PR-CARBON CREEK 76(10)D

CARBON CREEK COAL DEVELOPMENT

UTAH MINES LTD.

REPORT ON ALTERNATIVE ACCESS ROADS

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1.0 INTRODUCTION

Utah Mines Ltd. is conducting mineral exploration activities on coal licences in northeastern British Columbia at Carbon Creek. The Carbon Creek coal property is located'20 miles west of the W. A. C. Bennett Dam within the designated north-eastern coal block. The property lies some 30 miles west of Hudson Hope. The locations of the property and Hudson Hope are shown on Figure 1, along with the proposed and alternate routes.

The exploration activities which commenced in 1971 have progressed to the stage'where it is necessary for Utah to provide year-round access to the property. In this respect, Utah proposes to construct a Class 6 (B.C. Forest Service Standard) exploration access "tote" road to Carbon Creek. It is important that the corridor selectedcould eventually be upgraded to a commuting road for mine personnel. At this time, Hudson Hope is considered the only existing community within an acceptable commuting distance, and this fact is dependent on the acceptance of the proposed route.

The following document assesses the engineering, environmental; and socio-economic considerations in the selection of an access road for the potential Carbon Creek Coal Development.

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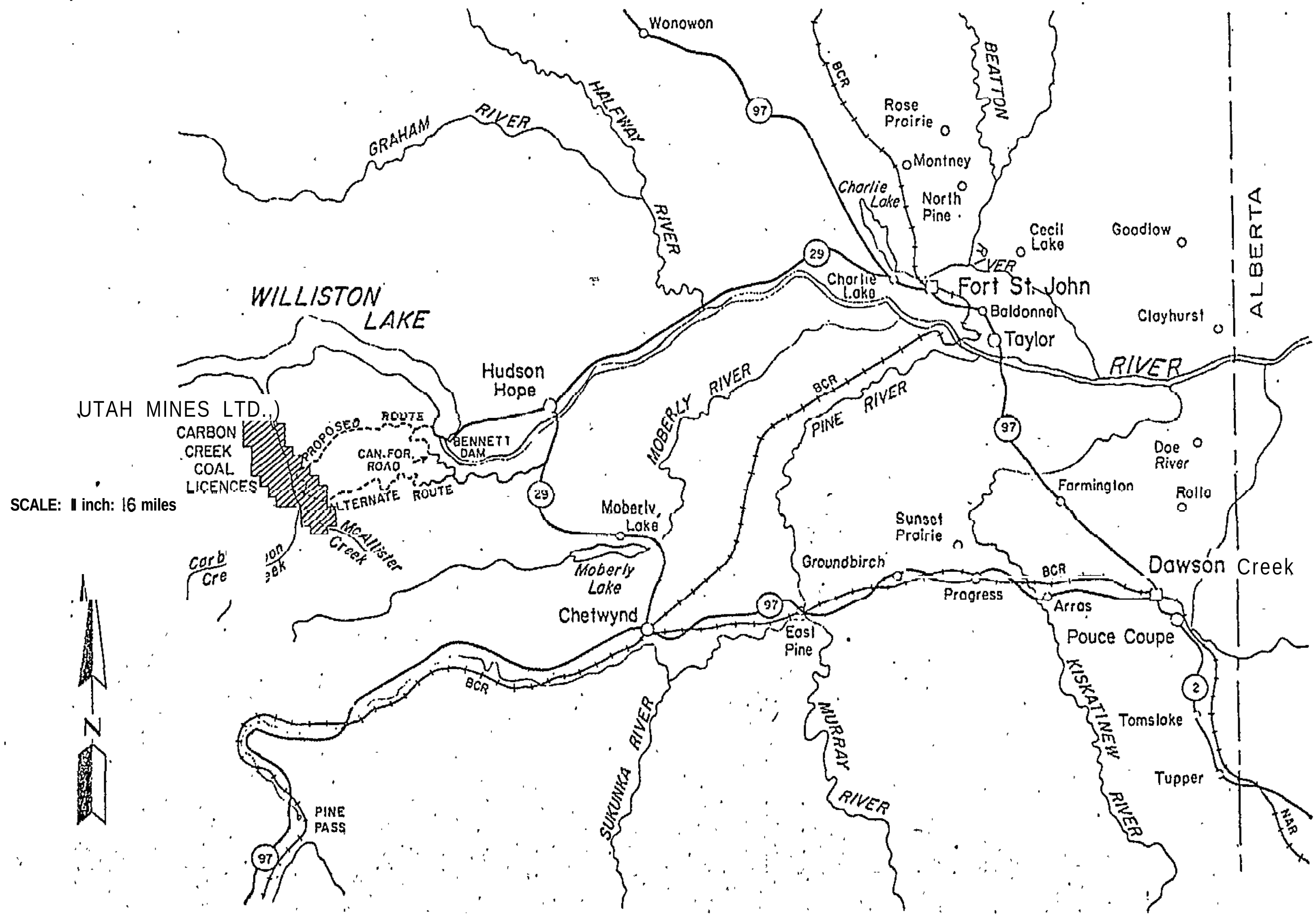
CARBON CREEK COAL DEVELOPMENT

PROPOSED ACCESS ROAD WITH

ALTERNATE ROUTE



1.1 OBJECTIVES AND TERMS OF REFERENCE

This study was commissioned by Utah Mines to investigate in detail the impact of route alternatives to the potential Carbon Creek Coal Development. The primary objective of the study was to satisfy requirements stipulated by *the* Lands Management Branch in order to obtain a permit to build an *access* road to Carbon Creek.

The following terms of reference were issued to Utah Mines by the Lands Management Branch.

1. Alternative corridors are to be identified over the total length of the routes in terms of preferred centreline definition, as determined by a reconnaissance survey.

2. Such a survey is to include an assessment of constraints as to slope, soils, terrain analysis, stream crossing, sites, disposal methods for waste (excavated material), sources of granular material, engineering control points, and environmental control points.

3. Locational criteria are to be conducted to a Class 3 Forest Service standard, due to possible upgrading of the road at the development stage.

4. Design critera are to be conducted to a Class 6 Forest Service standard.

5. Included in the report must be:
   - mapping of the alternate lines at a scale of 1:50,000

- tabular presentation of a comparison of the alternatives in terms of comparative distance, overall costs, costs *per* mile and estimated commuter driving time
- a narrative accompanying the mapping should discuss the comparative engineering constraints of each route. It should indicate how the presented lines will accommodate these factors,
- a detailed comparison, as per the above, of the route alternatives from Carbon Lake to the Coal Leases and Nright Lake to the Coal Leases, at a scale of 1 inch to 1000 feet.

6. Environmental considerations to be examined in detail.

7. Cost-benefit assessment of alternative access routes.

1.2 ACKNOWLEDGEMENTS

The following consultants and government agencies were responsible for and/or provided information for various sections of this report.

1.2.1 Engineering Section

McElhanney Surveying and Engineering Limited evaluated the findings of Utah Mines' engineers and reported -observations 'and recommendations as derived from the data supplied. McElhanney engineers used existing air photos and made reference to available soils maps to verify information from Utah Mines.

1.2.2 **Environmental Section**

1.2.2.1 Dr. Don McPhail, Professor of Fisheries (UBC), did the Aquatic Resources section of this report. His involvement included field surveys of the alternate routes, laboratory analysis, report writing and meeting with the regional Fish & Wildlife Biologist in Prince George, B.C.

1.2.2.2 L.R. Erickson of L.R. Erickson and Associates did the wildlife assessment. His work included field reconnaissance in the area, investigation of available information and consultation with Dr. Ian McTaggart-Cowan, Professor of Wildlife (UBC).

1.2.2.3 Don Benn, Recreation Consultant, did the recreation potential of the alternatives for the Stage I Report (in preparation) of the Carbon. Creek Coal Development. Excerpts from this report were used.. by Canadian Resourcecon in the socio-economic assessment.

1.2.3 **Cost-Benefit Analysis**

Canadian Resourcecon Ltd. prepared the cost-benefit assessment of alternative access routes. Assisting them in the' analysis were Sigma Resources and Suzanne Veit and Associates.

1.2.4 The Fish and Wildlife Branch in Prince George, B.C. provided direction in the Aquatic Resources study.

1.2.5 Environmental and Land Use Secretariat Resource Analysis Unit in Victoria provided various capability-maps of the area.

1.2.6 Environmental and Land Use Secretariat North East Coal Block Development Team provided assistance to the wildlife consultants on the field reconnaissance survey.

1.2.7 The Forest Service provided assistance to economic consultants in the form of forest capability maps of the area.

2.0 SUMMARY AND CONCLUSIONS

The construction and use of an access road into the Carbon Creek valley will cause some physical change to the area. In order to minimize the environmental impact and maximize the cost-benefits of an access road into the Carbon Creek valley, alternate roads were studied.

Basically the road would be from the W.A.C. Bennett Dam to the plant site of a potential coal development adjacent to Carbon Creek. The road would initially be constructed to a Class 6 Forest Standard with the thought of possibly upgrading to a commuter road if the property were to develop. The routes studied are: 1) the Carbon Lake route, referred to in this report as Route A, and 2) the Wright Lake route referred to as Route B. The engineering constraints, environmental impacts and cost-benefit aspects of the routes were studied.

The following conclusions are basically quotes from various consultant's reports.

2.1 Engineering

McElhanney Surveying and Engineering made the following comments concerning the alternate routes:

"The Carbon Lake route is the shorter of the two routes by 8.6 miles. As demonstrated in the previous section of this report, both the initial construction and the subsequent road users cost, are substantially less with the selection of the Carbon Lake Route.

The maintenance of the Carbon Lake Route would be considerably less expensive, not only due to the shorter length of the access road, but also because of the more favourable orientation of the valleys.

"The Little Carbon Creek Valley lies on a general bearing of northwest - southeast as opposed to the general bearing of eastwest 'for the valley leading from Carbon Creek to Wright Lake. Because of its location, the Little Carbon Creek Valley will receive considerably more sunshine hours per year. This will ensure that the Carbon Lake Route will be a safer'commuter route due to fewer icing problems in the spring and fall seasons. Also the route will be dryer overall, creating fewer run-off and washout problems of culverts.

It is recommended that the Carbon Lake Route. be selected for the access route to the potential coal development of Carbon Creek."

2.2 Environmental

Dr. Don McPhail, UBC Fisheries Professor and associate with Dolmage Campbell, makes the following statement concerning the aquatic resources of the alternate roads:

"Actual road construction is likely to have little permanent impact on aquatic environments along either route. If the access road is properly engineered, the impact of actual. construction should be temporary and'confined to stream crossings. In contrast, the impact of increased-access, and therefore increased angling pressure, on previously inaccessible streams and lakes can be considerable and permanent.

None of the streams along either route support large resident fish populations, and with the exception of Little Carbon Creek, these streams have little fishery potential. The most serious danger to streams along the routes is sedimentation during the construction phase. This is particu-

"larly true at stream crossings. Fortunately, the proposed access roads rarely cross permanent streams. The Carbon Lake route crosses Gaylard Creek only once -- in an apparently fishless area. The Wright Lake route crosses Dowling Creek (a tributary to Gething Creek), but again in an area of limited fishery potential.. Since streams in this area are subject to flash floods in summer, crossings will be engineered to handle large volumes of water. Such crossings should not constitute barriers to fish migration.

Although increased human access is not expected to seriously damage streams, there is potentially serious effect on lakes -- particularly on Carbon Lake. Wright Lakes does not support a fishery and shows little potential for development.. In contrast, Carbon Lake does support a fishery and has considerable potential. as a recreational area. At present there is a lodge.on Carbon Lake and although the trout are small their population is high and fishing is considered good.. Access is by air only and thus the lake is seldom fished by local people. An access road along the Carbon Lake route would open the lake to recreational fishing for all residents of the.Hudson Hope area. This would provide a trout fishery in an aesthetically pleasing area -- something that is now lacking around Hudson Hope. -However, if access to the lake is made available without some form of protective restriction, the angling potential of Carbon *Lake* will quickly decay. This is because Carbon Lake, like other small, virgin lakes in central B.C., has a large standing crop of, sports fishes but actual production is probably small. Certainly, the limnology of the lake suggests that productivity is low.

"In summary, Carbon Lake easily could be ruined by over-exploitation, but with good management it could also supply a quality sports fishery in an area where such fisheries are rare."

Mr. L.R. Erickson, of L.R. Erickson and Associates, made the following summary statement concerning the wildlife aspects of the road alternatives:

"In summary, the Carbon Lake alternative would provide access to areas-identified in this study as potential moose winter range (adjacent to and north of Gaylard -Creek) as well as a small area of Class 3 caribou range on Battleship Mountain. The Wright Lake route would provide access to moose winter ranges west of Wright Lake as well as an area of Class 3 caribou and mountain goat range on Mt. McAllister. Mountain goats are "found in very limited numbers" in the general area . . . (Mide 1966 a and b) and specific goat hunting regulations and enforcement should be implemented for Mt. McAllister if access is developed to Wright Lake. However, considering the length of the alternative routes, the positioning of both alternatives back from watercourses, and the fact that both routes traverse-C.L.I. Class 4 moose and caribou ranges there appears to be no major wildlife concerns or basis on which to choose one alternative over the other.,"

2.3 Cost Benefit

Canadian Resourcecon Ltd. have the following. statement to make on the cost-benefit assessment of the alternate route:

> "Costs and benefits for Route A (Carbon Lake) and Route B (Wright Lake) are summarized in Table 14 on page 94 of this report. Route A is shown to be considerably less. costly than Route B -- by some $7,550,000 in present value.. The benefit-cost ratio for Route A, based on the cost of the next most economical alternative, would be 5.1:1."

In concluding remarks, Canadian Resourcecon state, "The cost-benefit analysis shows a strong economic preference for Route. A, Carbon Lake, over Route B, Wright Lake."

It is evident that either route will remove minor amounts of vegetation in the area and will have *an* effect on the aquatic and *terrestrial* habitats. *But* the *major negative environ-*mental impact for either route will result from increased access to an area previously restricted to humans. Adjustments to hunting and fishing regulations, management policies, and enforcement requirements will probably be necessary if the area is developed.

It is recognized that, in selecting Route A along Carbon Lake, specific fisheries management problems could occur. Dr. McPhail offers the following mitigation and enhancement opportunities for'the Carbon Lake fisheries:

> "The best opportunity to create a new recreation area along with the access road lies in the Carbon Lake route. The'lake is scenic and has considerable fishery potential. However, this potential is delicate and Carbon Lake must

"be protected from over-exploitation. One simple method for avoiding over-exploitation is gear restriction. An obvious choice is to make Carbon Lake-a fly-fishing only lake. This would have two effects:'

1) It would protect the rainbow trout population from over-exploitation, but

2) It would probably over-protect the lake trout population (lake trout are less likely to take flies).

The first effect combined with careful protection of Little Carbon Creek to assure successful spawning and rearing should allow Carbon Lake to sustain a high quality rainbow trout fishery. The second effect is more difficult to assess. The lake trout population in Carbon Lake is marginal. Adult growth is slow and maximum size is small. Such a population would probably benefit from some controlled reduction in population size. Perhaps a limited ice-fishing season could be designed that would catch mainly trout.

An alternate method of reducing fishing intensity is to ban the use of motors. Carbon Lake is moderately long and often windy. If outboard motors are banned, the number of 'trollers will probably stay small enough to avoid over-exploitation."

CARBON CREEK COAL DEVELOPMENT

ENGINEERING DESIGN

OF ACCESS ROUTES

By McELHANNEY SURVEYING & ENGINEERING LTD.

1. INTRODUCTION

The scope of this report is to provide sufficient engineering technical data and economic considerations to assist in determination in the feiisibility of granting a land use permit for the constructionofauaccess route to a tentative coal mining property.

1.1 This document will endeavour to describe two primary route corridors from the coal field, situated on Carbon Creek in Liard Mining **District**; to **the W.A.C.** Bennett Dam.

1.2 Route corridor number one will commence in. the vicinity of the confluence of Little Carbon Creek and Carbon Creek. The route willcross Carbon Creek and then follow little Carbon Creek upstream to Carbon Lake. From thenorthendofthelake theroutewill cross t h e valley summit and head in an easterly direction to a crossing of Gaylard Creek. The route will then continue in an easterly direction on the north side of the Gaylard Creek Valley to the vicinity of the Williston Reservoir where the route crosses the dam. Route corridor number two will commence in the same general area as corridor number one and will head in a southerly direction along the west side of Carbon Creek for approximately one and one-half miles to an exis'ciug bridge crossing Carbon Creek and then along to the east side of the creek for approximately two miles to a small stream that commences on the west side of the valley summit at Wright Lake. The corridor follows this creek to the summit then along the south side of Wright Lake. From the east end of Wright Lake the route corridor follows the south side of Gething Creek for approximately two and one-half miles from where it starts to climb out of the valley to the top of the ridge to bypass two steepsided canyons at miles three and four, from Wright Lake, on Gething Creek. At approximately five miles from Wright Lake the route passes through a saddle andenters the valley of Dowling Creek. The route then continues along the West side of the valley until the valley flwr is achieved. The route then crosses Gething Creek approximately two miles upstream from the junction of Gething and Dowling Creeks and continues in a northerly direction to a crossing of Gaylard Creek approximately five 'miles from the W.A.C. Bennett Dam.

1.3 The need for an access road in this area is to facilitatethe exploration program and then to provide a roadway for commuter traffic.when the property is in production.

2. DESIGN CRITERIA

The location and &sign of this proposed access road will adhere to the criteria as prescribed by the B.C. Forest Service.

The route will be located and designed for use during the continued exploration and into the development stage of the property. The roadway will be designed for Class 3 alignment and will be constructed to a B.C. Forest Service Class 6 Standard. There will be a.12 foot-wide travelling surface with nominal grades of 10%, pitching for short distances, a maximum of 1,000 feet, to 15%. tie cleared right-of-way will not exceed 60 feet.

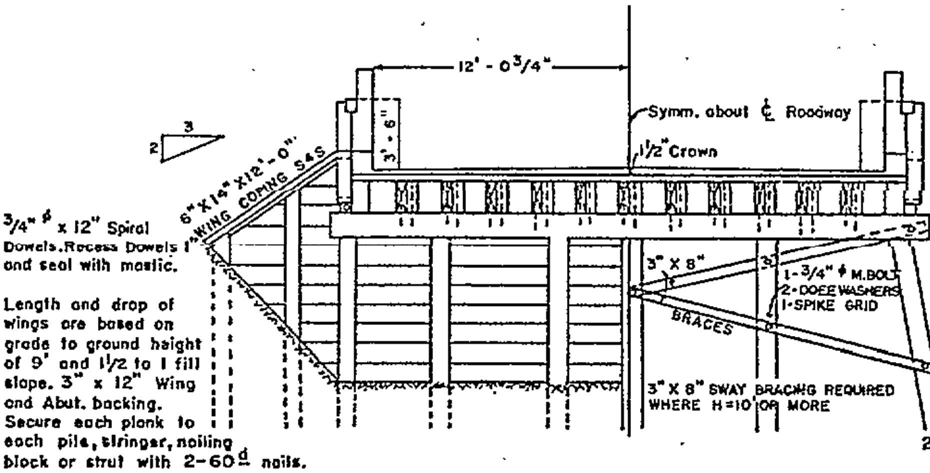
The culverts will be of corrugated metal pipe with a minimum diameter of 18 inches. Cross drains insidehill cuts will be spaced at a maximum distance of 400 feet.

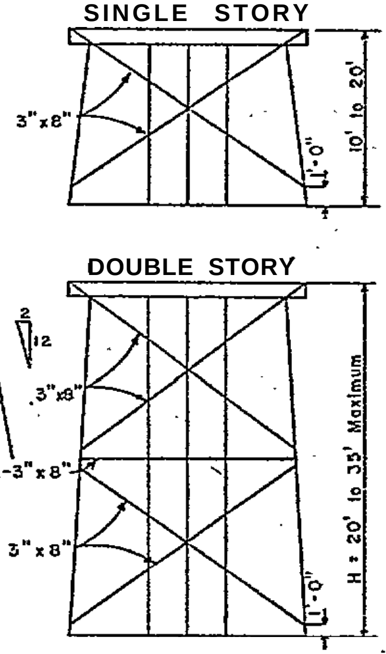
The bridge structures proposed for this access. route will be either five pile bent trestle bridges of H-20 S-16 design classification or sawn timber decked native timber spans with timbered abutments.

TIMBER BRIDGES

STANDARD DESIGN

H20 - S16 LOADING

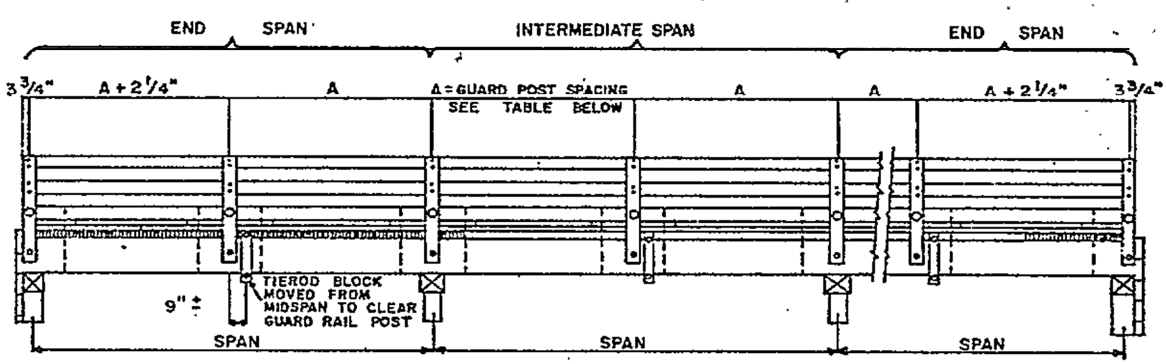




INTERIOR BENT SWAY BRACING

Maximum H for H20 Loading = 30'

Maximum H for H15 Loading = 35'



SIDE ELEVATION (TYPICAL)

SPAN	STRINGERS			GUARD RAIL BAYS	
	INNER	OUTER		NO PER SPAN	LENGTH A
15'-0"	6"X16"	10"X16"		2	7'-6"
17'-0"	6"X18"	10"X18"		2	8'-6"

NOTE: All timbers and piles are to be creosoted with the 8lb empty cell process.

FIGURE No.. - 2

McElhanney

3. STUDY METHODS AND PROCEDURES

The methods of collecting the data presented in this report consistofmp studies of and route projections on the largest scale mapping available - 1:50,000 National Topographical Series - stereo examination of existing aerial photography, at a scale of approximately one inch equals one-half mile, of the projected route corridors, helicopter flight reconnaissance of the corridors and finally an in situ investigation of portions of the two corridorsone, from Carbon Creek via Little Carbon Creek to Carbon Lake and the second, from Carbon Creek via an unnamed creek to Wright Lake.

The soils classifications were derived from the B.C. Government geological and agrological soils classification map sheets.

The data presented in this report was collected by Utah Mines Limited personnel and presented to McElhanney Surveying and Engineering Limited to evaluate the findings and to report the observations and recommendations as derived from the supplied data.

4. ROUTE CORRIDOR DESCRIPTIONS

There are two alternative route corridors which have been study as prospective routes to service the mine and the plant situated on Carbon Creek. The primary route via Carbon Lake will be designated the Carbon Lake Corridor and the secondary route via Wright Lake will be designated the Wright Lake . Corridor.

Each of the major route studies has been directed solely towards determining the most practical, general routingwith sufficient latitude allowed that detailed adjustment of final location can be fitted to the ground conditionsduring actual location surveys prior to and during the construe- tion of the route.

4.1 CARBON LAKE CORRIDOR

The Carbon Lake route commences in the vicinity of the confluence of Little Carbon Creek with Carbon Creek. An in situ investigation commenced two miles south of this point at an existing temporary bridge over Carbon Creek. This two mile of access road would be used only during further exploration and subsequent development operations. If the property is proven to be economical viable a subsequent bridge will be constructed in the vicinity of tie junctionof the two Carbon Creeks to ensure the shortest possible commuter route from the proposed plant site area to the townsite at Hudson Rope. The soils in the Carbon Creek Valley are well drained alluvial soils composed of loam to sandy loam to gravelly sandy loam on sand and gravel. The slopes are level to gently sloping stream deposits laid down in terraces.

Starting up the Little Carbon Creek Valley the route is located on the south side of the creek. The surface is broken by. hummocks ten to fifteen feet in height and the centreline of the route will have to be maintained well back from the escarpment of the creek to avoid any possibility of slide occurrence. The side slopes on the south slope of the valley are ±25% for the first 4,500 feet before they steepen to ±40%. Near mile 1 there is a large meadow which will be avoided by maintaining the route at an elevation of approximately forty feet above the meadow.

The route continues for one-half mile where a badly fractured rock outcrop has to be skirted and then starts to descend and follow the toe of a talus slope for approximately 2,000 feet before continuing to mile 2 and the west end of Carbon Lake. The soils along the first two miles of this route corridor are composed of moderate to steep Sloping colluvium on glaciated slopes in the lower portion of thevalley and the upper slopes are composed of clay loans and silt loams on calcareous stoney clay loams and clay till. The soils are generally up to where the bedrock outcrop is. The bedrock dyke is overlaid with sandy loam to angular gravelly sandy loam on undivided till and colluvium. The easterly side of,' the lake and from the north end of the lake to mile 6.5 the soils are generally very fine sandy loam with bands of loam to clay loam layered with very fine sands. The slopes are well drained and the landform is strongly to steeply sloping colluvium in the basin.

From mile 2 the route starts to climb along the hillside to avoid the immediate slopes of Carbon Lake. This alignment will also bypass a very steep sided rock walled canyon at mile 3 plus 900 feet. The route will then cross, with a minimal embankment, the small creek at the head of the rock canyons to avoid the extremely steep side slopes that would be encountered should the route be located higher on the valley walls. This route corridor now descends at an approximate gradient of minus 5% to mile 4.

The alignment from mile 4 continues in a north easterly direction for the next mile passing a small lake on the east&fore crossing the valley. Once past the north end of the lake the alignment swings in an easterly direction to cross low on an old vegetation covered landslide. From mile 5 to mile 8.3, at Gaylard Creek, the access corridor will be maintained along the toe of the north slope of the valley and away from any proximity to the creek bed.

The soils classification from mile 6.5 to mile 7.5 are loam over silky clay loam to loam on' stoney colluvium for the first quarter mile then tending to loam and. very fine sandy loam on angular sandy loam on undivided till and colluvium. This soil condition continues until the valley floor of Gaylard Creek is achieved.

The access route alignment is on the northerly: side of a low lying marshland formed at the confluence of a number of unnamed creeks and Gaylard Creek.

The bridged crossing of Gaylard Creek will be at approximately the 2,700 foot contour and approximately mile 8.3. The proposed bridge will be a five pile bent timber trestle bridge structure classified as a H-20 design. A typical design section of this class of timber trestle bridge is included in the appendices.

There are a number of apparent gravel deposits along this area of Gaylard Creek which could be used for road surfacing.

The route corridor from the bridge crossing of Gaylard is located on the north slops of the valley and at the toe of the hillside. The location will permit the construction of a well drained access road with relatively straight alignment and flat grades to mile 14.5.

The landform of the Gaylard Creek Valley from 'mile 7.5 to mile 13.5 is a kettled outwashed plain composed of glacio-fluvial terraces, from level to gently sloping, of sandy loams and gravelly sandy loams on calcareous morainal gravels mixed with very fine sandy loams, fine sands and silts.

The route corridor at mile 14.5 begins to climb out of the Gaylard Creek Valley. It is at this point the Wright Lake Corridor route would intersect the Gaylard Creek Valley and heads in an easterly direction for a low saddle at approximately mile 15.5 and then continues along the Elizabeth Creek Valley to the end of an existing road at mile 17.5. The existing road, approximately two miles in length, ends at the west side of the W.A.C. Bennett Dam. This two mile section of road will have to be reconstructed.

The soils from mile 13.5 to mile 16 are composed of colluvium and rock interdispersed with sandy loam, gravelly sandy loam, sand and gravel. The topography tends to be very steep with dissected slopes along the drainage channels and escarpments. From mile 16 the remaining three and one-half miles of this mute corridor is composed of sandy loam and gravelly sandy loam on calcareous morainal gravels mixed with fine sandy loam and silt loam on calcareous silts and silt loam and very fine sandy loam on calcareous clay loam till.

4.2 WRIGHT LAKE CORRIDOR - ROUTE DESCRIPTION

The Wright Lake route, commences in the same general area as the Carbon Lake route on the west side of Carbon Creek. The road will proceed southerly from the proposed plant site area to an existing bridge across Carbon Creek, approximately 1.5 miles above the Little Carbon Creek junction. After crossing the bridge the route will follow an existing exploration road, which will be reconstructed to the required Forest Service standards for approximately 2.25 miles, whence the mute corridor turns eastward up an unnamed creek. The route up the valley is located on the northern slope. At approximately mile 4.5 there is a creek entering from the north which will be crossedwithaculvert. The soils in the valley floor, for the entire distance to Wright Lake, are composed of loam and very fine sandy loam on angular gravelly sandy loam and loam on undivided till and colluvium. The slopes are moderate to steeply sloping colluvium on glaciated lower mountain slopes. The soils permit good drainage. The route is maintained on the north slope of the valley to mile 6.0: The main creek is crossed at this point with a five pile bent trestle bridge with three 15 foot spans and two timbered abutments and then continues along the south slope of the valley through a 2,000 foot long narrow canyon and on to a meadow at mile 7.75. The section of the route through the narrow canyon-. will require some stream bed protection during construction. The valley again opens up and the route will be located approximately 300 feet south of the meadow. The road would then continue around a rock outcrop and then along the toe of the talus slope to-the westendof Wright Lake. The rock outcrop at this point is the rock ridge that forms the summit. From the west end of Wright Lake this route would skirt a small talus slope and then follow the south shore of the lake to the easterly end of the lake at mile 9.25. At the east end of the lake there is a creek entering from the south which will require a trestle bridge of the same type as used at mile 6.0, but only two 15 foot spans will be required. The outfall creek from Wright Lake is Gething Creek. This route stays on the south side of the creekwhere there are a minimum of five Creek crossings, which would have to be crossed low in the valley to mile 11.85.

The soils in Gething Creek Valley are classified as loam and very fine sandy loam on angular gravelly sandy loam and loam on undivided till and colluvium. The slopes are well drained and the landform is moderate to steeply sloping colluvium on glaciated mountain slopes.

The route corridor would now ascend the side slopes on the south side of Gething Creek to achieve a plateau at mile 14.75. The Gething Creek Valley becomes a very steep sided, canyon like, valley for approximately the next four miles and this situationcauses the route to climb the intervening ridge to the next valley.

The route continues in an easterly direction and climbs over the ridge bypassing through the most northerly saddle and then descends, traversing the ridge to its northern end,. before again entering the Gething Creek Valley.

The soils on the ridge along this mute consist of loam and very fine sandy loam on angular gravelly sandy loam and loam on undivided till and colluvium overlaying sedimentary rock changing to very fine sandy loam with bands of clay loam and loam on very fine sand on the plateau at the foot of the ridge which in turn are overlaying outwashed sand and gravels in Gething Creek.

The route corridor after the trestle bridge crossing of Gething Creek, mile 17.5, continues in a north easterly direction climbing out of the Gething Creek Valley and heading for the ridge line above Gaylard Creek. At mile 19, along this route there will be another trestle bridge across a tributary of Gething Creek. It is proposed to join the proposed Canadian Forest Products road for three miles to the Gaylard Creek. The mileage at Gaylard Creek is mile 23.

The soils after climbing out of the Gething Creek Valley consist of loam and very fine sandy loam on angular gravelly sandy loam and loam on undivided till and colluvium. The crossing of Gaylard Creek will require a multi-storied, five pile bent trestle bridge. The route now climbs out of the Gaylard Creek Valley on the north side and heads in an easterly direction to a low saddle and Elizabeth Creek. The route corridor is located on the south side of Elizabeth Creek. The soil conditions after crossing Gaylard Creek continue to be loam to very fine sandy loam on angular gravelly sandy loam and loam on undivided till and colluvium. The access route now joins the existing road, of approximately two miles'inlength, to the W.A.C. Bennett Pam. The total mileage to the dam via the Wright Lake Corridor is approximately 28.6 miles.

5. ESTIMATED COSTS

5.1 CONSTRUCTION

	Carbon Lake Route	Wright Lake Route
Estimated total length (miles)	20.0	28.6
Estimated construction cost/mile (incl. clearing, grading and gravelling)	$13,500	$13,500
Estimated total construction cost	$270,000	$386,100
12% engineering cost (design, layout and construction supervision)	$ 32,400	$ 46,332
Estimated drainage cost (supply and installation)	$ 68,656	$122,507
Bridges - Estimated Number 2, Estimated Cost $44,000	$ 88,000	$4,000 $264,000
Total estimated construction cost	$459,056	$818,939

5.2 ROAD USERS COST

The road users cost comparison was derived from "Highway Engineers Handbook" by Wood published in 1960 by McGraw Hill Publishing Company, Section 3 Highway Economics. The cost figures used are out of date, but are acceptable for comparisons.

The Wright Lake Route is 48% more costly to use as a commuter route. The formula and calculations are attache&

McELHANNEY SURVEYING & ENGINEERING LTD.

ROAD USERS COST COMPARISON

Job No:

Location: Carbon Creek Date: Sept. 1976

Traffic	A.D.T.	Annual Time Factor
Cars	[illegible]	8.21
S.U. Trucks	112	12.79
Com. Trucks	n/a	16.05
Total		A.O.F. = 3.65 For all Vehicles

ROUTE NO. Carbon Lake Route

		Time Costs (Speed - m.p.h. & Time - min)						Operating Costs (Rate c/veh.mi. & Cost $)					
Grade %	Length Miles	Cars Speed	Cars Time	S.U. Trucks Speed	S.U. Trucks Time	Com. Trucks Speed	Com. Trucks Time	Cars Rate	Cars Cost	S.U. Trucks Rate	S.U. Trucks Cost	Com. Trucks Rate	Com. Trucks Cost
0	3.03	40	4.54	40	4.54			5.117	15.50	8.596	26.05		
1	4.34	40	6.51	40	6.51			5.135	22.29	8.778	38.10		
2	1.95	40	2.92	40	2.92			5.192	10.12	9.086	17.72		
3	2.94	40	4.41	40	4.41			5.322	15.65	9.580	28.16		
4	1.78	40	2.67	35	3.05			5.501	9.79	9.778	17.40		
5	1.26	40	1.89	30	2.52			5.721	7.21	10.256	12.92		
6	1.90	36	3.17	26	4.39			5.643	10.72	11.099	21.09		
7	0.30	32	0.56	22	0.82			5.650	1.70	12.233	3.67		
8	0.70	29	1.45	19	2.21			5.720	4.00	13.915	9.74		
9	0.50	26	1.15	17	1.76			5.921	2.96	15.967	7.98		
10	1.30	24	3.25	15	5.20			6.215	8.08	18.566	24.14		
Totals	20.00	X	32.52	X	38.32	X		X	108.02	X	206.97	X	

8.21 X 850 x 32.52	$226,940.82	
12:79 X 112 x 38.32	54,892.63	
16.05 X N/A		
Total Time Cost	$281,833.45	$ 281,833.00
3.65 X 850 x 108.02	$335,182.05	
3.65 X 112 x 206.97	$ 84,609.34	
3.65 X N/A		
Total Operating Cost	$419,741.39	$ 419,741.00
Total Annual Road User Cost: *		$ 701,574.00

ROUTE NO. Wright Lake Route

		Time Costs						Operating Costs					
Grade %	Length Miles	Cars Speed	Cars Time	S.U. Trucks Speed	S.U. Trucks Time	Com. Trucks Speed	Com. Trucks Time	Cars Rate	Cars Cost	S.U. Trucks Rate	S.U. Trucks Cost	Com. Trucks Rate	Com. Trucks Cost
0	5.56	40	8.34	40	8.34			5.117	28.45	8.60	47.79		
1	4.42	40	6.63	40	6.63			5.135	22.70	8.78	38.80		
2	3.83	40	5.75	40	5.75			5.192	19.88	9.09	34.80		
3	2.82	40	4.23	40	4.23			5.322	15.01	9.58	27.02		
4	1.52	40	2.28	35	2.60			5.501	8.36	9.78	14.86		
5	2.27	40	3.40	30	4.54			5.721	12.99	10.26	23.28		
6	1.32	36	2.20	26	3.05			5.643	7.45	11.10	14.65		
7	0.94	32	1.76	22	2.56			5.650	5.31	12.23	11.50		
8	1.86	29	3.85	19	5.87			5.720	10.64	13.92	25.88		
9	1.00	26	2.31	17	3.53			5.921	5.92	15.97	15.97		
10	1.15	24	2.88	15	4.60			6.215	7.15	18.57	21.35		
12	1.91	22	5.21	14	8.19			6.50	12.42	21.50	41.06		
Totals	28.6	X	48.84	X	59.89	X		X	156.27	X	316.97	X	

8.21 X 850 x 48.84	$ 340,829.94	
12.79 X 112 x 59.89	85,791.23	
16.05 X N/A		
Total Time Cost	$ 426,621.17	$ 426,621.17
3.65 X 850 x 156.27	$ 484,827.68	
3.65 X 112 x 316.97	$ 129,577.34	
3.65 X N/A		
Total Operating Cost	$ 614,405.02	$ 614,405.02

Total Annual Road User Cost	$ 1,041,026	Ref. Hwy. Eng. Handbk. (Woods) McGraw-Hill 1960
*	$ 701,574	Sec. 3 - Hwy. Economics, App. A
Difference	$ 339,452 or 48%	Tables 3-9, 3-10, 3-11 & 3-19

TABLE No. - I

6. OBSERVATIONS AND CONCLUSIONS

The Carbon Lake route is the shorter of the two routes by 8.6 miles. As demonstrated in the previous section of this report, both the initial construction and the subsequent road users cost, are substantially less with the selection of the Carbon Lake Route.

The maintenance of the Carbon Lake Route would be considerably less expensive, notonlydue to the shorter length of the access road, but also because of the more favourable orientation of the valleys.

The Little Carbon Creek Valley lies on a general bearing of northwest - southeast as opposed to the general bearing of eastwest for the valley leading from Carbon Creek to Wright Lake. Because of its location, the Little Carbon Creek Valley will receive considerably more sunshine hours per year. This will ensure that the Carbon Lake Route will be a safer commuter route due to fewer icing problems in the spring and fall seasons. Also the route will be dryer overall, creating fewer run-off and washout problems of culverts.

It is recommended that the Carbon Lake Route be selected for theaccess route to the proposed coal property on Carbon Creek.

UTAH MINES LTD.

CARBON CREEK COAL PROJECT

PRELIMINARY COST-BENEFIT ASSESSMENT OF ALTERNATIVE ACCESS ROUTES

Canadian Resourcecon Ltd.,
#309 - 811 Beach Avenue,
Vancouver, B.C.
V6Z 1C7

September, 1976.

1.0 INTRODUCTION

The cost-benefit analysis presented here is based to a large extent on readily available information, much of which is of a preliminary nature. Nevertheless, the sesults of the analysis are considered to be valid; the margin of error in the basic information would not be large enough to alter the fundamental conclusions.

It is understood that application is being made to construct a Class 6 "tote road" to serve the exploration phase and the initial phase of construction. This initial road would have to be upgraded, probably about 1979, to a standard suitable for high traffic volumes expected, during the peak of construction and the operation phase of the project.. The analysis presented here is, based on the premise that the projectwould proceed through these phases.

2.0.; ACCESS ROAD ROUTES

Consideration'is being, given to four alternative access road routes between Hudson's Rope and the Utah Mines Ltd. coal properties in the Carbon Creek valley. The routes and estimated mileages are as follows:

Route A : 35.5 miles, via the Bennett Dam; Gaylard Creek, Carbon Lake and Little Carbon Creek;

Route B : 43.6 miles, via the Bennett Dam, Gething Creek and Wright Lake;

Route G : 50.5 miles, via the Peace River bridge, Canfor access road, Carbon Lake and Little' Carbon Creek;

Route D : 50.4 miles, via the Peace River bridge, Canfor access road and Wright Lake,

Access via the Bennett Dam (Routes A and B) would provide significantly shorter routes than via the Peace River bridge (Routes C and D) - by 15 miles in the case of the Carbon Lake' route and by about 7 miles in the case of the Wright Lake route. Routes C and D could only be given serious consideration if Utah Mines Ltd. were denied access across the'dam, because these routes would be too long for daily commuting between Hudson's Hope and the minesite. For this reason, the assessment focuses on the comparison of Routes A and B. Commuting time and distance aspects are discussed under section 4.2.

3.0 BENEFIT-COST FRAMEWORK

The purpose of the proposed road would be to provide access between Hudson's Hope and the Carbon Creek minesite for transportation of workers, equipment and materials. To this *end,* the alternatives would provide the same primary benefits. The objective of the *analysis* is to compare costs and other benefits to determine.the route that will accomplish the primary objective at the least net cost.

The following sorts of costs and benefits are considered in this preliminary analysis:

(a) Road construction and maintenance costs for the alternative routes;

(b) Socio-economic costs' associated with commuting time and distance differentials;

(c) Safety and dependability considerations:

(d) Costs associated with potential environmental impacts;

(e) Benefits and costs associated with other potential users of the road.

These types of costs and benefits are examined in *Section 3* following.

All costs and benefits *are* given in constant 1976$, and compared on the basis of present values discounted to mid-i976 at annual rates of 8%, 10% and 12%. The period of the analysis is 30 years, 1976-2006.

4.0 COMPARATIVE COSTS AND BENEFITS OF ROUTES A & B

4.1 Road Construction and Maintenance Costs

Estimated construction and maintenance costs of initial tote roads and upgraded commuting standard roads'are provided in Table 12. Comparative costs for Routes A and B, on a present value basis, are estimated as follows:

Present Value of Construction & Maintenance Costs

Discount Rate	Route A	Route B	Incremental cost of Route B
8%	$2,050,000	$3,010,000	$960,000
10%	1,920,000	2,830,000	910,000
12%	1,800,000	2,670,000	870,000

4.2 Socio-Economic Costs Associated'with Commuting Times and Distances

The major use projected for the access road is commuting traffic between Hudson's Hope and the Carbon Creek minesite during the construction and operation phases of the mine, The present planning for the project is based on settlement of the majority of mine workers and their families in Hudson's Hope during the operation stage. A single workers camp would be developed at the minesite. The number of residents at the minesite camp would peak during the construction phase and gradually decline during the initial 5 years of operation, when a stable workforce settlement pattern would be established. It is expected that by 1985 about 70 percent of the workers would be settled in Hudson's Hope- and 30 percent at the minesite.

TABLE 12

ROAD CONSTRUCTION & MAINTENANCE COSTS, BENNETT DAM TO MINESITE

(a) construction Costs:

Year	Class of Road Constructed	Estimated Construction Cost Route A	Route B
1976	Tote road (Class 6)	$ 460,000	$ 820,000
1979	Commuting standard	1,440,000	1,970,000
		1,900,000	2,790,000
Present Values			
- 8% discount rate		1,600,000	2,380,000
- 10% discount rate		1,540,000	2,300,000
- 12% discount rate		1,480,000	2,220,000

(b) Maintenance Costs:

	Route A	Route B
Annual maintenance cost:	$ 40,000	$ 56,000
Present Values		
- 8% discount rate	450,000	630,000
- 10% discount rate	380,000	530,000
- 12% discount rate	320,000	450,000

SOURCES: Tote road cost estimates from McElhanney Surveying & Engineering Ltd. Commuting road cost estimates from Utah Mines Ltd. (preliminary figures). Commuting road cost is based on Class 3 road alignment specifications and surface paving with 3" cold mix asphalt. Road maintenance costs estimated at $2,000 per mile per year, based on Dept. of Highways experience in northeast B.C.

The development of Hudson's Hope as the community base for the mine operation workforce is judged to be superior to a new "resource town" near the minesite on socio-economic grounds. The principal caveat to this judgement is concern about the projected commuting time between Hudson's Hope and the minesite. The shortest of the routes under consideration would involve a one-way commuting distance of some 35 miles. It is considered that this distance would be manageable provided that careful attention would be paid to labour relations and community services and amenities. But the 35-mile commuting distance is still a major factor to be accounted for in project planning, and any prospective increase above this distance are a cause of considerable concern to the entire socio-economic assessment :-I--- of the project. If the commuting distance becomes such that the workers would judge it a major disadvantage of employment at the mine, the upshot would be high labour turnover,, high social costs due to the attendant instability in the community, high training costs for the mine operation and a chronic shortage of skilled labour.

The true costs of incremental commuting distances and times are difficult to project, but the following cost' factors have to be considered:

(i) The workers, particularly those living in Hudson's Hope, would suffer a cost associated'with the longer commuting time, based on the value of time that would otherwise be spent in leisure, recreation or work;

(ii) To compete with other prospective coal mine operations in northeastern B.C., 'Utah Mines Ltd.. might have to compensate their workers-in some way for the incremental commuting time-'on Route B.

'(iii) As outlined in the preceding paragraph, there would be some level of social costs to the community and mine operator'associated with the adverse effects on labour relations;

(iv) The fundamental decision between development of an existing town and. development of a new town near the minesite would have to be assessed for each increment on the commuting distance. At some point an entirely new order of socio-economic costs would have to be accounted for.

It is estimated that the round trip commuting time with Route B would be 32 minutes more.than with Route A for car travel and 42 minutes more for bus travel.* These time differentials are large enough that all of the above cost factors would have to be. carefully considered before the complete costs could be properly identified, which is beyond the scope of this preliminary assessment. Nevertheless* it is reckoned that the cost attributable to time differentials on mine-related commuting would be at least equal to time valued at $8 per hour.

* *Average speeds estimated by McElhanney Surveying & Engineering Ltd. on the basis of Comparisons of distances and grades of new roads constructed for each route. 'It is assumed that road surfaces would be paved.*

Table 13 shows the estimated mine-related traffic over the access road and present value factors computed for each $1 of incremental cost per return trip. Based on time valued at $8 per hour, and a time differential of 37 minutes (the average of bus and car travel time differentials for the two routes), the incremental cost of Route B over Route A would be $4.90 per return trip. A similar cost would apply to commerical traffic as well as to the mine employees, Applying the figure of $4.90 per round trip, the additional cost of travel time for Route B relative to Route A would be as follows:.

Incremental Travel Time Cost of Route B Relative to Route A

Discount Rate	Present Value of Incremental costs
8%	$7,010,000
10%	5,590,000
12%	4,560,000

There would also be a cost attributable to the cost of vehicle operation over the longer-distance. This cost is estimated at 5¢ per passenger-mile, or 80¢ per round trip, for the mine workforce and 25¢ per vehicle-mile, or $4.00 per round trip, for commercial traffic.* The additional cost of vehicle operation for Route B relative to Route A

* *These figures may be understated in that the passenger-mile estimate would be typical of car-pooling or bus operation, and the vehicle-mile cost figure for commercial traffic contains only a nominal allowance for heavy-duty trucks.*

would be as follows:

Incremental Vehicle Operation Cost of Route B Relative to Route A

Discount Rate	Present Value of Incremental Costs
8%	$1,550,000
10%	1,230,000
12%	1,000,000

The total cost attributable to incremental time and distance would be as follows:

Total Incremental Time and Vehicle Operation Costs of Route B Relative to Route A

Discount Rate	Present Value of Incremental Costs
8%	$8,560,000
10%	6,820,000
12%	5,560,000

TABLE 13

ESTIMATED MINE-RELATED TRAFFIC ON ACCESS ROAD

	Number of Return Trips				
	Utah Mines Ltd. Employees				
Year	Residents of Hudson's Hope	Minesite Residents	Sub-Total	Commercial Traffic	Total Mine-Related Traffic
	(1)	(2)		(3)	
1977		5,400	54,000	1,000	6,000'
1978	8,400	22,400	30,800	3,000	34,000
1979	24,500	33,000	57,500	5,000	62,000
1980	48,000	25,000	73,000	7,000	80,000
1981	84,700	28,500	113,200	10,000	123,000
1982	98,600	22,600	121,200	14,500	136,000
1983	114,006	19,400	133,400	14,500	148,000
1984	129,400	16,160	145,500	14,500	160,000
1985-2006	144,500	13,000	157,500	14,500	172,000

Present value factors per $1 of cost per return trip -

Discount Rate	Utah Mines Employees	Commercial Traffic	Total Mine-Related Traffic
8%	$1,310,000	$125,000	$1,430,000
10%	1,040,000	100,000	1,140,000
12%	850,000	81,000	930,000

Cont'd.

FOOTNOTES TO TABLE 13

(1) *Based on estimated number of workers resident in Hudson's Hope times an average 240 trips per year (see breakdown below).*

(2) *Based on estimated number of workers resident at the minesite times an average 50 trips per year (see breakdown below).*

Estimated residency of construction and operation workforce:

Year	Hudson's Hope	Minesite	Total Workforce
1977	–	108	108
1978	35	448	483
1979	102	660	762
1980	200	501	701
1981	353	570	923
1982	411	451	862
1983	475	387	862
1984	539	-323	862
1985–2006	602	260	862

(3) *Commercial traffic estimate with full operation based on September/76 traffic count at Island Copper, which has an operating workforce of 788 vs 862 projected for the Carbon Creek project. Annual commerical traffic breakdown @ full operation:*

	Vehicles/year.
– salesmen	1,000
– industrial & service vehicles	8,800
– delivery trucks	3,500
– fuel & other bulk supplies	1,200
	14,500

4.3 Safety and Dependability

This category of potential costs would include any hazardous driving conditions that could affect either the frequency or severity of accidents, and any conditions that could affect the frequency of lost time due to impassible roads.

It is considered that neither route would pose any undue hazards. Driving conditions are considered to be somewhat better with Route A than with Route B on the basis of comparisons of miles of relatively steep grades and the number of curves required.

The probable frequency of road blockages due to snow, mud-slides and rockslides has not been assessed for either route. Route A might be somewhat better than Route B in this respect because of the shorter distance and lower maximum elevation (by about 400 feet).

4.4 Environmental Costs and Benefits

Choice of road-location could affect the following resources and resource uses:

(i) Forestry - losses of forest production associated with the right-of-way for each *route,* and the associated economic values;

(ii) Fish - effects on fish production and the resulting economic effects on sport, subsistence and commercial fishing;

(iii) Wildlife - losses of wildlife habitat and the resulting economic effects on hunting, trapping and guiding;

(iv) Recreation - beneficial or adverse effects on outdoor recreation resulting from environmental changes and provision of access.

It is expected that other resources and resource uses, such as agriculture, grazing, minerals and water resources, will be unaffected by the choice of road location.

(a) Forestry

It is expected that Route A would have an *adverse* impact on the forest resources and Route B effectively no impact, as follows:

Route A

It is expected that a forestry access road would ultimately be constructed as far as the east end of Carbon Lake to harvest the forest resources of the area. But these forests are now immature and there will'be a loss corresponding to about 10 years growth on the eastern' section of the road right-of-way. The section of road from the Carbon Creek valley to the east end of Carbon Lake would probably not be built except to serve the. project. The loss of productivity from the western section is estimated at about 600 cunits based on -use of 90 acres with an average MAI of 16 cubic feet per acre per year. for a 40-year period.. The loss of productivity from the,. eastern section is estimated.to be about 500 cunits based on use of 155 acres with.an average MAI of 32 cubic feet 'per acre per year for a lo-year period.*

Route B

The forest resources in the vicinity of Route B are ready 'for harvesting now. Thus it is expected that a forestry access road would be constructed along Route B without the project, and no significant forest resource loss would be incurred.

Economic Values

From the provincial viewpoint, there would be a loss of forestry revenue associated with Route A, corresponding . . to a cut of 500 cunits from the. eastern section of the road 10 years- hence and an annual cut of 15 cunits for 40 years . . . from the western section of the road. Figuring the gross

* *Forest loss figures from a preliminary draft of forestry impacts by Sigma* Resource *Consultants Ltd.*

value of forestry losses at $40 per cunit, the present value of the losses would be as follows:

Cost of Forestry Losses, Route A

Discount Rate	Present Value of Forestry Losses
8 %	$16,000
10%	$13,000
12%	$12,000~

(b) Fish

According to McPhail, Utah Mines' consultant on aquatic resources, "... actual road construction is likely to have little permanent impact on aquatic resources along either route. If properly engineered, the impact should be temporary and confined to stream crossings."*

The most important impact would probably be an increased fishing pressure on Carbon Lake,. if Route A is select&d. "An *access* road along Carbon Lake route would open the lake to recreational fishing for all residents of the Hudson's Hope area. This would provide a trout fishery in an aesthetically pleasing area - something that is no-w lacking around Hudson's Hope." On the other hand "... Wright Lake does not support a fishery and shows little potential for development."** Protective restrictions might be required to avoid endangering the angling potential of Carbon Lake, such *as* gear restrictions or banning of motor boats.

* *From a preliminary draft on the* impacts of *road construction on aquatic resources, by J.D. McPhail,* Dolmage *Campbell and Associates Ltd.*

** *Ibid.*

In short, it is expected that the principal difference between the alternative routes, with respect to aquatic resources, would be an increase in sport fishing on Carbon Lake with selection of Route A. This is discussed further under recreation, item (d).

(c) Wildlife

A preliminary assessment of the wildlife impacts of the alternative routes has been made by L.R. Erickson for Utah *Mines Ltd.* The preliminary findings of this assessment indicate that "... considering the length of the alternative routes, positioning bf'both alternatives back from water-courses, and the fact that both routes traverse C.L.I. Class 4 moose and caribou ranges there appears to be no major wildlife concerns or basis on which.to choose one alternative over the other."*

At present, no differential costs can be attributed to wild-life resources in the comparison of the alternative routes.

(d) Recreation

The following summary of recreation potentials along the alternative routes is based on assessments of Utah Mines' environmental consultants.**

** From a preliminary draft on the impacts of road construction on wildlife resources, by L.R. Erickson & Associates.*

*** From preliminary drafts of reports on recreation by D.R. Benn and aquatic resources by J.D. McPhail.*

Neither of the two road alternatives would have much impact on outdoor recreation associated with streams or upland features. The major recreation'potential of the routes are Carbon Lake with Route A and Wright Lake with Route B. Both lakes appear to have moderately high recreation potential for 'canoeing, picnicking, camping and wildlife observation. Carbon Lake has more diverse. features, such as a small beach.and more varied adjacent uplands, and supports a trout fishery. Of the two, Carbon Lake is considered to be superior for recreation.

Existing and future demands for recreation resources and facilities in the region are unknown, so at the present time only qualitative statements can be made' with respect to potential benefits and costs-

Route A

Provision of an access road along Route A would undoubtedly result in increased use of Carbon. Lake for recreation. The benefits of the road would be a higher rate of use, with the attendant values, and reduced travel costs to those people who would use the lake with or without the road. On the other hand, it appears that the present users of the lake place a high value on the wilderness setting;. these values would be reduced by the road construction and increased activity around the lake. The tradeoffs between these potential. benefits and costs are not known.

Route B

Provision of an access.road along this route would also result in increased recreation activity at Wright Lake.. Based on the comparative recreation potentials, the resulting benefits from increased use would probably be lower than those with Route A. But at the same time, construction of Route B would preserve the high-valued present uses of Carbon Lake.

4.5 Benefits and Costs Associated with Other Potential Road Users

(a) Forestry Uses

As noted in Section 4.4, forests adjacent to Route B are ready for harvesting while those adjacent to Route A probably won't be harvested for about 10 years. For this reason, the potential forestry use benefits would be greater with Route B than with Route A.

Benefits for each route are calculated on the basis of costs that would be incurred to construct forestry access roads without the project. The forestry road patterns that would develop without the project are uncertain; the following assumptions probably represent the maximum potential incremental benefits in favour of Route B:

Route A : A forestry access road would be required about ten years hence, as far as the east end of Carbon Lake: it is assumed that this road would be constructed at a rate of 4 miles per year for 3 years, commencing in 1987.

Route B : A forestry access road would be required as far as the Carbon valley: it is assumed that this road would be constructed at a rate of 5 miles per year for 5 years, commencing in 1977.

Assuming a cost for forestry access roads of $25,000 per mile, the potential benefits for each route would be:

Potential Benefits From Reduced Costs of Forestry Access Roads

Discount Rate	Present Value of Benefits Route A	Present Value of Benefits Route B
8%	$120,000	$500,000
10%	100,000	470,000
12%	80,000	450,000

(b) Other Resource Uses

Potential uses of the road for other prospective mining ventures is uncertain. No differential benefits are obvious from present coal exploration in the area. It is expected that either of the roads would be utilized for recreation, but the numbers are uncertain; recreation travel would probably be slightly higher over Route A.

(c) Transmission Line Costs'

The current planning with respect to the proposed transmission line from the Shrum powerplant to the minesite calls for the line to follow the road right-of-way if Route A is selected. If the access road were constructed aiong Route B instead, the transmission line might either follow the road route, or a direct route might be followed via Carbon Lake. In the former case, the transmission line cost with Route B would be in the order of $800,000 greater than with Route A, based on typical B.C. cost estimates of $100,000 per mile for the proposed 138 KV line. It would undoubtedly be less costly to follow a separate corridor via Carbon Lake than to follow Route B via Wright

Lake. But selection of Route B for the access road would still involve incremental. transmission line costs: construction in a separate corridor'would probably be in the order of $10,000 per mile more costly due to the requirement for either separate access or more costly construction methods, and there would be additional environmental costs because of the presence of two separate cleared corridors.

It is reckoned that the direct'incremental transmission line costs attributable to Route B would be $200,000 plus any environmental costs associated with a.separate transmission line corridor.

5.0 SUMMARY & CONCLUSIONS

5.1 Summary of Costs & Benefits

Costs and benefits for Routes A and B are summarized in Table 14 with the dollar figures representing present values at a 10 percent discount rate. As noted in Section 3.0, the objective of the cost-benefit assessment is to determine the route that would accomplish the primary objective of providing access between Hudson's Hope and at the minesite at the least net cost. Considering those costs and benefits evaluated in monetary terms results in the following comparison of Routes A and B:

NET COSTS OF ROUTES A & B

present values at 10% discount rate

	Route A	Route B
Evaluated costs	$1,930,000	$9,850,000
Evaluated benefits	100,000	470,000
Net cost (evaluated in $ terms)	1,830,000	9,380,000

SOURCE: Table 14

Route A is shown to be considerably less costly than Route B - by some $7,550,000 in present value. The benefit-cost ratio for Route A, based on the cost of the next most economical alternative, would be 5.1:1.

Of the costs which have not been evaluated in monetary terms, it appears that fish and wildlife losses and safety and dependability aspects would not have any significant effect

TABLE 14

SUMMARY OF COSTS AND BENEFITS

(all $ figures are present values at a 10% discount rate)

Report Section	Item	Costs Route A	Costs Route B	Benefits Route A	Benefits Route B
4.1	Road construction & maintenance costs	$1,920,000	$2,830,000		
4.2	Incremental travel time cost	-	5,590,000		
	Incremental vehicle operation cost		1,230,000		
4.3	Safety and dependability	Routes appear similar, some preference to A.			
4.4	Gross forestry loss	$10,000	-		
	Fish & wildlife losses	Moderate Similar to B	Moderate Similar to A		
	Recreation benefits due to increased use rate			Higher than B	Lower than A
	Recreation costs due to loss of wilderness values	Higher than B	Probably negligible		
4.5	Potential benefits from reduced cost of forestry roads			$100,000	$470,000
	Incremental cost of transmission line	-	$200,000 plus envir. costs of corridor		
	Total evaluated costs & benefits	$1,930,000	$9,850,000	$100,000	$470,000

on the net cost.comparison: these factors are moderate in value and appear to be similar for both *alternatives.* Recreation costs and benefits are uncertain. Selection of Route A would provide recreation benefits by making Carbon Lake accessible to a larger number'of -users; it is considered to be superior to Wright Lake for recreation because of its trout fishery and more'scenic surroundings. On the other hand, present users of Carbon Lake would experience a loss in values presently associated with the wilderness setting and relatively isolated location. Even if Route B were selected for the road, there would be a change in.the recreation values associated with Carbon. Lake, because the transmission line would probably follow the Carbon Lake route: either that or incur considerably more costs by following Route B.

In sum, it is believed that the unevaluated benefits and costs of Route A relative to Route B tend to cancel out. It is probably fair to assume that recreation benefits would equal losses.

5.2 Sensitivity

(a) Discount Rate

The analysis is not particularly sensitive to discount rate- Replacing the dollar figures in Table 14 with the corresponding present values calculated with 8% and 12% discount rates would give the following comparison of net costs:

NET COSTS (Present Values)

Discount Rate	Route A.	Route B	Ratio. Route B: Route A
8 %	$1,950,000	$11,270,000	5.78
10%	1,830,000	9,380,000	5.13
12 %	1,730,000	7,980,000	4.61

(b) Travel Time Incremental' Costs

The cost of incremental travel time is'an important factor in the economic analysis, as indicated in Table 3. In view of these costs, it could be'economical to spend additional capital on road construction to reduce grades and increase speeds. In the comparison of Routes. A and B, this would have the effect of reducing the incremental travel time cost and increasing the incremental'road construction cost. However, the maximum reduction that could be effected in the incremental travel time cost charged to Route B would be about $1.9 million, at some 'unevaluated increase in additional construction costs for Route B. Such a reduction.." would not *alter* the conclusions.

(c) 'Recreation Losses Due to Route A

Even if the access road *via* Carbon Lake did not result in-increased recreation' use and the total spending by present users of Carbon Lake was charged'as a potential cost to Route A, the maximum foreseeable cost of recreation losses would be in the order of $1 million present value. For example, assuming a *future* use without the road of 20 recreation cabins, each for 100 days per year at an average of $50 per day, would give'an annual cost of $100,000 and. a present value, discounted to perpetuity at 10%, of $1 million.

(d) Decisions on Mine Development

On the basis of.the investigation program now underway, Utah Mines will make a decision on whether or not to-proceed with development of the Carbon Creek property.' The cost-benefit analysis is based on the premise that mine development would take place. If the decision is made not to proceed with mine development, costs and benefits would be obviously different. But even in the light of this possibility, Route A would be the preferred route because it is less costly to construct initially and there would be no long term environmental costs associated with this decision, since the road access could be cut off and the route reforested if necessary or desirable.'. On the other hand, if Route B were selected for the initial tote road, and the decision is made to proceed with mine development, it is clear that the tote road would be abandoned and a commuting standard route constructed on Route A.

5.3 Conclusions.

The cost-benefit analysis shows a strong economic preference for Route A over Route B. The potential margin of error in- the basic information used in this. analysis would not be large enough to alter this conclusion. So even though the analysis is of a preliminary nature, the results are considered to be valid for economic decisions on choice of. route.

PR-CARBON CREEK 76(9)D

GEOLOGICAL BRANCH
ASSESSMENT REPORT

0C 502

CARBON CREEK COAL DEVELOPMENT

ENVIRONMENTAL ASSESSMENT
OF ACCESS ROUTES
AQUATIC RESOURCES

By Dr. DON McPHAIL (UBC)

OPEN FILE

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PART III ENVIRONMENTAL ASSESSMENT

1.0 INTRODUCTION

The environmental assessment in this report includes general statements and specific details of the aquatic resources, wildlife capabilities and vegetation of the area. Other. important factors in the locational considerations of an *access* route such as terrain analysis, soils, geology, and gravel sources were investigated by the engineering consultants and are referenced in the McElhanney report.

2.0 GENERAL ENVIRONMENTAL ASSESSMENT

The three areas of major biological concern in the construction and development of roads are wildlife, aquatic biology and vegetation. A general statement for each area follows and includes a review of road construction impacts as well as their relationship within the area in question.

2.1 Aquatic Resources

The major aquatic impacts of road construction are sedimentation and the'creation of barriers to fish migrations. The influences of sediment on aquatic life have been recently reviewed. Typically, the effects are threefold: direct mortality on fishes due to suffocation; indirect mortalities due to reductions in benthic food items. (smothered bottom organisms), and changes in populations due to sediment related reproductive failure (smothered eggs or fry) .

Sediment loads large enough to direcly kill adult fish are unlikely except for brief periods duringthe construction phase, and then only immediately downstream of a crossing site. However, new road construction can increase erosion in the immediate area of the road and increased erosion can result in persistent increases in sediment.

A properly engineered road should not permanentiy . . . . . increase siltation in adjacent streams. The revegetatation of disturbed areas that will follow construction should minimize the erosion (sediment) impact on the aquatic environment. Therefore, assuming the road is properly engineered.and the right-of-ways are revegetated, the only serious siltation problem involves construction of stream crossings. Temporary increases in sediment levels are unavoidable at such sites. However, detrimental biological effects can be minimized by crossing at appropriate times.

Aside from sediment, the other likely effect of a road is the creation of migration barriers. Crossing of' secondary tributaries, some of which may be potential spawning streams, will be accomplished by culverts or bridges placed such that water velocities do not exceed the swimming capabilities of migrating fishes.: Critical water velocities and culvert lengths are known for most of the species likely to be encountered in the area.

2.2 Wildlife

The area in question has been relatively isolated from major biological disturbance up to this time, although it has received limited recreational use.

In general terms a road into terrain that has not previously been readily accessible experiences its major impact from the radical change in access. From the beginning of construction the road brings into the region an increased number of individuals with little concern for the integrity of wildlife population, or for preservation of the esthetic qualities of the terrain and vegetation. The road, therefore, completely alters the management situation. It requires re-adjustment of regulations governing hunting and fishing and a new level of enforcement communsurate with the changed levels of harvest which are certain to occur.

2.3 Vegetation

The major vegetation impacts envisioned to result from the proposed road are both direct (i.e. the removal of areas from production) and indirect (i.e. the influence of vegetation removal on wildlife and aquatic habitats).. The latter point can be mitigated with a revegetation program that could enhance the wildlife habitat and limit the erosional problems pertaining to aquatic habitats.

The vegetation of the area is boreal in nature. In general, the forests are open and.of low productivity. The dominant trees are white spruce (Picea Glauca), black spruce (Picea Mariana), and lodgepole pine (Pinus Contorta) growing alone, together or in combination with other less common species.

White spruce, a climax species, is generally restricted to fine textured soils and moist habitats and seldom forms pure stands. It grows together with subalpine fir

(Abies Lasiocarpa) and occasionally with trembling aspen (Pupulus Tremuloides) and paper birch (Betula Papyrifera). The proportion of subalpine fir in white spruce stands increases dramatically with increasing elevation.

Black spruce, an Edaphic Climax species, dominates lowland forest communities developed on organic soils. These often surround low moor sphagnum bogs in which white spruce also occurs.

Lodgepole pine is generally regarded as a successional species promoted by fire. Pure stands of pine occur on well drained coarse outwash soils where they may form. an edaphic climax because of the xeric nature of the habitat.

Forest capability maps were utilized in the selection of the road alignment to minimize future mainentance.

3.1 BIO-PHYSICAL ENVIRONMENT

3.1.1 Description of Habitats

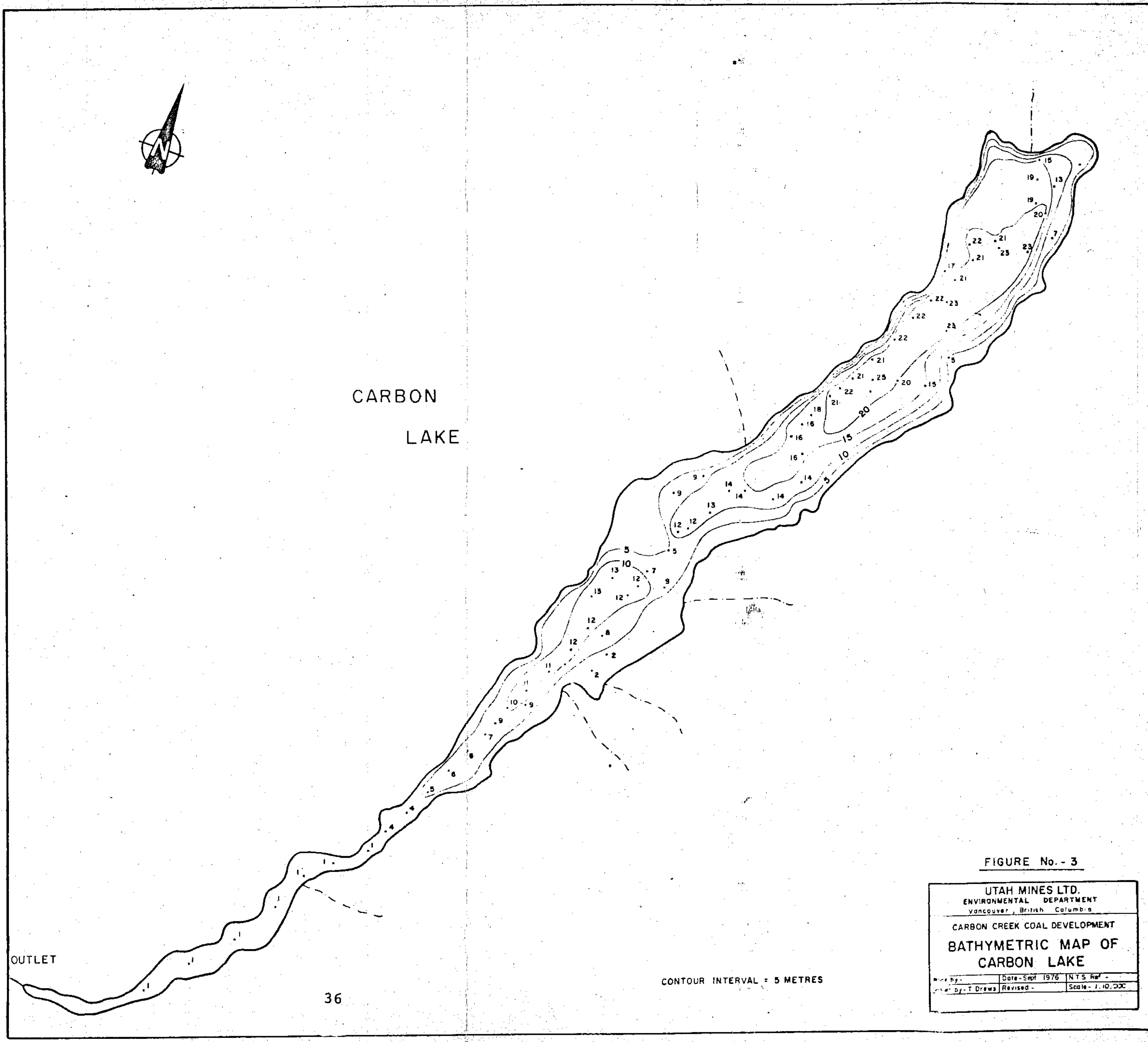
Although the proposed access roads both terminate near the junction of 11-Mile and Carbon creeks, they descend into the Carbon Valley by different routes (refer to plate #11). One route begins *at* either the damiste *or an existing* Canfor road (Johnston Creek Road) and proceeds up Gaylard Creek to Carbon Lake and then down Little Carbon Creek into the Carbon Valley. The alternate route also originates from the existing Canfor road but proceeds up Gething Creek to Wright Lake and then descends into the Carbon Valley by way of Wright Creek.

The following descriptions of aquatic habitats along the proposed access routes *are* based on an aerial survey of the routes plus a series of collections and observations along each route.

Observations and measurements were made using the following equpment:

- a Smith-Roote Type VA electro-fisher
- 57m of 8.5 m deep monofilament nylon gillnet (four panels: 2.4, 4.8, 7.2 and 9.6 cm mesh)
- dissolved oxygen meter (YSI)
- Pygmy Gurley Flowmeter (model: 625)
- an electrical thermometer (model FT3)
- *a* Furno FG-200 echo-sounder

Fish samples were transported *to* Vancouver for age and diet analysis. Age was obtained by reading scales. All scales were read separately by two observers, and scales with


CARBON
LAKE
OUTLET
CONTOUR INTERVAL = 5 METRES
FIGURE No. - 3
UTAH MINES LTD.
ENVIRONMENTAL DEPARTMENT
Vancouver, British Columbia
CARBON CREEK COAL DEVELOPMENT
BATHYMETRIC MAP OF
CARBON LAKE
Date - Sept 1976
N.T.S. Ref -
T Drews
Revised -

unresolvable differences in interpretation were deleted from the analysis.

Water samples were flown to Port Hardy, B.C., and analysed in Utah Mines' chemistry laboratory. The analyses are given in Tables2 and 3.

3.1.1.1 Carbon Lake Route

Road access alongthis route will affect three bodies of water; Carbon Lake, Little Carbon Creek, and Gaylard Creek.

a. Carbon Lake

Carbon Lake lies in a pass at the head of Little Carbon Creek. The altitude of the lake is approximately 930 m. Carbon Lake is 3.5 km long and has a surface area of 65.7 hectares (fig.3). The morphometry and water chemistry of Carbon Lake are summarized in Table 2.

The lake is long and narrow with the long axis running approximately northeast. There apparently is sufficient wind action to keep the lake mixed (no evidence of a thermocline or oxygen 'depletion. on Sept. 1, 1976). Except for a long, narrow reach towards the outlet stream (Little Carbon Creek) there is virtually no littoral zone. Most of the lake share slopes steeply to deep water and the substrate in these areas is either broken rock or rubble. The only emergent vegetation appears to be- sparse beds of Potamogeton sp. near the shallow, mud-bottomed outlet.. A series of smali intermittent streams enter the lake, but there is no permanent inlet stream.

b. Little Carbon Creek

Little Carbon Creek is the outlet of Carbon Lake. It wanders through a moose pasture and beaver workings before gaining velocity and flowing through spruce forest for 4.4 km to its junction with Carbon Creek. The overall gradient of Little Carbon Creek is near 3% and the stream is less than 5 meters wide in *most* places:. Little Carbon Creek was walked fromthelake to Carbon Creek, and there are no apparent barriers to fish migration on the stream (the highest waterfall on the creek drops less than 0.5 meters and there are no fast water chutes).

The beaver workings at the outlet of Carbon Lake *are* no barrier at present (on Sept. 1 there *was, no* actual beaver dam on the outlet).

Starting about 0.5 kilometers below the lake the stream becomes gravel bottomed and forms a series of alternating riffles and pools. The stream temperature is close to the lake surface temperature (11 °C, Sept. 1) and the banks appear stable (no slumping or undercutting). Presumably, the lake acts to stabilize *water* flows.

c. Gaylard Creek

This is a moderate sized creek (26.3 kilometers long, but only 3'meters wide at the proposed road crossing). Gaylard Creek rises at high altitudes and the water is clear and cold (5.5 °C at the crossing site on Sept. 1, 1976). The gradient *in* this *area is 2% and* the stream bottom is mostly gravel and cobbles.

Water velocities on Sept. 1 ranged from 30 to, 65 cm/sec. Although the overall gradient of Gaylard Creek is about 2%, there is'an area of 6% and higher gradients near the junction with Gething Creek. This area, and. further downstream, were visually surveyed fro? a helicopter. The area is characterized by numerous chutes and. falls (the highest estimated at 7 meters direct drop). This area very likely acts as a barrier to fish migration,

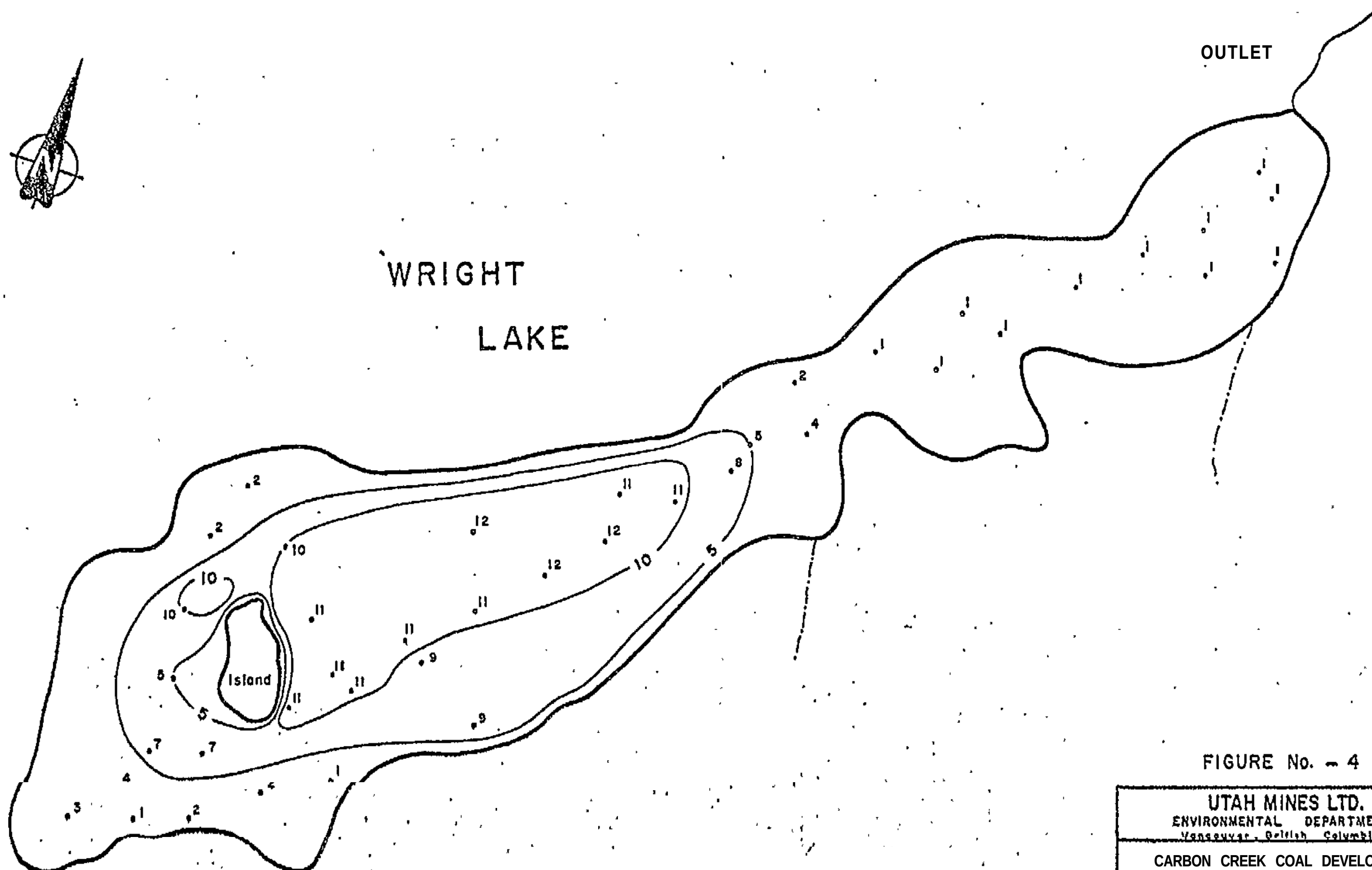
3.1.1.2 Wright Lake Route

Road access along this route will directly affect three bodies of water: Wright Lake, Wright Creek, and Gething Creek.

a. Wright Lake

Wright Lake lies in a pass between Gething and Wright creeks. The altitude is' approximately 1040 meters- The lake is 1.4 kilometers long and has a surface area of 31.2 hectares (fig.4). The morphometry and water chemistry of Wright Lake are summarized in Table 3.

The long axis of Wright Lake is again in a northeasterly direction, and although the lake is not as narrow as Carbon Lake, there apparently is still enough wind action to keep the lake almost 'isothermal and well oxygenated. Wright Lake is much shallower than Carbon Lake and the littoral zone is better developed. Again the shore'is largely broken rock, but in shallow areas. there are extensive weed beds '(mostly Potsmogeton sp.). The inlet streams are all small and apparently intermittent (all. were dry on Aug. 31, 1976). The outlet stream (Gething Creek) is blocked by a beaver dam.



CONTOUR INTERVAL = 5 METRES

FIGURE No. — 4

UTAH MINES LTD.
ENVIRONMENTAL DEPARTMENT
Vancouver, British Columbia

CARBON CREEK COAL DEVELOPMENT

BATHYMETRIC MAP OF WRIGHT LAKE

Work by -	Date - Sept. 1976	N.T.S. Ref. -
	Revised -	Scale - 1" = 10250"

b. Gething Creek

Gething Creek is the outlet of Wright Lake. It is slow flowing and mud-bottomed where it leaves the lake. This is due *to* a beaver dam that produces a waterfall of about 1 meter drop at the lake outlet, The stream continues to flow slowly for about 500 meters andthenpicks up velocity and'becomes a typical-gravel and cobble-bottomed mountain stream. Gething Creek flows from Wright Lake for 22 kilometers to its junction with Gaylard Creek. The overall gradient is 2%, but the gradient near the junction is steeper and a series-of falls and chutes probably constitute a barrier to fishes. From the air, much of Gething Creek above the fast water area appears'to be suitable salmonid habitat;

c. Wright Creek

This creek rises in a moose pasture about 500 meters, beyond Wright Lake. It is small (9.3 kilometers long and less than 5 meters wide), but has a steep gradient (8.3%). Although the gradient is steep, a helicopter survey revealed no waterfalls or other barriers. About one-third of the way down its length, the stream crosses. an existing exploration road. At this point, it is gravel-bottomed and swift flowing (over 1 m/sec.) but there are occasional bedrock pools of up to 2 meters in depth. A crossing-of Wright-Creek would be in this area.

3.2 Fisheries

All aquatic environments along the proposed routes were sampled for fishes. The collecting technique, fishing effort and catch for each sampling site are listed in Tables 4 and 5.

3.2.1 Species, Distribution and Relative Abundance

a. Carbon Lake Route

Three species were collected along the Carbon Lake route (Table 6), but only the two trouts (S. gairdneri and S. namaycush) are of fisheries value. Both trout are abundant in Carbon Lake; but . . . only rainbow trout were taken in Little Carbon Creek. Despite considerable effort, no fish were collected or observed in Gaylard Creek.

b. Wright Lake Route

Two species were collected along this route (Table 7). Wright Lake apparently contains only suckers (in large numbers). The outlet (Gething Creek) was sampled and also contains suckers, but they are rate in the creek and are apparently confined to an area close to the lake. These stream dwelling suckers probably represent individuals washed over the beaver dam at the lake's outlet. Wright Creek was sampled by electrofishing and apparently contains a sparse population of dwarf Dolly-Varden (S. malma).

3.2.2 Habitat Assessment

a. Carbon Lake

This lake contains a substantial population of rainbow trout. The trout appear to be in good shape and their scales indicate a decent growth rate (Table 8). All the sampled individuals contained food (terrestrial insects).

There are no-inlet streams suitable for spawning, but the outlet stream is unobstructed and contains ample spawning *and rearing areas.* In late August *many* of the backwaters *and.* pools *along* the upper part of the outlet contained *trout* fry. Scale reading (Table 8) also suggests some trout are permanent residents of Little Carbon Creek.

The lake trout population in Carbon Lake is also substantial, but in contrast to the rainbows they are not doing well. Growth is slow [Table 9) and even the largest individuals are feeding on plankton. Apparently, large food items are sufficiently rare in Carbon Lake that most lake trout never reach the size where they typically switch diets and become fish eaters.

The sloping rubble edges make most of the lake shore suitable for lake trout spawning. However, no small. lake trout were observed or netted.

In summary, Carbon Lake appears to be good rainbow trout habitat and only marginal lake trout habitat.

b. Gaylard Creek

We collected no fish in this stream, although the habitat in the proposed road crossing area appears suitable for salmonids.

c. Wright Lake

This lake contains no sportfish. The only fish in Wright Lake are longnose suckers and their age and growth are summarized in Table 10. Their growth rate is decent and the lake supports a very large population. The extensive littoral zone and well developed weed beds suggest that Wright Lake is potentially more productive than Carbon Lake. However, the lack of suitable spawning sites makes it unlikely that a self-sustaining trout population could be maintained in the lake.

d. Gething Creek

Two suckers were collected from the creek immediately below Wright Lake. These fish probably originated in the lake and, once over the beaver dam on the outlet, were unable to return to the lake. Most of Gething Creek appears to be suitable habitat for salmonids.

e. Wright Creek

The only fish collected in this stream were Dolly-Varden. They do not appear to be common, and the steep gradient and wide fluctuations in flow suggest that this stream has little fisheries potential.

3.3 BIO-PHYSICAL INTERACTIONS AND IMPACTS

Actual road construction is likely to have little permanent impact on aquatic environments along either route. If the access *road* isproperly engineers, the impact of acutal *con*-struction should be temporary and confined to stream crossings. In contrast, the impact of increased access, and therefore. increased angling pressure on previously inaccessible streams and lakes, can be considerable and permanent.

None of the streams along either route support large resident fish populations, and with the exception of Little Carbon Creek, these streams have little fishery potential. The most serious danger to streams along the routes is sedimentation during the construction phase. This is particularly true at stream crossings. Fortunately, the proposed access roads rarely cross permanent streams. The Carbon Lake route crosses Gaylard Creek *only* once, in an apparently fishless area. The Wright Lake route crosses Dowling Creek (a tributary to Gething Creek), but again in an area of limited fishery potential. Since streams in this area are subject to flash floods in summer, crossing will be engineered to handle large volumes of water. Such crossings should not constitute barriers to fish migration.

Although increased human access is not expected to seriously damage streams, there is potentially serious effect on lakes,. particularly on Carbon Lake. Wright Lake does not support a fishery and shows little potential for development. In contrast, Carbon Lake does support a fishery and has considerable potential as a recreational area. At present, there is a lodge on Carbon Lake and, although the trout are small, their population is high and fishing is considered good. Access is by air only and thus the lake is seldom fished by local people. An access road along the Carbon Lake route would open the lake to recreational fishing for all residents of the Hudson Hope area. This would provide a trout fishery in an aesthetically pleasing area, something that *is* now lacking around Hudson Hope. However, if access to the lake is made available without some form of protective restriction, the angling potential of Carbon Lake will quickly decay. This is because Carbon Lake, like other small, virgin lakes in central B.C., has a large standing crop of sports fishes but actual production is probably *small.* Certainly the limnology of the lake suggeststhat productivity is low.

In summary, Carbon Lake easily could be ruined by over-exploitation, but with good management it could also supply a quality sports fishery in an area where such fisheries are rare.

3.4 MITIGATION AND ENHANCEMENT SUGGESTIONS

The best opportunity to create a new recreation area along with the access. road lies in the Carbon Lake route. The lake *is* scenic and has considerable fishery potential. However, this potential is delicate and Carbon Lake must be protected from over-exploitation. One simple method for avoiding over-exploitation is gear restriction. An obvious choice *is* to-make Carbon Lake-a fly-fishing only lake. This would have two effects:

1) It would protect the *rainbow trout* population from over-exploitation, but

2) It would probably over-protect the 'lake'trout population (lake trout are less likely to take flies).

The first effect combined with careful protection of Little Carbon Creek to assure successful spawning and rearing should allow Carbon Lake to sustain a high quality rainbow trout fishery. The second effect is more difficult to assess. The lake trout population in Carbon Lake is marginal.. Adult'growth is slow and maximum *size* is *small.* Such *a* population would probably benefit from some controlled reduction in population size. Perhaps a limited ice-fishing season could be designed that would catch mainly lake trout.

An alternate method of reducing fishing intensity is to ban the use of motors. Carbon Lake is moderately long and often *'windy.* If outboard motors are banned, the number of trollers will probably stay small enough to avoid over-exploitation.

Whatever method is used to regulate the fishery, one thing is apparent. If Carbon Lake is opened to public access without protective regulations, the trout'fishery is almost' certain to collapse.

TABLE 2

LIMNOLOGICAL SUMMARY FOR CARBON LAKE

(Surveyed Sept. 1, 1976)

Lake Morphometry

surface area:	65.7 hectares
shore line:	8,013 meters
mean depth:	12.5 meters'
max. depth:	2 3 meters

Lake Chemistry

pH	8.3	log-units'
Total Alkalinity	129	mg/l
Calcium	30	mg/l
Magnesium	12	mg/l
Sodium	7.8	mg/l
Potassium	3.2	mg/l
Sulphate	0.2	mg/l
Phosphate	0.004	mg/l
Nitrates	(0.02	mg/l
Dissolved Oxygen	10-12	mg/l
Total Dissolved Solids	181	mg/l

Temperature (°C)

Surface	11.5
1 m	11.0
2 m	11.0
5 m	11.0
6 m	10.5.
10 m	10.0
15 m	10.0
20 m	9.5
bottom	9.5

morpho-edaphic index = 4.41

TABLE 3

LIMNOLOGICAL SUMMARY FOR WRIGHT LAKE

(Surveyed Aug. 31, 1976)

Lake Morphometry

surface area:	31.2 hectares
shore line:	3,520 meters
mean depth:	5.6 meters
max. depth:	17.0 meters

Lake Chemistry

pH	8.1	log.units
Total Alkalinity	81	mg/l
Calcium	20	mg/l
Magnesium	8	mg/l
Sodium	4.1	mg/l
Potassium	1.7	mg/l
Sulphate	<0.1	mg/l
Phosphate	0.006	mg/l
Nitrates	0.02	mg/l
Dissolved Oxygen	10-12	mg/l
Total Dissolved Solids	138	mg/l

Temperature (°C)

Surface	11.5
1 m	11.5
2 m	11.0
5 m	10.5
6 m	10.5
10 m	10.0
15 m	10.0
bottom (17 m)	10.0

Morpho-edaphic index = 7.50

TABLE 4

SUMMARY OF COLLECTION TECHNIQUES, FISHING EFFORT AND CATCH FOR SITES ALONG. THE CARBON LAKE ACCESS ROUTE

Site	Collecting Technique	Fishing Effort	Catch		
			Rainbow Trout	Lake Trout	Suckers
Carbon Lake	Gillnet set	2 hours (Mid-day)	13	14	7
Little Carbon Creek	Electro-fishing	300 sec.	4	0	0
Gaylard Creek	Electro-fishing	300 sec.	0	0	0

TABLE 5

SUMMARY OF COLLECTION TECHNIQUES, FISHING EFFORT AND CATCH FOR SITES ALONG THE WRIGHT LAKE ACCESS ROUTE

Site	Collecting Technique	Fishing Effort	Catch	
			Dolly-Varden	Longnose Suckers
Wright Lake	Gillnet set	24 hours	0	611
Gething Creek	Electro-fishing	300 sec.	0	2
Creek "B"	Electro-fishing	600 sec.	1	0

TABLE. 6

FISHES COLLECTED ALONG THE PROPOSED CARBON LAKE ACCESS ROUTE

Common Name	Scientific Name	Carbon Lake	Little Carbon Creek	Gaylard Creek
Rainbow Trout	Salmo Gairdneri.	+	+	-
Lake Trout	Salvelinus Namaycush	+		-
Longnose Sucker	Catostomus Catostomus	+		-

TABLE 7

FISHES COLLECTED ALONG THE PROPOSED WRIGHT LAKE ACCESS ROUTE

Common Name	Scientific Name	Wright Lake	"B" Creek	Gething Creek
Dolly-Varden	Salvelinus Malma	-	+	
Longnose Sucker	Catostomus Catostomus	+		+

TABLE 8

LENGTH, WEIGHT, AGE, SEX AND DIET OF RAINBOW TROUT IN CARBON LAKE AND LITTLE CARBON CREEK

Place	Standard Length (mm)	Weight (gms)	Sex	Age	Stomach Contents
Carbon Lake	125	40	M,imm.	1+	terrestrial insects
	140	55	M	1+	" "
	140	65	M	1+	" "
	155	75	M	1+	" "
	160	75	M	1+	" "
	165	80	M	1+	" "
	165	90	M	1+	" "
	185	110	M	1+	" "
	196	140	M	1+	" "
	205	160	M	1+	" "
	212	170	M	2+	" "
	217	180	F	2+	" "
	283	360	F	3+	" "
Little Carbon Creek	72	8	M,imm.	1+	empty
	82	13	M,imm.	1+	"
	82	13	M,imm.	1+	"
	152	74	M	2+	"

TABLE 9

LENGTH, WEIGHT, AGE, SEX AND DIET OF LAKE TROUT IN CARBON LAKE

Standard Length (mm)	Weight (gms)	Sex	Age	Stomach Contents
208	160	F, imm.	4+	Daphnia
255	280	M, imm.	5+	"
272	290	M	5+	"
275	340	F	6+	"
280	350	M	6+	"
290	380	M	6+	"
292	330	M	6+	"
295	410	F	7+	"
298	400	F	7+	"
302	425	M	7+	"
305	440	M	8+	"
306	395	M	7+	"
310	450	F	8+	"

TABLE 10

LENGTH, WEIGHT, AGE AND SEX OF A REPRESENTATIVE SAMPLE OF WRIGHT LAKE SUCKERS (CATOSTOMUS CATOSTOMUS)

Standard Length (mm)	Weight (gms)	Sex	Age
126	37	Imm.	3+
131	39	"	3+
133	47	"	3+
134	43	"	3+
135	47	"	3+
143	50	"	4+
174	90	"	4+
195	140	"	6+
196	130	M	6+
210	150	M	5+
215	180	M	5+
218	170	F	4+
241	220	M	5+
261	290	M	6+
276	400	F	7+
295	520	F	8+
327	570	F	8+
336	700	F	9+

A Report On Environmental Aspects Of Two Access Road Alternatives To Carbon Creek - Wildlife

Prepared For:
Utah Mines Ltd.

Prepared By:
L.R. Erickson and Associates

September 1976

4.1. INTRODUCTION

Utah Mines Ltd. is in the process of selecting a road access route to a construction camp and potential coal mine site adjacent to Carbon Creek. This watercourse is a tributary to Williston Lake in the Peace River district of northern British Columbia.

The purpose of this project was to identify wildlife environmental concerns of two route alternatives proposed by the mining company.

4.2. TIME FRAME AND DATA SOURCES

This study was commissioned on 25 August 1976 and completed on 8 September 1976.

Data sources included:

1. Utah Mines Ltd., Vancouver
2. Environment and Land Use Committee Secretariat Resource Analysis Unit, Victoria.
3. Environment and Land Use Committee Secretariat North East Coal Block Development Team, Fort St. John.

4.3. METHODOLOGY

4.3.1 Study Area Concept

Because of the widespread effects a new road can have on a biological system and because road development activities are sequential (the total ecological impact of road construction is the result of an additive process), the alternatives have been viewed against as broad a background as was possible. Therefore, analyses of wildlife effects were made primarily in the context of animal habitat and migration requirements.

4.3.2 Assumptions

1. The innundation of valley bottom land behind the Bennett Dam has undoubtedly had a drastic effect on wildlife distribution over the past several years. Removal of traditional ranges will have displaced many wildlife species to higher slopes which are likely unable to support additional animals. This predicament could place existing wildlife populations in a precarious situation when considering future development along the fringe of Williston Lake.

2. The climate of the area is described as "cold continental humid" with snowy winters, mild summers and large variations in temperature (Mide 1966 b). Local winter ranges are restricted by snow depth and have been reduced by the filling of Williston Lake. The combination of these factors will maintain animal populations at a modest level. However, it is assumed that the area will remain sparsely populated by humans restricting their primary activities to logging and possibly mining. On this basis the area is expected to continue to produce moderate wildlife populations.

4.3.3 Work Plan

The work plan was as follows:

1. Maps (1:50,000) and photo mosaics of the two road alternatives selected by Utah Mines were examined.

2. The Resource Analysis Unit of the Environment Land Use Committee Secretariat was visited and field maps and notes of winter flights in the area during January and February of 1966 and March of 1974 were reviewed.

4.3.3 <u>Work Plan</u> (cont'd)

3. Attempts were made to contact B.C. Fish and Wildlife Branch personnel in Fort St. John. Unfortunately study time constraints precluded their involvement in this phase of the project.

4. An aerial reconnaissance of both alternatives was completed on 1 September 1976. One ground check was made at the Gaylard Creek crossing. Battleship Mountain was surveyed from the air. A representative of the ELUC Secretariat North East Coal Development Team based in Fort St. John participated in the reconnaissance.

5. Available information was reviewed. References are cited in the Reference Material section of this report.

6. The proposed routes were examined in light of the available information and ecologically sensitive areas traversed by the proposed routes were identified.

7. A generalized text on the effects of the alternatives on indigenous wildlife species was prepared.

8. Recommendations on final route selection were presented to other specialists on the route selection team.

4.4. RESULTS

4.4.1 General

During each stage of road development, from the initial survey to the operation and maintenance stage, activities are undertaken that in one way or another affect the wildlife resources of the region through which it passes. Ecological effects of a new highway may be positive or negative, localized or far-ranging, avoidable or unavoidable. The strategy is one of avoiding as many negative effects as possible and reducing the severity of the unavoidable ones.

Effects of highways on wildlife:

The movement patterns of wildlife species are directly related to the vegetation cover, or, habitats of a given area. The location of a new road can have very significant repercussions on local and regional wildlife populations by its influence on the habitats which are traversed by, as well as adjacent to, the road.

The land areas required for construction activities and materials are initially pre-empted as wildlife habitat by vegetation removal. Most of the habitat along the righ-of-way area is similarily removed. Back-filling ponds and marshes and interference with drainage patterns can reduce or eliminate important habitat for many species; including waterfowl and aquatic furbearers. A completed highway may also separate different habitats by dissecting migration routes with the result that animals abandon traditional movement patterns. This can place animals in a more vulnerable position to legal and illegal hunting during critical seasons of the year. New roads also increase human access to areas supporting a variety of wildlife species unaccustomed to such human activities as hunting, snowmobiling, and cross country skiing. This newly created human access can result in depletion of the wildlife resource by overhunting or by the disturbance and/or destruction of winter or summer ranges.

4.4.1 General (cont'd)

A highway traversing areas heavily utilized by wildlife, a winter range, for example, is subject to animals crossing and re-crossing the right-of-way. These movements increase the possibility of animal-vehicle collisions.

Although these collisions occur throughout the year, their probability is increased by the attraction of travel routes provided by highway snow removal. Wildlife reluctance to abandon the cleared road and enter deep or crusty snow, or momentary blinding by headlights are the major causes of these confrontations. The results can be fatal to the animal and often cause expensive vehicle damage. These encounters can also result in injuries and exhaustion, reducing the animal's mobility and resulting in indirect mortality caused by the inability to obtain adequate food or to escape predators.

The habitat losses mentioned earlier can be partially replaced by planting cutbanks with forage species. However, if critical winter habitat is replaced by less critical summer habitat, or if a large number of animals attracted to the roadside vegetation are involved in collisions with vehicles, this positive effect of replanted cutbanks might be neutralized.

4.4.2 Specific

4.2.1 Ungulates

The Environment and Land Use Committee Secretariat completed winter aerial surveys of the general area in January and February 1966 and March 1974. In 1966 the Peace River was flown and abundant moose tracks were recorded at the confluence of Carbon Creek and the Peace River (Smith, 1966). Carbon Creek was flown in 1974 but no animal or track observations were recorded (Demarchi and Stewart 1974).

4.4.2 Specific (cont'd)

Utah Mines Ltd. surveyed the general area in January of 1976 (Jansen, 1976). The flight originated in Chetwynd and flew the upper Moberly River, McAllister Creek, Wright Lake and Bennett Dam areas. Moose concentrations were recorded 16 to 30 miles upstream of Moberly Lake, west of Bennett Dam and west of Wright Lake.

Comparative data between the two alternative routes is restricted to that collected during the 1 September 1976 summer reconnaissance. Two moose were observed feeding in the bog areas of Gaylard Creek. These areas are most prevalent downstream of the proposed road crossing. They provide summer range for moose and, judging by the degree of willow browsing observed during one ground check, some moose winter range. Those open bog areas are more numerous on the Carbon Lake route than they are on the Wright Lake route.

The preferred habitats and status of ungulates found in the study area are presented in Table 11. Latin names are listed in Appendix I.

The Canada Land Inventory program assessed the ungulate habitat traversed by both routes as Class 4 moose and caribou habitat with excessive snow depth being identified as a climatic factor restricting ungulate production (Figure 5).

4.4.2.2 Furbearers

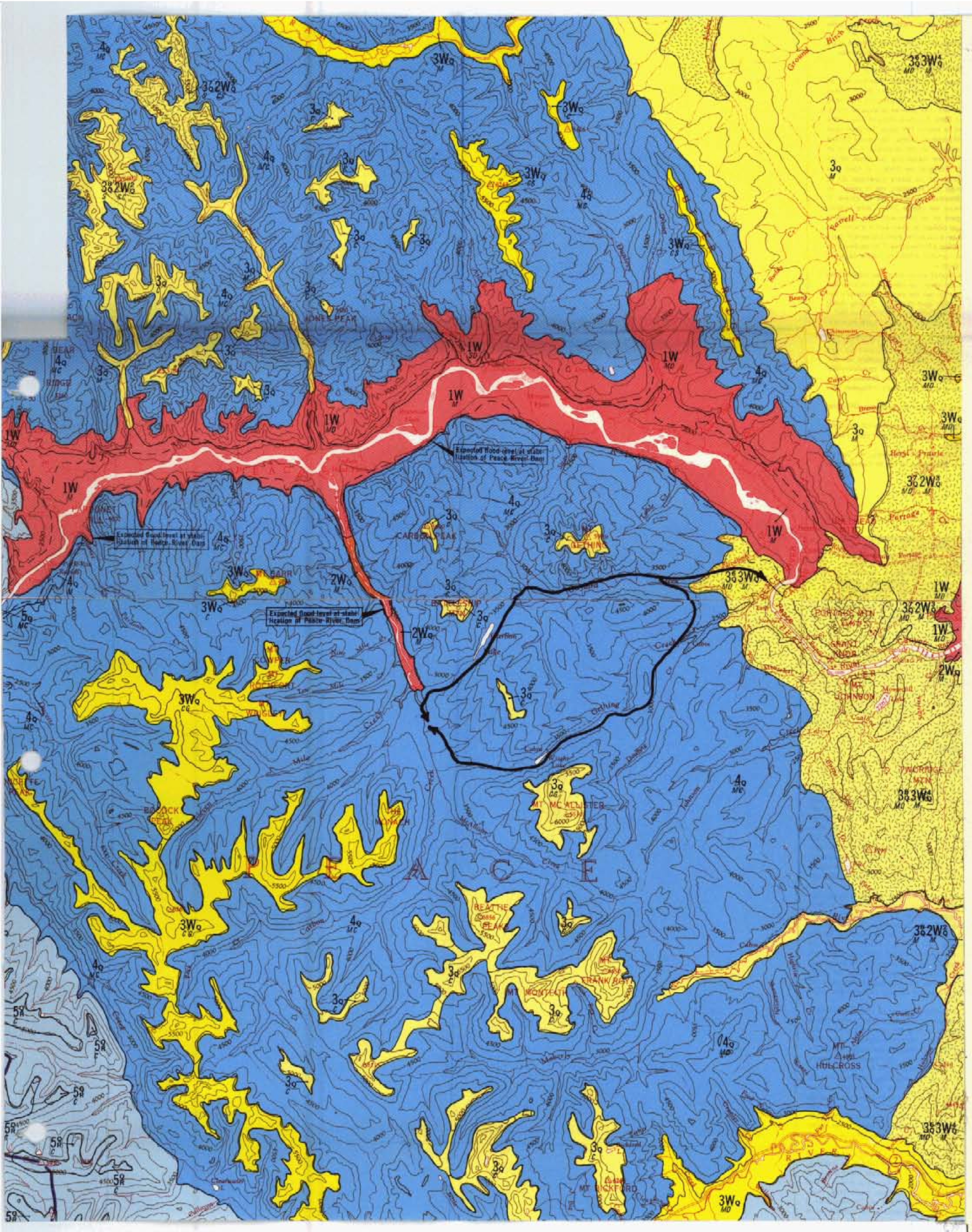
Furbearers reported in the area include coyote, lynx, wolf, black bear, red squirrel, beaver, fisher, wolverine, ermine and marten (Thurber, 1973). (Latin names are listed in Appendix I). Wolf, beaver and marten were reported to contribute the most trapping revenue.

Table 11 Preferred Winter (W) and Summer (S) Habitats Of Ungulates Found In The Study Area

SPECIES	STATUS	REFERENCE MATERIAL	PREFERRED HABITAT
Moose	Most abundant ungulate species	9,10 12 9,10	W. South and west facing "breaks" and bottom-lands of Peace River below 3000 feet. W. White spruce with aspen or cottonwood overstory and red osier dogwood and saskatoon understory. Recent burns regenerating in lodgepole pine aspen and willow. S. Water courses and small lakes.
Mule Deer	Very sparsely distributed	9,10	W. Open, exposed south or west facing Peace River "breaks" with reduced snow pack. S. Throughout area.
Osborn Caribou	Sparsely distributed	9,10	W. Windswept south or west facing alpine slopes at 5,000 to 6,500 feet. S. Alpine.
Mountain Goat	Found in very limited numbers	9,10 9,10	W. Alpine/subalpine. S. Alpine

Figure 5: Wildlife Capability Map

(approximate locations of proposed road alternatives are illustrated in black ink)



LAND CAPABILITY FOR WILDLIFE – UNGULATES

CANADA LAND INVENTORY

HALFWAY RIVER 94B

PINE PASS 93O

Scale 1:250,000 Échelle

DESCRIPTIVE LEGEND

In general, the needs of all ungulates are much alike: each individual and species must have a sufficient quality and quantity of food, protective cover, and space to meet its needs for survival, growth, and reproduction. The ability of the land to meet those needs is determined by the individual requirements of the species or group of species under consideration, the physical characteristics of the land, and those factors, such as climate, that influence the plant and animal communities.

On this map the land is divided into units on the basis of physiographic characteristics important to wild ungulates. The degree of limitation associated with each unit determines its capability class. The subclass denotes the primary factor that causes the limitation.

This classification system is based on two important considerations:

• Capability ratings are established on the basis of the optimum vegetational stage (successional stage) that can be maintained with good wildlife management practices.

• Capability ratings assigned do not reflect present land use (except in extreme cases such as heavily populated urban areas), ownership, lack of access, distance from cities, or amount of hunting pressure.

* CLASS 1 — LANDS IN THIS CLASS HAVE NO SIGNIFICANT LIMITATIONS TO THE PRODUCTION OF UNGULATES.

Capability on these lands is high. They provide a wide variety and abundance of food plants and other habitat elements.

CLASS 1W — Lands in this special class are Class 1 areas that are winter ranges on which animals from surrounding areas depend.

* CLASS 2 — LANDS IN THIS CLASS HAVE VERY SLIGHT LIMITATIONS TO THE PRODUCTION OF UNGULATES.

Capability on these lands is high but less than Class 1. Slight limitations are due to climatic or other factors.

CLASS 2W — Lands in this special class are Class 2 areas that are winter ranges on which animals from surrounding areas depend.

CLASS 3 — LANDS IN THIS CLASS HAVE SLIGHT LIMITATIONS TO THE PRODUCTION OF UNGULATES.

Capability on these lands is moderately high, but productivity may be reduced in some years. Slight limitations are due to characteristics of the land that affect the quality and quantity of habitat, or to climatic factors that limit the mobility of ungulates or the availability of food and cover.

CLASS 3W — Lands in this special class are Class 3 areas that are winter ranges on which animals from surrounding areas depend.

CLASS 4 — LANDS IN THIS CLASS HAVE MODERATE LIMITATIONS TO THE PRODUCTION OF UNGULATES.

Capability on these lands is moderate. Limitations are similar to those in Class 3, but the degree is greater.

CLASS 5 — LANDS IN THIS CLASS HAVE MODERATELY SEVERE LIMITATIONS TO THE PRODUCTION OF UNGULATES.

Capability on these lands is moderately low. Limitations are usually a combination of two or more of climate, soil moisture, fertility, depth to bedrock or other impervious layer, topography, flooding, exposure, and adverse soil characteristics.

SUBCLASSES

With the exception of Class 1, the classes are divided into subclasses according to the nature of the limitations, which determine the class. In most cases the limitations do not affect the animals themselves, but rather the ability of the land to produce suitable food and cover plants. For convenience the subclasses are placed in two main groups: those relating to climate and those relating to inherent characteristics of the land.

CLIMATE

The following are used to denote significant climatic factors that may affect either the animals or the ability of the land to produce suitable food and cover.

SUBCLASS Q: snow depth — Excessive snow depth that reduces the mobility of ungulates and availability of food plants.

UNGULATE INDICATOR SPECIES

Species of ungulates for which capability ratings are assigned are shown by the following symbols:

*A .... Antelope	*E .... Elk
C .... Caribou	G .... Mountain goat
D .... Deer (white-tailed deer, Columbia black-tailed deer, mule deer)	M .... Moose
	S .... Mountain sheep

EXAMPLES

An area of Class 5 land with topography and soil fertility limitations to deer production is shown: 5^{T}_{F} D

An area of which 70% is Class 4 for deer with limitations due to snow depth and topography and 30% is class 3 wintering area for elk and moose with slight limitations due to snow depth. $4^{7}_{QT}3W^{3}_{Q}$ D EM

An important wintering area for deer and mountain sheep of which 60% is Class 1 and 40% is Class 2 with slight limitation due to exposed bedrock is shown: $1W^{6}2W^{4}_{R}$ DS DS

4.4.2.3 Waterfowl

Waterfowl species reported to nest in the area include; Canada Goose, Mallard, Green-winged Teal, Barrow's Goldeneye, and Harlequin duck. Harlequin ducks were reported to nest along the Peace River downstream of Bennett Dam at a density of 2.86 pairs per mile. Canada geese were observed nesting on Peace River islands in the same area. Suitable habitat for, and status of,the other nesting species was reported to be, "very limited and populations are low" (Thurber 1973).

Other waterfowl species recorded for the area include: White-fronted Goose, Pintail, Blue-winged Teal, American Widgeon Shoveler, Common Goldeneye and Bufflehead (Thurber, 1973).

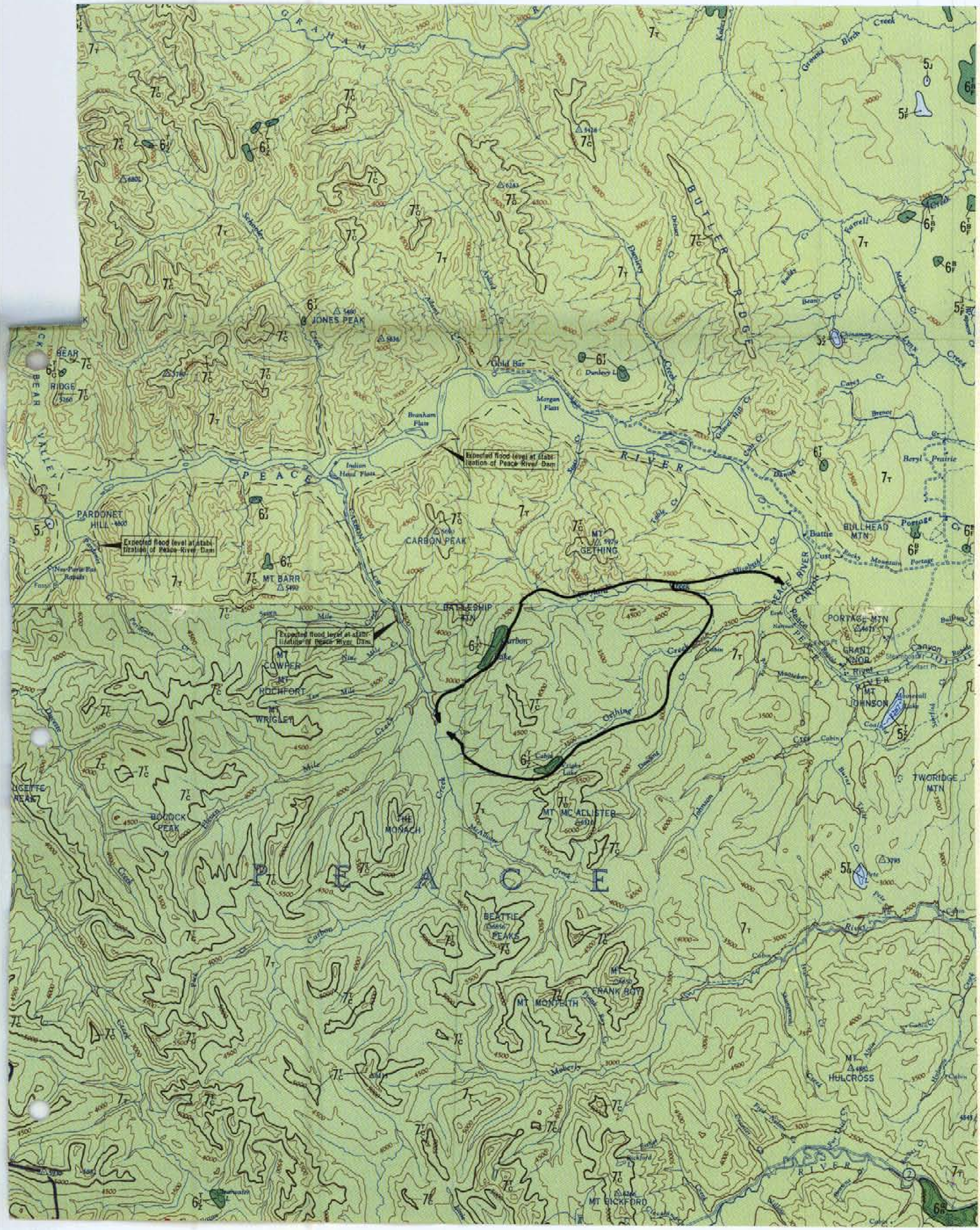
The Canda Land Inventory program assessed the waterfowl habitat traversed by both routes as primarily Class 7 with adverse topography limitations with Class 6 habitat containing adverse topography, reduced marsh edge and excessive or shallow water depth limitations at both Carbon and Wright Lakes (Figure 6).

4.4.2.4 Raptorial Birds

Bald and Golden eagles were observed and Peregrine Falcon have been reported in the B.C. Hydro Peace River Site One reservoir area (Thurber, 1973).

Figure 6: Waterfowl Capability Map

(approximate locations of proposed road alternatives are illustrated in black ink)



LAND CAPABILITY FOR WILDLIFE – WATERFOWL

CANADA LAND INVENTORY

HALFWAY RIVER 94 B

PINE PASS 93 O

Scale 1:250,000 Échelle

DESCRIPTIVE LEGEND

In general the needs of all waterfowl are much alike; each individual and species must be provided with a sufficient quality and quantity of food, protective cover, and space to meet its needs for survival, growth, and reproduction. The ability of the land to meet these needs is determined by the individual requirements of the species or group under consideration, the physical characteristics of the land, and those factors that influence the plant and animal communities.

On this map the land is divided into units on the basis of physiographic characteristics important to waterfowl populations. The degree of limitation associated with each unit determines its capability class. The subclass denotes the primary factor that causes the limitation.

This classification system is based on two important considerations.

- Capability ratings are established on the basis of the optimum vegetational stage (successional stage) that can be maintained when good wildlife management is practiced.
- Capability ratings assigned do not reflect present land use (except in extreme cases such as heavily populated urban areas), ownership, lack of access, distance from cities, or amount of hunting pressure.

CLASS 4 LANDS IN THIS CLASS HAVE MODERATE LIMITATIONS TO THE PRODUCTION OF WATERFOWL.

Capability on these lands is moderate. Limitations are similar to those in Class 3, but the degree is greater. Water areas are predominantly temporary ponds, or deep, open waters with poorly developed marsh edges, or both.

CLASS 5 LANDS IN THIS CLASS HAVE MODERATELY SEVERE LIMITATIONS TO THE PRODUCTION OF WATERFOWL.

Capability on these lands is moderately low. Limitations are usually a combination of two or more of the following factors: climate, soil moisture, permeability, fertility, topography, salinity, flooding, and poor interspersion of water areas.

CLASS 6 LANDS IN THIS CLASS HAVE SEVERE LIMITATIONS TO THE PRODUCTION OF WATERFOWL.

Capability on these lands is very low. Limitations are easily identified. They may include aridity, salinity, very flat topography, steep-sided lakes, extremely porous soils, and soils containing few available minerals.

CLASS 7 LANDS IN THIS CLASS HAVE SUCH SEVERE LIMITATIONS THAT ALMOST NO WATERFOWL ARE PRODUCED.

Capability on these lands is negligible or nonexistent. Limitations are so severe that waterfowl production is precluded or nearly precluded.

SUBCLASSES

With the exception of Class 1, and special Class 3M, the classes are divided into subclasses according to the nature of the limitations that determine the class. The following subclasses are used to denote significant limiting factors that may affect either the waterfowl or the ability of the land to produce suitable habitat conditions.

SUBCLASS C: climate — A combination of adverse climatic factors may act to reduce favorable habitat and the production and survival of waterfowl.

SUBCLASS F: fertility — The limitation is insufficient nutrients in the soil and water for optimum plant growth.

SUBCLASS T: adverse topography — Either steepness or flatness of the land may limit the development or permanency of wetlands.

SUBCLASS Z: water depth — Excessively deep or shallow waters limit the development of optimum waterfowl habitat.

CONVENTIONS

Large arabic numerals denote capability class.

Small arabic numerals placed after class or special class symbols indicate the approximate proportion (in tenths) of the complex represented by that class. The dominant class appears first in the symbol.

Small upper-case letters placed after class or special class symbols denote the subclasses, i.e., limitations.

* Denotes class or subclass not present on this map.

EXAMPLE

An area of Class 5 land with topography and water depth limitations to waterfowl production is shown: 5^{T}_{Z}

4.5 Wildlife Considerations

4.5.1 Ungulates

The route selected adjacent to Gaylard Creek and downstream from the proposed Gaylard Creek crossing site may be of wildlife concern. The physical (southern exposure, lower elevation and possibly reduced snow pack caused by a rainshadow effect of Battleship Mountain and Mt. Gething) and biological (vegetation cover) components of this area provide many of the requirements of moose winter range. The south side of Gaylard Creek appears to be less productive moose range and may be a better location for the road with regards to minimizing moose winter range interference.

Road construction will provide new public access into the Carbon Creek area. The Carbon Lake route will provide access to moose summer and possible winter range along Gaylard Creek and C.L.I. Class 3 caribou range on Battleship Mountain. The south alternative will provide access to the Wright Lake area and the sizeable C.L.I. Class 3 caribou and goat range on Mt. McAllister.Mountain goats are scarce in the area east of Carbon Creek and, as such, are worthy of special consideration. The Mt. McAllister herd may require special hunting regulations and enforcement to avoid overhunting if access is provided to Wright Lake.

4.5.2 Furbearers

Disturbance to aquatic furbearers can result from road construction if drainage patterns are altered or wetlands are filled. Chemicals (insecticides, pesticides, oil etc.) accidentally entering water courses during road construction and operation can also effect these species.

4.5.2 Furbearers (cont'd)

Trappers in the immediate area will be inconvenienced by either alternative. Road development will stimulate logging activity and public access. The former will remove furbearer habitat and interrupt established trails while the latter will greatly increase vandalism to traplines and cabins as well as disturb resident wildlife species.

The road itself can be a benefit to trappers by providing winter access but it can also be a hindrance if high snow berms make the cleared right-of-way difficult to cross.

4.5.3 Waterfowl and Raptorial Birds

Road construction can affect these species by removing habitat or by polluting watercourses.

Harlequin ducks nest adjacent to fast flowing mountain streams and are reported to nest in the Peace River just south of Bennet Dam. It is possible that the species also nests in Gaylard and Carbon Creeks. Minimizing removal of stream bank cover and alteration of water quality would help to reduce the road impact on production of this species.

4.6 CONCLUSIONS

Due to time and field data limitations this report is a preliminary description of the main environmental considerations only. It reviews available information, and presents wildlife observations obtained in a reconnaissance flight over the two alternatives. It should not be construed as a comprehensive environmental impact assessment of either alternative because additional field and office analysis would be required to complete such an assignment.

In summary, the Carbon Lake alternative would provide access to areas identified in this study as potential moose winter range (adjacent to and north of Gaylard Creek) as well as a small area of Class 3 caribou range on Battleship Mountain. The Wright Lake route would provide access to moose winter ranges west of Wright Lake as well as an area of Class 3 caribou and mountain goat range on Mt. McAllister. Mountain goats are, "found in very limited numbers" in the general area (Mide 1966 a and b) and specific goat hunting regulations and enforcement should be implemented for Mt. McAllister if access is developed to Wright Lake. However, considering the length of the alternative routes, the positioning of both alternatives back from watercourses, and the fact that both routes traverse C.L.I. Class 4 moose and caribou ranges there appears to be no <u>major</u> wildlife concerns or basis on which to choose one alternative over the other.

4.7 RECOMMENDATIONS

1. Road access development to Carbon Creek should be planned on a long term basis. That is, the route selected for initial access should meet the requirements of a commuting road if and/or when one is required.

2. Vegetation removal and thus wildlife habitat disturbance should be kept to a minimum. This includes right-of-way clearing, slash burning, interruption of drainage patterns and filling of wetlands.

3. A wildlife biologist should be involved as an advisor in the location, construction and operation phases of the road development. In this capacity he or she could provide biological input into site specific route selection, borrow pit location, spoil disposal, and solution of specific wildlife problems.

4. Time constraints precluded the involvement of some key Provincial Government personnel.

The contents of this report should be reviewed by Dr. J. Elliott, Fish and Wildlife Branch, Fort St. John to obtain his input.

A report by J. Bonar prepared for ELUC, Ft. St. John on the wildlife resources of Williston Lake should also be obtained and reviewed for additional information.

4.8 REFERENCE MATERIAL

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2. Canada Land Inventory. Land Capability for Wildlife-Waterfowl. Halfway River 94B Department of Regional Economic Expansion.

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6. Demarchi, D. and A. Stewart March 6-8, 1974. Winter flight observations. Pine Pass Mapsheet #930. Canada Land Inventory field map.

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11. Smith, B. January and February 1966. Winter flight observations. Pine Pass Mapsheet #930. Canada Land Inventory field map.

12. Thruber Consultants Ltd. 1973. Site One Development Environment Impact Study. British Columbia Hydro and Power Authority.

APPENDIX I: Latin Names of Species Referred to in Text

Common Name	Latin Name
Ungulates	
Moose	*Alces alces andersoni*
Mule Deer	*Odocoileus hemionus*
Osborn Caribou	*Rangifer tarandus*
Mountain Goat	*Oreamnos americanus*
Furbearers	
Coyote	*Canis latrans*
Lynx	*Lynx canadensis*
Wolf	*Canis lupus*
Black Bear	*Ursus americanus*
Red Squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
Fisher	*Martes pennanti*
Marten	*Martes americana*
Wolverine	*Gulo luscus*
Ermine	*Mustela erminea*
Waterfowl	
Canada Goose	*Branta canadensis*
White-fronted Goose	*Anser albifrons*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Green-winged Teal	*Anas carolinensis*
Blue-winged Teal	*Anas discors*
American Widgeon	*Mareca americana*
Shoveler	*Spatula clypeata*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Harlequin Duck	*Histrionicus histrionicus*

APPENDIX I: Latin Names of Species Referred to in Text (cont'd)

Common Name	Latin Name
Raptors	
Bald Eagle	*Haliaeetus leucocephalus*
Golden Eagle	*Aquila chrysaetos*
Peregrine Falcon	*Falco peregrinus*