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British Columbia Hydro and Power Authority

THERMAL COAL RESOURCES OF BRITISH COLUMBIA

VOLUME VI

ROCKY MOUNTAIN COAL RESOURCES
EAST KOOTENAY

DRAFT

April 1, 1974

DOLMAGE CAMPBELL & ASSOCIATES LTD.
VANCOUVER, CANADA

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CONSULTING GEOLOGICAL & MINING ENGINEERS
1000 GUINNESS TOWER
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SUMMARY & RECOMMENDATIONS

The East Kootenay coalfields underlie the extreme southeast corner of British Columbia, extending 100 miles northward from the U.S. border in a belt 5 - 20 miles in width centred on the town of Fernie. These coalfields represent the southern portion of the Rocky Mountain Coal Belt which is one of the major sources of metallurgical coal in North America.

The coal-bearing strata occur in the Coal Member of the Kootenay Formation. The Kootenay Formation is a deltaic deposit of early Cretaceous age that has been regionally folded and faulted along north-trending axes and subsequently uplifted and differentially eroded to leave three individual coalfields which make up the district:

The Upper Elk Coalfield - The northern 50 miles of the coal belt. Only locally explored and presently very locally developed. Includes the Fording Mine that presently produces 3 million long tons of clean coking coal.

The Crows Nest Coalfield - The middle 40 miles of the belt and the area of all of the historic mines, which produced over 50 million tons of thermal and coking coal between 1898 and the 1950's. Extensively explored but still with major productive potential. Includes the Kaiser Resources mines that presently produce a total of 4.5 million tons of clean coking coal.

The Flathead Coalfield - The southern 20 miles of the belt comprised of five scattered small remnants of the Kootenay Formation. Not developed but includes the Sage Creek deposit which could comprise a major source of open-cast thermal coal.

The Kootenay Formation contains up to 27 coal seams of which 10-15 are thick enough to be mineable at any one locality. Underground mines are favoured in areas of few structural discontinuities and rock cover in excess of a few hundred feet. Open-cast mines are developed in areas where structural deformation of coal seams and/or favourable topography result in large tonnages of coal close to the surface.

The total in situ coal reserves of the East Kootenay district are in the order of 20 - 30 billion tons, of which probably 10 - 15 billion lie within 2500 feet of the surface and are of mineable thickness. The ultimate mineable reserve of thermal and coking coals in the district await definition by comprehensive exploration and development.

The quality of the East Kootenay thermal coal averages approximately:

	As received	Air dried
Moisture	7 %	1 %
Ash	20 %	14 %
Volatile matter	--	20 %
Sulphur	0.5 %	0.5 %
B.T.U.'s/lb.	11,000	12,500

A 2000 megawatt thermal plant would require a feed of approximately 6.4 million tons of coal per year at 11,000 B.T.U.'s for 30 years. At present, no single open-cast deposit in the district contains such total reserves; however, four known deposits do contain sufficient proven and indicated open-cast thermal coal to sustain such a plant. Three of these deposits are privately owned and one is on the southern Dominion Coal Block under disputed federal-provincial jurisdiction.

By-product thermal coal from existing and planned coking coal plants in the district could now deliver a roughly-estimated 2.7 million tons per year grading 9600 B.T.U.'s/lb. and 32 % ash. If this is used as supplementary feed to the thermal plant the requirement for primary coal feed would drop to 4.2 million tons at 11,000 B.T.U.'s, an amount that could be readily developed in the district, depending on the competive demands for thermal coal that are now increasing sharply in the East Kootenay coalfields.

RECOMMENDATIONS:

The potential thermal coal feed to support a 2000 megawatt thermal plant in the East Kootenay district is essentially available both as in situ coal and as by-product coal; however, it remains to organize and assess the varied sources. To this end the following procedures are recommended:

1) One or more deposits of thermal coal be acquired by the owners of the thermal plant to provide a constant and basic feed at lowest probable cost.

2) The southern Dominion Coal Block and the Cadorna area are the only remaining crown coal land and should be obtained and assessed if a thermal plant study proceeds.

3) Existing plant owners be asked for samples of plant by-products for analyses. Enquires should also be made as to the cost of such by-products.

4) Selected property owners be approached as possible suppliers of primary thermal coal to a thermal plant.

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INTRODUCTION

TERMS OF REFERENCE:

For the purpose of this study, the writers have been requested by the British Columbia Hydro and Power Authority to:

a) Determine the extent, quality and availability of coal for thermal power generation in the East Kootenay district of British Columbia.

b) Determine for coal deposits in the district the most suitable methods for mining and transporting coal to a thermal plant located at Sparwood, B.C.

c) Prepare detailed cost estimates for capital, operating and transportation for each coal deposit that would supply feed to the proposed thermal plant.

A general report which dealt with the broad availability and costs of production of coal for a possible thermal plant in the East Kootenay District of British Columbia was prepared for the B.C. Energy Board in 1971. That report, "Thermal Coal Study, East Kootenay Area", November 19, 1971, by Dolmage Campbell and Associates Limited, was of a reconnaissance nature; nevertheless, the conclusion was drawn from the study that a coal thermal plant in the Fernie coal district was feasible. It was also concluded that a more definitive examination and assessment of the district would be necessary in order to establish more exactly the coal costs for such a plant. The present report contains the results of that assessment.

There is an immense amount of data concerning the East Kootenay coalfields in private files. Most of this information has not been available for this study; however, enough data have been obtained from many other sources to provide a sound technical basis for the assessment of the availability of coal from this district. Government reports and documents in the public domain provided excellent background information on all aspects of coal in the East Kootenays. Private companies operating and exploring in the district contributed current exploration and production data through discussions, correspondence and private reports.

A number of the senior personnel of Dolmage Campbell and Associates Limited are knowledgeable about most of the East Kootenay coal mines. Various staff members have had operating experience in the district, have recently visited and examined both of the producing operations in considerable detail, and have directed exploration and testing of the Dominion Coal Block for Pacific Coal Company in the mid 1960's.

PHYSIOGRAPHY:

The East Kootenay coalfields lie within the western middle ranges of the Rocky Mountains, generally in intermontane plateaus, such as the Flathead and Fernie basins, or intermontane valleys, such as the Fording basin.

Generally the coalfields lie between elevations of 4000 and 6000 feet, with surrounding mountain ranges rising to 8000 feet to the west and 9500 feet to the east, along the B.C. - Alberta boundary. Below about 5000 feet elevation the valleys and mountain slopes are relatively deeply covered by overburden and are densely forested, whereas above that elevation bedrock exposures are common and forests are sparse.

The terrain is mountainous, with steep-walled deep valleys flanked by precipitous mountain ranges or alpine plateaus. The grain of the topography is north-south, with the Elk River flowing southward along the western flank of the district to Elko, where it turns westward to join the Kootenay River in the Rocky Mountain Trench. The Fording River, 5 miles east of the Elk River, also flows southward from the Alberta border to join the Elk River 10 miles north of Sparwood.

The opencast coal mines are, and will be, developed along topographically advantageous ridges, plateaus and peaks.

The area is blanketed with glacial overburden to depths from nil to 100 feet or more.

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In compiling this report, the writers have made use of numerous private company reports which have very restricted availability as references. The principal readily available references are:

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CLIMATE:

The presence of long and lofty mountain ranges in the East Kootenay coal district plays an important part in the climate of the area. Generally the mean temperature, at Fernie, ranges between a high of 63° F in July, to a low of 17° F in February; with extreme lowest temperatures of -50° F and highest of 80° F.

The prevailing high level winds in the East Kootenays are westerly; however, the very high north-trending mountain ranges, that form the Rocky Mountains in this district, exert a strong influence on the air movements so that the surface winds invariably flow north-south along the major valleys.

Precipitation averages approximately 40 inches per year, including approximately 80 inches as snow.

The principal source of water in the area is the Elk River, which flows along the entire western margin of the district (Figure 1). Tributary streams are reasonably large but their flows fluctuate markedly with the seasons.

HISTORY:

The East Kootenay district of British Columbia has a long history of coal production, dating from the time of the construction of the railroads in western Canada and the northwest United States in the late nineteenth century. Coal was first discovered in the Fernie area in 1873; however, the first production activity did not occur until 1897 when the Crow's Nest Pass Coal Company Limited was organized after ten years of prospecting and promoting by William Fernie. In 1898, the Canadian Pacific Railroad reached Fernie from Fort McLeod and in 1902 the Great Northern Railroad reached Fernie from Montana.

Production began in 1898 from mines at Coal Creek, 5 miles east of Fernie, to be followed by Michel, 1899, Morrissey, 1902, Corbin, 1908, and Hosmer, 1908. The mines at Morrissey and Hosmer were closed in 1908 and 1914 respectively because of production problems caused by severe outbursts (Morrissey), and complex geology (Hosmer). Production continued at Corbin, 20 miles due east of Fernie, until 1935 and 1943-1948.

Prior to the 1960's, the major historical production in the district has come from the mines on Coal Creek and around Michel. The Coal Creek collieries ceased production in the late 1950's. The Michel area collieries have continued production to the present, through the transition of control from the Crow's Nest Pass Coal Company Limited to Kaiser Resources Limited in the late 1960's.

Present production from the district is coming from the Michel area and from newly-opened mines north of Michel on the Fording River.

Ignoring the production of the recently opened modern mines, the total production in the East Kootenay district has been approximately:

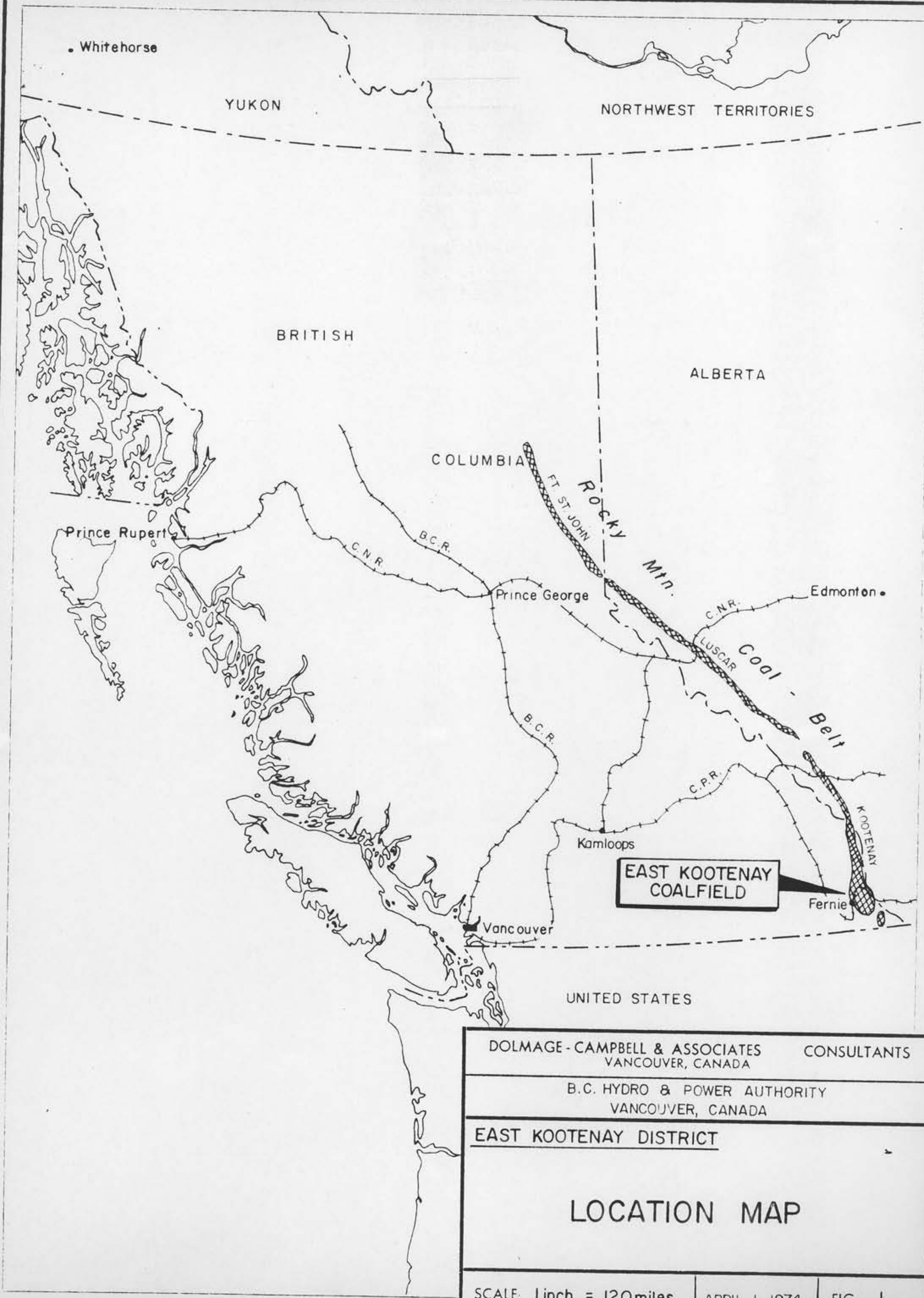
Michel	25 million tons
Coal Creek	20 million tons
Corbin	4 million tons
Hosmer	1 million tons
Morrissey	½ million tons

The relative remoteness of the East Kootenay district from major industrial centres has had an adverse effect on production of coal from this source, especially in times of fluctuating demand. The principal consumers of East Kootenay coal since the opening of the district have been the railroads; however, this market ceased to be important to the U.S.A. by the 1930's and suffered a major decline in the 1950's when the Canadian railroads converted from steam coal to diesel fuel.

Although the East Kootenay coalfields contain coal of excellent coking quality, the market for such coal was not actively cultivated by the operators in the district until the advent of Kaiser Resources Limited.

Since 1965, the rapidly growing Japanese economy created an increased demand in Japan for metallurgical coals from sources other than the traditional ones in the Eastern U.S.A. This demand has had a profound effect in rejuvenating exploration and development of coking coals in the entire Rocky Mountain coal belt and particularly in the East Kootenay portion in British Columbia.

Today Kaiser Resources Limited, the successor to Crowsnest Pass Coal Company, produces 5,000,000 long tons per year of clean coking coal, principally from a cluster of five large pits located north of Natal. Included in this tonnage is approximately 500,000 tons of clean coal from an underground hydraulic mining operation. A second underground mine produces coal by conventional mechanized methods but the product is processed separately for domestic consumption. Fording Coal Limited, the other operator in the district and a subsidiary of Canadian Pacific Investments and Cominco, produces 3,400,000 long tons of clean coal from two pits for the Japanese metallurgical market. Several other companies have reached a point of advanced exploration; notably the Emkay-Scurry Rainbow joint venture at Weary Creek, Crows Nest Industries at Line Creek, Pacific Coal on the Dominion Coal Block at Morrissey Creek, Byron Creek Collieries at Coal Mt., and Sage Creek Coal in the Flathead River area.



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EAST KOOTENAY DISTRICT

LOCATION MAP

SCALE: 1 inch = 120 miles	APRIL 1, 1974	FIG. 1

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GEOLOGICAL SETTING

ORIGIN OF ROCKY MOUNTAIN COALS:

The East Kootenay coalfield in British Columbia is the southern half of what is generally termed the Kootenay coal district of the Rocky Mountain coal belt. The Rocky Mountain coal belt extends for a distance of approximately 600 miles along the eastern ranges and foothills of the Rocky Mountains, from the U.S.A. border northwestward to the Peace River in British Columbia, (Figure 1). The coal belt is divisible into three major geological - geographical sections which overlap slightly and which have been named for the purpose of this study, from south to north, the Kootenay, the Luscar and the Fort St. John. A sub-section, the Nikanassin, overlaps the southern portion of the Luscar in Alberta.

Each of the above three main sections of the Rocky Mountain coal belt is approximately 200 miles in length and represents a geological unit wherein a certain number of coal beds occur with reasonable continuity within the same rock formation. Each of the three sections reflects a common geological environment that prevailed during Cretaceous time and that favoured the extensive development of coal-forming swamps along the western shore of the Cretaceous sea which then occupied the area of the present Canadian Plains. This geological development, as reconstructed from abundant geological evidence, resulted from the formation of very extensive river deltas along the emerging shore of the Cretaceous sea. The mouth of each of these delta complexes was upwards of 200 miles in width and could have been developed by one or several rivers. (For comparison, the Mississippi delta is approximately 300 miles in width and is fed by three major rivers besides the Mississippi.) In this environment, lagoons and swamps formed along the shoreline behind sandbars and, during the early stages of delta aggradation, they became hosts to prolific growths of grasses and bushes that evolved into extensive peat bogs, (not unlike those presently occurring in the Fraser River Delta), which eventually were transformed into coal by burial and compaction.

In the Kootenay delta, the later stages of delta maturity produced conditions which tended to be favourable for tree growth in the swamps, since the upper Kootenay coal layers have maceral contents more suggestive of wood and bark origins than do the lower coal layers. Upwards of 50 individual coal layers (seams) were derived from the swamps formed during the development of the Kootenay delta; however, few of these, if any, extended throughout the entire delta complex, so that there are generally no more than 25 individual coal seams in the Kootenay column at any particular location. The thickest and most continuous coal seams within the Kootenay delta formations attain individual thicknesses of up to 50 feet and lateral continuities in excess of 100 miles along strike and 10-20 miles down dip. These dimensions of coal seams represent original swamps that extended over 100 miles along the coast and tens of miles inland, or up-river.

The tectonic condition that gave rise to the formation of coal-bearing deltas along the western shore of the Cretaceous sea was principally the uplift of the (Cordilleran) land mass to the west. Prior to Cretaceous time, 136 million years ago, the land mass to the west had been low-lying and the rivers draining it carried mud and silt into the sea. This fine material was carried well out to sea and widely dispersed, and is now represented by the extensive, thick shale formations that underlie the subsequent deltas. By 141 million years ago, the land mass to the west had been uplifted enough to cause vigorous erosion of the underlying rock. The rivers became loaded with sand and gravel, as well as silt and mud, and the deposition of this material at the river mouths began the formation of the Kootenay delta complex. This condition continued well into Cretaceous time.

The entire Kootenay delta complex, now represented by the Kootenay Formation, was deposited over a time span of approximately 23 million years. Swamps began developing after about 1.5 million years and continued for the next 10-15 million years. The remainder of the Kootenay delta was completed under conditions that saw increased uplift and erosion of the land mass to the west, resulting in the deposition of thick cross-bedded sands and gravels essentially devoid of coal-forming swamps.

During the deposition of the Kootenay (delta) Formation, another such delta was being deposited to the northwest; however, this delta, termed the Nikanassin for this study, was possibly not as extensive as the Kootenay, and coal-forming swamps were fewer.

The Luscar and the Fort St. John coal-bearing deltaic deposits were formed further northwest along the Cretaceous shoreline from the Kootenay and in essentially the same manner; however, the coal-forming swamps as well as the thick sand and gravel deposits occurred with much less frequency in these deltas than in the Kootenay, suggesting possibly more subdued uplift of the land mass to the west. This condition of deposition is reflected in the pronounced decrease both in thickness and number of coal seams in the Cretaceous Rocky Mountain coal-bearing formations from the Kootenay in the southeast to the Gething and Gates, (Fort St. John delta), in the northwest. It is also of interest that the Luscar and Fort St. John coal-bearing deltas did not begin to form until approximately 106 million years ago, some 10 to 12 million years <u>after</u> the end of Kootenay delta deposition, indicating that the uplift of the western land mass progressed from southeast to northwest at a relatively protracted and possibly irregular rate.

KOOTENAY FORMATION:

The general character of the original Kootenay coal-bearing sediments has been described above. The resulting rocks have been grouped together as the Kootenay Formation. The extensive operations of the coal companies who have produced and explored in the East Kootenay district, plus the relatively detailed mapping of the district by the Geological Survey of Canada and others, has resulted in a very high degree of understanding of the geology of the Kootenay Formation. This has produced an intimate knowledge of the number, thickness, extent and nature of coal seams in local mining areas throughout the district; in particular with respect to those in the central part of the district (Crowsnest coalfield) and to a lesser degree in the northern (Upper Elk coalfield) and southern (Flathead coalfields) sectors (Figure 2).

The Kootenay Formation ranges between 2500 and 5500 feet in stratigraphic thickness, being thinnest at the northern and southern extremities of the original delta complex, and is sharply differentiated from the underlying and overlying formations. The underlying formation, the Fernie Formation, of Jurassic age, consists predominantly of shales, siltstones and fine grained, thin-bedded sandstones. The Fernie rocks conformably underlie the Kootenay Formation throughout southeast British Columbia. The overlying formation is the Cadomin Formation of the Blairmore Group of mid-lower Cretaceous age. In the Kootenay district the Cadomin is present only in the central portion (Crowsnest coalfield) of the district, having been removed by erosion elsewhere, and lies unconformably on the upper beds of the Kootenay Formation. The Cadomin consists principally of thick beds of cliff-forming massive sandstone and conglomerate.

CORRELATION:

Numerous attempts have been made by geologists to subdivide the Kootenay Formation into mappable sub-units that can be recognized throughout the district. These attempts have been frustrated by the fact that deltaic deposition, such as that which produced the Kootenay Formation, does not lend itself to order and continuity of individual beds nor to consistency of thickness of beds. The channels, lagoons and sheet floods characteristic of deltas tend to produce irregularly distributed, generally discontinuous deposits. Thus, the beds throughout the Kootenay Formation are lenticular; however, the lateral continuity of individual beds varies widely throughout the formation, from less than a mile to as much as 100 miles. This applies to all types of beds, including coal; some coal seams are uniform in thickness and character over tens of square miles of area, whereas others are extremely variable in thickness and character within a one-square-mile area.

Due to its deltaic origin, the Kootenay Formation itself ranges considerably in total thickness within the district; for example, the formation is approximately 2000 feet in thickness at the south end of the Dominion Coal Block, near Lodgepole Creek, and is 3600 feet in thickness at Michel, 20 miles to the north, but is only 1600 feet in thickness at Flathead in the south edge of the district. Along with these changes in overall thickness, the individual members within the formation naturally change as well. At Michel, the Kootenay Formation contains about 22 coal seams; however, at Flathead it contains few coal seams.

It is rarely possible to correlate the stratigraphic sections of the Kootenay Formation measured at widely separated localities except in a very general sense. This general correlation is made possible by the areal continuity of a few beds or groups of beds, namely:

1) The upper 1200-1600 feet of the Kootenay Formation is made up of sandstone and conglomerate beds that form the Elk Member. This member is host to a relatively few, scattered lensy coal seams of mineable thickness. The upper contact of the Elk Member is unconformable against an overlying Cadomin conglomerate bed. The lower contact of the Elk Member is not so readily identified, being somewhat transitional from the underlying Coal Member of the formation.

2) The base of the Kootenay Formation is everywhere distinctly identifiable by a thick, 50 feet to 230 feet, massive quartz-like sandstone bed termed the Moose Mountain Sandstone. This bed lies conformably on the underlying Fernie Formation rocks.

3) The beds between the Elk Member and the Moose Mountain Sandstone are generally shale with abundant intercalcations of sandstone and coal. This section, some 1500 to 2200 feet in thickness, is termed the Coal Member. Continuity of individual beds within the Coal Member is difficult to establish without physically tracing them because they tend not only to change in thickness but also to change their relative position within the stratigraphic column.

A few individual beds are relatively persistent, at least throughout the Crowsnest coalfield and possibly throughout all of the coalfields in the district. These are:

(a) Balmer coal - The Moose Mountain Sandstone is almost everywhere overlain by a thick, 12 ft. - 50 ft., coal seam that has been, and is being, extensively mined throughout the district. It has been variously labelled the K1, #-1 Bed and the Balmer Seam.

(b) Hillcrest Sandstone - A sandstone bed, 50-75 feet in thickness, lies 75 to 150 feet stratigraphically above the Balmer coal and appears to be persistent throughout the district.

(c) No. 2 Coal - A persistent, generally thick, 15-50 feet, coal seam lies 10 to 120 feet stratigraphically above the Hillcrest sandstone. This bed commonly splits into two thin beds.

(d) Middle Sandstone - A relatively thick, 60-175 feet, persistent sandstone bed lies approximately midway between the Moose Mountain sandstone and the Elk Member, dividing the Coal Member into an upper and a lower half. This sandstone bed has been named the Middle Sandstone for this study.

(e) Coal Creek # 5 Seam - A relatively thick, 20-40 feet, persistent coal bed lies about 150 feet stratigraphically above the Middle sandstone. This was termed the No. 5 Seam at Coal Creek where it is comprised of two coal seams, 11 and 18 feet, separated by 10 feet of shale.

COAL MEMBER: (Figure 4)

All of the commercial coal seams in the Kootenay Formation occur below the Elk Member in the underlying 2000 stratigraphic feet known as the Coal Member. Three stratigraphic sections through the Coal Member in the Crowsnest coalfield are shown in Figure 4. These sections were measured at Coal Creek, at Morrissey Creek and at a point between those two locations. The sections are 5½ and 3½ miles apart, thus they span only a small portion of the entire district, which is about 200 miles in length, but cover a more than ample span to accommodate many mines and encompass major coal reserves.

The lateral correlation of the Moose Mountain sandstone, the Balmer coal, the Hillcrest sandstone, the No. 2 Coal, the Middle sandstone and the Coal Creek No. 5 Coal is well demonstrated by these three sections in the Crowsnest coalfield (Figure 4). Equally well demonstrated by these sections is the difficulty of correlating most of the other sandstone and coal beds by projection from section to section. However, it should be noted that the McEvoy (middle) section was hampered considerably by local overburden cover and that if sandstone beds could be identified in some parts of that section the overall correlation of the beds might improve markedly.

It is evident from these sections that the coal-rich portions of the Coal Member are persistent throughout the area, although individual coal seams may or may not be. It is also evident, at least for this distance of about 10 miles, that the Coal Member contains a relatively consistent amount of coal:

	Coal Cr.	McEvoy	Morrissey Cr.
No. of coal seams	18	14	22
No. under 5 feet	5	4	10
No. over 12 feet	5	4	3
% coal in member	8.2	9.5	8.5

In the Crows Nest coalfield a general geological similarity exists between the top and bottom halves of the Coal Member, as separated by the Middle Sandstone; suggesting a cyclic development of the member and the possibility of dividing the member into at least two distinct and similar sub-members. A comparison of the main continuous features of these two sub-members, taken from Figure 4, is tabulated below:

	Upper Sub-member	Lower Sub-member
Total thickness	600-800 ft.	800 ft.
Coal seams over 2 ft.	6-10	6-8
Basal sandstone thickness	Middle S.S.(50'-180')	Moose Mt. S.S.(50'-230')
Major basal coal seam	Nil	Balmer Seam (12'-50')
Major coal 200 ft. above base	Coal Cr.#5 (20'-40')	No. 2 Coal (20'-50')

Generally, fewer of the coal seams in the Upper Sub-member than in the Lower Sub-member are over 5 feet in thickness, thus the Lower Sub-member is the most favourable half of the Coal Member for the development of commercial (mineable) coal.

It is evident from the extensive mining and exploration done in the Crowsnest Pass coalfield that the continuity of mineable coal throughout the field is excellent, although some individual beds may pinch out within a few miles. This feature of general continuity of coal sections is important to appreciate when coal reserves are calculated. Although specific coal reserves are established by concentrated work in local mining centres, it is obvious in the case of the Kootenay district, because of the known continuity of mineable coal in the section, that extensive coal reserves may be reliably estimated by extrapolation between widely separated explored locales.

The coal seams of the Kootenay Formation are remarkable in their number and thickness as well as in their general continuity throughout the district, either as individuals or as closely juxtaposed beds. In the Crowsnest coalfield, 23 mineable seams have been recorded from various localities with a total coal thickness of from 100 to 172 feet. The Upper Elk coalfield contains 26 coal seams at the north end of the belt, with a total coal thickness of 380 feet.

STRUCTURAL GEOLOGY:

The exploitation of the coal occurring in the Kootenay Formation has been, and is, profoundly influenced by the structural geology of the rock formations. The Kootenay Formation has been extensively deformed by the folding, thrust faulting and normal faulting that accompanied the crustal stresses that resulted in the uplift of the Rocky Mountains. Intensities of deformation of the Kootenay strata range from negligible to intense throughout the district; therefore, the location of mines has been influenced not only by geographic accessibility but also by the presence or absence of geological deformation and by the geometrical relationship between the mountain topography and the deformed coal beds.

Underground coal mines are most profitable where they exploit undisturbed coal seams. Even considerable folding can be compensated for in underground mines through the use of recently-developed mining equipment and techniques; however, intense repeated folds and/or displacements by closely-spaced faults can render any underground coal mine uneconomic. For these reasons, the underground coal mines in the Kootenay district have been located where the strata are relatively undisturbed and generally dipping at less than 20°.

In contrast, most of the surface mines in the Kootenay district have been located in areas where erosion has exposed intensely deformed sections of coal-bearing strata. Where coal beds have been vertically repeated by low angle thrust faults and/or horizontally repeated by intense isoclinal folding, generally accompanied by local thickening of the coal beds due to the flow of the incompetent coal during deformation, large local concentrations of coal have been developed. Where thick coal seams, such as the Balmer, have been so deformed, and reformed, single masses of coal exceeding 100 million tons have been developed. Such masses are almost impossible to mine by existing underground methods because of the complexity of the structures and the incompetence of the deformed coal and enclosing strata; however, where such masses of coal lie at or near the surface, they are amenable to highly productive, low cost strip or openpit mining methods.

KOOTENAY COALFIELDS:

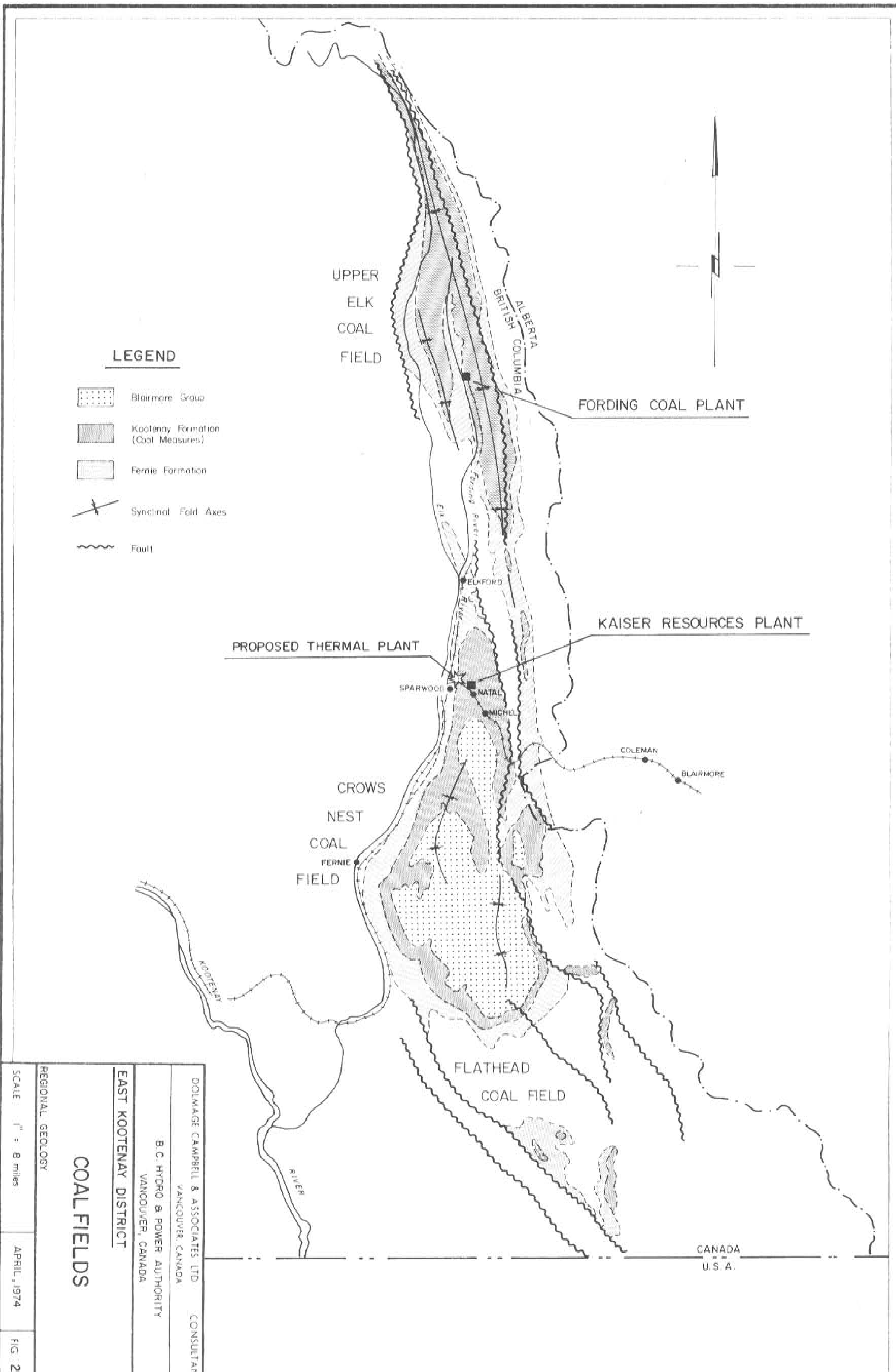
In Tertiary time, during the formation of the Rocky Mountains, the pre-Tertiary rock strata were deformed by folding and faulting along generally northwest trending axes; however, in the British Columbia portion of the Kootenay district the axes of deformation are north-south. Structural discontinuities and erosion have left the deformed Kootenay Formation in British Columbia in three main trough-like bodies that represent three individual coal basins; designated, from south to north, the Flathead, the Crowsnest and the Upper Elk coalfields (see Figure 2). The Crowsnest coalfield is the largest, encompassing approximately 200 square miles of the

Kootenay Formation; the Upper Elk encompasses about 100 square miles of the Kootenay, while the Flathead encompasses only a few square miles. The coal reserves in each of these coalfields are proportional to these areas.

The Crowsnest coalfield is made up of the Fernie coal basin and small satellite coal areas along its east flank. All of the Kootenay coal production until 1973 has been derived from the Crowsnest coalfield. The coalfield extends for a north-south length of 34 miles and attains a maximum width of 12 miles near Fernie. The coal-bearing strata dip gently toward the centre of the basin and are generally flat-lying across most of the central portion. Near the edges of the basin, the beds are turned steeply upward at dips as high as 70 degrees but more generally 20-30 degrees. They are dislocated in many places by thrust and/or normal faults of a few feet to several hundreds of feet displacement. Deformation of the strata is more intense along the eastern flank of the basin (coalfield) where regional thrust faults slice the Mesozoic formations from the eastern boundary of the Fernie basin. One of these eastern fault slices extends northward east of Elkford where it widens into the Upper Elk coalfield (Figure 2).

The Upper Elk coalfield, concordant with the general tectonic framwork of the Rocky Mountains, extends north-northwest for approximately 60 miles. The belt consists of erosional remnants at its southern extremity but is continuous northerly to its limit near the Alberta border (Figure 2). Three dominant structural features occur within the coalfield; (i) the Fording River syncline, (ii) an eastern zone of faulting, and (iii) a related double fold on the west, (Greenhills Syncline and Fording River Anticline), located midway along the principal syncline. The Elk River Thrust terminates the folded structure near the upper reaches of the Elk River.

The Flathead coalfield is comprised of several, relatively small erosional remnants or local, isolated thrust plates of Kootenay Formation strata. The coalfield is bounded on the west by the MacDonald Thrust fault and is in the form of an easterly-dipping monocline that has been modified by northwest-striking block faults.



UPPER ELK COAL FIELD
LEGEND
Blairmore Group
Kootenay Formation (Coal Measures)
Fernie Formation
Synclinal Fold Axes
Fault
ALBERTA
BRITISH COLUMBIA
FORDING COAL PLANT
Elk River
Fording River
ELKFORD
KAISER RESOURCES PLANT
PROPOSED THERMAL PLANT
SPARWOOD
NATAL
MICHEL
COLEMAN
BLAIRMORE
CROWS NEST COAL FIELD
FERNIE
KOOTENAY
RIVER
FLATHEAD COAL FIELD
CANADA
U.S.A.
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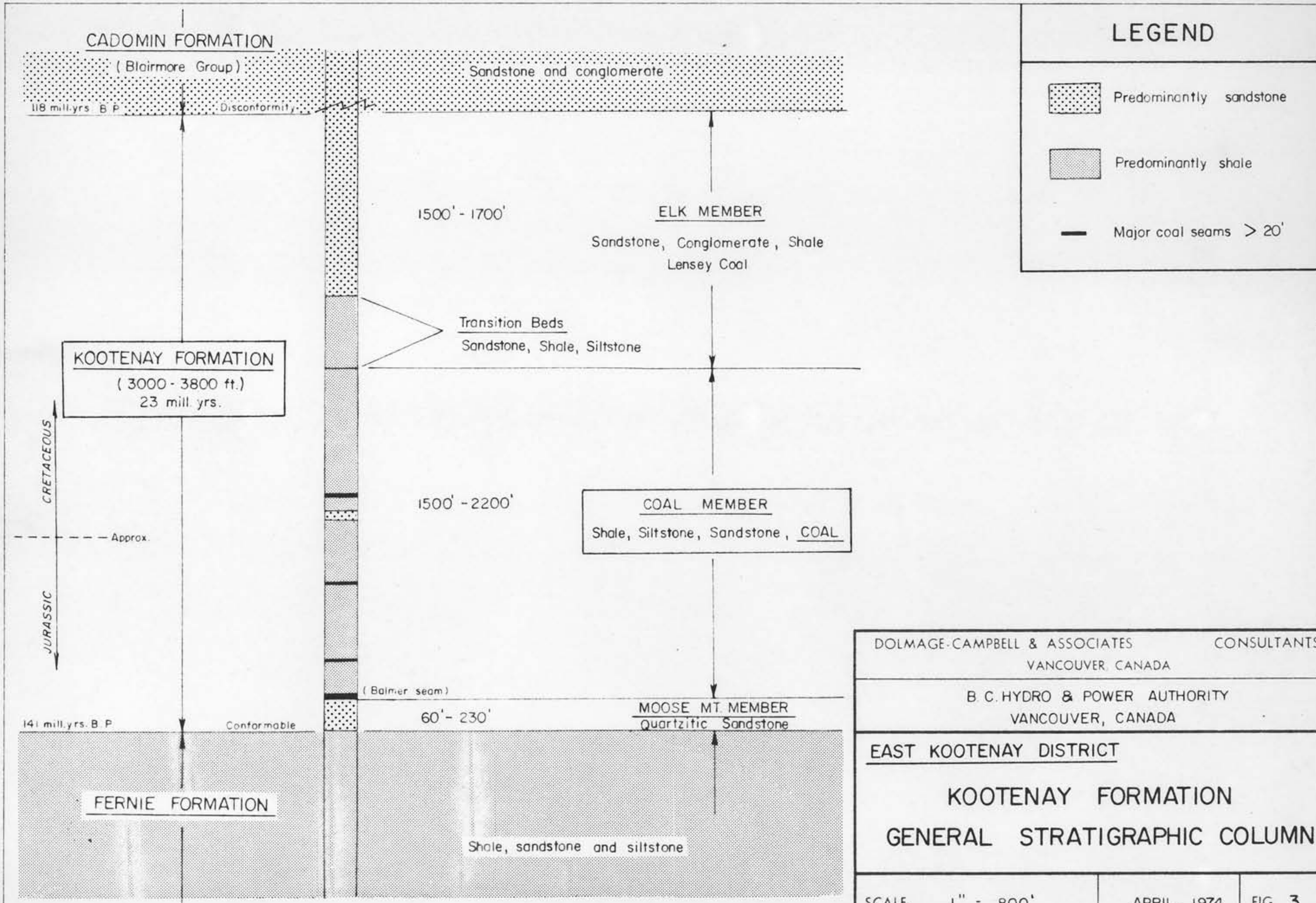
VANCOUVER, CANADA
EAST KOOTENAY DISTRICT
COALFIELDS
REGIONAL GEOLOGY
SCALE 1" = 8 miles
APRIL, 1974
FIG 2
DWG G74-1B



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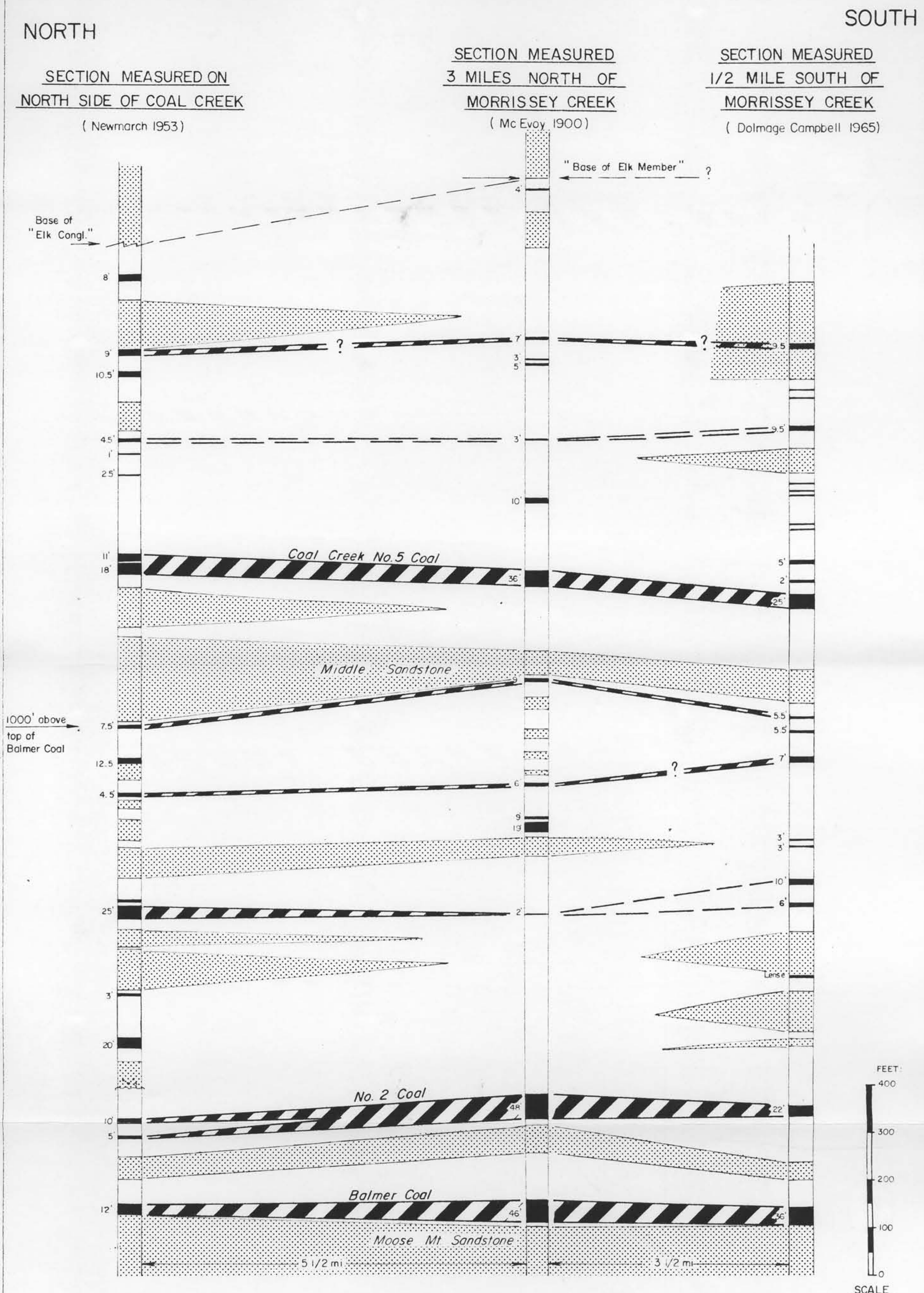
EAST KOOTENAY DISTRICT

KOOTENAY FORMATION
GENERAL STRATIGRAPHIC COLUMN

SCALE 1" = 800'	APRIL, 1974	FIG 3

DWG. G74-89 A



LEGEND

- Shale
- Sandstone
- Coal With thickness in feet

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EAST KOOTENAY DISTRICT

KOOTENAY FORMATION COAL MEMBER SECTION

SOUTH CROWSNEST FIELD

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COAL CHARACTERISTICS

COAL RANK:

The quality of the coal in the East Kootenay district is variable both from seam to seam as well as from locality to locality on the same seam. These variations are principally in moisture content, ash content and coking quality. From an operational standpoint, the blending of coal derived from different seams or different localities is therefore necessary in order to produce a raw coal feed of consistent quality to meet the current demanding specifications of the coking coal sales contracts. For the same reasons, blending may also be required to yield uniform feed to a thermal plant, although the specifications would be less stringent than those for single market metallurgical coal.

The coals of the Kootenay district are principally medium-volatile bituminous coking coals. The fuel ratio of the coals (volatile combustibles/fixed carbon) generally increases noticeably from the bottom to the top of the Coal Member; however, the coals still fall within the medium-volatile bituminous classification.

The Kootenay coals possess some characteristics that will require consideration and possible research if the coals are to be directed to thermal plant use. There is little published information on this but, for their analysis and rank, these coals require abnormally high ignition temperatures and tend to burn relatively slowly, hence the combustion apparatus must accommodate these characteristics in order to utilize efficiently the thermal value of the coals.

For the most part, the Kootenay coals contain little or no pyrite; hence the sulphur content is uniformly low (usually 0.5% or less) and is of organic association. Ash fusion temperatures exceed normally measured limits (+ 2700^{o} F), therefore the coals are non-clinkering.

METALLURGICAL COAL:

The coals of the Rocky Mountain Belt in British Columbia and Alberta comprise the largest reserves of coking coal in Canada, and one of the principal reserves in the world. Few of the known coals in the Coastal or Interior belts in British Columbia possess coking qualities. The coals in these belts that do have some coking quality are generally limited in extent and/or have only marginal coking quality. In contrast, essentially all of the coal in the Kootenay coalfields cokes to some degree and most of it to a high enough degree, after washing and/or blending, to be presently marketable as excellent metallurgical coal.

The demand for coking coal is increasing with the rising demand for steel, and since a relatively small percentage of the world's total coal reserves has good coking quality, the pressure for production from the known accessible fields of coking coal is steadily increasing and will continue to do so in the foreseeable future. As the demand for coking coal rises in Western Europe and Japan, the resources of coking coal in those regions have become severely depleted; therefore, interest in newly developing coalfields such as the Canadian Rocky Mountains is constant and is directly responsible for the current revitalization and expansion of exploration and production of these coalfields. For this reason, the price of thermal coal derived from these coalfields is, and will continue to be, governed by the primary interest of the mine owners in the marketing of coking coal. Thus, although the coal resources of the Kootenay district are vast, the availability of thermal coal from the district is economically restricted to occurrences of non-coking coal, either as oxidized metallurgical coal or as primary non-metallurgical coal, and to waste products or by-products from coking coal plants. In 1974, for the first time in the modern history of the Kootenay district, a producer, Kaiser Resources Limited, has indicated the availability of thermal coal for sale.

Because of the close relationship between the coals in the Rocky Mountain Belt and the market for metallurgical (coking) coals, the nature of the coking quality of coal should be understood when evaluating the development of the thermal coal potential of this coal belt.

The coking quality of coal refers to its specific application in the production of iron by blast furnace and related processes. The coke that is used in blast furnace charges with iron ore is required to perform the following basic functions in the furnace:

(i) Act as fuel; therefore, have high calorific value.

(ii) Provide reducing gas (CO_2); therefore, have high carbon content and good reactivity.

(iii) Provide as high a permeability in the shaft of the furnace as possible; therefore, it must have high resistance to breakage and abrasion, (which would result in the collapse of the charge column in the furnace), at high temperature.

The coke used in the furnaces is a spongy material derived from the pyrolysis of a (coking) coal. The principal physicochemical changes brought about by the heating of the coal (pyrolysis) is the plasticizing and expansion of the coal due to the formation of pore spaces in a cohesive mass. During the heating of a good quality coking coal, the coal will become plastic at about 400-550° C and its porosity will increase from a few percent to over 50 percent. Good metallurgical cokes are obtained from coals that show a fair plasticity, an oxygen content of not more than 4 percent, and a resolidification point of about 500° C.

The swelling characteristics of heated coal are measured by means of a relatively simple laboratory test whereby a fixed quantity and dimension of coal is heated under controlled conditions. The size of the resultant product (coke) is compared to a standard scale of "free swelling indices" graduated from 1 to 10. A non-coking coal will have a free swelling index (FSI) of zero, whereas a good coking coal will have an FSI of six or better. Raw coals with free swelling indices of from three to six may be improved to marketable metallurgical products by cleaning and blending; therefore, it is difficult to establish a cut-off whereby coal below some particular FSI is automatically marketed only as a thermal coal. It is conceivable that in some areas where alternative power sources are very costly, it may be economically sensible to use good metallurgical coal for thermal purposes.

The characteristics of coals that have coking qualities are understood only in a general way and are not readily apparent by observation. The metamorphic processes that change the rank of coals from lignite through to anthracite exert a basic control on the coking quality of the coal. Lignites do not coke principally because their high moisture content and large pore volume result, during pyrolysis, in the great dilution of any plasticizing agents that may be present and in the loss of those agents by the rapid escape of water vapour through the permeable pore structure. Conversely, anthracites do not coke because metamorphism has driven off too much of the volatiles that are necessary for the production of (swelling) pore spaces during pyrolysis. Thus, all coking coals are bituminous in rank.

The two properties that control the coking behaviour of coal are swelling and agglutination. The volatile matter must be present in the coal to provide the expanding agent (swelling) during pyrolysis; however, plasticizing agents must also be present in the coal in order to capture the expanding volatiles in pore spaces whose walls will swell and fuse to form a coherent and cohesive coke.

The origins of these properties in coals are known only in a general sense. They are primarily related to the nature of the plant material that formed the coals.

Coal is comprised of various mixtures of ten basic components of organic origin. These components are termed macerals and they are analogous to minerals in rock in that they are microscopically, and occasionally megascopically distinct from one another. The macerals are divided by physical properties and origin into three groups, as follows:

Vitrinite	Oxygen-rich residual plant cell wall and cell cavity material. The major component of coal; forms the familiar jet black and brilliant bands. The role of the vitrinites in the coking process is obscure but is evidently related to the capability of the cell structure to form cohesive pore structures.
Inertinite	Carbon-rich, hydrogen-deficient material similar in origin to vitrinite. Inertinites have no reaction or role in the coking process.
Exinite	Hydrogen-rich tar-and-gas-forming material derived from plant spores, cuticles, resins and algae. The exinites are the most important macerals in the coking process, evidently supplying the plasticizing material that is critical for cohesive swelling.

It is evident that the coking quality of coal is first established by the composition of the original plant remains and then developed by the modifications imposed by metamorphism. There can be little doubt that plant associations in the original coal swamps were modified both laterally and vertically from one geological interval to another, by changes in water depths, etc. In the case of coking properties, such primary changes could give rise to the occurrence in coalfields of coal seams with differing coking characteristics and of individual seams with different coking characteristics in different layers of the seam. This variation would explain the fact that in the Kootenay coalfields there is a wide range in coking qualities from seam to seam as well as laterally and vertically within single seams. This feature complicates the development of the district for thermal coal because what may be a non-coking seam in one locality may be a good quality coking seam in another.

Generally speaking, most of the coals in the Kootenay district have good coking characteristics and generally the FSI improves substantially as the ash content decreases. However, exceptions occur and in the case of exceptionally low-volatile coals the coking ability is seriously reduced or even virtually eliminated. Some seams in the district are exceptionally good coking coals while others are poorly coking.

Important to the development of thermal coal in the Kootenay district is the fact that the oxidation (weathering) of coking coals destroys their coking quality. In addition, the high volatile, better swelling coals, common in the Kootenay coals, are the most easily oxidized and thus most easily rendered non-coking. In the Kootenay district, topographic relief is great and rainfall is moderately high; therefore, there is abundant opportunity for the oxidation of coal seams to considerable depths. In addition, the local proliferation of faults in the strata provide additional conduits for groundwater circulation to coal seams, causing local oxidation of seams at even greater depths. It is such oxidized seams that provide most of the "thermal coal" in the Kootenay district.

Although the price of thermal coal will continue to increase in the future, there is little liklihood that it will catch up to the price of metallurgical coal, which is steeply accelerating. For this reason a thermal plant located in the East Kootenay area will not be able to compete for metallurgical coal; therefore, it must obtain its feed from seams of non-coking coal and/or from by-products of the coking coal operations.

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COAL DEPOSITS

For the purposes of this report, the East Kootenay coal fields have been divided into twenty individual deposits, determined by the ownership of contiguous coal licenses (or equivalent), (Figure 5). Seven deposits lie in the Upper Elk coalfield, seven in the Crows Nest coalfield, and five in the Flathead coalfield. The deposits vary widely in potential production capacity due to the extent of each property and the nature of the geology. Only eight of the twenty properties are either producing (C and H), are near a production decision (B and F), or have completed reasonably advanced exploration (G, I, L, and S). On the basis of the presently available information, the remainder must be viewed as prospects, although some deposits may have received some preliminary exploration.

(With respect to the eight major properties, investigation of the current, anticipated, and potential production of in situ thermal coal and by-product material is presently being investigated.)

(1) UPPER ELK COAL FIELD (Blocks A to G) (Figure 5)

The seven coal properties comprising the Upper Elk coalfield are summarized as follows:

(i) Cadorna Creek (Block A)

The Cadorna Creek deposit, a coal prospect presently unclaimed by any individual or company lies immediately north of the large licence holdings of the Emkay-Scurry joint venture. The nature, quality and distribution of the coal seams within the coal measure will not be known until definitive exploration is carried out on this deposit although much will be learned from the exploitation of the Emkay-Scurry property. Coal that might be extracted by open-cast mining is indicated on the west bank of the Elk River where the Kootenay formation abuts a major regional thrust fault.

(ii) Weary Ridge (Block B)

A joint venture comprising Emkay Resources Ltd. and Scurry-Rainbow Oil Limited has outlined a very large deposit of coal on their property on the upper reaches of the Elk River. Drilling has been concentrated on the east bank of the river where the combined geological and topographical setting has created favourable large open-cast mining conditions.

Little work has been done on the west bank where the coal seams apparantly steepen as they approach the Elk River Thrust Fault. Oxidized coal has been indicated but no reserves have been determined.

(iii) Fording River (Block C)

Fording Coal Co. operates two large open pits and a cleaning plant on Fording River, about 17 miles north of Elkford. The plant lies midway between the two existing pits; the Clode pit on the east side and the Greenhills pit on the west side of the Fording River. The Greenhills Pit, a valley pit, mines the basal (Balmer) seam of the Coal Member and, in part, the next three seams up the stratagraphic section. The Clode Pit, a mountain pit, mines the Balmer seam and four, perhaps five or six, successively high seams.

The plant is designed to process 4,000,000 long tons of raw coal per year, to produce 3,000,000 long tons of clean coal for the Japanese metallurgical market.

No reserves of in situ (primary) thermal coal have been developed; however because of the very large tonnages of coal in the potential reserve category on their property, substantial tonnages of in situ thermal coal no doubt will eventually be defined as exploration for coking coal progresses.

(iv) Todhunter Creek (Block D)

Crows Nest Industries have acquired a block of coal licenses in the Todhunter Creek area. The extent of exploration, if any, done on this property is not known. No reserves of either coking or thermal quality coal have been developed, hence the property must be regarded as an unexplored prospect, even though the coal measures are known to occur on the property.

(v) Ewin Creek-Greenhills (Block E)

Kaiser Resources retain, by virtue of their very large holdings in the East Kootenay district, coal lands in both the Upper Elk and Crows Nest coalfields. A large single block of land extends from the lower Elk River, near Elko, B.C., north for 60 miles and attains a width of 5 to 10 miles. The Upper Elk segment, designated here as Block E, contains coal measures in two sections; the Greenhills syncline on the west, and the Fording River syncline on the east.

As far as is presently known, little exploration has been done and no reserves have been blocked out on these Upper Elk properties since Kaiser Resources and their predecessor company concentrated their exploration and production efforts on the Crows Nest coalfield.

(vi) Line Creek-Ewin Pass (Block F)

Crows Nest Industries have explored three coal areas along the upper reaches of Line Creek by diamond drilling and adit test work. They have blocked out three potential open pit areas, (Line Creek Ridge, Horseshoe Ridge, and Ewin Pass). Coking coal reserves are reported to be sufficient to produce 4,000,000 long tons of raw coal for in excess of 15 years. No finite reserves of in situ thermal coal have been outlined, although oxidized coal zones have been reported to vary in thickness from 60 to 350 feet in width.

(vii) Crown Mt. (Block G)

Crows Nest Industries have outlined a small coal reserve on their holdings at Crown Mt., presumably the reserve has been predicated on its amenability to be mined by open-cast methods. The defined reserve of 6,500,000 tons consists of 3,500,000 tons of coking coal and 3,000,000 tons of coal of unknown quality.

(2) CROWS NEST COAL FIELD (Blocks H to N) (Figure 6)

(i) Elk River (Block H)

Kaiser Resources Ltd., the largest single land holder in the East Kootenay district, in addition to substantial coal lands in the Upper Elk coalfield, (Block E), have under their control approximately two-thirds of the entire Crows Nest coalfield. Coal reserves are in the order of several billion tons, although most must be extracted by underground mining methods.

The company is presently operating a very large open pit mine on Harmer Ridge north of Natal, (Elkview Mine), two underground mines at Natal, a cleaning plant and by-product coke plant at Michel, and a large cleaning plant at Elkview. The Balmer North Mine, at Natal, produces from the Balmer seam using underground continuous mining machines. The product is trucked to the Michel plant for coke production which with other prepared coal products is sold domestically. The Balmer South Mine, also at Natal, produces from the Balmer seam by underground hydraulic methods. The product is trucked to the Elkview plant and processed with Harmer Ridge coal for sale to the Japanese. The Harmer Ridge open pit mine, consisting of five separate pits, provides the bulk of the feed for the entire Kaiser complex which produces 4,500,000 long tons of clean coal annually for the Japanese market.

In situ thermal coal reserves (unsuitable for blending in the coking coal operation) are reported to be approximately 8,000,000 tons. Thermal coal mine by-product, once used as fuel for drying coking coal, is now being stockpiled (1,000,000 tons are presently on hand). The dryers have been converted to natural gas.

(ii) Dominion Coal Blocks (Blocks I)

Federal government coal land holdings in the East Kootenay district comprise the north and south Dominion Government Blocks. At Morrissey Creek, the south end of the southern Coal Block was explored for coking coal by the Pacific Coal Co. Ltd. under the direction of Dolmage Campbell and Associates Ltd. and later by Nittetsu Mining Company during the period 1964 - 1968. During the same period Marubeni-Iida (Canada) Ltd. explored the north end of the southern Coal Block, in the area of an outlying subsidiary basin.

At Morrissey Creek, substantial reserves of coking coal were outlined. In addition, a recoverable reserve of 355 million tons of in situ thermal coal was outlined. Approximately 20%, (71 million tons), of the foregoing reserves can be categorized as assured (or proven); the remainder no doubt exist but because the drill holes and surface exposures are relatively far apart they must be considered as inferred (probable) reserves. The vast bulk of these thermal coal reserves must be extracted by underground methods; approximately 25,000,000 tons could probably be recovered by open-cast mining techniques.

Work on the north end of the southern Coal Block by Marubeni-Iida was restricted to the lowest three of the thirteen seams which lie in the lower half of the Kootenay Formation in this location. A substantial tonnage of coking-quality coal was outlined however no reserve of in situ thermal coal was reported.

(iii) Tent Mt. (Block J)

Coleman Collieries have a small property, (Two coal licenses), attached to their Alberta holdings on Tent Mt. This property was mined for many years and is considered to be largely depleted. No existing reserves of in situ thermal coal have been reported from the British Columbia side.

(iv) Andy Good Creek (Blocks K)

Crows Nest Industries retain coal licenses immediately north and south of Byron Creek Collieries property on Coal Mountain at Corbin. No coal reserves have been outlined to date. However, because of the proximity to the known thermal coal deposit on Coal Mt. owned by Byron Creek Collieries, it is probable that some similar quality coal will be found on the north and south extensions of the Coal Mt. structure.

(v) Coal Mountain (Block L)

Byron Creek Collieries Ltd. owns the largest known deposit of strictly thermal quality coal in the East Kootenay district, located on Coal Mountain at Corbin. The strata underlying Coal Mountain represent an erosional remnant of a folded thrust plate. This remnant of the Kootenay Formation contains three seams, the principal one of which is the basal or Mammoth seam, (equivalent to the Balmer seam elsewhere in the district), which ranges in thickness from 100 to 150 feet and contains the bulk of the coal reserve on the property. Generally the coal in this block has been extensively crushed and sheared during the deformation of the strata. This deformation also resulted in the intimate mixing into the coal of the original shale partings and some of the adjacent shale walls. For this reason coal cleaning is required for the Coal Mt. deposit.

The bulk of the Coal Mt. coal does not coke; however, in some isolated areas of Coal Mt. the coal has been less deformed and is essentially unaffected by oxidation, and produces excellent coke, FSI 6-9. Available data indicate that air dried coal from Coal Mt., cleaned to 16% ash, has the following characteristics:

Moisture	1%
Ash	16%
Volatile matter	24 - 26%
Fixed carbon	60%
Sulphur	0.2 - 0.5%
B.T.U./lb.	12,500

Approximately 2.75 million tons of coal were mined from Coal Mountain from 1908 to 1934.

The entire in situ Coal Mountain reserves are estimated to be in the order of 85 million tons of which 57 million tons are in the proven and probable categories. The principal specific reserves are as follows:

Open pit	No. 3 Pit	10,660,000 tons
	North ridge pit	9,000,000 tons
		19,660,000 tons
		(Possibly 6 mill. tons non-recoverable.)
Underground	No. 6 Syncline	32,000,000 tons
	S.W. Shoulder	2-6 mill. tons

It should be appreciated that with the presently rapidly improving strip mining technology, the proportion of coal that has been heretofore designated as recoverable by surface mining can probably be appreciably increased, not only at Coal Mountain but also throughout the Kootenay district.

Ontario Hydro presently have an option to purchase the Coal Mt. reserves, with Byron Creek Collieries remaining as operator. The option apparently would be exercised if a test shipment of 250,000 tons (to be mined and shipped in 1974) proves economically suitable for the Ontario Hydro thermal requirements.

(vi) Foisey Creek (Block M)

Crows Nest Industries have a property on Foisey Creek, a branch of the Flathead River on the southern edge of the Fernie Coal Basin. No coking or in situ thermal coal reserves have been established.

(vii) Lodgepole Creek (Block N)

Kaiser Resources have acquired several licenses on the south and southeastern edge of the Fernie Basin. No coal reserves have been established as far as is known.

(3) FLATHEAD COAL FIELD (Blocks O to T) (Figure 7)

(i) Squaw Creek (Block O)

One owner has adjoining coal licenses that straddle the Kootenay coal measure near the intersection of the Flathead River with the main road traversing the Flathead district. From the presently available information no established coal reserves have been outlined.

(ii) Shepp Creek (Block P)

Crows Nest Industries have coal licences adjoining the Flathead road. No information is presently available regarding the degree and nature of exploration carried out on this property.

(iii) Storm Creek (Blocks Q)

Crows Nest Industries own two blocks of licenses on the coal measure at the height of land between Cabin, Howell and Bighorn Creeks. No information is presently available from these properties.

(iv) Howell Creek (Block R)

Crows Nest Industries have a small property covering the coal measures wholly within a large property owned by Sage Creek Coal Company. No direct information is known on this small property; however, the coal deposit established by Sage Creek Coal may be expected to extend to the Howell Creek property.

(v) Sage Creek (Block S)

Sage Creek Coal Co., a subsidiary of Rio Algom Mines, has carried out exploration on its Sage Creek property and intends to develop the property with a view to placing it into production; however, no production decision has been made at this time.

The Kootenay Formation in the area ranges in thickness from 650 to 850 feet. Work undertaken on two prominent hills (North and South) has established that coal occurs in four horizons having an aggregate thickness of approximately 100 feet. Coal reserves have been calculated to be 120,000,000 tons, presumably mineable by open-cast methods.

Quality data is available only from the first coal seam above the basal (Balmer) seam. (At Sage Creek the basal seam is approximately 40 feet in thickness and comprises the largest single coal source.) The air dried coal characteristics of the seam above the basal are:

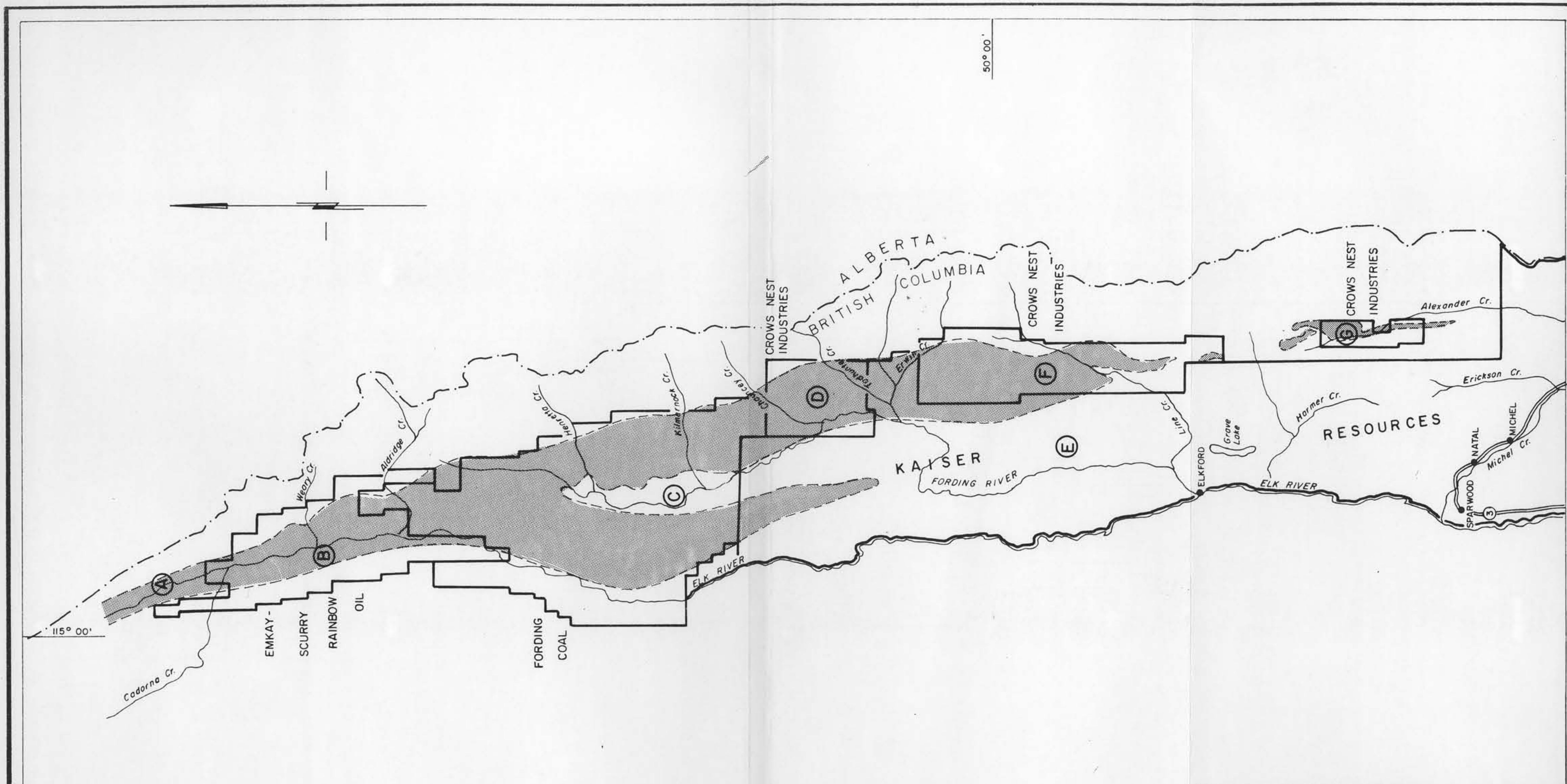
Moisture	0.68 %
Ash	18.9 %
Sulphur	0.3 %
Volatile Matter	21.1 %
Fixed carbon	59.2 %
BTU's/lb.	12,000

The coking quality of the Sage Creek coal is variable, ranging from 1.5 to 6.5 FSI, (averaging 4). With plant treatment, the free swelling index increases to 5-7, in line with the Japanese specifications.

It remains to be determined whether, in view of the limited work done to date with respect to coal analyses and the extent and nature of the various seams, the Sage Creek coal deposit will be found attractive by potential Japanese coking coal buyers. If not, it can then be viewed as a potential thermal coal deposit which could conceivably be mined at a rate of possibly three to four million tons annually.

(vi) Block T

Alienated lands, located east of the Sage Creek property, suggest that the area is underlain by a coal deposit; however, none is recorded in the geological literature. This property is regarded, therefore, to be of little importance.



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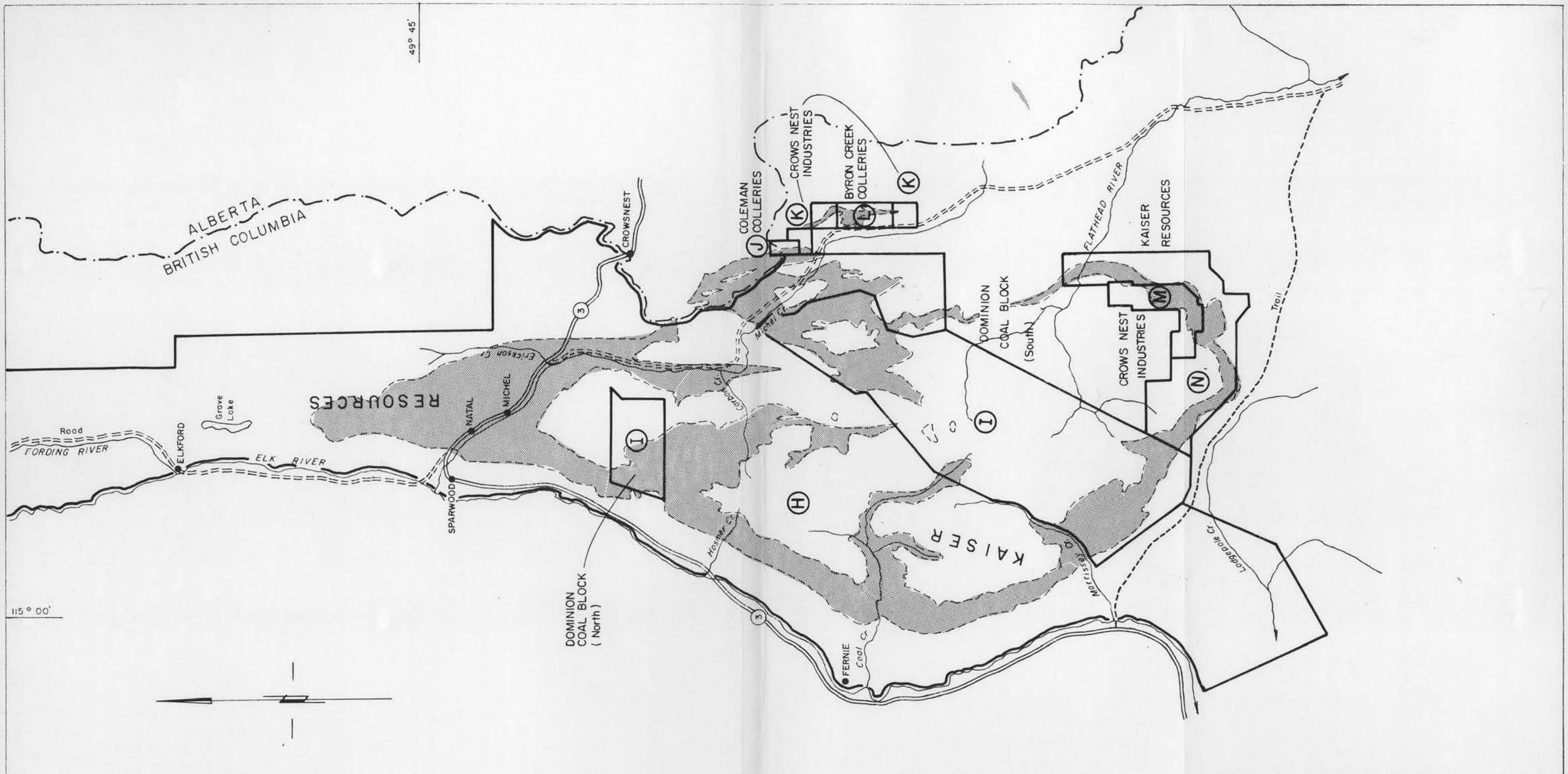
UPPER ELK RIVER COALFIELD

PROPERTY MAP

EAST KOOTENAY DISTRICT

SCALE: 1 inch = 4 miles	APR. 1, 1974	FIG. 5

DWG. G74-2 B



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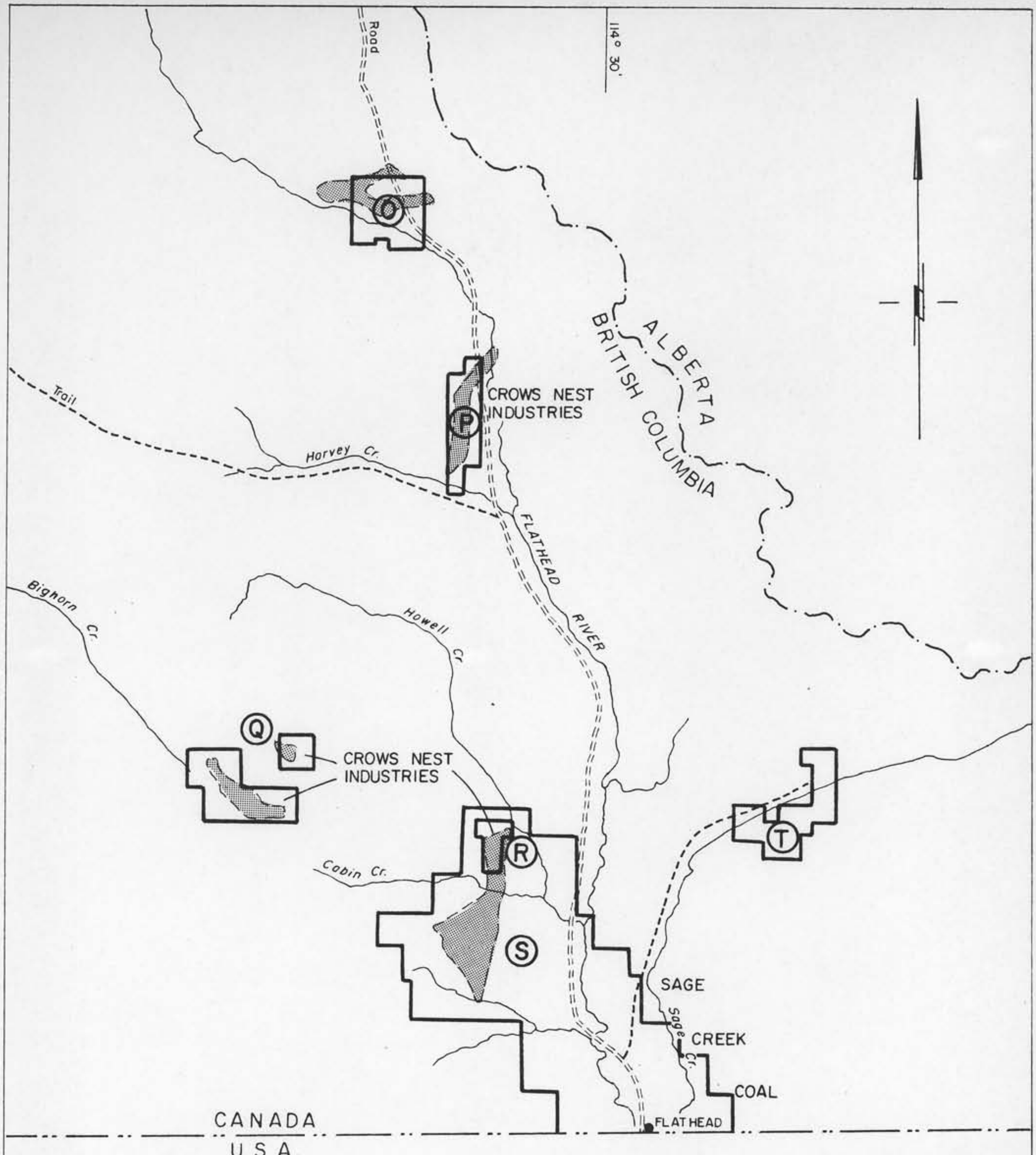
CROWSNEST COALFIELD

PROPERTY MAP

EAST KOOTENAY DISTRICT

SCALE:	1 inch = 4 miles	APR. 1, 1974	FIG. 6

DWG. G74-3 B



Kootenay Formation

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FLATHEAD COALFIELD

PROPERTY MAP

EAST KOOTENAY DISTRICT

SCALE: 1 inch = 4 miles	APR. 1, 1974	FIG 7

DWG. G74 - 4A

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COAL RESERVES, KOOTENAY DISTRICT

(This section is still in preparation)

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THERMAL COAL SOURCES

The Kootenay coalfields contain vast reserves of coal. Total reserves are probably of the order of 20 to 30 billion tons. Of this probably some 10-12 billion tons lie within 2500 feet of the surface in seams of mineable thickness and probably about one-half of this amount is recoverable by present mining practices. Advances in deep mining technology in other countries in recent years suggest that over the next few decades it will be practical to mine coal to depths of 4000-5000 feet with resultant large increases in recoverable reserves.

The estimated requirement for a 2000 megawatt plant is 6,400,000 tons per year of raw coal at 11,000 B.T.U./lb. thermal value. Hence the 30 year requirement would be 192,000,000 tons. It is obvious that the Kootenay coalfields could support a 2000 megawatt plant for 30 years with only a minor depletion of total recoverable coal reserves.

Several factors are of key importance in the practical assessment of immediately recoverable thermal coal reserves. Firstly, the great bulk of total reserves, probably 90-95%, are recoverable only by underground mining whose costs at present are generally higher than those for open cast mining. Also, with the exception of the Cadorna Creek area (which is owned by the Crown) and the Dominion Government Block (in which title is questionable) all other coal lands in the district are owned by existing companies. Secondly, most Kootenay coals are either excellent coking coals or can be upgraded to at least fairly good coking coals by cleaning. Further, the best open cast deposits known to date are either in production under contract as coking coal mines, (i.e.: Kaiser and Fording), or contemplated for production as coking coal mines (i.e.: Emkay-Scurry, Crows Nest Industries and Sage Creek); thus, any primary production of thermal coal must compete with the current (rising) price for metallurgical coal.

In this report an effort has been made to first catalogue those field reserves which are essentially non-coking yet would appear to be the economically most favorable sources of energy. These fall into three categories as follows:

1) In Situ open-cast deposits
2) Mine by-products
3) Plant by-products

IN SITU OPEN-CAST DEPOSITS

In situ coal in the Kootenay coalfields is a blocked out reserve that has been defined during the exploration for coking coal and subsequently because of its low coking quality, (less than 3.5 Free Swelling Index), remains unmined. It may consist of an entire seam, a lengthy section of a seam (usually near surface) or conceivably an entire deposit (several seams). It could be mined separately as a discrete thermal coal deposit with a reasonably assured quality and extraction rate.

As shown in Table 1, four properties apparently contain a substantial reserve of in situ thermal coal; based on currently available information. All are open cast deposits. These are:

1) Byron Creek Collieries at Corbin (Block L) whose deposit does not lend itself to coking coal production as well as most and which contains 85,000,000 tons of open pit coal. The grade has not been published, however grade is unofficially reported (air-dried basis) as follows; Moisture 1%, Ash 16%, Volatiles 23%, Fixed Carbon 60%, Sulphur 0.4%, Calorific Value 12,500 BTU/lb.

2) Pacific Coal at the southern end of the south Dominion Coal Block (Block 1) with approximately 25,000,000 tons reported. The grade (on an air dried basis) is reported to be; Moisture 1.25%, Ash 7.73%, Volatiles 14.5%, Fixed Carbon 76.5%, Sulphur 0.61%, Calorific Value 12,250 BTU's.

3) Kaiser Resources (Block H) near their present operation on Harmer Ridge with 8,000,000 tons reported. The grade is (on an air dried basis); Moisture 1.8%, Ash 12.4%, Volatiles 20.5%, Fixed Carbon 65.3%, Sulphur 0.30%, Calorific Value 12,400 BTU's.

4) Crows Nest Industries at Crown Mt. (Block G) with 3,000,000 tons. The quality is presently unknown.

These four deposits contain a combined thermal coal reserve of 121,000,000 tons. Open cast mining recovery rates will vary from 75 to 95% depending upon the geology and topography so the yield could be about 103,000,000 tons. Average grade would be approximately; Moisture 1.1%, Ash 14.0%, Volatiles 21.0%, Fixed Carbon 63.9%, Sulphur 0.4%, Calorific Value 12,400 B.T.U./lb. (As the years go by practical stripping ratios will probably increase so this tonnage can be expected to increase substantially.)

MINE BY-PRODUCTS

Mine by-products are defined as poorly or non-coking coal that is mined and stockpiled separately during the course of mining for coking coal. It is coal whose cokeability has been reduced due to oxidation; the oxidation having been caused by the penetration of groundwater. The extent of oxidation will vary according to the lithological nature of the overlying strata, the degree of faulting and fracturing, the proximity to the surface, and the historical drainage pattern.

The mine operators blend as much of the oxidized coal back into the high F.S.I. coking coal as possible, so long as the final product from the wash plant meets the contracted specifications. The rate of blending the oxidized coal (less than 3.5 F.S.I.) with the good coking coal is variable, so that the annual tonnage (and quality) of mine by-products from a given operation is relatively unpredictable. In addition, each coal operator, because of the unique oxidation history of his particular deposit, will experience differing proportions of oxidized coal, differing blending procedures and hence widely differing amounts of coal in stockpile for eventual thermal plant feed.

On the basis of presently available information mine by-products could conceivably come from four sources:

1) Kaiser Resources at Harmer Ridge produce 4,000,000 long tons of clean coal per year (plus 500,000 from one of their underground operations) for the Japanese market. From the open-cast operation 500,000 tons of mine by-product is produced annually (present stockpile of 1,000,000 tons). The grade of this material (on an air dried basis) is; Moisture 1.0%, Ash 14%, Volatiles 22%, Fixed Carbon 60%, Sulphur 0.4%, Calorific Value 12,000 B.T.U.'s. However, as has been discussed, their ability to maintain such a grade must be regarded as speculative.

2) Emkay-Scurry-Rainbow anticipate producing a mine by-product of approximately 400,000 tons annually grading 7-8% Moisture, 20% Ash, 0.6% Sulphur, and 10,000-11,200 B.T.U.'s (on an as received basis).

3) Crows Nest Industries Ltd. from their Line Creek operation expect to produce 340,000 tons annually with an anticipated grade of; Moisture 6-8%, Ash 22-25%, Sulphur 0.5%, Calorific Value 10,900-11,350 B.T.U.'s (on an as received basis).

4) Fording Coal currently produces 3,000,000 long tons of clean coal per year. Their estimate is that 160,000 tons of by-product material of an unknown grade would be produced annually. Their sales contract is for 15 years but metallurgical coal should be produced at the contract rate or better for an additional 15 years. No analysis is at hand.

Total annual production of mine by-products from these four operations on an as received basis would then be about 1,400,000 tons at an average grade of approximately 7% Moisture, 19% Ash and 11,200 B.T.U./lb.

TABLE 1

EAST KOOTENAY COAL FIELDS
THERMAL COAL
POSSIBLE ANNUAL PRODUCTION (Short Tons)

Block	Coking Coal Production Rate (LT per yr.)	Thermal Coal In - Situ (ST per yr.)	Mine By - Product (ST per yr.)	Plant By-Product Middling (ST per yr.)	Plant By-Product Refuse (ST per yr.)	Plant Totals
A						
B	4,000,000		400,000	100,000	250,000	350,000
C	3,000,000		160,000	1,000,000	130,000	1,130,000
D						
E						
F	3,000,000		320,000	268,000	740,000	1,008,000
G		200,000 (15 years)				
H	4,500,000	500,000 (15 years)	500,000	900,000	225,000	1,125,000
I		2,000,000 (12 years)				
J						
K						
L		2,000,000 (30 years)				
M						
N						
O						
P						
Q						
R						
S	2,000,000					
T						
Plant Totals				2,268,000	1,345,000	3,613,000
Mine Totals		4,500,000	1,380,000			

PLANT BY-PRODUCTS

DEFINITIONS

The raw coals of the Kootenay district all require beneficiation in highly sophisticated and complex "washing plants" in order to produce saleable coking coal. As each raw coal has some unique characteristics each plant is uniquely engineered to suit the particular coal to be processed. In the process usually 65 to 80% of the mine raw product reports in the clean coking coal product while the balance is rejected to waste. Such wash plant waste products are refered to as "refuse". The gravity separations (called "washing") carried out in the plants are more effective when the particle size of feed is narrower, hence all plants separate the raw coal into size fractions by screening or classification prior to the actual gravity separations. As a result each plant creates several refuse products of varying size ranges within the plant; however, those coarser than 28 mesh (0.5 mm) are usually joined before disposal in dumps and are commonly refered to as coarse refuse. Those products finer than 28 mesh are commonly joined and piped out in water as a "pulp" for disposal in settling impoundments. Such products have been refered to as fine refuse, effluent or tailings. For purposes of clarity in this report plan waste products coarser than 28 mesh will be refered to as "refuse" while waste products finer than 28 mesh will be refered to as "tailings".

POTENTIAL PLANT BY-PRODUCTS

Normally the waste products from a gravity separation plant consist of a range of particles heavier than about 1.4 specific gravity which vary from moderately dirty coal (15-25% Ash) through dirty coals (25-50% Ash), coaly or carbonareous shales (50-85% Ash), and on to non-carbonaceous shale and sandstone. At present there is no market for any part of any of these products hence all are wasted in their entirety. However, with a thermal plant in the area capable of utilizing dirty coals, each operation could add additional separations at specific gravitites of say about 1.8. This would then yield three products; clean coal as at present (-1.4 S.G.), refuse (+1.8 S.G.) and an intermediate product of 1.4 to 1.8 SG. Such an intermediate product is refered to as a "middling" and will be referred to as such in this report. Occasionally a plant is so designed as to include separation out of a size cut which is not economically worth further processing for one reason or another and is rejected as waste. Where such a waste product falls in the range of about 15 to 35% Ash it will be referred to in this report also as a "middling."

Broadly speaking, gravity separations on coals become increasingly costly and decreasingly effective as the particle size decreases. It is quite probable that middlings can be recovered economically down to 28 mesh from most plants both existing or proposed. From 28 mesh to 60 mesh the economics should be considered as questionable. Below 60 mesh the economics of gravity separation must be considered as very doubtful although in some cases simple classification at say 60, 100 or 200 mesh can yield a useable product because the very fine coal in these cases is just not inherently very dirty.

The purchase price to a proposed thermal plant for plant wastes should be expected to be very low indeed, hence these by-products all should be investigated for possible use "as is", or as a source of very low cost "middlings" by further processing. While such products might not be suitable boiler feed along it is likely that they could be blended with raw coal and oxidized coal to yield a suitable boiler fuel. As such the plant by-products could conceiveably represent lower cost energy than one or both of the other constituents. In the following list of waste products in no case is information at hand on which to accurately estimate the possible yield or grade of a middling to be derived through further processing. Accordingly the following figures concerning all "middlings" are derived by speculation and should be properly regarded as "educated guesses" only. Ultimately, accurate forecasts can be made after laboratory testing of existing refuse products and/or raw coals.

PLANT BY-PRODUCT SOURCES

Fording Coal and Kaiser are both currently producing refuse products of potential value for thermal use and have some quantities on hand. The Emkay-Scurry and Crows Nest Industries properties will contribute substantial additional quantities when they are ultimately exploited. Together these plant wastes represent a significant portion of the fuel required for a 2000 megawatt thermal plant at a potentially inexpensive energy unit cost. Following are existing stocks as of November 1973 and ongoing production rates along with some rough speculations on potential beneficiation of certain of these by-products which would appear to be non-useable in their present form.

1) Fording Coal produces coarse and fine refuse products. The refuse, consisting of 5"-3/8" and 3/8"-28 mesh cuts, are joined and disposed of in surface dumps. The company has on hand approximately 839,000 tons with a grade (air-dried basis) of; Moisture 1.0%, Ash 69%, Volatiles 12.5%, Fixed Carbon 17.5%, Sulphur 0.24%. (No calorific value is specified.) Ongoing annual production (under new coking coal specifications) is expected to be 1,165,000 tons at a grade of 72-73% ash. Obviously this is not useful thermal plant feed; however, it is still possible that some useful recovery could be realized, say, possibly a yield of about 30% at a grade of about 30% ash and 10,000 B.T.U./lb.

Fording Coal also has on hand 314,000 tons of useable minus 28 mesh tailings consisting of 28-60 mesh and minus 60 mesh products and together running 33% ash. This is considered to be useable as such and it is unlikely that re-washing would be economically worthwhile. However, it is possible that one or more of the cleaner in-plant "cuts" which are combined to create this tailing could be isolated for thermal use without any further gravity separation, resulting in a smaller tonnage of somewhat better grade.

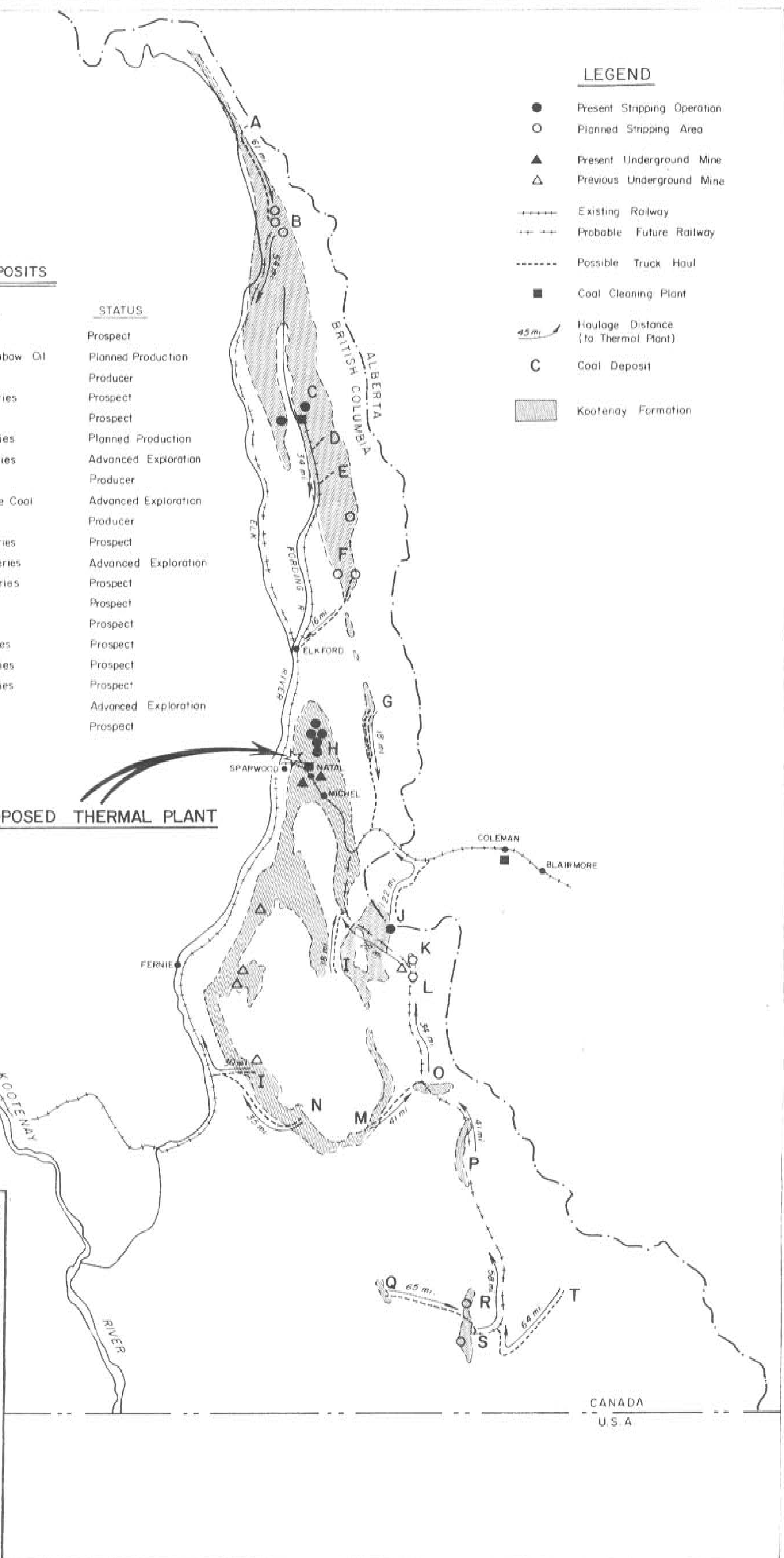
2) Kaiser Resources produces both refuse and tailings in large quantities. The refuse is a combination of 4"-3/8" and 3/8"-28 mesh sizes. They have 3,700,000 tons on hand grading 36% ash and 10,000 B.T.U./lb. Ongoing annual production under the new specifications is expected to be 960,000 tons at 46% ash and 7,800 B.T.U./lb. This might be suitable as thermal feed without treatment. Alternatively, a further separation might yield something like 70% of this tonnage at roughly 30% ash and 10,000 B.T.U./lb.

Kaiser also have on hand 800,000 tons of minus 28 mesh tailings grading 40% ash, 0.5-1% moisture, 14-17% volatiles, 0.20-0.25% sulphur and 9,500 B.T.U./lb. This may be useable as is but would probably not be worth reprocessing. Ongoing annual production is expected to be 240,000 tons of similar grade.

3) Emkay-Scurry will certainly produce substantial by-products; however, at this stage only fragmental information is at hand. No tonnage or grade figures are available for refuse; however, the annual tonnage can be expected to be of roughly the same order as Fording and Kaiser. Indications are that approximately 100,000 tons of middlings at about 30% ash and 9,700 B.T.U./lb. and 250,000 tons of tailings at about 60% ash and 3,800 B.T.U./lb. would be produced annually. The middling would be useable. The tailing is considered to be too dirty for thermal use "as is", however the top size is not known so it is difficult to speculate on what could be derived from it.

4) Crows Nest Industries are expected to produce substantial tonnages of plant by-products; however, again, the information at hand is fragmental. Indications are that they will produce 168,000 tons annually of a minus 200 mesh product grading approximately 15-17% Moisture, 17-22% Ash, 0.5% Sulphur and Calorific Value 10,100-10,600 B.T.U./lb. A second product anticipated is a cyclone underflow amounting to 101,000 tons annually at 33-35% Ash. The proposed plant is also expected to produce refuse (size range not known) at a rate of 740,000 tons annually and a grade of 50-55% ash. Some useful by-produce could likely be derived from this refuse.

SUMMARY: The two existing and two projected operations are expected to generate 4,500,000 to 5,000,000 tons annually of combined refuse, middlings and tailings. While accurate determinations of useable by-products cannot be made at this stage, very broad speculation suggests combined useful products of the order of 2,700,000 tons grading roughly 32% Ash and 9,600 B.T.U./lb. As the years go by coking coal specifications will likely be further relaxed with some resulting decrease in quantity, and possibly also quality, of plant by-products.



COAL DEPOSITS

BLOCK	OPERATOR	STATUS
A	None	Prospect
B	Emkay - Scurry Rainbow Oil	Planned Production
C	Fording Coal	Producer
D	Crows Nest Industries	Prospect
E	Kaiser Resources	Prospect
F	Crows Nest Industries	Planned Production
G	Crows Nest Industries	Advanced Exploration
H	Kaiser Resources	Producer
I	Pacific Coal - Fernie Coal	Advanced Exploration
J	Coleman Collieries	Producer
K	Crows Nest Industries	Prospect
L	Byron Creek Collieries	Advanced Exploration
M	Crows Nest Industries	Prospect
N	Kaiser Resources	Prospect
O	Unknown	Prospect
P	Crows Nest Industries	Prospect
Q	Crows Nest Industries	Prospect
R	Crows Nest Industries	Prospect
S	Sage Creek Coal	Advanced Exploration
T	Unknown	Prospect

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EAST KOOTENAY COALFIELD

THERMAL COAL SOURCES

TRANSPORTATION NETWORK

SCALE 1 inch = 8 miles | APRIL 1, 1974 | FIG. 8

DWG 674-5 B

The eight possible by-products from the four plants (actual and anticipated) would be highly variable in quality, character, and supply rate. Therefore, for each of the by-products, an individual assessment of its suitability for a thermal plant feed will be required. Whether the by-product can be fed directly to a plant, whether it should be reprocessed first, and whether the material can be shipped economically will need to be ascertained in each specific case; however, it is clearly evident that the existing and projected plant by-products contain enough total energy to comprise a major proportion of the feed necessary to sustain a 2000 megawatt thermal plant, (i.e.), 2.7 million tons @ 9600 BTU/lb. = 740 megawatts (approx.). If this amount of feed would be available to the thermal plant at low cost then the balance of the feed, to generate the full 2000 megawatts, would be in the order of 4.2 million tons at 11,000 BTU/lb. This could be obtained by mining primary thermal coal from one or several of the many previously-described deposits in the district.

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THERMAL COAL COSTS

(In preparation.)

Terms of reference

Plant by-products

Surface mines

Underground mines

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CONCLUSIONS

PRIMARY THERMAL COAL:

Although the various coal deposits in the East Kootenay district exhibit a wide range in characteristics, the average quality of raw coal that would provide the bulk of the feed to a thermal coal plant on an as received basis is:

Moisture	7 %
Ash Content	20 %
Sulphur Content	0.5 %
Calorific Value	11,000 B.T.U.'s/lb.

At this grade approximately 6,400,000 tons per annum would be required for a 2000 megawatt plant. The total amount of coal necessary to support such a plant for 30 years is 192 million tons. There is ample mineable reserve of thermal coal in the East Kootenay district to meet this requirement; however, the presently specifically defined reserves of thermal coal are all on privately held properties whose owners until very recently have been primarily concerned with the production of coking coal. Now, with the sharp increase in emphasis to thermal coal as a major source of energy in North America, renewed attention is being paid to the Canadian Rocky Mountain thermal coals by both domestic and foreign buyers. It is evident that within a few years or less the most readily mineable reserves of thermal coal in the East Kootenay district will likely be committed to these markets.

The available thermal coal in the East Kootenay district exists both as surface and underground mineable coal and mostly on private holdings; however, major reserves are postulated and indicated on the two portions of the coalfields that are still public domain, the Cadorna Creek area to the north, and the Dominion Coal Blocks to the south. Of these the southern Dominion Coal Block contains the most significant, the best defined and the most accessible reserves. The total amount of coal underlying this Coal Block, in seams thicker than 5 feet, probably exceeds 7 billion tons; if only 25 percent is mineable it still represents a major source of coal, much of which would be non-coking, for a thermal plant.

A comprehensive assessment of the best possible sources of primary thermal coal in the East Kootenay district for feed to a public utility thermal plant requires that the ownership of the southern Dominion Coal Block, (federal or provincial?), be determined.

PRESENT SOURCES OF PRIMARY THERMAL COAL:

Major reserves of proven or indicated strippable thermal coal are presently known to occur on at least four properties in the East Kootenay district, (i.e.) Coal Mt., Harmer Ridge, south Dominion Coal Block and Crown Mt. It is estimated that these reserves could yield at least 100 million tons with an air dried average grade of:

Moisture	1.1 %
Ash	14 %
Volatiles	21 %
Fixed Carbon	63.9 %
Sulphur	0.4 %
B.T.U.'s/lb.	12,400

To this could be added upwards of 100 million tons from the Sage Creek deposit if the coal does not prove of suitable metallurgical grade.

Potential major sources of thermal coal also exist in the Emkay-Scurry, Fording and Line Creek deposits.

Major reserves of proven or indicated underground thermal coal exist on essentially every property in the East Kootenay district. Most of these reserves can be mined separately from coking coal reserves. With the low underground coal mining costs being realized by Kaiser Resources using hydraulic methods, and by other operators in the world using mechanized methods, the potential of the East Kootenay vast underground thermal coal reserves as a competitive energy source cannot long be ignored.

Thus, the problem of supplying primary thermal coal feed to a 2000 MW public utility plant in the East Kootenay is principally one of initiating the exploration and development of the reserves on Crown and/or public properties for this specific market. There is no doubt that the above-listed existing and potential mines could readily sustain such a plant, or larger, either collectively or, in some cases, singly if their indicated or inferred thermal coal reserves were to be exploited for that purpose. The costs of this feed would have to be determined for each property by each operator, but since a very large percentage is mineable by surface methods the cost should be low.

This report has principally reviewed the coal reserves and quality of the present producing companies and those that have carried out a high level of exploration on their properties. Little attention has been given to the other prospects because they do not contain as large areas of the coal measure (except perhaps Block E) and, in most cases, they have not been comprehensively explored.

In this report emphasis has been placed on current reserves that can be extracted by relatively low-cost surface mining methods. Based on the available information there are in the East Kootenay district approximately 746,000,000 tons of open-cast coal reserves; 121,000,000 of these can be considered thermal quality, and the remainder (625,000,000 tons) is metallurgical grade. Mining (81-95%) and wash plant (75%) recoveries are not included in these figures. It is clear that these tonnages represent only a small part of the potential coal reserves in the East Kootenay coalfields and the vast bulk of the district's coal must eventually be extracted by underground methods.

With regard to potential coal reserves in the district, both from a thermal and coking coal standpoint, little consideration has been given by the present property owners to date to underground sources. However, with the successful introduction of the hydraulic method of mining and the rapid price increase of competitive fuels (oil and gas) it is evident that the recent preoccupation with only open-cast coal production can be expected to change rapidly.

Because of the large tonnage of coal required for a 2000 megawatt plant, (6,400,000 annually or a recoverable reserve of 192,000,000 tons), and because most of the reserve coal in the East Kootenay district is metallurgical grade and therefore not desirable for thermal feed, several alternative primary thermal coal sources must be considered. Even if a single deposit of sufficient reserves were to be defined, physical limitations would possibly prevent extracting coal at the desired annual rate. For these reasons it is sensible to consider the use of by-product coals from the existing, and proposed, coking coal operations as a possible source of thermal plant feed to supplement the anticipated mine production.

COKING PLANT BY-PRODUCT COAL:

It is evident that presently available and anticipated by-product coal (mine and plant), because of its irregularity of supply and its wide variability in grade, can only be considered at this time as supplementary feed to a thermal plant whose basic feed and quality control would be assured from in situ thermal coal sources.

It is estimated in this study that the two existing and the two presently proposed coking coal operations in the East Kootenay district would possibly generate a total of 2,700,000 tons of useful by-product coal that would grade roughly:

Ash	32 %
B.T.U.'s/lb.	9,600

This feed would be available for at least 30 years and would increase as more coking plants are brought into production. Since this coal is presently being discarded it should be available to the thermal plant at little more than handling costs.

If this amount of by-product coal is used as thermal feed it could generate approximately 740 megawatts of power. The remaining 1260 megawatts of the 2000 megawatt plant would then require the use of 4.2 million tons of 11,000 BTU primary (mine) thermal coal. This tonnage could presently be mined from the four properties listed in Table 1 whose reserves are proven or indicated. Additional sources of mine coal would no doubt become available rapidly as the district continues its present rate of development.

THERMAL COAL

It is evident that a 2000 megawatt thermal plant in the East Kootenay district cannot be sustained on the present and proposed coking plant by-products. Nor can it be sustained for 30 years on any single open-cast thermal coal deposit indicated in the district to date. However, the coal potential of the district is immense and it is barely in its initial stage of major exploitation; therefore, it can be reasonably predicted that, with increased exploration and development, the availability of in situ and by-product coal will increase rapidly within this decade.

At this time a 2000 megawatt plant could be sustained (for 30 years) by feed from several known properties with known thermal coal open-cast reserves supplemented by the by-product coal available from four coking coal plants. The proportions, quality and cost of the feed from each of the sources must be determined from the property owners and from testing of the existing by-products.

Since the basic feed for such a thermal plant would advantageously, and probably more cheaply, be obtained from one or both of the crown properties in the district, (Cadorna Creek and the southern Dominion Coal Block), it is recommended that the ownership of the Dominion Coal Block be determined and if possible the coal reserves on that block be secured. With such a base the selection of by-products and other mined coal from the independent operators in the district could be made with some flexibility and bargaining power.

Respectfully submitted,

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