This project is a contribution to the Canada/British Columbia Mineral Development Agreement 1985–1990.

Province of British Columbia Ministry of Energy, Mines and Petroleum Resources

Energy, Mines and Resources Canada Énergie, Mines et Ressources Canada

ISKUT VALLEY ROAD OPTION STUDY

Report
to
B.C. Ministry of Energy, Mines
and Petroleum Resources

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA D. SMITH

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SUMMARY

This report presents an assessment of corridors that can be developed to provide road access along the Iskut, Unuk and Craig Rivers in northwestern British Columbia. The study is focussed on engineering factors, including feasibility, road alignment and cost, but environmental considerations have been addressed in an overview manner utilizing information compiled from existing sources.

The study involved a review of previous engineering and geological reports supplemented by detailed terrain analysis of the corridors by aerial photo interpretation. Road alignments were established on 1:10,000 scale topographic maps produced for the study and field checked for engineering aspects by helicopter reconnaissance in July 1989. Construction and maintenance costs of the road were established.

A draft report was prepared in April 1989 in advance of field checking and submitted to Federal and Provincial Government agencies for review. Where appropriate, comments received from these agencies have been incorporated into the finalized report.

This study was funded jointly by 19 mining/exploration companies and by the governments of Canada, through the Department of Energy, Mines and Resources, and British Columbia, through the Ministry of Energy, Mines and Petroleum Resources, under the Canada/British Columbia Mineral Development Agreement.

The companies that contributed to the study are: Cominco Ltd., Skyline Gold Corporation, Sulphurets Gold Corporation, Echo Bay Mines Limited, Consolidated Silver Standard Mines Limited, Newhawk Gold Mines Ltd., Prime Resources Corporation, Calpine Resources Incorporated, Pezgold Resource Corporation, Adrian Resources Ltd., Ticker Tape Resources Ltd., Cheryl Resources Inc., Magenta Development Corp., Link Resources Inc., Crest Resources Ltd., Corptech Industries Inc., Equity Silver Mines Limited, Homestake Mineral Development Company and Mingold Resources Inc.

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THURBER

Section 1

INTRODUCTION

1.1 GENERAL

This report presents an assessment of potential road corridors in the Iskut and Craig River valleys between Highway 37 near Bob Quinn Lake and the Alaska-B.C. border and along the Unuk River valley as far as the Sulphurets Creek area. Schedule A of the Terms of Reference for the study, prepared by the Ministry of Energy, Mines and Petroleum Resources (MoEMPR) provides a comprehensive rationale for the study. A summary of this rationale is presented below.

The lower Stikine, Iskut and tributary river valleys have exceptional mineral potential, significant timber resources and wilderness recreation opportunities. However, lack of infrastructure, and particularly road access, has consistently been identified as a main constraint to development and results in use of air transportation out of Wrangell, Alaska for support of much of the present mining activity in the area.

Road access into the area will:

- Reduce the operating costs of existing air-supported mines and permit development of deposits with lower grade ores that could not bear the cost of air support.
- Provide access to areas of undeveloped timber in the lower Iskut and Unuk River valleys that are otherwise uneconomic.
- Enhance the tourist potential of the lower Iskut and Stikine River valleys.

The corridor systems analyzed during the study and nodes used to identify corridor segments are shown on Dwg. 15-8-10-1 and defined as follows:

- Iskut Road East (A-B)
- Unuk Road (B-E)
- Iskut Road Central (B-C)

- Iskut Road West: North Corridor (C-D)
- Iskut Road West: South Corridor (C-G)
- Craig Road (C-F)

Node C at the Bronson Creek airstrip is defined as the destination for the Iskut and Craig River corridors with the assumption that access to Node C would be provided either from Highway 37 (via A-B-C) or from the Stikine River (via D-C or G-C) or from the international border down the Craig River (via F-C).

A draft report dated April 13, 1989, was prepared in advance of field checking of the proposed road corridors and submitted to Federal and Provincial Government agencies for review. Where appropriate, comments received from these agencies have been incorporated into the finalized report.

1.2 SCOPE OF STUDY

Terms of Reference for the study are given in Schedule A of the Agreement between Thurber Consultants Ltd. (TCL) and the MoEMPR and are not included herein. In summary, the study objectives are to:

- Recommend preliminary road alignments within the Iskut, Craig and Unuk River valleys based on sound geotechnical evaluation, cost and consideration of other resource values.
- To estimate capital and maintenance costs for roads equivalent to Ministry of Forests' Class 2 and Class 5 standards.
- To identify and provide an overview of salient environmental concerns.

The Terms of Reference have been closely followed during the study.

1.3 STUDY TEAM

The study has been carried out with TCL as prime consultant responsible for coordination and geotechnical aspects of the study, and the following subconsultants:

- DeLCan Corporation, for highway engineering and cost estimating.
- Norecol Environmental Consultants Ltd., for the environmental component.
- Nadir Mapping Corporation, for preparation of topographic mapping.

The report has been prepared by TCL using input provided by DeLCan and Norecol and represents the joint views of the study team.

1.4 ROAD DESIGN STANDARDS

Design standards for a Class 5 road are defined by the Terms of Reference as follows:

- 5 m wide travelled portion.
- 8% maximum grade with 10% for up to 100 m.
- 5% maximum grade on switchbacks with 20 m minimum radius.
- Bridges designed for 90 tonne loading and 200 year flood.
- Cut and fill slopes at 2H:1V, unless competent materials permit steeper slopes.

The Class 2 road has similar standards to the above except for increased width, defined as 7 to 9 m travelled portion.

Section 2

STUDY PROCEDURE

2.1 PROJECT INITIATION

Tasks carried out to initiate the study comprised a review of existing documentation, as listed in the References, and analysis of 1:50,000 scale NTS topographic maps to establish potential road corridors in the Iskut, Unuk and Craig River valleys. The topography shown on the 1:50,000 scale NTS maps clearly indicated that, east of Bronson Creek in the Iskut Valley and in the Unuk and Craig Valleys, it was possible to define a band, generally no more than 1 km wide, which enclosed economically feasible road alignments between nodes, contrary to the process anticipated in the Terms of Reference of evaluating corridor options between nodes. These bands were established prior to the February 6, 1989 meeting with the Iskut Road Review Committee in Victoria to expedite the study and permit 1:10,000 scale photogrammetric mapping to proceed. NTS maps at 1:50,000 scale showing the proposed mapping limits east of Node C were tabled at the meeting to demonstrate that road corridors other than those selected for mapping would have required unnecessarily difficult terrain to be traversed.

West of Bronson Creek along the Iskut River to the Stikine, the 1:50,000 scale topography indicated that a road was feasible on either the north or the south side of the Iskut River. Subsequent to the March 6 meeting, the Review Committee concluded that 1:10,000 scale mapping should be prepared for the North Corridor, with 1:50,000 scale mapping to suffice for the South Corridor. Furthermore, we were advised by Mr. R. Crook (pers. com., February 23) that the Iskut Road West corridors were to stop at the east bank of the Stikine River.

Detailed descriptions of the subsequent work carried out for each study component are presented below.

2.2 GEOTECHNICAL

A geotechnical terrain analysis was carried out for the corridor system by studying over 200 medium-scale aerial photos and transferring photo interpretive mapping onto the 1:10,000 scale topographic maps. The terrain maps are included in a separate map folio which does not form part of this report.

The terrain analysis for the Iskut Road West-South Corridor was completed on 1:50,000 scale base maps.

Each segment of road was classified into one of 4 units in terms of terrain conditions and construction cost, in accordance with the system described in Section 6.1.

2.3 HIGHWAY ENGINEERING

A road alignment was defined in each corridor on the 1:10,000 scale topographic maps, except for Iskut Road West-South Corridor, for which 1:50,000 mapping was used. The alignment was selected to satisfy the grade requirements given in Section 1.4 and to take into account the geotechnical terrain constraints provided by TCL. Road alignments are shown at 1:10,000 scale on Dwg. 15-8-9-3, which is contained in a separate map folio, except for the Iskut Road West-South Corridor alignment and part of the North Corridor which is shown at 1:50,000 scale on Dwg. 15-8-9-2 in the Appendix.

Unit costs for road construction under varying conditions were established and applied to each road corridor for Class 5 and 2 standards. Maintenance costs were also estimated.

2.4 ENVIRONMENTAL

The environmental objectives for the study are summarized as follows:

- To review previous unpublished and published reports, plans, projects, mapping programs and

other sources to provide baseline information regarding natural resources.
- To describe the resource potential of the Iskut, Craig and Unuk River valleys.
- To present an environmental overview for each road corridor.

The environmental information presented in the report is regional and based on information compiled from available sources and mapped at 1:250,000 scale. The information does not represent detailed site specific or local conditions.

The intent of the environmental study was to provide an overview of resources in the Iskut region, to allow identification of potential conflicts and possible areas where more detailed information will be required. Comments submitted by Federal and Provincial Government agencies following review of the draft report refer, in general, to more detailed information requirements appropriate to the next phase of environmental ground-truthing and alignment study.

2.5 FIELD RECONNAISSANCE

A 2-day reconnaissance of the proposed road alignments was carried out July 24-25, 1989 by Mr. D. Smith of TCL, Mr. R.J. Walker of DeLCan and Mr. J. Brenner of MoEMPR.

Helicopter over-flights were utilized to confirm the general engineering feasibility of the 1:10,000 scale road alignments and establish that terrain conditions did not require major realignment in any area. No ground traverses were carried out.

Environmental study personnel did not participate in the reconnaissance.

Section 3

GENERAL DESCRIPTION OF CORRIDORS

3.1 GENERAL

The 250 km corridor system is shown on Dwg. 15-8-9-1. A brief description of each corridor is presented below. Geological and terrain conditions are described in Sections 4 and 5 respectively.

3.2 ISKUT ROAD EAST (A-B)

This 40 km oorridor descends the south side of the Iskut Valley from Node A on Highway 37 to Node B near Volcano Creek. The first few kilometres from Node A follow an existing logging road. B.C. Hydro's Reserve for the Iskut River Hydroelectric Development extends to el. 347 for about 12 km of the corridor. Node B, on the south side of Volcano Creek, is the starting point for the Unuk Road.

3.3 UNUK ROAD (B-E)

This 42 km corridor ascends the valley of Volcano Creek to the Iskut-Unuk drainage divide and then south into the Unuk Valley. Steep rock slopes and continuous steep grades are characteristics of this corridor. The Unuk River is crossed near the southern end of the corridor at the junction of the Unuk and South Unuk Rivers.

3.4 ISKUT ROAD CENTRAL (B-C)

This 32 km corridor continues down the south side of the Iskut Valley to the Bronson Creek airstrip at Node C. This corridor has much low-relief terrain formed by post-glacial lava flows. Node C is the starting point for the three remaining corridors to the west and southwest.

3.5 ISKUT ROAD WEST - NORTH CORRIDOR (C-D)

This 54 km corridor gives access to the north side of the lower Iskut Valley. A major bridge crossing of the Iskut River is required at km 11.7. The corridor reaches the Stikine Valley and turns northward to end at the Choquette River (Node D). The corridor is characterized by highly variable construction conditions including rockwork, locally abundant sources of granular borrow and traverses of floodplain and wetlands.

3.6 ISKUT ROAD WEST - SOUTH CORRIDOR (C-G)

This 55 km corridor stays entirely on the south side of the Iskut River. The corridor extends west from Bronson Creek with several bridges required in the Craig River Valley. The corridor follows the south margin of the Iskut Valley across several alluvial fans, terraces and wetland areas as well as till and bedrock slopes. On the approach to the Stikine River, a major wetland area will have to be avoided by building across levees and marginal wetlands along the the Stikine River

3.7 CRAIG ROAD (C-F)

This 28 km corridor extends from Bronson Creek to the Alaska Border (Node F) in the upper Craig River valley. Much of the corridor traverses fan, terrace and wetland alluvium of the Craig River.

Section 4

ENGINEERING GEOLOGY

4.1 BEDROCK GEOLOGY

The bedrock geology of the study area is compiled in a 1:1,000,000 scale map by Souther et al. (1979). More detailed mapping by Grove (1986) covers the Unuk Road corridor.

Much of the eastern third of the study area is formed by folded and slightly metamorphosed siltstone and greywacke at the northwest margin of the Bowser Basin. The remaining area is formed by plutonic, volcanic and some high-grade metamorphic rocks.

There are several Pleistocene and recent (Holocene) basaltic volcanoes in the area; some are described by Grove (1986). Post-glacial lava flows extend about 25 km down the Iskut Valley in the Iskut Central Corridor. While these flows may have issued from the small volcano near Node B, our study suggests there is another volcano on the north side of the Iskut River just east of the mouth of Forrest Kerr Creek. Hoodoo Mountain is an ice-capped volcano on the north side of the Iskut River. Its Pleistocene to Holocene flows cross the road corridor in the area.

The geologic mapping and photo evidence indicates bedrock in the area is generally resistant and competent. However, excavation in the Holocene volcanics may encounter weak zones or soil-rock material with adverse geotechnical characteristics.

4.2 SURFICIAL GEOLOGY

The surficial geology of much of the study area is mapped at 1:250,000 scale by Ryder and LaCelle (1984) and TCL (for Ian Hayward and Associates, 1982). Pedology Consultants Ltd. (1983) mapped terrain in the eastern third of the area at a scale of 1:50,000. The report by Ryder (1984) summarizes terrain conditions in the region.

The study area lies within the Coast Mountains. The region was covered by the Cordilleran Ice Complex until about 10,000 years ago. Remaining alpine glaciers are generally retreating from Neoglacial maximum positions of about 100 years ago.

The Iskut Valley widens in the area of Forrest Kerr Creek although it is deeply cut into recent lava flows as far downstream as Bronson Creek. Below Bronson Creek, the sediment-laden Iskut River is heavily braided and anastomosed to its confluence with wide valley of the Stikine River.

Alpine glaciers and meltwater streams shed debris which forms major alluvial and colluvial fans at several locations. The great fans of Twin River, Hoodoo Creek and Johnson Creek are especially notable on the north side of the Iskut River. The Twin River fan has forced the Iskut against a bedrock ridge to provide a relatively narrow bridge crossing of the Iskut River on Corridor C-D. Several smaller alluvial-colluvial fans have potential for granular borrow.

Beyond the main valley floors, the road corridors generally encounter shallow (less than 2 m) deposits of till and colluvium. Geotechnical properties of the area soils are not documented. Silty to sandy till and colluvium with adverse moisture characteristics are expected in many areas. Volcanic flows may yield much angular rubble.

Many alluvial-oolluvial fans are important potential sources of granular borrow. The geotechnical characteristics of these deposits are not documented.

4.3 TERRAIN HAZARDS

The aerial photo study indicates there is a widespread contrast in soil stability between north and south-facing slopes. Steep north-facing slopes show evidence of soil creep in shallow soil material The contrast is especially evident on bedrock controlled ridges and high slopes in the Iskut East corridor. The contrast in soil slope conditions may in part be due to persisting snow cover on the north facing slopes. Where a choice can be made, roads should be located on south-facing slopes to minimize construction and maintenance difficulties.

Steep, unstable slopes occur in the Iskut Road East Corridor above the B.C. Hydro Reserve. In addition, steep side slopes in the Unuk Valley may present major geotechnical difficulties.

Some snow avalanche tracks may be crossed but the proposed road corridors generally avoid major avalanches. Where avalanche tracks must be crossed, the alignment should be finalized in the field to minimize the potential hazard.

No major landslide and rockfall areas are traversed by the corridor systems. In spite of this, continuous attention to local rockfalls, debris avalanches and debris slides will be required during detailed road location surveys.

Active, distributary channel systems on large alluvial-colluvial fans will require entrainment and erosion protection works. Glacier outburst floods may pose significant debris flow or flood hazards on some of the fans in the area (see Ryder, 1984, p. 53).

4.4 FROZEN GROUND

The study area is near the southern limit of the permafrost zone (Brown et al., 1981). Ryder (1984) noted frozen ground in bogs and palsas (organic mounds) in the region. Discontinuous (and possibly degrading) permafrost or persistent frozen ground may occur in favourable settings such as north-facing slopes and organic soils.

Permafrost and related geomorphic processes such as frost-heave should be expected in alpine areas. The Unuk Road corridor crosses an alpine divide between the Iskut and Unuk Rivers. In this area, the extensively exposed bedrock may contain veins of icy permafrost.

4.5 VOLCANIC HAZARDS

The Holocene eruptions in the Iskut Valley and adjacent areas (Grove 1986, p. 61-64) suggest there may be a low probability of volcanic activity in the Iskut Valley (Souther, 1981). Volcanic eruptions occurred about 130 years ago on a tributary of the Unuk River about 25 km south of the study area (Grove, 1986, p.64).

Section 5

TERRAIN ASSESSMENT

5.1 GENERAL

Terrain conditions in each of the corridors are described below, with emphasis on conditions and features which may affect road building and maintenance. Kilometre stations referred to in the description start at zero working west or south from each of Nodes A, B and C. Reference should be made to Dwg. 15-8-9-1 for the locations of major features.

5.2 ISKUT ROAD EAST (A-B)

The road alignment in this corridor must consider a Flood Reserve established at el. 347 m by B.C. Hydro for the proposed Iskut River Hydroelectric Development.

The proposed alignment leaves Highway 37 and descends across till and bedrock slopes to the Ningunsaw River valley. The first few kilometres from Highway 37 follow an existing logging road system which has not been located accurately on 1:10,000 scale mapping. Therefore, some revision to the road alignment shown on Sheet 5 of Dwg. 15-8-9-3 may be required during final location studies.

The Ningunsaw River is crossed with a bridge at km 5.3. At km 6, the road ascends till and bedrock slopes along the Ningunsaw and turns southwest into the Iskut Valley.

From km 14 to km 36, the proposed road alignment is on the Iskut Valley floor within the Hydro Reserve. An alternative alignment which stays above the Reserve is also shown on Dwg. 15-8-9-3. The lower alignment is recommended in order to:

- Avoid significant areas requiring bedrock excavation on the alignment above the Reserve.
- Avoid steep, unstable slopes above the Reserve for about 4 km on the approaches to Bill Creek.

These slopes are expected to cause significant maintenance problems.

- Provide a road which is 2 km shorter than one which entirely avoids the Reserve and requires a long side hill traverse up Bill Creek valley.

Thus, although riprap protection will be required for the proposed alignment on the valley floor, and the road would need to be relocated above el. 347 m when the Iskut Reservoir is formed, we believe the recommended alignment should be utilized.

On the proposed alignment, from km 14, the road begins to follow the Iskut Valley floor on low river terraces and active alluvium. At about km 23, the road reaches the alluvial fan of Bill Creek and continues onto a bridge crossing of this creek at km 24.2.

From Bill Creek, the proposed route continues across terrace and floodplain alluvium on the south margin of the Iskut Valley to km 36.

At km 36, the proposed route ascends to the Hydro Reserve across till and bedrock slopes on a steep ascent toward a bridge crossing of Volcano Creek at km 39. As the road approaches this crossing, it avoids large avalanche tracks and canyon walls above and below the bridge site. The route continues 1 km across lava flows to reach Node B at km 40.

Granular borrow is available at the Ningunsaw Crossing and Bill Creek (km 5 and 24 respectively). We assume granular borrow can be extracted from low terraces along the Iskut River and from fan deposits in the area of km 38 and 40.

5.3 UNUK ROAD (B-E)

This 42 km corridor requires a steep ascent from the Iskut valley to the alpine drainage divide between the Iskut and Unuk Rivers. From km 0 (Node B), at the base of a volcano, a switchback ascent is required to km 3 where the alignment is above a severe canyon at the narrow entrance to the upper valley of Volcano Creek.

From km 3.2 to 7.4, the road ascends fan alluvium, till and bedrock on the floor of Volcano Creek Valley. This 4 km sector offers the last opportunities for granular borrow until reaching the Unuk River valley about 23 km to the south. Volcano Creek will be crossed at km 5.

At km 7.4, the road begins its steep ascent to the head of the valley with almost continuous bedrock. Avalanche tracks may have to be crossed between km 8.6 and 10. Beyond km 10, the road traverses alpine terrain. The Iskut-Unuk drainage divide is crossed at about km 14 as the road traverses bedrock terrain. The summit of the road at el. 1110 m is reached as the road cuts through a prominent ridge at km 18. Between km 18 and 19, the road traverses rocky alpine terrain before leaving the alpine area to descend to the Unuk Valley.

Very difficult geotechnical conditions are expected as the road descends at maximum grade across bedrock-controlled steepland slopes between km 19 and 30.8 near the Unuk Valley floor.

From km 30.8 to the Unuk River bridge crossing at km 38.2, the road crosses mixed ground including till, much bedrock and and several alluvial fan deposits where granular borrow may be found.

South of Unuk River bridge, most of the route crosses fan and terrace alluvium and several wetland areas. Some granular borrow sources are expected in this sector. The bridge crossing of Sulphurets Creek is at km 39.2. The route continues to Node E (km 42) on alluvial and wetland soils.

5.4 ISKUT ROAD CENTRAL (B-C)

This 32 km corridor crosses lava flows on the south side of the Iskut Valley from km 0 at Node B to km 22.4. The longitudinal gradient is minimal with nearly flat cross slopes over most of this sector. The Iskut River flows in a basalt-walled canyon to the north of the alignment. Several of the major stream crossings in the sector lie above tributary canyons of the Iskut River.

From km 22.3 to Bronson Creek at km 32, most of the route encounters bedrock. Severe avalanching will be avoided from km 25 to 29 by locating the route on steep, south-facing, bedrock slopes. Node C is at the foot of bedrock slopes near the Bronson Creek airstrip just beyond the required Bronson Creek bridge at km 32.

Other bridges are required at Jennifer Creek (km 9.2), Seth Creek (km 10.7) and Snippaker Creek (km 17.5).

Granular borrow is expected in fan deposits near each of the bridge crossings and near km 7, 15 and 29.2

5.5 ISKUT ROAD WEST - NORTH CORRIDOR (C-D)

This 54 km corridor extends from the Bronson Creek airstrip to the Choquette River in the Stikine Valley. The corridor has a variety of ground with several areas of difficult construction.

Km 0 to 3.6 is common to the 3 corridors which start at Node C. This sector will be built across steep bedrock on the north side of the valley occupied by tailings ponds for the SNIP property. An alternative alignment on the south side of the narrow valley may require several avalanche crossings and cause interference with operations at SNIP.

After a narrow wetland crossing at km 3.5, the route continues across several ridges to an alluvial terrace of the Craig River at km 4.2. Granular borrow may be available in the terrace between km 4.6 and 6. The road then begins its ascent of a complex bedrock ridge which is traversed until the Iskut River is reached at km 11.7.

The Iskut River Bridge will be a major structure requiring thorough geotechnical and hydrological investigation. The south abutment will likely be set on bedrock but piers and the north abutment will be in alluvial deposits. The bridge is expected to be about 120 m in length.

The Twin River alluvial fan is reached at km 11.8 where the road turns west across several distributary channels and fan deposits which will provide granular borrow. Lava flows from Hoodoo Mountain lie just north of the route near km 13 where it begins to cross a narrow wetland and a short piece of steep rockwork at km 14.3. From km 14.3 to km 15, the proposed route is located along the margins of the Iskut floodplain to avoid a very steep rock section.

From km 15 to 17.8, the road must be built on some very steep slopes formed by the lava flows of Hoodoo Mountain directly above the Iskut River. The road begins its 8 km traverse of the great fan of Hoodoo Creek at km 18. This fan offers abundant granular borrow. Hoodoo Creek will be crossed with a bridge at km 21.6.

After a short wetland crossing at km 25.8, the road traverses rugged bedrock terrain as far as km 35.4. Some small river terraces and fan complexes may be crossed near km 28, 31 and 32. A stream at km 32.4 is expected to require a bridge.

From km 35.4 to 46.5 the route traverses wetlands on the north side of the Iskut River, including a 5 km traverse of the Johnson River alluvial fan. A bridge is expected at the Johnson River crossing at km 42 and at several other stream crossings. Abundant granular borrow is expected from the Johnson River fan and colluvial fans near km 46.

From km 46.5 to km 52.3, the road follows the base of steep, to very steep, forested bedrock slopes that curve northward into the Stikine Valley. Much end-haul construction may be necessary. Abundant granular borrow will be found at the ends of this sector. The road can be built on low river terraces between km 48 and 49. A bridge is expected at km 48.

At km 52.3, the road reaches the large alluvial fan of the Choquette River. This fan offers abundant supplies of granular borrow. The corridor ends at Node D, km 54, on the south side of the Choquette River.

5.6 ISKUT ROAD WEST - SOUTH CORRIDOR (C-G)

This 55 km corridor was studied on aerial photos for alignment and terrain mapping on 1:50,000 scale NTS maps. Although the route has marginal geotechnical advantages over the North Corridor, it requires an adverse 7 km long floodway approach to a very long bridge across the Stikine River proposed by the B.C. Ministry of Highways (MoH) in 1978. The route will require 10 other bridges and significant incursions into the Craig, Iskut and Stikine floodplains and wetlands.

The first 8 km of this corridor are common with the North Corridor (see Section 5.5). The proposed route leaves a bedrock ridge near km 8 and begins the 5 km wide crossing of the complex channel system of the lower Craig River. As many as 5 bridges may be required including the major crossing of the Craig River at km 13. Granular borrow will be available in low terraces. Several wetland areas will have to be crossed.

At km 13.4, the route strikes across a bedrock-controlled slope directly above the Craig River channel as far as km 14. From km 14 to 15.6, the road will cross mixed till, bedrock and colluvial terrain including a prominent spur at km 15.2. Several avalanche areas occur in this sector.

From km 15.6 to 16.6, the road crosses the alluvial fan of Zippa Creek with its bridge at km 16.1. This fan may supply granular borrow. West of km 16.6, the road will cross an irregular, north-facing slope formed of till, bedrock and colluvium. Several snow avalanche tracks can be avoided at the west end of this sector which ends in the area of km 20.

From km 20 to 30, the road crosses complex fluvial features including fans, terraces and wetlands. The road follows a narrow terrace along the south bank of the Iskut River between km 20 and 20.8. The alluvial fan of Fizzle Creek is crossed between km 20.8 and 23.4 with a bridge at km 22.3. The road extends westward over more alluvial deposits to the large fan of the Inihini River at km 27.9.

The bridge crossing of the Inihini is located at km 29.6. The route continues across a short segment of this fan and reaches bedrock sideslopes above an extensive wetland at km 30. Granular borrow is available at several locations in this 10 km sector.

From km 30 to 31.9, the road encounters bedrock before regaining alluvial fan and terrace features at km 31.9. These deposits continue along a major side channel of the Iskut River to km 34.6.

From km 34.6 to 40.7, the road traverses bedrock controlled side slopes directly above the Iskut River. There are several very steep side slopes and a number of steep gully crossings in this segment. Small alluvial-colluvial fans may be encountered at km 37.5 and 40.6. Caralin Creek is expected to require a bridge at km 37.5. The proposed road leaves the bedrock terrain at km 40.7 to traverse till slopes and a river terrace along the Iskut River as far as km 42.6.

The remaining 11 km of approach to the Stikine River bridge avoids a direct crossing of a very large wetland area on the east side of the valley. The last 4 km of the proposed route coincides with the MoTH 1978 alignment. Heavy riprap protection of fills will be required along much of this segment.

The proposed road strikes across alluvial terrace and fan deposits at the mouth of the Iskut River from km 42.6 to 46.6. Some wet ground may be encountered but abundant granular borrow may be available in the area of km 44. At km 46.6, a bridge across a side channel reaches a large, forested island formed of low terraces and flood channels of the Stikine. A second bridge at km 48.6 connects the island to a narrow levee at the outside of the east main channel of the Stikine River. The levee system is followed to the bridge site at Node G, km 55. An alternative alignment (which avoids the need for the two bridges) may be available along a narrow levee and across muskeg floodways to the east.

5.7 CRAIG ROAD (C-F)

This 28 km corridor ascends the valley of the Craig River to the Alaska border. The Craig headwaters extend southwestward another 15 km to a steep alpine pass. Much of this route can be built on alluvial terraces, fans and adjacent wetlands.

Most of the first 6 km of this road will be built over bedrock-controlled terrain on a southward approach to the Craig Valley (also see Section 5.5). From km 6 to the proposed Craig River bridge at km 9.8, the road crosses low river terraces, some wetlands and a short sector of steep bedrock. Granular borrow is anticipated near km 6 and near the bridge site. A 120 m long bridge is anticipated for the Craig. Foundation soils are expected to be coarse alluvium.

After a short section of rockwork at km 10, the road crosses a large alluvial fan where an abundant supply of granular borrow is available. From km 11.4 to 12.2, a steep bedrock sidehill will be traversed with a low river terrace and wetlands beyond as far as km 14. After another rock section between km 14 and 14.4, the alignment will cross low terraces and wetlands while avoiding several large avalanche tracks at km 14.8 and km 16 to 16.8.

From km 17 to 19.2, the route crosses the large alluvial fan of Dick Creek with a bridge required at km 18.4. A difficult wetland area will have to be crossed between km 19.2 and 20 before reaching the Simma Creek alluvial fan with its bridge at km 20.8. More wetland is reached at km 21.4. Several low terraces and wetland areas and a section of bedrock are traversed as far as km 24.6.

The large distributary channel system of the Boundary Creek alluvial fan is avoided by keeping the road in its recommended location on the north side of the Craig River at the U.S. border.

Granular borrow is available in a low terrace along the Craig River between km 24.6 and 26. At km 26, the route begins across bedrock-controlled slopes and several low river terraces before reaching Node F at km 28.

Section 6

ROAD COST ESTIMATES

6.1 BASIS OF CONSTRUCTION COST ESTIMATES

Construction costs for the proposed road alignments have been estimated based on the type of terrain traversed by each route. Unit costs of grade construction for a Class 5 road were established for 4 terrain classes, as follows:

Terrain Class	Terrain Description	Cost of Grade Construction ($/km)
1	Low relief surfaces, even profile. Sideslopes less than or equal to 3H:1V. Dry soil conditions.	64,500
2	Low to moderate relief surfaces, uneven or hump-backed profile. Sideslopes between 2H:1V and 3H:1V. Dry soil conditions.	72,500
3	High relief surfaces, grade constrained profile. Sideslopes greater than 2H:1V. Wet soil conditions or muskeg.	85,000
4	Rock excavation	350,000

The road grade construction costs shown above cover clearing and grubbing, stripping, sub-grade construction with a haul distance of less than 4 km, installation of culverts up to 1500 mm diameter and placing of granular surfacing.

Culverts bigger than 1500 mm diameter were assigned a unit cost of $10,700 for supply and installation.

Bridge costs utilized for the study varied between \$4,500/m and \$3,500/m for spans of 20 to 35 m. For spans of 40 m or more, a cost of \$4,500/m was used.

Class 2 road grade construction costs, for a 9 m wide surface with 1 m rounding for the shoulders, were assumed to be 160% of the equivalent Class 5 cost for each terrain class. A similar cost increase has been applied to large culvert installation.

6.2 CLASS 5 ROAD CONSTRUCTION COSTS

Estimated costs for construction of a Class 5 road in each corridor segment are presented in Table 6.1. Engineering and contingency allowances are shown in amounts of 8% and 20% respectively, of road construction cost.

6.3 CLASS 2 ROAD CONSTRUCTION COSTS

Estimated costs for construction of a Class 2 road in each corridor segment are presented in Table 6.2. Similar engineering and contingency allowances apply as for the Class 5 road.

6.4 MAINTENANCE COSTS

Maintenance of all of the route alignments will be made difficult by the steep terrain. Snow chutes and creek crossings will require regular inspection and cleaning in order to ensure the road is not damaged by natural hazards. In addition, the steep terrain will mean that cuts in overburden will likely require attention, particularly during and after spring thaw. Some sloughing should be expected in this regard.

A maintenance cost of \$20,000/km/year has been assumed for all routes. This cost includes road grading, ditch and culvert maintenance, all general maintenance required to keep the road open and winter ploughing.

6.5 COST SUMMARY

The costs presented in Tables 6.1 and 6.2, combined with annual maintenance costs calculated in accordance with Section 6.4, are summarized in Tables 6.3 and 6.4 for Class 5 and 2 roads, respectively, to indicate the total cost of providing road access to the Bronson Creek area from Highway 37 to the east and from the Stikine River to the west, and the cost of access along the Unuk and Craig River corridors.

The additional cost of building a road in the Iskut Valley from Bob Quinn Lake to the Bronson Airstrip entirely above the B.C. Hydro Reserve is estimated to be about $10 million for a Class 5 and $15 million for a Class 2 road.

Table 6.1
CLASS 5 ROAD CONSTRUCTION COSTS

Corridor	Length km	Terrain Class (km) 1	2	3	4	Grade Construction Cost $	Large Culverts Number	Large Culverts Cost $	Bridges Number	Bridges Total Length m	Bridges Cost $	Road Construction Cost $	Engineering Cost (8%) $	Contingency Cost (20%) $	TOTAL CONSTRUCTION COST $
Iskut Road East (A - B)	40	17.4	9.8	6.1	6.3	4,528,850	23	246,100	3	80	305,000	5,080,000	406,400	1,016,000	6,502,400
Unuk Road. (B - E)	42	8.8	0.4	4.8	27.7	10,678,000	30	321,000	2	220	990,000	11,989,800	959,100	2,397,800	15,345,900
Iskut Road Central (B - C)	32	24.1	0	1.2	7.1	4,136,050	7	74,900	4	120	510,000	4,721,000	377,700	944,200	6,042,900
Iskut Road West - North Corridor. (C - D)	54	21.2	0.2	12.3	20.2	9,442,050	55	588,500	8	405	1,792,500	11,823,100	945,800	2,364,600	15,133,500
Iskut Road West - South Corridor (C - G)	55	22.9	4.2	11.4	16.1	8,334,250	27	288,900	11	840	3,750,000	12,373,200	989,900	2,474,600	15,837,700
Craig Road. (C - F)	28	12.7	0.3	4.9	9.9	4,700,350	31	331,700	3	200	870,000	5,902,100	472,200	1,180,400	7,554,700

Table 6.2

CLASS 2 ROAD CONSTRUCTION COSTS

Corridor	Length km	Terrain Class (km) 1	2	3	4	Grade Construction Cost $	Large Culverts Number	Cost $	Bridges Number	Total Length m	Cost $	Road Construction Cost $	Engineering Cost (8%) $	Contingency Cost (20%) $	TOTAL CONSTRUCTION COST $
Iskut Road East (A - B)	40	17.4	9.8	6.1	6.3	7,246,160	23	393,760	3	80	305,000	7,944,900	635,600	1,589,000	10,169,500
Unuk Road. (B - E)	42	8.8	0.4	4.8	27.7	17,084,800	30	513,600	2	220	990,000	18,588,400	1,487,100	3,717,700	23,793,200
Iskut Road Central (B - C)	32	24.1	0	1.2	7.1	6,617,680	7	119,840	4	120	510,000	7,247,500	579,800	1,449,500	9,276,800
Iskut Road West - North Corridor (C - D)	54	21.2	0.2	12.3	20.2	15,107,280	55	941,600	8	405	1,792,500	17,841,400	1,427,300	3,568,300	22,837,000
Iskut Road West - South Corridor (C - G)	55	22.9	4.2	11.4	16.1	13,334,800	27	462,240	11	840	3,750,000	17,547,000	1,403,800	3,509,400	22,460,200
Craig Road. (C - F)	28	12.7	0.3	4.9	9.9	7,520,560	31	530,720	3	200	870,000	8,921,300	713,700	1,784,300	11,419,300

Table 6.3

SUMMARY OF CLASS 5
ROAD CONSTRUCTION AND MAINTENANCE COSTS

Segment	Length km	Total Construction Cost $ million	Annual Maintenance Cost $ million
Iskut Road from Bob Quinn Lake to Bronson Airstrip (A-B-C)	72	12.5	1.4
Iskut Road from Bronson Airstrip to Stikine-North Corridor (C-D)	54	15.1	1.1
Iskut Road from Bronson Airstrip to Stikine-South Corridor (C-G)	55	15.8	1.1
Unuk Road	42	15.3	0.8
Craig Road	28	7.6	0.6

Table 6.4

SUMMARY OF CLASS 2
ROAD CONSTRUCTION AND MAINTENANCE COSTS

Segment	Length km	Total Construction Cost $ million	Annual Maintenance Cost $ million
Iskut Road from Bob Quinn Lake to Bronson Airstrip (A-B-C)	72	19.4	1.4
Iskut Road from Bronson Airstrip to Stikine-North Corridor (C-D)	54	22.8	1.1
Iskut Road from Bronson Airstrip to Stikine-South Corridor (C-G)	55	22.5	1.1
Unuk Road	42	23.8	0.8
Craig Road	28	11.4	0.6

Section 7

ENVIRONMENTAL CONSIDERATIONS

7.1 ENVIRONMENTAL FACTORS

7.1.1 Climate

The climate of the study area is associated with the physical features of the Iskut River drainage, in particular the presence of the Coast Mountains within the basin. As a result, the climate of the study area changes from an an interior zone to the east of the mountains to a northwest coastal zone to the west, with a transition zone between them.

There are strong temperature and precipitation gradients along the Iskut River Valley (Norecol, 1988). The eastern portion experiences a cold and relatively dry continental-type climate characterized by long, cold winters and short cool summers. The western portion, at the confluence of the Stikine and Iskut Rivers near Nodes D and G, has a climate described by Trewartha and Horn (1980) as "temperate oceanic". The dominant feature of this type of climate is moist Pacific weather systems. Depending upon their trajectory across the Pacific, these systems bring moist maritime polar or maritime arctic air masses onto the coast year round, but more frequently in winter. The winters are much more moderate than east of the Coast Mountains and have heavy precipitation in the form of rain or snow. The heaviest and most intense precipitation occurs in late fall, principally as rain. This can cause severe and sudden flooding, particularly if the rain occurs with snow on the ground. Summers are short and cool, with moderate rainfall.

7.1.2 Hydrology

The road corridor options follow 3 major river valleys, the Iskut, Unuk, and Craig. Water Survey of Canada stations are located on the Iskut and Unuk Rivers, but not on the Craig. Detailed hydrological studies have been carried out on only the Iskut River for the Skyline and SNIP Projects.

As described in the SNIP Project Stage 1 Report, hydrologic characteristics vary considerably (with climate) along the Iskut River. Peak discharge from snowmelt in the headwaters of the Iskut River is moderated because of lake storage. As the Iskut River enters the Coast Mountains, the runoff processes are dominated by snow and glacier melt and fall rain events (Jones & Associates 1984). The gauging station on the Iskut River near its mouth recorded a minimum mean yearly flow of 62 m^3/s for February, compared to a maximum mean yearly flow of 1110 m^3/s for July (Environment Canada, 1983). Examination of annual hydrographs indicates that streams in the lower Iskut and neighbouring coastal basins all had distinct snowmelt peaks in summer and separate rainfall generated peaks in the fall (Norecol, 1988).

The Unuk River gauging station recorded a minimum mean yearly flow of 16 m^3/s in February and a maximum yearly flow of 240 m^3/s in July. The annual hydrograph indicates a similar snowmelt and rainfall response as in the Iskut basin.

7.1.3 Biogeoclimatic Zones

Figure 7.1 shows the 5 biogeoclimatic zones through which the road corridors pass, as mapped by the B.C. Ministry of Forests (1988c and 1988d), namely:

- CWHwm (Wet Maritime subzone of Coastal Western Hemlock zone)
- MH (Undifferentiated Mountain Hemlock)
- ICHvc (Very Cold subzone of Interior Cedar - Hemlock)
- ESSFi (Subcontinental Northern Forested plus Parkland Engelmann Spruce - Subalpine Fir)
- AT (Alpine Tundra)

In the study area, the CWHwm zone extends east in the Iskut River valley as far as Snippaker Creek and at lower elevations along the Unuk River from Node E to the vicinity of Tom MacKay Lake.

The MH zone is found between about el. 400 m and el. 1000 m in the vicinity of the CWHwm zone locations described above.

East of Snippaker Creek, the Iskut River valley is dominated by the ICHvc zone to about el. 850 m. Above el. 850 m in this area, the ESSFi zone is present. The ESSFi zone is also found along the Unuk Road corridor north of Tom MacKay Lake.

The AT zone is found at above el. 1000 m west of Snippaker Creek and along Unuk River south of Tom MacKay Lake. It is found at above el. 1200 to 1300 m north and east of these locations.

Most of the Iskut Road West - North and South Corridors and the Craig Road corridor pass through the CWHwm zone, with a few road sections passing in or near the MH zone. The Iskut Road Central and Iskut Road East corridors pass primarily through the ICHvc zone, with a few corridor sections located in or near the ESSFi zone. The Unuk Road corridor passes through the ICHvc zone from the Iskut River for approximately 8 km before entering the ESSFi zone (and the AT zone shortly thereafter) as it crosses over a pass north of Little Tom MacKay Lake. Once over the pass, the corridor re-enters the ESSFi zone, and descends to the CWHwm zone (with some minor sections passing in or near the MH zone).

7.2 MINERAL RESOURCES

The area from Stewart to the Iskut River is currently the most intensely explored area in British Columbia and this trend is expected to continue over the next few years. Recent exploration activity in the region has been concentrated in the Johnny Mountain area on both sides of the Iskut River, the Unuk River drainage and the upper reaches of Sulphurets Creek. All areas are close to the proposed road corridors. Further discussion of the mineral resources of the region, primarily taken from MINFILE (1989) and Equity Preservation Corp. (1988), is presented below.

The distribution of exploration activity in the region is illustrated on Figure 7.2 by identification of the type and density of mineral activity in 10 km by 10 km squares over the 1:250,000 scale map area. Of the 157 documented mineral occurrences, 2 are producers, 2 are past producers, 3 are developed prospects, 15 are prospects and the remainder are showings. Some of the properties listed as prospects or showings in MINFILE (1989) may be considered as developed prospects in the near future. Furthermore, not illustrated on the MINFILE map are Calpine Resources' joint venture property near Tom MacKay Lake and Teuton Resources Corporation gold prospects in the Unuk River drainage.

Properties listed as producers in the map area are the Goldwedge - Catear Property and Johnny Mountain Gold Mine. The Goldwedge property is located in the Sulphurets Creek drainage approximately 2 km north of Brucejack Lake at el. 1550 m. A 45 tpd gold mill will be operated for an expected mine life of 15 years based on current total reserves in the Golden Rocket Zone. The Johnny Mountain Gold Mine operated by Skyline Resources is located on the west side of Mount Johnny at about el. 1200 m. The mine has experienced some operating difficulties but in late 1988 was producing gold at a milling rate equivalent to 112 tpd. Based on updated reserves, the mine could operate at that rate for approximately 15 years.

The 3 developed prospects in the map area comprise the E and L Nickel property near the headwaters of Snippaker Creek, the Inel deposit east of the Bronson Glacier and the SNIP Property near Bronson Creek.

7.3 FISHERIES RESOURCES

7.3.1 Introduction

Fisheries resource information presented herein is derived from Department of Fisheries and Oceans (DFO) Habitat Inventory and Information Program stream information summaries and a Ministry of Environment (MoE) biophysical stream survey summary report of the Iskut, Stikine and Unuk Rivers (Hawthorn, et al. 1984). Data is summarized in this section with respect to anadramous (sea run) and resident fish, and rearing and spawning habitat. Where pertinent in the context of this summary, major river and stream features are described. Habitat and distribution data is summarized on Figure 7.3.

7.3.2 Iskut River from Bob Quinn Lake to Bronson Creek

7.3.2.1 General

No anadramous fish occur in this reach of Iskut River above the junction with Snippaker Creek because of a canyon which prevents upstream fish migration. Thus, only resident fish species are found above Snippaker Creek. Streams tributary to the Iskut River above Snippaker Creek provide very little suitable fish habitat due to steep gradients, although alluvial fans at junctions with the Iskut may be utilized. Snippaker Creek and downstream tributaries to the Iskut River provide good fish habitat. Many offer better habitat for spawning and rearing in their lower reaches near the Iskut than does the main channel of the Iskut.

7.3.2.2 Anadramous Species

The Iskut River between Snippaker and Bronson Creeks provides both rearing and spawning habitat for sockeye salmon and spawning habitat for coho, according to DFO records. Mainstem margins and back and side channels with reduced glacial flour provide favourable habitat. All five species of salmon occur throughout most of this section of the river.

7.3.2.3 Resident Species

Rainbow trout are reported in the Iskut River as far as the canyon below Forest Kerr Creek (DFO, 1989). Above the canyon, Dolly Varden char and mountain whitefish were captured by MoE. Fish are limited to clear water in side channels of the Iskut or in tributary fans near the tributary mouths.

7.3.3 Iskut River from Bronson Creek to the Stikine River

7.3.3.1 General

Below Bronson Creek, the lower Iskut River flows in a wide, braided channel with a very shallow (up to 0.3%) gradient. The river's glacial origin makes it very turbid and cold. Side channels are less turbid because lower water velocities allow sediment to settle and because of the greater influence of clear groundwater sources. These clear side channels contain the best fish habitat.

Tributary streams in the lower Iskut are predominantly of glacial origin and of steep gradient, except near their confluence with the Iskut. Outwash fans of tributaries contain moderately good fish habitat.

7.3.3.2 Anadramous Fish

All five species of salmon plus steelhead trout occur in this reach of the Iskut River. The river system, with the limitations noted above, provides both spawning and rearing habitat. Sockeye salmon spawn in the south side channel of the Iskut Sound between 21 and 33 km upstream of the confluence with the Stikine and in back sloughs on both sides of the River between the Hoodoo River and Bronson Creek. Sockeye salmon rear in favourable habitats throughout lower Iskut. Coho salmon spawn in large slough areas along margins of the river throughout this reach. Rearing also occurs throughout this reach. Pinks spawn in a south side channel 35 km from the Stikine confluence and chum spawn at several points on the periphery of the mainstem from 25 km upstream of the Stikine confluence up to Bronson Creek. Chinook have been observed to spawn in Iskut River tributaries, but probably also spawn in the main channel. Chinook rearing occurs throughout this reach of the Iskut. Steelhead migrate to the Craig River.

7.3.3.3 Resident Fish

Dolly Varden char, rainbow trout, cutthroat trout and mountain whitefish have been reported in the lower Iskut River. These fish also occur in tributaries.

7.3.4 Unuk River and Tom MacKay Creek

7.3.4.1 General

From Node E for 20 km north, to about km 25 where the road corridor swings to the northwest out of the Unuk Valley, the Unuk River forms a braided channel ranging in width from 100 to 800 m. Small, clear groundwater-fed side channels and non-glacial, clear water tributaries form important spawning and juvenile rearing habitat for salmonids. However, most tributaries, including major ones such as Storie and Sulphurets Creeks, are glacier fed and consequently silt laden. Most fish, with the exception of Dolly Varden char, seek clear water tributaries and flood plain sloughs and lakes in order to avoid glacial silt.

Downstream (northeast) of where the road leaves the Unuk valley, the Unuk River gradient steepens, forming a velocity barrier to migration of anadramous fish (salmonids).

Tom MacKay and Little Tom MacKay Creeks have a steep gradient and do not provide suitable fish habitat, except close to the confluence with the Iskut River. Little Tom MacKay Creek joins the Iskut at about the upstream limit of reported resident fish distribution.

7.3.4.2 Anadramous Fish

Anadramous species in the Unuk River within the study area include coho, sockeye and chinook. Coho occur up to the long canyon that prevents upward migration of anadramous fish, in the lower South Unuk River and in the lower reaches of several clear water tributaries. Chinook and sockeye are also reported in the Unuk River and may have a similar distribution, although the latter is more restricted than the former.

7.3.4.3 Resident Fish

Cutthroat trout occur in the lower portion of the Unuk River while Dolly Varden char occur throughout the river within the study area.

7.3.5 Craig River

7.3.5.1 General

Unlike most Iskut River tributaries, the Craig River is a low gradient channel for approximately 40 km from its confluence with the Iskut River and contains excellent fish habitat. The Craig River is the largest producer of coho in the Iskut River system (DFO, 1989). MoE's assessment of the River is that it contains the greatest amount of good to excellent fish habitat in the part of the Iskut system surveyed by the MoE.

7.3.5.2 Anadramous Fish

Sockeye spawn along the River to within 3 km of Node F on the Alaska border. Coho occur within the same reach. Pinks occur from below the confluence with the Jekill River, and chinook and chum salmon occur in about the last 10 km of the River. DFO surmises that the mainstem of the Craig River may provide limited spawning potential because of unstable flow conditions, coarse gravel substrate below the Jekill River and boulders upstream. Some of the mainstem substrate may be suitable for chinook spawning. Although these constraints have been identified, the DFO considers the entire Craig River as critical habitat for anadramous fish (von Finster, pers. comm.).

7.3.5.3 Resident Fish

Dolly Varden char are reported on the Craig River at least as far as sockeye have been reported, and may extend into Alaska. They are also reported in the lower ends of major tributaries of the Craig. Rainbow trout occur in the Craig and Jekill Rivers. These trout extend up the Jekill River at least to within 3 km of the confluence with Olatine Creek. Cutthroat trout are reported to occur up to near the junction with the Jekill River. Mountain whitefish have been caught in the lower 10 km of the Craig River.

7.4 FORESTRY

Forest resource information for the study area, available from the Ministry of Forests and Lands (MoFL), is limited to the lower Iskut and Craig Rivers. Figure 7.4 shows the forest resources inventoried and mapped as engineering units by MoFL (1988a). Units 2, 7, 9 and 15 have significant limitations to harvesting due to limited timber volume, high development costs and/or engineering constraints. Unit 8, which is comprised primarily of cottonwood, contains numerous river channels which are important spawning grounds for migrating salmon (MoFL, 1988a).

Forest cover in the Iskut/Craig study area is comprised primarily of mature and overmature hemlock, spruce, balsam, cottonwood and pine. Hemlock accounts for 85% of the total merchantable volume (total volume less decay, waste and breakage, to a d.b.h. of 22.5 cm and a 10 cm top), followed by spruce (10%) and balsam, cottonwood and pine (5% total).

Forest resources and harvesting feasibility for the Iskut region are currently under review by MoFL. Thus, the assessment and comments presented herein, which are based on available documents, may be subject to review in the future.

Forestry activities in the Iskut River valley and adjoining valleys have been limited to date. An unsuccessful pilot project was developed by Skeena Forest Products Ltd. in 1965, on their T.S.L. near the confluence of the Stikine and Iskut Rivers. Halvorsen and Pohle partially logged an area near the mouth of the Iskut River in 1984 and 1985, but the operation was unsuccessful. There are currently some active logging operations along Highway 37, in the vicinity of Bob Quinn Lake. This timber is hauled to Stewart (MoFL, 1988a).

The feasibility of future timber harvesting in the Iskut valley is described in the MoFL (1988a) publication "Lower Iskut Development Study". The publication states that "although it is feasible to develop the Lower Iskut for timber harvesting purposes with regard to terrain, soils and hydrological features, the economic feasibility of this development may be marginal". The primary constraint to timber harvesting in areas away from existing highways is access development, as indicated by recent timber sales in the Bob Quinn area, involving a round trip haul distance to Stewart of 450 km (MoFL, 1989). The Iskut valley from Bob Quinn Lake to Bronson Creek is considered to have the highest timber values, but economic harvest could extend well past Bronson Creek if a haul road were in place, depending on specific wood quality and healthy log export markets (MoFL, 1989). A 20 year Small Business Enterprise Program proposed by MoFL will cover the corridor area between Bob Quinn Lake and Bill Creek (at km 24) (MoFL, 1989)

7.5 WILDLIFE

7.5.1 Species

Wildlife studies in the study area are limited primarily to those completed for local mining projects, such as SNIP (Norecol, 1988) and Johnny Mountain (Skyline Explorations Ltd., 1987), and studies completed for B. C. Hydro's Stikine-Iskut projects (Talisman, 1982; Ian Hayward and Associates, 1982). Biophysical capability mapping for ungulates has been undertaken for the region by the MoE. The mapping does not extend beyond Tom Mackay Lake into the Unuk River drainage. Figure 7.5 identifies Class 1 and 2 ungulate habitat along the road corridors.

Moose appear to be the most common ungulates in the Iskut River valley and adjoining valleys. They inhabit the area year-round, dispersing into various upland habitats for the snow-free season and moving, in winter, to lowlands along the major rivers. During a series of winter flights throughout northern British Columbia in 1967 to 1971, in which moose occurrence was tabulated as animals seen per hour of flying, the average abundance for the Iskut Valley (on Mapsheets 104B and 104C) was in the lowest category above zero (1 to 29 animals/hour) (MoE files, Smithers). On a government survey along the Iskut Valley in February 1979, only 4 moose were seen along 65 km of river below Bob

Quinn Lake (Stewart and Edie, 1979). The most recent winter flight in the area found 6 moose, all in the vicinity of the Craig - Iskut River confluence. Moose have been observed wintering in the Craig River Valley and near the confluence of the Craig and Iskut Rivers (Norecol, 1988). Studies completed for B. C. Hydro (Ian Hayward and Associates, 1982) indicate that the dense, hemlock forests of the lower elevations along the Unuk River support small numbers of moose which depend on the floodplain of the Iskut River for winter range.

Mountain goats are common, if not abundant, throughout the rugged mountains of the Iskut drainage. There have been numerous sightings on the slopes of Snippaker Mountain (Norecol, 1988; Luckhurst and Marsh, 1973).

The lower Iskut River drainage is known or suspected to be within the broad geographic range of black-tailed deer, moose, and mountain goat. The potential for black-tailed deer is based on a distribution map prepared by the provincial government (MoE, 1980b). Winter snow depths throughout the study area are limiting even for moose (MoE, 1982), and local appearances of deer would likely involve only occasional summer transients (Norecol, 1988).

There may be caribou in the vicinity of Tom MacKay Lake, as biophysical inventory mapping indicates that this area has a moderate capability to support caribou (MoE, 1982).

Both black and grizzly bears exist in the lower Iskut area in the highest category of relative abundance (MoE, 1979 and 1980c). They are found in almost all vegetation types. Wildlife studies conducted for the SNIP Project (Norecol, 1988) indicate that bears are the most conspicuous, if not the most abundant, of the large mammals in the area.

Floodplains form critical habitat for grizzlies, moose and a number of furbearers. Avalanche chutes also form important habitat for grizzlies, and these are common along the Craig River and in several other locations (Fuhr, pers. comm.). Figure 7.6 illustrates active floodplains and avalanche tracts in the study area. Other important habitat areas include wetlands, spruce forests and riparian areas along small streams. A wetland floodplain complex found at the confluence of the Stikine and Iskut Rivers is particularly critical wildlife habitat, although the extent of this unit along the Iskut River has not been mapped. Grizzly habitat in this study area is considered to be of regional, if not provincial, significance (Fuhr, pers. comm.).

Coyote, wolf, red fox, beaver, porcupine and various small mammals also occur in the area. Based on summer observations, beavers and red squirrels are the most conspicuous furbearers in the vicinity of the SNIP Project (Norecol, 1988). Many of the lakes and larger ponds in the area (for example, Triangle and Monsoon Lakes) are maintained at current levels by beaver impoundments, and recent or old sign were seen at several other locations, especially in the Craig River Valley. Local trappers also report the presence of mink, wolverine and short-tailed weasel (Norecol, 1988).

A total of 31 species of birds is known or suspected to occur in the vicinity of the SNIP property. Swans (believed to have been Trumpeter Swans) were observed on wetlands in the Craig River valley in the fall of 1987. The birds were probably migrants, since any breeders should have been observed during the May survey. Sandhill Cranes may nest in the general area. Waterfowl observed in the area include Canada geese, mallards, ring-necked ducks, hooded mergansers, and green-winged teal. Wetlands throughout the area are dominated by sedges and lack the mud margins and robust marsh plants (cattails, rushes) which are most commonly associated with good production of waterfowl, shorebirds and other wetland species. Upland birds present in the area include blue grouse and ruffed grouse. Raptors which have been observed in the area include bald eagles, Harlan's hawks and sharp-shinned hawks.

7.5.2 Use

7.5.2.1 Hunting

The study area lies in Management Unit 6-21 of the Skeena Sub-region, administered by the Smithers office of the MoE. Hunting seasons exist in this unit for moose (bulls only), thinhorn sheep (full curl rams only), mountain goat, grizzly bear (fall and spring season), black bear (fall and spring season), wolf, coyote, lynx, wolverine, waterfowl, grouse and ptarmigan. With the exception of thinhorn species, all of these species are available in the study area. However, the remote location and lack of road access generally preclude hunters from using the area (Norecol, 1988; Ian Hayward and Associates, 1982).

7.5.2.2 Guiding

The road corridors traverse 3 guiding territories (621G003, 621G002, and 617G002) (MoE files, Smithers).

The registered trapline owners in the vicinity of the SNIP property operate their trapping camp as an outfitting operation for B. C. resident hunters in the fall. They report that hunters pursue grizzly bears and moose and that 1 or 2 grizzly bears were taken in the Craig River area during the past several years (Norecol, 1988). Within the registered guiding territories, grizzly bears and mountain goats are the key potential source of income to the guiding operations.

7.5.2.3 Trapping

The road corridors traverse 7 traplines. No information is available, except for Registered Trapline 0621T002 held by Nancy and David Watson. Their camp is along the lower Craig River and their traplines run throughout the SNIP Project area.

7.6 RECREATION/TOURISM

At present, the Iskut River valley is predominantly wilderness. Recreational usage is not extensive due to lack of access (Norecol, 1988; The Eikos Group, 1983; DPA Consulting, 1982).

Recreational resources include Bob Quinn Lake, the headwaters of Forrest Kerr Creek, the Newmont Lake and Tom Mackay Lake uplands, and the lower Iskut River (DPA Consulting, 1982). Recreational facilities in the area are minimal and are primarily restricted to the Bob Quinn Recreation Site. Although there are numerous outdoor recreational opportunities in the Stikine-Iskut area, the lack of facilities typically limit the recreationist to wilderness pursuits (DPA Consulting, 1982).

The MoF has prepared a Recreation Corridor Management Plan for the Lower Stikine to address future recreational use of the area. The Plan, which would be applicable to much of the Iskut Road West - North and South Corridors, extends from the Stikine River along the Iskut River to the vicinity of the Craig River. Goals for the Plan include:

- To provide for low impact recreation compatible with maintaining the natural character of the river corridor.

- To manage timber harvesting in order to maintain the natural character of the river, so that the recreational experiences sought by visitors and wildlife, fish, heritage and other values are not impaired. For timber management purposes, the corridor is divided into three management units, of which Unit 3 (Darsmith Creek to the International Boundary) is applicable to the study area. The goal for Unit 3 is to permit selective timber harvesting utilizing aerial methods only at this time.

- To manage mining exploration and development so as to maintain the natural character of the river and recreational experiences sought by visitors.

- To manage the fisheries resource to protect and enhance fish populations and their habitat consistent with the objectives of the recreation corridor management plan.

- To manage the wildlife resource to protect and where possible to enhance existing populations of wildlife.

- To recognize the use of the Lower Stikine by the Tahltan people as a fundamental precept for any designation and management program.

- To ensure that opportunities for traditional non-native activities are maintained.

- To protect important heritage sites within the Corridor.

According to the Eikos Group (1983), recreational activity in the Stikine-Iskut Region is expected to increase, even in the absence of hydroelectric development. The estimated increases in recreational users can be attributed to increasing population of the region and the Province and to increases in tourism as Highway 37 becomes better known as an alternative route to Alaska.

Studies completed for B. C. Hydro (Ian Hayward and Associates, 1982) in the Unuk River - Treaty Creek area indicate that the main recreational features in that area are the rivers and streams, combined with the mountain scenery. The Iskut River was considered to have limited recreational potential, with difficult access through a forested valley with deeply incised tributary streams.

7.7 LAND RESERVES

There are a number of reserves in the Stikine-Iskut basins, including both park reserves (administered by the Ministry of Parks and intended for future use as parks) and ecological reserves (administered by the Ecological Reserves Unit and intended to protect ecologically significant natural features). One reserve, the Bob Quinn Ecological Reserve on the Ningunsaw River south of Bob Quinn Lake, may affect the Iskut Road corridor. The purpose of this reserve is to conserve an ecological unit with unusually diverse vegetation where three biogeoclimatic zones are contiguous. An additional ecological reserve within the study area is proposed (Eikos Group, 1988) for the lava beds at the confluence of Forrest Kerr Creek and the Iskut River. However, the Ecological Reserves Unit has no record of this reserve (Goulet, pers. comm.).

There are no Provincial or National parks in the study area and, since there are no roads, no forest camp grounds. One potential land restriction does, however, exist on the lower Stikine and could affect road corridor choices that involve this river. The Wilderness Advisory Committee recommended in 1986 that the lower Stikine between Highway 37 and the Alaska border should be designated a scenic corridor with boundaries set back to the canyon edge. This recommendation, if followed, would pose a conflict to road construction on the Stikine near the mouth of the Iskut River. At the present time, the status of this recommendation is uncertain.

7.8 TRANSPORTATION

Several private and emergency air strips have been constructed in the study area located at Bob Quinn, Snippaker, Johnny Mountain, Bronson and Skud.

Highway 37 near Bob Quinn has been made into an emergency landing strip. The surface of the highway has been widened by approximately 23 m for a distance of 1220 m and is suitable for small aircraft.

A strip was constructed in the early 1970s on Snippaker Creek in a reasonably wide valley above its confluence with the Iskut River. The strip has not been regularly maintained for several years and is now only suitable for large-tired aircraft (Beaver and Otter). The strip's length of less than 760 m makes it unsuitable for larger freight aircraft such as DC-3s and Hercules.

The Johnny Mountain strip was constructed in 1983 in an alpine area. It is 1500 m long and 24 m wide. Aircraft up to Hercules size can utilize the strip, although it contains a hill in the middle and is somewhat rough.

The Bronson strip was built in 1986 and upgraded in 1988 to allow Hercules aircraft to land. The strip is currently 1480 m long and about 50 m wide. It is a smooth graded strip with a well maintained surface.

A small strip at the mouth of the Skud River on the Stikine was built to service several exploration camps in the area. Small aircraft, such as a Brittan Norman Islander and Cessna 206, can use the strip. No other information on the strip is available.

7.9 SUMMARY OF ENVIRONMENTAL CONCLUSIONS

7.9.1 Iskut Road from Bob Quinn Lake to Bronson Airstrip (A-B-C)

The environmental concerns associated with construction of a road from Bob Quinn Lake (Node A) to Node C at Bronson Airstrip are considered minimal in comparison to the other corridors.

Design consideration must by given to the Ecological Reserve at Bob Quinn Lake, B.C. Hydro's Flood Reserve upstream of Forest Kerr Creek, the volcano formations at Node B, the resident fisheries resource downstream from Node B, the Class 1 and 2 ungulate habitat capability between Node B and Verritt River, and the anadramous fisheries resource downstream of Snippaker Creek.

The corridor will access a number of mining properties in the Iskut River - Bronson Creek area and will be a major benefit to those exploring or developing in the area. A road will also benefit timber harvesting in the Iskut and adjacent valleys. Recreation use of the area will likely increase because of the access and link with Highway 37. However, use will likely remain low unless park or recreation areas are established or the road provides access to a recreation destination of significant interest. There are guide areas and trap lines along the corridor and their short and long term use will require further study.

7.9.2 Iskut Road from Bronson Airstrip to the Stikine River (C-G and C-D)

There are three major concerns that could present constraints to construction of a road in either the North or South Corridor. These concerns include the extensive fisheries resource in the lower Iskut River, the grizzly bear habitat that is of regional significance and the wetland complex at the confluence of the Iskut and Stikine Rivers.

The South Corridor will require crossing of the wetland complex at the Stikine-Iskut confluence. This route has the potential to impact the fisheries resource, grizzly habitat and areas of Class 1 and 2 habitat for ungulates. Although not mapped, there is also good indication that there is extensive waterfowl habitat in the area. Grizzly bear and Class 1 and 2 ungulate habitat extends along the entire South Corridor. The South Corridor does not encroach into the Iskut River channel but will require extensive construction over the Craig River floodplain. The potential environmental risks involved in road construction in this corridor are high.

The North Corridor passes near the wetland complex at the confluence of the Iskut and Stikine Rivers but the proposed alignment is up on the valley walls with only marginal encroachment into the wetlands. The Corridor does traverse grizzly bear habitat and areas of Class 1 and 2 capability for ungulates from the Stikine River to the Hoodoo River. Some encroachment into the Iskut River will be required in the vicinity of Twin River. The potential impacts on spawning and rearing areas should be documented. The potential environmental risks involved in road construction in this corridor are high but still less than those for the South Corridor.

7.9.3 Unuk Road (E-B)

The most environmentally sensitive area along the corridor is the Alpine Tundra zone north of Tom MacKay Lake. Design consideration should be given to the anadramous and resident fisheries resources in the Unuk

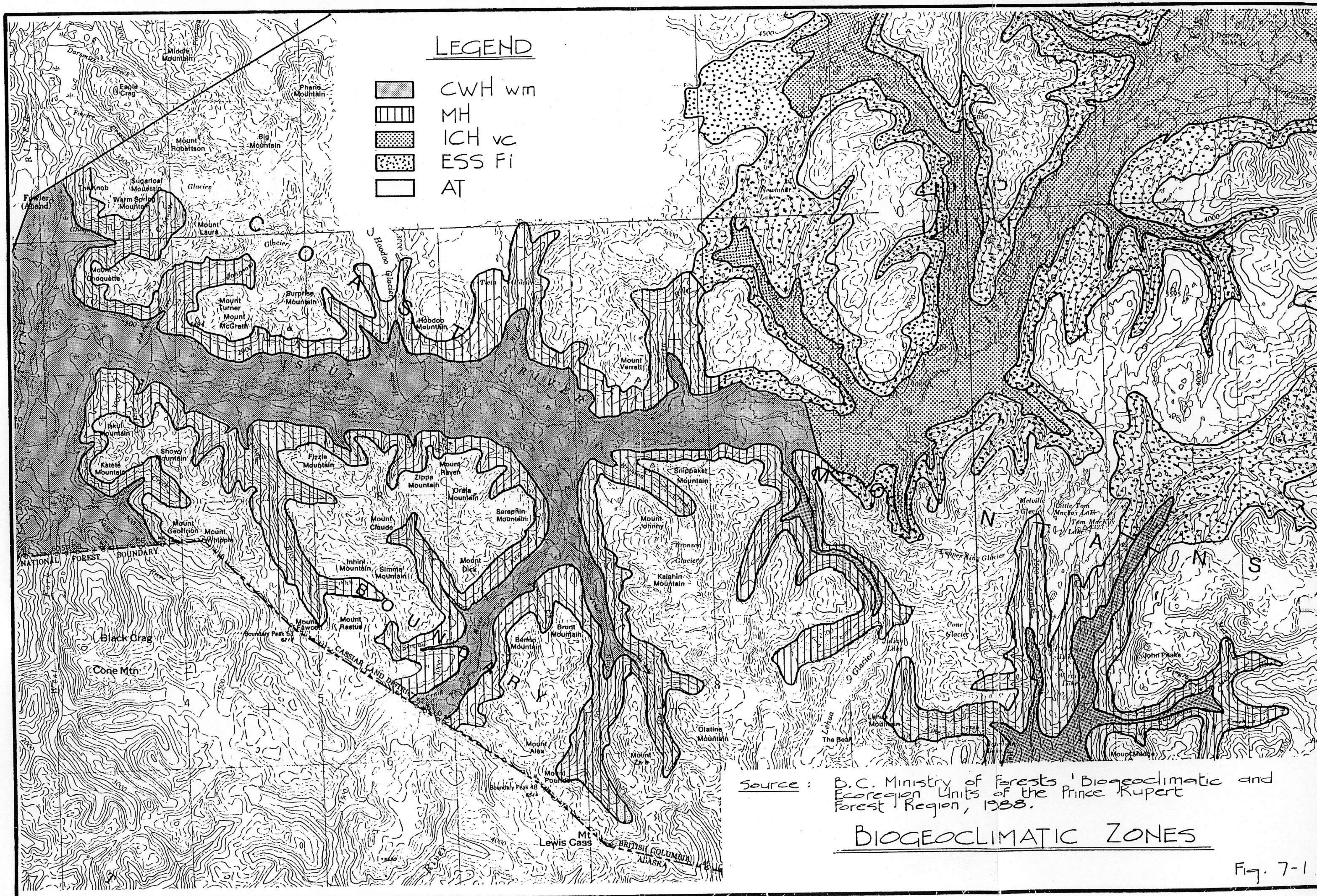
River. The habitat capability for ungulates and grizzly bear habitat information has not been mapped for the Unuk drainage and should be investigated if this corridor is to be considered further for road development.

Accessible resources in the vicinity of the corridor include the potential large tonnage mining operations on Sulphurets Creek. The forest resources in the region have not been mapped but appear to be of marginal value and perhaps less than those in the Iskut drainage. The recreation potential of the area is considered low and no areas of recreational significance have been identified. The guide areas and trap lines in the corridor will require more detailed investigation to determine potential impacts.

7.9.4 Craig Road (F-C)

The value of the fisheries resource in the Craig River reported by DFO may present a major constraint to construction of a road within this corridor. The extension of probable key grizzly bear habitat from the lower Iskut and the active hydrological processes may contribute to the environmental risk of constructing a road within this corridor.

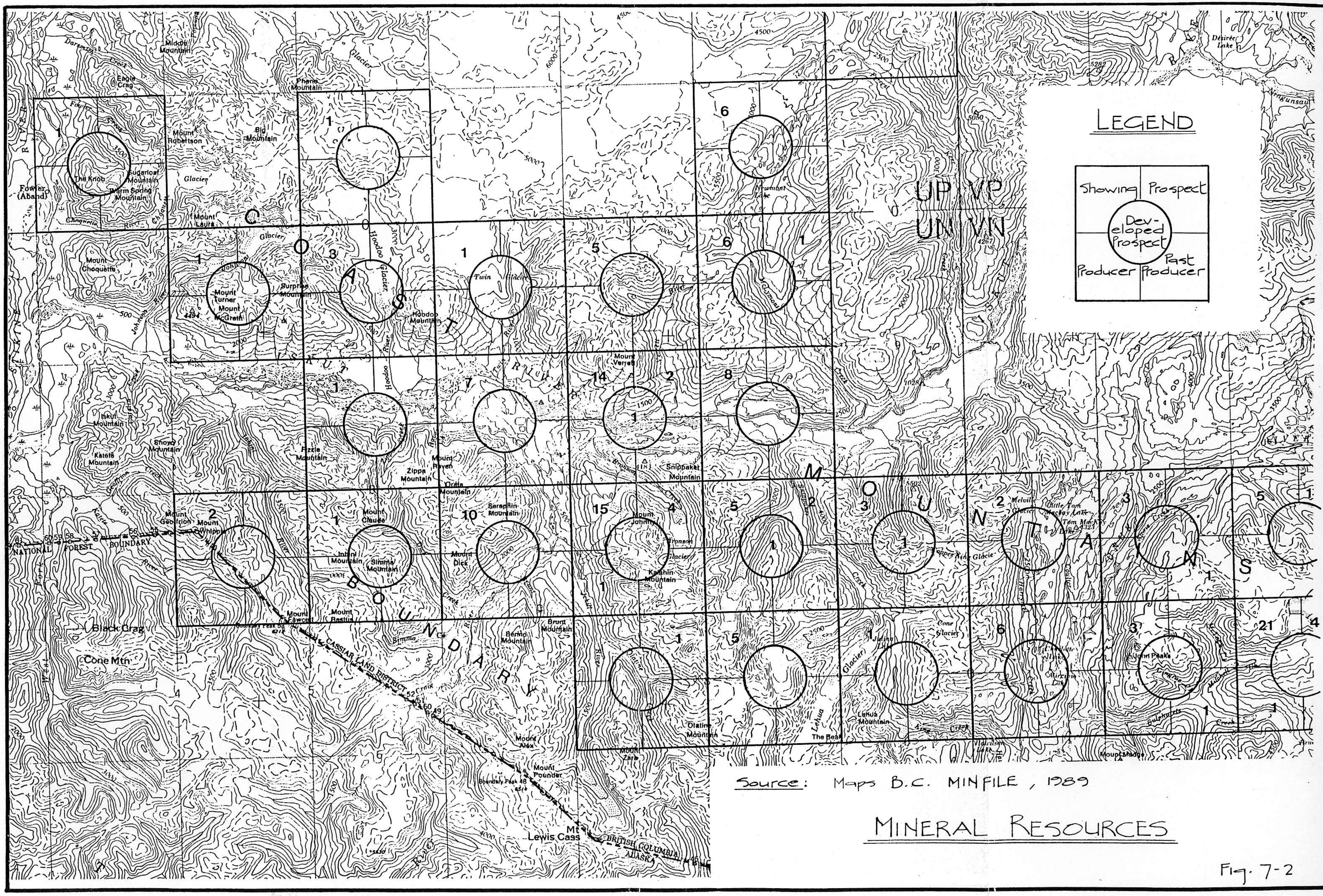
The mineral resources in the Craig River drainage are undeveloped. The upper reaches are either unexplored or have very little mineral resource value. The forestry resources are of moderate value, with 97% hemlock indicated in Engineering Unit 6. There are registered traplines and guide areas in the road corridor. These resources require further investigation to provide information on potential impacts. Construction of a road within this corridor could present potentially high environmental risks.



Source: B.C. Ministry of Forests 'Biogeoclimatic and Ecoregion Units of the Prince Rupert Forest Region, 1988.

BIOGEOCLIMATIC ZONES

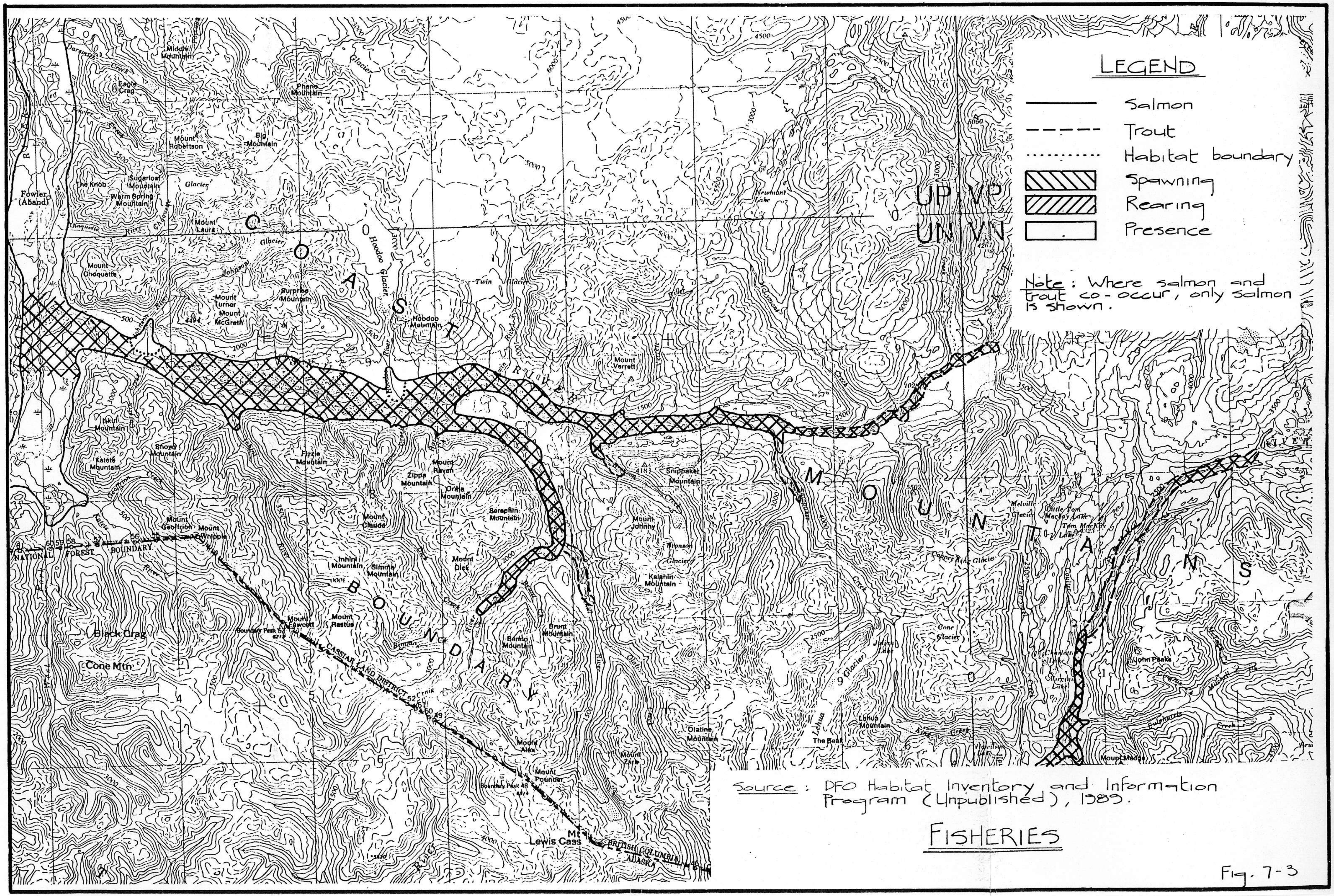
Fig. 7-1



Source: Maps B.C. MINFILE, 1989

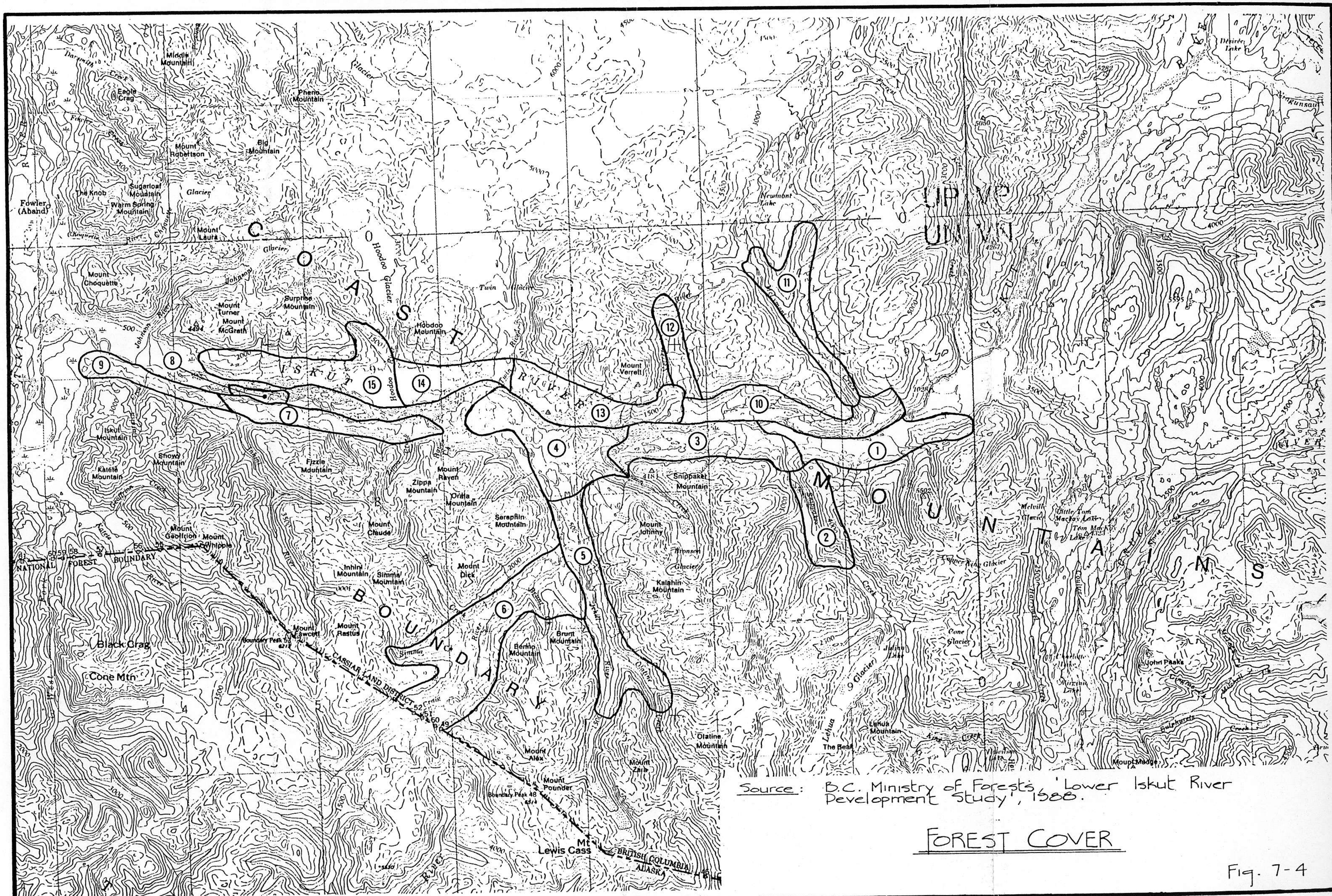
MINERAL RESOURCES

Fig. 7-2



FISHERIES

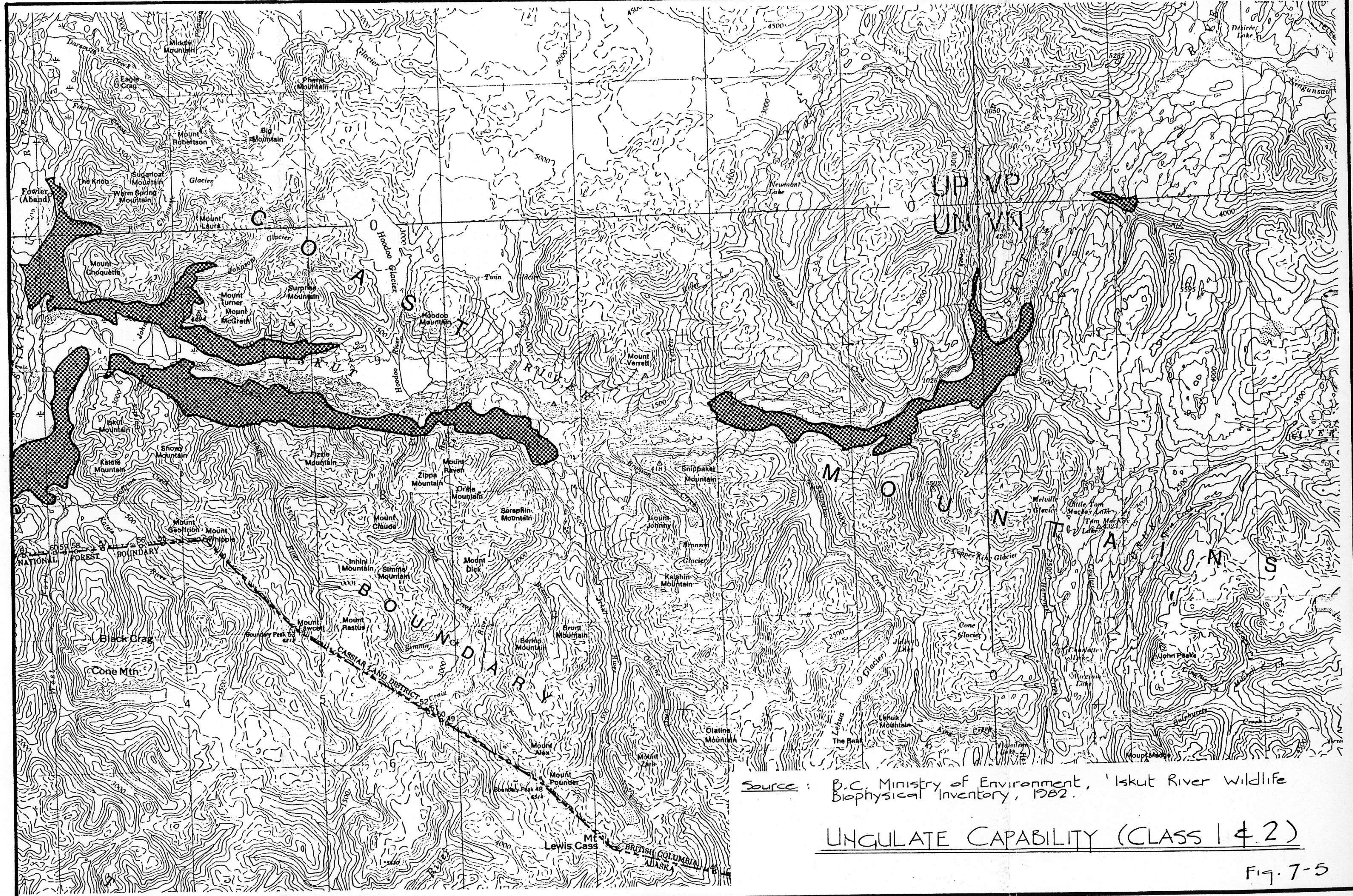
Fig. 7-3



Source: B.C. Ministry of Forests, 'Lower Iskut River Development Study', 1988.

FOREST COVER

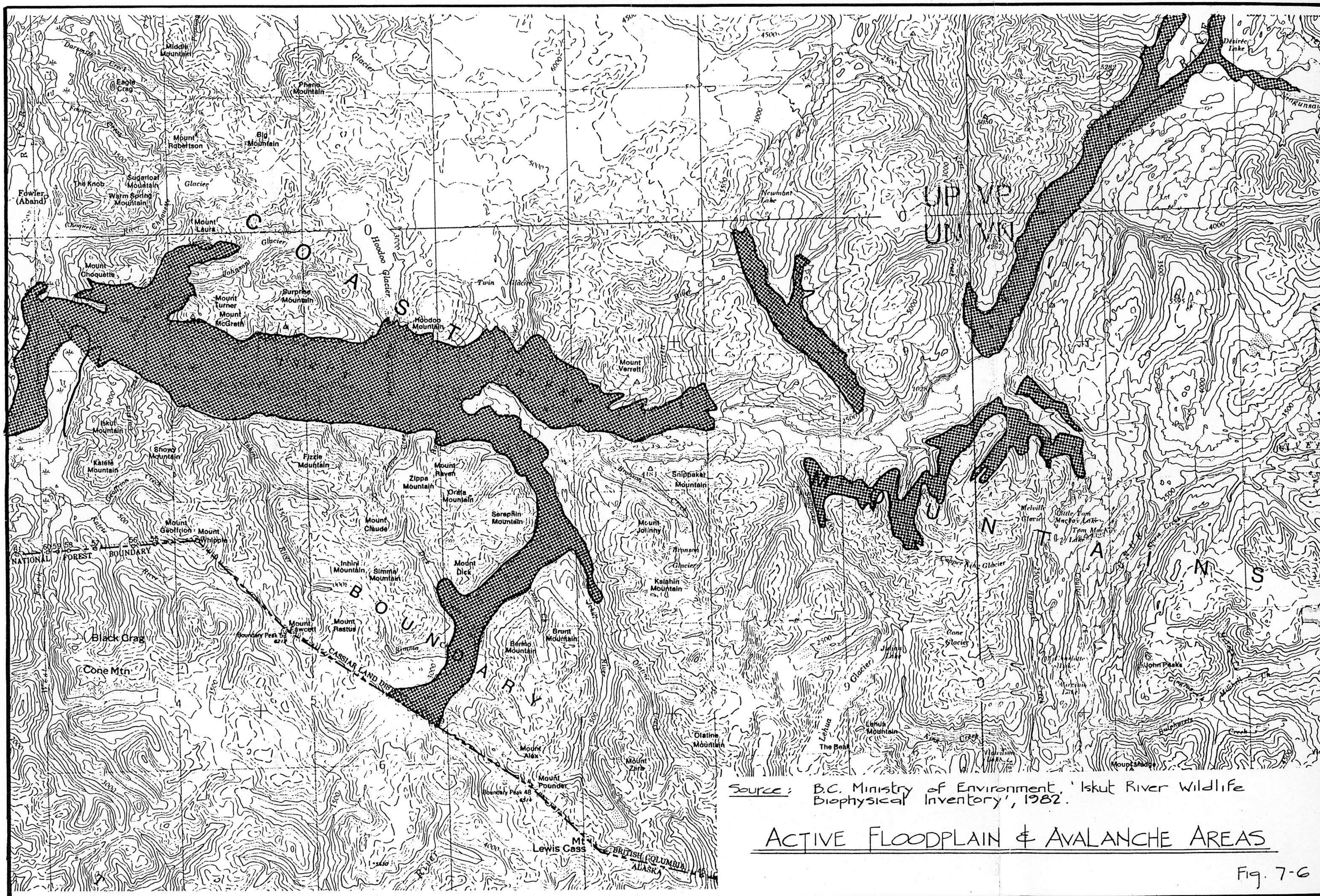
Fig. 7-4



Source: B.C. Ministry of Environment, 'Iskut River Wildlife Biophysical Inventory, 1982.

UNGULATE CAPABILITY (CLASS 1 & 2)

Fig. 7-5



Source: B.C. Ministry of Environment, 'Iskut River Wildlife Biophysical Inventory', 1982.

ACTIVE FLOODPLAIN & AVALANCHE AREAS

Fig. 7-6

Section 8

ROAD DESIGN AND CONSTRUCTION CONSIDERATIONS

8.1 GENERAL

Comments provided in this section are generalized since it is not known which, if any, of the road corridors will be utilized for construction. Furthermore, the schedule for design and construction is uncertain.

Several sections of road corridor which were identified in the draft report as requiring inspection have been reviewed during the July field reconnaissance to confirm engineering feasibility. However, additional ground traverses will be required once a decision is made to proceed with design and construction.

Experience during construction of the Golden Bear access road and elsewhere indicates the importance of identifying and investigating potential sources of gravel for road surfacing in advance of construction. A field investigation program should be anticipated for this purpose.

8.2 CONSTRUCTION DIFFICULTIES

Some areas of difficult construction have been identified in the report. These generally comprise steep bedrock or north-facing overburden slopes with the potential for instability in cuts.

8.3 MANAGEMENT OF ENVIRONMENTAL IMPACTS DURING CONSTRUCTION

The management of environmental impacts during road construction should be initiated during final design and planning phases. Site specific concerns should be identified and site investigation carried out to establish design criteria and the feasibility of management procedures and objectives. At each stage from planning and investigation to construction and ultimate use of the road, impact management should be reviewed with Government agencies. Published references that provide environmental resource management guidelines should also be utilized.

MAPS AND AERIAL PHOTOS USED DURING STUDY

NTS MAPS

1:250,000 scale: 104 B and C

1:50,000 scale: 104 B/7 - 13, 15,16

PHOTOGRAMMETRIC MAPPING

1:10,000 scale. 23 sheets showing 1 to 2 km wide road corridor with 10 m contour interval. Prepared by Nadir Mapping Corporation from 1982 aerial photos.

AERIAL PHOTOS

1:32,000 scale taken in 1950 and 1957.

Line 1	BC1211	114-117
Line 2	BC1212	12-24
Line 2a	BC1281	94-102
Line 3	BC1213	41-47

1:39,000 scale taken in 1965.

Line 4	BC5160	030-050
Line 5	BC5158	234-237
Line 6	BC5160	071-075
Line 7	BC5157	242-246
Line 8		207-212
Line 9		132-136
Line 10		098-102
Line 11		014-017
Line 12	BC5155	252-264
Line 13		161-177
Line 14		143-158
Line 15		063-069
Line 15a		056-058
Line 16		042-048
Line 17	BC5154	207-211
Line 18		190-196
Line 19		113-117
Line 20		090-104
Line 21		022-038

1:69,000 scale taken in 1982.

Line 1	BC82022	115-120
Line 2		156-164
Line 3		193-199
Line 3a		210-212
Line 4		218-234
Line 5	BC82018	012-015
Line 5a		020-023
Line 6		033-037
Line 6a		042-045
Line 7		084-086

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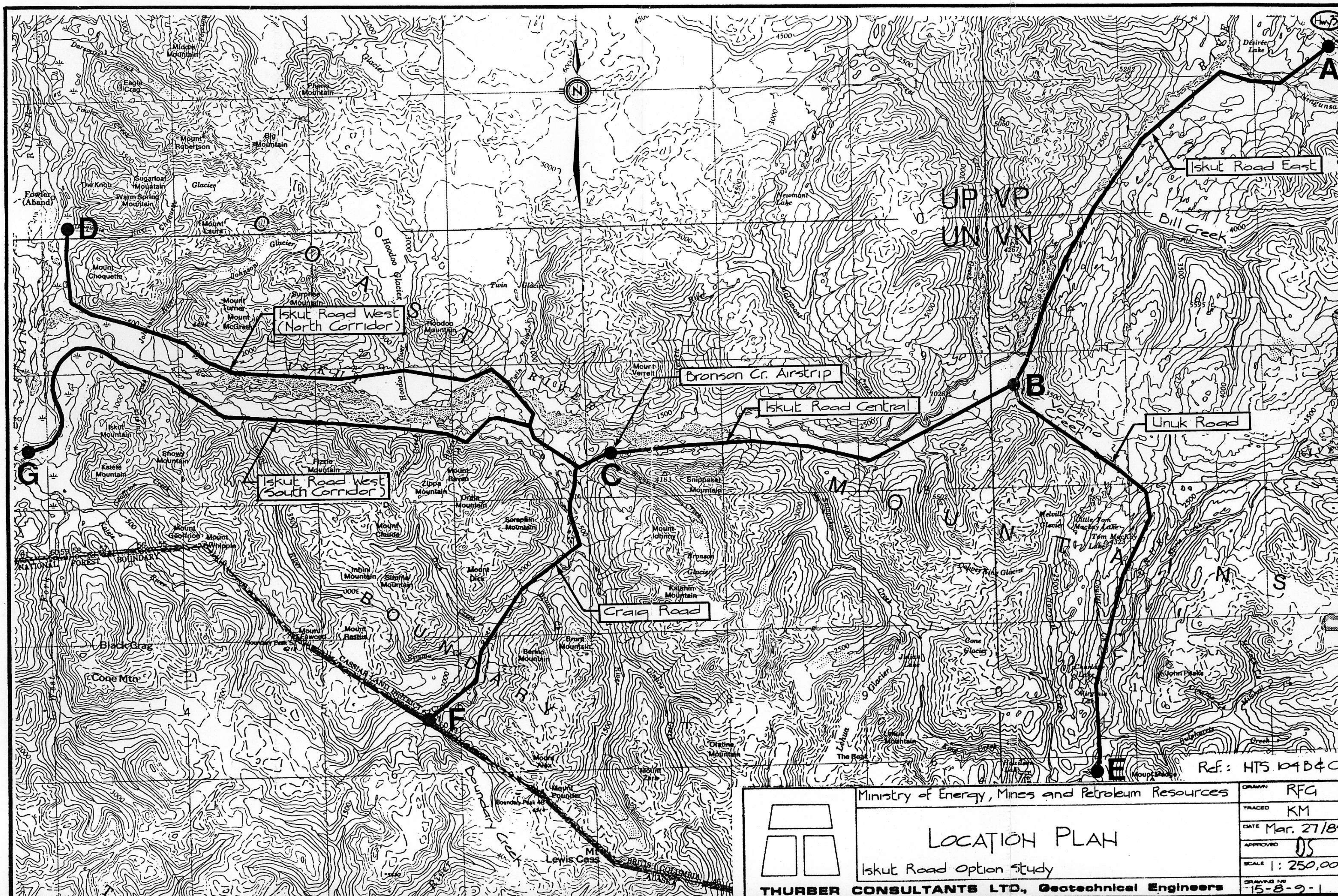

A
B
C
D
E
F
G
Hwy 37
Iskut Road East
Bill Creek
Iskut Road West (North Corridor)
Iskut Road West (South Corridor)
Bronson Cr. Airstrip
Iskut Road Central
Unuk Road
Craig Road
COAST MOUNTAINS
BOUNDARY
Boundary Creek
Fowler (Aband)
Mount Choquette
Mount Verrett
Snippaker Mountain
Mount Johnny
Newmont Lake
Hoodoo Glacier
Hoodoo Mountain
Twin Glacier
Volcano Creek
Black Crag
Cone Mtn
Mt Lewis Cass
NATIONAL FOREST BOUNDARY
CASSIAR LAND DISTRICT
Ref.: HTS 104 B&C
Ministry of Energy, Mines and Petroleum Resources
LOCATION PLAN
Iskut Road Option Study
THURBER CONSULTANTS LTD., Geotechnical Engineers
DRAWN RFG
TRACED KM
DATE Mar. 27/89
APPROVED DS
SCALE 1: 250,000
DRAWING No 15-8-9-1


11 km to D Choquette River
(713000m E.)
346000m E.
ISKUT RIVER
BOUNDARY RANGES
COAST MOUNTAINS
ISKUT RIVER
Proposed Iskut River Bridge
2 km to C Bronsen Creek
km 54.6
ELBOW MTN
KATETE MTN
Kakali
BRITISH COLUMBIA
ALASKA
Ref.: HTS 104 B&C
Ministry of Energy, Mines & Petroleum Resources
ROAD ALIGNMENT
ISKUT WEST CORRIDORS
Iskut Road Option Study
THURBER CONSULTANTS LTD., Geotechnical Engineers
DRAWN RFG
TRACED KM
DATE April 13, 1989
SCALE 1:50,000
DRAWING NO. 15-8-9-2