DOLMAGE CAMPBELL & ASSOCIATES LTD.
CONSULTING GEOLOGICAL & MINING ENGINEERS
1000 GUINNESS TOWER
VANCOUVER 1, B.C.

British Columbia
Hydro and Power Authority

Report on the

COAL POTENTIAL

of the

QUEEN CHARLOTTE ISLANDS

March 31, 1974

C. R. Saunders Dolmage Campbell & Associates Ltd. Vancouver, Canada

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SUMMARY

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SUMMARY

There are two ages of coal on the Queen Charlotte Islands, Tertiary (younger) and mid-Jurassic (and possibly Cretaceous). Exposures of both ages occur only on the eastern half of Graham Island, the largest and most northerly of the major islands in the Queen Charlotte group. Virtually all earlier exploration and mining, which took place during the period 1865 to 1914, was concentrated in the anthracite-bituminous coals of the older formations. All of these coal exposures and workings are located on alienated coal lands held, at least in part, by MacMillan Bloedel Ltd.

The low grade lignite Tertiary coal occurs in the Skonun Formation, which underlies much of the northeastern portion of Graham Island, and therefore, constitutes a potentially large reserve. Unfortunately, the grade, seam thickness and configuration, and depth of occurrence detract considerably from the economic potential of the coal and it is consequently not considered for exploration. As well, it appears that a new provincial park encompasses much of the potentially coal-bearing Skonun Formation, thereby making it out-of-bounds to exploration or mining.

The mid-Jurassic coal was explored at a number of "camps" which can be consolidated for study and further exploration into four areas: Wilson Creek, Falls Creek, Yakoun Lake and Slatechuck. All are located in the central portion of the southern half of Graham Island. Although past production from the various workings in these areas was virtually nil, there is reasonable evidence to suggest that sufficient coal, to supply a 10 M.W. thermal plant for 30 years, can be located in at least one of these areas. The most promising, from present data, is Wilson Creek; reasonable possibilities exist at Slatechuck and Falls Creek as well. Yakoun Lake has a very low potential. Mining would almost certainly be by underground methods.

The average quality, (excluding calorific value of which only one is available), from a limited number of old analyses is noted below; the Tertiary lignite is included for comparative purposes. Note that zone waste is not included.

	Wilson Creek	Slatechuck	Falls Creek	Tertiary Lignite
Moisture (%)	1.9	5.1	1.5	18.5
Volatile Matter (%)	32.8	5.3	22.5	44.2
Fixed Carbon (%)	48.2	73.6	49.2	34.7
Ash (%)	17.1	16.0	26.8	2.6
Sulphur (%)	0.9	0.6	0.7	---

A four phase exploration program is proposed, the four phases to be: 1) examination of all coal areas; 2) geological mapping and some sampling of the two or three most promising areas; 3) initial definitive exploration (drilling) of one and possibly two areas; 4) complete definitive exploration of the most promising area, (probably Wilson Creek). The cost of this program is estimated to be in the order of $250,000.

INTRODUCTION

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INTRODUCTION

Coal deposits on the Queen Charlotte Islands are of two ages, Tertiary (younger) and Mid-Jurassic (older). These two types of deposits are reasonably dissimilar in location, attempts at development, coal rank, etc., and consequently are discussed separately in this report. They are both included in one report because of objective No. 1 noted below.

TERMS OF REFERENCE

The primary objectives of this report are to:

1) Determine the potential of coal deposits on the Queen Charlotte Islands as a fuel source for a thermal generating plant.

2) Develop an exploration proposal to delineate a measured or proven-probable reserve sufficient to fuel a 10 M.W. thermal power plant for a minimum period of 30 years.

AVAILABLE DATA

Most data concerning the Queen Charlotte coal deposits are contained in old Federal and Provincial government reports; and because they are old, (turn-of-the-century), a number of problems arise. Topographic maps were not available and where sketch maps are included they are of a scale which is too small to be of more than general use. Reference was often made to stream crossings and other notable points on trails; these trails no longer exist, names (of streams, etc.) have been changed, and distances were determined by guesstimate only. As well, the remoteness of the occurrences combined with their general lack of serious development and production probably resulted in their receiving a relatively low priority for official examination and reporting. The result is that most of the occurrences can only be located approximately and the relationship between adjacent occurrences is not always clearly understood.

Following is a list of the more pertinent references used for this report.

Sutherland-Brown, A.; Geology of the Queen Charlotte Islands; British Columbia Department of Mines and Petroleum Resources, Bulletin 54, 1968.

Brewer, W. M.; Graham Island; British Columbia Department of Mines, Annual Report, 1914.

MacKenzie, J. D.; South-Central Graham Island, B.C.; Geological Survey of Canada, Summary Report, 1913.

Clapp, C. H.; A Geological Reconnaissance on Graham Island, Queen Charlotte Group, B.C.; Geological Survey of Canada, Summary Report, 1912.

Ells, R. W.; Graham Island (of the Queen Charlotte Group, B.C.); British Columbia Department of Mines, Annual Report, 1906.

Dawson, G. M.; Queen Charlotte Islands; Geological Survey of Canada, Report of Progress, 1880.

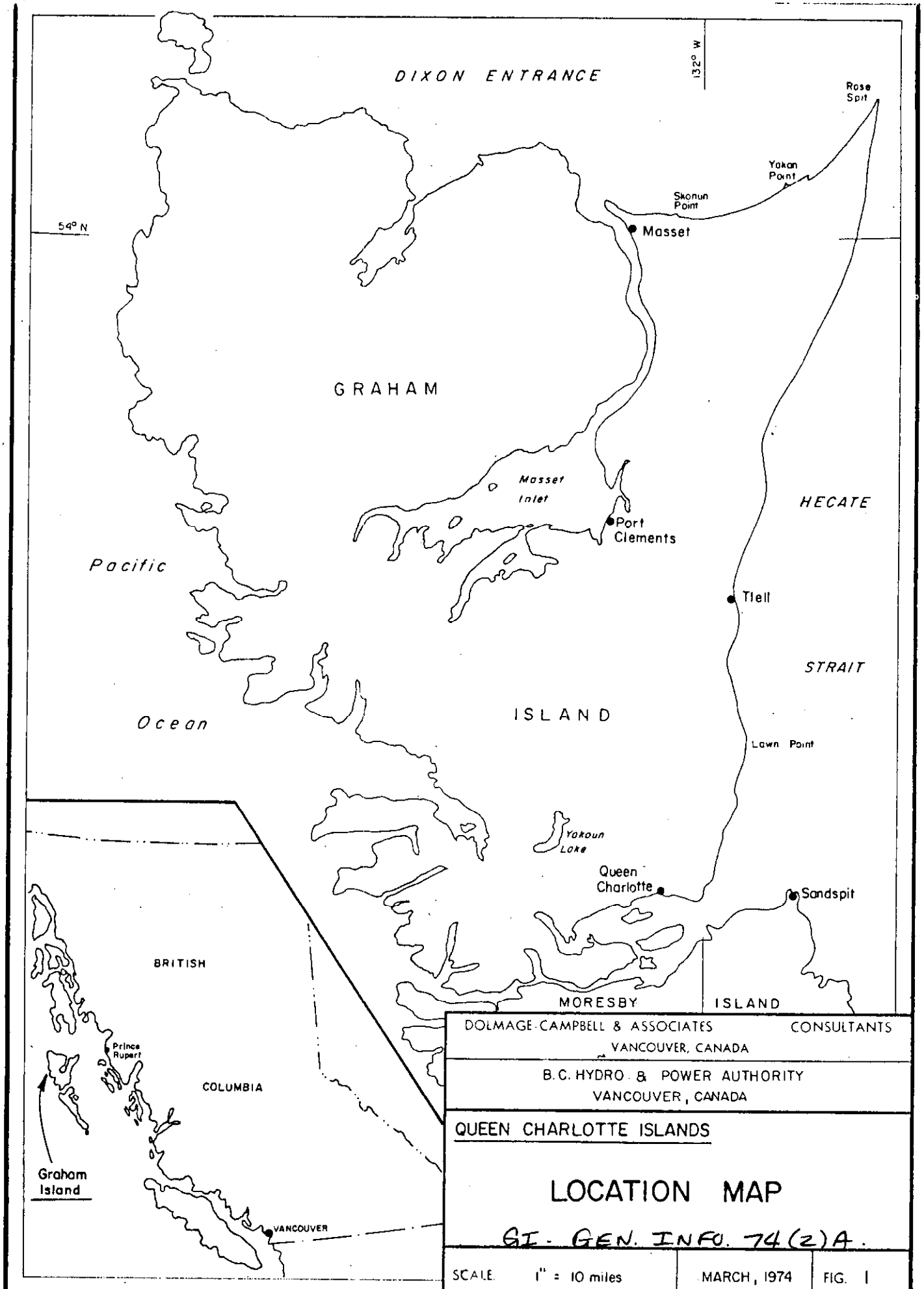
LOCATION (Figure 1)

All of the coal exposures on the Queen Charlotte Islands are on the eastern half of the large northern island, Graham Island. The Tertiary occurrences are in the generally flat northeastern portion whereas the mid-Jurassic occurrences are in the southerly, central area of higher relief and more rugged topography.

The island is being logged on a sustained yield basis but much of it, particularly inland from the coasts, is still covered by virgin forests. Rock outcroppings, except in the higher, more rugged areas, are sparse. The climate is mild, humid and stormy.

HISTORY

Coal exploration in the Queen Charlottes started about 1865 in the Kagan Bay - Long Inlet area with the opening of the Cowgitz Mine. This mine was prepared for full-scale mining without adequate preliminary exploration or study and consequently it closed in 1872 after the waste of much capital. However, it did have the affect of leading to the early investigations of the Geological Survey of Canada by Richardson, Billings and Dawson. After this venture there was little activity until the beginning of this century when exploration became quite intense, being centred about the upper Honna and Yakoun Rivers and at Skonun Point, all on Graham Island. Relatively large sums were expended but the exploration found no significant mineable reserves of coal. Foreclosure by a major investor in one of the companies combined with the start of World War I finished



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QUEEN CHARLOTTE ISLANDS

LOCATION MAP

GI. GEN. INFO. 74(2)A.

SCALE 1" = 10 miles | MARCH, 1974 | FIG. 1

DWG. G74 - 61 A

coal exploration for the time. Again, however, geological studies by Ells, Clapp, and MacKenzie were initiated primarily to aid coal exploration. It is from the reports of these pioneers that much of the data are drawn for this report.

The "exploration" conducted during the periods noted above consisted primarily of excavating pits, adits and short shafts on coal exposures. Geological techniques do not appear to have been employed. Consequently, although little in the way of mineable coal reserves were found it does not necessarily follow that no appreciable reserves exist.

The work undertaken at the various mines or "camps" is, with considerable uncertainty, listed below:

Skonun Point - drilling only; no other physical work.

Cowgitz - three major adits, three short adits, three small shafts; a total of approximately 1100 ft. of cross-cutting and 500 ft. of drifting on coal; only a few hundred tons of coal shipped.

Slatechuck - one cross-cutting adit 757 ft. in length; generally considered a part of the Cowgitz Camp.

Camp Robertson - one adit, 68 ft. in length, and one 30 ft. inclined shaft.

Camp Anthracite - one adit consisting of a short cross-cut and 30 ft. of drifting.

Camp Trilby (Yakoun Lake) - one cross-cutting adit, 50 ft. in length.

Camp Wilson - two adits, one open cut, two shallow pits and five diamond drill holes. Total underground workings consist of approximately 180 ft. of drifts and cross-cuts and 40 ft. of shafts.

COAL RIGHTS

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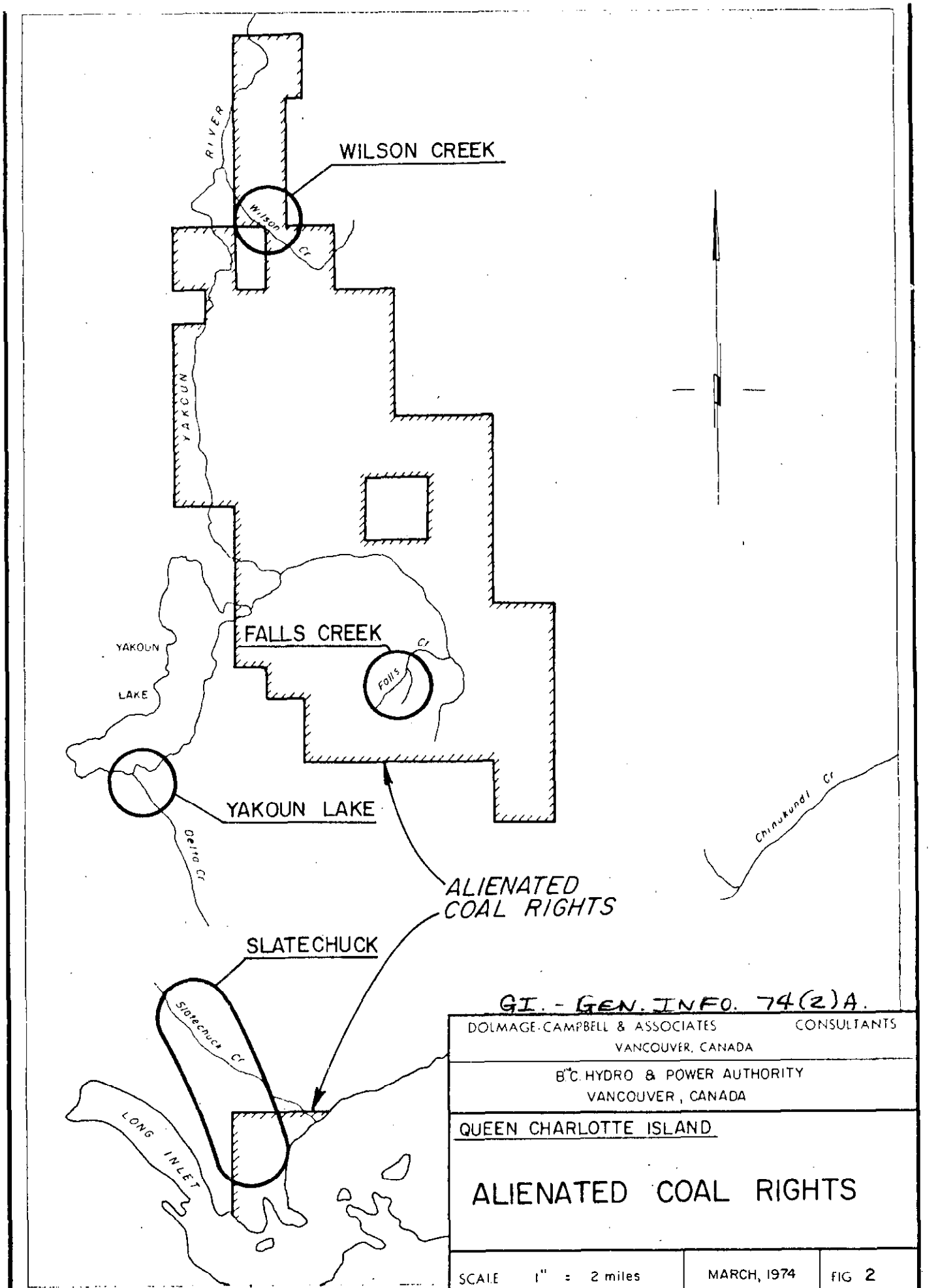
COAL RIGHTS

Most of the coal rights on the Queen Charlotte Islands are held by the Crown. Unfortunately, the area of prime interest with respect to this study, the Mid-Jurassic coal-bearing sequence in the south-central portion of Graham Island, comprises "alienated" coal rights. (See Figure 2.) This area encompasses most of the known coal occurrences and previous explorations and developments in the Mid-Jurassic rocks, (Yakoun Formation).

No detailed or legal search of coal rights ownership has been attempted but it is understood, upon reasonable authority, that the coal rights are held by MacMillan Bloedel Ltd. Furthermore, it is apparent that they are cognizant of their ownership of a potential resource. This company, MacMillan Bloedel Ltd., is presently considering the merits of undertaking exploration of their coal holdings, particularly in the Camp Wilson area.

Much of the area underlain by the Tertiary Skonun Formation on the northeast portion of Graham Island is believed to lie within the confines of a new provincial park, Naikoon Park. Maps of the park are being sought but as yet have not been obtained. However, it has been indicated verbally by the Parks Branch that the park extends from Rose Spit in the northeast, southerly to the Tlell River on Hecate Strait and encompasses an area of 272 square miles.



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ALIENATED COAL RIGHTS

SCALE 1" = 2 miles	MARCH, 1974	FIG 2

DWG. G74-62A

TERTIARY COAL

(LIGNITE)

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TERTIARY COAL (SKONUN)

GEOLOGICAL SETTING

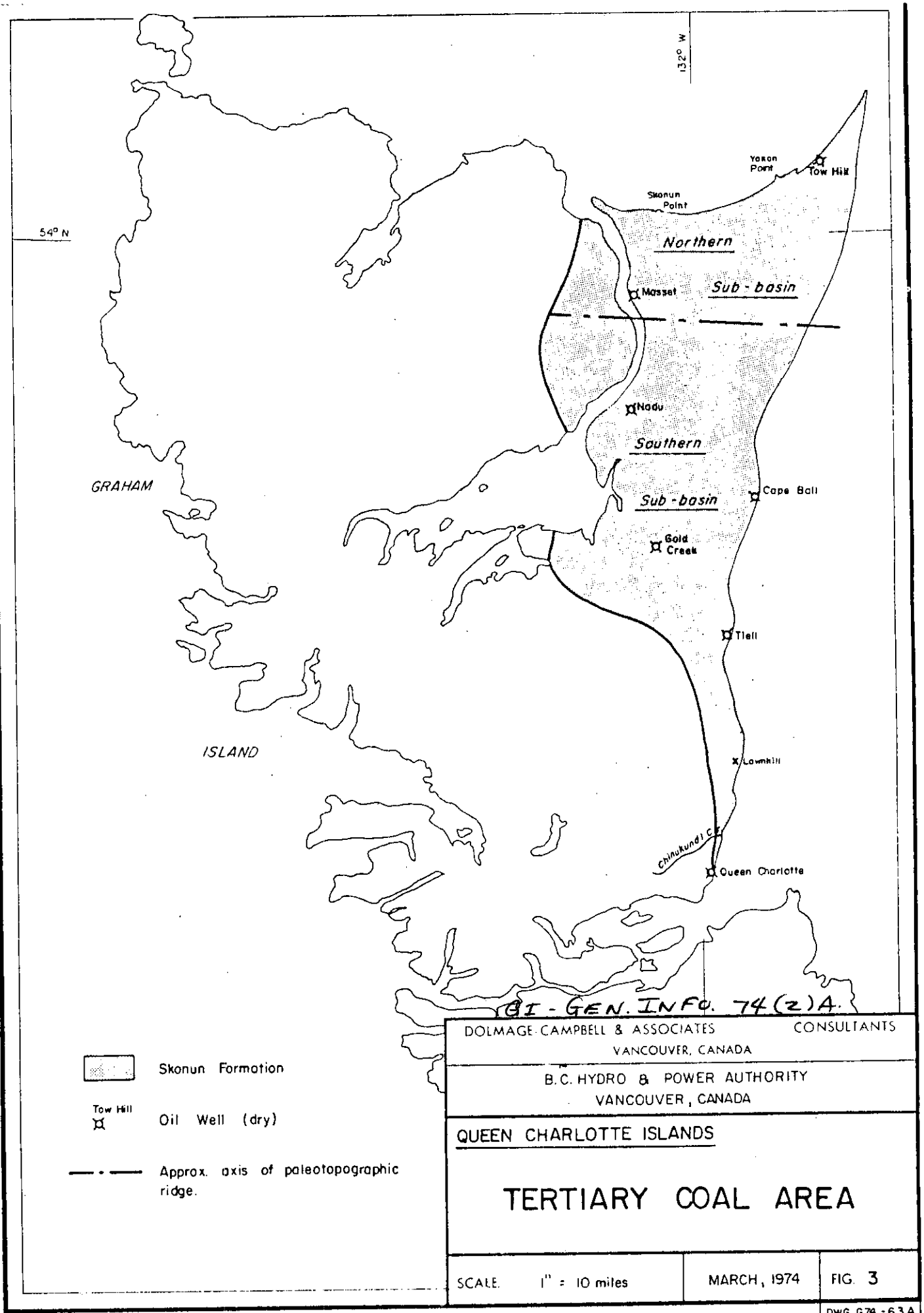
All of the recorded Tertiary coal exposures are lignites. They occur in the only sedimentary Tertiary sequence in the Queen Charlotte Islands, the Skonun Formation. This formation probably underlies the north-eastern portion of Graham Island (Figure 3) but its total extent is difficult to determine because of extensive glacial till cover, and because the Skonun rocks are friable and do not withstand weathering well, so that exposures are very limited. Considerable information concerning the lithology of the formation has been obtained from six exploratory oil wells drilled around the approximate (land) perimeter of the formation.

The Skonun Formation is composed of sandstone, siltstone, and shale with less conglomerate, lignite, and marl. Seventy to eighty percent of the formation is composed of arenaceous deposits, and these characteristically are clean, friable, poorly lithified rocks. Bedding types vary widely, with massive poorly defined bedding being commonest, but well-defined thick and thin beds, laminated sandstone, and intercalated sandstone and shale beds are all present.

Shales and siltstones form lesser parts of the formation. True shales are virtually absent; all are silty.

Carbonaceous deposits are common and vary from a tough fibrous or woody lignite, such as outcrops at Skonun Point, to black shiny coal with conchoidal fracture, such as occurs in wells at Tlell and Gold Creek at a depth of about 3000 ft.

The Skonun Formation accumulated during the Late Tertiary in a fairly large basin subjected, at least on its margin, to alternating marine and non-marine conditions. The part of the basin underlying the Queen Charlotte Islands is separated into two sub-basins by an east-west ridge as shown on Figure 3. In the southern part, sediments accumulated under a fairly stable regimen and now have gentle basinward dips increasing with depth, which probably result from compaction. In the northern part the tectonic regimen was more active, resulting in steeper and variable dips due in part to subsequent fault and fold deformation and in part to high initial dips associated with truncated slump structures.



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TERTIARY COAL AREA

SCALE 1" = 10 miles | MARCH, 1974 | FIG. 3

DWG. G74 - 63 A

COAL OCCURENCES

There is an apparent abundance of lignite coal in the Queen Charlotte Islands but there are presently no known economic reserves. The coal is present in a number of surface exposures and in the oil wells drilled into the Skonun Formation, (Figure 3).

At Skonun Point, 9 lignite beds are exposed at low tide in outcrops scattered along 4000 ft. of beach. The thickest bed is 3 feet thick and the aggregate thickness is about 20 feet. The beds occur within a silty shale sequence some 230 feet thick. The lignites occur within an east-west anticline that plunges gently to the west and is slightly arcuate in plan, concave to the north. The north limb (seaward) dips uniformly at about 20° whereas the south limb varies from about 50° near the fold axis to 25° some 500 feet farther south. A nearby (?) diamond drill hole (location unknown) intersected 13 beds of lignite separated by clay. Although one bed is reported to be 6 feet thick, the aggregate coal thickness and total thickness of the coal horizon intersected in the drill hole are unknown. One early report states, rather conflictingly, that 10 beds are exposed on the beach and that they range from 1 to 15 feet in thickness. However, such a thickness seems doubtful when the various other reports and data are considered.

At the mouth of Chinukundl Creek are exposed several stringers up to a foot thick of woody lignite. North of Chinukundl Creek, between Lawn Hill and Cape Fife (?), numerous fragments of lignite are found on the beach, suggesting that lignite may crop out in the vicinity, possibly below low-water mark.

At Yakan Point, approximately 10 miles east of Skonun Point, irregular masses of lignite occur in sandstones and shales. Nothing is recorded of their thickness, attitude or extent.

Other minor occurrences of lignite float have been noted but their location is in some doubt.

From the several oil well logs it is apparent that the coal in the southern sub-basin occurs only at considerable depth, the range being 2500 ft. to 5000 ft. Bed thickness and coal quality are not known. The well near Tow Hill in the northern sub-basin intersected several lignite beds near surface but still apparently below open-cast mining depth (greater than 200 ft.).

COAL POTENTIAL

TONNAGE

The potential tonnage of coal in the Skonun Formation is huge if economic factors are disregarded. Previous estimates range up to one billion tons. However, to be meaningful, estimates of potential coal quantities must be qualified by present or expected future economic factors. Unfortunately the available data on which to base any calculations are very sparse; consequently, reserve estimates can only be classified by the somewhat nebulous term of "potential" rather than by the more definitive terms of proven, probable or possible.

The coal in the southern sub-basin of the Skonun Formation is, considering its probable quality, (lignite), and apparent lack of appreciable bed thickness, (thick beds are no where reported in the literature), at too great a depth to be even remotely economic at this time. This part of the basin is therefore considered to contain no economic coal deposits.

Coal in the northern sub-basin occurs at and near surface and, although apparently in generally thin seams, in aggregate thicknesses which, under the proper conditions, might support open pit or strip mining. The quantity of such near-surface coal is virtually impossible to determine from present data but would presumably have to be in the order of a hundred million tons to be an economic proposition. There is ample room for such quantities to occur in the northern part of the Skonun Formation. Lesser quantities, sufficient to fuel a 10 H.W. thermal plant, may be present but the cost of locating and mining such a low grade resource do not appear to be justifiable if better potential sources are available elsewhere.

Furthermore, the geological and economic considerations may be of academic interest only if the new provincial park encompasses most of the northern sub-basin.

GRADE

Only a few samples of the lignites have been analysed and unfortunately no calorific values have been determined. All samples are from Skonun Point and were no doubt taken at or near surface. Sample No. 1 was air dried; the basis for analysis of the other two is unknown.

TABLE NO. 1

ANALYSES OF COALS FROM SKONUN POINT

	No.1	No.2	No.3	Ave.
Water	11.03	22.0	22.5	18.5
Volatile Matter	49.75	45.5	37.5	44.2
Fixed Carbon	35.94	31.5	36.5	34.7
Ash	3.28	1.0	3.5	2.6

In addition, an altimate analysis was conducted on sample No. 1

Carbon	56.3	Sulphur	0.3
Hydrogen	5.9	Moisture	10.0
Nitrogen	0.3	Ash	4.1
Oxygen	33.1	Carbon-hydrogen ratio	9.5

It should be noted that for lignite coal the maximum calorific value, on a moist ash-free basis, is 8300 BTU per pound.

JURASSIC COAL

(ANTHRACITE-BITUMINOUS)

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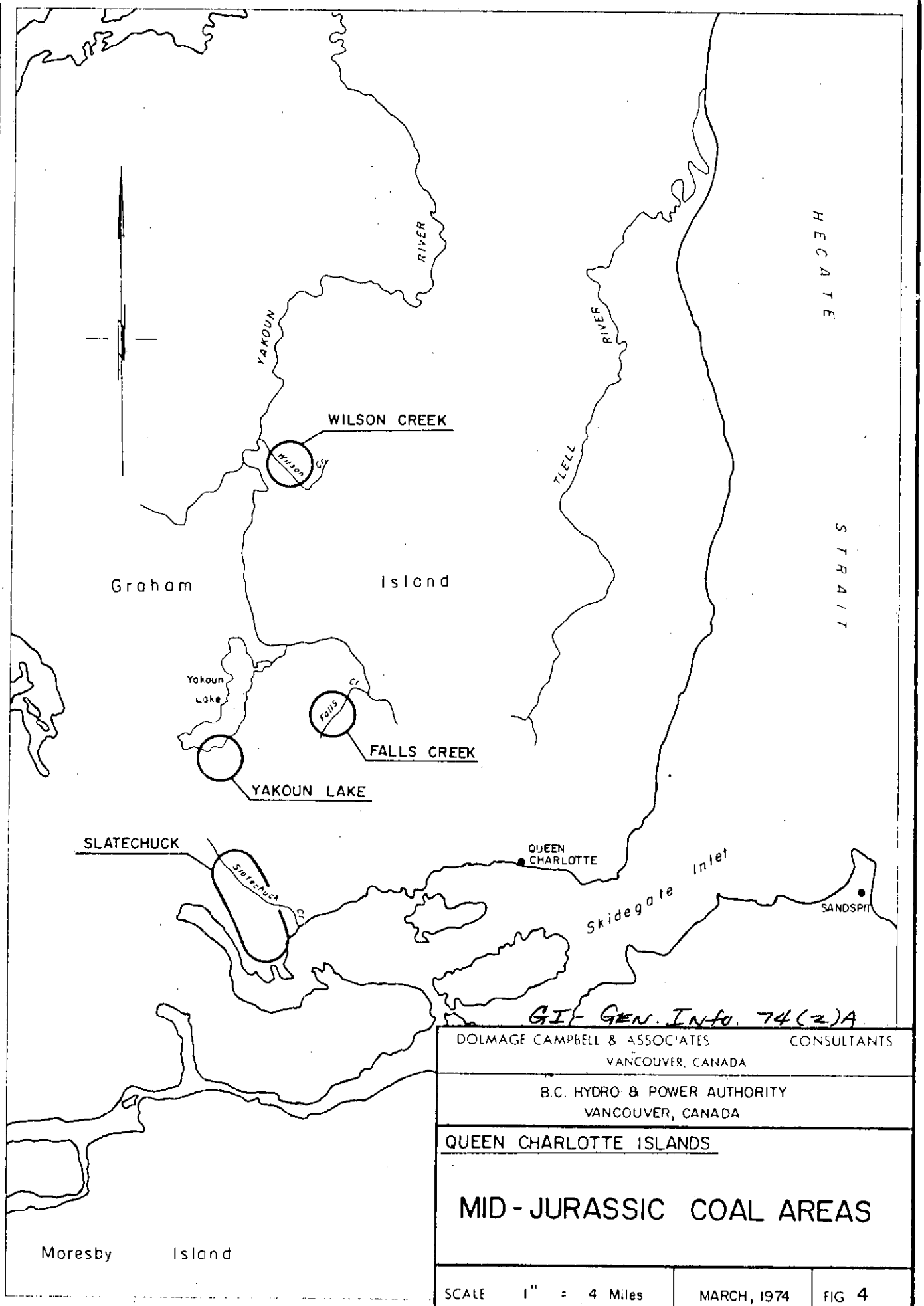
MID-JURASSIC COAL (YAKOUN)

GEOLOGICAL SETTING

The identification of the particular formations that are host to the various bituminous to anthracite coal occurrences on south-central Graham Island is open to question. Early geological work suggested they were of Cretaceous age whereas more recent, and considerably more detailed, work has suggested that at least some are mid-Jurassic in age. The coal at Camp Wilson definitely occurs within the Middle Jurassic Yakoun Formation. The Camp Robertson-Camp Anthracite area, (Falls Creek), has been mapped as Cretaceous Haida Formation but the possibility of this coal occurring in Yakoun Formation overlain by Haida Formation is considered likely. The Cowgitz-Slatechuck coal occurrences are difficult to categorize as to host formation because of the structural complexity of the area. However, they do appear to occur within the Cretaceous Queen Charlotte Group, but within which formation within this group cannot be determined with any certainty.

The sedimentary units within the several potential host formations display generally similar lithologies. All are composed of clastic sediments which are predominantly silty to sandy. Shales form generally minor constituents although the Haida Formation does contain an upper shale member. Lithologic sections are not consistent from place to place and it is this considerable variation they exhibit that, in part, makes the various formations difficult to identify. Further identification problems are caused by the variation in the contact between subsequent formations from completely conformable to totally unconformable.

Structure within the formations is generally simple, consisting primarily of flexures and broad, open folds and local faults. Original despositional features are sometimes evident: cross-bedding, slumping, draping over paleotopographic highs, etc. On a local scale, folding and faulting can be more intense.



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MID-JURASSIC COAL AREAS

SCALE 1" = 4 Miles	MARCH, 1974	FIG 4

DWG G74-64 A

COAL OCCURRENCES

The mid-Jurassic coal exposures are grouped into four general areas. These are, from north to south, Wilson Creek (Camp Wilson), Falls Creek (Camps Robertson and Anthracite), Yakoun Lake (Camp Trilby), and Slatechuck (Camp Cowgitz and Slatechuck Creek).

WILSON CREEK

Coal is known to occur over a strike length of approximately 750 feet along Wilson Creek. It has been exposed or intersected in an adit, shaft and diamond drill hole. Its general attitude is N10°W by 80°E and it varies from 5 to nearly 17 feet in thickness. From surrounding surface geology, (outcrops are very sparse), and a number of diamond drill holes, (five in total), there is the suggestion that the coal exposures lie on the west limb of a syncline.

The measures associated with the seam consist of a roof of greenish grey pebbly sandstone and conglomerate, and a floor of bluish green sandstone, 30 feet thick, overlying carbonaceous sandy shale. The rocks in the immediate vicinity are fairly uniform and have a general strike of N10° - 20°W, with a steep dip of 60° - 80° to the east. The possibilities of open-cast mining are remote.

A number of proximate analyses have been done on samples of Camp Wilson coal over the years, mostly prior to 1914; these are listed in Table 2.

On the basis of the single calorific value and average proximate analysis, the Wilson Creek coal would have a rank of "high volatile B bituminous".

FALLS CREEK

A number of discrepancies occur in the literature concerning the Camp Robertson-Camp Anthracite areas but the descriptions given by J. D. McKenzie in the Summary Report of the Geological Survey of Canada in 1913 appear to be the most authoritative and accurate. McKenzie notes that previous investigators supposed there were two coal seams present at Camp Robertson but that in fact there is only one seam that has been folded and faulted and thereby locally gives the impression of two seams.

TABLE 2

ANALYSES OF COALS FROM WILSON CREEK

Number	1	2	3	4	5	6	7	8	9	10	11	12	13	Ave.
Moisture	1.8	1.22	2.2	1.82	2.02	1.6	1.33	2.3	2.44	2.65	1.06	2.47	1.91	1.9
V. M.	35.2	36.20	30.1	30.81	39.21	29.9	30.40	6.1	35.96	38.19	43.48	35.25	35.24	32.8
F.C.	46.4	46.48	38.3	40.84	50.51	31.8	31.17	74.1	48.64	53.73	46.01	59.36	59.39	48.2
Ash	16.6	16.10	29.4	26.53	8.26	36.7	57.10	17.5	12.96	5.43	9.45	2.92	3.46	17.1
S		1.00		0.50			1.20		0.80					0.9
Coke	barely	firm, coher-ent	barely	--	--	barely	--	--	firm, coher-ent	firm	--	coher-ent	non-friable	

Note: 1) Numbers 3,6,8 - total moisture
2) Numbers 2, 4, 5, 7 - air dried
3) Number 2, calorific value = 11,235 Btu per pound

The Falls Creek seam has been traced along the eastern limb of an anticline, (along the axis of which flows Falls Creek), for a distance of about 1500 feet south from the most northerly working. At this point, at the so-called Nutter Mine, only thin coaly streaks are present. To the west the seam, although not exposed in the immediate vicinity, is thought to underlie a considerable area; its gross attitude is flat or gently rolling but depth below surface probably precludes surface mining techniques.

The coal, where exposed, has a maximum zone thickness of 8 ft. 9 ins. of which up to 3 ft. 10 ins. is coal. Generally, individual seams are less than 2 feet thick, being separated by thin partings of shale and bone.

At Camp Anthracite, (on Anthracite Creek?), an adit exposes what is considered to be the Falls Creek seam (or zone). The zone is 9 feet thick and contains 4 ft. 5 ins. of crushed coal in several bands.

A number of analyses from both Camp Robertson and Camp Anthracite are recorded. In virtually all cases the samples are of narrow, (less than one foot), coal sections within the broader zone. Even so they are consistently high in ash, (See Table 3).

YAKOUN LAKE

The Yakoun Lake occurrence, referred to as Camp Trilby in some literature, is located near the southeast corner of Yakoun Lake where it swings from north-south to east-west. Geologically, the area is described as "a small basin of coaly shale in which occurs a small deposit of impure anthracite." The basin is a narrow syncline striking about N25°W. Coal has been located on each limb of the syncline and in both localities has a steep dip.

The exposed coal consists of several thin seams of coaly material, none over 3 inches thick. It is suggested that the coal is coked rather than metamorphosed by later volcanic rocks. It is very light and often exhibits columnar structures perpendicular to the bedding.

There are no recorded analyses from these occurrences.

TABLE 3

ANALYSES OF COALS FROM CAMP ROBERTSON

Number	1	2	3	4	5	6	7	8	9	10	11	12	Ave.
Moisture	1.28	0.30	2.12	0.64	1.76	0.42	1.61	0.47	1.09	0.80	1.33	1.20	1.1
V. M.	25.99	27.73	24.60	26.27	29.66	27.29	24.19	25.81	13.92	23.27	35.25	29.13	26.1
F. C.	52.58	52.18	38.56	44.44	41.12	46.09	43.85	45.53	41.83	51.39	42.57	47.52	45.6
Ash	20.15	19.82	34.72	28.65	27.46	26.20	30.35	28.29	43.16	24.54	20.85	22.15	27.2
Sulphur		0.88		0.92		0.50		0.54	0.54				0.7
Coke	Coherent but tender		firm		coherent		coherent						

Notes: 1) Numbers 1, 3, 5, 7, 9 - loss at 105°C
2) Numbers 2, 4, 6, 8 - air dried
3) The following samples are essentially duplicates: 1&2, 3&4, 5&6, 7&8.

ANALYSES OF COALS FROM CAMP ANTHRACITE

Number	1	2	3	Ave.
Moisture	5.69	1.52	2.85	3.4
V. M.	7.83	8.69	7.59	8.0
F. C.	42.10	80.07	68.25	63.5
Ash	44.38	9.72	21.31	25.1
Coke	non-coherent			

SLATECHUCK

The several exposures and workings in the Slatechuck area are situated along an approximate north-south line some two miles in length. From descriptions of the coal in the exposures and workings it appears that only one coal horizon is present but because of folding and faulting it locally gives the impression of two and occasionally more zones or seams. The coal has been metamorphosed by volcanics, dikes and sills. The host rocks are black shales both above and below the coal with (feldspathic) sandstone below the lower shale. Folding and faulting have been locally intense resulting in "badly disturbed" ground and "crushed" coal. The degree of disburbance appears to decrease, but not disappear, northwards into Slatechuck Creek.

Coal seams have been traced continuously as much as 450 feet along strike and discontinuously considerably farther. Zone widths range up to 6 feet but rarely is an individual coal seam within the zone thicker than 3 feet. The proportion of coal in the zone appears to be in the 50-75% range but could average considerably more or less.

A number of proximate analyses are available and are presented in Table 4.

TABLE 4

ANALYSES OF COALS FROM THE SLATECHUCK AREA

Moisture	1.60	1.89	3.61	6.68	6.85	6.69	6.60	6.45	6.75	6.77	2.3	5.1
V. M.	5.02	4.77	8.14	8.28	5.43	6.59	3.95	4.15	4.25	4.23	3.8	5.3
F. C.	83.09	85.76	74.09	68.49	66.32	57.23	68.17	63.60	65.50	85.48	90.8	73.6
Ash	8.76	6.69	14.16	18.55	21.40	29.49	21.28	25.80	23.50	3.52	3.1	16.0
Sulphur	1.53	0.89			0.20	0.30	0.43	0.45	0.34	0.42		0.6
Coke	non-coherent			non-coherent			non-coherent					

The rank of this coal is anthracite.

COAL POTENTIAL

The coal potential of the mid-Jurassic (Cretaceous) coal-bearing formations on the Queen Charlotte Islands is quite large considering the extent of these formations, over 500 sq. miles. It is however, unknown whether, and very doubtful that, coal occurs throughout the formations. But the area in which coal is known or suspected to occur is also of considerable size, encompassing some 200 square miles of favourable formations on southern Graham Island. Such an area can be said to be "potentially coal-bearing" but no meaningful reserves can be determined. Firmer data, on which to base reserve estimates is only available from the several areas or camps in which exploration was done in the past. The potential of these areas is discussed in the following paragraphs with those of the least potential dealt with first followed progressively by those with more potential. In this reverse order the areas are: Yakoun Lake, Falls Creek, Slatechuck, and Wilson Creek.

YAKOUN LAKE

Considering the rather favourable topographic setting of these deposits near Yakoun Lake, they immediately are suspect because of the lack of exploration applied to them. Such suspicions are borne out by the results obtained in the meagre workings. The coal occurs in several seams, none of which is over 3 inches thick. Furthermore, the coal has been coked by intrusive rocks. The economic coal potential of this area is very low and consequently it receives no further consideration in this study.

FALLS CREEK

The Falls Creek area encompasses an appreciable potential tonnage of coal but whether all or even part of this tonnage can be economically obtained, or is of a grade worth obtaining, is another matter. The zone potential in the immediate area of the various old workings is in the range of 1 to 5 million tons depending on the distances of extrapolation. The amount of coal within the zone is considerably less, probably in the order of $\frac{1}{2}$ to 2 million tons. However, even these figures are misleading in that some, perhaps most, of the coal may not be economically mineable because of thickness or configuration.

Combined with an apparently low proportion of coal in the zone is a further adverse feature, high ash content of the coal. The average ash content of 15 samples is 26.8%. The calorific value is unknown but on an as-received basis will be relatively low and, considering zone waste, will be very low unless beneficiation is considered.

The Falls Creek area has little possibility of fulfilling the objectives of this study. But, because of the number of occurrences and workings, it cannot be completely ignored if other exploration for coal is conducted on the Queen Charlotte Islands. At such time the area should be examined. However, the probability of locating economically mineable deposits in this area is considered to be low.

SLATECHUCK:

More exploration and development has been conducted in the Slatechuck area, (Cowgitz, Slatechuck Creek), than in any other area on the Queen Charlotte Islands, thus implying that the best potential coal sources occur here. However, the fact that this is the most accessible coal area on the Islands probably had a very strong effect on concentrating work on these occurrences.

The potential reserves at Slatechuck could be in the order of 10 million tons; the economically mineable reserves are presumably much lower. Mineable thickness of coal zone appears to be in the range of 4 to 6 feet, although locally thicker areas are almost certainly present. The amount of waste within the zone may be an inhibiting factor. Folding and faulting are not uncommon and may result in some local areas being unmineable for this reason alone. For thermal purposes the "disturbed" and "crushed" coal encountered by some of the early miners will be a problem only as it affects mining.

The ash content of the coal is moderately high, (16%), and if combined with zone waste will be very high, probably in the order of 50%. The calorific value is not known but for anthracite coal, the as received C.V. for 50% waste and 5% moisture should be approximately 7000 Btu.

AND MAY NOT BE...

There is a reasonable probability of locating the required thermal coal reserve in the Slatechuck area. If it exists it will probably be mineable only by underground methods, it will be relatively costly to mine, it will have a high total ash content and consequent relatively low calorific value, but it will be well located with regard to exploration, development, and shipping (if required). If considered without regard for other possible sources, it definitely warrants initial exploration.

WILSON CREEK

The exploration and development done on Wilson Creek, although obviously limited to some extent by its remote location, was of a more professional nature than that done in the other coal areas. This was no doubt a result of the relative quality of the Wilson Creek coal. Unfortunately, the amount of exploration was rather

limited in areal extent and thus it is virtually impossible to make a meaningful estimate of potential coal reserves for the general area. In the immediate vicinity of the Wilson Creek explorations there is a potential reserve in the order of 500,000 tons; and this reserve is primarily coal, not coal plus zone waste.

The Wilson Creek coal has an ash content of approximately 17% and, on the basis of one determination only, a calorific value in the order of 11,000+ Btu. On this basis only, it is the best thermal coal on the islands. Seam continuity is as good as or better than in the other mid-Jurassic coal areas and the possibilities for significant extensions beyond the old workings are good. The major drawbacks to exploring and developing these coal occurrences are their relatively remote location, lack of rock exposures, and heavy forest cover. There is little doubt that the Wilson Creek coal area warrants exploration as a possible thermal fuel source.

PROPOSED EXPLORATION

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PROPOSED EXPLORATION

In developing an exploration program for thermal coal sources on the Queen Charlotte Islands the economics of local versus imported coal supplies has been disregarded even though, considering the tonnage required, the cost of mining local coal will probably be considerably higher than, say, the cost of mining at Comox. The economic merits of local versus imported coal has not been included within the scope of this geological report. The exploration recommended in the following paragraphs is based only on the relative merits of the several coal occurrences on Graham Island.

The total amount of coal required for the proposed 10 M.W. thermal plant for a 30 year period, taking into account mining recovery, confidence of reserves, calorific value, etc., will be in the range of 1.4 to 3 million tons, this range being primarily dependent upon as-received calorific value.

TARGET AREAS

There are five possible coal exploration targets in the Queen Charlotte islands; four reasonably discrete targets in the mid-Jurassic (Cretaceous) formations and one quite nebulous target, the northern sub-basin in the Tertiary formation. From discussion in the previous sections these targets can be rated as to their probability of containing the required coal reserves.

Considering known seam continuity, thickness, zone waste, calorific value, folding and faulting, and reliability of data, there is little question that the Wilson Creek area has the best potential for containing the required reserve. Conversely, it is the most remote of the possible targets and will be the most costly to explore and to develop. However, its potential, on the basis of present data, definitely out-weighs this disadvantage.

In order of descending probability the other targets are: Slatechuck, Falls Creek, Skonun Point and Yakoun Lake. Slatechuck is probably the least costly to explore because of its location near tide-water. Skonun Point (Tertiary) offers the largest potential reserve, an attribute of little importance for the present objective.

NATURE OF THE PROGRAM

Very little "hard" data, (maps, plans, sections, logs, etc.), are available as a basis for exploration. Instead, much of the data consist of verbal descriptions using old terminology and names, and some of the descriptions are partially conflicting. Consequently, further exploration must commence with the acquisition of the missing hard data before more definitive exploration, such as diamond drilling, can be undertaken. Furthermore, considering the decisions to be based upon this work, it should be expanded beyond the apparently best target, Wilson Creek, and include other, at least moderately potential, targets, these being Slatechuck and Falls Creek.

The exploration program will consist of several phases, each of which will result in a major decision. The phases will be:

Phase I - Examination of all occurrences.

(Decide which should be taken to phase 2 - presumed to be Wilson Creek, Slatechuck, and Falls Creek)

Phase II - Geologically map the target areas and take some samples.

(Determine which target warrants more definitive study, probably Wilson Creek, but other factors may enter suggesting two targets be considered for phase 3.)

Phase III- Initial definitive exploration.

(Obtain an indication of continuity, potential size, etc.)

Phase IV- Complete definitive exploration (one target only) and calculate reserves, grade, etc.

ESTIMATED COST

The cost of the proposed exploration on Graham Island in the Queen Charlottes will be abnormally high for a number of reasons. The islands are relatively remote from service and supply centres and access about the islands is generally poor. The exploration season may be limited, or at least hindered, by the severe storms and heavy rainfalls prevalent during much of the year. Thick forest cover and swampy ground will inhibit the movement of equipment to some degree. The comparatively small size of the exploration program will result in higher fixed costs and unit costs.

CONCLUSIONS

It is difficult, from present data, to realistically estimate beyond the second phase of exploration; however, general figures are presented below to serve as a costing guide, with the reservation that they are subject to considerable change as data from each phase become available.

Phase I -	primarily examinations	$ 3,000.00
Phase II -	Field mapping; analyses	$ 12,000.00
Phase III -	Initial definitive exploration	$ 75,000.00
Phase IV -	Final exploration	$175,000.00
	TOTAL	$265,000.00

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VANCOUVER 1, B.C.

CONCLUSIONS

Two ages of coal occur on Graham Island in the Queen Charlotte Islands, Tertiary (younger) and mid-Jurassic (and possibly Cretaceous). The Tertiary coal exposures are limited to the north coast of the island but coal can occur throughout a large area of the northeastern portion of the island. This coal is low grade (lignite), occurs in narrow seams, and has not been located in quantity or configuration amenable to surface mining techniques. Considering the coal quality, probable cost of exploration, required reserves, and the better potential in other formations, it is concluded that no exploration should be undertaken for this coal. Furthermore, exploration may not be possible if much of the area is encompassed by the new provincial park.

The mid-Jurassic (Cretaceous) coal occurs in four areas in the south-central part of Graham Island and of these, three are deserving of at least initial exploration. In order of decreasing potential these are: Wilson Creek, Slatechuck, and Falls Creek. From present data it can be concluded that one of these areas, most probably Wilson Creek, will prove to have sufficient reserves to supply a 10 M.W. thermal plant for 30 years, probably from an underground mine.

Exploration should be done in a number of phases with each succeeding phase dependent upon the results obtained from the preceding phase. The total exploration cost, although rather uncertain for the latter phases, is estimated to be in the order of $250,000.

Respectfully submitted,
DOLMAGE CAMPBELL & ASSOCIATES LTD.

C. R. Saunders, P.Eng.