	7,328,600	11,175,400	40,953,000	59,457,000
Alberta	2,203,900	32,096,100	12,940,200	47,240,200
Saskatchewan	291,500	7,024,000	4,698,400	12,013,900
Western Canada Total	9,824,000	50,295,500	58,591,600	118,711,100

Tab. 4 : Coal Resources of Western Canada by Province (in thousands of short tons)

Province	Measured	Indicated	Inferred	Total
		Low and Medium Volatile Bituminous		
Alberta				
Inner Foothills				
Luscar Formation	542,000	7,426,500	3,535,400	11,503,900
Inner Foothills				
Kootenay Formation	440,100	12,193,700	3,831,100	16,464,900
Alberta Total	982,100	19,620,200	7,366,500	27,968,800

Province	Measured	Indicated	Inferred	Total
		Low and Medium Volatile Bituminous		
British Columbia	6,943,000	10,775,000	40,480,100	58,198,100
Rank Total	7,925,100	30,395,200	47,846,600	86,166,900
		High Volatile Bituminous		
Alberta				
Outer Foothills		6,278,600	3,043,700	9,322,300
British Columbia	45,600	100,400	172,900	318,900
Rank Total	45,600	6,379,000	3,216,600	9,641,200
		Subbituminous		
Alberta	1,221,800	6,197,300	2,530,000	9,949,100
		Lignitic		
British Columbia	340,000	300,000	300,000	940,000
Saskatchewan	291,500	7,024,000	4,698,400	12,013,900
Rank Total	631,500	7,324,000	4,998,400	12,953,900
Grand Total	9,824,000	50,295,500	58,591,600	118,711,100

Tab. 5 : Coal Resources of Western Canada by Rank and Province (in thousands of short tons)

The above estimate corresponds approximately in definition with the mineable coal reported by MacKay, although it relates to Western Canada only and also shows a much larger tonnage reflecting a greater knowledge gained through new exploration by industry. The author did not attempt to go further by allowing for a probable percentage of extraction and showing RECOVERABLE coal as did MacKay.

Briefly, the 1970 report did confirm earlier estimates that Canada possesses very large reserves of coal, measurable in hundreds of years of supply, even at greatly increased levels of production. Significantly, also the report showed that we have firm knowledge about of relatively high percentage of the total as represented by the 9.82 million tons of MEASURED coal (about 8% of total coal). An important observation by the author was that only 7 percent of the MEASURED bituminous coal (low, medium and high volatile) can be extracted by surface mining, that is 0.56 billion tons.

The bulk of the MEASURED reserves must be won by underground method. This underlines the need for an early and vigorous development of new underground mining methods suitable for the thick, highly inclined and severely faulted coal seams of the bituminous coal fields.

Although the above geological reporting and coal analyses programs have been of value in defining the locations, magnitude and broad characteristics of the Canadian coal resources, there remains a major task of determining how much of this coal can be economically extracted with known technology (RECOVERABLE COAL). The office of Exploration und Bergbau GmbH of Canada in Calgary has listed in Tab. 6 some of the recoverable coal of some known deposits of bituminous coals in Alberta and British Columbia when parameters for the calculation where available. Otherwise the in place or clean coal is stated in Tab. 6.

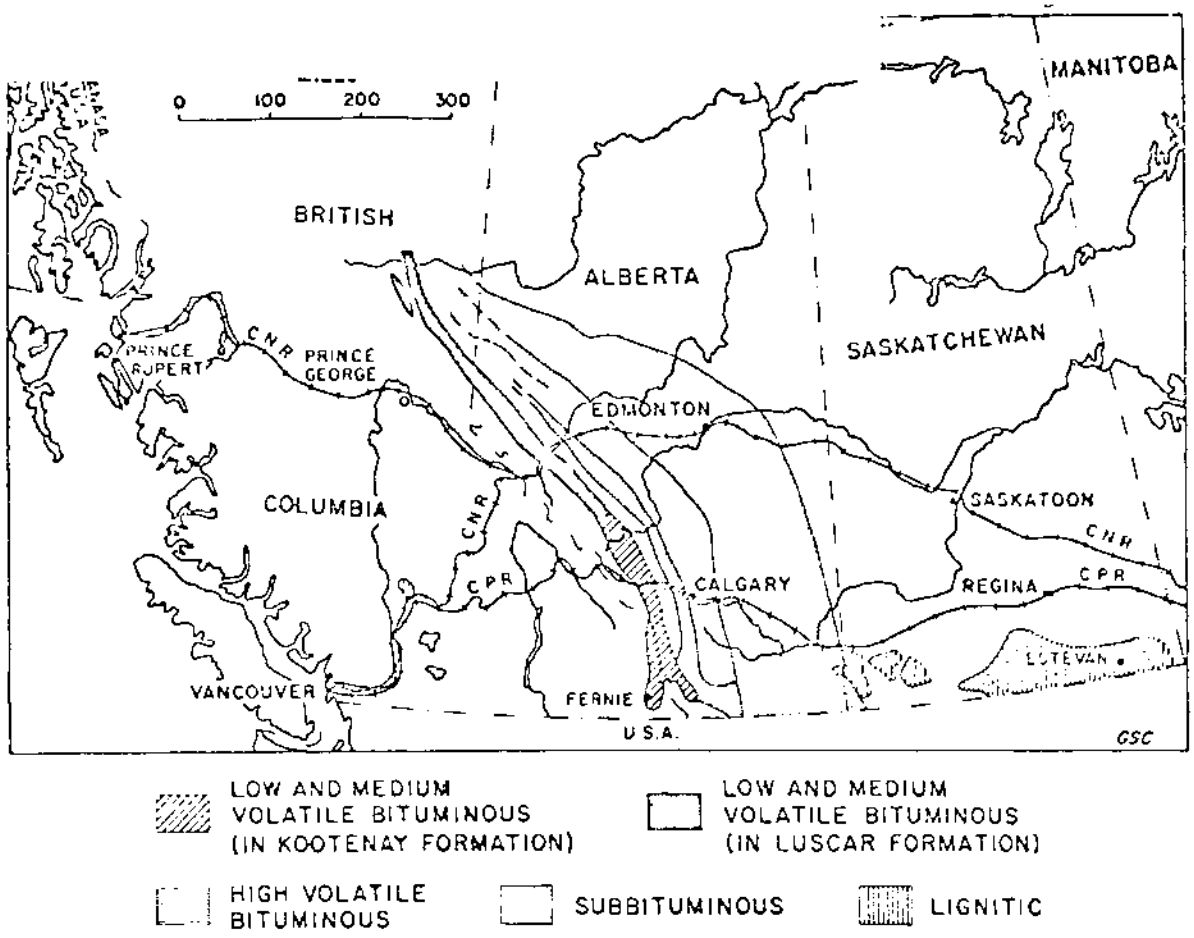


Fig. 2 : GENERAL AREAL DISTRIBUTION BY RANK OF HIGH POTENTIAL COAL DEPOSITS OF WESTERN CANADA

3.1 DISTRIBUTION BY RANK OF WESTERN CANADIAN COALS (Fig. 2) (2)

The general areal distribution by route of the coal deposits of Western Canada is shown in Fig: 2. It is quite evident that westward from the low route lignitic deposits of Saskatchewan there is a steady progression upward in rank through the sub-bituminous coals of the Alberta Plains and the high volatile bituminous coals of the Outer Foothills belt to the low and medium volatile bituminous coals of the Inner Foothills Belt of western Alberta and southeastern and northeastern British Columbia. Though not shown, coals of anthracitic rank do occur in the Inner Foothills Belt, notably in the vicinity of Canmore, Alberta, some 60 miles west of Calgary. This progression upward in rank from east to west is attributable mainly to the fact, that from east to west the coal measures

are increasingly geologically older and this greater degree of maturity is manifested by an increase in the rank of the contained coal. The relatively high rank of the coals in the mountain belt is attributable mainly to the heavy load placed on the seams in the geosyncline that occupied the present position of the mountains with structural deformation playing only a minor role in the upranking of the coals (the last evaluation of processes leading to the formation to the present distribution of rank is a scientific approach to the problem by Mr. Latour (2)).

3.1.1 YUKON TERRITORY

The coal deposits of the Yukon are of Mesozoic and Tertiary ages. In the southwestern part the Mesozoic coals occur in two formations, the Laberge and the immediately overlying Tantalus Formations. The Laberge is regarded as Lower Jurassic with possibly some Upper Jurassic, and the age of the Tantalus Formation is considered to be Upper Jurassic and Lower Cretaceous. The Mesozoic coals are mostly bituminous in rank, and the most important occurrences are at localities 5, 6, and 7 (Fig.3).

The Tertiary coals, which are all lignitic, occur in Yukon and White River drainage areas in the western part of the Yukon (Locs. 1 and 2), Upper Liard River in southeastern Yukon (Loc.4) and in the Bonnet Plume area (Loc. 3) in the northern part of the Yukon.

3.1.2 NORTHWEST TERRITORIES, MAINLAND

Only three occurrences in this large area are worthy of note. Four seams of lignitic coal occur in Tertiary sediments on the west side of Great Bear Lake (Loc. 8, Fig.3). Upper Cretaceous strata on the northwestern edge of Mackenzie River delta contain at least one seam of high volatile bituminous coal (Loc. 9).

This seam was mined for several years and thé coal used as a fuel at Aklavik. Seams of subbituminous coal of Cretaceous age occur at locality 10, with one seam reported to be 25 feet thick but containing some bands of shale.

3.1.3 NORTHWEST TERRITORIES, ARCTIC ISLANDS

There are now a sufficient number of reliable reports of coal seams of mineable thickness to indicate that the Arctic Islands coal deposits are extensive. The rank of the coals contained in these deposits is still uncertain as most analyses to date have been made on samples of severely weathered coal taken from outcrops. However, it seems safe to say that generally the coals are poorly consolidated and low in rank, seldom exceeding the subbituminous rank.

Subbituminous coal of Pennsylvanian age occurs on Cornwallis Island (Loc. 13, Fig. 3). Lower Cretaceous or Jurassic subbituminous coal is present on Baffin Island (Loc. 14). On Prince Patrick Island (Loc. 12) there is subbituminous coal that is Early Cretaceous in age. On the north coast of Banks Island (Loc. 11) there is Upper Cretaceous coal of lignitic rank. Ellesmere Island (Locs. 15 to 20) appears to be underlain by much coal. These deposits are Late Cretaceous or Tertiary, and all the coal is lignitic. Medium volatile bituminous coal of Late Cretaceous or Tertiary age is reported on Axel Heiberg Island (Loc. 17), but the reliability of the analyses is questionable due to the nature of the sample provided.

In British Columbia, except for the deposit in the southeastern and northeastern parts, the coal deposits are confined mainly to small, widely separated areas, and the coals exhibit a wide range in rank.

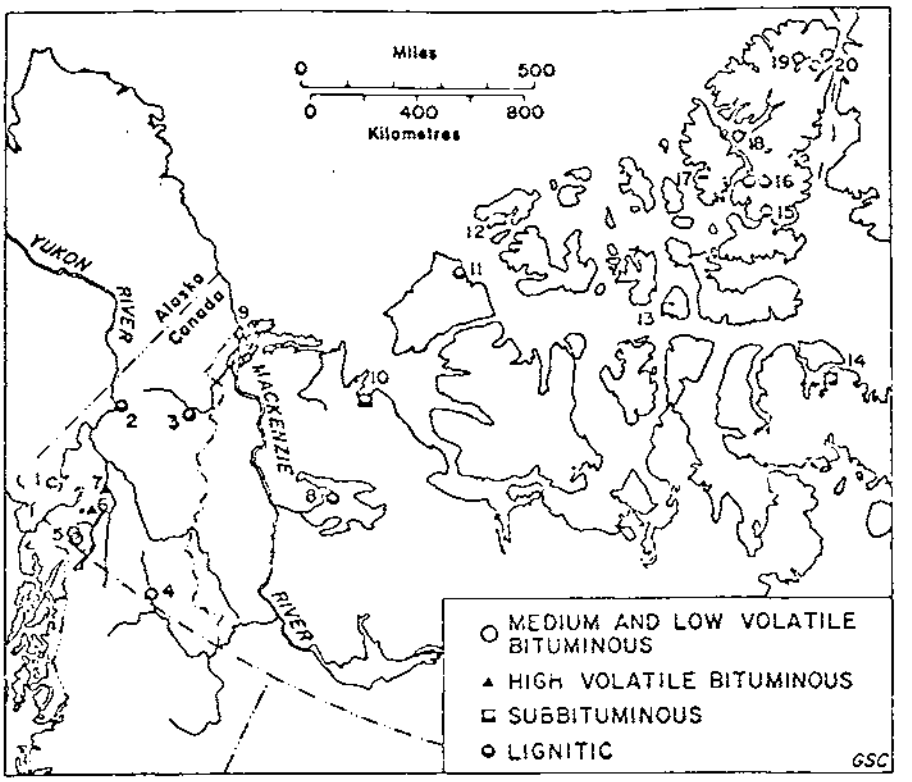


Fig: 3 . : Coal Occurrences in Yukon Territory and Northwest Territories
Coal Occurrences in Northern Canada (2)

Fig. 3 shows the locations and ranks of coal occurrences where one or more seams are known to be at least Resources and Description of Western Canada Coal Deposits (2).

Western provinical coal resources, in decreasing order, are British Columbia with 50.1 per cent, Alberta 39.8 per cent, and Saskatchewan 10.1 per cent. This order differs considerably from previous estimates (see Tab. 1) which placed Alberta in the leading position, followed by British Columbia and then Saskatchewan. The change in order between Alberta and British Columbia has been brought about, not because Alberta's resources are considered any less than before, but rather because it is estimated that British Columbia now possesses significantly greater resources than before. This increase in British Columbia's resources is due to the great increase in exploration in southeastern British Columbia in the past few years.

Exploration in Alberta has been progressing at a slower rate because of the very large area to be explored and the more inaccessible character of much of the terrain.

3.1.4 SASKATCHEWAN

Saskatchewan's coal deposits, all lignitic in rank, occur in a belt along the southern edge of the province and are contained in the Ravenscrag Formation of Early Tertiary age. This belt is the northern fringe of a large basin that extends through western North Dakota and eastern Montana.

The coal measures attained their best development in the development in the Estevan area where eight seams are recognized of which only four have thicknesses of five feet or more. All four have been mined in the Estevan area, and production has been mainly by strip mining. Only in the Estevan area has there been sufficient exploration to permit estimates to be made of measured resources.

The resources are shown in Tab. 7 . The measured reserves represent only that coal contained in seams five feet or more in thickness at depths not greater than 150 feet from surface. The same limit of seam thickness applies to the indicated and inferred categories, but the depth of overburden is extended to a maximum of 500 feet.

District	Measured	Indicated	Inferred
Estevan	291,500	1,044,400	487,200
Radville Block		2,352,000	1,008,000
Willowbunch Block		2,408,000	2,184,000
Wood Mountain Block		616,000	672,000
Pinto Butte Block			44,800
Eastend Block		570,000	268,800
Cypress Lake Block		33,600	33,600
Saskatchewan Total	291,500	7,024,000	4,698,000

Tab. 7 : Coal Resources of Saskatchewan (in thousands of short tons)

3.1.5 ALBERTA

Coal-bearing formations underlie much of the southern half of Alberta and contain coal of all ranks under a great variety of geological conditions. The coal deposits are readily grouped into three large areas that extend throughout the province parallel to the mountains. These are termed the Plains Area, Outer Foothills Belt and Inner Foothills Belt. The reserves for each zone are shown in Tab. 8 .

District	Measured	Indicated	Inferred
Plains Area	1,221,800	6,197,300	2,530,000
Outer Foothills Belt		6,278,600	3,043,700
Inner Foothills Belt			
North (Luscar Fm)	542,000	7,426,500	3,535,400
South (Kootenay Fm)	440,100	12,193,700	3,831,100
Alberta Total	2,203,900	32,096,100	12,940,200

Tab. 8 : Coal Resources of Alberta (in thousands of short tons)

3.1.5.1 PLAINS AREA

As indicated in Tab. 8 Mr. Latour arrives at nearly 10 Million tons of which approximately 1.2 Million tons are in the measured category. The measured resources include only that coal contained in seams five feet or more in thickness at depths from surface of not more than 150 feet.

A more recent study by the Energy Resources Conservation Board (4) on the coal resources of the Province of Alberta, came to the following result (as per December 31, 1972):

(In Million of Tons)

Region	Rank	Mineability	In Place	Recoverable
Plains	Subbituminous	Surface	5107	4304
		Underground	2064	1037
		Beyond Economic Reach	3001	-
			10172	5341

The following parameters apply for this calculation:

A recovery factor of 85% for surface mining methods and 180 feet depth with an overburden ratio of 15 cyd per ton.

The calculation shows that 42% of the PROVEN Plains Reserves is considered to be recoverable by surface mining method, and an overall recovery of 53% is expected.

The recoverable reserves of 4.304 billion tons of subbituminous Plains coal calculated by ERCB are nearly double as much as the measured (but not recoverable) reserves of Mr. Latour's publication. This is most likely due to the extensive exploration during the last years in the Plains area.

The ultimate reserves against the proven reserves in the plains area are shown in the next Tab. 9.

		Millions of Tons	
		Proved (December 1972)	Ultimate
Surface-Mineable			
Northern District		504	1,200
Central District		3,800	4,400
Southern District		NIL	NIL
	Subtotal	4,304	5,600
Underground-Mineable			
Northern District		77	6,600
Central District		805	34,400
Southern District		155	3,400
	Subtotal	1,037	44,400
	TOTALS	5,341	50,000

Tab. 9 : Recoverable and ultimate reserves in the Plains Region

3.1.5.2 OUTER FOOTHILLS BELT (3)

Coal in this belt is all high volatile bituminous in rank and is Late Cretaceous and Tertiary in age. The Upper Cretaceous formations extend in narrow bands along the full length of this belt and contain coal seams which, for the most part although in a few instances, thicknesses of between 5 feet and 15 feet have been recorded. The Tertiary coal deposits are the most important in this belt and these are best developed in the area between North Saskatchewan River and Athabasca River, and include seams of good mineable thicknesses.

Because of their proximity to the mountains, the coal deposits in this belt have been subjected to a considerable degree to the same forces that formed the mountains. Consequently, the seams may be at any altitude, or folded, or truncated by faults or otherwise structurally deformed. These conditions together with a terrain that provides limited outcrops make exploration difficult. It is known that in some places seams have been structurally thickened, and one such occurrence -wherein a seam of normal thickness of some 20 feet is thickened to 120 feet- was successfully strip-mined in the vicinity of Sterco - Coal Valley.

The Latour report shows indicated and inferred reserves totalling 9.3 billions of tons (Tab. 8) none of it is measured. The Energy Resources Conservation Board has calculated the proven and recoverable high volatile bituminous coals of the Outer Foothill Belt for Alberta as follows (Tab. 10).

Region	Rank	Mineability	In-Place	Recoverabl
Outer Foothills Belt	High Volatile Bituminous	Surface	120	102
		Underground	379	124
		Beyond Economic Reach	36	-
			535	226

Tab. 10 : Proved Remaining Reserves of High Volatile Bituminous Coal in Alberta (Million of tons)

The recoverable 102 million tons by surface-mining are 19% of the ultimate surface reserves, and an overall recovery of 42% is anticipated.

3.1.5.3 THE INNER FOOTHILLS BELT (3)

For the most part the belt extends along the eastern front of the Rocky Mountains from near the International Boundary through to Peace River. The coal, with few exceptions, is low and medium volatile bituminous in rank and invariably has a low sulphur content. Coals of excellent coking quality have been found at various localities throughout the belt, but certainly not all the coal is of this quality. Within a given stratigraphic section containing several seams, the coking quality may vary from seam to seam and, indeed, within a seam.

From the southern extremity of this belt for a distance of about 200 miles northward, the coal seams are contained in the Kootenay Formation which is mainly Late Jurassic with the highest beds considered to be Early Cretaceous in age. The Kootenay appears to have attained its maximum development in the Fernie-Michel area of British Columbia. Eastward from this area there is a rapid reduction in the thickness of the formation and in the number of contained coal seams, and there is a similar but less pronounced reduction northward from this area. The British Columbia part of the belt is separated from the Alberta part by an area of older non-coal-bearing rocks which were thrust into place by a major west-dipping fault. The separation becomes less to the north, and the two belts merge together where the British Columbia belt crosses into Alberta.

At about the same latitude that coal seams disappear in the Kootenay Formation, other seams start to appear in the overlying Luscar Formation of Early Cretaceous age. The seams increase in number and thickness to the north and would seem to be best developed in the Mountain Park

area and again in the Smoky River area. The belt extends northward into British Columbia at least as far north as Peace River. In northeastern British Columbia the coal is contained in the Gething Formation and the Commotion Formation. The two are separated by non-coal-bearing, marine Moosebar Formation, but all three formations are equivalents of the Luscar Formation to the south.

The coal resources, according to Mr. Latour, are shown in Tab. 8. In total, the belt is estimated to contain nearly 28 billion tons of which about 1.2 billion tons are in the measured category. All the resources are contained in seams five feet or more in thickness and at a depth not exceeding 2500 feet.

A more recent evaluation for Alberta (4) by the Energy Resources Conservation Board shows the following results (Tab. 11).

Region	Rank	Mineability	In-Place	Recoverable
Inner Foothills Belt	Low and Medium Bituminous	Surface	1364	1162
		Underground	5413	2058
		Beyond Economic Reach	695	-

Tab. 11 : Proved Remaining Reserves of Low to Medium Volatile Bituminous Coal in Alberta (In Million of Tons)

The recoverable 1.162 billion tons are believed to be 15 percent of the ultimate reserves, and an overall recovery of 43 percent is expected.

3.1.6 BRITISH COLUMBIA

For British Columbia information about the coal deposits is only available by the Latour report (3) and not in a detailed form as done for Alberta by the Energy Resources Conservation Board.

British Columbia has four main areas with potential coal occurrences; Southeastern Area, South-central Area, Central Area and Northeastern Area. The information on these areas in this report is as before more or less copied from Mr. Latour's report (3). The resources of these areas are presented in Tab. 12.

3.1.6.1 SOUTHEASTERN AREA

The main characteristics (low to medium volatile coals) were discussed along with those of the Inner Foothills Belt of Alberta. The resources are shown in Tab. 12.

District	Measured	Indicated	Inferred
Southeastern Area	6,930,500	10,402,300	40,033,200
South-central Area	373,600	395,900	353,200
Central Area	12,000	4,600	119,700
Northeastern Area	12,500	372,600	446,900
British Columbia Total	7,328,600	11,175,400	40,953,000

Tab. 12: Coal Resources of British Columbia (In Thousands of Tons)

Some 57 billion tons are estimated to occur in the area and nearly 7 billion tons are in the measured category. That such relatively large resources can be assigned to this area is a reflection of the information available due to the recent high level of exploration and development in the area.

3.1.6.2 SOUTH-CENTRAL AREA

Three small coal basins are included here for consideration : the Tulamee, Merritt-Nicola and Hat Creek deposits. All three of the deposits are Tertiary in age, but the rank of the coal is different

in each: the Tulameen coal is subbituminous to high volatile bituminous; the Merritt-Nicola coal is mostly high volatile bituminous; and the Hat Creek coal is lignitic. Outcrops of coal are scarce, and the seams are normally covered with a great thickness of younger sediments and alluvium and, at Hat Creek, by younger volcanic rocks as well. The deposits are folded and cut by faults so that the total picture is one of difficult exploration. The Hat Creek deposits are unique in that they contain the thickest assemblage of seams so far known anywhere in Canada. At least five seams are known to be present and their aggregate thickness is in the order of 2,000 feet. It is recognized that these seams are not pure lignite but instead contain many interbeds of clay. Nevertheless, they do constitute a deposit with a very high potential and, moreover, they do pose the possibility that some of the other scattered occurrences that have been reported elsewhere in British Columbia may be similar to the Hat Creek deposits.

The resources of the South-central Area are shown in Tab. 12. The measured resources are estimated to be approximately one-third of the total resources of one billion tons.

3.1.6.3 CENTRAL AREA

At least 21 coal occurrences have been reported, but only two are considered to contain resources within the definition set forth: Telkwa with a rank of medium to high volatile bituminous coals and Bowron River with high volatile bituminous coals.

The resources of this area, as shown in Tab.12, are not large and reflect the small areal extent of the deposits and the lack of information concerning them.

3.1.6.4 NORTHEASTERN AREA

The characteristics of this area were discussed along with those of the Inner Foothills Belt of Alberta. Because of the relative remotenessof the area, exploration has lagged behind that in the more accessible parts of the belt to the south. Results of recent exploration indicate that the reserves of this area are very considerable. Resources estimates shown in Tab:12 are still rather conservative.

3.2 STRATIGRAPHIC DISTRIBUTION OF WESTERN CANADIAN COKING COALS

The coking coals of Western Canada are primarily found along the eastern slopes of the Rocky Mountains with a few isolated occurrences of low grade coking coals in the interior of British Columbia. The geographic distribution of the coal bearing formations covers the eastern Rockies coking coal belt from the United States border to north-east British Columbia. As can be seen, the coal bearing formations occur in linear belts paralleling the mountain front. This pattern of formational outcrop is a result of the geological structure of the area.

The coking coals occur exclusively within Lower Cretaceous and possibly Upper Jurassic rocks, but not wholly within the same formation. The rock units which have been recognized as coal bearing are the Kootenay Formation, the Blairmore Group, the Luscar Formation, the Commotion Formation and the Gething Formation. Some of these Formations are lateral equivalents of one another, and their inter-relationship is illustrated in the "Geological Distribution of Coking Coal Reserves", Tab. 13). A few general comments can be made with regard to the typical thicknesses and characteristics of the coal found within the different formations.

AREA (see figs. 2-4)	FLATHEAD	ISOLATION RIDGE	CLEARWATER	MOUNTAIN PARK	SMOKY-COPTON	KAKWA / TORRENS	QUINTETTE - WOLVERINE	SUKUNKA	PEACE RIVER CANYON	PINK MTN.
OPERATING COAL MINES (1973)	KAISER RESOURCES LTD. SPARWOOD FORDING COAL LTD. ELKFORD	COLEMAN COLLIERIES LTD. COLEMAN CANMORE MINES LTD. CANMORE		CARDINAL RIVER COAL CO. LUSCAR	McINTYRE COAL MINES LTD. GRANDE CACHE					
LOWER CRETACEOUS	BLACKSTONE FM.	BLACKSTONE FM.	BLACKSTONE FM.	BLACKSTONE FM.	SHAFTSBURY FM.	SHAFTSBURY FM.	HASLER FM.	HASLER FM.	BUCKINGHORSE FM.	BUCKINGHORSE FM.
	BLAIRMORE GP. — MILL CRK. FM.	BLAIRMORE GP.	BLAIRMORE GP.		MOUNTAIN PARK FM.	LUSCAR FM. — COMMOTION FM.	COMMOTION FM. — BOULDER CRK. MB. / HULCROSS MB. / GATES MB.	COMMOTION FM. — BOULDER CRK. MB. / HULCROSS MB. / GATES MB.	COMMOTION FM. / GATES MB.	
	BEAVER MINES FM	BEAVER MINES FM	BEAVER MINES FM.	BEAVER MINES FM.	LUSCAR FM.	MOOSEBAR FM.	MOOSEBAR FM	MOOSEBAR FM.	MOOSEBAR FM.	
	GLADSTONE FM.	GLADSTONE FM	GLADSTONE FM.	GLADSTONE FM		GETHING FM.	GETHING FM.	GETHING FM.	GETHING FM.	GETHING FM.
	CADOMIN FM	CADOMIN FM	CADOMIN FM	CADOMIN FM.	CADOMIN FM	CADOMIN FM.	CADOMIN FM.	CADOMIN FM.	CADOMIN FM.	
JURASSIC	KOOTENAY FM. — MUTZ MB. / HILLCREST MB / ADANAC MB / MOOSE MTN. MB	KOOTENAY FM. — MUTZ MB / HILLCREST MB / ADANAC MB / MOOSE MTN MB	KOOTENAY FM.	NIKANASSIN FM.	NIKANASSIN FM.	MINNES GP.	MINNES GP.	MINNES GP.	MINNES GP.	MINNES GP.
	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.	FERNIE GP.

FIGURE 1

MAJOR COAL RESERVES

MINOR COAL RESERVES

Tab. 13 :

EXPLORATION UND BERGBAU GMBH OF CAN.

WESTERN CANADA
GEOLOGICAL DISTRIBUTION
OF
COKING COAL RESERVES

PAUL DYSON CONSULTANTS

3.2.1 COALS OF THE KOOTENAY FORMATION

The Kootenay formation contains potentially economic deposits of coking coal throughout the south-west of Alberta and the south-east of British Columbia. In general, the seams vary from thicknesses exceeding 40 feet in British Columbia to thicknesses of only about 8 feet in the Panther River area. North of the Panther River, only one potentially mineable deposit of Kootenay coal is reported to exist. This deposit is in the Hummingbird-White Rabbit area (West Ram River), but very little factual information is available regarding the coal occurrences in the area. Coals from the Kootenay formation vary from anthracites to medium volatile bituminous coals, are generally low in sulphur and, as a rule, contain less than 15% ash in situ. Coal is being mined from the Kootenay formation by Kaiser Resources Ltd., Fording Coal Ltd, Coleman Collieries Ltd., and Canmore Mines Ltd. These mining operations do not all produce coal from the same seam, but certain quality characteristics appear to be a problem which is common to all the operators. The main problem appears to be the difficulty in washing coals of the Kootenay formation to an ash content below 8% and at the same time maintaining an acceptable yield of product coal.

3.2.2 COALS OF THE BLAIRMORE GROUP - LUSCAR FORMATION

The Blairmore Group and the Luscar formation are treated together as they are in general lateral

equivalents as can be seen from the "Geological Distribution of Coking Coal Reserves" (Tab. 13). As shown in this figure the coals of the Commotion formation in north-eastern British Columbia are also lateral equivalents of these coals, but an arbitrary cut off has been made at the Alberta - British Columbia border.

The Blairmore Group contains coal seams which have been recognized as far south as a point immediately east of the Highwood area. However, coal seams that are potentially mineable under present day economic conditions have not been recognized in the Blairmore group south of the Red Deer River. From this point northwards to the Alberta - British Columbia border, one or more coal seams occur which have thicknesses that have been recognized are approximately 40 feet for a coal seam in the Rock Lake area (30 miles southwest of the Smokey River area). Cardinal River Coal Co. in the Luscar area are mining some seams that have coal thicknesses much greater than this, but these thicknesses are attributable to tectonic thickening rather than to true stratigraphic thickness.

Coals of the Blairmore Group - Luscar formation vary from low volatile bituminous to high volatile bituminous, are low in sulphur and appear to have highly variable ash content, both as raw coals and as cleaned coals at acceptable yields. Cardinal River Coal Co. and McIntyre Coal Mines Ltd. are currently producing coals from the Luscar formation.

3.2.3 COALS OF THE COMMOTION FORMATION

The Commotion formation is the lateral equivalent of the upper portion of the Luscar formation. The term Commotion formation has been widely used throughout the north-east of British Columbia, and its relationship within this formational terminology is illustrated by the figure "Geological Distribution of Coking Coal Reserves" (Tab. 13). As can be seen from this figure, it has been however subdivided into a series of members and the main coal occurrences are within the Gates members. A few thin, in general less than 5 feet, coal occurrences have been observed in the Boulder Creek member, but they are not believed to be of economic significance.

Coal thicknesses found in the Commotion formation vary from maximums in excess of 40 feet in the Saxon Ridge area, to only about 6 feet in the Sukunka area. It is reported that up to six seams have thicknesses which might be economically recoverable in the north-east of British Columbia.

Coals of the Commotion formation range from medium to high volatile bituminous, are generally low in ash and low in sulphur. While no commercial mining operations are currently recovering coals from the Commotion formation, all data so far obtained from exploration would indicate that these coals are readily washable to ash contents of around 6% and that they have the desirable characteristic of high fluidity.

3.2.4 COALS OF THE GETHING FORMATION

The Gething formation is the lateral equivalent of the lower part of the Luscar formation. It is recognized as far south as the Mountain Park area and extends throughout the northeast of British Columbia coking coal area. Seams within the Gething formation attain maximum thicknesses in the Pine Pass area where seams up to 25 feet thick have been reported. These thick seams generally contain one or more shale partings thicker than one foot. Thin seams are present in the Smoky River area, but, in general, the seams of the Gething formation are about 6 to 8 feet thick in the area extending from the Alberta - British Columbia border to the Sukunka River. Coal seams within the Gething formation are thinning rapidly in the Peace River area and no viable coal seams appear to be present in the Gething formation more than 15 or 20 miles north of the Peace River.

These coals are generally medium to low volatile bituminous, are very low in ash and low in sulphur. No commercial mining operations are presently recovering coals from the Gething formation, but the Sukunka project is at the stage where an announcement of a production schedule is anticipated in the future. The testing of samples from this project indicates that these coals are probably well suited to washing to an extremely low ash content (less than 5%) at acceptable yields. Coals from the Gething formation are further reported to have the desirable characteristic of high fluidity.

IV PRODUCING MINES AND COKING COAL PROJECTS IN WESTERN CANADA

4.1 KAISER RESOURCES LTD.

Kaiser Resources Ltd. operates the open pit Balmer and the hydraulic underground mine at Michel. Furthermore, the company holds vast coal bearing areas in Southern British Columbia, acquired from Crowsnest Industries Ltd. This property splits into a northern part, the Elk Valley Coal Field, and a southern part, the Crowsnest Coal Field. Kaiser Resources Ltd. is a joint venture of 53.7% Kaiser Steel Corp., 27.4% Japanese Steel Industry and 18.9% public shares. In the frame of this company set-up, a participation of our group might be possible for a development of a new project in Kaiser's property.
Coal and coke quality of not yet developed areas in the Kaiser property are listed in Appendix 2.

4.1.1 BALMER

The open pit Balmer with the bottom coal mining underground operation at Balmer North Mine and the Hydraulic Mine at Michel, are the operations of Kaiser Resources Ltd. located around Sparwood in British Columbia. The operation is linked by 723 miles of CPR-railway track to the loading facilities for ocean going vessels at Robertsbank. Production started with 2.5 million tons in 1970, 3.622 million tons in 1971, 4.045 million tons in 1972 and 4.96 million tons in 1973. The present sales contract to Japan calls for 4.5 million tons of coking coal per year until the 1st of March 1985. The Japanese customers had originally contracted 75 million tons over 15 years.

The o/p-mining area and the location of the hydraulic mine site is illustrated in Fig. 3. The mining operations for coking coal are all extracting coal from the thick basal seam (Seam No. 10 Balmer Seam).

Seam No.	Raw Coal (bcyd)	S.G[1] Raw Coal (sht/cyd)	Raw Coal (sht)	Percentage of Total Coal Reserves (%)	Loss of Oxid. Coal (bcyd)	Percentage of Loss of Oxid. Coal (%)	Mining L (bcyd)	Percentage of Mining Loss (%)	Recovered Raw Coal (sht)	Percentage of Recovered Raw Coal Per Seam(%)	Waste in Raw Coal Production (bcyd)	Waste (bcyd)	Total Waste (Waste + Oxid. Coal + Mining Loss)(bcyd)	Yield Washplant (%)	Washed Coal (sht)	Ratio* (bcyd:sht Raw Coal)	Ratio* (bcyd:sht Washed C
2	13,531,800			9.8	478,200	3.5	957,300	7.1	14,781,700	10.4	583,500	51,897,500	53,315,000				
3	5,912,600			4.3	235,300	4.0	645,800	11.0	6,148,500	4.3	1,101,000	49,242,600	50,123,700				
4A+4	23,272,700			16.8	872,500	3.8	2,687,600	11.6	24,088,800	17.0	2,346,400	116,864,800	120,424,900				
6	2,863,800			2.1	124,900	4.4	396,700	13.9	2,862,200	2.0	1,048,100	21,093,300	21,614,900				
7	3,523,100			2.5	142,700	4.1	475,700	13.5	3,549,500	2.5	454,900	22,526,600	23,145,000				
8	12,087,800			8.7	494,200	4.1	1,274,900	10.6	12,609,400	8.9	882,200	49,861,700	51,630,800				
9	8,785,600			6.3	329,600	3.8	572,500	6.5	9,633,600	6.8	446,700	47,673,100	48,575,200				
10	13,514,100			9.8	578,000	4.3	826,500	6.1	14,797,900	10.4	1,508,800	45,287,200	46,691,700				
11	3,607,000			2.6	166,600	4.6	376,700	10.4	3,743,800	2.6	582,400	14,302,700	14,846,000				
12	9,011,600			6.5	396,600	4.4	970,500	10.8	9,341,600	6.6	1,260,500	36,602,100	37,969,200				
13	7,412,200			5.4	339,900	4.6	1,493,200	20.2	6,817,700	4.8	1,627,700	40,608,900	42,442,000				
14	7,998,900			5.8	389,300	4.9	1,330,500	16.6	7,673,100	5.4	1,581,000	45,075,900	46,795,700				
15	7,551,900			5.5	384,300	5.1	866,000	11.5	7,700,600	5.4	1,038,400	33,100,500	34,350,800				
16	5,163,900			3.7	271,700	5.3	988,900	19.2	4,769,800	3.4	1,170,700	37,813,600	39,074,200				
17	5,862,100			4.2	312,500	5.3	832,300	14.2	5,764,600	4.1	1,025,300	34,547,000	35,691,800				
18	5,058,700			3.7	259,000	5.1	530,900	10.5	5,216,500	3.7	1,992,500	33,206,000	33,995,900				
19	3,182,200			2.3	211,200	6.6	990,200	31.1	2,420,500	1.7	1,065,500	62,766,800	63,968,200				
Total: 2-19	138,340,000	1.22	169,051,500	100.0	5,986,500	4.3	16,216,200	11.7	141,919,800	100.0	19,715,600	742,452,300	764,655,000	60	85,151,900	5.39:1	8.98:1
2+11 -19	68,380,300			49.4	3,209,300					48.1							
3 -10	69,959,700			50.6	2,777,200					51.9							
2+10 -19	81,894,400			59.2	3,787,300					58.5							
3 -9	56,445,600			40.8	2,199,200					41.5							

1) = 1.45 t/m^3

Tab. 38: Coal Reserves and Waste Material in the "Initial Study Area", Area A and B, between Gridlines 170+00 and 370+00, Elk River Deposit.

4.1.1.1 COAL RESERVES

Approximately 1 000 000 000 sht tons in place of the Balmer Seam (No. 10) coal, averaging 51.5 feet in thickness and under less than 2000 feet of cover, occur in roughly 10 000 acres north of Michel Creek, plus the Sparwood Ridge area. A general breakdown of reserves tonnage (in place) is as follows:

	Short Tons in Place
Strip Coal (to 500 feet isopach)	170 000 000
Underground coal-favourable conditions (15 % recoverable)	110 000 000
Underground coal-unfavourable and unknown conditions	720 000 000
Total coal in place	1 000 000 000

During the stage of proving the reserves, Kaiser put all emphasis on the open pit reserves. The final reserve calculation was finished in 1968 and based on a 4.5 : 1 (bcyd : sht Raw Coal) ratio, and a 55 degree cut wall was placed on the section in a position where the proper stripping ratio would be obtained. A second calculation was prepared at 14 : 1 (bcyd : sht Raw Coal) incremental stripping ratio at high wall, which is the economic cut off. The results are shown in Tab. 14.

Recent production experience has proven, that part of the reserves calculation in Tab.14 was wrong. The surprise was caused by finding that the Balmer Seam No. 10 dipped more steeply than formerly assumed, which, in conjunctionwith unforeseen lower dump slope angles ruled out the use of the 54 cby dragline and converted the production to a shovel and truck operation. The overburden ratio was increased to at present 7.2 : 1 and an overall average of 5.6 : 1. Also, the washery yield will only be between 75 - 80%, Ø 77 and not 80%.

AREA	Based on Coal in Place SHT	4.5 : 1 Coal to Breaker SHT	Stripping Ratio Overburden cyd	Ratio Washed Coal 80% Yield-SHT	Stripping Ratio	Based on Coal in Place SHT	14 : 1 Coal to Breaker SHT	Incremental Ratio - Economic Cut Off at High Wall (2) Overburden cyd	Washed Coal 80% Yield-SHT	Stripping Ratio
Harmer Ridge	46 600 000	39 800 000	181 700 000	31 900 000	4.56	59 000 000	51 000 000	260 000 000	40 400 000	5.1 : 1
ADIT 29	19 700 000	16 800 000	74 300 000	13 400 000	4.42	62 400 000	53 000 000	415 000 000	42 600 000	7.8 : 1
CAMP 8	27 500 000	23 500 000	103 900 000	18 800 000	4.42	52 600 000	46 000 000	327 000 000	36 000 000	7.3 : 1
TOTAL	93 800 000	80 100 000	359 900 000	64 100 000	4.48	174 000 000	149 000 000	1 002 000 000	119 000 000	6.3 : 1

(1) "Coal in Place" x 90% (non-oxidized coal) x 95% mining recovery = "Coal to Breaker", Losses added to overburden

(2) Economic studies March 1968 indicate 14 : 1 incremental stripping ratio at high wall is economic cut off.

Tab. 14 : Balmer Open Pit Reserves, Kaiser Resources Ltd.

4.1.2 WHEELER - HOSMER RIDGE

The Wheeler Ridge deposit, together with its extension Hosmer Ridge, belongs to Kaiser's southern property part, the Crowsnest Coal Field. A study about the practicability of hydraulic mining in this area should be conducted and a preliminary investigation program should be connected with an option. Generally, it is undoubtedly to mention that a bulk sample coke oven test has indicated poor coking quality of seam No. 3, which is the one of major interest.

The location is marked in Fig. 4 . The town sites of Fernie, situated 10 miles to the south, and Sparwood, some ten miles to the north, serve the needs of the immediate area. The CPR-railway passes through both towns and only a short spur line is to be constructed to connect the deposit and the existing railway track.

4.1.2.1 COAL RESERVES AND COAL QUALITY

The most promising seam, because of its suitability for hydraulic mining in the Wheeler Ridge area, is Seam No. 3, which varies in thickness from 7 - 15 m, and the average might be approximately 10 m.

Tab.18 shows the reserves and quality of all seams, a total potential of 677 million sht in place. The reserves in Seam No. 3 in the Hosmer-Wheeler Ridge Area, are said to be 136 million sht in place, of which 87 million sht clean coal may be obtained.

A bulk sample from Wheeler Ridge Seam No. 3 tested in Ottawa's Fuel Research Centre gave the following results (Tab.16).


MICHEL
SPARWOOD RIDGE SOUTH
HOSMER-WHEELER
MARTEN RIDGE NORTH
TENT MT.
FERNIE RIDGE
MARTEN CREEK
MT. TAYLOR EAST
MT. TAYLOR SOUTH
MORRISSEY RIDGE
FLATHEAD RIDGE
LEGEND
PROVEN RESERVES
PARTIALLY EXPLORED RESERVES
PROJECTED RESERVES
KAISER RESOURCES
COAL RESERVES
CROWSNEST COAL FIELD
146-10-1

FIG. 4

Seam No.	Average Seam Intercept (ft)	Reserves in Place 000's sht (all categories) (0 - 2500' Cover)	Reserve a	Reserve b	Potential a & b	Raw Coal Raw Ash %	Raw Coal FSI	Raw Coal Yield %	Clean Coal at S.G.	Clean Coal V.M. %	Clean Coal F.C. %	Clean Coal Ash %	Clean Coal FSI	Clean Coal S %	Clean Coal Fluid dd/m	Clean Coal Moist %
1	5	14 959		x		23.3	1	85.0	1.70	32.1	56.9	8.5	1	0.48	1.0	2.5
2	19	66 890		x		33.5	3	56.3	1.57	32.2	57.4	7.6	6½		189	2.8
3*	35	135 975		x		8.4	7½	91.9	1.50	32.4	57.3	3.8	7½	0.44	390	1.9
4	6	26 800		x		23.4	2½	72.4	1.50	28.7	61.0	8.4	5½	0.45	5.0	1.9
5	7	29 357		x		22.0	1½	66.5	1.45	27.6	63.5	7.2	2½	0.37	0.8	1.7
7 & 8	38	163 085		x	7	31.8	2½	46.4	1.46	28.6	59.7	10.2	5	0.42	891	1.5
					8	14.5	2	81.1	1.48	27.0	63.3	8.5	3	0.40	10	1.2
9	19	159 335		x	U9	23.6	4½	67.4	1.52	29.5	59.3	10.2	6½	0.44	244	1.0
					L9	18.7	5½	81.1	1.60	29.2	60.6	8.4	6	0.41	30	1.8
10	20	80 557		x		15.8	2½	68.7	1.42	29.4	62.4	7.0	7	0.32	45	1.2
	TOTAL	676 958		x												

Tab.18 : Wheeler-Hosmer Ridge, Raw Coal Reserves

* Sample from adit No. 14

a = Strip mining

b = Underground mining

a & b Both strip and underground

4.1.3 PARCEL 73 DEPOSIT

The Parcel 73 deposit in British Columbia, surrounded by ground which is held by Kaiser Resources Ltd., is tied and blocked in by the Dominion Coal Bloc Legislation for further development. The deposit will not be open for development until the Crows-nest Pass Act is amended, which is not likely to happen very soon, because unfortunately in this Act the freight rates are stated in conjunction with rates for wheat from the Western Provinces to the Eastern Provinces of Canada. The area is also legally disputed by the Provinical Government of Alberta and the Federal Government of Canada, who both claim the responsibility and legal rights to the area. Furthermore, Kaiser Resources Ltd. claims that the deposit is located in its sphere of interest and cannot be developed without Kaiser.

4.1.3.1 COAL RESERVES

The two seams, No. 9 and No. 10 are situated in a gently dipping syncline on the base of mapping the outcrops, trenching, 5 adit and six drillholes, the deposit is investigated by the following parameters:

Coal bearing area	2.16 km^2
Average thickness Seam No. 9:	approx. 24 m (9 - 51m)
Average thickness Seam No. 10:	approx. 20 m (7 - 45m) in 2 to 4 plies

Seams No. 9 and No. 10 are separated by 32 m waste material and the overburden is 79 m thick.

Area	Seam No.	Average Seam Intercept (ft)	Reserves in Place 000's sht (all categories) (0 - 2500' Cover)	Reserve Potential a	b	a & b	Raw Coal Raw Ash %	FSI	Clean Coal Yield at %	S.G.	V.M. %	F.C. %	Ash %	FSI	S %	Fluid dd/m	Moist %
North West Half	Composite Coal Thickness	164	128 527		x												
South West Half	10	30	43 113	x[1]			19.2	6½	71.0	1.42	26.4	66.2	6.3	8	0.56	108	1.1
							27.5	5½	58.2	1.42	27.9	64.5	6.0	7½	0.69	710	1.6
	9	60	72 905	x[2]		U9	17.0	4	81.8	1.50	26.9	62.8	9.0	5	0.27	66	1.3
						M9	26.5	3	55.0	1.45	27.4	61.6	9.0	5½	0.39	310	2.0
						L9	17.4	4	71.7	1.45	27.8	61.4	9.2	5½	0.33	51.5	1.6
	8 & 7	37	7 938		x	8	13.0	3½	88.2	1.50	26.8	63.5	8.5	3½	0.33	0	1.2
						7	25.2	2	59.1	1.42	29.1	60.9	8.2	6	0.59	20.9	1.8
	5	10	875		x		15.7	2½	79.4	1.44	28.4	61.4	8.6	5	0.47	7.5	1.6
	4	15	589		x		20.6	2½	72.5	1.50	28.8	60.8	8.8	3½	0.39	3.2	1.6
			253 947														

Tab.19 : Parcel 73 (Dominion Government Bloc), Coal Reserves and Coal Quality

a Strip mining
b Underground mining
a & b Both strip and underground
x[1] 9 Seam probably strippable 5 yds.rocks/sht Coal in place
x[2] No. 10 Seam ratio probably 5 : 1

4.1.4 MARTEN RIDGE DEPOSIT

The location of the Marten Ridge deposit in Kaiser's Crowsnest Coal Field is shown in Fig. 4.

The coal bearing member of the Kootenay Formation in the Marten Ridge Area has seven coal seams of interest. This member also contains three lesser seams and one other seam, M-Seam, is found in the Moose Mountain Member. The coal seams are numbered according to Wheeler Ridge terminology, thus suggesting a tentative correlation.

The coal can be ranked as high volatile bituminous. Due to the high volatile matter content and limited economic reserves, the coal is more or less not of great interest to our group. The reserve problem can be overcome by including the adjacent high volatile coal area Hosmer-Wheeler Ridge.

4.1.4.1 COAL RESERVES

The following parameters were used by Kaiser Resources Ltd. to determine the coal reserves.

A) Probably satisfactory for open pit mining:

1. Seam should have an acceptable coal to overburden ratio (about 7 : 1 used herein).

2. Eighty-five percent recovery of metallurgical coal is used to calculate open pit reserves. Seven and one-half percent pit loss is included in the overburden and oxidized coal is excluded in the calculation of pit ratios.

B) Probably satisfactory for hydraulic mining:

1. Seam should be 20 feet or more in thickness
2. The dip of the seam should be between 7 and 60 degrees
3. The roof rock should be shale and not hard sandstone or conglomerate
4. Fifty percent recovery is used to calculate hydraulic mining reserves

C) Probably satisfactory for conventional mining:

1. Seam should have a minimum of 5 feet and a maximum of 20 feet in thickness
2. Fifteen percent recovery is used to calculate conventional underground mining reserves

D) Possibly not mineable:

1. Seams stratigraphically separated by less than 100 feet (minimum amount of section needed for mining without stress conditions)
2. The lower portion of seams having a thick rock split
3. Fifteen percent recovery is used for seams which are probably not mineable

Conditions are such, that only five of the seven principal seams could be mined by underground method. By hydraulic mining method, 3-, 8U-, 8L and 9L seams would yield 36 206 312 tons of coal. Hydraulic mining areas for 3- and 8U Seams are located on Marten Ridge, where seam thicknesses exceed 20 feet. Those for 8L and 9L Seams are situated on the south branch of Marten Ridge. The tonnage is listed in Tab.21.

Seam	MARTEN RIDGE			MARTEN RIDGE - SOUTH BRANCH		
	COAL (SHT)	OVERBURDEN (BCYD)	RATIO (BCYD:SHT)	COAL (SHT)	OVERBURDEN (BCYD)	RATIO (BCYD:SHT)
2	341,837			31,860		
3	812,573			92,936		
2-3 Pit	1,154,410	8,694,471	7.53:1	124,796	932,025	7.47:1
5U	618,943			80,349		
5L	704,770			72,824		
5 Pit	1,323,713	7,561,074	5.71:1	153,073	951,529	6.22:1
2-3-5-Pit	2,478,123	16,255,545	6.56:1			
7	60,910	475,969	7.81:1	180,232	1,153,087	6.40:1
5-7 Pit				333,305	2,104,616	6.31:1
8U	66,451	394,914	5.94:1	344,993	3,057,952	8.86:1
8L	77,951	524,499	6.73:1	424,898	2,782,602	6.55:1
8U-8L Pit	144,402	919,413	6.37:1	769,891	5,840,554	7.59:1
9U	39,273					
9L	80.963					
9 Pit	120,236	778,653	6.48:1	534,507	3,555,825	6.65:1
Pit Totals:	2,803,671	18,429,580	6.57:1	1,762,499	12,433,020	7.05:1

Tab. 20 :O/P Raw Coal Reserves of Marten Ridge and Marten Ridge South Branch.

Table 21 : Marten Ridge area reserve summary (U/G and O/P)

Seam	Cover-feet	Tons in Place 0-15	15 - 30	30 - 90	TOTAL	Open Pit	Tons Recoverable U/G Hydraulic	U/G Conventional	Possibly Not Mineable	Oxidized	Reserve Classification
2	0-1500	-	863,224	4,194,795	5,058,019	373,697	too thin	stress	665,540	181,447	partially explored
	1500-2500	-	-	2,935,694	2,935,694	-	too thin	stress	440,354	-	partially explored
	2500	-	-	5,517,392	5,517,392	-	-	-		-	projected
					13,511,105						
3	0-1500	-	1,884,686	14,396,956	16,281,642	905,509	7,344,151	-	-	462,010	partially explored
	1500-2500	-	-	12,532,035	12,532,035	-	6,266,018	-	-	-	partially explored
	2500	-	-	21,777,125	21,777,125	-	-	-	-	-	projected
					50,590,802						
5U	0-1500	-	1,632,105	5,930,866	7,562,971	695,192	too thin	962,343	-	223,226	partially explored
	1500-2500	-	-	3,000,627	3,000,627	-	too thin	450,093	-	-	partially explored
	2500	-	-	9,594,631	9,594,631	-	-	-	-	-	projected
					20,158,229						
5L	0-1500	-	1,753,282	7,115,669	8,868,951	777,594	too thin	split	1,256,481	268,144	partially explored
	1500-2500	-	-	6,497,952	6,479,952	-	too thin	split	971,993	-	partially explored
	2500	-	-	13,484,346	13,484,346	-	-	-	-	-	projected
7	0-1500	-	2,082,777	6,523,231	8,606,008	241,142	too thin	1,209,849	-	256,649	partially explored
	1500-2500	-	4,827,882	4,827,882	4,827,882	-	too thin	724,182	-	-	partially explored
	2500	-	10,164,574	10,164,574	10,164,574	-	-	-	-	-	projected
8U	0-1500	-	4,204,655	12,506,490	16,711,145	411,444	1,461,263	1,917,711	-	519,830	partially explored
	1500-2500	-	-	10,735,401	10,735,401	-	too thin	1,610,310	-	-	partially explored
	2500	-	-	26,179,622	26,179,622	-	-	-	-	-	projected
					53,626,168						
8L	0-1500	-	5,277,584	8,940,070	14,217,654	502,849	2,818,204	stress	1,145,189	351,065	partially explored
	1500-2500	-	29,133	7,606,229	7,635,362	-	too thin	stress	1,145,304	-	partially explored
	2500	-	-	23,198,339	23,198,339	-	-	-	-	-	projected
					45,051,355						
9U	0-1500	-	-	1,884,314	1,884,314	39,273	too thin	split	261,151	97,098	partially explored
	1500-2500	-	-	-	-	-	-	-	-	-	
	2500	-	-	-	-	-	-	-	-	-	
					1,884,314						
9L	0-1500	-	7,345,625	16,466,689	23,812,313	615,470	10,504,919	229,242	-	660,113	partially explored
	1500-2500	-	880,762	14,676,751	15,557,513	-	7,778,757	-	-	-	partially explored
	2500	-	-	51,348,447	51,348,447	-	-	-	-	-	projected
					90,718,273						
		-	25,953,833	302,018,126	327,971,959	4,566,170	36,206,312	7,103,730	5,886,012	2,909,572	
			Total in Place								

quantities are given in short tons

Conventional underground mining on 2-, 5L-, part of 8L and 9U seams would be prohibited by either rock splits in the coal or less than 100 feet section between seams and the coal from such seams must therefore be classified as "not mineable".

Further reserves are located in the Marten Ridge - South Extension Area. Reserve figures are for a 25 degree westerly dip of the sediments but no attempt was made to separate the reserves into various "cover" categories. The reserves are shown in the following Tab. 22.

The dips of the coal seams in the Marten Ridge Area, although reported mainly in the 30 to 90 degree range, average only slightly more than 30 degrees. The O/P reserves are shown in Tab.20, and Tab.21 gives the total reserves (U/G + O/P).

Seam		Projected Thickness	Tons in Place in thousand tons
Marten Creek Area	Marten Ridge Area		
B	2	5.0	12 778 000
7	3	19.7	50 344 000
5	5U	7.4	18 911 000
5	5L	10.4	26 587 000
	7	7.2	18 400 000
	8U	16.0	40 889 000
	8L	11.4	29 133 000
	9	26.3	67 211 000
		TOTAL:	264 211 000

Tab. 22 : Summary of Marten Ridge - South Extension Coal Reserves

Two main seams outcrop in the Marten Creek Area in the upper 450 feet of Kootenay Formation. The upper seam, B Seam, reaches a maximum thickness in the area of 15.0 feet. It occurs from 0 to 60 feet under the Basal Elk Conglomerate, or in some cases, sandstone. The roof varies from silty shale on Marten Ridge and the north end of Leach Ridge to sandstone and conglomerate on the southern part of Leach Ridge.

The second of the main seams, #7 Seam, occurs 250 to 360 feet lower in the section and reaches a maximum thickness of 18.0 feet. The roof is a silty shale, but a sandstone and/or conglomerate bed occurs just above the shale. No exposures of this seam could be found on Leach Ridge, because of heavy overburden.

Another seam, #5 Seam, occurs 140 to 190 feet below #7 Seam. The coal in this seam on Marten Ridge is very shaley with abundant shale splits. The seam could not be located on Leach Ridge, because of heavy overburden. For the above reasons, tonnages were not estimated for this seam.

4.1.5.1 COAL RESERVES

Coal thicknesses for the calculated areas are as follows:

B-Seam	10.0 to 15.0 ft
No. 7 Seam	12.0 to 18.0 ft
No. 5 Seam	9.0 to 18.0 ft for the above mentioned reasons, reserves were not calculated for this seam.

Reserves were calculated for depth of cover increments of 0 to 1500 ft, 1500 to 2000 feet, and 2000 to 2500 feet. None of the dips used for calculations exceed 30^{o}. All coal is considered as underground, because of the dip of the beds into the ridges.

At the time of the reserve calculations, quality parameters could not be considered, since only limited surface channel sampling was undertaken. Tab.24 presents the estimated probable reserves for areas and cover increments. Probable reserves are calculated for the 0-1500 foot increment, where reliable surface measurements are available from cross-sections. Possible reserves are classified as those with 1500 to 2500 feet of cover and those in the 0-1500 feet cover increment, where extrapolation of surface data was used in the computation.

Boundaries	B-Seam	No. 7 Seam	Totals
0-1500 Probable	25.177	11.221	36.398
0-1500 Possible	15.102	18.578	33.680
1500-2000 Possible	54.612	36.215	90.827
2000-2500 Possible	36.901	61.903	98.804
	131.792	127.917	259.709

Tab.24: U/G Reserves Marten Creek Area, in Million of Tons.

4.1.5.2 COAL QUALITY

One adit per seam was driven, and samples were tested of seams No. 7, No. 5 and B. The results are computed in the following Tab. 25.

In general terms, the coal of the Marten Ridge, Marten Creek and Hosmer-Wheeler Ridge indicates high volatile matter content.

4.1.6 BURNT RIDGE AREA DEPOSIT

Burnt Ridge, Burnt Ridge Extension, the Green Hills and the Ewin Creek licenses comprise Kaiser Resources Ltd.' Burnt Ridge Area in the Elk Valley Coal Field. Kaiser's Burnt Ridge Area is roughly triangular in shape and is centered approximately 22 miles north of Sparwood, British Columbia and 4 miles northeast of the new town of Elkford, B.C., which was built to accommodate employees of Fording Coal Co. Ltd. (Fig. 5).

The whole area is made up of 25 120 acres of former C.N.I land (including 2420 acres in four coal licenses within the Ewin Creek, Todhunter Creek drainage area). The Burnt Ridge, and Burnt Ridge Extension Areas are in the preliminary stages of geological investigations. In Burnt Ridge, 7 adits have been driven in 7 seams. One adit has been driven in the Burnt Ridge Extension Area in the Basal Seam (= Balmer Seam).

A Canadian Pacific Railway spur line, which links the Fording Coal operation to the CPR mainline at Sparwood, passes between Burnt Ridge and Burnt Ridge Extension.

Good access to the Burnt Ridge Area is provided by logging road. A Government maintained highway now connects Sparwood to Elkford and extends to the Fording Coal operation.

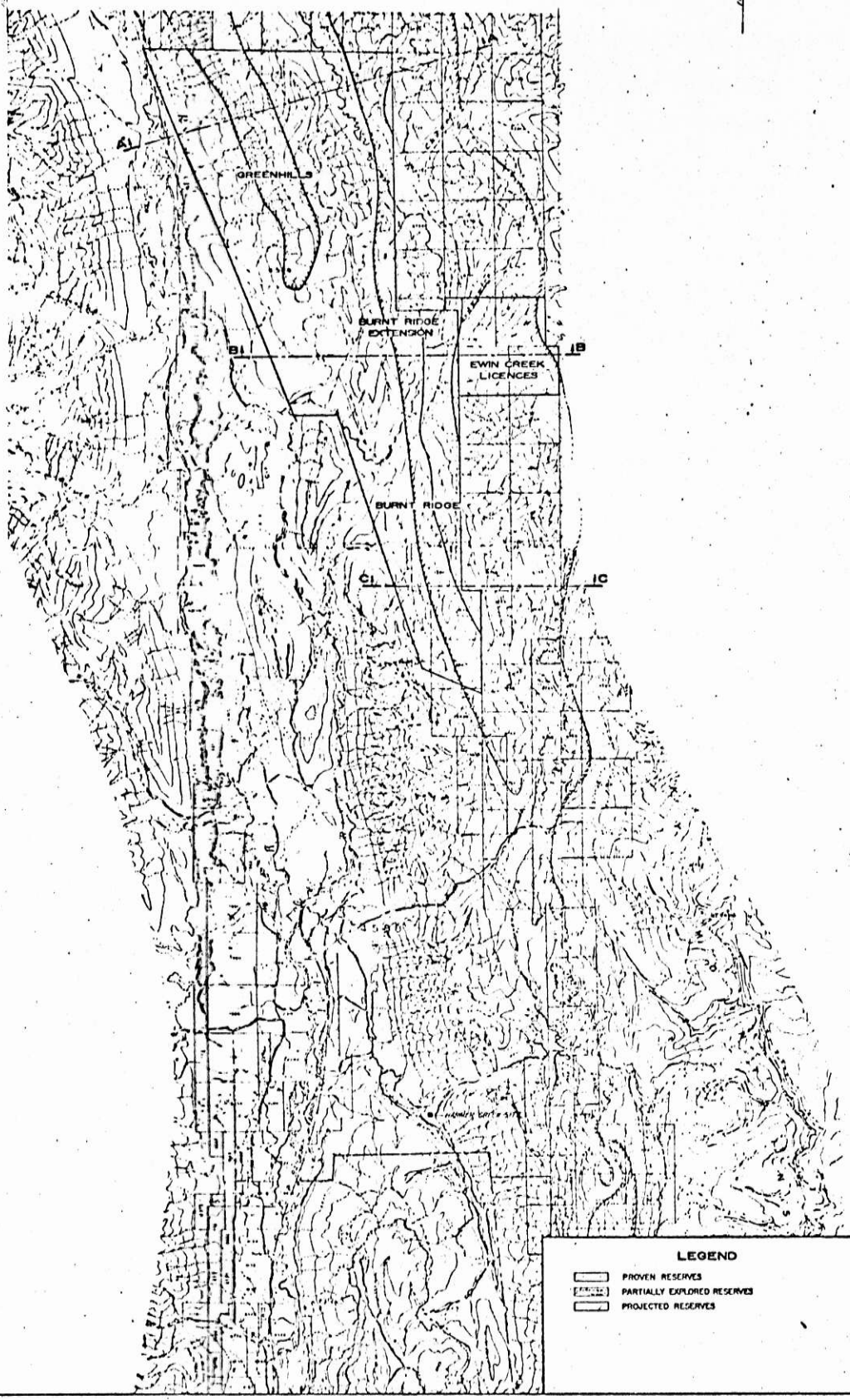


FIG. 5

LEGEND

- PROVEN RESERVES
- PARTIALLY EXPLORED RESERVES
- PROJECTED RESERVES

KAISER RESOURCES

COAL RESERVES

ELK VALLEY COAL FIELD

DATE APRIL, 1973

146-10-2

4.1.6.1 COAL RESERVES BURNT RIDGE AND BURNT RIDGE EXTENSION

At the present stage of information available, the coal reserves are only calculated by surface information. The Burnt Ridge and Burnt Ridge Extension lie on the west limb of a broad syncline and the Ewin Creek licenses are on the east limb.

The strata of the west limb of the syncline strike generally north-south and dip 25 - 65 degrees to the east. The strata on the east limb have the same general strike and dip 20 - 50 degrees west. Compression faults and large drag folds can be observed within the Kootenay Formation in the west limb of the syncline, indicating possible thickening and/or thinning of the coal.

The reserves are listed in Tab.27. The reserves amount to 274.4 million sht possible raw coal in place, of which approximately 19.2 million sht raw coal in place may be strippable. Due to the steep dip and thicknesses, most of the reserves are applicable to hydraulic method (note the thicknesses of Seam No. 3 and No. 7 at Burnt Ridge).
The overburden ratio for the combined O/C reserves in both areas is approximately 4.4 bcyd : 1 sht raw coal.

4.1.6.2 COAL QUALITY

7 adits were driven in 7 seams on Burnt Ridge and one adit on Burnt Ridge Extension in Seam No. 10 (Basal Seam = Balmer Seam). The results on washability are compiled in the following Tab. 28.

Tab.27 : PRELIMINARY RESERVE ESTIMATE, Burnt Ridge Areas (Page)
(Based on surface observations)

Total Reserves

		Thickness In Feet	Coal in Place NT	
Burnt Ridge				
North End	#1 Seam	26'	14,900,000	
	#2 Seam	21'	9,200,000	
West of Fault	#3 Seam	37'	14,100,000	
(to 1500' Cover	#4 Seam	20'	5,400,000	
On #1 Seam - Upper	#5 Seam	16'	3,500,000	
Seams less within	#6 Seam	16'	3,000,000	
property).	#7 Seam	38'	5,200,000	
			55,300,000	55,300,000
Central	#3 Seam	25'	25,400,000	
(to 2500' Cover)	#7 Seam	40'	39,200,000	
			64,600,000	64,600,000
South End	#3 Seam	28'	11,500,000	
	#4 Seam	12'	5,100,000	
(to 2500' Cover)	#7 Seam	37'	16,100,000	
			32,700,000	32,700,000
				152,600,000
				Sht Ra
Burnt Ridge Extension				
North End	#1 Seam	25'	89,900,000	
(to 2500' Cover)				
South End			32,900,000	
(to 1000' Cover)				
			122,800,000	122,800,000)Sh
TOTAL INFERRED RESERVES				274,400,000)Ra

Strippable Reserves *

Burnt Ridge		
Seam #3	1,315,400	
Seam #4	849,100	
Seam #6	272,600	
Seam #7	8,586,700	
TOTAL COAL	11,023,800	Sht Raw in place
TOTAL O.B.	45,646,600	Cubic Yards

Stripping Ratio - 4.1 : 1

Burnt Ridge Extension

Seam #1	8,200,000	Sht Raw in place
TOTAL O.B.	38,800,000	Cubic Yards

Stripping Ratio - 4.7 : 1

* To calculate strippable reserves, 40 degree pit walls were used in all cases. For stripping ratios no allowance was made for pit loss or oxidation.

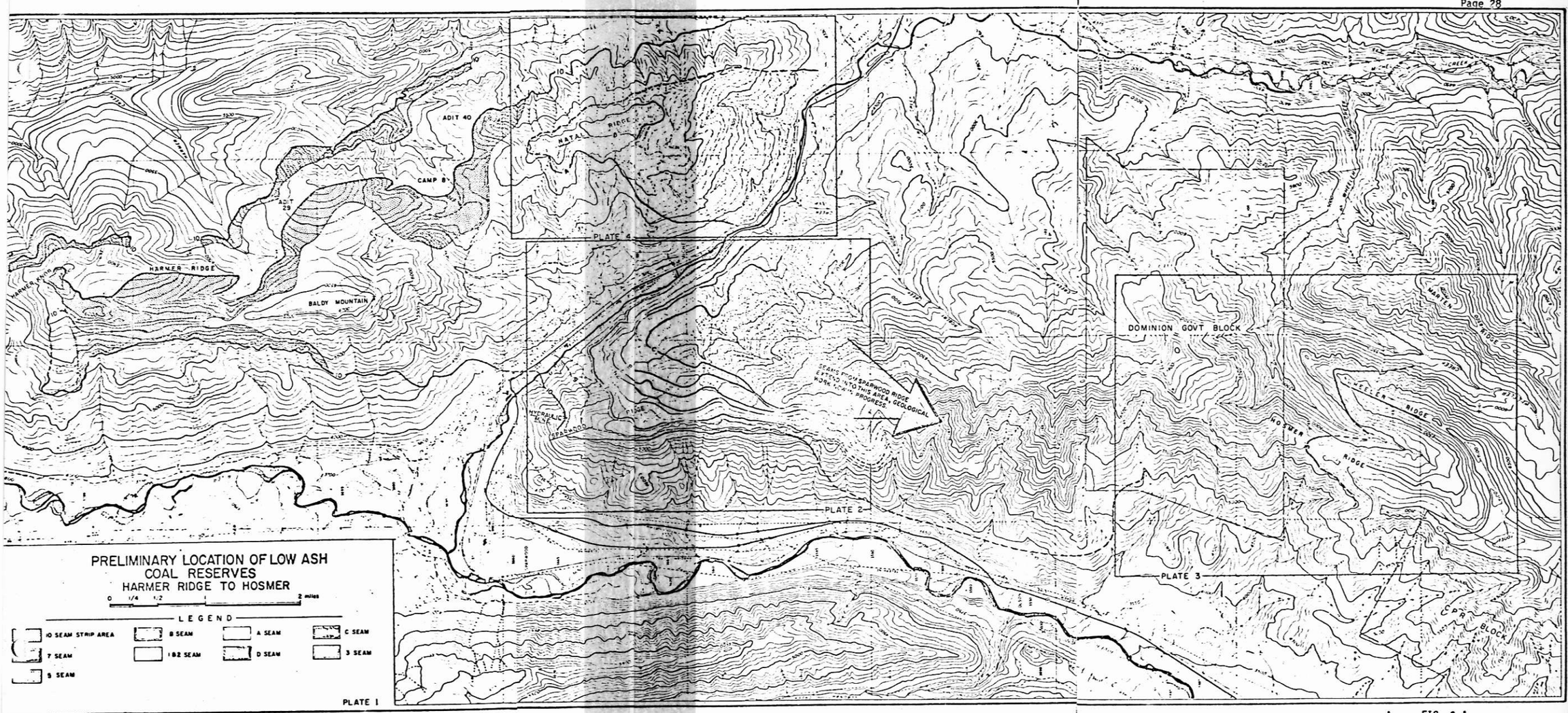

ADIT 40
CAMP 8
ADIT 29
HARMER RIDGE
BALDY MOUNTAIN
HARMER KNOB
NATAL RIDGE
PLATE 4
PLATE 2
PLATE 3
DOMINION GOVT BLOCK
HOSMER RIDGE
CEDAR BLOCK
SEAMS FROM SPARWOOD RIDGE EXTEND INTO THIS AREA. GEOLOGICAL MAPPING IN PROGRESS
PRELIMINARY LOCATION OF LOW ASH COAL RESERVES
HARMER RIDGE TO HOSMER
0 1/4 1/2 1 2 miles
LEGEND
10 SEAM STRIP AREA
7 SEAM
5 SEAM
B SEAM
1 B2 SEAM
A SEAM
D SEAM
C SEAM
3 SEAM
PLATE 1

FIG. 3 A

The available information indicates clearly that the coal falls in the medium volatile matter range. So far, only No. 7 Seam and Seam No. 1 indicate coking coal quality. The sample of Seam No. 6 was oxidized. Seam No. 7 shows acceptable coking characteristics for stability, hardness and JIS + 15mm, but Seam No. 1 shows inferior coking characteristics to Seam No. 7 for stability, hardness and JIS + 15mm.

4.1.7 FLATHEAD RIDGE DEPOSIT

The Flathead Ridge Area is located in southeastern British Columbia, in Kaiser's Crowsnest Coal Field, 18 to 20 miles southeast of Fernie and approximately 16 miles west of Elko. The overall length of the area is approximately 13.5 miles and the width varies from 0.6 miles to 1.5 miles.

The CP Railroad follows along the east bank of the Elk River about eight miles west of the property.

A two ton bulk sample was taken from each of the adits for washability and carbonization tests. On Flathead Ridge, at the west end of the property, the general attitude of the beds is northwest southeast and dipping to the northeast between 20 and 35 degrees. Faults which occur are mainly low angle reverse faults, which dip to the east-northeast and have displacements from a few feet to several hundred feet.
At the north end of the property, the beds strike north-south and dip to the west between 30 and 60 degrees.

4.1.7.1 COAL SEAMS - WEST LODGE POLE

Six coal seams are exposed at the west end of the Flathead Ridge.

1 Seam: One seam is the lowest seam in the section and where it has been cut, it lies directly on the Moose Mountain Member. In adit No. 1, one seam is 46.0 feet thick and is sheared and slickensided. Several siltstone bands up to 0.8 feet in thickness occur in the adit and the coal is dirty with a raw ash of 26.1% (db).

3 Seam: Three seam is 365 feet up section from the top of the Moose Mountain and it is 30.6 feet thick at the portal of adit #2. The coal in the adit is sheared and contoured, so that the seam thickness at the adit crosscut could not be determined. The coal has several bands of hard, dark gray siltstone up to 0.5 feet in thickness and has a raw ash of 22.5% (db). The footwall is interbedded dark gray and black shales and the hanging wall rock is hard, dark gray shale.

4 Seam: Four seam is 725 feet up section and is 22.6 feet thick in adit #3. The coal in the adit contains minor shale bands, less than 0.2 feet in thickness and has an overall raw ash of 18.8% (db). The footwall rock is interbedded, dark gray and black shale with coal stringers. The hanging wall rock is a hard, dark gray, massive siltstone which grades upward into a fine to medium grained sandstone.

5 Seam: Five seam is 920 feet up section from the Moose Mountain Member and in two cuts 500 feet apart the seam measured 26.5 feet and 30.0 feet. The coal in the outcrop contains minor shale partings up to 0.1 feet in thickness and has an overall raw ash (db) in the two cuts of 13.6% and 10.1%. The footwall rock is dark gray shale, interbedded with minor coal stringers. The hanging wall rock is dark gray shale.

6 Seam: Six seam is 960 feet up section from the top of the Moose Mountain. It is exposed in the same cuts as 5 Seam and measures 10.3 feet and 7.1 feet in thickness. The coal is clean, except for one or two boney bands and the raw ash (db) in the two cuts is 13.5% and 16.6%. Six seam is separated from 5 Seam by about 15 feet of interbedded siltstone and shale with minor coal stringers. The hanging wall rock is a gray shale which grades upward into bedded siltstone.

7 Seam: Seven seam is 1,140 feet up section from the Moose Mountain. The only exposure on seven seam is along the main access road and at this point the seam measures 19.5 feet. The seam is clean, except for one shale band 0.1 feet thick, with a raw ash of 7.3% (db) in the outcrop. The footwall rock is very hard, massive dark gray siltstone and fine grained sandstone. The hangingwall consists of 1.5 feet of gray silty shale and 1.6 feet of boney coal followed by dark gray massive siltstone which grades upward over two feet into a massive fine grained sandstone.

4.1.7.2 COAL SEAMS - NORTH LODGE POLE

Three seams were exposed on the west side of North Lodge Pole Creek. The two lower seams, #1 and #3, were so badly faulted where they were cut, that they could not be measured.

5 Seam: Five seam was cut in two places, 3,800 feet apart. In the first cut, the seam measures 21.0 feet and has a raw ash of 9.5% (db). In the second cut, the seam is 34.0 feet thick and has a raw ash of 14.0% (db). In the first cut, the hanging wall rock is a massive fine grained, silty sandstone with a 0.5 foot thick carbonaeous shale band five feet above the hanging wall. The coal in the second cut has a hanging wall of bedded siltstone.

4.1.7.3 COAL SEAMS - MC LATCHIE CREEK

Three coal seams were exposed and cut on the northeast end of the property on the ridge between McLatchie Creek and Foisey Creek.

L 1 Seam: Lower one seam is 40 to 50 feet above the Moose Mountain and is 21.8 feet thick. The seam is dirty, with rock splits up to 0.5 feet thick, and has a raw ash of 40.3% (db). The hanging wall rock is gray shale interbedded with siltstone.

4 Seam: Four seam is approximately 750 feet up section from the Moose Mountain and is 24.5 feet thick. The seam appears clean, but the proximate analysis on the outcrop sample shows a raw ash of 38.2% (db). The hanging wall is a gray, sandy shale.

The parameters used for the coal reserves calculation are the same as for the Marten Ridge deposit.

4.1.7.4 COAL RESERVES

Table 29 shows the total coal in place, up to 2,500 feet of cover, broken down by seam and area, in the Flathead Ridge.

Table 30 shows the coal for each area and indicates the amount of coal which exists from 0 to 1500 feet, 1500 to 2500 feet plus 2500 feet of cover for dip conditions of 0 - 15^{0}, 15 - 30^{0} and 30 - 60^{0}. The 30 - 60^{0} dip category includes all coal that has greater than a 30 degree dip. In calculating tonnages, the true thickness was used and no correction was made for the dip of the seam. Projected reserves were calculated for the North Lodge Pole area. east of section 44, and are included in Table 30 . For calculation purposes, Seams 1, 3 and 5 were projected by Kaiser Resources Ltd.

TABLE 29 : COAL IN PLACE - FLATHEAD RIDGE

McLatchie	L 1 Seam	24,576,485	
Total			24,576,485
McLatchie	1 Seam	40,538,664	
West Lodgepole	1 Seam	100,642,723	
North Lodgepole	1 Seam	67,390,638	
East of Sec. HH	1 Seam	35,617,000	
Total			244,189,025
West Lodgepole	3 Seam	64,732,340	
North Lodgepole	3 Seam	38,447,872	
East of Sec. HH	3 Seam	19,583,000	
Total			122,763,212
McLatchie	4 Seam	16,958,170	
West Lodgepole	4 Seam	33,030,084	
North Lodgepole	4 Seam	3,060,212	
Total			53,048,466
West Lodgepole	5 & 6 Seam	21,440,256	
North Lodgepole	5 Seam	8,880,766	
East of Sec. HH	5 Seam	8,913,800	
Total			39,234,822
West Lodgepole	7 Seam	11,004,511	
Total			11,004,511
Total NT of Coal in Place to 2500 Feet of Cover			494,816,521

Table 30: Coal Reserves According to Dips, Seams and Cover Thicknesses.

FLATHEAD RIDGE (West Lodgepole Area) compilation of tons of coal in place for each seam. Calculations include all area within property boundary up to Section M.

Seam No.	Approx. Average Thickness	Cover in Feet	0° - 15° %	0° - 15° Tons	15° - 30° %	15° - 30° Tons	30° - 60° %	30° - 60° Tons	Total Tons of Coal in Place
1	42.0'	0-1500	35.7	18,674,867	63.5	33,217,201	0.8	418,485	52,310,553
		1500-2500	30.2	14,596,315	69.8	33,735,855	-	-	48,332,170
		2500+	40.0	660,562	60.0	990,842	-	-	1,651,404
									102,293,127
3	30.0'	0-1500	46.6	22,464,373	53.4	25,742,435	-	-	48,206,808
		1500-2500	19.0	3.139,851	81.0	13,385,681	-	-	16,525,532
									64,732,340
4	19.0'	0-1500	36.1	10,700,332	63.9	18,940,476	-	-	29,640,808
		1500-2500	53.1	1,799,706	46.9	1,589,570	-	-	3,389,275
									33,030,084
5 & 6	34.0'	0-1500	0.9	180,761	99.1	19,903,835	-	-	20,084,596
	combined	1500-2500	35.0	474,481	65.0	881,179	-	-	1,355,660
									21,440,256
7	18.0	0-1500	4.1	451,185	95.9	10,553,326	-	-	11,004,511
									11,004,511

FLATHEAD RIDGE (North Lodgepole) Compilation of tons of coal in place for each seam. Calculations include all areawithin property boundary up to Section AA. and Section HH.

1	40.0'	0-1500	35.8	11,355,455	60.1	19,063,209	4.1	1,300,485	31,719,149
		1500-2500	64.6	23,043,782	33.8	12,056,963	1.6	570,744	35,671,489
		2500+	100.0	1,356,106	-	-	-	-	1,365,106
									68,755,744
3	26.0'	0-1500	54.4	13,333,278	41.9	10,269,565	3.7	906,859	24,509,702
		1500-2500	50.9	7,099,619	49.1	6,848,551	-	-	13,948,170
									38,447,872
4	19.0'	0-1500	36.0	1,099,639	64.0	1,954,914	-	-	3,054,553
		1500-2500	-	-	100.0	5,659	-	-	5,659
									3,060,212
5	21.0'	0-1500	43.6	3,872,014	56.4	5,008,752	-	-	8,880,766
									8,880,766

FLATHEAD RIDGE (McLatchie Creek Area). Compilation of tons of coal in place for each seam. Calculations include all area within the property boundary and between Section Mc-1 and Section Mc-31,

L1	21.8'	0-1500	-	-	-	-	100.0	15,076,323	15,076,323
		1500-2500	-	-	30.9	2,935,550	69.1	6,564,611	9,500,162
		2500+	-	-	82.1	1,238,375	17.9	269,999	1,508,374
									26,084,859
1	36.7'	0-1500	-	-	-	-	100.0	24,804,515	24,804,515
		1500-2500	-	-	31.7	4,987,735	62.9	9,896,779	15,734,149
		2500+	-	-	83.3	586,705	16.7	117,623	704,328
									41,242,992
4	24.5'	0-1500	-	-	2.5	327,987	97.5	12,791,502	13,119,489
		1500-2500	-	-	75.5	3,051,751	20.5	786,930	3,838,681

TABLE 31: FLATHEAD RIDGE - RECOVERABLE RESERVES TO 2500 FEET OF COVER (ALL AREAS)

AREA	SEAM #	RECOVERABLE RESERVES	TYPE OF RESERVES	MINING METHOD AND REMARKS
West L.P.	1	50,321,361 tons	Part. Exp.	Hydraulic Mining. High ash coal.
	3	32,366,170 tons	Part. Exp.	Hydraulic Mining. High ash coal.
	4	4,954,512 tons	Part. Exp.	Probably not mineable, dips too steep for conventional mining and roof rock not suitable for hydraulic mining.
	5	2,363,788 tons	Part. Exp.	Probably not mineable due to proximity of 6 seam.
	6	818,698 tons	Part. Exp.	Probably not mineable, dips too steep for conventional mining and seam too thin for hydraulic mining.
	7	1,650,767 tons	Part. Exp.	Probably not mineable, dips too steep for conventional mining and roof rock unsuitable for hydraulic mining.
North L.P.	1	33,695,318 tons	Part. Exp.	Hydraulic Mining } Due to the high degree of faulting in this area, mining by any method could prove very difficult. The suitability of 5 seam roof rock for hydraulic mining is also questionable.
	3	19,228,936 tons	Part. Exp.	Hydraulic Mining
	4	1,530,036 tons	Part. Exp.	Hydraulic Mining
	5	4,440,383 tons	Part. Exp.	Hydraulic Mining
McLatchie	LI	12,288,243 tons	Part. Exp.	Hydraulic Mining. High ash coal.
	1	20,269,332 tons	Part. Exp.	Hydraulic Mining. High ash coal.
	4	8,479,090 tons	Part. Exp.	Hydraulic Mining. High ash coal, good roof rock for hydraulic mining.

192,406,674 Total Tons Raw Coal (Partially Explored, Recoverable)

from the west side of the North Lodge Pole Creek and it was assumed that all the coal is within 2500 feet of the surface.

Table 31 lists the recoverable reserves, which are probably using the most suitable mining method as determined by use of the criteria listed under "Coal Reserves - Recoverable". After application of the criteria, it appears that none of the seams are suitable for conventional underground mining, and where hydraulic mining is applicable, only high ash coal is obtainable or the area is heavily structured in the geological way. It appears therefore, that the coal of the Flathead area is not interesting to our group.

Summarizing the results of the Flathead investigation, the following conclusions can be made:

The coal in the lower seams in the Flathead Ridge is high ash coal and is probably not suitable for mining under present economic conditions.

Hydraulic underground mining seems to be the only suitable method for mining coal in the Flathead Ridge area, since in the most cases, dips are too steep for conventional underground mining methods. The upper seams in the West Lodge Pole area appear to be good quality coal, although they have not yet been bulk sampled.

4.1.7.5 COAL QUALITY (Tab.32)

The coal quality of the seams, which accumulate quite a recoverable potential (Seam No. 1 and No. 3) show a high ash clean coal product. The washability of Seams No. 4, 5, 6 and 7 is much better, despite the fact that no yield figures were obtainable, but most of the reserves in these are not mineable, due to unfavorable geological

conditions (see remarks in Tab.32). Volatile matter content is in the desirable low to medium range.

Due to these facts, the Flathead area does not seem of great interest to us.

Nowhere to date has coal been found in the Flathead Ridge Area, which could be extracted by strip mining methods.

4.1.8 FERNIE RIDGE AND MORRISSEY RIDGE DEPOSITS

The Fernie Ridge and Morrissey Ridge Areas in Kaiser's Crowsnest Coal Field are located 5 to 10 miles northeast and southeast of the town of Fernie, B.C. respectively. Both areas were actively explored for coal occurrences during 1960 and 1961 by United States Steel Corporation.

The Coal Creek and Elk River Collieries, situated between these two areas, were operated from 1897 to 1958 when it was closed because of the lack of market, having produced over 20 million tons of coal. The Carbonado Colliery operated mines in the Morrissey Ridge 1902 through 1909, and produced a total of 486 000 tons.

Provincial Highway No. 3 and the Canadian Pacific Railroad generally follow the Elk River, which flows some two miles to the west of both Fernie Ridge and Morrissey Ridge. Rail distance to the port at Roberts Bank is about 670 miles

4.1.8.1 COAL RESERVES AND COAL QUALITY

Between 9 and 11 coal seams were measured varying from 6 to 40 feet in thickness. The coal reserves according to seam, seamcover and

RESERVES - FERNIE RIDGE

SEAM	SEAM THICK.	0° - 1500' COVER: 0°-15°(1.0086) PLAN. READ.	AREA ACRES	TONS IN PLACE	15°-30°(1.0824) PLAN. READ.	AREA ACRES	TONS IN PLACE	30°-60°(1.4142) PLAN. READ.	AREA ACRES	TONS IN PLACE	TOTAL (000's) PLAN. READ.	AREA ACRES	TONS IN PLACE	1500' - 2500' COVER: 0°-15° (1.0086) PLAN. READ.	AREA ACRES	TONS IN PLACE	15°-30° (1.0824) PLAN. READ.	AREA ACRES	TONS IN PLACE	30°-60° (1.4142) PLAN. READ.	AREA ACRES	TONS IN PLACE	TOTAL (000's) PLAN. READ.	AREA ACRES	TONS IN PLACE
1	14.1	-			3.85	353.5	10,036	9.44	866.9	32,005	13.29	1220.4	42,041	0.92	84.5	2,226	2.10	192.8	5,474	6.46	593.2	21,902	9.48	870.5	29,602
2	22.0	-			3.41	313.1	13,827	9.89	908.2	52,402	13.30	1221.3	66,229	1.92	176.3	7,262	2.06	189.2	8,353	6.79	623.5	35,977	10.77	989.0	51,592
3	13.2				2.10	192.8	5,116	6.86	630.0	21,855	8.96	822.8	26,971	2.85	261.7	6,458	1.91	175.4	4,653	5.12	470.2	16,312	9.88	907.3	27,423
4	11.2	-			-			3.50	321.4	9,421	3.50	321.4	9,421	-			-			3.28	301.2	8,829	3.28	301.2	8,829
5	23.8	0.39	35.8	1,595	1.88	172.6	8,264	10.14	931.2	58,218	12.41	1139.6	68,077	4.23	388.4	17,296	1.32	121.2	5,802	7.72	708.9	44,324	13.27	1218.5	67,422
6	9.1	-			-			6.51	597.8	14,308	6.51	597.7	14,308	-			-			5.26	483.0	11,560	5.26	483.0	11,560
7	9.8	1.92	176.3	3,238	1.75	160.7	3,160	10.42	956.9	24,676	14.09	1293.9	31,074	6.60	606.1	11,132	0.89	81.7	1,607	10.46	960.5	24,771	17.95	1648.3	37,510
8	20.4	2.72	249.8	9,546	0.51	46.8	1,920	6.72	617.1	32,973	9.95	913.7	44,439	7.10	652.0	24,918	1.10	101.0	4,142	5.38	494.0	26,398	13.58	1247.0	55,458
9	10.6	7.83	719.0	14,274	1.14	104.7	2,234	12.08	1109.3	30,871	21.05	1933.0	47,379	17.22	1581.3	31,391	5.28	484.9	10,345	7.73	709.8	19.754	30.23	2776.0	61,490
10	8.0	7.54	692.4	10,367	0.62	56.9	919	3.42	314.1	6,584	11.58	1063.4	17,870	19.33	1775.1	26,675	2.80	257.1	10,731	0.25	23.0	481	22.38	2055.2	37,887
8	14.7	7.64	701.6	19,264	1.55	142.3	4,199	12.11	1112.1	42,914	21.30	1956.0	66,377	21.24	1950.5	53,556	7.24	664.8	19,612	8.27	759.4	29,306	36.75	3374.7	102,474
													434,186												

RESERVES - MORRISSEY RIDGE

1	23.7	0.31	28.5	1,262	22.32	2049.6	97,728	-			22.63	2078.1	98,990	4.21	386.6	17,142	13.32	1223.2	58,322	-			17.53	1609.8	75,464
2	18.0	0.96	88.2	2,977	22.92	2104.7	76,145	-			23.88	2192.9	79,122	6.61	607.0	20,496	11.70	1074.4	38,870	-			18.31	1681.4	59,366
3	31.4	0.66	60.6	3,564	14.90	1368.3	86,309	-			15.56	1428.9	89,873	2.10	192.8	11,342	8.55	785.1	49,527	-			10.65	977.9	60,869
4	13.6				5.08	466.5	12,723	-			5.08	466.5	12,723	-	-		3.10	284.7	7,764	-			3.10	284.7	7,764
5	12.2				10.03	921.1	22,556	-			10.03	921.1	22,556	-	-		6.58	604.2	14,798	-			6.58	604.2	14,798
6	7.9				2.76	253.5	4,044	-			2.76	253.5	4,044	1.63	149.7	2,222	4.46	409.6	6,535	-			6.09	559.3	8,757
7	16.7				1.43	131.3	4,410	-			1.43	131.3	4,410	-	-		1.10	101.0	3,392	-			1.10	101.0	3,392
8	7.2				1.24	113.9	1,648	-			1.24	113.9	1,648	-	-		1.83	168.0	2,432	-			1.83	168.0	2,432
9	11.1				5.26	483.0	10,754	-			5.26	483.0	10,754	17.15	1574.9	32,725	10.39	954.1	21,242	-			27.54	2529.0	53,967
10	7.6				1.37	125.8	1,914	-			1.37	125.8	1,914	-	-		3.02	277.3	4,219	-			3.02	277.3	4,219
													326,034												291,028

Planimeter Reading x 91.83 = Area in Acres.

Planimeter Reading (Sec. Dip) Thickness (170,370) = Tons Coal Raw.

$$\frac{4 \times 10^6 (1.15)}{27}$$

Tab. 33 : Raw Coal Reserves Fernie - And Morrissey Ridge

Grand Total 0 - 2500 feet 545,062 Thousand Tons in Place

No. of Seam	Average Thickness (ft)	Adit No.	Raw % Ash	Coal FSI	Clean Coal Yield @ 1.55 S.G.	% Ash	% V.M.	% F.C.	FSI	% Sulphur	0°-35°	15°-30°	30°-60°	Mine Ability	Reserve Class	Recovery, in Thousand Tons Clean Coal
e Ridge											Dip, Thousand Tons					
1	14.1	19	22.5		71	13.5	19.6	66.9	1.0	0.53	236	1650	5740	B	Ind	7626
2	22.0	22	40.3	1.0	51	12.6					1851	5654	22538	A	Ind	30043
3	13.2		appr. 18-22		75 appr.						726	1097	4294	B	Ind	6117
4	11.2	26	31.9	1	58	9.7							1586	B	Ind	1586
5	23.8	23	25.9	1	52	11.2					4910	3656	26660	A	Ind	35226
6	9.1		appr. 20-22		60 appr.								2327	B	Ind	2327
7	9.8	29	25.2	NA	73	5.9					1572	521	5412	B	Ind	7505
8	20.4	30	19.3	1	69	8.5	27.2	64.3	1.0	0.38	11889	2090	20482	A	Ind	34461
9	10.6		appr. 15-20		85 appr.						5820	1602	6453	B	Ind	13875
10	8.0				64 appr.						3555	1116	677	B	Ind	5348
8	14.7	31	9.4	7½	77	5.8	30.4	63.8	37	0.46	8409	2748	8340	B	Ind	19497
											38968	20134	104509			163611
Morrissey Ridge																**Morrissey Ridge**
1	23.7	17,2,16,21	16.0-25.0	1½	64-83	9.2-13.7	16.5-18.0	72.8-74.0	1	0.34	7269	61639		A	Ind	68908
2	18.0	18,5,15	14.3-35.9	1	66-85	7.7-11.4	18.1-18.3	70.5	1-1½	0.46-0.50	8184	40254		A	Ind	48438
3	31.4	10	20.1		72	10.7	17.6	71.5	1	0.38	4118	43451		A	Ind	47569
4	13.6	14,25	24.7-29.2	1	67-74	10.8	16.7	72.5	1	0.53		2271		B	Ind	2271
5	12.2	8, 9	15.2-15.9		85	7.6-8.0	20.1-21.8		2 - 3	0.55-0.56		4761		B	Ind	4761
6	7.9	34,6,28	15.2-44.0	3-6	51-83	6.8	23.7		6½	0.49	209	998		B	Ind	1207
7	16.7		appr. 17		60 appr.							700		B	Ind	700
8	7.2		appr. 19		70 appr.							426		B	Ind	426
9	11.1	35,3,32	7.7-11.9		85-93	3.8-8.2	24.5-28.1	68.9	3½-9	0.45-0.64	4171	4079		B	Ind	8250
10	7.6	11,33	25.0-38.1	8½	45-64	8.6	27.1		8	0.84		587		B	Ind	587
											23951	159166				183117

REMARKS:

Average thickness of coal areas.

Coal in place - (area of unmined coal) x thickness = cu. yds. of coal in place.
1 cu. yd. of coal in place = 1.15 net tons raw
correction for slope of seam applied to areas in calculations.

Reserve classification - (i) "Proven reserves of coal are reserves for which tonnage is computed from measurements in drill holes spaced at approximately 0.5 mile intervals or less, which are supplemented by seam data from outcrops, adits or existing mine workings.

(ii) "Probable reserves of coal" are reserves for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are approximately 1.0 mile apart but they may be as much as 1.5 miles apart for beds of geologic ontinuity.

(iii) "Indicated reserves of coal" are those which little or no exploratory drilling or adit driving has been done but where geologic studies have determined continuity of the Kootenay coal bearing formation and to a considerable extent have correlated the various coal seams.

Mineability

A - Probably satisfactory for hydraulic mining. Use 50% recovery of total coal in place.
B - Probably satisfactory for Conventional mining. Use 15% recovery of total coal in place.
C - Possibly not imeable because of splits or proximity to other seams. No recoverable reserve.
D - Probably no recoverable reserves within former workings.

Mining Recovery - Mineability factors applied are based on information available from hydraulic test mine in Balmer South and mining Department opinion that minimum seam thickness must be 20 feet.

Tab.34: Fernie and Morrissey Ridges, Clean Coal Reserves and Coal Quality, if available.

dips are given in Tab.33 . The reserves to 2500 feet cover total to:

Fernie Ridge	=	925 433 000 sh tons in place
Morrissey Ridge	=	545 062 000 sh tons in place
TOTAL	=	1 470 495 000 sh tons in place

According to Kaiser's compilation, these reserves may result in the following recovered clean coal tonnage: (Tab: 34)

Fernie Ridge	=	163 611 000 sh tons clean coal
Morrissey Ridge	=	183 117 000 sh tons clean coal
TOTAL	=	346 728 000 sh tons clean coal

The percentage of clean coal recoverable by hydraulic mining is approximately 76.3%. The rest applies to conventional mining.

The coal has more or less high ash content and shows poor to insufficient swelling characteristics. Most of the hydraulic coal has low volatile matter content. For more quality information see Tab.34.

4.1.9 NATAL AND SPARWOOD RIDGES DEPOSITS

Both areas are located south of Kaiser's Balmer open pit mine and are divided by the Michel Creek. Along the Michel Creek Valley runs the track of the Canadian Pacific Railway.

Two seams explored in the Natal Ridge Area are designated Seams A and D. The Sparwood Ridge Area has several more seams, which are designated as follows: Seam C (Upper and Lower), Seam B, Seam A, Seam 1, Seam 2, Seam 5 (Upper and Middle) and Seam 7 (Upper).

4.1.9.1 COAL RESERVES AND COAL QUALITY

Coal Reserves and Coal Quality are tabulated in Tab. 35. The most prominent seam in the Natal Ridge is Seam A, which accumulates 43 mio tons in place. Far more reserves are in the Sparwood Ridge Area, but part of the coal may not be recoverable due to close proximity to each other. All seams show acceptable ash content of washed coal and volatile matter is in the medium range. The yield figures could not be obtained from Kaiser, but considering the raw ash content, they must be in an acceptable range. Some of the adits did not reach unoxidized coal and therefore some seams in the Sparwood Ridge Area show none or only marginal swelling.

The report of Kaiser does not state how the reserves can be mined, but it is believed that the reserves apply to underground mining. Only Seam No. A has a thickness of 36 feet suitable for hydraulic mining.

4.2 FORDING COAL LTD.

The coal deposit of Fording Coal Ltd., called Fording River, is controlled by 60% of Canadian Pacific Investment and 40% of Cominco. The operation is managed by Cominco. The deposit is located 34 north of Sparwood in British Columbia. The development of the surface coal mine was completed early 1972. The first shipment of coking coal was in April 1972 to Japan. Under a 15 years contract with Japanese customers, Fording has to produce 3 million tons per year. The coal is transported to the harbour and loading facilities at Robertsbank, near Vancouver, for a distance of approximately 700 miles by Canadian Pacific Railways.

All the open pit reserves of Fording River are committed by long term contracts to the Japanese customers. There is no tonnage left for our European group in the immediate future.

4.2.1 COAL RESERVES AND COAL QUALITY

The coal reserves of Fording River are 40 - 45 million tons clean coal and 60 million tons clean coal for underground mining in the blocked-out areas. Fording River did not give an estimation for the rest of the reserves. A length of 2 miles towards the south and a length of 10 miles towards the north from the blocked-out area is not yet explored.

The overburden ratio for the strip reserves averages 5.18 bcyd per 1 sht of raw coal. 6 seams are to be mined in the open pit and the volatile matter increases the younger the seam is. The seams are dipping generally 15 to 20 degrees, but due to the synclinal structure of the deposit, large parts of the deposit are flatlying (Green Mtn) and suitable for dragline operation.

Late in 1970, McIntyre acquired controlling interest in Capton Excol Ltd. with a holding of 36 480 acres adjacent to Smoky River's properties.

4.4.1 COAL RESERVES AND COAL QUALITY

Of all coal seams, only No. 4 Seam is found at every locality, where the correct stratigraphic interval has been probed. The major portion of coal produced by McIntyre has come, and will continue to do so in future, from No. 4 Seam. Other mines will drive coal from No. 10 Seam, and surface mines will recover coals from Nos. 10 and 11, as well as from No. 4.

The larger coal seams are briefly described as follows:

(a) No. 4 Seam ranges in thickness from 6.2 to 36.0 feet and averages just over 20 feet. The lower half of the seam is soft and difficult to recover in diamond drilling. Underground mining is confined to the upper half of the seam. The upper 2 feet or less is comprised of a carbonaceous shale or siltstone caprock with thin interbedded coal partings. This horizon has proved difficult to hold in place as the hanging wall.

(b) No. 10 Seam has an average thickness of 9.6 feet within a range of 2.0 to 19.6 feet. The wide variance in thickness is the result of differing amounts of shale, mudstone and siltstone in the upper portion of the interval.

(c) No. 11 Seam is the uppermost seam of mineable thickness but, on average, contains a high percentage of partings and benches of high ash material. Its thickness ranges from 3.8 to 13.0 feet with an average of 7.4 feet.

(d) No. 3 Seam is absent from much of the western part of McIntyre lease area where it appears to be replaced by a dark carbonaceous shale. Where it does occur, its average thickness is 4.6 feet within a range of 1.2 feet to 12.4 feet.

(e) Seams 6, 7 and 8 occur in a stratigraphic interval of less than 25 feet and are considered to be one coal zone. Within the interval the seams occupy approximately 8 feet in total thickness with the relative amounts of each seam and the distance between them varying markedly from one location to another.

McIntyre Porcupine Mines Ltd. has calculated the total tonnage in their leases as follows:

In calculating the coal reserves of the McIntyre leases, all seams of greater than 20 inches in thickness are included. Proven reserves are those for which the points of observation and measurement are so closely spaced, 1500 feet or less, that the computed tonnages are correct to within 20%. Indicated and inferred reserves are based partly on points of specific measurements and partly on a general knowledge of local structure and continuity. The specific gravity used is 1.33 which gives a density of one long ton per cubic yard. Classification according to mine type, surface or underground, is based on seam configuration and position. Moderately inclined reserves are those for which the average dip is greater than 20^{0}. Tab.36 is a summary of the in-place coal reserves.

	PROVEN (x 1,000 Long Tons)		INDICATED & INFERRED (x 1,000 Long Tons)
UNDERGROUND			
Moderately Inclined	57,220		34,410
Steeply Inclined	302,090		1,359,920
SURFACE			
Open Pit and Strip	192,870		200,000
TOTALS	552,180		1,594,330
Combined Total		2,146,510	

Tab. 36: Total Coal Tonnage in Place, Smoky River Deposit

The above stated coal tonnage by far do not represent economically extractable coal.
The reserves of the developed surface mine No. 9 are as follows (raw coal):

Seam No. 11	:	8.9 Mio cyd
Seam No. 10	:	17.8 Mio cyd
Seam No. 4	:	44.6 Mio cyd
Total	:	71.3 Mio cyd

Remark: Smoky River is using a convertion factor of 1 cyd = 1 lgt raw co

Seam No. 11 will most likely not be mined due to the inferior washing yield (only 43.6%). For these reserves, an overburden ratio of more than 10 : 1 (bcyd : lgt) will apply. For No. 9 surface mine the planning for the first 6.46 years is completed and based on the following figures:

Seam to be mined	:	No. 4
Production	:	1 300 000 lgt/year recovered raw coal
1974 - 1980	:	8 400 000 lgt/year recovered raw coal
Overburden	:	45 000 000 bcyd
Ratio	:	5.36 : 1 (bcyd : lgt raw coal)
Expected washing yield	:	72.7 %
Ash	:	4.65 %
Volatile Matter	:	19.35 %
FSI	:	8

If No. 9 mine is in operation, the production will be split by 55% from No. 2 underground mine and 45% from No. 9 surface mine.

The contract specifications for Smoky River at present are as follows:

Volatile Matter	:	17.5 - 20%
Ash (adb)	:	7.0 % max. $\pm$ 0.5 %
Sulphur (adb)	:	0.50 % max.
FSI	:	7 - 9
Inherent Moisture	:	approximately 1 %
Total Moisture (as received)	:	6.0 % max.

4.5 COLEMAN COLLIERIES LTD.

Coleman Collieries Ltd. belongs 82% to Northern and Central Gas Corporation Limited and 18% to the public. Northern and Central Gas is 94% Canadian owned.

Coleman Collieries has the following holdings:

1. The present open pit operation at Tent Mountain.

2. The present underground operation at Vicary Creek.

3. Adjacent to Vicary Creek towards the south the new mining field Gomyo, to be developed in the near future.

4. Large land holdings in the north of Vicary Creek not yet explored. The area is commonly known as Dutch Creek.

5. The large coal lease Isola explored by only three scout drill holes.

The wash plant of Coleman is located 650 miles railway distance from the harbour of Port Moody. Truck haulage from Tent Mountain to the washery is 16 miles and from Vicary to the washery is 12 miles. The Isola area is 31 miles north of Coleman.

Almost all of Coleman Collieries property is located in Alberta. Only a small part of Tent Mountain belongs to British Columbia. Because most of the Tent Mountain production comes from Alberta and the mining operation is controlled by the Alberta mining inspector, only Alberta

royalties were paid. That may change in the future.

Mr. Blackmore explained that basically two possibilities exist for a participation in a coal venture with this company.

1. An option for the exploration of the areas Dutch Creek, Oldman River, and specifically Isola. The option of 50% can be exercised by depositing a down payment of 1 million dollars and spending 2 - 3 million dollars within three years. If the option is not taken the down payment will be refunded.

2. The major share holder would be willing to sell controlling interest of Coleman Collieries issued stock. Mr. Blackmore said that a figure of approximately $15.00 per share would apply after evaluating the companies assets. Total equity issued by the company is 1,116,890 shares.

   Both offers are interesting and the company should be contacted to discuss this matter further. The hydraulic potential of the not yet properly explored areas represents an alternative to the Rock Lake area or is even better than this area. The existence of coking coal in this area has been proven by the Coleman Collieries operation and,for example,by the Isolation Ridge deposit.

Most of it lies on the east limb of the complex Tent Mountain syncline. The proposed hydraulic mine site contains 10 million sht recovered raw coal.

Mr. Blackmore said an estimated 8 million dollars is to be invested to open the hydraulic mine site for an annual production of 0.5 million lgt washed coal.

The principal seam mined in the open pit at Tent Mountain is seam No. 5. (20 - 50 ft. thick)

2. Vicary Creek

The coal mined in Vicary Creek is Vicary seam No. 2. The seam dips 35-43^{o} and varies in thickness from 14 - 20 ft. The seam is presently mined by room and pillar dispite the fact that according to the Chief Mining Engineer the dip and seam thickness would represent a perfect hydraulic mining situation, but to invest for a new mining method and equipment, Coleman Collieries has no capital.

In Vicary Creek there are 34 million sht raw coal in place left. Applying 50% underground recovery and 83% washing yield the total washed coal left in Vicary Creek amounts to 14.11 million sht.

The drill hole results are compiled in the following tabulation No. 37. The analyses results are not averaged because the information is not sufficient. The coal is of low to medium volatile matter rank.

4.6 ELK RIVER DEPOSIT

The Elk River coal license area, obtained 1967 by Scurry Rainbow Oil Ltd., consists of 19,200 acres and is presently owned in a joint venture by Scurry Rainbow Oil Ltd. with 50% Emkay Canada National Resources Ltd., a 100% subsidiary of Morrison & Knudson Company,Inc.

It is known that Morrison & Knudson Company, Inc. is not interested in developing the property and is prepared to sell the 50% equity participation they hold. By purchasing the 50% participation belonging to Morrison & Knudson, our group will also operate the mine if developed, as Scurry Rainbow Oil Limited has not shown such an intention and certainly has not the expertise to do so.

4.6.1 LOCATION AND ACCESS

The Elk River property is located in the Rocky Mountains in the south-west of British Columbia, Canada, within the valley of the Elk River. Approximate center of the property, consisting of 19,200 acres of coal licenses on Crown Forest Land, is near 50 degrees, 24 minutes north and 114 degrees, 56 minutes west.

The mining area is situated approximately 45 miles north of Sparwood, B.C., the nearest township which is also the site of Kaiser's Balmer Mine. The Fording River mine, owned by Canadian Pacific Oil and Gas Limited, is approximately 15 miles to the north from the center of the Elk River property.

There are two road connections to Calgary. The first one goes south over Elkford - Sparwood and Highway No. 3 to Fort McLeod and then north again on Highway No. 2 to Calgary (a total of 225 miles, 20 miles improved gravel forest service road from the Elk River deposit to Elkford, and 205 miles paved road to Calgary). The second road leads to the north over 20 miles of an improved power line maintenance road, which connects the Kananaskis Highway. The Kananaskis is an improved gravel road running 25 miles further north to the Trans-Canada Highway No. 1.

The nearest railroad, owned by Canadian Pacific Railroad, is located in Sparwood, 47 miles south of the Elk River property. The total distance to Vancouver, Robertsbank, is 745 miles. A spur line from Sparwood to Fording River exists.

The town of Elkford, Government-owned and built for the mine of Fording River, will most likely serve as well for the required labour force of the Elk River deposit.

4.6.2 COAL RESERVES

The coal reserves of the "Initial Study Area A and Area B" were re-calculated by Mr. Linhart. His reserve calculation resulted in the following tabulation (Tab. 38). A reserve estimate for the total area is given in Tab. 39. This estimate was computed by Morrison & Knudson. The subdivisions

(areas) used for this reserve calculation are described as follows:

Areas A and B: The Initial Mining Area.
Between grid lines 180+00 and 360+00, Mr. Linhart extended the Initial Mining (Study) Area to 170+00 and 370+00 (1000 feet more towards north and south).

Areas C and D: Extensions of Areas A and B towards north.

Area E : This area is commonly refered to as Big Weary Ridge. It is the extension of Areas A and B towards south.

Areas F and G: Both Areas are adjacent to each other in the western steep dipping part of the syncline. Open pit inferred reserves are calculated by Morrison & Knudson down to an elevation of 5200 ft. These reserves can also be declared as hydraulic mining reserves.

Area H : Declared by Morrison & Knudson as uncertain open pit reserves, but at present time should rather be refered to as hydraulic mining reserves. The area is the most southern extension of Area G. Reserves are uncertain and calculated down to an elevation of 5200 ft.

Areas J and K: Inferred underground reserves below the open pit and hydraulic reserves on both limbs of the syncline calculated down to an elevation 3200 feet. The reserves are inferred (Area J) and uncertain (Area K).

Pan Ocean is definitely open for any deal on its 40% equity in the Sage Creek deposit.

4.7.1 LOCATION AND ACCESS

The Sage Creek Coal property, comprising 24,642 acres in 51 coal licenses, is located 40 miles south-east of Fernie, B.C., and about 50 miles south of Kaiser's coal operations. The property adjoins the Montana - U.S.A border on the south and can be reached by several gravel roads from the west, north and south. The central part of the property lies at latitude 49° 06'N and longitude 114° 34'W. The nearest railway is the main line of the Canadian Pacific at Elko, B.C., - a distance of about 30 miles to the west (direct map distance). An alternative rail route to the south, of about 40 miles in length, would join up with the Burlington Northern Railway in Montana. However, to connect the proposed mine site with the Canadian Pacific rail line, a true mileage of 48 miles spur line with rough terrain at the end of the tracks (mountainous area) is required. Much easier is the alternative rail connection to the south, but this is probably politically not feasible, and the mileage for this spur line is also 47 miles. Rio Algom would prefer to go south. The rail distance from the proposed mine site to Robertsbank on the Pacific coast is approximately 700 miles. Hitachi, in conjunction with Rio Algom, is also investigating the possibility of pumping a minus 3/4 inch size coal fraction over the initial 30 miles to Elko.

Rio Algom is intending to build a townsite at the mine, because the nearest town Fernie is situated approximately 45 miles north of the property, but the Government will most likely insist that Fernie is used as townsite for the labor force required to operate the Sage Creek deposit.

4.9 DEPOSITS OF DENISON MINES LTD.

4.9.1 SAXON DEPOSIT

The area is quite remote and infrastructure cost for the development of this deposit may be high. Nevertheless, the coal is the best so far reported, and therefore the deposit has to be considered in the near future. Denison Mines Ltd. is willing to issue an option of 50% for the property and many reasons point towards our group to obtain the option without hesitation. The coal has low ash, positive dilatation, FSI of 6½ - 8 and excellent coking characteristics which make this coal a prime coking coal. Furthermore, the production of the first 5 to 10 years, according to production volume, may be obtainable by open pit mining. This has to be proven by further thorough exploration. After the open pit is mined out, mining will continue by hydraulic mining methods still over drainage elevation. The disadvantage of this deposit is the remoteness of the area.

4.9.1.1 LOCATION AND ACCESS

The Saxon Area is located in British Columbia and the eastern side of the lease joins the border of British Columbia and Alberta. 65 miles of rail spur line have to be constructed through a valley of mountainous areas, which would join the CN-Railway, approximately in the vicinity of Dome Creek. A pipeline for this purpose can also be considered. The rest is 563 miles to Prince Rupert, or 603 miles to Vancouver.

4.9.1.2 COAL RESERVES (Tab. 47)

The structure geology in the Saxon Area is more complex than for example in Denison's Quintette Area. The stratigraphy in the area is as follows:

Parameters			
Seam	A	B	D
Dip of Seam	35 - 50°	35 - 50°	35 - 50°
Average Seamthickness (ft)	10 - 40	10 - 14	10 - 28.5
Preparation Yield (%)	65 - 85	65	65 - 70
Mining Loss U/G (%)	62.5	62.5	62.5
O/C Ratio (bcyd:sht Raw Coal)		7:1	

Coal Reserves all Seams Combined

O/C Reserves Raw Coal	250 million sht
U/G Reserves Raw Coal	
Total Reserves Raw Coal	250 million sht
O/C Reserves Clean Coal	20 million sht exploration potential
U/G Reserves Clean Coal	40 - 45 million sht, applying 65% yield and 37.5 mining recovery
Total Clean Coal	60 - 65 million sht
Production Planned	2 million lgt/year justified considering the reserves

Tab. 47 : Coal Reserves of the Saxon Area of Denison Mines Ltd., British Columbia

with American high volatile coals, the good coking characteristics of the Saxon coals deteriorate.

Denison Mines believes that the area could be developed between 1978 and 1980. That time may appear too soon, however, the property seems to be a potential mine site for the early 80's for development. In any case, it is advisable to secure the potential of this area by an option for the future. Also the property has to be seen in connection with the adjacent properties of Kakwa Mines Ltd. (Cyprus), and Kakwa River of Woods Petroleum in Alberta, which have a good coking coal potential. The whole area seems to be a nucleus for future potential development.

All available quality figures are listed in Tab. 48.

4.10 QUINTETTE DEPOSITS, BABCOCK, WOLVERINE AND FIVE CABIN SYNCLINE

For the Quintette Area there is a joint venture of 51% Denison Mines Ltd. and 49% World Resources Company, a division of Alco Standard Corp., (Barnes & Tucker). This joint venture is still current for the Wolverine and Five Cabin Syncline area, but was altered for the Babcock area. In this area Mitsui has purchased a 10% equity participation with an option for further 15% if the area goes into production:

25.0% Mitsui
36.5% World Resources Comp.
38.5% Denison Mines Ltd.

World Resources Company has several times indicated that they are open to sell their interest in the Quintette area, but they did not give any indications of what percentage or terms they are thinking.

4.10.1 LOCATION AND ACCESS

Figure 6 provides the locations of the three deposits Babcock, Wolverine and Five Cabin Syncline within the Quintette license. The lease is situated in British Columbia.

Access to Babcock from Dawson Creek, B.C. (121 miles) and Grande Prairie, Alberta (115 miles) is via secondary and dry weather roads. Due to expanding logging and gas exploration activities, additional access routes are being developed. The Quintette joint venture favours completion and improvement of a route from Dawson Creek to Babcock along a route developed by a logging company. This 101 miles long route would be a permanent high speed, all weather road for the movement of personnel and equipment.

To the Wolverine Area, access from Chetwynd, B.C. consists of 43 miles of all weather gravel road and an additional 14 miles of limited access road. Chetwynd is located on Highway 97, 63 miles due west of Dawson Creek, B.C.

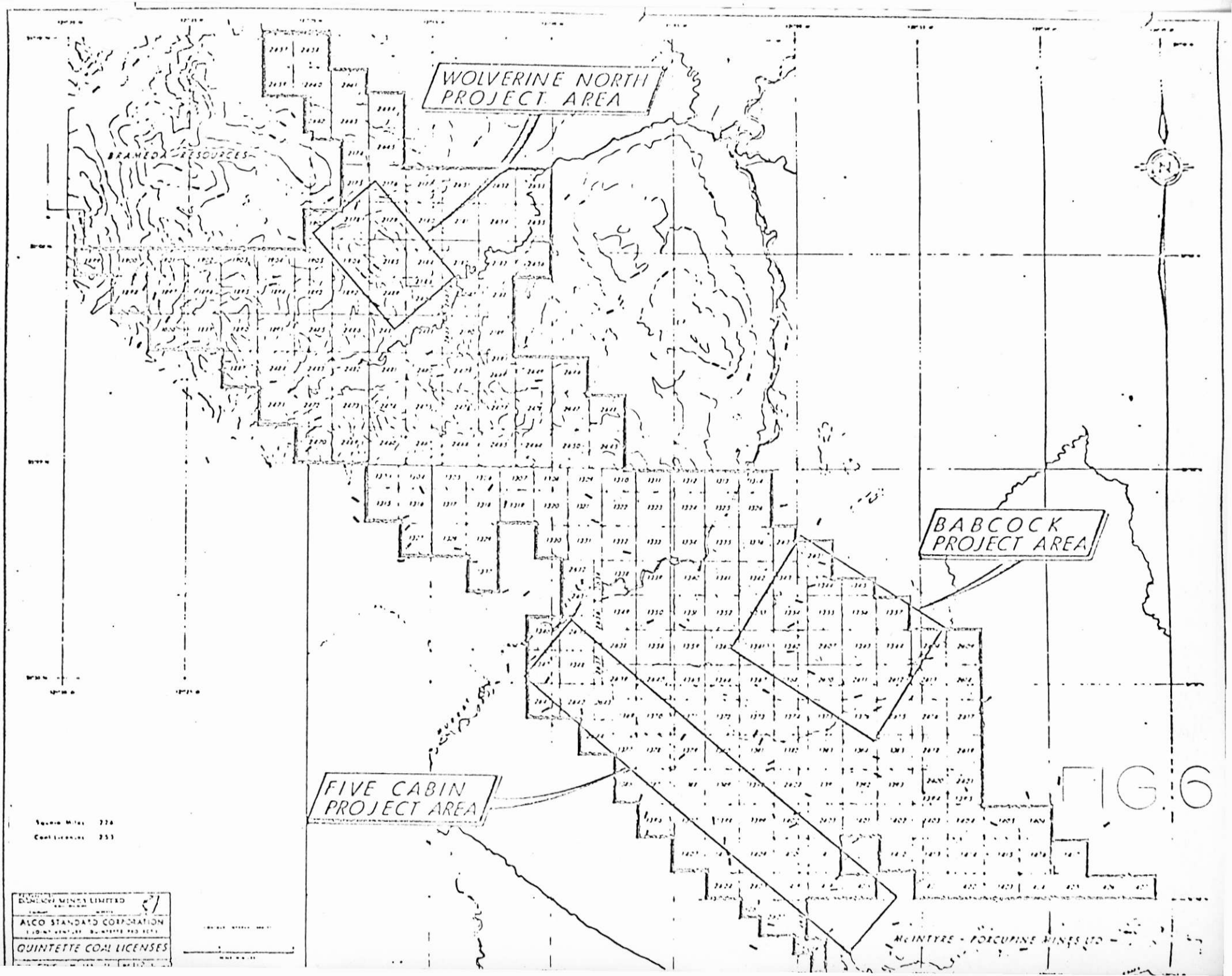
The Five Cabin Syncline area can be reached by 85 miles of all weather dirt road from Highway No. 2 at Beaverlodge, Alberta, and 14 miles of four wheel drive access to the drill camp located in the central portion of the syncline.

4.10.1.1 RAILWAYS

For the development of Babcock, Denison Mines Ltd. would favour two possible railway routes out of at least six routes possibly existing:

1. Via BCR (Chetwynd Route)

Distance	- to Vancouver area port	715 miles
	- to Prince Rupert	740 miles


WOLVERINE NORTH PROJECT AREA
BRAMALEA RESOURCES
BABCOCK PROJECT AREA
FIVE CABIN PROJECT AREA
FIG 6
ALCO STANDARD CORPORATION
QUINTETTE COAL LICENSES
McINTYRE - PORCUPINE MINES LTD

Plus new rail needed	70 - 75 miles
Rates to Vancouver area (incl. Gondolas)	4.50 - 4.60 $/sht
Handling Charges	0.75 $/sht

2. Via CNR (Monkman Pass Route)

Distance - to Vancouver area port	750 miles
- to Prince Rupert	610 miles
Plus new rail needed	92 - 105 miles
Rates to Vancouver area (incl. Gondolas)	6.30 $/sht
Handling Charges	0.75 $/sht

According to Denison Mines Ltd., the B.C. Railways proposal is the more attractive, although the rate depends upon the development of the Sukunka deposit. The rates are from Denison's March 1973 report.

For connecting the Wolverine area with a rail link the following possibilities are existing:

1. If Quintette-Babcock is in production, only 6 miles spur line is needed to link the two deposits.

2. If the project stands on its own, total 55 miles are to be constructed, or if Sukunka operates, then only 42 of new rail is needed. Further distances to the port are:

Chetwynd to Prince George	= 218 miles
Prince George to Prince Rupert (by CNR)	= 467 miles
Prince George to Vancouver (by BCR)	= 426 miles

The Five Cabin Syncline deposit is 10 miles further away from any railway link than Babcock, so the same distances apply as for Babcock.

4.10.1.2 HOUSING AND PERSONNEL TRANSPORTATION

Considerations in this respect are only done for Babcock. The closest significant population centres via any new all weather road to Babcock are:

Chetwynd, B.C.	Population - 1,300 - 75 miles from Babcock
Dawson Creek, B.C.	Population - 12,500 - 95 miles from Babcock
Grande Prairie, Alta	Population - 14,000 -115 miles from Babcock
Prince George, B.C.	Population - 40,000 -140 miles from Babcock

For Denison, the most attractive community in which to base a work force, appears to be Dawson Creek. Dawson Creek has excellent recreational facilities, excess hospital and school facilities and over 500 fully serviced building lots.

4.10.2 COAL RESERVES (Tab. 49)

4.10.2.1 QUINTETTE BABCOCK

The joint venture agreement with Mitsui for Babcock includes all parts of Babcock, i.e. the flat lying part and steeply dipping Waterfall Creek syncline and the not yet thoroughly investigated Quintette Trend and the Murray Syncline Areas. The Japanese are very much interested in the steep dipping strata (Waterfall Creek) for hydraulic mining. At present, the flanks of the syncline are investigated for this purpose.

The seams of the Babcock area are all in the Gates Coal-Formation and designated D, E, F, G, I and J, but seams G and I are not in the mining plan. Seam D, which might have an unknown open cut

potential has a hard sandstone roof. All other seams have bituminous shale roofs.

The reserve situation justifies a 2 million lgt/year (see Tab. 49). Denison believes in an operation commencement in 1977.

The U/G reserves of 250 million sht raw coal can be enlarged by 75 million sht in situ from the Quintette Trend area and a not yet calculated potential of the vast Murray Syncline.

4.10.2.2 QUINTETTE WOLVERINE

So far, 6 boreholes have been drilled on the property, which indicated that the Gething Coal Formation and the Gates Coal Formation contain coal-bearing strata. The Gates Coal Formation has 11 seams of which only the lower two (No. 1 and No. 2) are mineable. The Gething Coal Formation has as recoverable seams the Skeeter seam and the Chamberlain seam. Each geological formation contains 50% of the reserves. The reserves amount to 104 million sht in place or 46 million sht washed coal. A breakdown per seam is listed in Tab. 49.

QUINTETTE FIVE CABIN SYNCLINE

The reserves of the Five Cabin Syncline Area are also distributed by 50% each on the Gates and Gething Coal Formations. For underground mining, only Seam No. 5 (Gates) and seam II/III (Gething) seem to be suitable, but for the open cut reserves the Seams No. 1, No. 5 and No. 7 (all Gates) and No. II/III (all Gething) appear to be recoverable.

Area	QUINTETTE-BABCOCK							QUINTETTE-WOLVERINE						QUINTETTE-FIVE CABIN SYNCLINE				
Seam	D	E	F	G	I	J	Total**	GAT.CF:	No.I	No.2	GETH.CF:	No.II (Skeeter)	No.III (Chamberlain)	Total	GAT:CF: No.1 (O/C)	No.5 (O/C&U/G)	No.7 (O/C)	GETH.CF No.II/III (O/C&U/G)	Total
Dip of Seams	5°-15°	5°-15°	5°-15°	5°-15°	5°-15°	5°-15°			10°-20°	10°-20°		10°-20°	10°-20°		One Syncline Side 40° - 70°, the other side 30° - 50°.				
Average Seamthickness (ft)	7.8	6.65	8.4	6.86	9.45	16.60			6.97-8.47	5.98-9.56		6.77-9,10	5.64-5.98						
Mining Loss U/G (%)	43	35	45	40	35	58.82			35	40		40	40						
O/C Reserves Raw Coal (mio sht)															2.143	3.184***	0.797	8.141***	14.265[4]
U/G Reserves Raw Coal (mio sht)	49.036	45.528	59.118	3.120	44.136	101.359	255.041		31.858	19.774		28.334	24.281	104.247		Conv. 19.482, Hydr.20.036		Conv. 40.666, Hydr.34.593	114.777
Total Reserves Raw Coal (mio sht)	49.036	45.528	59.118	3.120	44.136	101.359	255.041		31.858	19.774		28.334	24.281	104.247	2.143	39.518	0.797	75.259	117.717
O/C Reserves Clean Coal (mio sht)															0.994	2.220***	0.359	6.056***	9.629[4]
U/G Reserves Clean Coal (mio sht)	21.539	19.165	25.493	1.105	19.598	31.133	97.330		16.104	7.055		9.978	12.878	46.015		Conv. 10.052, Hydr.8.760		Conv. 25.338, Hydr.20.149	64.299
Total Clean Coal (mio sht)	21.539	19.165	25.493	1.105	19.598	31.133	97.330		16.104	7.055		9.978	12.878	46.015	0.994	18.812	0.359	45.487	65.652
Stripping Ration																7:1 bcyd:lsht raw coal			
Production Planned		2 million lgt/year										1 million lgt/year justified according to reserves				capable of 1 to 2 million lgt/year			

not included in mining plan
** without seams G and I
*** included in U/G reserves
4) partly included in U/G reserves

Tab. 49 : Coal Reserves Quintette Area, Denison Mines Ltd.

The coking properties are unknown because no tests were performed.

The Five Cabin Syncline area has the same problem as Wolverine because the coals vary in both Coal Formation, and the coals have to be blended. The Gates Coal Formation has high volatile coals with high FSI values and slightly higher ash content than the Gething Coal Formation, which has low to medium volatile coals with low FSI values.

Denison states that an equal blend of potentially mineable seams would be expected to produce coal with raw ash of 12.7%, which on a 7.0% ash (airdried basis) would yield 85% product with a proximate analysis as follows:

Ash	6.97 %
V.M.	23.65 %
F.C.	67.87 %
S	0.21 %
FSI	3.5 - 6.6

The coking properties of the Five Cabin Syncline area are unknown because no tests were performed.

4.11 CORBIN CREEK DEPOSIT

The deposit Corbin Creek is owned by Byron Creek Collieries Limited. Our information on this interesting deposit is only limited, because Byron Creek has been reluctant to supply information material.

Byron Creek Collieries has not indicated that they may accept partners for the development of the deposit, as they did in the earlier stage. A one million lgt/year is planned and the company thinks of a 20 million dollars investment.

Because the coke quality and the coal washability of the deposit is so far unknown, it seems too early to recommend the deposit for a participation. A large part of the deposit seems to be only steaming coal.

4.11.1 LOCATION

The deposit is located in British Columbia and is very close to the Alberta - British Columbia border. The deposit is south of Coleman Collieries' Tent Mountain Mine. Only 13 miles spur line needs to be newly constructed, to connect the deposit with the CPR mainline south of Michel (Kaiser) with the Gillivray loop. Byron Creek Collieries has ensured already the right of way for these 13 miles.

4.11.2 COAL RESERVES AND COAL QUALITY

The coal reserves are located similar as in Luscar in 5 synclinal folded areas. This folding has thickened the coal seams, which can be correlated with Kaiser's Balmer seam, up to 200 ft. thickness. The coal reserves are calculated on a 70% washery yield and 6 : 1 bcyd : sht clean coal. Taking these parameters into consideration, the following reserves in place are encountered:

51.5 million sht measured and indicated
5.5 million sht inferred
7.5 - 27.5 million sht further potential

4.12 SUKUNKA DEPOSIT

The Sukunka deposit belongs 52.5% to Brascan Ltd., (Mikas Oil Ltd.), 40.0% to British Columbia Railway and 7.5% to Coalition Mining Ltd. Coalition Mining Ltd. is also the operating company.

In general terms, the Sukunka deposit has very good coal quality, but underground mining conditions, (bad roof), and 40% Government participation in the project and the remoteness of the area have made the project uninteresting for us.

4.12.1 LOCATION AND ACCESS

The Sukunka Coal Project, covering an area of 41 square miles, is located some 37 miles south of Chetwynd in British Columbia, Canada. Chetwynd is connected to the coast of Vancouver by the Pacific Great Eastern Railway. The Canadian National Railway joins the Pacific Great Eastern Railway at Prince George, connecting to Prince Rupert on the west coast.

The rail distance to the coast is approximately 700 miles (to Squamish). Of this distance, 37 miles new spur line to Chetwynd have to be constructed.

4.12.2 COAL RESERVES

In general terms, within the two principal coal seams, the Chamberlain and Skeeter Seams are 74 million long tons of medium to high rank bituminous medium volatile coal. From these reserves, 41 million long tons of washed coal can be produced with an ash content in the range of 4 to 5%, which will produce a strong, hard metallurgical coke.

A breakdown of reserves per seam as measured and indicated reserves is given in Tab. 51. The figures in this reserve calculation are based on 70% extraction during mining, and a washing yield. of 80% and 70% for the Chamberlain and Skeeter Seams respectively.

4.13 GREGG RIVER

The Gregg River coking coal deposit, if developed, will be operated by Manalta Coal Ltd., a 100% subsidiary of Mannix Co. Ltd. Manalta has entered negotiations with Japanese customers for a long term sales contract, and these negotiations are in the final stage. Because of these negotiations, Manalta has acted very reluctant in respect to a participation of our group. It is almost certain, that Gregg River will be the next deposit being developed for the Japanese market.

4.13.1 LOCATION AND ACCESS

The Gregg River Coal property is located about 170 miles west of Edmonton, Alberta, and 25 miles south of Hinton. It is adjacent to the Cardinal River Coal Ltd., and encompasses the head waters of the Gregg River. The property, comprising 17,600 acres of coal leases, extends for about 15 miles in a north-westerly direction along the eastern slopes of the Rocky Mountains.

Topographically, the lease area is of moderate to rugged relief, with maximum differential elevations in the order of 500 ft. Access from Hinton to the Gregg River mine area is provided by an all-weather, gravelled highway, recently constructed by the Alberta Government. From this road, an access road of 1½ miles to the mine and wash plant site has to be constructed as part of an overall mine development.

The CNR mainline to Vancouver passes through Hinton; at Bickerdike, a branch line, 64 miles in length, leads to Cardinal River Coal Mines at Luscar. Manalta proposes for Gregg River to use the same route, but this will necessitate in an extension of the CNR branch line from Cardinal River mine to the proposed wash plant and coal loading site of about three miles.

Gregg River mine will require a labour force of about 300 men. Because of the proximity of Hinton, 25 miles by all-weather highway, it will not be necessary to provide accommodation at the site. The men and their families will find their own accommodation in Hinton. Transportation arrangements will be made to convey the men to and from the Gregg River mine.

4.13.2 COAL RESERVES

Only the metallurgical coal that is proposed to be recovered to produce 22.5 million long tons, considering 1.5 million lgt/year production over a period of 15 years, is included in the proven recoverable pit coal category. Additionally, in the proven category is the coal available in C - D_3 syncline, in H - 3 monocline and in syncline R - S.

Proven Category:

i.e.	Mining plan	28.4 million long tons
	Remaining in C - D_3	5.3 million long tons
	Remaining in H - 3	0.7 million long tons
	Remaining in R - S	0.4 million long tons
	Total proven metallurgical coal recoverable:	34.8 million long tons

Manalta Coal Ltd. has calculated for the total washed coal production of 22.5 million long tons in 15 years two possibilities for the mining operation, which resulted in the following overburden ratios:

1. Possibility:
   6.7 : 1 bcyd : 1gt Raw Coal
   8.5 : 1 bcyd : 1gt Clean Coal

2. Possibility:
   6.9 : 1 bcyd : 1gt Raw Coal
   8.7 : 1 bcyd : 1gt Clean Coal

It appears that the ratio on clean coal basis is computed on a 79.1% yield of the wash plant.

PROBABLE CATEGORY

The probably metallurgical recoverable coal is calculated as follows:

East end of A' - B'	1.4 million lgt
"H - H' & "H" to South Drinnan Creek	3.5 million lgt
R' - S' Syncline	0.2 million lgt
Total probably metallurgical coal recoverable	5.1 million lgt at a mining rat of 8.1 to 1

POSSIBLE CATEGORY

These reserves are as follows:

West End of "A - B"	4.7 million long tons
"H - H" & "H" to South Drinnan Creek to Mystery Lake Fault	1.3 million long tons
R - S inferred	1.2 million long tons
Synclines & Anticlines West of Drinnan Creek	22.0 million long tons
Total possible metallurgical coal recoverable	29.2 million long tons at a rat of 8 to 1

Additional possible in unmapped areas adjacent to Mystery Lake Fault and Drinnan Fault 10 million long tons

SUMMARY OF RESERVES

Total recoverable metallurgical coal in the property is estimated at 79.1 million long tons.

Proven	34.8 million lgt
Probable	5.1 million lgt
Possible	39.2 million lgt
	79.1 million lgt

Applying a washery yield of 76%, this is a total of 60 million lgt of clean product.

4.13.3 COAL QUALITY AND COKE OVEN TESTS

Manalta Coal Ltd. has calculated the coal quality for the 15 years production as follows:

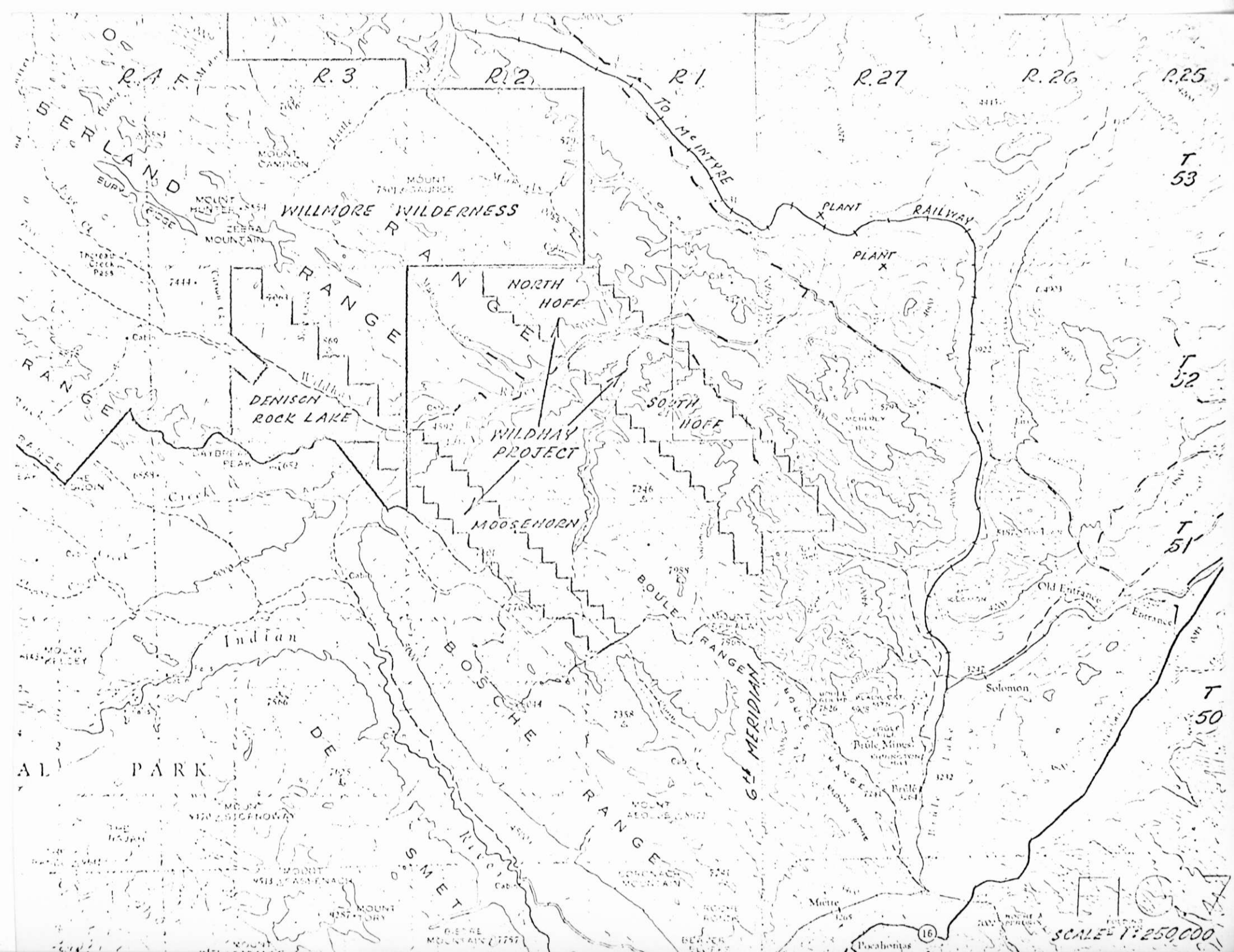
4.16 WILDHAY PROJECT

Exploration und Bergbau GmbH of Canada had filed an application for the south-west extension of the Rock Lake area, but a lease was not granted, because the area was set aside some time ago for the purpose of a possible exchange of acreage with coal lease acreage lying inside the Willmore Wilderness Park. Negotiations in this respect at ministerial level are completed, and the area was received, apparently as compensation for the area Rock Lake in the Willmore Wilderness Park. This is not mentioned, and Denison Mines Ltd. still has strong hopes on the Rock Lake area, if the newly granted Wildhay area does not prove sufficient coal for a mining operation.

4.16.1 LOCATION AND ACCESS

The Wildhay Project is located 35 miles (56 km) north-west of Hinton, Albera, a mining and lumber industry town with a population in excess of 10 000. The Alberta Resources Railway runs north-south just to the east of this property and comes within 5 miles (8 km) of the southern tip of the South Hoff Block and within 15 miles (24 km) of the North Hoff Block. The Moosehorn Block is located 10 miles further southeast.

The Wildhay Project consists of 3 Blocks (Fig. 7), the Moosehorn Block and the South Hoff Block, for which Denison Mines Ltd., through its subsidiary, Dencoke Coal Limited, is presently in the process of acquiring leases, and they have been assured by the Government, that the third block, the North Hoff Block, is available to them on a first refusal basis, when the area north of the Wildhay River is re-opened for coal lease applications.


R. 3
R. 2
R. 1
R. 27
R. 26
R. 25
T. 53
T. 52
T. 51
T. 50
SERLAND RANGE
WILLMORE WILDERNESS
RANGE
NORTH HOFF
SOUTH HOFF
DENISON
ROCK LAKE
WILDHAY PROJECT
MOOSEHORN
BOULEAU RANGE
BOSCHEKUNG RANGE
TO McINTYRE
PLANT
RAILWAY
Old Entrance
Entrance
Solomon
Pocahontas
Indian
SCALE 1:250,000

4.16.2 EXPLORATION POTENTIAL

The information compiled here is copied from Denison's exploration proposal.

SUMMARY:

The areas encompassed by the Wildhay Project, for which coal lease acquisition has been approved, contain large expanses which are underlain by the Luscar Formation. All of the coking coal which is produced from the Cardinal River Mine to the south, and the McIntyre Mine to the north, comes from this formation, and it is a well documented fact that the formation is coal bearing both within the Wildhay Project area and adjacent to it. The total exploration potential of the project areas is expected to be in excess of 100 million tons.

Moosehorn Block

The Moosehorn Block is bounded on the east by relatively unfaulted Nikanass in strata, which are followed stratigraphically by the Cadomin Formation and the coal bearing Luscar Formation. The Luscar Formation is repeated by thrusting within the property and may be overturned in a syncline which is located on the down thrust side of the Miette Thrust.

Two outcrops of coal, about 7,500 feet (2,250 m) apart, each 15 feet (4.5 m) thick have been reported in the southeast end of the Moosehorn Block. No assays are available, however. Near the northern end of the property, where the Cadomin Formation is repeated by a small thrust fault, a 4,500 foot (1,300 m) trench was put in to locate the main coal zone without success, and the large 20-40ft (6-12m) coal seam which is known on Denison's Rock

Lake property to the north has not yet been found here.

Assuming that a 15 foot coal seam, or its equivalent can be found over most of the length of this property, an exploration potential of 50 million tons can be expected. If a larger seam is also found, or if there is repetition due to faulting, this potential could be significantly increased.

South Hoff Block

The Luscar Formation within the South Hoff Block is bounded to the east by the Collie Creek Fault and to the west by the Folding Mountain Thrust and its associated faults. The Luscar Formation itself is repeated within the property by faulting and the potential for locating mine sites is increased by a series of anticlines and synclines. A considerable amount of exploration has been done near the Collie Creek Fault and the coal seams have been found to be too highly faulted to allow for correlation. It is for this reason that exploration should now be concentrated on the western side of the block where the disturbance does not appear to be so severe.

In the work that has been done to date, coal seam intersections of 18 and 22 feet (5.5 and 6.7 m) have been obtained but true thicknesses and seam correlations are not known. The free swelling indices of clean coal at 7-10% ash ranged from 5 to 9 on a wide variety of samples, but only rotary drilling was used so no meaningful data on raw ash or cleaning characteristics was obtained. At present it can only be said that thick, mineable seams should be present and that they may have good to excellent coking quality.

Assuming that one 15 to 20 ft. (4.5 to 6 m) coal seam may be present and that it outcrops twice over about half the length of the property, an exploration potential of 50 to 60 million tons can be expected. Naturally, from the known structure, many more repetitions may be expected and if they contain good coal seams and are structurally continuous, this may significantly increase the potential for discovery.

North Hoff Block (Not yet approved for leasing)

The North Hoff Block is simply an extension of the South Hoff Block, between the Wildhay River and McIntyre's Moverly Creek property in the Wilderness Park. Cursory foot traverses in 1969 failed to locate any coal seams in this block but it is reliably reported that McIntyre has intersected at least one 18 to 20 foot (5.5 to 6 m) seam just north of the block. In addition, it should be noted that almost all of the seams in the South Hoff Block were discovered by trenching or drilling. If the seams have not been eroded in this area, it is not unwarranted to expect 30 million tons of coal to be discovered.

4.17 HIGHWOOD AREA DEPOSIT

The Highwood Area described in this report was formerly known as Ford Coal Property of Ford Highwood Coal Ltd., or Highwood Coal Mines Ltd. Our group tried to file an application for the area on the 9th day of November 1973, but we were informed by the Mining Recorder that the area is still held as reserved by the Government. Furthermore, we were informed that the most likely process, if the Government will ever release this area, which is apparently very sensitive for the conservation authorities, is an advertisement calling for tenders on this property. The most successful bid will then receive the area. The Mining Recorder has put us on the list for those companies which will be informed if the Government of Alberta is calling for tenders. It is strongly recommended to compete bidding on acquiring this area due to its coal potential.

The information summarized here was obtained from two geological consultants, who have collected the various existing data available on the property ranging in age from 25 to 70 years. In fact, there is an abundance of conflicting and questionable data from numerous sources and the conclusions presented here are a combined personal assessment of the two consultants, Mr. Paul Dyson and Mr. Jaro Horacek, of what is the most likely interpretation of the data.

4.17.1 LOCATION AND ACCESS

The deposit is situated in Alberta, close to the border of British Columbia and Alberta, between Canmore and Coleman. The area is accessable by paved and gravel road by a 1½ - 2 hours drive from Calgary.

Mr. Dyson states that transportation of coal out of the Highwood area would not be simple, as the nearest railway connection is at Cayley, 35 miles east of the property, and at the Fording Coal Plant, approximately 16 miles to the south-west. The distance to rail might even be lessened in the next few years, if either the Isolation Ridge area or the Elk River area in B.C. (only 10 miles to the west) are developed. The connections to Fording River or Elk River mean rough terrain.

4.17.2 COAL RESERVES AND COAL QUALITY

It seems as if there would not be any trouble with coal reserves. Numerous workers have come up with estimates of the reserves which range from 1 082 million tons in place in seams greater than 3 feet thick under less than 2000 feet cover (Mackey 1946) to 254 million tons above the level of the Highwood River (McEvoy 1919) and 223 million tons above drainage (Stevens 1951). Mr. Horacek recalculated the reserves and came to the conclusion, that 210 million lgt in place are existing. A report prepared in 1945 states that

approximately 30 million tons in place may be strippable at that time. Taking the development of modern mining equipment from that time until today into consideration, the open cut potential can probably be increased. That means a mining method would either have to be open pit or hydraulic as the structure would preclude the using of any conventional underground mining method. Detailed surface mapping and drilling would be required to prove up the details of plans for either method but the property does appear to be well suited for development by hydraulic underground methods. Many millions of tons of coal exist above drainage north and south of the Highwood River and numerous "cross strike" seams - Cat Creek, Lineham Creek, etc. would provide additional access to the seams where substantial tonnages could still be mined to the rise.

The reserve calculation of Mr. Horacek is shown in Tab. 55. The reserves are located in four main coal seams present within the Kootenay Formation named the Egbert, the Connors, the Douglas-Glover and the Holt in order to descending stratigraphic position. Due to the complexity of folding in the area, thickness data is conflicting, but the thickness ranges shown on the map from Paul Dyson have been reported. A general conclusion would be that in any given section, it is likely that two seams exceed 15 feet each in thickness. Similarly, thicknesses exceeding 20 feet are frequently reported and possibilities exist for thicknesses exceeding 40 feet. It is realized, that these latter thicknesses probably represent tectonic thickening of the coal seams, but limited areas of such thickness would contribute significant tonnages of potential open pit coal. Some of the raw coal quality is also compiled in Tab. 55. However, in general, the volatile content of the Highwood coals ranges from 14% to 20% on a raw coal basis. On a washed coal basis, slightly higher values could be anticipated.

4.18 KAKWA RIVER DEPOSIT OF KAKWA MINES LTD. (CYPRUS MINES CORP.)

The Kakwa River Coking Coal Project is owned by a syndicate of nine residents in Edmonton, which have formed Kakwa Mines Ltd. This syndicate is managed by Mr. Walter Filipek.

Notus Exploration Company, a wholly owned subsidiary of Cyprus Mines Corporation, has optioned the property from Kakwa Mines Ltd., and Anvil Mining Corporation Limited did so far the exploration work for Notus.

The option agreement of Notus with Kakwa Mines Ltd. (syndicate) is a straight cash purchase of the 100% Kakwa Mines Ltd. shares for 3.8 Million Dollars. No royalties are included in the agreement. The option period consists of 4 periods, each period is one year. At the end of 1972, the third option period was completed and 1.1 Million Dollars spent. At this time, the Japanese coking coal market was fading away, and Notus did not start the fourth option period, which would have committed 250,000,000 Dollars cash to the syndicate and doing 750,000,000 Dollars worth of work on the property. Notus asked for an extension of the fourth option period, and this extension was granted by the syndicate scheduling the commencement of the fourth period October 1st, 1973, but Notus feels that there is still more time needed for thorough assessment of the deposit and therefore the syndicate was asked for another extension of the fourth option period. The granting of this extension is in progress.

4.18.1 LOCATION

The property is situated in a remote but very potential area, together with the deposit of Woods Petroleum (adjacent lease) and opposite the border of British Columbia is the Saxon Deposit of Denison Mines Ltd. 60 miles spur line or pipe line has to be

REMARKS

The tests which give the FSI of four in seam No. 3 is not shown on the attached tabulation. We hopefully feel that we will receive more qualified information from Notus.

4.19 KAKWA RIVER COAL PROJECT OF WOODS PETROLEUM OF CANADA LTD.

The area is owned by Woods Petroleum of Canada Ltd., a 100% subsidiary of Woods Corporation. Except for producing oil wells (4611 equivalent barrels per day 1972) in Canada, the company has no mining expertise. The Canadian Division Manager, Mr. D. J. Ewing, indicated recently in a meeting with Dr. Lange, that Woods Petroleum would sell the 20,480 acres large coal lease for a lump sum of 6.0 Million Dollars, and a 3% Royalty on the coal price.

4.19.1 LOCATION AND ACCESS

Geographically, the permit area is situated in the extreme western and central part of Alberta, adjacent to the British Columbia - Alberta provincial boundary (see Appendix 9). Joining the property are the coal areas of Denison Mines Ltd. (Saxon Area in B.C.) and Kakwa River of Kakwa Mines Ltd. (optioned by Cyprus Mines Corp.). The area is remote and the nearest producing coal mine is Smoky River, 30 miles south-east as the crow flies.

Two possibilities for a railway transportation are existing:

1. To Prince Rupert: approximately 50 miles new construction is needed, plus 575 miles existing railway line

2. To Vancouver: approximately 60 miles new construction is needed, plus 625 miles existing railway line

4.19.2 COAL RESERVES

The area is investigated by a few scout drillholes, some chip samples and two adits, of which one is in oxidized coal. During this initial program, four major coal seams are developed in the Commotion Formation; these seams designated A, B, C and D in ascending order, outcrop mainly above tree-line along the northern part of the permit area. Seam thicknesses in the investigated area, based on hand trenching and outcrop exposure, are as follows:

A Seam -- varies from less than 5 feet to 15 feet thick
B Seam -- varies from 14 to 42.3 feet thick
C Seam -- varies from less than 5 feet to 14 feet thick
D Seam -- varies from 9 feet to 21.5 feet thick

The estimated average cumulative thickness of seams A, B, C and D, throughout the investigated area, is 50 feet.

Most of the coal in the investigated area dips to the south-west at 40 to 60 degrees; however, the coal beds are somewhat folded and faulted, particularly along the more northerly part of the permit area.

Possible coal reserves in the investigated area based on the above data, are estimated at 232.5 million tons. This reserve figure is only a rough approximation of possible coal in place measured 2500 ft down the dip. The reserves are placed wholly in the possible category as recovery of the coal is considered problematical due to steeply dipping structure. A portion of 3 - 4 million tons in place appears to be strippable.

4.20 ISOLATION RIDGE DEPOSIT

The Isolation Ridge comprises a lease of 36,721 acres and is still exclusively owned by CanPac Minerals Limited. However, CanPac has called for tenders on this property. The successful bidder is not yet known. Our group did not participate in bidding, because the deposit is not of interest to us, due to a high phosphor content. Samples have been sent to Germany to test if delution of phosphor can be done by means of beneficiation, but results have not yet been received. The latest information is that Granby Mining has the option contract on the property, and is conducting exploration on work on the property.

4.20.1 LOCATION AND ACCESS

The Isolation Ridge property is located in the south-west of Alberta, some 30 miles north of the Crowsnest Pass and some 7 miles east of the Continental Divide. The property may be reached from Coleman, on Alberta Highway No. 3 in the Crowsnest Pass, by way of the Alberta Forest Service trunk road connecting Coleman with Kananaskis. The Forest Service Branch road leading to the property leaves the Coleman - Kananaskis road at Mile 29 and follows the valley of the Oldman River. From Mile 9 of the branch road, the company's access roads reach out to all parts of the property.

4.20.2 COAL RESERVES

The economic reserves in the north part of the Isolation Ridge are located in Seams No. 8 and No. 7. Further to the south, Seam No. 8 is less important and Seam No. 7 with the bulk of reserves in this area splits into ply 7 Upper and ply 7 Lower.

4.21 COPTON DEPOSIT

The Copton area belongs to a company called Copton Excol Ltd., which is a syndicate and is managed by Mr. Walter Filipek in Edmonton. Copton Excol has optioned off the property to McIntyre Porcupine Mines Ltd. Rumors exist that Amax Coal Company of America has acquired a participation in this property and an exploration program is planned for 1974.

The coal in the Copton area is of low volatile matter content and therefore might be suitable for our group, but the coal does not coke on its own and seems only to produce a satisfactory coke in blends with high volatile coal. This reason and the likely fixed participation of Amax as well as the loss-operating McIntyre Porcupine Mines Ltd. Company may prevent a participation of our group in this project.

4.21.1 LOCATION

The Copton East Coal deposit (designated by McIntyre Porcupine Mines Limited as "No. 20 Mine Area") is a north-western part of the coal producing Smoky River Coal Field (Fig. 8). This coal field is located in west central Alberta, 95 miles from the town of Hinton and 11 miles from the new mining town of Grand Cache. The Copton deposit itself is located approximately 7.5 miles (as the crow flies) north-west of the present preparation plant. Actual length of a haul road proposed from the central part of the deposit (i.e. Big Pit - the area of major strippable reserves) to the new, proposed preparation plant site on Sheep Creek, would be 7 to 8 miles.

The railway distance from the present McIntyre's preparation plant to Vancouver Neptune Terminal is 690 miles.

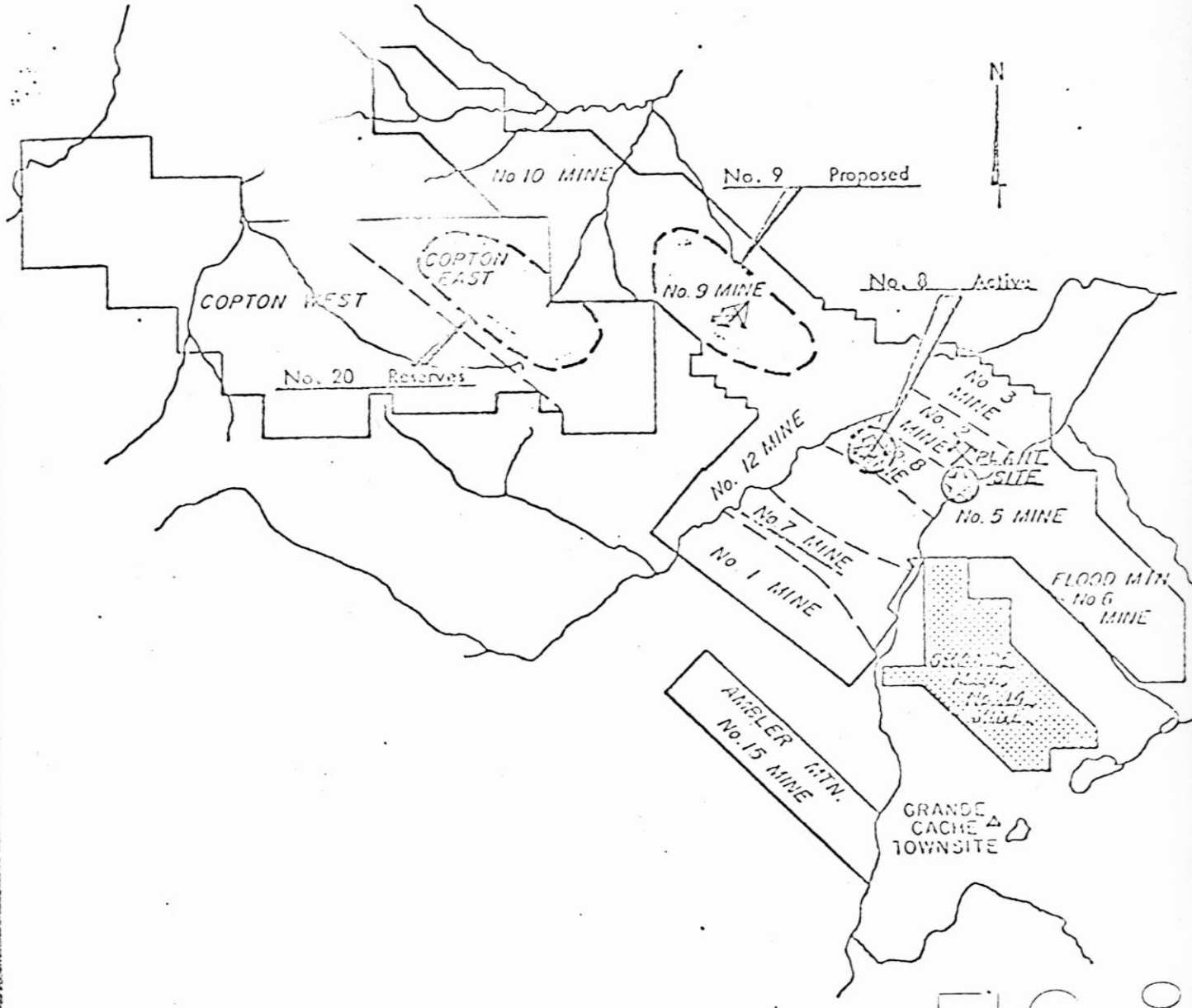


FIG. 8

LOCATION MAP
Coal Leases, Active and Proposed Surface Mi
Smoky River Area, Alberta
MC INTYRE PORCUPINE MINES LIMITED
Scale 1" = 2.5 Miles (approx.)
September 1973 John T. Boyd Compa
Mining Engineers

NOTE: BASE MAP BY PAUL WEIR CO.
ADDITIONS BY JOHN T. BOYD CO.

Tab. 62 : SUMMARY OF SURFACE MINE RESERVES
COPTON EAST (NO.20 MINE AREA)

Reserve Block	Leased Reserves			Unleased Reserves		
SMALL PITS	In Place 10^3 L. Tons	Waste and Overburden 10^3 yards^3	In Place Ratio	In Place 10^3 L. Tons	Waste and Overburden 10^3 yards^3	In Place Ratio
Pit Number 1	872	5 935	6.8	192	1 303	6.8
2	-	-	-	1 809	12 047	6.7
3	887	5 367	6.1	961	5 814	6.1
4	5 746	29 957	5.2	-	-	-
5	1 243	4 909	3.9	-	-	-
6	1 701	8 224	4.8	-	-	-
7	177	981	5.5	1 780	9 920	5.6
TOTALS IN PLACE	10 626	55 373	5.2	4 742	29 084	6.1
TOTALS RECOVERABLE *	9 298	56 701	6.1	4 149	29 677	7.2
BIG PIT						
Segment No. I	16 733	120 577	7.2			
II	12 481	56 709	4.5			
III	61 080	663 137	10.9			
IV	20 701	189 237	9.1	3 313	30 277	9.1
TOTALS IN PLACE	110 995	1029 060	9.2	3 313	30 277	9.1
TOTALS RECOVERABLE **	97 351	1042 704	10.7	2 900	30 690	10.6
GRAND TOTAL						
IN PLACE	121 621	1084 433	8.9	8 055	59 361	7.4
RECOVERABLE	106 649	1099 405	10.3	7 049	60 367	8.5

* based on average pit losses of 12.5%
** based on 90% recovery of No.4 Seam and
85% recovery of zone No.7

4.22 PINE PASS DEPOSIT

The Pine Pass Area belongs to Pan Ocean Oil Ltd. This company has optioned the area by 60% to Great West Steel Industries Ltd., a company in Vancouver, B.C. Great West Steel has several times indicated that they would accept partners for the exploration of the project, but indications of coal thicknesses encountered in a small initial study area are not favourable. Anyhow, vast areas of the property are not yet touched by any geological investigation and Great West Steel plans to spend $ 150,000 in 1974 for geological reconnaissance investigations.

The area has a distinct advantage, if mineable coal thicknesses can be located, in that it is situated on the northern end adjacent to the Pacific Great Eastern Railroad, and any mine would be in trucking distance to that railroad. Great West Steel thinks of a small outfit with approximately 500 000 tons per year production from an underground mine.

4.22.1 LOCATION AND ACCESS

The property is located in British Columbia directly south of the Pine River. The Hart Highway provides excellent access along the northern side of the area. It is an all weather paved highway.

A road passable to pick-ups in good weather extends up Hasler Creek from its junction with the Pine River to a point adjacent to the old Hasler mine. Other than this, no access is available to vehicular traffic within the area of interest.

The Pacific Great Eastern Railroad passes by at the northern end of the property, which extends to Prince George. From there

the coal can be railed either to Vancouver or Prince Rupert.

The distance from Chetwynd to Prince George is 218 miles and from Prince George to Vancouver, the distance is 426 miles or to Prince Rupert 467 miles.

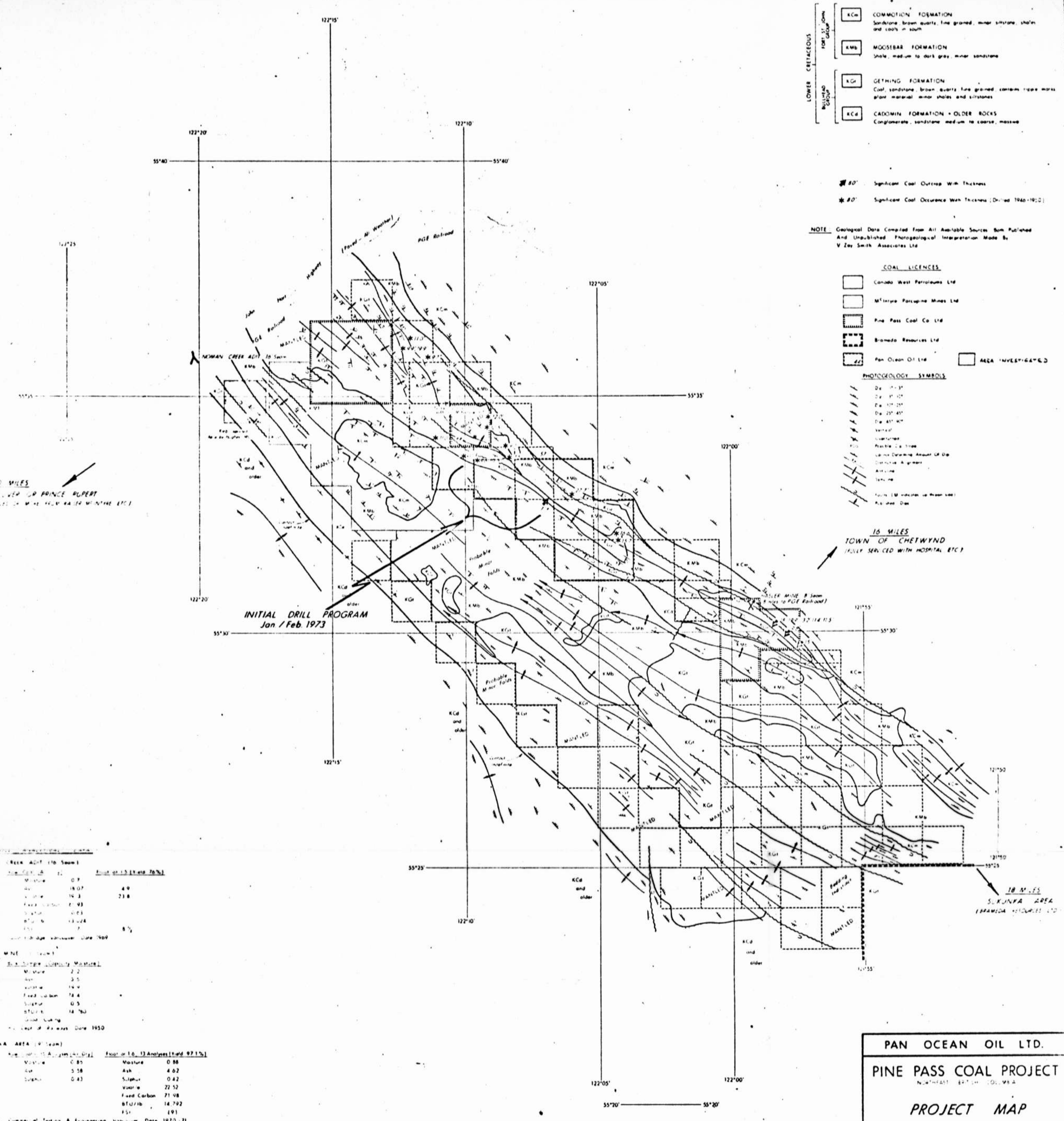
4.22.2 COAL POTENTIAL AND COAL QUALITY

The small portion investigated of the total coal license is shown in Fig. 9. In that area, no real economic seam was found during the drilling program in January and February 1973. The presence of coaly zones thicker than 10 feet has been established by this program, but unfortunately, wherever these zones were encountered - at surface or in a drillhole - they were characterised by numerous shaly splits making the seam as a whole non-economic.

The only seam encountered in the drilling program that appears to have economic potential is the "B" Seam. This seam is thicker than 6 feet where last known and seems to be excellent quality for a low ash metallurgical grade coking coal.

Vaste areas held by Pan Ocean are as yet wholly unknown. No firm conclusions can be drawn as to their potential until test holes have been drilled at selected locations. This will be done by Great West Steel in 1974. It is not worthwhile to attempt more detailed mapping of the surface in this poorly explored area until these test holes have been drilled.

From a structural point of view there does not appear to be large (over 5 square miles) flat/low dip areas. However, the potential certainly exists for mineable areas of 2, 3 or 4 square miles which might well be suited for the development of 250 000 to 500 000 tons per annum U/G mines, if a suitable seam is present.


EXPLANATION
LOWER CRETACEOUS
FORT ST. JOHN GROUP
KCm COMMOTION FORMATION
Sandstone, brown quartz, fine grained, minor siltstone, shales and coals in south
KMb MOOSEBAR FORMATION
Shale, medium to dark gray, minor sandstone
BULLHEAD GROUP
KGt GETHING FORMATION
Coal, sandstone, brown quartz fine grained, contains ripple marks plant material minor shales and siltstones
KCd CADOMIN FORMATION + OLDER ROCKS
Conglomerate, sandstone medium to coarse, massive
80' Significant Coal Outcrop With Thickness
80' Significant Coal Occurence With Thickness (Drilled 1946-1950)
NOTE: Geological Data Compiled From All Available Sources Both Published And Unpublished. Photogeological Interpretation Made By V Zay Smith Associates Ltd
COAL LICENCES
Canada West Petroleums Ltd
McIntyre Porcupine Mines Ltd
Pine Pass Coal Co Ltd
Brameda Resources Ltd
Pan Ocean Oil Ltd
AREA INVESTIGATED
PHOTOGEOLOGY SYMBOLS
Vertical
Overturned
Anticline
Syncline
Published Dips
122°15'
122°20'
122°10'
122°05'
122°00'
122°25'
121°55'
121°50'
55°40'
55°35'
55°30'
55°25'
55°20'
John Hart Highway (Paved - All Weather)
PGE Railroad
NOMAN CREEK ADIT 16 Seam
MANTLED
Probable Minor Folds
KCd and older
80 MILES
TO PRINCE RUPERT
INITIAL DRILL PROGRAM
Jan / Feb 1973
16 MILES
TOWN OF CHETWYND
(FULLY SERVICED WITH HOSPITAL ETC.)
HASLER MINE 8 Seam
(6 miles to PGE Railroad)
18 MILES
SUKUNKA AREA
(BRAMEDA RESOURCES LTD)
KCm
KMb
KGt
KCd

Analytical Data

(1) NOMAN CREEK ADIT (16 Seam)

	Raw Coal (Air Dry)	Float at 1.5 (Yield 76%)
Moisture	0.7	
Ash	18.07	4.9
Volatile	19.3	23.8
Fixed Carbon	61.93	
Sulphur	0.63	
BTU/lb	13,024	
FSI	7	8½

Coalbridge, Vancouver. Date 1969

(2) HASLER MINE (8 Seam)

Bulk Sample (Capacity Moisture)

Moisture	2.2
Ash	3.5
Volatile	19.9
Fixed Carbon	74.4
Sulphur	0.5
BTU/lb	14,780
Good Coking	

B.C. Dept. of Railways. Date 1950

(3) SUKUNKA AREA (9' Seam)

Raw Coal [illegible] Analyses (Air Dry)		Float at 1.6, 13 Analyses (Yield 97.1%)	
Moisture	0.85	Moisture	0.88
Ash	5.58	Ash	4.62
Sulphur	0.43	Sulphur	0.42
		Volatile	22.52
		Fixed Carbon	71.98
		BTU/lb	14,792
		FSI	(9)

Commercial Testing & Engineering, Vancouver. Date, 1970-71

FIG 9

PAN OCEAN OIL LTD.

PINE PASS COAL PROJECT
NORTHEAST BRITISH COLUMBIA

PROJECT MAP

JUNE 1973

Contour Interval 100 Feet

PAUL DYSON CONSULTANTS & HOLDINGS LTD

APPENDIX 12