PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED ALCAN PIPELINE

VOLUME III

(APPENDICES)

SCHULTZ

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VOLUME III
(APPENDICES)

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FOR

GULF INTERSTATE ENGINEERING COMPANY
Houston, Texas

BY

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Vancouver, Canada

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APPENDICES

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ERRATUM TO APPENDIX I

* The terminology used in this section may be somewhat misleading. Please substitute intermediate level vegetation for shrubs, and ground level vegetation for herbs, wherever they appear in the text.

APPENDIX I

BIOGEOCLIMATIC ZONES AND FOREST COMMUNITIES

APPENDIX I

BIOGEOCLIMATIC ZONES AND FOREST COMMUNITIES

Krajina (1969) has advanced systematic mapping and classification of the vegetation of British Columbia under the units of biogeoclimatic zones. These zones take into consideration all climatic, physiographic, edaphic and biotic conditions under which vegetation may grow. Utilizing techniques of applied ecology, detailed classifications supported by field studies have been made for the life zones in British Columbia. The classification has been used extensively in Volume II of this report. An excellent map illustrating the positions of the biogeoclimatic zones is available and forms the basis of the vegetation study of the proposed Loops from Fort Nelson to Sumas.

The Looping Program proposed here extends from the northeast part of the province and extends across nine biogeoclimatic zones. Almost every plant presented in the province could conceivably be found on the various loops. Therefore, lists of species of plants have not been compiled. Rather, at every stopover point along the route, (see Volume II, Loop Maps) notes were taken on the plant communities on the pipeline and in the surrounding forests. The plant associations presented here are taken only from the areas adjacent to the pipeline. For the sake of simplicity and to avoid repetition, many of these observations on plant communities have been combined to be presented as one plant community. This is especially true in the boreal forest region of white spruce-aspen forests and coastal forest region of Douglas fir-cedar-hemlock forests. More detailed information on the analysis of plant associations is presented in "Ecology of Forest Trees in B.C." by Krajina (1969).

A. Canadian Boreal Forest Zone

The Canadian Boreal Forest Zone virtually encompasses the northern half of the province at elevations below 4,000 feet. It is composed of two biogeoclimatic zones - boreal white and black spruce and sub-boreal spruce. The sub-boreal spruce zone is slightly less continental; it is slightly warmer in January and cooler in July. The winter is shorter, vegetative season is longer and annual precipitation is higher than in the boreal white and black spruce zone. The productivity of trees is therefore slightly higher.

The major coniferous tree species in the boreal white and black spruce zone are white spruce, black spruce, lodgepole pine, tamarack, and alpine fir. Black spruce is the most shade tolerant tree, growing well only on acid, poorly drained and nutrient-poor soils. On rich soils, alpine fir is the most shade tolerant tree. Aspen, balsam poplar, paper birch, and alder are the most frequent deciduous trees and shrubs. Loops 1-7 occur in this zone.

In the sub-boreal spruce zone, the major coniferous tree species are lodgepole pine, white spruce, alpine fir, black spruce and rarely Douglas fir. White spruce may be hybrid with Engelmann spruce in this region. Deciduous trees are represented by aspen, balsam poplar, paper birch, scrub birch, and alder. Loops 8 and 9 occur in the sub-boreal spruce zone.

Along the Peace, Nelson, and Liard Rivers in the Boreal white and black spruce zone, great quantities of glacial outwash sediments have resulted in a special edaphic effect originally referred to as "Peace River Aspen-White Spruce Parkland".

Tamarack grows mainly in neutral to alkaline bogs, or on limestone substrate. White spruce and lodgepole pine grow well in silty soils with moderate drainage. However, lodgepole pine is a major colonizer of a region following the effects of fire or logging. It grows extensively over the southern areas of the boreal forest, but is very shade intolerant.

Aspen and scrub birch are major colonizers of burn areas following severe fires. Balsam poplar prefers wetter, moderately drained soils for optimum growth. White birch is usually found on hillsides in more well drained soils in associations with aspen, white spruce or lodgepole pine. Scrub birch and alder are found, along with aspen in wetter areas, in open muskeg or along creeks.

Plant communities in the Boreal Forest Zone are:

a) Upland Forest

Upland forests in the boreal forest regions are characterized by the occurrence of white spruce, aspen, birch, and lodgepole pine. In mesic habitats (Moderately drained, moderately textured, moderate soil nutrients), white spruce becomes the dominant forest tree forming extensive forests. However, almost all of the province has been logged in the past or has been swept by fire. Very few climax, virgin forests remain. Hence, white spruce is most often found in mixed stands with varying amounts of aspen, birch, or lodgepole pine.

Fire is the major factor in re-establishing a new forest of white spruce in mesic habitats which otherwise would become dominated by black spruce as the climax tree. Modern logging practices also encourage new growths of white spruce by tree cultures. White spruce will grow in any habitat except nutrient-low, poorly drained bogs occupied by black spruce. On all mesic habitats it becomes the tallest tree and makes its best growth in moderately rich silty soils.

Common associates of white spruce are aspen, white birch, and lodgepole pine. In the past, logging practices of clearing out all the trees and effecting little or no revegetation led to the occurrence of extensive stands of aspen, birch, or lodgepole pine. These trees are relatively fast growing compared to white spruce. They tend to enrich the soil (especially birch, aspen, and to some extent balsam poplar) with their leaves. White spruce becomes the dominant shrub and will, in time, overtop the aspen and birch and form a white spruce forest. Following severe fires, when all ground cover is removed, frequently the first tree species to move into the area is lodgepole pine. This tree has no shade tolerance, and will only grow where other trees are absent. It forms very dense forests; the lower branches are generally shaded out, die and form the characteristic shape of the tree with a straight branchless trunk and a crown of branches at the top. Dense forests of lodgepole pine cannot regenerate themselves unless thinning occurs. White spruce usually comes in as the dominant shrub in these areas, in time rising above and shading out the pine.

Shrub growth and ground cover are most extensive in young deciduous forests of aspen and birch where the soils are richer and the canopy is more open. As the amount of spruce increases, the soils become more acid, the canopy more closed, shrub growth is reduced, and ground cover is sparser until all that remains is feather moss under tall closed white spruce forests.

Field checks carried out in the deciduous forests that border the Peace River on Loops 5 and 6 revealed the following understory structure. Tree height was up to 50 feet in tall aspen, birch, and balsam poplar forests.

Shrubs

wild rose	scrub birch
raspberry	red osier dogwood
white spruce	edible cranberry
buffaloberry	alder
balsam poplar	

Herbs

horsetail	gentian
fireweed	locoweed
coltsfoot	hedysarum
cow parsnip	milk vetch
grass	sedge
bedstraw	clover
wild lily of the valley	yarrow
strawberry	wintergreen
twinflower	bunchberry
vetch	feather moss
peltigera	

Mixed stands of white spruce, aspen, birch, and lodgepole pine were observed in field checks on Loops 1, 2, 4, 5, and 8. The understory structure consisted of the following:

Shrubs

alder	raspberry
wild rose	saskatoon
edible cranberry	huckleberry
willow	gooseberry

Herbs

twinflower
bunchberry
winter green
buttercup
wild lily of the valley
grass
vetch
strawberry
lady fern
horsetail
bog cranberry
feather moss
fireweed
false Solomon's seal
sedge
bedstraw
Venus' slipper
bearberry

Only one stand of tall white spruce forest was sampled. It occurred along the south side of Parker Creek on Loop 1. The following understory structure was observed:

Shrubs

white birch
wild rose
willow
labrador tea
edible cranberry

Herbs

Venus' slipper
bog cranberry
feather moss
peltigera
horsetail
twinflower
moss

b) Treed Muskeg

In the Boreal Forest Zone, black spruce represents the climatic climax forest type. It is a highly frost resistant tree and the most shade tolerant conifer in the boreal forest. In densely stocked black spruce forests, however, shade is so deep that only after natural thinning will new regeneration occur. Black spruce is a very slow growing tree and because of its shade tolerance, the productivity of a mature forest is very low. Black spruce grows best in low nutrient, poorly drained soils.

Lodgepole pine is frequently seen in association with black spruce. Presumably it grows there due to its uncompetitive nature and its low shade tolerance. It may grow in black spruce stands or in random belts scattered throughout the black spruce forests. Sjors (1961), in discussing similar patterns found in the subarctic parts of the boreal zone, suggests that the reason for the elevated ridge seems to be the pressure of the ice being exerted horizontally during the freezing period in early winter. A similar explanation may well apply to the patterned ground of northern British Columbia.

Tamarack is another shade intolerant tree. It makes its best growth in neutral to alkaline bogs, rich in nutrients or on a limestone substrate. It is easily overshaded by other trees and seldom exists in pure stands.

Shrub and herb growth in treed muskeg is rather limited. However, there are many different kinds of mosses and lichens in such an area. In open or drier muskeg areas, more varied shrub and herb growth is observed. In a black spruce forest on Loop 2, the following shrubs and herbs were noted:

Shrubs	Herbs
labrador tea	bog cranberry
	peltigera
	reindeer moss
	reindeer lichen
	feather moss
	moss

Next to the black spruce forest was an old burn area. For comparison, the shrub and herb layers observed were as follows:

Shrubs	Herbs
scrub birch	bog cranberry
labrador tea	horsetail
black spruce	peltigera
	sedge
	reindeer moss
	moss

c) Floodplain Forest

Floodplain forests develop on the alluvial sediments deposited on islands and riverbanks. The forest types are variable, ranging from short dense clumps of willow to tall white spruce forests. Balsam poplar may be the dominant deciduous tree in these areas. The growth forms are variable just as the watercourse forms are variable. Meandering streams, particularly in muskeg areas, may support low dense willow bushes. Sandbars, gravel flats, and alluvial deposits along swifter rivers may be colonized by other types of willows and balsam poplar. Riverbanks or deposits with higher silt contents may support tall mixed forests of white spruce, aspen, birch, and balsam poplar, or tall forests of white spruce.

Floodplain growth on a gravel flat on Trutch Creek on Loop 2 was observed to consist of scattered balsam poplar to 15 feet in height; herbs included grass, fireweed and horsetail.

On Loop 7, there was extensive willow brush between the Pine River and the taller mixed forests. The height of the willow and alder was about 15 feet and it was very dense. The understory structure was composed as follows:

Shrubs

willow	alder
raspberry	red osier dogwood

Herbs

white violet	sedge
cow parsnip	mountain bluebell
horsetail	meadow rue

B. Cariboo Aspen Parklands Zone

This biogeoclimatic zone is characterized by the occurrence of aspen, lodgepole pine, and Douglas fir. It comprises all all the forests lying below 3,000 feet in an area from south of Prince George to north of Clinton along the Fraser River, and beyond 100 Mile House. The soils are mesic dystric brunisols. Annual total precipitation is 14"-22". The zone is characterized by fairly dry warm summers but the winters are still severe.

The main coniferous trees in this zone are lodgepole pine, Douglas fir, white spruce, and to a limited extent black spruce. White spruce is present in moister and cooler sites, especially those flooded in the spring. However, white spruce is absent from the southern parts of this zone. Black spruce occurs only in wet sites in the northern areas of the zone. Lodgepole pine and Douglas fir are the most common conifers within this zone, with Douglas fir becoming dominant in the southern regions of the zone.

The main deciduous trees are aspen, birch, and black cottonwood. Aspen and birch are common in secondary stands and especially in rich loamy soils. They are generally found in association with lodgepole pine or Douglas fir, and are rarely found in pure stands. Black cottonwood is a tree of wetter habitat. Tall cottonwoods may be found along creeks and river throughout the Cariboo Aspen Parklands, but even more frequently in the southern areas.

The Cariboo Aspen Parklands vegetation occurred in four Loops (10, 11, 12, and 13). On Loop 9, Douglas fir was evident and became dominant in areas. This Loop was situated almost at the southern limit of the Sub-Boreal Spruce Zone and the occurrence of Douglas fir would suggest that this Loop was perhaps situated in the ecotone between the two biogeoclimatic zones. Some of the communities encountered on Loop 9 will be discussed in the Cariboo Parklands Zone along with Loops 10, 11, 12, and 13.

The upland forest plant community within the Caribou Aspen Parklands Zone is described as follows:

The climax forest for the Cariboo Aspen Parklands is a tall Douglas fir forest with little underbrush. Such areas are not found along the pipeline route and indeed very few climax stands of interior Douglas fir remain in the province. The area has been selectively logged; the best Douglas fir has been removed. The scattered fir that are left may reach heights of 120 feet. After these climax forests were destroyed, natural re-vegetation controlled the type of forests.

The most common upland forest in this zone is a mixed forest of aspen, lodgepole pine, and Douglas fir, with perhaps a scattered assortment of tall Douglas fir. Following logging or fire, lodgepole pine or aspen are the first colonizers of an area. Lodgepole pine is very intolerant of shading by other trees but given no competition, it will form extensive stands, sometimes exceedingly dense. It makes its best growth in the first 20 years following a fire. Aspen is also a fast growing tree along with birch and pine. In logged areas where these species were likely the only shrubs under the tall Douglas fir forest, the removal of the tree canopy has promoted the development of the extensive deciduous and mixed woods stands from which the area derives its name. After a period of many years, Douglas fir will eventually catch up to and surpass the existing vegetation of aspen, birch, and pine. Douglas fir is very slow growing when shaded, but grows much better once it breaks through the canopy of the forest.

In a tall Douglas fir forest occupying a small area along a creek on Loop 13, the structure of the forest was observed. The Douglas fir ranged upwards to about 100 feet in height.

Tall Shrubs (to 15 feet)

Douglas fir
lodgepole pine
birch
white spruce
aspen

Low Shrubs

wild rose
saskatoon
edible cranberry
willow
buffaloberry
black twinberry

Herbs

bunchberry	twinflower
wheat grass	bedstraw
mountain bluebell	bearberry
wild pea	Venus' slipper
strawberry	violet
lichen	moss
sedge	false Solomon's seal
horsetail	meadow rue
peltigera	club moss

Tall mixed stands of aspen, Douglas fir, birch and cottonwoods were investigated. One of these was observed on Loop 11. The trees averaged 60 feet in height, although some of the Douglas fir were taller.

Tall Shrub

alder	willow

Low Shrub

black twinberry	willow
gooseberry	

Herbs

raspberry	yarrow
cow parsnip	fireweed
tall meadow rue	violet
grass	vetch
bracken fern	strawberry
anemone	

C. Interior Douglas Fir Zone

This biogeoclimatic zone occurs only over a very small portion of the pipeline route. The Interior Douglas Fir Zone is the second warmest interior zone and includes the forests below 3,000 feet. The annual total precipitation is 14"-22". The summer and winter months are wetter than the drier spring and autumn months. The soils are mesic. Grey luvisols occur in the wetter areas; dystric brunisols in the drier areas.

The forests in the Interior Douglas Fir Zone are almost exclusively coniferous. The major trees are Douglas fir and lodgepole pine. Ponderosa pine occurs as a pioneer tree species, although it makes its best growth in this zone. Since the areas observed along the pipeline have been logged, few large Douglas firs have been left, although they would form the climax forest.

The coniferous forests of the Interior Douglas Fir Zone are described as follows:

The dominant community in the Interior Douglas Fir Zone is as it occurs on the first half of Loop 14, as a tall, medium dense lodgepole pine forest with a few scattered tall Douglas fir. In many areas, Douglas fir is the dominant tall shrub or may even be co-dominant with lodgepole pine as tree cover. In a short while, these forests will be dominated by Douglas fir. Aspen occurs as a tall shrub or a low tree but does not become as dominant as in the Cariboo Aspen Parkland Zone. White spruce may also occur in the lodgepole pine forests and presumably will shade it out when it grows taller.

A tall lodgepole pine forest of around 50' in height was sampled on Loop 14. The structure of the understory was revealed as follows:

Tall Shrub

white spruce	Douglas fir

Low Shrub

buffaloberry	saskatoon
wild rose	

Herbs

strawberry	bunchberry
grass	bearberry
twinflower	sedge
violet	wintergreen
wild lily of the valley	peltigera
dwarf huckleberry	moss
white death camas	prince's pine

D. Ponderosa Pine - Bunchgrass Zone

The Ponderosa Pine - Bunchgrass Zone comprises the forests below 2,500 feet in elevation. Total annual precipitation is less than 14" in this, the driest and in summer, the warmest area in British Columbia. The soils are mesic brown to dark brown chernozems which are very well suited to agriculture. However, this zone is very dry and irrigation of crops is necessary, since there is no surplus of groundwater to maintain a constant groundwater level.

The major conifer in this zone is ponderosa pine. It does not grow to great heights and is very shade intolerant. Thus it forms open parklike stands. Douglas fir occurs here but in this zone it requires shade for good growth. Lodgepole pine occurs in a few well watered sites. Rocky mountain juniper also occurs in association with ponderosa pine. The deciduous trees include aspen and black cottonwoods. Aspen may be found scattered about in the open ponderosa pine forests, but becomes more common along small creeks on hillsides and around small water-holes or ponds. Cottonwoods similarly occur along the larger creeks and rivers on the rich soils alongside the watercourse.

The Ponderosa Pine - Bunchgrass Zone includes the southern half of Loop 14 (from Mile 464), and Loops 15 and 16.

Plant communities in the Ponderosa Pine-Bunchgrass Zone include:

a) Upland Forest

Upland forest in this zone is dominated by ponderosa pine or Douglas fir growing in open to scattered park-like stands. Most of the coniferous trees occur at slightly higher elevations on the hillsides; the bottomland is too dry or has been cleared for agriculture.

Douglas fir may get established in stony soil or talus on hillsides, since it requires more water. It is the most shade tolerant tree in this region. On mesic soils where ponderosa pine readily regenerates, Douglas fir exists only as scrub in the most shaded places. Ponderosa pine regenerates readily in this zone but grows more poorly than in the Interior Douglas Fir Zone, where it grows as a pioneer species. Ponderosa pine has a very low frost resistance, much lower than Douglas fir. Conversely, this pine cannot compete in a more humid zone unless it is the tallest tree in the canopy. In the Ponderosa Pine-Bunchgrass Zone, ponderosa pine becomes the climatic climax species on glacial till soils.

In a medium height Douglas fir forest on Loop 14, the understory was assessed. The trees were open to scattered, about 60 feet in height and on rocky soil.

Tall Shrub

rocky mountain juiper

Low Shrub

rabbitbush	sagebrush
wild rose	

Herbs

chickweed	yarrow
huckleberry	strawberry
wild oats	moss
grass	

In open ponderosa pine forests on Loops 15 and 16, the understory structure was assessed. Tree height was about 40 feet and the ground was sloping.

Low Shrub

saskatoon	wild rose
rocky mountain juniper	snowbrush

Herbs

yarrow	dandelion
wild pea	daisy
chickweed	tansy mustard
wheat grass	prickly pear cactus
wild oats	lichen
butter and eggs	draba
storksbill	tall mahonia
great mullein	spring sunflower

b) Floodplain Forests

On the rich alluvial soil along the creeks and rivers, and in the well watered chernozems farther back are lush deciduous floodplain forests. The waters flood the land every spring and deposit a thin layer of rich silt upon which develop tall cottonwoods and dense shrubbery along the banks. One such tall deciduous belt occurred along Barricade Creek on Loop 14. The cottonwoods, many degenerate, reached heights of 100'. The understory observed was as follows:

Tall Shrub

black cottonwood	yellow cedar
rocky mountain juniper	bitter cherry

Low Shrub

black twinberry	wild rose
gooseberry	saskatoon
huckleberry	red osier dogwood

Herbs

dandelion	yarrow
yellow clover	bunchgrass
wild oats	wild pea
strawberry	great mullein
knapweed	prickly pear cactus

c) Grasslands

While the climax forest types is ponderosa pine growing on glacial till soils, the climatic climax plant association on chernozemic soils is bunchgrass. Ponderosa pine is absent. The soils are strongly melanized and calcified. Grazing has retarded this development somewhat and has provided conditions favorable for the establishment of non-palatable plants such as sagebrush, pasture wormwood, and rabbitbush. Areas of this nature were encountered on Loops 14 and 15, although they were not sampled.

E. Coastal Western Hemlock Zone

The Coastal Western Hemlock Zone is the wettest zone in British Columbia. The total annual precipitation is 65" - 262". Usually the zone has a mild winter and a cool summer. This is suitable for the highest production of several coniferous trees including Douglas fir, western hemlock, red cedar, grand fir, and yellow cedar. Forests under 3,500 feet elevation fall into this biogeoclimatic zone.

The forests in this zone are composed of very tall coniferous trees on mountain slopes. The forest is closed and shrub growth is sparse. High production in this zone make it especially attractive for forest harvesting. Along the valley bottoms, tall mixed forests of red cedar, western hemlock, and black cottonwood crowd together.

Loop 17, running through the Boston Bar Creek and Coquihalla River Valleys is in the Coastal Western Hemlock Zone, as is the northern part of Loop 18.

Plant communities in the Coastal Western Hemlock Zone are:

a) Upland Forests

The pipeline does not cross substantial amounts of the coniferous uplands forest as it is built almost entirely on the valley bottoms and alluvial floodplains of Boston Bar Creek and the Coquihalla River. The tall cedar, hemlock, and Douglas fir forests in the upper sections of the Loop are inaccessible by vehicle or helicopter. The coniferous forests south of Dewdney Creek have been logged and are not nearly so impressive as the trees in the more remote sections.

An immature Douglas fir forest near Ladner Creek was sampled on Loop 17. The trees were about 60 feet in height and the canopy was closed. Understory structure was revealed as follows:

Tall Shrub

western hemlock
red cedar
vine maple

Herbs

tall mahonia
sword fern
lady fern
false Solomon's seal
wild lily of the valley
violet

A mature red cedar-Douglas fir forest was sampled along Dewdney Creek. These trees were large, easily topping 120 feet. Douglas maple was scattered underneath the larger conifers. The maple reached 35 feet in height. The understory was observed to be:

Tall Shrub

Douglas maple	red berry elder

Low Shrub

devil's club	thimbleberry
currant	

Herbs

lady fern	false Solomon's Seal
bleedingheart	bedstraw
siberian miner's lettuce	moss
sword fern	bindweed
liverwort	

b) Floodplain Forests

The floodplain forests along the Coquihalla River on Loop 17 are very extensive, tall, and dense. They are formed on the alluvial flats and gravel bars of the river or on the bottom of the valley adjacent to the river. The forests developed on the gravel flats and river banks consisted of tall black cottonwoods with scattered tall cedar and hemlock trees. The understory is dominated by tall shrub willow, alder, and maple, growing very densely. Farther away from the river, there are more Douglas fir, cedar, and hemlock as the valley bottom starts to slope upwards. The forests in this region consist of tall conifers along with maple, cottonwoods, and alder.

A tall mixed forest was sampled around Mile 590. It consisted of cedar and Douglas fir to 70 feet in height, cottonwoods to 50 feet, and alders to 40 feet in height. The canopy was closed. Understory structure was revealed to be:

Shrub

red berry elder

Herbs

bleedingheart
bindweed
bedstraw
cow parsnip
false Solomon's Seal
siberian miner's lettuce
sword fern
orchard grass
lady fern
hedge nettle

Some of the vegetation along the Coquihalla River near the mouth of Sowaqua Creek was sampled. No trees were present although there were indications from fallen logs that tall cottonwoods were formerly present. The shrub and herb cover consisted of the following plants:

Tall Shrub

river alder
Douglas maple

Low Shrub

red cedar
thimbleberry
black twinberry
baneberry
raspberry
gooseberry
salmonberry
red berry elder
red osier dogwood

Herbs

false Solomon's Seal	coltsfoot
orchard grass	sedge
fireweed	
siberian miner's lettuce	cow parsnip
horsetail	

F. Coastal Douglas Fir Zone

The Coastal Douglas Fir Zone is drier than the Coastal Western Hemlock Zone, with a total annual precipitation of 26" - 60". It encompasses the regions from sea level to 500 feet on the lower mainland. The winter months are the wettest; the summers are relatively dry. The Coastal Douglas Fir Zone is productive both for forestry and for agriculture. The zone is characterized by tall forests of Douglas fir, red cedar, grand fir, sitka spruce, white pine, lodgepole pine, arbutus, bitter cherry, black cottonwood, river alder, broadleaf maple, and Douglas maple. The forests in this zone have particularly heavy undergrowth. The Coastal Douglas Fir Zone includes Loops 18 and 19.

There are no forested areas along Loops 18 or 19, except in isolated woodlots along creeks, in Indian Reserves, or in parks. The rest of the land has been cleared for agriculture. Along Maria Slough and Elk Creek, and in some areas of Loop 18, the pipeline passes close to closed deciduous forests of medium height. The forest consists of arbutus, broadleaf maple, cherry, alder, and cottonwood. The understory was exceedingly thick. Along the Fraser River, similar tall deciduous forests with scattered Douglas fir and cedar occur. Field checks were not initiated on either of these Loops and no samples of the forest vegetation are available.

APPENDIX II

EXISTING ENVIRONMENTAL SECTION

FROM

WESTCOAST TRANSMISSION COMPANY LIMITED'S

PIPELINE CONSTRUCTION SPECIFICATIONS

APPENDIX II

EXISTING ENVIRONMENTAL SECTION
FROM
WESTCOAST TRANSMISSION COMPANY LIMITED'S
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Section 25 - Environmental and Ecological Requirements

In addition to the ecological and environmental requirements implicit in other sections of these construction specifications, the following specific requirements are brought to the CONTRACTOR'S attention:

25.1 Wildlife

That the CONTRACTOR shall ensure that members of his construction crew do not harass or depredate any wildlife species. In providing this assurance, the CONTRACTOR shall prohibit his personnel from the carrying of firearms on the right-of-way. CONTRACTOR shall control garbage to avoid attracting wildlife. British Columbia fishing and hunting regulations as outlined under authority of the B.C. Fisheries Act (1948, c.125) and the B.C. Wildlife Act (1966, c.55) must be complied with. Harassment of wildlife by all terrain vehicles is prohibited under the B.C. All Terrain Vehicles Act (1971, c.3), section 4.

25.2 Beaver Dams

Before any beaver dams are opened to drain impounded water, the local Conservation Officer of the Fish and Wildlife Branch, Department of Recreation of Conservation, and/or trapline permittee(s) should be contacted.

25.3 Archaeological and Palaeontological Sites

The attention of the CONTRACTOR is drawn to the possibility that he may encounter archaeological and/or palaeontological sites on the route of the pipeline project and should the possibility of such a site be discovered during his construction activities, the CONTRACTOR is specifically requested to bring the location of the site to the immediate attention of the OWNER. The OWNER will provide the CONTRACTOR with an immediate decision as to the CONTRACTOR'S treatment of the possible site with the OWNER, in all likelihood, bringing the possible site to the immediate attention of various provincial archaeological and palaeontological authorities for their consideration. Until such time as the value of any discovered site has been assessed, the CONTRACTOR will limit his activities to whatever extent deemed necessary by OWNER to prevent damage to the site until such time as an archaeological or palaeontological assessment can be made. The protection of archaeological and historic sites is covered under the B.C. Archaeological and Historic Sites Protection Act (1972, c.4).

25.4 Stream and Creek Crossings

Particularly in northern areas, and where muskeg is encountered, all stream and creek crossings traversed by the pipeline shall be field located and flagged by mosaic chainage, or other means, with particular care taken during construction to ensure that the normal drainage direction of the creeks and streams has not been changed. Ditch breakers, as per typical drawing PL-TM-104, shall be installed on the down slope right-of-way side of such crossings to ensure that the stream or creek flow does not flow or channel down the backfilled trench line, particularly when the ditch line backfill settles due to permafrost thawing. The CONTRACTOR shall give specific attention to the necessity of providing ditch plugs on the immediate sides of all stream crossings to prevent the stream from diverting down the ditch-line during construction, or to prevent ditch water from various sources from entering into the stream or creek and causing siltation conditions.

CONTRACTOR shall ensure that:

- All construction related activities in or near streams be kept to an absolute minimum.

- The width of the cleared stream crossing be the minimum required for construction and safe operation of the access.

- Trees be felled away from stream beds and any debris introduced into the water be removed immediately.

- No debris of any kind be placed where it will enter the stream at break-up.

- Construction roads across streams be composed of gravel or stone and should be provided with culverts, bridges or fish passages to prevent blockage of fish movements. All structures shall be removed before the spring break-up to avoid blockage.

- OWNER and Fisheries Service shall be informed before any blasting is carried out on or near any stream lake or reservoir.

The deposition of a deleterious substance of any type in water frequented by fish, or in any place where it could enter such waters, is prohibited under the Fisheries Act (1970, C.F-14), section 33.

25.5 Gravel Requirements

Where the CONTRACTOR requires certain gravel quantities in his construction activities, such quantities shall not be taken from any stream or creek. Similarly, particular attention shall be made to the backfilling of streams and rivers to ensure that the backfill material does not create any ponding of the stream or creek due to the foreign nature of the backfill material.

CONTRACTOR shall obtain a permit for the excavation and removal of river bed material on all streams, regulated pursuant to the British Columbia Gravel Removal Order as amended by SOR/71-100. Applications for this permit shall be forwarded to the Director of Fisheries.

25.6 Muskeg Rip-rapping

Where it is required by the CONTRACTOR to rip-rap or corduroy the construction right-of-way for construction pruposes, the CONTRACTOR shall, if requested by OWNER, remove at regular intervals certain of the corduroy or rip-rap material to ensure that the natural drainage of the muskeg area is not inhibited.

25.7 Right-of-Way Clearing and Timber Removal

The CONTRACTOR shall give specific attention to the clearing of trees located on muskeg conditions. The CONTRACTOR shall, wherever possible, cut the trees flush with the terrain surface and not remove unnecessary stumps, thus creating opportunities for bog holes in the muskeg surface.

The CONTRACTOR shall ensure that:

- As few trees as possible be removed. Removing additional trees to accommodate future operations shall be avoided.

- Timber is not disposed of by "push-outs".

- Log jams in streams located within the right-of-way be removed.

- Cross-stream or cross-ridge skidding of trees be avoided.

25.8 Right-Of-Way Debris

The CONTRACTOR shall collect all forms of right-of-way debris from his operations, such as paint cans, plastic cans, bottles, coating materials and containers, welding rods etc. and dispose of such debris in an area and a manner approved by the OWNER and various regulatory authorities having jurisdiction. Special care shall be given to the disposal of garbage to prevent the attraction of wildlife. The CONTRACTOR shall ensure that during the course of his operations on the right-of-way that he does not dispose of any fuel, lubricating fluids, insecticides, or herbicides on the right-of-way to the detriment of the general environment.

25.9 Pipeline Accesses

Where it is required that the CONTRACTOR construct various pipeline accesses or shoeflies, the CONTRACTOR shall ensure that such accesses are properly restored in a stable condition, satisfactory to land owner or government regulatory authority. Where rip-rapping is required, Section 25.6 shall apply.

25.10 Erosion

At all times the CONTRACTOR shall take whatever steps are deemed necessary to limit the amount of erosion materail entering various rivers, streams and creeks which will have a detrimental effect on the river biota due to increased siltation conditions.

25.11 Slope Diversion

The CONTRACTOR shall give strict attention to selective terracing or inverted herringbone diversions (rather than angled slashed) on steep slopes encountered on the pipeline route. Particular attention will be made to this section in northern areas where slope stability is generally very sensitive. The height of inverted herringbone diversions will depend on the slope considered and where deemed necessary in the opinion of the OWNER the CONTRACTOR shall install split culverts down each side of the right-of-way on the considered slope in order to conduct surface runoff directed by terracing or heeringbone diversions down the edges of the right-of-way, thus preventing the erosion of the sides of the right-of-way.

25.12 Permafrost

Areas of permafrost readily visible on a pipeline route, and any discovered due to excavation activities by the CONTRACTOR shall be brought to the attention of the OWNER. Where practical, all permafrost from the pipeline trench shall be excavated in order to ensure that the pipeline is founded on stable material. The CONTRACTOR at the OWNER'S direction, shall adjust the weighting of the pipeline in areas of permafrost in order to provide a neutral buoyancy condition.

25.13 Fire Control

The CONTRACTOR shall ensure that he has sufficient equipment and personnel at all times, as required by the Forest Service, to permit the suppression of any accidental fire originating from his construction activities. The CONTRACTOR'S attention is drawn to the requirement that he must supply close co-ordination and co-operation with Forest Service agencies in the event of a forest fire outbreak which may not, in some cases, have commenced due to his activities.

Field personnel shall report any smoke they cannot account for.

Each helicopter used regularly shall have (and be prepared to use) a Monsoon Bucket at each camp.

The provision of access to fire fithting equipment during seasons of high fire hazard is contained in the Regulations for Forest Fire Prevention of the B.C. Forest Act.

25.14 Right-Of-Way Grading Operations

In treed areas the CONTRACTOR must dispose of grading material in a manner satisfactory to the OWNER, land owner, and/or Forest Service. The CONTRACTOR must not dispose of grading material into treed areas.

25.15 Establishment of Campsites

Where it is necessary that the CONTRACTOR construct a camp for his personnel, the CONTRACTOR will obtain the necessary permits and authorizations from the provincial health and pollution authorities for the safe disposal of garbage and human waste.

The CONTRACTOR shall select open or sparsely forested areas when possible.

Caution must be exercised to minimize damage to the site.

When the camp is disbanded, all trash shall be cleaned up.

The provision of sanitary facilities and disposition of sewage material is covered under B.C. legislation by Section 6 of the Litter Act (1970, c.22), the Health Act, and Section 5 of the Pollution Control Act, 1967 (1967, c.34).

25.16 Pollution Control

The CONTRACTOR shall ensure that:

- All debris that results during construction is cleaned up.
- All markers (flagging, stakes, etc.) are to be of the type that permits removal when their use is terminated.
- Old campsites and garbage left in the area from previous field parties shall be cleaned up.
- Garbage shall be carried back to camp by field personnel.

- Garbage shall be placed in closed containers for future disposal.

- Combustible material shall be disposed of at the base camp by high temperature incineration. A Class III type incinerator, American incineration institute, is recommended.

- Incinerators shall be located to minimize the danger of fire. Spark arrestors should be provided on all incinerators.

- All camps shall avoid accumulating garbage which could attract wild animals. Daily incineration is required. Residue from the incinerator is to be disposed of along with non-combustible garbage.

- Non-combustible garbage that contains food is incinerated before disposal. Non-combustible garbage is to be disposed of at an approved site.

- The disposal of garbage on water or land without a permit is prohibited under Section 4 of the B.C. Litter Act (1970, c.22).

Permits are issued in compliance with Section 5 of the B.C. Pollution Control Act, 1967 (1967, c.34) and disposal facilities are expected to meet the requirements outlined under the B.C. Health Act and regulations (1970, c.22, S.4; 1972, c.33, S.5).

The CONTRACTOR shall ensure that the disposal of sewage must be in compliance with all existing legislation, particularly Section 5 of the Litter Act (1970, c.22), Section 5 of the Pollution Control Act, 1967, Section 2.139 of the Sanitation Regulations and the B.C. Pollution Board's Minimum Requirements for Discharge of Domestic Wastewaters to Surface Waters.

The CONTRACTOR shall ensure that:

- Fuel storage sites are selected and prepared to prevent pollution of any stream and to minimize lateral flow of spilled fuel on the land surface.

- If the local terrain would not contain a spill, a dyke is to be constructed. At permanent storage sites, a permanent dyke should be built which would contain the volume of the largest tank.

- The storage area shall be on the same level or lower than the camp, so that any spill and/or fire will not endanger the camp facilities.

- Any fuel cache located within 300 feet of a stream is placed above the normal high water mark.

- When filling the tanks, allowance is made for thermal expansion.

- Extreme care is exercised to prevent spillage during refueling and oil changing operations.

- If a spill occurs during winter, the area is cleaned up before spring thaw. Mechanical removal of the spilled substance by scraping or shovelling is recommended. Snow can be used as a natural absorbent, although straw or sawdust would facilitate future burning.

- If a spill occurs during the summer, the area is immediately cleaned up. Spills on water shall be removed by vacuum pumping. Land spills shall be cleaned up by using an absorbent material, such as straw, and hauling the contaminated straw to a disposal area.

- Disposal of spill material and waste oil is accomplished by burning if recycling is not practical.

The CONTRACTOR is restricted from widespread use of pesticides. Control of biting insects shall be on a personal basis except for localized spraying around campsites.

The CONTRACTOR is restricted by the following when water is used for testing the pipeline:

- water used for hydrostatic testing is to be discharged, preferably back into the source of the water, and with minimal erosion and siltation of the receiving water;

- pump intakes in salmon-bearing waterways are to be screened as regulated under Section 28 of the Federal Fisheries Act;

- where required, water use permits and approval must be obtained from the Lands and Forests Department of the Provincial Government, and/or the Fisheries and Marine Service of Environment Canada.

APPENDIX III

EVALUATION BY C.E. BARKER

June 15, 1976

C.D. Schultz & Company Limited
325 Howe Street
Vancouver, B.C.
V6C 2A1

Gentlemen:

I was employed by Bechtel Price Callahan during the last year of construction on the Canol Pipeline as Superintendent of Canol 4 (the section of the Canol line from Whitehorse to the Alaska border). This work included the pipeline and seven attendant pump stations and housing for temporary and permanent staff.

Upon completion of the above work I was transferred to Johnsons Crossing as assistant to Justin Barber who was assistant area manager. My assignment was the construction of the Canol road and the completion of the pipeline from the Pelley River to a point 170 miles west of Camp Canol. I was not involved in the station construction on this section.

The Canol line was a high pressure pipeline of four inches in diameter from Norman Wells to Whitehorse and of three inches in diameter from Whitehorse to Fairbanks.

The line was designed to pump Norman Wells Crude Oil, which was a very light Crude pumpable at very low temperatures.

The Crude oil line ran from Norman Wells to a refinery at Whitehorse, also a part of the project.

The three-inch line from Whitehorse to Fairbanks was a Products line and therefore could be operated at tremendously low temperatures.

Both the four-inch and the three-inch lines were constructed above-ground and buried only in river crossings and road crossings. The pipeline was laid bare and to my knowledge was never coated or wrapped. There was no cathodic protection provided either in the short buried sections or road crossings.

It will be difficult to equate the problems encountered or the consequent damage and erosion following construction of lines of such small diameter surface laid, to a large diameter buried line transporting gas rather than oil, especially on a wartime project where little regard was given to environmental damage.

During the construction of the Haines Fairbanks Pipeline which parallels the Canol line from Haines Junction to Fairbanks, I was a Shareholder and Vice President of Marwell International, a Partner in the joint venture firm of "Williams Brothers, McGlaughlin & Marwell" who contracted for the entire construction and initial operation of the Haines Fairbanks Pipeline.

I was appointed Project Manager of the station construction, operation and testing by the joint venture group and spent the greater part of two years on this project.

There was very little evidence of any erosion along the Canol line from Whitehorse to Fairbanks and all of the stream crossings were still in place at the time.

The Haines Fairbanks line was an eight-inch products line and was buried throughout the Alaska portion. There was very little of the line that is buried in Canada. However, there was a short section about twenty-five miles from the Alaska border between M.P. 1,190 and M.P. 1,200 on the Alaska highway.

In digging the trench for this section, about a foot and a half of frost was encountered in a three-foot ditch. There also was permafrost at both of the stations in the Yukon between Haines Junction and Mile Post 1,200 on the highway.

Permafrost was also encountered in all of the major stream crossings between the Koidern River and Mile 0 on your map of the proposed line.

Permafrost in the above area appeared to be sporadic but very little excavation was done other than at water crossings and the stations.

The Alaska Highway gives this line a tremendous advantage in both cost and time of construction over any of the other proposals.

The availability of large quantities of gravel within truck haul distances is another plus for this location.

Yours truly,

C. E. Barker

C.E. Barker

Log of the Canol Pipeline route and a section by section evaluation of the old Canol line and a portion of the Haines Fairbanks Pipeline where it parallels the Canol line between M.P. 0 and M.P. 350.

Mile 0 to Mile 10

- No major stream crossings
- No heavy side hill cuts and little erosion
- No special problems in constructing either Haines Fairbanks or Canol lines.

Mile 10 to Mile 20

- Beaver Creek Crossing - frozen banks and bottom; tough trenching; about two miles of swamp this section
- No heavy cuts on right-of-way; little evidence of erosion

Mile 20 to Mile 30

- Some buried pipe on Haines Fairbanks section, encountered about 1 1/2 ft. frozen ground
- Only creek crossings and tiny lakes
- No cuts - no erosion of any consequence

Mile 30 to Mile 40

- No major problems this section
- Dry creek crossing; frozen banks and bottom
- Recommend installation of breakers on all river banks in future construction this area

Mile 40 to Mile 50

- A couple of miles of swamp
- Koidern River spread out; several fingers
- Banks not steep, little erosion visible
- Recommend herringbone and sack breakers, all river banks

Mile 50 to Mile 60

- Small shallow lakes, branch of Koidern to cross
- No visible erosion

Mile 60 to Mile 70

- No major problems this section

Mile 70 to Mile 80

- No special problems
- Koidern River crossing frozen banks and bottom
- Flooding during summer - usually of short duration

Mile 80 to Mile 90

- No special problems in this section
- Donjek river crossing; all gravel; wide crossing dug easily with back hoe to depth required for 8" line
- Forded this river with 2 wheel-drive vehicles except during flood times
- No sharp banks
- Water fast

Mile 90 to Mile 100

- No special problems this section

Mile 100 to Mile 110

- Very similar to last section

Mile 110 to Mile 120

- About five miles of this section subject to flooding
- Will be hard to avoid some side-hill

Mile 120 to Mile 130

- No problems this area

Mile 130 to Mile 140

- No major problems

Mile 140 to Mile 150

- No major problems
- Some side hill - not heavy cutting - slight slope erosion

Mile 150 to Mile 160

- No major problems
- Excavation for station (Haines Fairbanks) in permafrost

Mile 160 to Mile 170

- Small creek crossings - no permafrost

Mile 170 to Mile 180

- Small creek crossing - no permafrost in crossing
- Haines Fairbanks line departs from Canol at about M.P. 180

Canol line only from here

Mile 180 to Mile 190

- No problems

Mile 190 to Mile 200

- Ashihik River Crossing - no permafrost in crossing

Mile 200 to Mile 210

- Small creek crossings
- All muskeg - better going when frozen

Mile 210 to Mile 220

- Muskeg all the way
- traversing right-of-way major problem

Mile 220 to Mile 230

- Muskeg - small stream crossing - no frozen banks
- Moving on right-of-way major problem

Mile 230 to Mile 240

- No major problems. Mendenhall Creek small when crossing installed

Mile 240 to Mile 250

- Some sidehill in this area - little right-of-waying done except clearing

Mile 250 to Mile 260

I have very little first-hand knowledge of the problems encountered in this section as the pipeline was installed in this area prior to my arrival on the project. Fair progress was made in this area and outside of right-of-way problems that applied to the greater portion of the line. I do not know of any specific problems in this area.

Mile 260 to Mile 275

All of this section was also installed prior to my arrival on the project.

Mile 275 to Johnson's Crossing, about Mile 350

This entire section was installed under supervision of E.W. Davis during the same period that I was involved with the installation of the pipe on Canol 4. I was transferred to Johnsons Crossing the third week in October when the entire area was blanketed with snow and when I left the completed project in March it was still covered with snow. I therefore was unable to observe any erosion which may have been caused by the construction of the pipeline. However, as there was a minimum of excavation performed on the right-of-way and trenching only across the streams at points of crossing, I would only expect to find subsidence caused by the vehicular traffic on the right-of-way.

It is my opinion that all of the route from the Alaska border to Johnsons Crossing presents problems of less magnitude than any route which I examined in the Mackenzie valley, or the Alaska section of the proposed gas line from Prudhoe Bay. Construction of this line could be accomplished in most cases by normal methods and could for the most part be buried. I am assuming that the line will probably be forty-two inches in diameter and could get into a lot more permafrost than was encountered by the smaller lines in the buried sections. Specialized equipment has been developed for trenching in permafrost and for bending the larger diameter pipe. The biggest problem remaining is damage to the right-of-way which is still caused by almost all of the conventional pipeline construction equipment.

APPENDIX IV

ADDITIONAL INFORMATION

SCHULTZ

PART A: OVERVIEW FLIGHT OF BEAVER CREEK TO ZAMA LAKE

An overview flight of the proposed pipeline route took place on June 18, 19 and 20, 1976 between the Alaska-Yukon border and Zama Lake.

The following discussion provides a preliminary identification of potential problem areas.

Mile Y33.0*

A washout occurred approximately four years ago along the old pipeline right-of-way (the Haines-Fairbanks pipeline) exposing the pipeline.

Mile Y50.0-Y160.0

Aufeis was seen throughout this section on major watercourses such as the White, Donjek and Slims Rivers. Scour problems can result from excessive aufeis.

Mile Y72.0

Standing water is evident in depressions along the old pipeline right-of-way. This could be due to thawing of permafrost and subsequent land subsidence.

Mile Y85.0-Y95.0

The drainage pattern in this section runs at right angles to the pipeline route. This could cause ground water pondage against the pipeline and subsequent ice bulb formation if the gas is chilled.

Mile Y112.0

The proposed pipeline route crosses the southern end of Duke Meadow, a proposed International Biological Program Ecological Reserve. This sensitive area supports a sizeable population of sharptailed grouse.

*Mileages are approximate

Mile Y110.0-Y150.0

Washouts along watercourses draining into Kluane Lake have left the old pipeline exposed. Most of these streams terminate in active alluvial fans with shifting channels.

Mile Y150.0

The proposed route crosses exposed bedrock slopes at the south end of Kluane Lake. These slopes appear to be fairly stable, as there are no extensive talus slopes.

Mile Y180.0-Y190.0

Stream banks have slumped in several locations along watercourses in this section. Careful siting of the pipeline route will be required to avoid unstable areas.

Mile Y255.0

Steep cliffs to the north of the proposed route may be a raptor nesting area.

Mile Y385.0-Y395.0

The Alaska Highway follows a narrow corridor between the muskeg of the Morley River valley to the south and bedrock to the north. The potential pipeline route is thus restricted.

Mile Y445.0-Y460.0

The Rancheria River runs through a narrow valley cut into bedrock. The slopes on the north side of the river are steep, and it may be preferable to relocate the pipeline route on the south side of the river. If the route is relocated, it will cross a small fish-bearing stream which is tributary to the Rancheria River.

Mile B0.0-B50.0

Dease River, Angus Creek and other watercourses in this section show signs of stream bank slumping.

Mile B120.0

Tributary streams to the Liard River canyon area flow down steep sided, V-shaped gullies. In several cases, erosion is evident along the banks.

Mile B150.0

The north side of the canyon at Hell Gate was extensively burned in the past. Although some revegetation has occurred, bare slopes and surface erosion are evident.

Mile B150.0-B160.0

The pipeline route follows the side slopes of a valley through bedrock for approximately ten miles.

Mile B175.0

The exact location of the crossing of the Toad River is unknown. In the vicinity of the crossing however, the river channel varies from a narrow bedrock gully to a wide braided flood-plain.

Mile B170.0-B180.0

Extensive standing water occurs on a seismic line which follows the proposed pipeline route between the Toad and Dunedin Rivers.

Mile B200.0-B210.0

A rock cliff near the proposed route could be a raptor nesting area.

Mile B250.0

The crossing of the Prophet River should be upstream from the steep cliffs and slumps that are evident at the proposed crossing.

Mile A0.0-A50.0

No problems are foreseen for this section at this time.

PART B: GROUND SURVEY OF BEAVER CREEK TO ZAMA LAKE

A community and land use survey along the Alaska Highway to provide detailed and updated information was undertaken from Fort Nelson, B.C. to Burwash Landing, Y.T. Sections from Beaver Creek to Burwash Landing, and from Fort Nelson to Zama Lake, were not observed due to lack of time and access.

a) Beaver Creek to Kluane (Figures 1A to 1D)

Considerable community expansion and upgrading has occurred in the predominantly native community of Burwash. With the aid of a portable community-run sawmill, a new community center and several new houses have been erected. The new museum, showing enclosed and open-air displays of the area's past, was officially opened in June, 1976. There is an abandoned gasoline station-lodge complex just north of the town on the highway. The Burwash Lodge on the lake, provides all facilities for travellers.

Three miles south of Destruction Bay, a government defense installation is in operation. Access by the public is prohibited.

At Mile 1,071 of the Alaska Highway, a new hunting-fishing lodge has opened. The Kluane Lake Wilderness Camp provides lodging, boats, fishing guides, and taxidermy service.

There is no evidence of restoration of the Kluane-Silver City historic site. Access to the area is provided by a three-mile side road at Mile 1,051. At the north end of Silver City, private development in the form of new log cabins and frames for buildings is taking place.

A second access road to the lake at Mile 1,053, leads to the Arctic Institute of North America research station complex, which is a base camp for varying numbers of scientific researchers. Across from the station (but still two miles from the highway), a gas station-lodge-cafe complex is in existence. This operation is slated to move to the highway at Mile 1,055; a new road has been cleared, and the owner is drilling for water at this new junction.

b) Kluane To Whitehorse (Figures 1D to 1F)

Land in this segment of the corridor is used primarily for recreational uses, with camp and picnic sites at many river crossings. Much of the area is used for open range for horses owned by outfitters. Abandoned buildings, dating from the 1900's and the 1940's, provide the traveller with a sense of the two significant time periods in the area's historical evolution.

The Kluane-Haines Junction section provides scenic views of the Kluane range. A defence facility, similar to that described above, is situated at Mile 1,026. Three miles west of the Junction, the headquarters for the Kluane National Park have taken over and expanded upon the old experimental farm complex buildings. There is fenced pasture for horses along the road on both sides of the junction.

Two new subdivisions have helped alleviate the housing shortage in Haines Junction, and the Local Improvement District is planning a second mobile home park. While there are very few serviced lots available, many recently built houses are still unoccupied. Portable classrooms at the school suggest educational facilities need expansion. New log houses are being erected in the native village area, one mile east of the junction. The band office for the Champagne-Aishihik Bands is located in this area.

The Canyon City-Aishihik area (Mile 996) is the site of Indian burial grounds as well as an historic bridge. West of the bridge on the south side of the highway, a new outfitter business has recently opened; new log cabins have been erected. New gasoline and accommodation facilities at the Aishihik road junction provide services previously offered by an abandoned gas station-motel-tavern complex at Mile 995.

No services are available at Champagne (Mile 974). The only permanent residents raise horses for outfitters; they occupy many of the historic buildings located here. The Indian cemetery contains graves dating from 1900 to the present. Ease of access and the "unconventional" nature of the graves (most are covered by small "spirit houses") make this an appealing stop for tourists. Some graves have been vandalized.

There is an abandoned cafe-motel-service station at Mile 968. An outfitting business is located at Mile 946.

c) Whitehorse to Watson Lake (Figures 1F to 1J)

The Alaska Highway strip in the vicinity of Whitehorse, contains highway-oriented services, light industrial, and distribution sites from Miles 921 to 907. Additional activity is centered around the railroad interface at McRae (Mile 909). From miles 883 to 900 the highway is being upgraded in preparation for paving.

Services previously provided at Squanga Lake (Mile 849) have been closed. Between Johnson's Crossing and Teslin, there are four roadside stands selling fresh fish caught in Teslin Lake.

Mostly through the effects of the Teslin Band Council, housing and community improvements have been made in the Teslin Native village (one-half mile from the highway). Commercial functions are located exclusively along the highway. Very strong community impact can be anticipated, particularly with the construction of the 2,000 foot crossing of Nitsulin Bay. Re-routing around the bay may be a feasible alternative.

A new outfitting camp has been built eight miles east of Teslin. All service facilities at Morley River (Mile 778) have been closed. In contrast, two new gasoline stations and cafes have been recently opened at Miles 717 and 721. Accommodation is offered at the latter location.

Approximately twenty new log houses have been built near the north side of the highway in the native community of Upper Liard (Mile 642). Nursing facilities are no longer available.

d) Watson Lake to Liard Hotsprings (Figure 1I to 1K)

Commercial growth in Watson Lake is located in a strip along the Alaska Highway on either side of the Airport Road junction, formerly known as Watson Lake Wye. The permanent population of 550 doubles in the summer months, with the influx of transients. The newest and largest residential area (including a mobile home park) is northeast of the junction, although new residential and recreational home development is occurring along the north shore of the lake, along the Airport Road. One mile north of the junction is the moderately large Yukon Forest Products sawmill site.

The Indian settlement of Lower Post has been declining since the large Indian Residential School closed in June, 1975. Its June, 1976 population is estimated at between

100 and 150. Housing is generally in poor condition on the Indian Reserve; the only white residents are employed at the cafe-service station, the Forestry Office, and the elementary school.

The lodge at the Liard River Crossing is undergoing renovation and expansion, and a construction crew is upgrading the bridge itself. The Liard River Hotsprings Provincial Park is a very popular recreation and camping area; the major attraction is the hotsprings pool, accessible by a 400 yard boardwalk from the highway.

PART C: GROUND SURVEY OF FORT NELSON TO SUMAS

A ground survey of the proposed Loop segments and environs was conducted from June 19 to June 23, 1976. The following additional observations were made:

Loops 1-5
These were not visited.

Loop 7
No observable change.

Loop 8
At the east end of the Parsnip River bridge, approximately ten mobile homes are situated near the right-of-way. Their relocation could be a straightforward matter, since none are on permanent footings.

South of the Parsnip River, several permanent dwellings are located very close to the proposed Loop segment.

Loop 9
No observable land use changes. Recreational development on the shores of Summit Lake appears to be continuing.

Loop 10
At the southern end of the Loop segment, the right-of-way crosses several hay fields. Construction noise will not affect the community of Hixon.

Loop 11
Most of the right-of-way along the proposed Loop segment is being used as pasture or croplands.

Loop 12

At the southern end of the Loop segment, a house and a game butcher shop have been built adjacent to the right-of-way at the Horsefly Road crossing (367.9)

Loop 13

No significant additional observations.

Loop 14

The southernmost two miles of the proposed Loop section passes through several hay fields.

Loop 15

Small acreage homesite development is proceeding in Lower Nicola around the proposed Loop segment area.

Loop 16

Recreational values for the area will increase when the provincial highway is constructed.

Some cropland (hay fields) will be disrupted during summer work schedules and may require compensation.

Loop 17

The Coquihalla route is heavily used by radio-controlled logging trucks, and construction-related traffic could come into conflict with this existing use.

Loop 18

No recent significant changes in land use on Seabird Island were observed.

PART D: LIARD RIVER HYDRO-ELECTRIC DEVELOPMENT

Since the completion of Volume I of this report, Westcoast Transmission Company Ltd. have made changes to the route of their proposed 42"Φ pipeline in northern British Columbia to take into account possible future hydro-electric development of the Liard River. These changes involve the addition of approximately five miles to the overall length of the line and, in several places, the relocation of the line from the alignment shown on our maps 1J through 1L in order to avoid areas of possible inundation. The changes as well as the location of the proposed dams and reservoirs are shown on the following Figures A1, A2, and A3. Because of the additional length of pipeline, the location mileages of the compressor stations are also changed though only the station just west of the Liard River Hot Springs Provincial Park has been actually physically moved. The new mileages are as follows:

Compressor Station	Mileage	Remarks
1	B7.0	
2	B57.4	
3	B104.5	Liard River Hotsprings
4	B157.0	
5	B207.0	
6	B259.0	Fort Nelson Process Plant
7	B355.5	B.C./Alberta Border

According to information received from the British Columbia Energy Commission and B.C. Hydro and Power Authority, the potential dam sites on the Liard River, known as "A", "E" and "G", are located as follows:

Site "A": 30 miles upstream of the confluence of the Liard and Fort Nelson Rivers.

Site "E": 15 miles downstream of the Liard River Hotsprings Provincial Park.

Site "G": approximately at Mile Post 553 of the Alaska Highway.

The levels of the three reservoirs would be approximately 1,300 feet, 1,650 feet and 2,050 feet, respectively. Four major crossings of the potential reservoirs "E" and "G" are encountered by the rerouted pipeline, two of which would be at locations where the original route already crossed the Liard River. Westcoast Transmission Company Ltd. have indicated that the original construction of the proposed pipeline will make provision for future reservoir crossings by the use of weighted heavy wall pipe wherever it may become inundated.

Relocating the pipeline across the river from the Liard River Hotsprings is advantageous from an environmental impact point of view as it removes the right-of-way "scar" from the vicinity of the park, though the park would be flooded if the Site "E" dam were built.

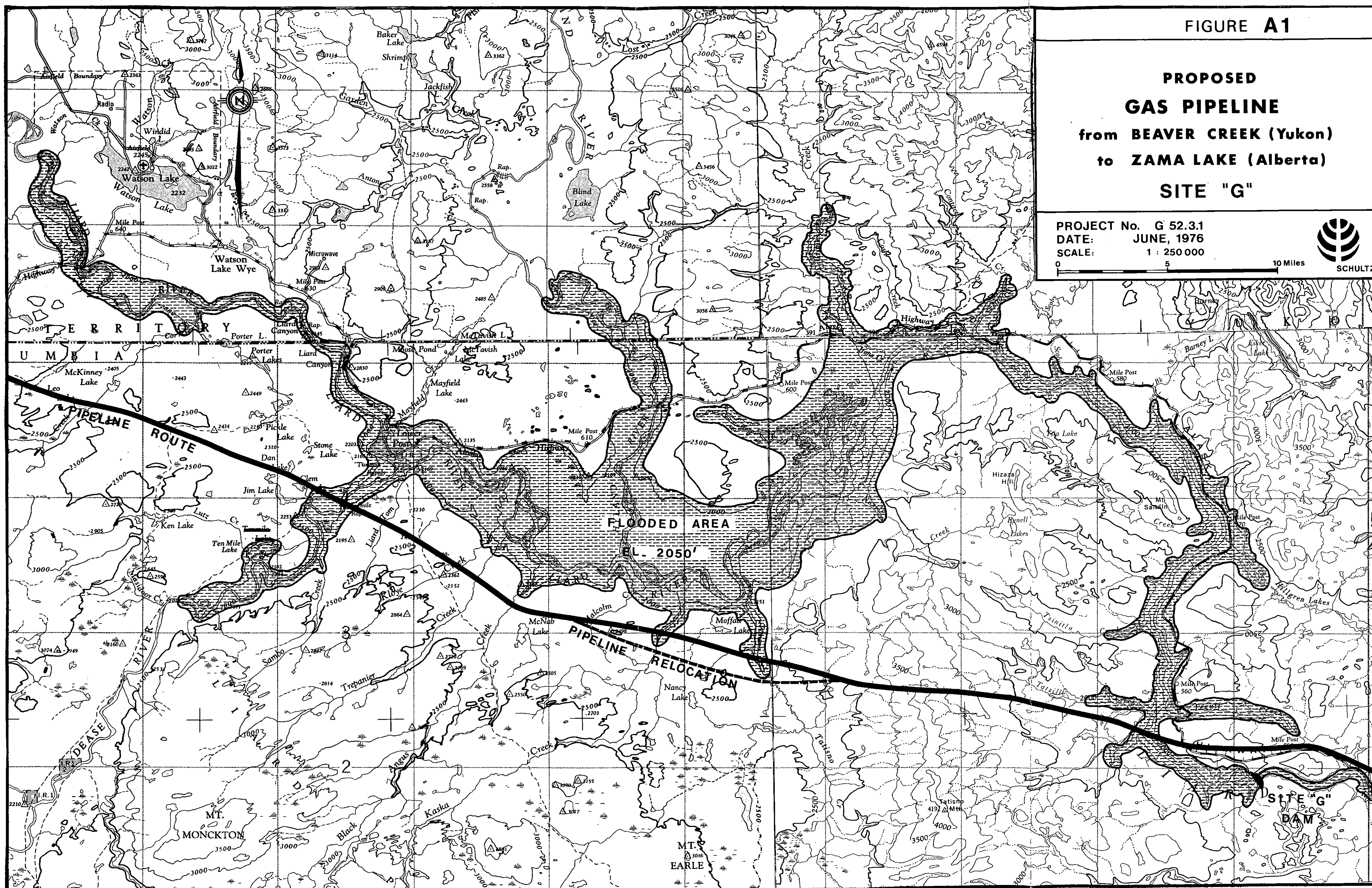

FIGURE A1

PROPOSED
GAS PIPELINE
from BEAVER CREEK (Yukon)
to ZAMA LAKE (Alberta)
SITE "G"

PROJECT No. G 52.3.1
DATE: JUNE, 1976
SCALE: 1 : 250 000
0 5 10 Miles

SCHULTZ

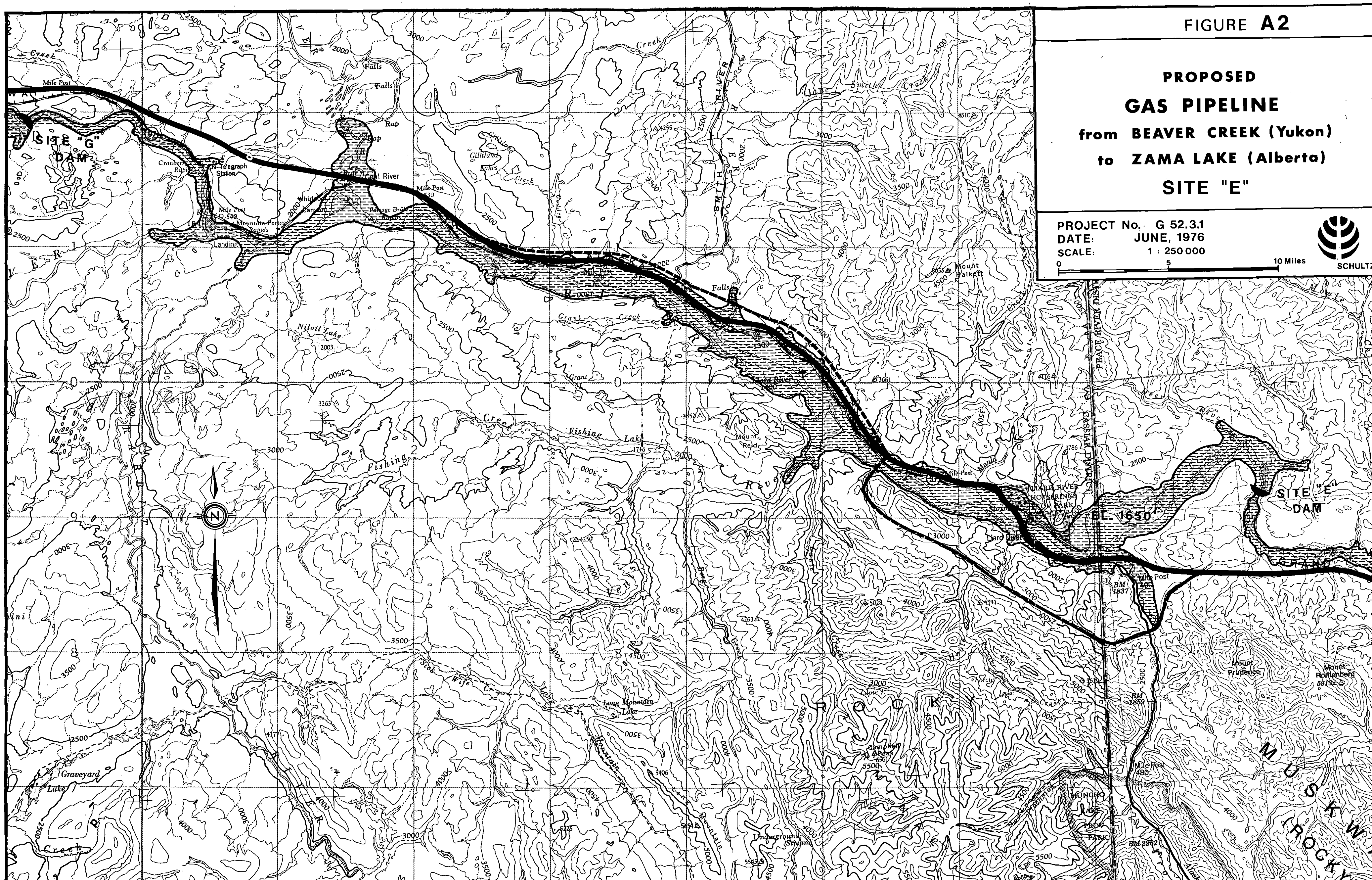
FIGURE A2
PROPOSED
GAS PIPELINE
from BEAVER CREEK (Yukon)
to ZAMA LAKE (Alberta)
SITE "E"
PROJECT No. G 52.3.1
DATE: JUNE, 1976
SCALE: 1 : 250 000
0
5
10 Miles
SCHULTZ
SITE "G" DAM
SITE "E" DAM
EL. 1650
Telegraph Station
Mile Post
Falls
Rap
Gilliland Lakes
Grant Creek
Niloil Lake
Fishing Lake
Fishing
Mount Reid
Mount Halkett
PEACE RIVER DIST
CASSIAR DISTRICT
Sick Wife Cr
Long Mountain Lake
Graveyard Lake
Underground Stream
Mount Prudence
Mount Rottenberg
ROCKY
MUSKWA
ROCKY
SMITH RIVER
Creek
Liard River

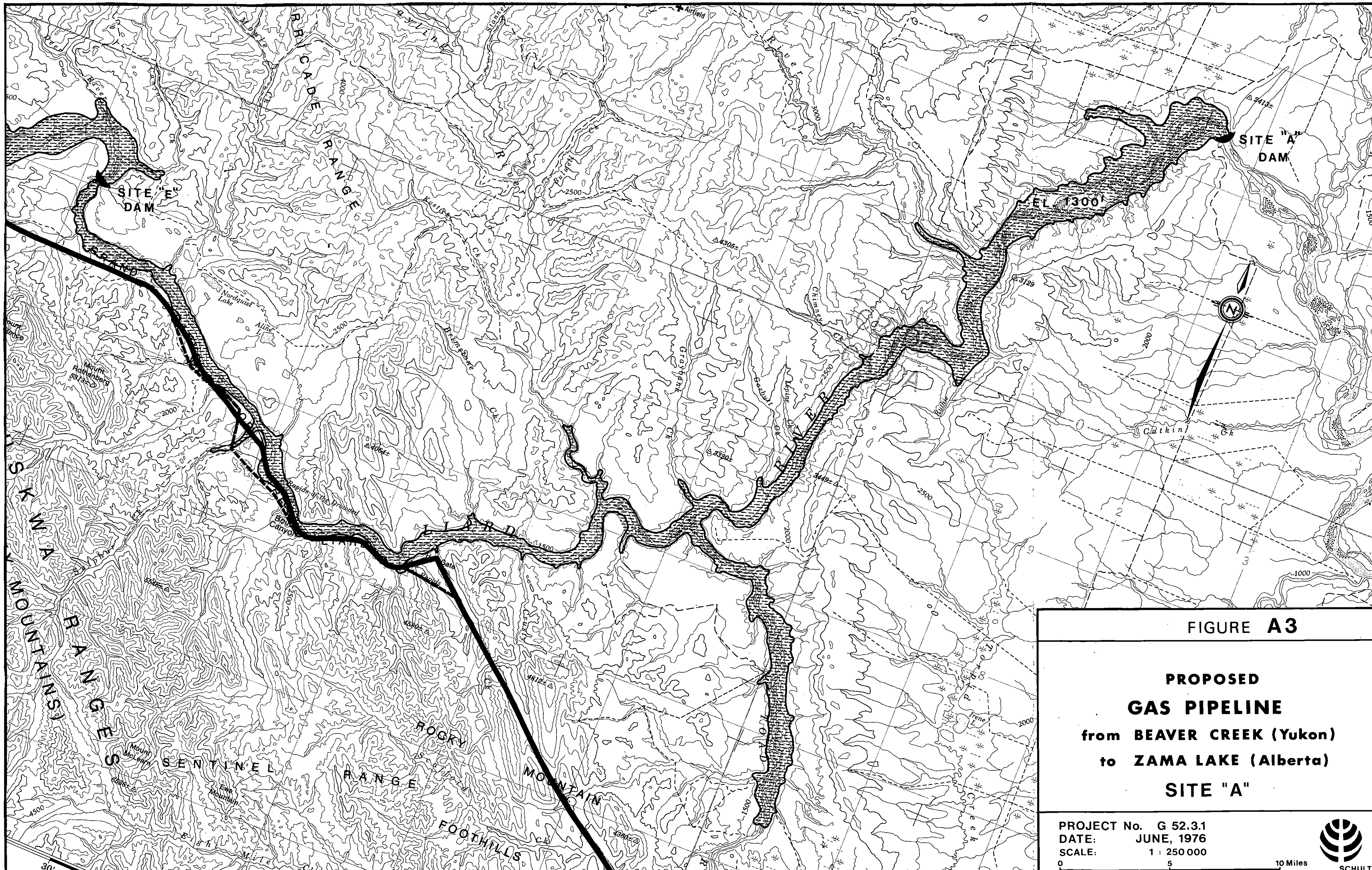

FIGURE A3

PROPOSED
GAS PIPELINE
from BEAVER CREEK (Yukon)
to ZAMA LAKE (Alberta)
SITE "A"

APPENDIX V

CURRICULA VITAE

C.E. BARKER

Experience

Mr. Barker has worked in the engineering and heavy construction industry for over 30 years. He has been associated with pipeline projects in the Middle East, Latin America, United States and Northern Canada. He has held the position of Superintendent or Project Manager on projects involving over 4,000 miles of gas, oil and water pipelines.

Mr. Barker started his career with a contracting company which constructed railroads for the Union Pacific, Santa Fe, Rock Island, and other major American railroads. His construction experience also included the building of large earth-fill dams, bridges, pumping stations, compressor stations, and chemical and industrial plants associated with the gas and oil industry.

Mr. Barker was a senior officer with the Bechtel organization for nine years, responsible for all Bechtel's major projects in the Pacific Northwest.

In 1971, Mr. Barker retired from the Bechtel organization. He has since acted as an independent consultant on pipeline projects and has specialized in services pertaining to feasibility studies and construction management.

Mr. Barker's relevant experience in the North includes the following achievements:

- Made the first location study for the original Trans Alaska Pipeline.

- Was Project Manager on the Haines Cutoff Products Line from Haines to Fairbanks.

- Was Assistant Division Manager on the Canol Pipeline from Norman Wells to Whitehorse to Fairbanks.

- Was involved in preliminary studies for logistics and transport for several Mackenzie Valley pipeline projects, covering:

C.E. Barker - continued

Experience (Cont'd)

- construction methods
- Transport of supplies and materials
- personnel
- operation of the proposed pipelines

Mr. Barker has become familiar with the entire length of the Mackenzie River Valley and adjacent areas in the Yukon and Alaska.

MICHAEL BOYD

Degrees	B.Sc. (Honors) Zoology, University of Alberta, 1972 Provisional Candidate for M.E.D. (Environmental Sciences) University of Calgary
Experience	Mr. Boyd spent the summer of 1970 with a University of Alberta Research Team studying the population dynamics and behavior of pika. He also assisted in a similar observational-behavioral study of ruffed grouse. During the 1971 field season, Mr. Boyd worked with the Peace-Athabasca Delta Project. This project, a major intergovernmental and multidisciplinary study, provided him with experience in waterfowl and small mammal surveys. Mr. Boyd also presented a summary report of project data related to Bald Eagle sightings and nesting occurrences on the Delta. During the winter of 1971-72, Mr. Boyd participated in an analysis of acoustic signals of quail while completing his degree requirements. From May to September in 1972, Mr. Boyd was a research assistant for the Canadian Wildlife Service. During this period, he was involved in a study of habitat utilization by big game in Southern Alberta. He was also associated with population studies of birds, mammals, and aquatic invertebrates. From September 1972 to May 1973, Mr. Boyd was employed by the Fish and Wildlife Division of the Province of Alberta. During this period his work included aerial surveys of big game, preparation of bibliographies, and research for departmental reports. Mr. Boyd joined Schultz International Limited in May, 1973, as a Wildlife Biologist for the Mackenzie Highway project. His responsibilities on this major study have been duck counts, wildlife surveys, stream analysis, and a comprehensive investigation of bear den sites.

Michael Boyd - continued

Experience (Continued)	Mr. Boyd is presently in charge of field studies assessing the impact of forest harvesting on ungulates and furbearers in Saskatchewan. Information obtained on furbearers from this project is being used by Mr. Boyd towards his masters thesis.
Technical Activities	Member of the Canadian Nature Federation Member of the Federation of Alberta Naturalists.

JOHN BOYLE

Date of Birth: October 22, 1946

Place of Birth: Montreal, Canada

Citizenship: Canadian

Academic Background:

- Bachelor of Applied Science (Honors) in Chemical Engineering, University of British Columbia, 1968.
- Graduate Study in Geography, Resource and Environmental Management, University of Toronto, 1970/71.

Experience:

- Engineer with Phillips Barratt and Partners, Consulting Engineers and Architects, 1973-75. All phases of project engineering of fish processing plants, from preliminary design to site supervision, with emphasis on waste treatment facilities.
- Engineer with Howard Paish & Associates, Environmental and Resource Management Consultants, 1971-72.
  Environmental impact study of proposed tanker transportation of crude oil from Valdez, Alaska to Cherry Point, Washington State.
  Organization of B.C. "Man and Resources" Program, Phase I.
- Operational Research Analyst, Gulf Oil, Canada Limited, 1968-70. Development of computer programs for design and economic evaluation of pipelines, and for scheduling of tanker use on Great Lakes and St. Lawrence Seaway.

Memberships: Association of Professional Engineers of British Columbia.

Canadian Nature Federation

KERRY JAMES CLARK

Place of Birth

New Westminster, Canada

Citizenship

Canadian

Academic Background

University of British Columbia, B.Sc. (Honours), Zoology, 1971.

Fields of Special Competence

Apiculture
Stream and Arctic Fish Habitat Assessment

Studies and Assignments Inside British Columbia

Streams near Fort Nelson; Blueberry and Beatton Rivers near Fort St. John; Pine River near Chetwynd; tributaries near Summit Lake; Fraser tributaries near Hixon and 150-Mile House; Nicola River near Lower Nicola; Coquihalla River; Elk River and tributaries north of Sparwood; Kootenay Lake near Balfour; Revelstoke National Park; Glacier National Park; Cleland Island near Tofino; Nimpkish Valley; Lower Fraser Valley.

Studies and Assignments Outside British Columbia

Alberta - Copton and Sheep Creeks near Grande Cache
Yukon - tributaries of Pelly River near Macmillan Pass
Northwest Territories - Streams from Ft. McPherson to Yukon border. Watercourses from Inuvik to Fort Good Hope; Fisherman Lake near Ft. Liard; tributaries of Keele River near Macmillan Pass.

Experience with Schultz Organization

Aquatic Biologist from May 1973 to date.
Project Manager on certain projects starting September 1973.

Kerry James Clark - continued

1975 - Inventory of aquatic resources at the site of a proposed surface coal mine.
- Preparation of a program for monitoring the effects of winter gas pipeline construction across watercourses.
- Assessments of preliminary route selection for gas pipelines, with evaluations of fish resources.
- Determination after four years of pipeline presence of any changes in a productive northern lake. Project Manager .
- Investigation of fish deaths near a gas pipeline. Project Manager.
- Assessment of watercourse crossings along a major gas pipeline.

1974 - Inventory of aquatic resources at the site of a proposed tungsten mine.
- Assessment of the effects on fish migration of a large culvert installed on an arctic river. Project Manager.
- Survey of fish resources along 200 miles of the proposed Mackenzie Highway.

1973 - Evaluation of a proposal to divert a section of river to facilitate railway construction. Project Manager.
- Investigations following an oil spill in Burrard Inlet, Vancouver.
- Evaluation of fish resources along the proposed Dempster and Mackenzie Highway routes.

Previous Experience

1973 -	Aquatic Biologist (Coal mine studies)	B.C. Research
1972 -	Habitat Protection Technician (Coal mine studies)	B.C. Fish and Wildlife Branch
1971 -	Research Assistant (Coastal seabirds)	Institute of Animal Resource Ecology U.B.C.
1970 -	Research Assistant (Biological Pest Control)	Canada Dept. of Agriculture
1969 -	Park Naturalist Lumber-worker	Revelstoke and Glacier National Parks B.C. Forest Products, Hammond Division

Kerry James Clark - continued

Related Activities

National Association of Underwater Instructors - Certificate as Scuba Diver, 1971.

B.C. Department of Agriculture - Certificate as Master Beekeeper, 1969.

B.C. Honey Producers Association - Delegate to Conventions, Executive to date.

S.M. GEDDES

Place of Birth

Vancouver, B.C. Canada.

Date of Birth

March 6, 1951

Citizenship

Canadian

Academic Background

Simon Fraser University, 1973-76
(Degree expected 1977)

Areas of Specialization

Transportation Geography: B.C. Cultural and Urban Geography.

Studies and Assignments in British Columbia

Coastal Region: Consumer Credit Practices and Problems in B.C. Communities (for British Columbia Department of Consumer Services).

Researcher on study of air travellers, Vancouver International Airport.

DAVID E. GYTON

Place of Birth

Montreal, Quebec

Date of Birth

April 3, 1943

Citizenship

Canadian

Academic Background

University of New Brunswick, B.B.A. (Economics and Management Science) 1967.
University of New Brunswick, B.Sc.F. (Business and Forest Management) 1968.

Fields of Special Competence

Logging and forest road construction
Economics of harvesting operations

Studies and Assignments Inside Canada

British Columbia, Alberta, Saskatchewan, Ontario, New Brunswick, Nova Scotia.

Studies and Assignments Outside Canada

Nil

Experience with Schultz Organization

Assessment of the environmental effects of timber harvesting in the Province of Saskatchewan with particular reference to Forest Roads.

David E. Gyton - continued

Previous Experience

Prior to 1967	Research Assistant (site rehabilitation) Canadian and Ontario Governments.
1968 - 1971	Logging supervisor, District logging engineer, Assistant District Logging Superintendent. With two Pulp and Paper Companies in Ontario.
1971 - 1974	Woods Manager and Forester. Lovington Planer Mill.
1974 - 1975	Manager of Operations. Gormely Forestry Service Ltd.
1975	Forester. C.D. Schultz & Company Limited

Professional Memberships

Member, Association of British Columbia Professional Foresters.

Member, Canadian Institute of Forestry.

Related Activities

Member, Canadian Power Squadron

J.S. HART

Date of Birth

December 1, 1949

Place of Birth

Ottawa, Canada

Citizenship

Canadian

Academic Background

Trent University, B.Sc. (Honours), Geography, 1974.
Present enrollment in an M.A. programme in Geography at the University of British Columbia.

Areas of Specialization

Hydrology
Watershed and Fluvial Geomorphology
Current research - Sediment sources and yield in a Coast Mountains Watershed.

Experience

Personal research:

1) Investigation of the partial area model of runoff production, Peterborough, Ontario.
2) Investigation of the effect of suburban development on storm runoff and sediment yield.
3) Investigation of the hydraulic geometry of a mountain stream, Chamonix, France.

Teach assistantship:

1) Geography 101 (Introductory Physical Geography), U.B.C.
2) Geography 213 (Physiography), U.B.C.

Surveying experience: 2 courses and field experience.

Cartographic experience - course work and research positions.

CLAUDIA MARGARET HAYWARD

Place of Birth

Victoria, B.C.

Citizenship

Canadian

Academic Background

University of Victoria, B.Sc. (Zoology and Mathematics)

B.C. Institute of Technology (Forest Resources - Fish, Wild-life and Recreation)

Fields of Special Competence

Fisheries and Wildlife Resources

Studies And Assignments Inside British Columbia

Sparwood, Bull River, Garibaldi Park, Abbotsford Lake

Studies and Assignments Outside British Columbia

Pointed Mountain - Northwest Territories

Experience with Schultz Organization

Fisheries Technician - data collection and report preparation for projects in Northwest Territories and Alberta.

Previous Experience

1971-73	Secondary school teacher	Salmon Arm, B.C.
1974	Wildlife Technician	B.C. Fish and Wildlife Branch

A.L. HORSMAN

Place of Birth

Hamilton, Ontario, Canada. (January 4/31)

Citizenship

Canadian

Academic Background

University of British Columbia, B.A. (English and International Studies, 1961).

University of British Columbia, M.A. (Geography, 1974).

Simon Fraser University, Ph.D. (Candidate - Geography).

Areas of Specialization

Regional and Urban Development/Community Planning/Social Surveying.

Studies and Assignments in British Columbia

Chemainus, Vancouver Island, Urban Renewal Program.

Prince Rupert, Community Attitudes Study re: Regional Economic Development.

Greater Vancouver Regional District, Citizen Attitudes Toward Urban Development.

Greater Vancouver Regional District, Land use Geo-Code Mapping.

East Kootenays, Local Attitudes Toward Hydro Development.

Chilliwack, Feasibility of Residential Development on Upland Area.

Vancouver City, Development of Local Area Urban Plans.

Studies and Assignments Outside of Canada

Research Director: Project involved field and archival research in Washington D.C., Washington, Montana, Colorado, Missouri (Historical Study of Resource Record For Two Indian Reservations).

Experience with Schultz Organization

Research Director (as above)
Director of Social Attitudes Study - Grande Cache, Alberta.
Research Director and Field Analyst - Residential Study, Chilliwack.
Editor and Researcher - Integrated Forest Study, Saskatchewan.

Previous Work Experience

1948-1952	Agriculture/Range Worker, Australia.
1952-1958	Diamond Driller, Great Britain, Canada.
1958-1961	University Student - Summers in Drilling Industry, B.C.
1961-1970	Researcher (Geographical Studies) and some Post-Graduate work.
1970-1974	Research Director (Independent), mostly academic (Degree 1974).
1974-1975	Planner, City of Vancouver.
1975	Joined Schultz Organization.

Present Status

Mr. Horsman is currently a staff member of Schultz International Limited. He is employed primarily in directing research work, and performs various editorial duties. Mr. Horsman is responsible for supervising the social and economic division within the Schultz Organization.

Mr. Horsman is a doctoral candidate at Simon Fraser University. His dissertation topic is regional resource development and community participation in resource planning.

M.J. KENT

Degrees	B.A. (Honours), Geology, Simon Fraser University 1972. M.Sc., Physical Geography, University of Alberta, expected in 1975.

Experience

Mr. Kent was a compositor for a large book publisher for nine years before embarking on his undergraduate studies at Simon Fraser University. He worked as a salesman for a major Canadian retail company to finance his studies, and on completion of his B.A. in May 1972, he worked for the B.C. Provincial Parks Branch on a maintenance and construction crew for the summer of that year.

While studying for his advanced degree, Mr. Kent served as a Graduate Teaching Assistant, instructing the laboratory portions of various courses.

Mr. Kent carried out aerial photograph interpretation work for a land use study of the Cooking Lake Moraine, in May and June of 1974. He was employed for this work by Mr. J.D. Park, who had obtained a contract for the project from the Alberta Department of the Environment.

From September 1974, to April 1975, Mr. Kent was employed by Dr. A. Laycock, of the University of Alberta's Geography Department, to continue aerial photograph interpretation work for the Cooking Lake Moraine study. He was responsible for calculating and mapping water storage and albedo (light reflectance) values in the study area.

Mr. Kent has had extensive experience in the writing of reports and research papers, and has travelled widely throughout Europe, the Middle East, West Pakistan, the Bahamas and West Indies, Canada and the northern U.S.A.

At this time, Mr. Kent is coordinating a large, multi-disciplinary environmental assessment for a proposed coal mine on Alberta's East Slope.

Technical Activities

Member, Canadian Association of Geographers.

GEOFFREY MAINS

Place of Birth

Workington, Great Britain

Citizenship

Canadian

Academic Background

B.Sc.	(General Science)	University of Toronto, 1968
M.Sc.	(Biochemistry)	University of Toronto, 1970
Ph.D.	(Biochemistry)	University of Toronto, 1973

Killam Postdoctoral Fellow (Forest Ecology),
University of British Columbia
1973-1975

Fields of Special Competence

Environmental Planning and Management
Environmental and Ecological Chemistry
Ecosystem approaches to Resource Inventory and Development

Studies and Assignments in Canada

Ontario, Northern Canada, Alberta, British Columbia

Experience with Schultz Organization

1975 - present. Joined Schultz in December 1975.
Contributed to various reclamation and land use projects in B.C. and Alberta.
Developed an ecosystem approach for reclamation in alpine and subalpine coal mining operations.

Previous Experience

1973-75: Faculty of Forestry, U.B.C.
Studies of biochemical relationships between soils and vegetation in forest ecosystems.

GEOFFREY MAINS

Previous Experience (continued)

Studies of nutritional constraints on logging in subalpine forests.

Computer modelling studies of nutrient dynamics and decomposition processes in forest ecosystems.

Teaching in forest ecology, forest environmental management and chemical ecology.

1973: Planned Parenthood Association of British Columbia.
Honorary Secretary of Provincial Board, involved in developing and providing family planning services, and population education programs in British Columbia.

1973-1975: Independent Work. Developed concepts of and approaches towards steady state social and economic systems, derived partially from considerations of biological analogies. This work is now in a manuscript form, under consideration for publication.

1969-1973: Department of Biochemistry, University of Toronto.
Studies on the structure, function and evolution of enzymes.
Course work in aquatic ecology, animal and population ecology, and environmental chemistry.

Member of numerous staff-student committees dealing with teaching, research and program development in the Department of Biochemistry.

Studies of metal pollution from mining activities in soils and lakewaters of Sudbury, Ontario.

Studies of soil fluoride contamination from industrial activities in Hamilton, Ontario.

GEOFFREY MAINS

1969-1973:	Pollution Probe, University of Toronto.
	Founding member of one of Canada's most successful environmental groups.
	Developed public education programs, collected and organized information, involved in government lobbying, and extensively wrote and spoke on environmental matters. Projects included: Management of provincial parks, pesticide usage policy, sewage treatment, eutrophication, urban air pollution, solid waste disposal, and urban development. Helped initiate and contributed to a program enhancing public awareness of energy and resource conservation. This program, still in effect, is an important component of a nationwide lobby dealing with many aspects of arctic resource development, and Canadian energy policies.
1971:	Systems Research Group, Toronto. As part of a study for Energy Mines and Resources, Canada, produced reports on world environmental problems, and on the biological effects of pulp and paper pollution.
1971:	Mid-Canada Development Foundation. As a consultant to the Task Force on Environmental and Ecological Factors. Assisted in producing a conceptual framework of constraints and approaches to development in Canada North of the 60th parallel.
1968:	Ontario Department of Highways. Summer work involving on-site studies of high-stress concrete.
1967:	Ontario Department of Highways. Summer work consisting of soil surveys in Southern Ontario.

GEOFFREY MAINS

Professional Memberships:

Ecological Society of America.

Publications:

Dr. Mains has co-authored about a dozen papers and theses in the field of biochemistry, as well as consulting reports and literature surveys on subjects such as vanadium pollution, biological movement of organo-chlorine pesticides, and energy.

He was a major author of the book "Pollution Probe" (New Press, Toronto, 1970) and has written a biological overview of the environmental crisis "The Oxygen Revolution" published in both Canada and Great Britain.

As well as his most recently completed manuscript on steady state societies, Dr. Mains is working on a manuscript dealing with alternative Canadian futures.

MANFRED MALZAHN

Date of Birth

November 22, 1948

Place of Birth

Germany

Citizenship

Canadian

Academic Background

Simon Fraser University, B.A. (Honours), Geography, 1976. Specialized in Economic and Cultural Geography, with emphasis on Development Studies.

M.A. Candidate at McGill University, Montreal, Quebec.

Areas of Specialization

History of Economic Development in British Columbia; Resource-use and Settlement Patterns.

Experience

Research Assistant on research project dealing with economic and settlement history of British Columbia's central interior, (four months).

Several papers on various aspects of Central British Columbia.

Total 12 months employment as unskilled worker in mining exploration in British Columbia and Yukon.

Prior to attending University, worked for two years (unskilled) in the B.C. Forest Industry.

LEONARD WALDEMAR MOTTUS

Place of Birth

Alberta, Canada

Citizenship

Canadian

Academic Background

University of Montana, B.Sc. (Wildlife Technology), 1962

University of Alberta, M.Sc. (Zoology), 1969

University of Alberta, Ph.D. (Zoology), 1972

Awards

University of Alberta, Graduate Teaching Assistantship 1966-68.

University of Alberta, National Research Council Scholarship, 1968-71.

University of Alberta, Graduate Teaching Assistantship, 1971-72.

University of Manitoba, Post Doctoral Fellowship, 1972.

Fields of Special Competence

Environmental Impact Studies
Wildlife Ecology
Project Management
Multiple Land Use Planning

Studies and Assignments Inside Canada

British Columbia, Alberta, Saskatchewan, Manitoba, Yukon, and Northwest Territories.

Studies and Assignments Outside Canada

United States

Leonard Waldemar Mottus - continued

Experience With Schultz Organization

Vice President and Manager of Environmental Services of C.D. Schultz and Company Limited and Schultz International Limited.

Project Manager for environmental impact studies of the Mackenzie and Dempster Highways in Norther Canada.

Project Manager for environmental studies at the Poplar River thermal generation station and at three hydro power sites on the Saskatchewan River.

Project Manager for environmental impact assessments of several pipelines in British Columbia, including the Fireweed Pipeline, the Helmet Pipeline, the Territories Mainline Extension, and the Mainline Looping Program.

Project Manager of an evaluation of an oil spill in the Salmon River in Northern British Columbia.

Project Manager of an environmental study of a mining development in the Yukon Territory.

Senior biologist on a wildlife study in Northern Saskatchewan as part of a multi-disciplinary assessment of forest harvesting practices.

Project Manager of an environmental assessment of a coal development in the alpine region of Alberta.

Project Manager of an environmental program on a transportation corridor in Northern Alberta.

Project Manager of a fisheries study at a multi-plate culvert in the Northwest Territories.

Project Manager on the development of an environmental awareness training package for northern highway construction.

Numerous other senior consulting assignments to projects executed by the Schultz organization.

Previous Experience

1956-57 Surveyed timber berths for the Department of Lands and Forests of the Government of Alberta.

1957-58 Surveyed power lines for Farm Electric Services Limited, Alberta.

1962-63	Apprentice lineman on a powerline construction crew for Calgary Power Company, Limited, Alberta.
1963-65	Supervised the construction of transmission lines as an engineering assistant for Calgary Power Company Limited, Alberta.
1965-72	Various research projects related to animal behavior in Alberta and Manitoba. Studies included social behavior of coyotes, ethology of white-tailed deer, movement studies of carp, and a small mammal survey. Also taught several courses in biology, zoology, and comparative animal behavior.
1972	Joined Schultz Organization.

Professional Memberships

Canadian Society of Environmental Biologists
American Association for the Advancement of Science
National and Provincial Parks Association of Canada
Canadian Society of Zoologists
American Society of Mammalogists

Related Activities

Vice President (B.C. Chapter), Canadian Society of Environmental Biologists, 1974.

Publications and Presentations

Mottus, L.W., 1969. General Activity and Maintenance Behavior of Coyotes in Captivity. Unpublished M.Sc. Thesis. University of Alberta, Edmonton, Alberta.

Mottus, L.W., 1969. The Coyote And The Moon. Unpublished paper presented at the 8th Annual Convention of the Canadian Association for Laboratory Animal Science, Edmonton, Alberta.

Mottus, L.W., 1971. Barometric Pressure - The Neglected Variable. Unpublished paper presented at the 5th Annual Prairie Universities Biology Students Conference, Regina, Saskatchewan.

Mottus, L.W., 1972. Activity of Coyotes And The Lunar Cycle. Unpublished paper presented at the 6th Annual Prairie Universities Biology Students Conference, Edmonton, Alberta.

Leonard Waldemar Mottus - continued

Mottus, L.W., 1972. Differential Responses of Captive Coyotes to Various Canid Scents. Unpublished Ph.D. Thesis. University of Alberta, Edmonton, Alberta.

Mottus, L.W., 1974. A Systematic Approach to Building An Environmentally Sound Highway. Paper presented at a symposium entitled "New Requirements in Road Construction", sponsored by the Centre for Continuing Education, University of B.C.

Appearances Before Regulatory Boards and Commissions

National Energy Board of Canada.

SCHULTZ

PETER E. OSTERGAARD

Place of Birth

Valleyfield, Quebec, Canada

Date of Birth

August 1, 1951

Citizenship

Canadian

Academic Background

Queen's University at Kingston. B.A. (Honours, First Class), Geography, 1973.

University of British Columbia. M.A. Geography, 1976.

Areas of Specialization

Northern Settlements, Quality of Life Studies, Housing, and Neighbourhood Studies, Urban and Regional Planning in Northern Communities.

Publications

Dimensions of Interprovincial Tourist Flows, Canadian Government Travel Bureau, Marketing Research Paper, Ottawa, 1972. 20 pp.

Isodemographic Maps of Canada 1867-2001. Maps and text prepared for Ministry of State for Urban Affairs, Ottawa, 1973.

A Geographical Marketing Model of Automobile Tourist Flows From The United States to Canada. Canadian Government Office of Tourism Research Report, Ottawa, 1974. 68 pp.

"Objectives and Concerns for Development in the Prince George Region" - The Caledonian, 5:1 (January 1976).

Peter E. Ostergaard - continued

Quality of Life in Yellowknife, N.W.T. Dept. of Indian Affairs and Northern Development (forthcoming).

Previous Work Experience

Summers 1971, 1972: Field Assistant, Geological Survey of Canada, Lower Mackenzie Valley, N.W.T.

Summer 1973: Research Officer, Canadian Government Office of Tourism, Ottawa.

1973-75: Graduate student and Teaching Assistant, University of B.C.
Part-time Lecturer at Vancouver City College and Capilano College, North Vancouver (Geography).

1975-76: Instructor in Geography, College of New Caledonia, Prince George, B.C.

Present Status

Mr. Ostergaard is returning to Prince George as a College Instructor for the 1976-77 academic year. During the summer he is employed part-time as a socio-economic researcher and consultant. In addition to his college teaching responsibilities, he occasionally conducts surveys and prepares reports for regional and municipal planning departments.

DAVE G. PATON

Degree	B.Sc. Zoology and Botany (1972), University of Manitoba
Experience	While completing his degree at the University of Manitoba, Mr. Paton worked as a fishing guide, surveyor and research assistant. Upon graduation in 1972, he worked as a research assistant on the Churchill-Nelson Impact Study on hydro developments.

Prior to joining Schultz International Limited, Mr. Paton was involved in consulting activities in Alberta and the Northwest Territories. His work included detailed vegetation studies on the Mackenzie Highway, biological inventories of the Tar Sands area, and aerial photointerpretation.

Mr. Paton joined Schultz International in 1975 to assist environmental impact assessments of pipeline and coal mine developments in western Canada.

He also prepared an environmental overview of a major highway transportation corridor designed for northern Alberta.

STEPHEN PATTISON

Degrees

B.A., Simon Fraser University, 1969.

Major in Cultural and Economic Geography, Minor in Sociology and Communications.

Experience

In 1967, Mr. Pattison was a laboratory instructor in the Geography Department at Vancouver City College, giving instruction in geomorphology and cartographic techniques. In 1969, he became a researcher with bibliographic services at the Simon Fraser University Library, specializing in Government documents.

In 1971, Mr. Pattison conducted development studies for the Rural Development Office, B.C. Department of Agriculture, concerning several British Columbia native Indian Bands. The report which he wrote focused on development problems and approaches to fishing, forestry and aquaculture in the Ocean Falls Regional District.

In 1972, Mr. Pattison researched and assisted in writing a social-geographic guide to Vancouver Island. In 1973, Mr. Pattison became a production assistant for community liaison at radio station CJVB, a multi-lingual/multi-ethnic radio station in Vancouver.

Since joining the Schultz organization in 1974, Mr. Pattison has been involved in Arctic environment assessment and integrated resource development projects. He prepared an environmental handbook for the use of northern highway construction crews. He has been manager of several research projects to investigate permafrost deposits and terrain/ vegetation stability on certain gas pipeline routes in northeastern B.C. and adjacent territories.

Mr. Pattison is project manager for a major study on rural social-economic development based on forest industrial development. A community development program was prepared for three native Cree villages in the lower Peace River valley of northern Alberta.

Stephen Pattison - continued

Technical Activities — Member, Canadian Association of Geographers

Publications — S.L. Pattison, Ocean Falls Regional District - A Rural Development Study, Dept. of Agriculture, Victoria, 1971.

with K.M. Pattison, Milestones on Vancouver Island: A Concise Guide to Historical and Geographical Points of Interest, Milestone Pub., Victoria, 1973.

Schultz International Limited, Environmental Handbook for Northern Highway Construction, Dept. of Public Works, Edmonton, 1975.

JANET M. TEVERSHAM

Place of Birth

Welwyn Garden City, Herts, England

Date of Birth

March 17, 1947

Citizenship

Canadian

Academic Background

B.Sc. (Geography), University of Birmingham, England, 1968.

M.A. (Geography), University of British Columbia, 1973.

Fields of Special Competence

Plant Ecology

Studies and Assignments in Canada

Lillooet Valley, Pemberton, B.C.
Fraser Valley Floodplain, B.C.
University Endowment Lands, Vancouver, B.C.
Beaufort Sea Coast, Yukon Territory
Athabasca Tar Sands - Surficial Geology, Alberta
Coalmine Environmental Study, Rocky Mountains, Alberta

Studies and Assignments Outside Canada

United Kingdom
France
Tanzania

Publications

Teversham, J.M. and O. Slaymaker. "Vegetation Response to Fluvial Activity in the Lillooet Valley, B.C." In press.

Janet M. Teversham - continued

Experience With The Schultz Organization

1. Surficial Geology - Interpretation and Mapping of the Athabasca Tar Sands.

2. Review of Coal Mine, Environmental Study, Alberta.

Previous Experience

1968-1970	Teacher at Ashira Girls Secondary School, Tanzania.
1970-1971	Teacher at St. Constantine's School (Greek), Tanzania. Grades 4-6.
1971-1974	Teaching Assistant, University of British Columbia. Physical Geography 101, Biogeography 315, Forestry Biometrics 430.
1971-	Student, M.A. Thesis: "Vegetation Response to River Change in the Lillooet Valley Near Pemberton, British Columbia". This was a study of the vegetation found on the floodplain and its relationship to sediment type, flooding frequency and channel movement.
1974-	Physical Scientist on a Geological Survey of Canada Research Team. Botanical, Surficial Deposits, and land surveying work was carried out between Herschel Island and Shingle Point, Yukon Territory.
1974-1976	Sessional Lecturer at the University of British Columbia teaching Physical Geography and Ecology.
1976-	C.D. Schultz and Company Limited.

APPENDIX VI

REFERENCES

REFERENCES

Alaska Natural Gas Transportation System, 1976.
Final Environmental Impact Statement - Canada. United States Department of the Interior, Washington, D.C.

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