British Columbia Hydro and Power Authority

THERMAL COAL RESOURCES OF BRITISH COLUMBIA

VOLUME V

NORTHERN COALFIELDS
of the
INTERIOR BELT
of
BRITISH COLUMBIA

February 1, 1975

DOLMAGE CAMPBELL & ASSOCIATES LTD.
VANCOUVER, CANADA

Gen-B.C. North-Interior Belt 75(10) A

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SUMMARY

The Northern Coalfields of the Interior Belt of British Columbia occupy an area bounded on the south by the 54th parallel, on the west by the B.C. - Alaska boundary, on the north by B.C. - Yukon boundary, and on the east by the Rocky Mt. Trench. Coal exploitation of this large area to date has been restricted to intermittent exploration and small scale production, primarily because of the remoteness of the region and the fact that no metallurgical coal has been found in its coalfields.

Coal deposits occur in three groups of sedimentary rocks that collectively range in age from Lower Jurassic to Early Tertiary. These groups are the Lower to Middle Jurassic Laberge Assemblage, the Middle Jurassic to Lower Cretaceous Bowser Assemblage, and the Upper Cretaceous to Lower Tertiary Sustut and Sifton Assemblages.

The Laberge Group, situated predominantly in extreme northwestern B.C., contains four ittle-known, isolated, widely-spaced coal occurrences that are reported to be thin and possibly discontinuous. However, the geological setting indicates that thorough prospecting is warranted, particularly within the section of the unit that lies south of the King Salmon Thrust Fault.

The Bowser Assemblage, the Mesozoic marine sedimentary sequence comprising the Bowser Basin, hosts the most important coal deposits in the Northern Interior Belt. These are the Groundhog coalfield and the Telkwa River and Zymoetz River deposits in the Bulkley River coalfield. Groundhog coal ranges in rank from low volatile bituminous to anthracite, has a generally high ash content, and exhibits calorific values which, although averaging 10,500 Btu per lb., show a wide range in available analyses. Bulkey River coal, based upon Telkwa River deposit samples, is high volatile bituminous with calorific values ranging from 12,300 to 13,500 Btu/lb.

The Sustut and Sifton Assemblages, a sequence of continentally-deposited sedimentary rocks, contains numerous, generally thin, coal occurrences in many isolated, remant "basins". The remnants range from many small to two large lineal-shaped ones designated the Sustut and Sifton Basins. Little exploration for commercial deposits has been carried out in these rocks.

The potential in situ coal resources in the Northern Interior Belt are presently restricted to Upper Jurassic rocks in the Bowser Assemblage pending further prospecting within the Laberge, Sustut, and Sifton Groups. The indicated coal resources are $3\frac{1}{2}$ billion short tons and they occur predominantly in the Groundhog coalfield. The inferred coal resources, also predominantly in the Groundhog area, range from 16 to 82 million short tons.

It is concluded that in the Groundhog and Bulkley River coalfields sufficient coal resources are indicated to support thermal plants in each area. Substantial tonnages of coal in the Groundhog district could probably be extracted by surface mining methods. The Telkwa deposit may, with exploration, be shown to contain appreciable tonnages of surface minable coal; however, most would likely have to be extracted by underground mining methods. The Zymoetz River deposit could provide additional feed to a thermal plant based on Telkwa River coal, but no open pit coal would be available from that deposit.

All of the coal areas in the Northern Interior Belt require comprehensive drill exploration to verify their potential.

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INTRODUCTION

The coal deposits of the Interior Belt of British Columbia are considered for convenience in the present study as two distinct groups. The southern group comprises the deposits of Tertiary age that extend from the U.S. border north to Prince George at latitude 54° north. The northern group, which is described in this report, comprises the coal occurrences and deposits that lie north of the 54th parallel within the Interior Belt. Coal occurrences in the northern half of the Interior Belt lie in rocks of three broad age groupings.

TERMS OF REFERENCE

The object of this report is:

a) to list and discuss all of the presently known coal deposits and occurrences in the Northern Interior Belt, and

b) to assess each deposit as a potential source of thermal coal.

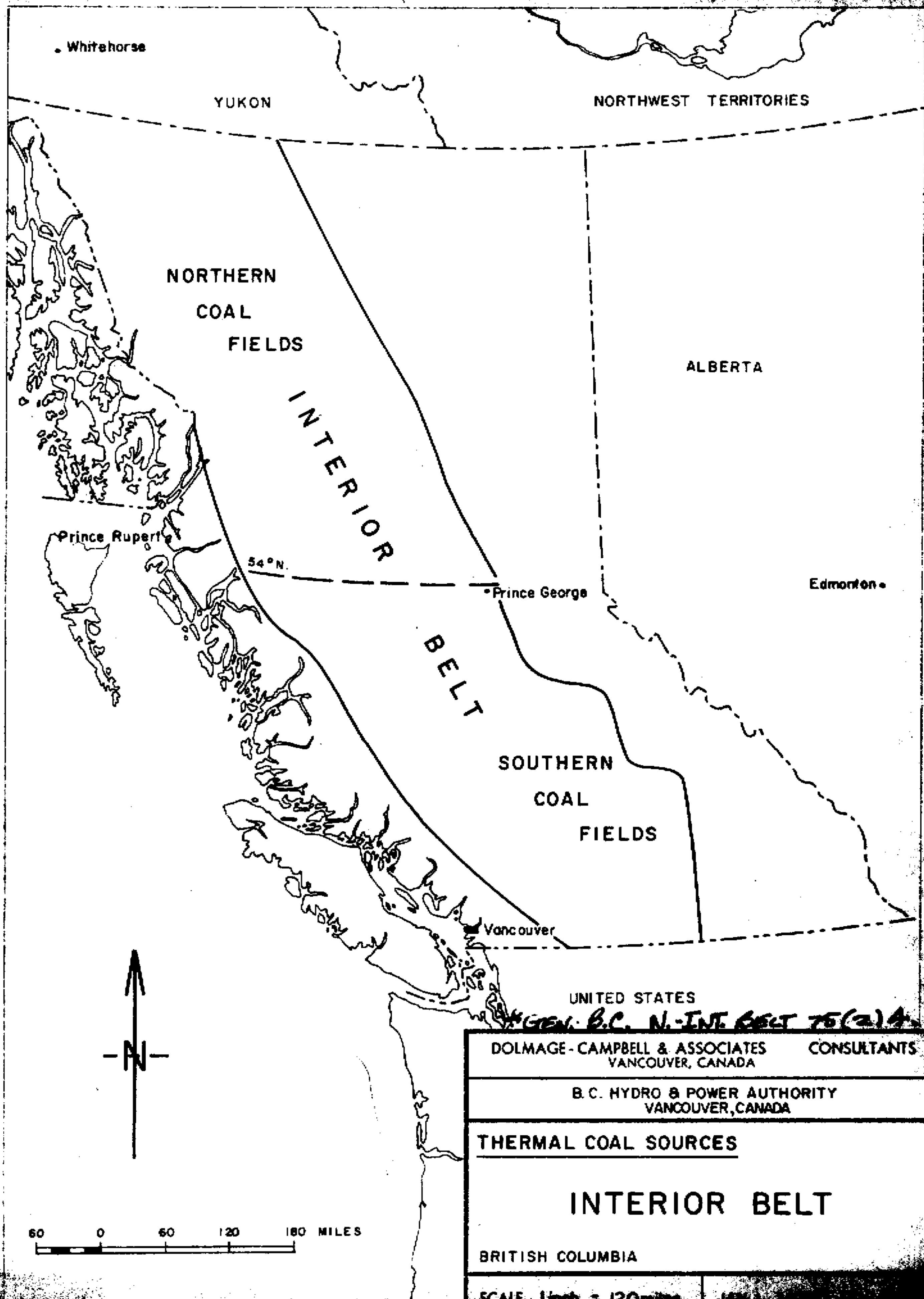
LOCATION: (Figures 1a - 1b) (54° N to 60° N)

The northern coalfields of the Interior Belt lie between latitude 54° north near Prince George and the British Columbia - Yukon border at the 60th parallel. The belt is bounded on the west by the Coast Range Mountains, essentially the B.C. - Alaska panhandle boundary, and on the east by the Rocky Mountain Trench.

Most of the area is remote from the province's major population centres. The northern branch of the C.N.R. provides rail access to tidewater along an east-west alignment at the southern edge of the area. A branch of the B.C. Railway currently under construction will connect Dease Lake in the heart of the area with Prince George and the C.N.R. The two principal coalfields in northern British Columbia, the Bulkley River and Groundhog coalfields, are traversed by the C.N.R. and B.C.R. respectively. The Cassiar-Stewart Highway, passing through the northern terminus of the B.C.R., connects Watson Lake in the Yukon Territory with tidewater at Stewart, B.C.

PHYSIOGRAPHY

The Northern Interior Belt of British Columbia comprises a series of broad uplands or plateaus, sharply bounded on the west by the Coast Range Mountains and on the east by the Rocky Mountains, which rise dramatically above the broad level of the Interior plateaus. A central core of ranges, the Cassiar-Omineca Mountains, rise as sharply as the flanking mountains and effectively bisect the area into eastern and western halves. These two broad plateaus are locally interrupted by many small mountain ranges many of which are of volcanic origin.



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VANCOUVER, CANADA

THERMAL COAL SOURCES

INTERIOR BELT

BRITISH COLUMBIA

SCALE: 1 inch = 120 miles

The plateaus are sharply incised by six major river systems and their tributaries. The Taku, Stikine, Nass, and Skeena rivers drain the western (Stikine) plateau into the Pacific Ocean. The Liard and Peace (or Findly) rivers drain the eastern (Liard) plateau into the Arctic Ocean via the McKenzie River System.

The landscape has been modified by Pleistocene glaciation. Extensive glacio-fluvial deposits mantle the area, often to depths in excess of 100 feet.

CLIMATE

Because the prevailing weather patterns are generated from the Gulf of Alaska eastward across the northern interior, a series of wet belts are created by rising, chilled air along the Coast Range Mountains and along the west flank of the Cassiar-Omineca Ranges and the Rocky Mountains. The intervening belts along the Stikine Plateau and Rocky Mt. Trench exhibit generally drier conditions.

The winters are long and cold. Permafrost becomes more widespread progressively northward. Snow falls in late September and remains on the ground everywhere until mid-May, vanishing only above 4500 feet in mid-June.

Vegetation generally corresponds broadly to climatic belts. In the wet areas typical coastal forests are common, consisting of dense willow, alders, devil's club, spruce, hemlock, and fir. In the drier belts hemlock and fir occur but are less dense, and extensive areas of grassland intervene. Willows and cottonwoods in the dry belts are relatively restricted to river and stream valleys.

HISTORY

Because of the remoteness of the region, no coal production of any consequence has been obtained from coal deposits in the Northern Interior Belt. The construction of the Grand Truck Pacific Railway (the forerunner of the C.N.R.) at the turn of the century stimulated small-scale production and exploration from deposits along its right-of-way between Prince George and Prince Rupert. However, only a deposit at Telkawa achieved any significant production through the years and this was on an intermittent, small tonnage basis.

Otherwise, the extensive deposits indicated to occur in the Groundhog area at the headwaters of the Skeena River attracted speculators who dreamed of using this coal as a basis for constructing a rival east-west railway to the Grand Trunk Pacific. McKenzie and Mann interests even began construction of a railroad from Stewart prior to World War I with a view to developing the coalfield. However, after only a few miles of construction, the effort was suspended.

REFERENCES AND AVAILABLE DATA

The principal author of this report, Mr. R. S. Adamson and the principal co-author, Dr. D. D. Campbell have several years of direct mineral exploration experience in northern British Columbia. Both authors have managed and supervised major base metal exploration programs in the area and are thoroughly familiar with the general geology and tectonics of the region.

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GENERAL COAL GEOLOGY

In northern British Columbia coal occurs in three groups of sedimentary rocks that collectively range in age from Lower Jurassic to Lower Tertiary. The groups, from the oldest to the youngest, comprise the Laberge, Bowser, and Sustut-Sifton Assemblages. The Laberge and Bowser Groups are predominantly marine, whereas the Sustut and Sifton Groups are continental in origin.

The Laberge Group comprises an apparently comformable sequence of clastic sedimentary rocks that occupies a broad synclinorium bounded in the northeast by faults adjacent to the Atlin Horst and on the southwest by an unconformity. Extending from the Pelly River in the Yukon Territory to a point 60 miles east of Dease Lake, B.C., the Laberge Group manifests itself as a long narrow, crescent-shaped lineal belt of faulted and folded rocks. In British Columbia the sequence averages 20 miles in width and attains a length of 300 miles. These rocks are from Lower to Middle Jurassic in age.

The Bowser Group occupies a northwest-trending sedimentary basin about 100 miles in width and 200 miles in length. Mesozoic formations within the Bowser Basin comprise a complexly folded and faulted, predominently marine, clastic sequence known informally as the Bowser Assemblage. In the basin's northwestern quadrant, the Bowser Assemblage is synonomous with the Bowser Group; whereas in the south the term is somewhat more restrictive as more definitive mapping of Bowser rocks is currently being undertaken. In general, all Mesozoic sedimentary and volcanic rocks which occur within the Bowser Basin are presently recognized as the Bowser Group. The age of the Group extends from Middle Jurassic to Lower Cretaceous.

The Sustut Group constitutes the conspicuously-bedded non-marine strata that occupies two large and several smaller sedimentary remnants, collectively termed the Sustut Basin. The basin, excluding small outliers, extends approximately 250 miles in length, from Takla Lake northward to the Stikine River, averages 15 to 20 miles in width. Essentially the same as the Sustut Group in age, nature of deposition, and distribution, the Sifton Formation occupies an equally long narrow basin. Separated from the Sustut Basin by the Cassiar-Omineca mountain ranges, the Sifton Basin averages 5 miles in width and essentially occupies the floor of the Rocky Mt. Trench from Pine Pass northward for 250 miles. The marked linearity of the continental seas now expressed by the Sustut Group and Sifton Formations may be attributed to their development along major fault zones or rifts of continental magnitude. These are the Omineca-Pichi Fault System (Sustut Basin) and the Rocky Mt. Trench (Sifton Basin). Clastic material was fed into these linear seas during the uplift and development of the Coast Range and Cassiar-Omineca Mountains.

The presence of widespread coal and clastic sediments in the Laberge, Bowser, Sustut, and Sifton basins, suggest that extensive delta development took place at the mouths of numerous sediment-bearing rivers along the shorelines of the respective seas. With continued uplift of adjoining land masses, and the gradual withdrawal of the sea, many of the deltas became progressively larger, prograding seaward and laterally along the shoreline. These deltas became the loci of luxurious growths of plant material in swampy and lagoonal environments, which led to the creation of peat bogs and eventually coal.

The present geological evidence indicates that the most extensive and prolonged delta development took place during deposition of the Bowser Assemblage. Coal-forming deltas in basins of other ages in general appear to be more local in distribution and less prolonged in time.

UPPER CRETACEOUS TO LOWER TERTIARY COAL

GEOLOGICAL SETTING

The Sustut and Sifton basins contain continental sedimentary rocks that range in age from Late Cretaceous to Early Tertiary.

The Sustut Group has been divided into two formations: the Tango Creek Formation, which was deposited during the Late Cretaceous to the Paleocene, and the Brothers Peak Formation, which contains rocks of Eocene, and possibly Paleocene age. The Tango Creek Formation comprises sandstone, conglomerate, siltstone, mudstone, and thin lignite seams. Its thickness ranges from 1500 feet to 4200 feet. The Brothers Peak Formation, varying in thickness from 1000 feet to 2700 feet, contains essentially similar rocks; however, within this sedimentary sequence interbedded acidic tuffs occur.

Thin Seams of coal occur near the top of both formations.

The Sifton Formation, named initially in 1941 by Hedley and Holland, has not been given Group status. Exposures of Sifton rocks are generally poor, because the formation predominantly underlies the flat, heavily-wooded floor of the Rocky Mt. Trench. The formation comprises conglomerate, sandstone, mudstone, siltstone, and minor coal. The structure is complicated and the stratigraphy poorly understood; the maximum recorded measurable section is 300 feet.

Hedley and Holland reported minor occurrences of lignitic coal in Sifton Formation rocks from a locality near Sifton Pass in 1941. Coal in Tertiary sedimentary rocks on the Rapid River near its confluence with the Dease River, (Figure 2), are probably occurrences in erosional remnants of the northern limit of the Sifton basin.

Several relatively small outliers that are similar in character and age to the Sustut and Sifton assemblages occur in northern-central British Columbia. Some, such as the one on Driftwood Creek near Smithers and those along the Liard River, are known to contain indications of coal. In general though, they are restricted in areal extent and do not offer the prospecting potential of the larger basins.

(1) LIARD RIVER OCCURRENCES (Figure 1-b)

Several minor occurrences of poor quality coal have been reported from Tertiary sedimentary rocks exposed along the Liard River near the B.C.-Yukon border and some of its large tributaries, notably the Dease, Hyland, and Coal rivers. The coal, interbedded with shale, sandstone and conglomerate, occurs in a few small and apparently isolated basins. However, as the river systems traverse the broad, flat Liard plain, outcrops tend to be few and restricted to river valleys, hence the distribution of Tertiary rocks is poorly understood and in fact may be much more extensive than is indicated. North of the B.C.-Yukon border, the Tertiary sedimentary rocks are more plentiful, suggesting that the exposures in British Columbia represent remnants of a much larger basin centred in the Yukon.

No precise thickness of coal nor quality data have been reported; however, in the Yukon, coal seams in the same rocks are apparently of mineable thickness. In British Columbia, coal occurrences consist of thin seams in poorly exposed outcrops or as float in river gravels. The coal has been described as a poor-quality lignite. No exploration or even local production is known to have been carried out on any of the occurrences.

(2) RAPID RIVER OCCURRENCES (Figures 1-b, 3)

Six miles from the confluence of the Rapid and Dease rivers, coal occurs in sedimentary rocks of Tertiary age, (Figure 3). Considered to be the northernmost extremity of the Sifton Group of rocks, the sedimentary sequence consists of conglomerate, sandstone, shale, and minor coal. These rocks occupy a northwest-trending basin 10 miles in length by 3 miles in width, which is bisected by the northwest-flowing Rapid River.

Several small seams of coal are reported to occur in the northeast side of Rapid River. One seam, presumably the best, ranges in thickness from 6 inches to 1 foot. The coal, lignitic in character, has apparently not been analyzed as no quality data are available.

(3) STIKINE RIVER OCCURRENCES (Figures 1-b, 4)

Coal occurs in Tertiary sedimentary rocks on the Tuya and Tahltan rivers which drain into the Stikine River near the mouth of the Stikine Grand Canyon. The sedimentary formations for the most part are exposed along the steep canyon walls of the Tuya and Stikine rivers, (Figure 4) and also along branching creeks which flow easterly into the Tuya River. The sedimentary sequence, dipping moderately to steeply north, consists of sandstone, shale, conglomerate, tuff, and minor coal of the Sustut Group.

Five coal occurrences on the Tuya River drainage and one on the Tahltan River were examined in 1953 by Dr. W. Smitheringale. Several seams in the Tuya River area ranged from 1.5 feet to 30 feet in thickness. Two seams on the Tahltan River ranged from 4 feet to 11 feet in thickness. The coal is described as "very poor quality" lignite. Samples were taken from a seam on the Tuya River (7 feet in thickness) and one seam on the Tahltan River, (11 feet in thickness). The samples were presumably taken from the best looking seam available at each of the two localities. The analyses results are summarized as follows (on an as-received basis):

	Tuya	Tahltan
Moisture	16.9 %	22.0 %
Ash	5.1 %	21.8 %
Volatile Matter	35.6 %	26.8 %
Fixed Carbon	42.4 %	29.4 %
Sulphur	0.9 %	0.2 %
Calorific Value	9680 B.T.U.'s per lb. (12,361 d.m.m.f.)	6,480 B.T.U.'s per lb. (10,624 d.m.m.f.)

(4) SUSTUT RIVER OCCURRENCES (Figures 1-b, 5)

In the Sustut River area coal occurs in sedimentary rocks ranging in age from Upper Cretaceous to Lower Tertiary (Sustut Group). Two occurrences are located approximately four miles southwest of the junction of Red Creek with the Sustut River, (Figure 5). The sedimentary sequence, comprising conglomerate, sandstone, shale, with minor tuff, and coal, has been moderately to steeply folded along northwest axes.

No information regarding the extent, thickness, or quality of these younger coals in the Sustut area has been documented.

(5) DRIFTWOOD CREEK OCCURRENCE (Figure 7)

A small basin of Tertiary sedimentary rocks containing coal lies seven miles east of Smithers on Driftwood Creek, (Figure 7). A seam of coal 1.8 feet in thickness crops out on the east bank of the creek.

A sample taken from the seam in 1911 graded 7.9% moisture, 13.4% ash, 36.6% volatile matter, and 42.06% fixed carbon. A zone that included the above seam and interbedded coal and shale below the seam (total thickness 6.2 feet) graded 7.4% moisture, 32.7% ash, 31.9% volatile matter, and 28.1% fixed carbon (presumably on an as-received basis).

Because of the small area comprising the basin and the thinness of the single known seam, the Driftwood Creek occurrence is considered to be of no economic interest.

UPPER JURASSIC TO LOWER CRETACEOUS COAL

GEOLOGICAL SETTING: (Figures 2, 6, 7, 8)

Until recently the Bowser Basin of northwestern British Columbia has, except for its fringes, been explored only by geological mapping of a broad reconnaissance nature. The basin was partially mapped on a reconnaissance basis in 1957 by the Canadian Geological Survey. In recent years (1970 - 1974) more detailed regional mapping has been undertaken in the northeast by G. H. Eisbacher and in the south by T.A. Richards and O. L. Jeletsky of the Geological Survey. A large part of the basin remains to be mapped. The Bowser Assemblage in the northeast includes rocks ranging in age from Middle Jurassic to Lower Cretaceous In the south, where more precise mapping is presently underway, the Assemblage is now restricted to rocks of Late Jurassic age.

In the northeast quadrant of the Groundhog Coalfield three major facies have been identified; a Middle to Upper Jurassic facies representing a prograding-delta shale-basin environment, an Upper Jurassic (to possibly Lower Cretaceous) facies representing an alluvial fan-coal swamp environment, and a possibly Lower Cretaceous facies comprising deposits laid down by streams on a relatively flat alluvial plain. Coal occurs as thin lenses in the highest part of the oldest facies, is widespread and thick in the Upper Jurassic facies, and is absent in the younger facies. These facies were apparently developed as the ancient shoreline receded southwestward.

The post-depositional structure of the Bowser Basin in the northeast consists of: (a) a series of northwesterly-trending folds overturned to the northeast and, (b) local thrust faults that occurred during the uplift of the Coast Range Mountains. in Late Cretaceous and Early Tertiary time.

In the southern Bowser Basin, (Hazelton, Babine Lake, Smithers region), the Bowser Assemblage of Late Jurassic age comprises Upper and Lower units. The lower unit consits of marine black shale, marine and non-marine clastics, and minor tuffaceous volcanic rocks. The upper unit consists of fluvial, deltaic, and marine clastics, and includes most of the coal in the region. Middle to Upper Jurassic sedimentary and volcanic rocks of the Hazelton Group underlies the lower unit. Scattered exposures of Lower to Middle Cretaceous sedimentary and volcanic rocks of the Skeena Group overlie rocks of the Bowser Assemblage. The Upper Bowser Assemblage tentatively comprises six major facies, (T. A. Richards & O. L. Jeletsky), including a coal-bearing delta facies with coastal swamps, deltas, etc. To the south the Assemblage is predominantly composed of meandering stream deposits. Progressing northward the section becomes increasingly marine as the alluvial-deltaic sequence appears to prograde with a northward withdrawal of the ancient sea.

The structure of the southern Bowser Basin differs from that in the northeast. Fold axes strike north-northwest to north and have been modified locally by numerous, small granitic intrusive bodies throughout the area.

(1) GROUNDHOG COALFIELD: (Figure 6) 56° N. Lat., 128° W. Long.

The Groundhog Coalfield was initially discovered by James McEvoy in 1903. The coalfield, situated at the headwaters of the Nass and Skeena rivers, encompasses an area approximately 1500 square miles in size. Intense prospecting activity was carried out by early explorers from 1911 to 1912 when many of the coal occurrences were examined by driving several short adits. This activity was stimulated by the expectation that a railroad would be constructed to the area from Stewart, B.C., 80 miles west. No further work was done until 1948 when the area was mapped by Buckham & Latour for the B.C. Dept. of Mines. In 1968 Dillingham Corp. of Canada Ltd., under the direction of J. M. Black, implemented prospecting and geological mapping of the area in a search for coking quality coal. This effort was unsuccessful. In 1970 Canex-Placer Ltd. secured coal licenses in the area, mapped 200 square miles of the coalfield in considerable detail, and drilled six diamond drill holes, (3,377 ft.), in three of the most economically-promising areas.

The regional geology of the Groundhog Coalfield comprises a series of sedimentary formations that have been folded along northwest axis; these folds apparently have been overturned to the northeast and in part thrust faulted. Recent work done by Canex Placer indicates that the local geology is not as structually complex as suggested by previous workers in the district in spite of the above somewhat complex tectonic history. The Geological Survey of Canada (G. H. Eisbacher, 1974), who mapped the area on a reconnaissance basis in 1969-1972, states that the coalfield is underlain by the Groundhog-Gunanoot Facies. This Facies probably represents an uppermost Jurassic-Lower Cretaceous alluvial fan and coal-swamp environment that prograded over a delta and sub-sea fan during gradual regression of the sea to the southwest.

Coal seams, exposed in valley bottoms and the lower slopes of valleys, are interbedded with shale and sandstone and may occur over a stratigraphic interval of 1500 to 2500 feet. Several seams are apparently present but correlations between seams are reported to be tenuous. Approximately 5 to 10 seams average 4 feet in thickness and two seams are 10 and 12 feet thick.

Canex Placer drilled four holes centred on McEvoy Flats, (Abraham and Discovery creeks), one hole near the mouth of Beirnes Creek, and one hole on Telfor Creek. In each of these areas several coal seams occur in reasonably close stratigraphic proximity. One area, probably McEvoy Flats, is described as being probably strippable (verbal communication); the other two are possibly strippable. Much more drilling will obviously be required to determine to what extent stripping can be economically achieved.

COAL QUALITY: The coal in the Groundhog Coalfield has been classified as low volatile bituminous or anthracite. During the period 1911 to 1912 numerous samples were collected from several seams by a number of workers in the district. A. F. Buckham and B. A. Latour collected the available analyses (108 samples; 68 representative and 40 picked specimens) and tabulated them in their 1950 publication. Following is a summary of those analyses which relate to the three potentially-strippable areas explored by Canex-Placer:

McEvoy Flats: Samples from Abraham Cr., Lower and Upper Discovery Creeks, and Davis Creek.

moisture	1.04% - 5.7%
ash	4.0 % - 25.4%
volatile matter	5.2 % - 8.7%
fixed carbon	62.1 % - 84.5%
sulphur	0.46% - 0.74%
calorific value	12,215 - 13,814 Btu per lb.

Beirnes Creek: Samples from the Scott and Pelletier seams

moisture	1.08% - 1.35%
ash	27.0 % - 29.0 %
volatile matter	7.06% - 7.69%
fixed carbon	62.0 % - 65.0 %

Telfer Creek: Samples from Seams A, 2, 4, and 7

moisture	3.5 % - 6.0 %
ash	21.8 % - 34.1 %
volatile matter	4.0 % - 13.3 %
fixed carbon	46.7 % - 70.7 %
sulphur	0.44% - 1.57%
calorific value	9,360 - 11,980 Btu per lb.

None of the coals proved to have significant coking quality.

The Groundhog Coalfield hosts many coal seams that could be suitable for thermal plant feed. Along the Skeena River valley from Currier Creek to Beirnes Creek, a distance of 12 to 15 miles, several coal seams occur over a reasonably narrow stratigraphic interval and under relatively gentle topographic conditions. Within this belt three areas have been isolated, which are potentially mineable by open pit methods. Based on the available information, it is evident that with detailed exploration, one or more multiple-seam coal deposits could be outlined along the Skeena River, possibly on both sides. The potential certainly exists for the outlining of sufficient tonnages of open pit coal to support a large thermal power plant.

(2) SUSTUT RIVER COALFIELD: (56° 25' N., 126° 45' W.) Figure 5

Approximately 15 miles northeast of Bear Lake on the northern extension of the B.C. Railway, coal occurs in a northwest-trending belt 30 miles long by four miles wide. The Sustut River, flowing southwesterly across the belt effectively bisects the belt in northwestern and southeastern sectors which are 10 and 20 miles in length respectively.

The geology of the belt is structurally very complicated. Sustut Assemblage rocks have been deposited unconformably on Bowser Assemblage rocks. Both Groups have been deposited, again unconformably, on a basement of Triassic to Mid Jurassic volcanic rocks of the Takla Group. Fold structures existed in the underlying Bowser Group rocks before deposition of the Sustut Group. Subsequently, both the Bowser and Lower Sustut rocks were asymetrically-folded and thrust northeastward over older Takla Group rocks and occasionally Upper Sustut Group rocks as well. This period of deformation, reflected in numerous northwest-striking folds and thrust faults in the Sustut River region, is probably related to uplift of the Coast Range Mountains through the early Tertiary.

Eleven coal occurrences lie in the northwestern sector of the Sustut River belt; nine are Upper Jurassic in age (Bowser Assemblage) and two are Late Cretaceous to Palecene in age (Sustut Assemblage). In the southeastern sector seven occurrences extend intermittently over a length of 15 miles in several, apparently narrow, erosional outliers and thrust faulted slices of Bowser Group rocks.

Very little information is available on coal in the Sustut River region. Mr. Adamson, of Dolmage Campbell & Associates Ltd., examined a few, well-exposed, seams of the eight clustered occurrences at the northwestern extremity of the belt in 1974.' They appeared to be relatively-thick, moderately to steeply dipping, and extensive. In 1912 G. S. Malloch examined two seams 3 feet thick at a locality centred on the southeastern sector (56° 15' N., 126° 35' W.). A picked sample from the lower seam analyzed as follows:

moisture	5.4 %
volatile matter	23.32%
fixed carbon	57.48%
ash	13.80%

It is evident that, in view of their favourable accessibility to railroad, the Sustut River coal occurrences warrant a thorough preliminary examination in spite of the complex geological structure indicated in the area. Initial emphasis should be placed on the group of occurrences situated near the headwaters of Red Creek at the northwestern end of the belt. The coal seams in this area appear to continue for some distance (4 miles) northwestward to a large flat area at the headwaters of Birdflat and Two Lake creeks. In addition, detailed prospecting for coal should be extended northwestward along the belt extension for another 10 miles to the vicinity of the divide between the Mosque and Niven rivers.

(3) BULKLEY RIVER COALFIELD: (Figure 7)

Introduction: The Bulkley River Coalfield comprises several coal deposits and occurrences lying within rocks of the Bowser Assemblage, situated around the southern periphery of the Bowser Basin. Stimulated by the construction of the Grand Trunk Pacific Railway (now the C.N.R.) which traverses the district, exploration and small-scale production has been carried out since the turn of the century on seven of these deposits. The deposits are enumerated, with included occurrences shown bracketed, as follows:

1) Telkwa River (Goathorn Creek and Pine Creek)
2) Zymoetz River (or Coal Creek)
3) Morice River (Chisholm Lake, Clark Fork, Goldstream)
4) Kispiox (Skeena, Shegunia Creek)
5) Hazelton (Cedar Creek)
6) Seton
7) Kathlyn Lake

Most of the coal occurs within relatively small erosional remnants of the Bowser Basin whose areal extent was originally considerably larger.

(i) Telkwa River Deposits: (54° 40' N., 127° 10' W.) Figure B.

The principal coal producing basin in the Bulkey River Coalfield lies along Goathorn Creek, a tributary of the Telkwa River, situated a few miles northwest of Telkwa on the C.N.R. Coal has been produced intermittently, essentially for domestic production from seven small underground mines and two small open pits, since 1918. The total production, achieved largely from the five miles shown on Figure 8, from 1918 to 1970 was slightly in excess of 477,000 tons.

Exploration in the area, consisting of diamond drilling, was carried out in 1943, 1946, 1950, and 1951 by Bulkley Valley Collieries and the Federal Government. A total of 33 holes have been diamond drilled on both sides of the Goathorn Creek Valley and 4840 feet of rotary drilling was done in 1969. In 1969 Canex-Placer explored a section of the basin drained by Pine Creek on the north side of the Telkwa River. Twenty three rotary holes (4734 feet) were drilled; however, the results were reported to be discouraging. The basin north of the river is largely capped by volcanic flows.

Coal along the Telkwa River and Goathorn Creek occurs in a thin-bedded sedimentary sequence belonging to the Bowser Assemblage. The sedimentary formations occur as several small erosional remnants, which unconformably overlie volcanic rocks of the Hazelton Group. The largest, extending along Goathorn Creek, (Figure 8) contains most of the known coal deposits. These remnants, collectively encompassing about twelve square miles in areal extent, are capped by volcanic rocks north of the Telkwa River.

The sedimentary sequence, comprising mudstone, sandstone, and minor coal, has been severely faulted, broadly folded, and intruded by dikes. Coal seams and the enclosing sandstones and mustones have exhibited a tendency to be lenticular and lensy making correlation difficult. The complex geology, therefore, has historically impeded systematic, larger-scale underground mining in the area. However, as the dips of seams are for the most part relatively consistant, (northeasterly at 20° or less), several small mines have been developed between fault blocks where stream erosion has provided direct access to coal seams via adits.

The coal measure in the Telkwa basin has a maximum thickness of 200 feet. The base of the coal measure above the volcanic basement lies from 100 feet along the Telkwa River to 350 feet near the south end of Goathorn Creek. Up to 15 coal seams ranging in thickness from paper thin to in excess of 14 feet are indicated to occur in the section. Apparently, the number of seams increases and the coal measure thickens to the east suggesting that the coal measure may be partially eroded on the west; however, extensive glacial deposits in the area that limit outcrop exposures to streams and rivers make this assumption conjectural. Three coal seams in excess of 5 feet in thickness are known; the middle seam (Main or Betty) has provided almost all of the production over the years. It ranges in thickness from 10 to 14 feet. The upper seam (Major) and lower seams (10-12 and 6-7 feet thick respectively) have been reported to occur at single localities. The middle (Betty or Main) seam occurs in the five mines shown in Figure 8.

Rank: The coal in the Telkwa area has been classified as high volatile B bituminous. Some seams coke while others do not. Many samples have been taken from outcrops and mines and analyzed since 1906. The quality of the coal from those samples documented ranges as follows (probably on an as-received basis):

moisture	1.1 % - 6.6 %
volatile matter	22.6 % - 32.4 %
fixed carbon	56.3 % - 66.9 %
ash	4.1 % - 11.0 %
sulphur	0.52% - 1.6 %
calorific value	12,290 - 13,570 Btu per lb.

In summation, coal deposits in the Telkwa Basin, because they are bounded by faults, tend to be small, hence have lent themselves to development as small-tonnage, intermittent, underground or open pit producers. Nonetheless, coal seams are numerous, reasonably thick, widespread and occur near the surface within a relatively-restricted stratigraphic interval. Therefore, it is evident that substantial tonnages of coal occur in the Telkwa Basin that could possibly provide a basis for larger-scale openpit production, providing that sufficient coal reserves could be precisely defined. The complex geology in the basin and the lack of a large coal market inhibited the development of large reserves, even though numerous underground workings, surface exposures, and drill holes had been available. Systematic and thorough diamond drill exploration, supported by detailed mapping of surface exposures and underground workings, will be required to more precisely determine the extent, configuration, and amount of coal in the Telkwa Basin.

(ii) Zymoetz River Deposit: (54° 50' N., 127° 45' W.)

The Zymoetz River coal deposit lies at the headwaters of the Zymoetz (or Copper) River 25 miles west of Smithers. The deposit was initally explored prior to 1914 by driving several prospect adits. It was drilled in 1922, (3 holes, 2539 feet), and in 1968, (3 holes, 545 feet); the latter for sampling purposes. In 1970 the coal licenses, currently held by Western Coal & Coke Ltd., were optioned to Kaiser Resources who evaluated the property but apparently did no physical work.

The coal occurs within a small, remnant basin near the base of a sedimentary sequence belonging to the Bowser Assemblage. The age of the coal, although not precisely known, is suspected to be Upper Jurassic. The sedimentary foremations comprise grey mudstone, siltstone, sandstone, and minor conglomerate and coal. In the vicinity of the coal occurrences the strata strike north 30° east and dip 25° northwest; however, elsewhere in the basin attitudes very widely.

Coal occurs in five separate seams in the lower 300 feet of the sedimentary sequence. Two lower seams (1 and 2), 25 to 100 feet apart stratigraphically, range in thickness from 6 to 16 feet. The lowest of these two seams contains several rock partings. Two of three other seams higher in the section are 2 to 3 feet in thickness.

Kaiser Resources have estimated that the basin has potential coal resources of 35,000,000 tons. Using an 8-foot average seam thickness, (presumably the No. 2 seam), the company has calculated an established reserve of 310,000 tons of indicated (probable) coal and 1,492,000 tons of possible coal. The quality of the coal as indicated from two samples taken by Western Coal and Coke Co. Ltd. in 1968, are summarized as follows (on an air dried basis):

	No. 1	No. 2
moisture	3.4%	2.7%
ash	2.0%	6.4%
volatile matter	39.6%	40.1%
fixed carbon	55.0%	50.0%
sulphur	0.5%	0.4%
calorific value	13,970	13,400 Btu per lb.

No. 1 sample was a hand specimen taken from an outcrop. No. 2 was chipped across a 1½-foot seam. The coal is reported to be high volatile, both A and B, bituminous (A.S.T.M. classification) and to exhibit a low free swelling index.

The Zymoetz River coal deposit will have to be mined by underground methods.

(iii) Morice River Occurrences: (54° 15' N., 127° 15' W.)

Coal has been reported from one relatively large and two smaller remnant sedimentary basins lying across the Morice River, some 26 miles due south of Smithers, B.C. The sedimentary sequence of the Bowser Assemblage in this area comprises siltstone, mudstone and greywacke.

The largest basin (Chisholm Lake), approximately 100 sq. miles in areal extent, has not been explored but must be favourably regarded as a good prospect at this time, because of its size and the presence of reasonably-thick coal seams in nearby basins. A few seams, ranging in thickness from 4 to 6 inches, have been reported from one locality in the basin but these are not regarded as definitive for the basin.

A smaller basin to the north (Clark Fork) was explored on a preliminary basis by Bethlehem Copper Corp. Ltd. in 1968. Exploration consisted of drilling three holes (1988 feet) and cutting several bulldozer trenches. Three seams were reported in 1908 to occur in this area. Thicknesses range from three to eight feet.

(iv) Kispiox Occurrences:

Coal-bearing sedimentary rocks of the Bowser Assemblage occur on both banks of the Skeena River where the Kispiox River meets it. Two coal seams crop out on the east bank and three on the west bank. One seam on the east bank exceeds 5 feet in thickness. The remaining four seams range in thickness from two to three feet. Several short adits were driven on some of these in 1912, but as far as is known no exploration has been carried out since. The coal in the adits and on the surface exposures is badly crushed.

A sample from the 5-foot seam taken in 1909 returned the following analysis (basis not stated):

moisture	1.8 %
volatile matter	20.63%
fixed carbon	57.29%
ash	20.92%

The average analyses of samples taken from the five seams and a sixth seam located 1½ miles above the mouth of the Kispiox is as follows, (basis unknown):

moisture	1.4 %
volatile matter	17.4 %
fixed carbon	58.3 %
ash	22.9 %

Because the seams in the Kispiox area tend to be relatively thin and because the coal-bearing strata generally are closely faulted and folded, the Kispiox occurrences are not economically attractive. Therefore, they should not be regarded as a potential source of thermal plant fuel. The possibility, however, remains that more seams in excess of 5-feet thickness may occur in the area; this would have to be verified by exploration.

(v) Shegunia Creek Occurrence:

In 1908 three coal seams were reported to occur in the Skeena River Valley two miles above the mouth of the Shegunia or Salmon Creek. Two of these seams are two feet in thickness; the other was reported to be five feet in thickness. Analyses from these seams ranged as follows:

volatile matter	18-21%
fixed carbon	57-59%
ash content	20-22%

Recent prospecting in the area failed to locate these occurrences. Presumably they have since become hidden by overburden and vegetation.

(vi) Hazelton Occurrences:

Coal occurs in sedimentary rocks of the Bowser Assemblage at two localities near Hazelton, B.C.; on the left bank of Cedar Creek, eight miles west and one mile south, and up Coyote Creek. The sedimentary sequence, consisting of sandstone, shale, and minor coaly bands, attains a thickness in excess of 1000 feet.

One seam, 3 to 4 feet in thickness, occurs on Cedar Creek. Thin seams are reported from Coyote Creek. Two samples taken from the Cedar Creek seam averaged: 1.3% moisture, 10.1% volatile matter, 79.0% fixed carbon, and 9.5% ash.

Little exploration has been done on these occurrences because of the crushed nature of the coal, the limited indicated area of the sedimentary basin, and the relative thinness of the seams. They offer little encouragement for locating substantial tonnages of coal in the vicinity.

(vii) Seton Occurrences:

Several coal occurrences have been reported from a small basin in the valley of the Bulkley River approximately 20 miles upstream from Hazelton, B.C. Up to twelve seams of coal, ranging in thickness from 12 to 40 inches, occur within a 500-foot thickness of interbedded sandstone and shale. The basin, apparently relatively undisturbed, in contrast to most of the other well faulted and folded erosional remnants making up the Bulkley River oalfield, attains a width of three miles and a length of four miles along the river. The sedimentary sequence comprises grits, conglomerates, sandstones, and shales.

The largest seam in the section, opened up by an adit, is 4½-feet in thickness including several bands of bone. A second seam, 17 inches in thickness, lies stratigraphically above. Samples taken from these two seams, excluding boney material, averaged; 1.5% moisture, 19.5% volatile matter, 43.8% fixed carbon, coal 30.4% ash.

Although the coal is possibly high in ash for normal market purposes, based only on the above sampling, this basin warrants preliminary exploration because of its undisturbed nature, its large areal extent, and its number of coal seams.

(viii) Kathlyn Lake Occurrences:

A small coal basin, six miles in length, lies along the west side of the Bulkley River Valley on the east flank of Hudson Bay Mountain, near Lake Kathlyn on the outskirts of Smithers, B.C.

Several adits expose seams of coaly material contained in a metamorphosed sedimentary sequence. The host rocks, slate and quartzite, were developed as a result of an intrusion of a large granitic mass in the core of Hudson Bay Mountain. The coal contained in the sedimentary rocks, consequently, has been baked to an anthracite.

The seam, only 2½ feet in thickness, has also been steepened to a 45-60° dip by doming of the rocks above and surrounding the intrusion. Because of its poor quality and small size, the seam is of no commercial interest.

LOWER JURASSIC TO MIDDLE JURASSIC COAL

Four coal occurrences have been reported from rocks of the Laberge Group in northwestern British Columbia. This distribution of the Laberge rocks is shown in Figure 2.

GEOLOGICAL SETTING

The Laberge Group consists of a lineal, folded trough of marine-deposited sedimentary rocks cut longitudinally by the King Salmon Thrust Fault. Middle Jurassic rocks north of the thrust represent an offshore sedimentary facies comprising greywacke, siltstone, sandstone, mudstone, conglomerate, and limestone. Lower Jurassic rocks south of the thrust, represent a nearshore facies that includes conglomerate, greywacke, sandstone, siltstone, shale, and very minor coal. These latter rocks are characterized by abrupt facies changes, local unconformities, channelling, and other features associated with deposition in a rapidly subsiding basin near a high relief source area.

In the Yukon Territory the Laberge Group is overlain by the coal-bearing Tantalus Formation ranging in age from Upper Jurassic to Cretaceous.

(1) TAGISH LAKE OCCURRENCE

Coal has been reported from Graham Inlet on Tagish Lake near Atlin; however the actual presence has never been substantiated. There is considerable doubt whether it even exists.

(2) TAKU RIVER OCCURRENCES

A four-foot seam of coal occurs on the Taku River near its junction with the Inklin. No other information is available about this particular occurrence. Another coal occurrence has been reported from near Sloko Lake on the Sloko River but no precise information regarding location, thickness, or grade is known.

(3) TRAPPER LAKE OCCURRENCES

East of Trapper Lake, dense resinous coal from 1 inch to 4 inches in thickness is reported from Middle Jurassic shales.

COAL POTENTIAL

Although the coal potential of the Northern Interior Belt of British Columbia is possibly vast, it is difficult to assess on the basis of the presently-available information. The remoteness of the region and the absence of geological mapping until recent years have not encouraged prospecting for coal. Based on the present data, it is evident that during the Upper Jurassic, the climatic and depositional conditions were very favourable for the development of extensive, thick, and repetative coal seams. Conditions during the Middle Jurassic (Laberge), Middle Cretaceous (Skeena), and Upper Cretaceous to Tertiary (Sustut-Sifton), were apparently less favourable.

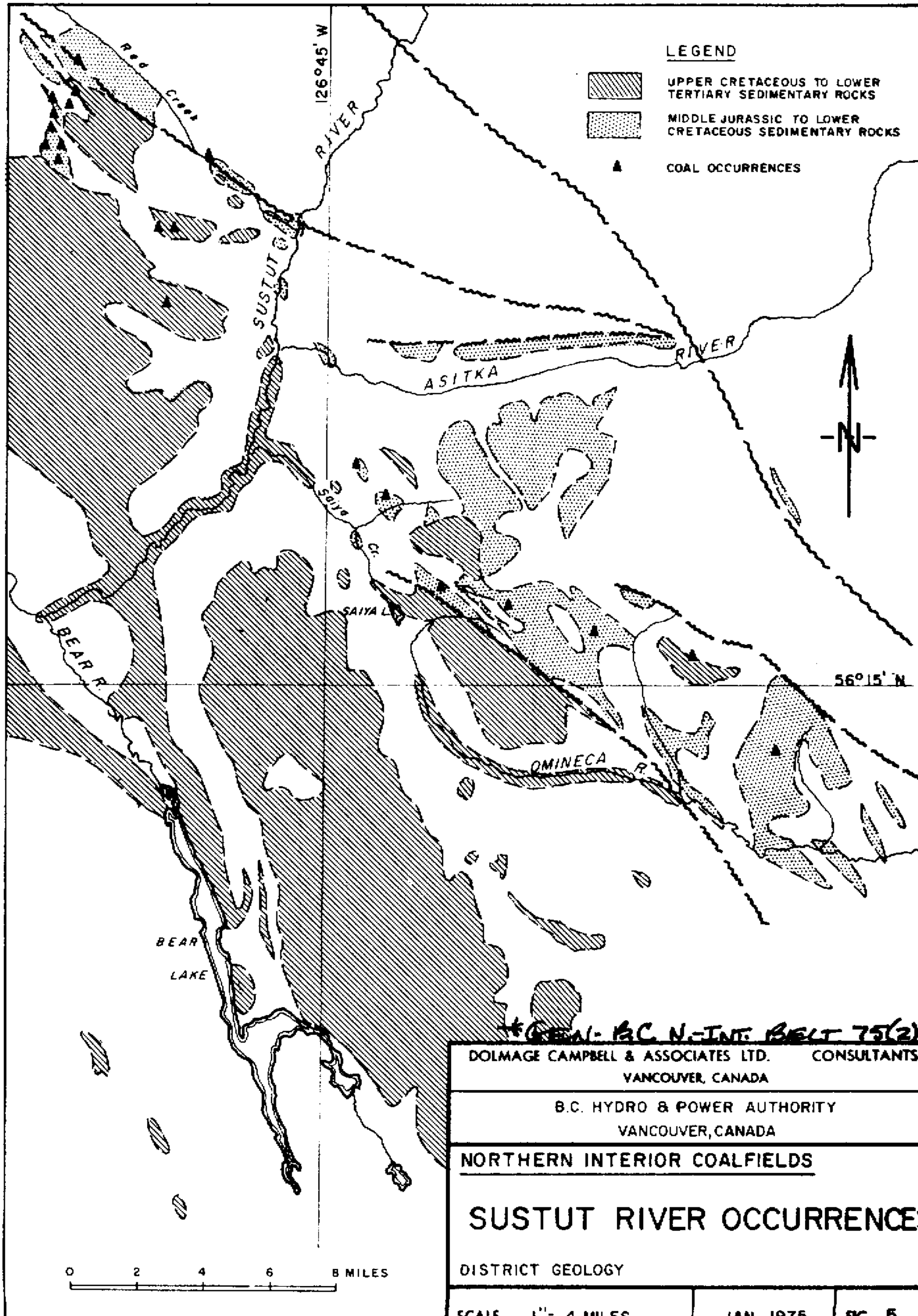
The presence of coal occurrences in rocks other than Upper Jurassic (Bowser Assemblage) should be viewed as prospective. No measurable potential exists in non-Upper Jurassic strata because the seams are generally thin (less than 3 feet) and apparently lack continuity. In Upper Jurassic rocks of the Bowser Basin, seams frequently are relatively thick (in excess of 3 feet), are apparently continuous (indicated by drilling), and occur in sizable "basins" with mapped limits.

With regard to the Upper Jurassic deposits documented in this report, sufficient measurable data is available to estimate the coal potential of three areas. These are the Groundhog Coalfield, the Telkwa River Deposit, and the Zymoetz River Deposit. Insufficient data is available for the Sustut River, Kispiox, Hazelton, Seton, Kathlyn Lake, and Morice River deposits. The total potential in situ coal resources of the Northern Interior Belt of British Columbia, in seams greater than 3 feet in thickness, is estimated to be:

Basin	Indicated (mill. short tons)	Inferred (mill. short tons)
Groundhog	3,400	16,000 - 82,000
Telkwa River	156	104 - 246
Zymoetz River	35	13 - 61
	3,591 mill. short tons	16,117 - 82,307 mill. short tons

It is clear that the Groundhog Coalfield contains the largest coal resources in Northern British Columbia. Approximately 3½ billion short tons have been indicated to occur along a 15 mile stretch of the Skeena River. The calorific value of the coal averages 10,500 Btu per lb. Approximately 44 percent, or 1.5 billion tons, of these indicated resources are in seams in excess of 5 feet thick. It appears that part of these resources may be mined by relatively-low cost, open pit mining methods. Inferred coal resources, considered likely to exist in the remainder of the Groundhog coalfield range from 16 to 82 billion short tons. This estimate assumes that coal is continuous throughout the assumed area of coal formation and that the average total seam thickness ranges from 10 to 50 feet.

In the Bulkley River Coalfield, the indicated coal resources are estimated to be 191 million short tons. Inferred coal resources range from 117 to 307 million short tons. These resources are considered likely to exist in only two deposits in the Telkwa River and Zymoetz River areas. The grade of the Telkwa River coal ranges from 12,290 to 13,570 Btu per lb., that of the Zymoetz River coal ranges from 13,400 to 13,970 Btu per lb.



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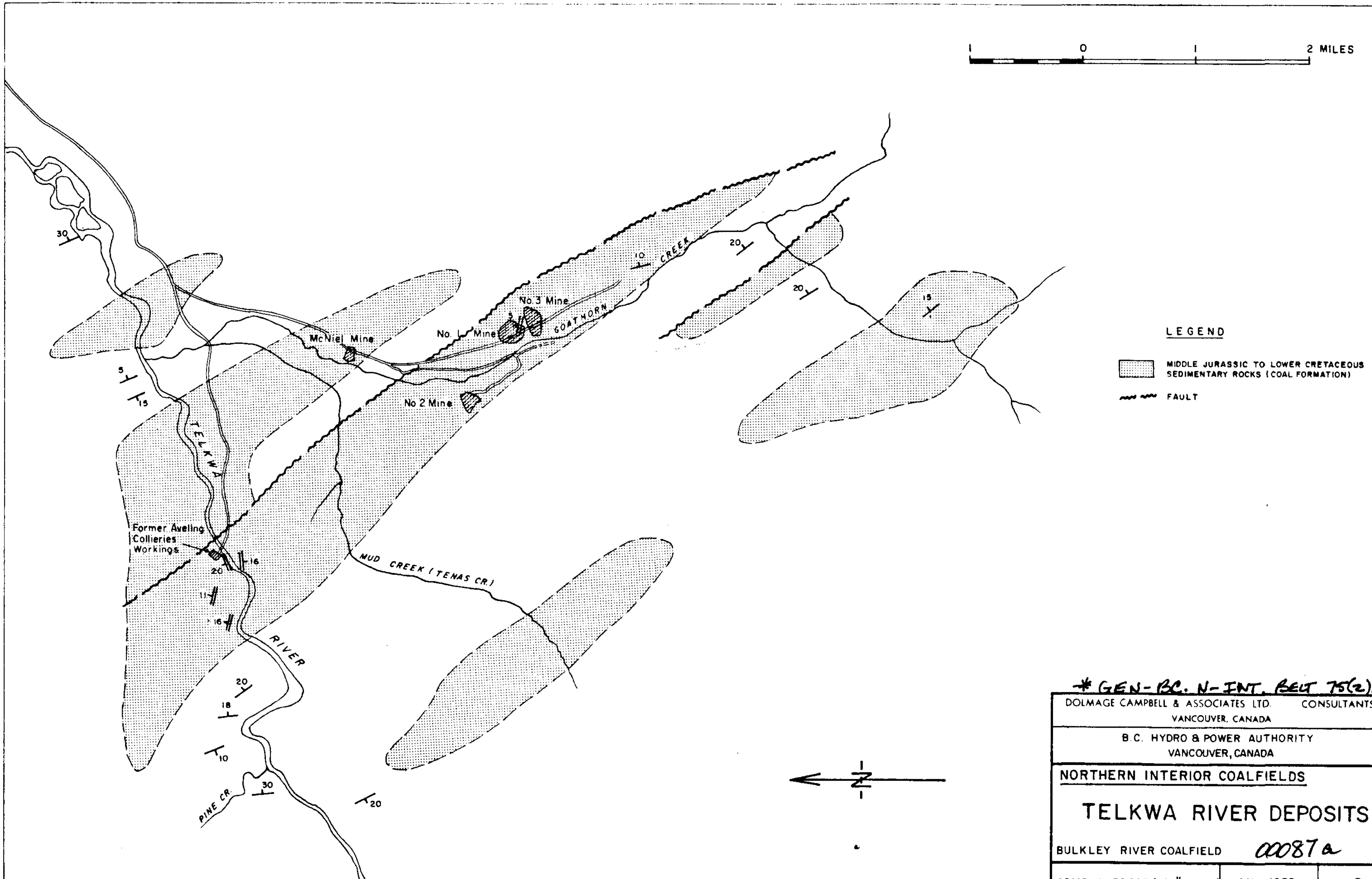
NORTHERN INTERIOR COALFIELDS

SUSTUT RIVER OCCURRENCES

DISTRICT GEOLOGY

SCALE: 1" = 4 MILES	JAN. 1975	FIG. 5



*GEN-BC. N-INT. BELT 75(2)A.

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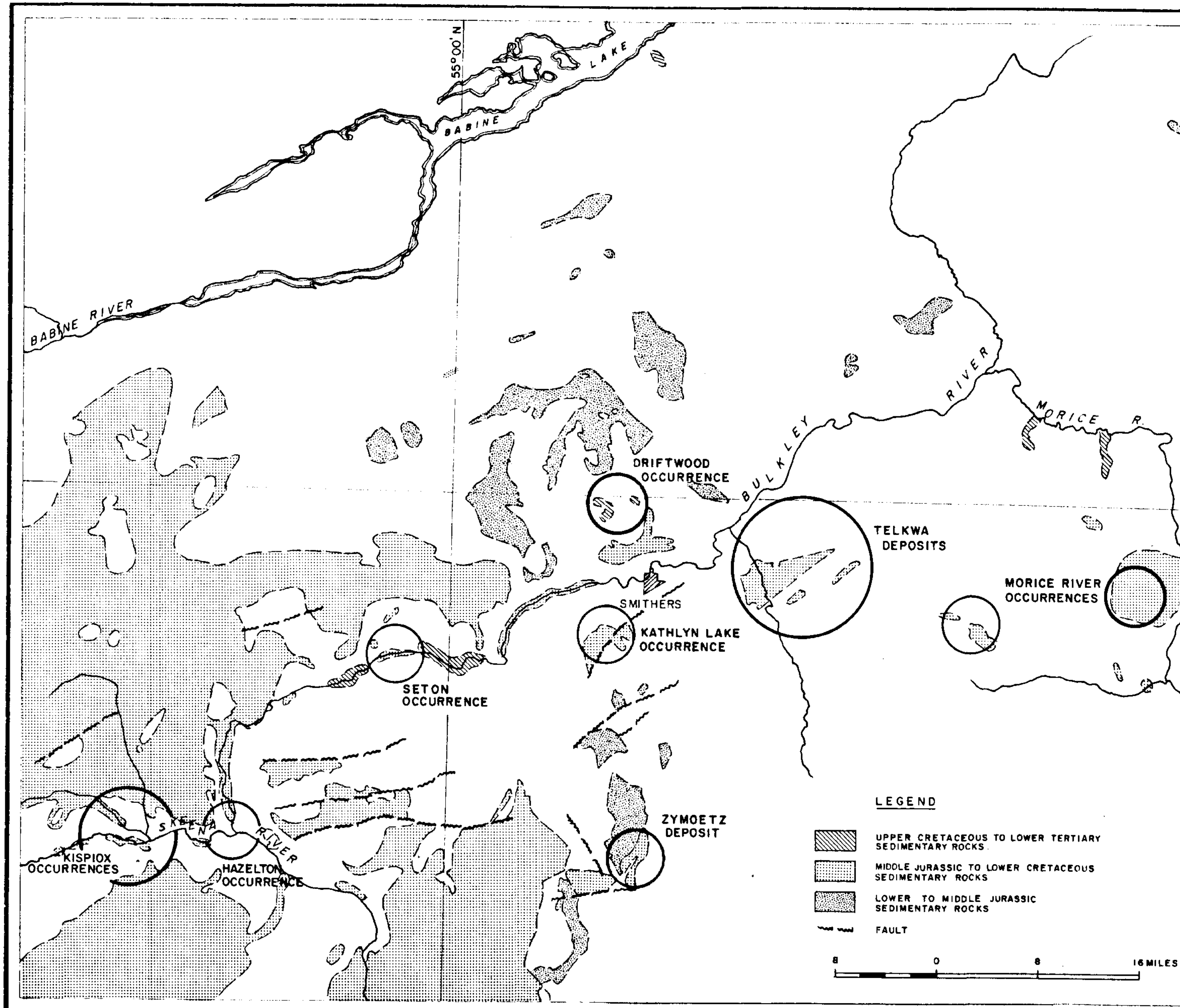
NORTHERN INTERIOR COALFIELDS

TELKWA RIVER DEPOSITS

BULKLEY RIVER COALFIELD 00087a

SCALE 1 : 50,000 (1·25" = 1 MILE) | JAN. 1975 | FIG. 8



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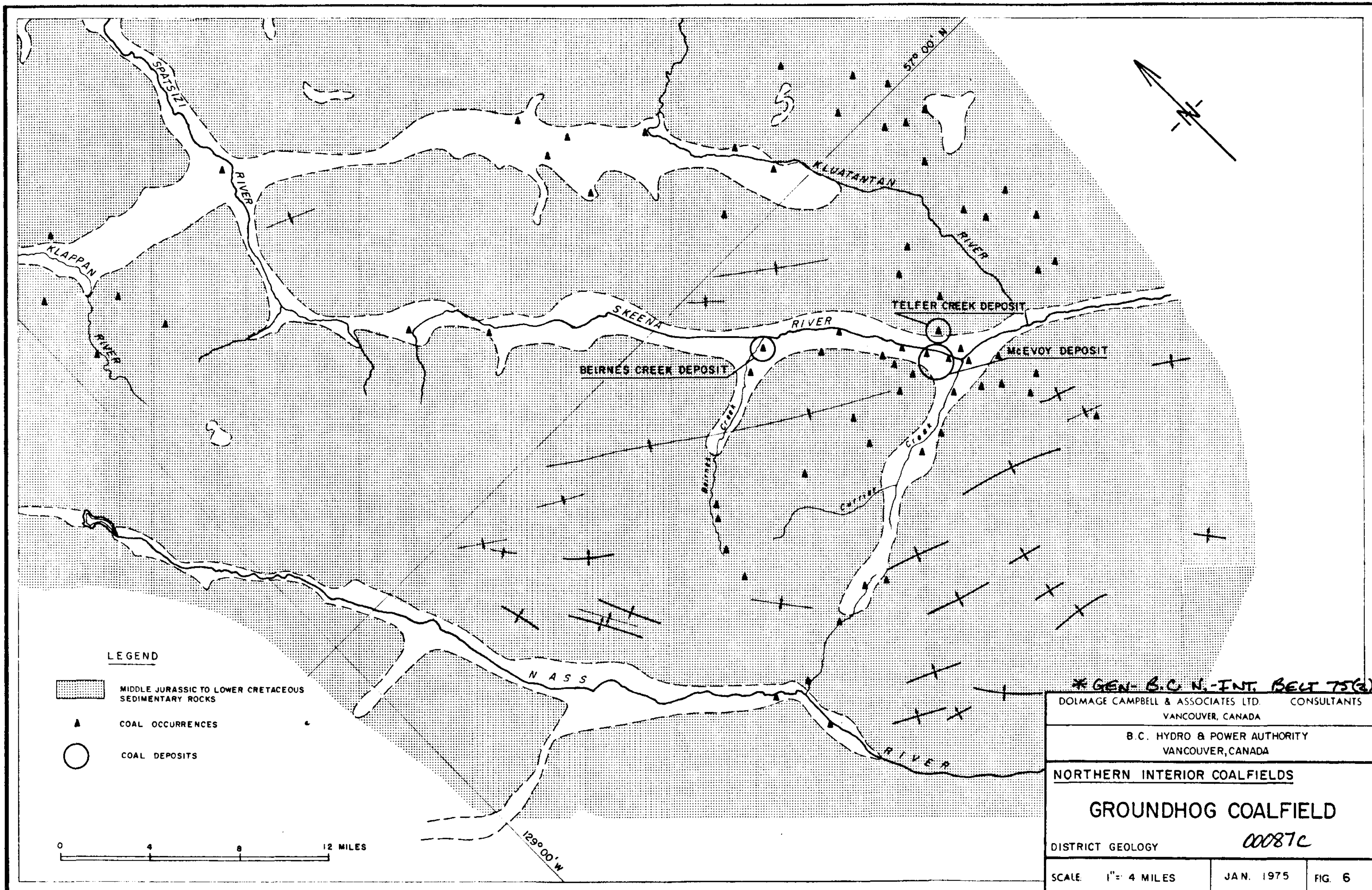
NORTHERN INTERIOR COALFIELDS

BULKLEY RIVER COALFIELD

DISTRICT GEOLOGY 00876

SCALE 1" = 8 MILES	JAN. 1975	FIG. 7

VANCAL - 72



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NORTHERN INTERIOR COALFIELDS

GROUNDHOG COALFIELD

DISTRICT GEOLOGY 00087C

SCALE 1" = 4 MILES	JAN. 1975	FIG. 6

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CONCLUSIONS

As a result of this study it is evident that the Bowser Basin hosts the most important coal deposits in the northern half of the Interior Belt of British Columbia. Rocks of the Laberge and Sustut-Sifton Assemblages, while being decidedly prospective in terms of eventually finding numerous coal deposits, do not appear to contain coal seams as thick, prolific, or continuous as those presently known to occur in the Bowser Assemblage.

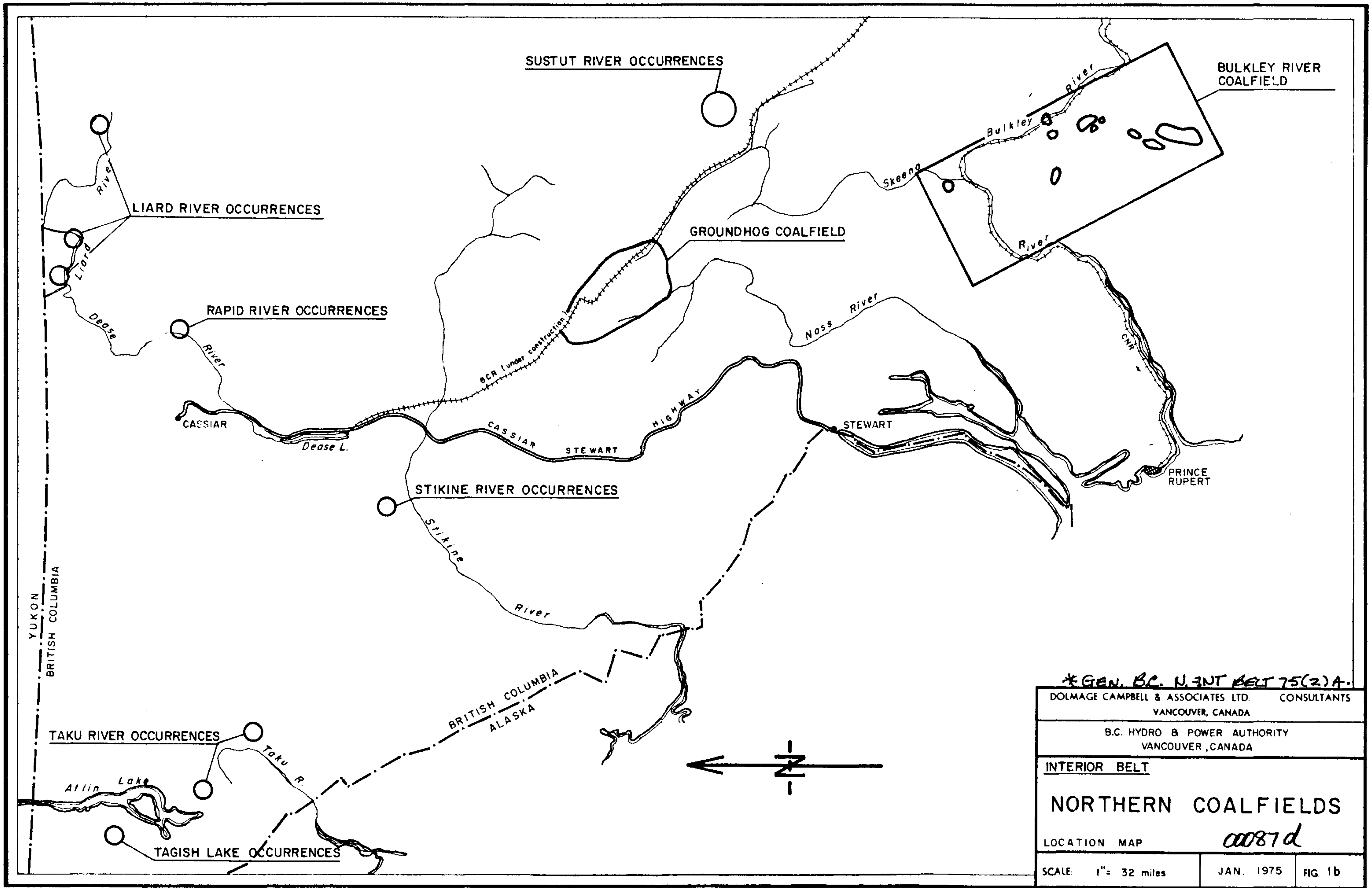
From a potential resource standpoint, the entire marine-nonmarine interface extending in a crescent-shape along the eastern part of the Bowser Basin offers attractive exploration opportunities to find other coal-bearing districts in addition to the three presently indicated. The Bulkley River Coalfield, because of its location and accessibility to tidewater, has received the most definitive exploration; however, in general the coal deposits in the Bulkley River area occur in small, widespread, isolated, erosional remnant "basins". These have been subsequently affected by severe faulting and intrusion which tends to make exploration more difficult and costly. Therefore, future development of the Bulkley River coal district does not offer the scope that the Groundhog Coalfield, and possibly, the Sustut Coalfield, do. In the latter coalfields, the coal seams are thicker, more extensive, and far more continuous.

In summary, it is concluded that the Groundhog Coalfield contains sufficient indicated and inferred coal resources to support several major thermal plants, although, as yet no established coal reserves have been defined. Some of these indicated resources could probably be mined by surface methods. The Bulkley River Coalfield could also probably support a thermal plant but its capacity would possibly be less than 2000 MW. The Telkwa River Deposit would have to provide the bulk of the feed to a plant constructed in the Bulkley River region.

Respectfully submitted by,
DOLMAGE CAMPBELL & ASSOC. LTD.

R. S. Adamson, P. Eng.

Douglas, D. Campbell, Ph.D., P. Eng.


SUSTUT RIVER OCCURRENCES
BULKLEY RIVER COALFIELD
Bulkley River
Skeena River
LIARD RIVER OCCURRENCES
Liard River
GROUNDHOG COALFIELD
RAPID RIVER OCCURRENCES
Dease River
BCR (under construction)
Nass River
CNR
CASSIAR
Dease L.
CASSIAR STEWART HIGHWAY
STEWART
PRINCE RUPERT
STIKINE RIVER OCCURRENCES
Stikine River
YUKON
BRITISH COLUMBIA
BRITISH COLUMBIA
ALASKA
TAKU RIVER OCCURRENCES
Taku R.
Atlin Lake
TAGISH LAKE OCCURRENCES
N
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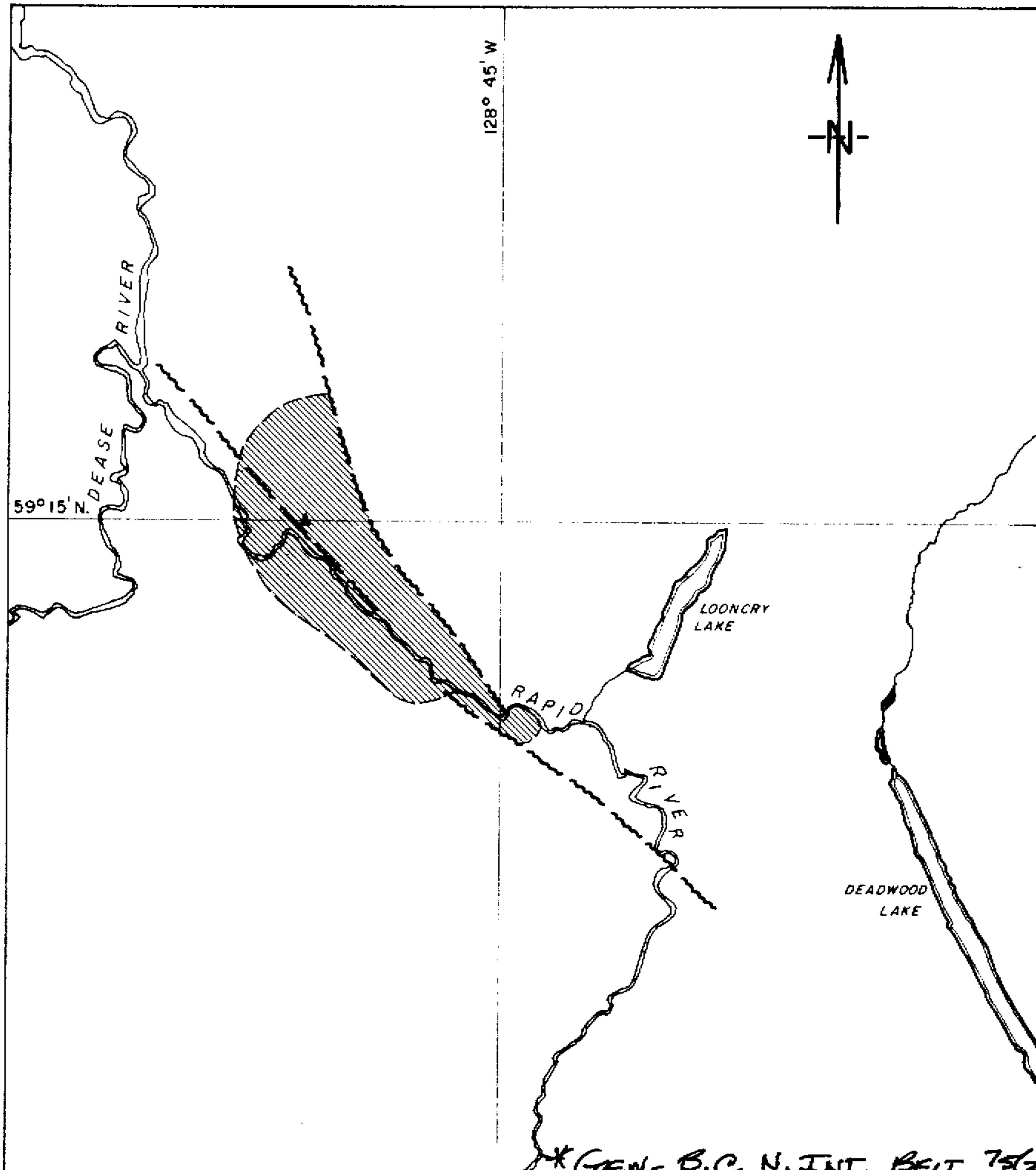
INTERIOR BELT
NORTHERN COALFIELDS
LOCATION MAP
00087d
SCALE: 1" = 32 miles
JAN. 1975
FIG. 1b



*GEN-B.C N. INT. BELT 75(2)A.

LEGEND

UPPER CRETACEOUS TO LOWER TERTIARY SEDIMENTARY ROCKS.

▲ COAL OCCURRENCES

0 2 4 6 8 MILES

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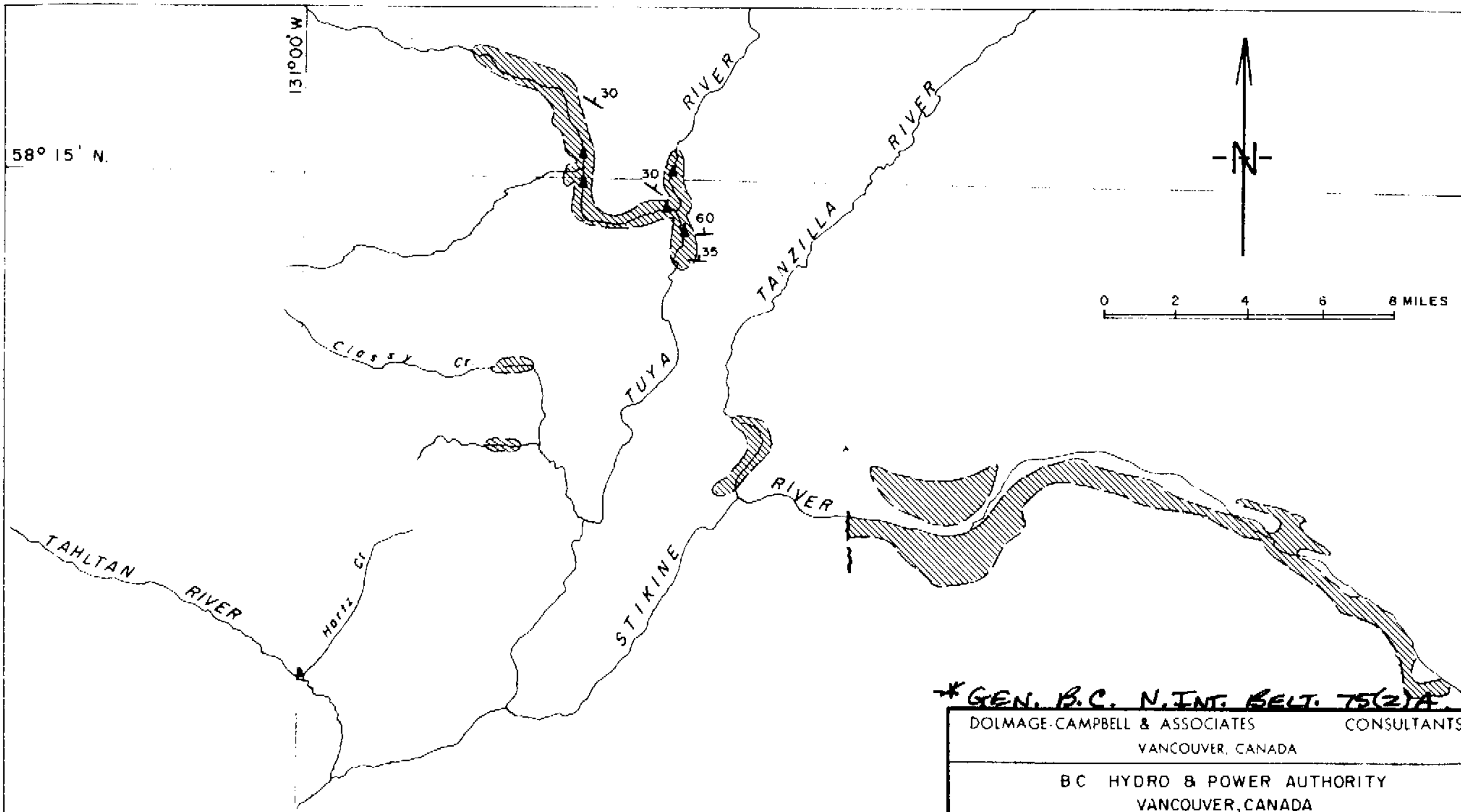
NORTHERN INTERIOR COALFIELDS

RAPID RIVER OCCURRENCES

DISTRICT GEOLOGY

SCALE 1" = 4 MILES	JAN. 1975	FIG. 3



UPPER CRETACEOUS TO LOWER TERTIARY, SEDIMENTARY ROCK

▲ COAL OCCURRENCES

*GEN. B.C. N.INT. BELT. 75(2)A.

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STIKINE RIVER OCCURRENCES

DISTRICT GEOLOGY

SCALE 1" = 4 MILES	JAN. 1975	FIG 4

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INTERIOR BELT

SCALE : 1" = 16 MILES | JAN. 1975 | FIG. 2