INDIAN AND NORTHERN AFFAIRS CANADA WASTE MANAGEMENT PROGRAM

KUDZ ZE KAYAH PROJECT

DRAFT

ENVIRONMENTAL BASELINE
AND
GEOTECHNICAL EVALUATION REPORT

Prepared by:

geo-engineering
(M.S.T.) LTD.

June 2000

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Prepared for:
INDIAN AND NORTHERN AFFAIRS CANADA
WASTE MANAGEMENT PROGRAM
Whitehorse, Yukon

Prepared by:
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TABLE OF CONTENTS

LIST OF FIGURES IN APPENDIX A

LIST OF TABLES

1.0 INTRODUCTION

The Waste Management Department of Indian and Northern Affairs Canada commissioned Geo-Engineering (M.S.T.) LTD. (Geo-Engineering) to compile an environmental baseline and to evaluate geotechnical, hydrological and hydrogeological conditions of the Kudz Ze Kayah Project (Figure 1-1). The authorization to proceed with the first phase of the study was received on January 10, 2000. The scope of this work was outlined in Geo-Engineering's proposal dated October 29, 1999 and is summarized below:

- collection and review of available information, including, but not limited to: aerial photographs, site maps, records, existing permits, water licences, operating permits, inspection reports, non-compliance reports, listings, etc., pertaining to site, users and occupants;

- collection of information on the operational history of the site, including, but not limited to: process changes, waste management changes, spills, leaks, operational upsets, regulatory actions, complaints, etc;

- establish current land tenure, status, disposition, etc.;

- identification of existing structures and equipment to determine their structural integrity, mobility and ability to meet design criteria upon closure of the site;

- collection of information relating to the abandonment plans including, but not limited to:

    - whether the sites have approved or conceptual abandonment plans and the requirement to submit an abandonment plan for review and approval, and

    - review and description of existing and intended land uses of the site and surrounding areas,

    - review of existing financial security arrangements.

On that basis, the following mining project aspects are to be addressed:

- topography, including physical hazards,
- surface water and drainage,
- ground water,
- fill materials and debris,
- surface disturbances,
- type and condition of vegetation,
- hazardous or potentially hazardous materials,

- utilities,
- buildings,
- landfills, disposal areas,
- pits, adits,
- wastewater treatment and disposal areas,
- roads,
- traditional uses (including historical, archaeological, etc.),
- soils,
- climatological data.

Exploration programs and preliminary design of the proposed mine and its infrastructure were completed. However, no mining was initiated and detailed design and construction of the main mine structures, such as tailings ponds, process facilities, etc. would have to be undertaken.

Preparation of this report represents the final phase of this study stage. The report is issued as a preliminary document and a ground truthing reconnaissance and additional site investigations are supposed to be undertaken prior to issuing the final report.

2.0 BACKGROUND AND HISTORY

2.1 PROJECT LOCATION

The Kudz Ze Kayah (in Kaska language meaning "Caribou Country") Project is based on a massive sulphide deposit containing copper, lead, zinc, gold and silver (ABM deposit). The project area is located 260 km northwest of Watson Lake, 115 km southeast of Ross River, and 24 km southwest of the Robert Campbell Highway near Finlayson Lake, Yukon. The coordinates are 61°28' N latitude and 130°32' W Longitude.

The area of the project is located within the Pelly River and Pelly Mountain eco-regions (Figure 2-2). The major part of the Pelly River eco-region is underlain by metamorphic rock; however, large bodies of volcanic and intrusive rocks and small bodies of sedimentary rocks occur throughout.

2.2 The deposit lies on the northern edge of the Pelly Mountains, a range which trends in a northwest-southeast direction. Area drainage includes Finlayson Creek and its tributaries, and the Finlayson River which flows into the Frances River, which in turn empties into the Liard River. Geona Creek (Kaska for "Wolf") is a tributary of Finlayson Creek and flows across the sub-crop of the ABM deposit.

2.2 PROJECT HISTORY

Exploration work, undertaken by Cominco in 1994, delineated the approximate extent of the ABM deposit. The initial results were encouraging and an Advanced Exploration Project ("AEP") was carried out in 1995. It consisted of drilling, engineering and environmental studies. The AEP was described in a document (titled "Advanced Exploration Projects Description, dated January 6, 1995) which was submitted to the Federal Territorial Lands Advisory Committee and other stakeholders.

Consultations with government representatives and First Nations were initiated in September 1994. The AEP was presented and discussed at open house meetings in Whitehorse, Ross River, Two Mile and Watson Lake in February 1995. In March 1995, Cominco signed a Socio-Economic Participation Agreement with the Ross River Dena Development Corporation which includes economic opportunities and cooperation regarding the development of Kudz Ze Kayah, subject to satisfactory environmental conditions and relevant permits. Cominco have continued to meet with government agencies and First Nations through 1995 to discuss issues and provide details on progress.

A drilling program (NQ coring), undertaken in 1995, was designed to provide a detailed characterization of the extent and variability in grade of the mineralization, assess mining methods and confirm the absence of important mineralization under possible locations for mill, tailings, and waste rock sites. Additional drilling and trenching was carried out to provide sufficient quantities of ore to conduct a pilot plant metallurgical test program.

The majority of equipment and supplies for the AEP were transported into the property from the highway using Delta all-terrain vehicles over a winter trail. The trail included a snow bridge over Finlayson Creek. All other transportation was by helicopter. To facilitate access to site late in summer of 1995, a 4 m wide tote road was constructed, using mainly granular material. Fisheries habitat evaluations for the tote road stream crossings were undertaken and reported to Fisheries and Oceans Canada. A bridge over Finlayson Creek was built using two flat deck rail cars. It is planned to upgrade this tote road prior to actual mine development to meet the parameters required for the mine access road.

The following site investigations were undertaken, as part of the AEP, to provide data necessary:

- to determine a source of fresh water for the mine project,
- to select locations for waste disposal, a mill site and an air strip;
- for the design of open pit slopes, waste disposal sites and mill site structures; and
- to evaluate pit dewatering requirements.

Geotechnical studies were performed at potential tailings dam, waste rock disposal and mill sites to confirm locations and provide data for conceptual designs.

Baseline environmental studies were initiated in July 1994. In November 1994, meetings with Yukon Government and DIAND representatives were initiated in Whitehorse to inform them of the potential mine project in general, and the proposed AEP in particular. Environmental issues were discussed and considered in the development of programs to support the AEP. Cominco consulted the Ross River Dena and solicited their concerns and requirements regarding the proposed project.

Further baseline environmental studies were initiated in March 1995, as part of the AEP. The studies included water quality sampling, the installation of climate and surface hydrology monitoring stations and wildlife surveys. This enabled the collection of late winter data. Concurrently, the proposed study programs were drafted in detail in a document dated March 8, 1995, and submitted to the Regional Environmental Review Committee (RERC) and other stakeholders for review. Following the feedback (in oral and written responses and during meetings in Whitehorse in April 1995), the programs were revised and recirculated in a report entitled *Kudz Ze Kayah Baseline Environmental Studies*, dated May 26, 1995. Other field studies were conducted, including core selection and sampling for acid generation potential assessments, water sampling, stream sediment sampling, fisheries assessment, wildlife surveys and a heritage resource evaluation.

Meetings with DIAND personnel resulted in the determination of the primary responsibilities for project assessment under the Canadian Environmental Assessment Act (CEAA). Cominco submitted draft guidelines for an Initial Environmental Evaluation (IEE) report to the Regional Environmental Review Committee (RERC) in the Project Overview, and received the final IEE guidelines on November 7, 1995.

Cominco submitted the IEE, including an October 1996 Addendum, on October 21, 1996 and the Regional Environmental Review Committee completed its review in December 1996.

The Water Licence Application was filed on December 17, 1997 and the Yukon Territory Water Board held the public hearings on February 24 and March 3, 1998. License Type A, No. QZ97-026 was issued by the Yukon Territory Water Board on December 17, 1998 and signed by the Minister of Indian and Northern Affairs on November 2, 1999. The expiry date of the Licence is September 28, 2018.

Currently, Expatriate Resources Ltd. intends to acquire this project and undertake some infill drilling.

3.0 SITE CHARACTERIZATION

Kudz Ze Kayah is located in the northern foothills of the Pelly Mountains in the Yukon Plateau, and on the east side of the divide between the Pelly River and Liard River drainage basin. The project area is located in the Finlayson Creek/River drainage, which forms part of the Liard Basin.

From the mining perspective, the project is located in the Watson Lake Mining District of the Yukon Territories, approximately 115 km southeast of Ross River near the watershed of a small north-south trending valley (Photo 1). The valley floor is occupied by a small north-flowing stream, known as Geona Creek, a tributary of Finlayson Creek. The topography in the area consists of rolling hills, with lakes occupying valley bottoms. In the immediate vicinity of the deposit, elevations range from approximately 1,400 m a.s.l. at the valley floor, to approximately 1700 m a.s.l. along the heights of land to the east and west.

3.1 SURFACE GEOLOGY

The project area was glaciated and bedrock exposures are encountered only in deep ravines or on steep slopes where post-glacial erosion removed the overburden mantle.

Regional 1:100 000 surficial geology maps (GSC Map 1797A: 1993) indicate that the deposit area is underlain by a till blanket (greater than 1 m thickness) to till veneer (less than 1 m thickness). In the project area, the till is often overlain by alluvial fan sediments consisting of gravel, sand and silt up to 10 m or more in thickness. Colluvial apron

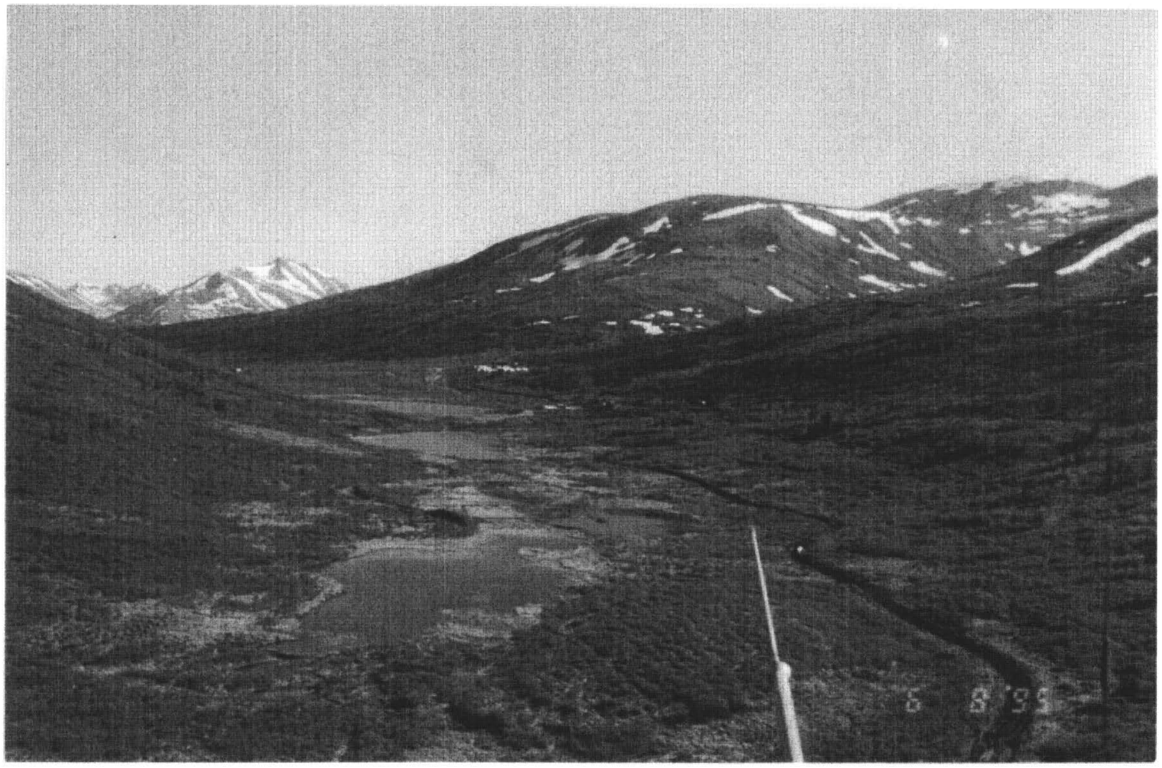

Photo 1: Geona Creek headwater area, looking south. The proposed open pit is located in the lake area and these lakes would have to be drained if the project proceeds. Exploration camp is in the background. Note the access trail prior to the construction of the tote road.

sediments are also common. These consist of bouldery diamicton and poorly sorted sands and gravels deposited at the base of steep slopes by slope wash and localized slumps.

To the north of the proposed open pit mine, in the Geona Creek valley, regional surficial geology maps indicate glaciofluvial deposits composed of sand and gravel. Geotechnical investigations confirmed the existence of these deposits, reaching a depth of 20 m at the proposed tailings pond dam. Their thickness increases in the downstream direction where 40 m deep test holes did not reach the bedrock valley floor. Similar permeable and very thick overburden cover was encountered in the East Creek and Finlayson Creek valleys. The surficial geology and terrain features in the Geona Creek valley are shown on Figure 3-1.

The project is located within the discontinuous but widespread permafrost zone. Ground temperature measurements and observations were made as part of the 1995 field investigation. Records of ice content and distribution were made during test pit excavations. Temperature was measured by a temperature probe in the piezometer pipes. Unfortunately, instrument problems rendered the 1995 data suspect.

Test pits excavated in June 1996 were examined in detail for the presence of ice. Ice was encountered within the upper 2.0 m of most of the 14 test pits excavated within the immediate vicinity of the proposed tailings pond dam.

Additional ground temperature data was collected during the 1996 field investigations. This consisted of observations of ice in test pits and temperature measurements using an improved temperature probe which was lowered into the piezometers installed in 1995. The detailed results are presented in the 1996 field investigation report.

Permafrost (represented by segregated ice) occurs only above the regional groundwater table. As a result, the deepest frozen ground was encountered on the valley slope. It is believed that the depth of frozen ground likely exceeds 15 m on the proposed tailings dam abutments. The permafrost is considered to be relatively "warm" since its temperature ranges between 0° to -1° C.

3.2 BEDROCK GEOLOGY

The ABM deposit lies in a belt of metamorphosed rocks referred to as the Yukon-Tanana Terrane. The Yukon-Tanana Terrane (YTT) correlates with the Nisutline Allochthn, of the Kootenay Terrane (Monger *et al.,* 1991) and with the Misutlin and Nasina Assemblages of the Nisling Terrane (Wheeler *et al.,* 1988; Mortenson and Jilson, 1985) in the Klondike area. The regional geology is shown on the map in Figure 3-2.

In the Kudz Ze Kayah area, the YTT consists of a layered sequence of metamorphosed sedimentary and volcanic rocks subdivided into three main assemblages: (1) a "lower unit" of pre-Devonian Quartzite, pelitic schist and minor marble, (2) a "middle unit" of Late Devonian to Lower Mississippian carbonaceous phyllite and schist with interbanded mafic and locally significant felsic volvanic units, and (3) an "upper unit" comprising Pennsylvanian marbles and quartzite. Volanism in the "middle unit" was accompanied by the intrusion of two to three Late Devonian to Mississippian mafic to felsic metaplutonic suites. The ABM deposit is hosted within felsic volcanics of the "middle unit".

Stratigraphy of the YTT exhibit a pervasive subhorizontal to shallow dipping penetrative ductile deformation fabric and have been metamorphosed to middle greenschist facies (chlorite – biotite grade).

The ABM is a volcanic-hosted massive sulphide deposit hosted within a thick felsic tuff and sill/flow complex with minor traffic sills/flows and interbedded sediments. It occurs roughly 200 metres stratigraphically below the base of an overlying carbonaceous, locally calcareous phyllite metasedimentary sequence. The property geology is shown on Figure 3-3.

Bedding strikes generally east-north-east with dips of 15 to 35 degrees to the north. The bedding parallels a shallow north to northeast dipping, penetrative schistosity that formed during a strong regional deformation event which resulted in isoclinal recumbent folding of the local stratigraphy. Bedding has been transposed parallel to this fabric. Isoclinal folding exists on a small and medium scale in drill core and in outcrop and likely reflects larger folding. As a result of tight isoclinal folding and fold limb parallel faulting, the ABM deposit itself, at least in part, is overturned. Evidence includes base and previous metal and barium zonation within the deposit itself, the position of proximal chloritic alteration above portions of the deposit and lithogeochemical signatures which suggest a petrogenetic link between the units hosting the deposit and those overlying them.

The hosting felsic ash tuffs comprise light grey to yellow to green, fine-grained to granular quartz-feldspar-sericite/Muscovite schists with minor calcite, dolomite, and/or iron carbonate. Proximal intense alteration assemblages, associated with mineralization, form dark green rock comprising chlorite, barite-bearing orthoclase, albite, ankerite, dolomite, calcite, and silica, with or without pyrrhotite, pyrite, magnetite, chalcopyrite and sphalerite. Portions of this sequence of tuffs are potentially moderate to strongly acid generating.

Structurally overlying the host tuffs are ribboned to thinly banded, commonly boudinaged, siliceous felsic ash tuffs. These grade into fine lapilli tuffs and quartz phyric crystal-rich ash tuffs towards the top of the felsic sequence. These overlying lapilli to ash tuffs are expected to be non-acid generating. Rhyolite flows and sills with associated dikes comprising dense siliceous creamy white to light grey quarts with or without feldspar phyric to aphyric units, occur locally within the sequence and can be found above, below, and locally within the sulphide deposit.

A strongly foliated calcite-chlorite, with or without biotite mafic sill, occurs immediately below the base of the deposit. It locally has a splayed, composite character and elsewhere is massive and thick. These mafics are definable as non-acid generating but are not mined, except on the eastern wall of the pit.

The host felsic volcanic sequence underlies the extreme upper reaches of the Geona Creek and Geona Lakes and South Lakes and extends east and west along strike. North of Geona Lakes, the property is underlain by units of the overlying metasedimentary sequence. These units occur along ridges east and west of Geona Creek and have been exposed in geotechnical test pits, and in drill core. They comprise dominantly carbonaceous to graphitic to calcareous mudstones/phyllites with minor intercalated ankeritic, calcareous chlorite schists/mafic tuffs and sills.

The information used to evaluate the ABM deposit geology incorporates data collected from the property during 1994 and 1995. Diamond drilling was carried out both years by D.J. Drilling; the first year with a helicopter-movable Boyles 25A and a Longyear LF70 and the second year with two Longyear 38 drill rigs. In total 21,663 metres of NQ diameter drill core has been produced: 8,485 metres in 52 holes in 1994, and 13,178 metres in 100 holes in 1995.

The sulphide deposit subcrops beneath 2 to 20 m of glacial overburden. The subcrop extends 550 m in an east-west direction across the valley floor, and extends a further 150 m to the east beneath a thin cap of hanging wall rock. Its southeast part has been downdropped about 150 m by a fault which dips at 70 to 75 degrees towards 150 degrees. The fault itself is a broken, fractured, gouge zone 50 to 60 m wide. A cross-section (north-south) of the ore body is shown in Figure 3-4.

The down dip extent of the deposit is about 350 m; the upper part dips at about 30 degrees north, flattening to less than 10 degrees at about 200 m downdip. Over much of its aerial extent, the deposit is sheet-like and forms a main, single layer. In the south-west part, two main layers of sulphides merge locally into a single thick zone. The sulphide sheets range in thickness from less than 2 to 39 metres.

By volume, approximately 70% of the material contained within the deposit model comprises three types of sulphide rock: chalcopyrite/pyrrhotite net-textured rock (4%), magnetite-laminated sulphides (28%), and wispy-laminated sulphides (38%). Other subordinate types include pyrrhotite-rich sulphides (0.5%), chalcopyrite-rich sulphide rock (1%), and fine-grained megascopically homogenous pyrite rock (14%). Heavily disseminated sulphides in host schists (4%) and proximal altered rock (7%) also have intermittent but economically significant concentrations of base and precious metals.

A mine ore reserve of 11.3 million tones, grading 5.9% Zn, 0.9% Cu, 1.5% Pb, 133 grams per tonne Ag, and 1.3 grams per tonne Au, has been modeled using MEDS. This includes 10% mining dilution and 95% recovery of ore.

Approximately 10% of the material included within the ore outline is silicate-carbonate-sulphide alteration carrying significant values immediately adjacent to sulphide rock. Where this alteration assemblage contains 8% or more zinc equivalent grade adjoining sulphide rock, it has been included in the ore envelope. A significant portion of this material is potentially acid generating. The rocks within the ore envelope were classified (by Cominco) as weakly (WPAG) or strongly potentially acid-generating (SPAG) and estimated volumes are 30%T and 5% of the total waste, respectively.

3.3 CLIMATE

The area has a typical northern interior climate with over 50% of precipitation falling as snow. Typical temperatures in the region range from a daily mean of around -25°C in January to a daily mean of around 15°C in July. Extreme temperatures in the region range from -60°C to 35°C.

The snow-pack generally peaks in early April at most snow course stations, although snow may continue to accumulate later in the year at higher elevations. Precipitation is higher on the windward side of mountain ranges, and there is a general trend towards higher precipitation in the direction of the Selwyn and Logan Mountains, to the northeast of the site. Snow-melt and ice breakup in the area streams generally occurs between late April and early May. Summer rainstorms can result in significant flood peaks throughout the months of May to September, although such events are most likely to occur in June or July.

Climatic normals for the project area were determined, in the IEE submission, by reviewing long-term records from stations in the region (regional analysis). Data from both the Atmospheric Environment Service (AES) and Water Survey of Canada (WSC) networks, were utilized (see Figure 3-5 for station locations). These data were analyzed for regional trends, and allowed estimation of appropriate site parameters. The principal climatic parameters are precipitation and evaporation which, together with stream-flow estimates, were used in developing a water balance and for predicting receiving water quality for the proposed mining development.

Estimated mean monthly precipitation, evaporation and temperature values for the project area, based on regional data, are listed in Table 1. The mean annual precipitation (MAP) was estimated at 655 mm, consisting of 265 mm of rainfall and 390 mm of snowfall, in terms of water equivalent. Total lake evaporation was estimated at 300 mm. Therefore, for water bodies, precipitation is approximately double the evaporation.

Frequency analysis, using data from long-term regional stations, was used to estimate extremes in annual precipitation for the project area. This analysis yielded 100-year return period high and low annual precipitation estimates of 990 mm and 411 mm, respectively. Corresponding 10-year return period estimates were 819 mm and 506 mm, respectively.

Two climate stations were established in the project area during 1995, as shown in Figure 3-6. A low elevation station was located just east of Geona Creek, adjacent to the proposed location of the tailings impoundment, and was in full operation between April 13 and September 3, 1995. A high elevation station was initially located (on April 12) at the Kudz Ze Kayah exploration camp at the head of Geona Creek, before being moved to its high elevation Location on May 8. The station was also in full operation until September 3, 1995.

Table 1. - Estimated Mean Monthly Precipitation, Evaporation and Temperature Values for Kudz Ze Kayah

Month	Rainfall (mm)	Snowfall (mm)*	Total Precipitating (mm)	Lake Evaporation (mm)	Temperature (°C)#
January	0	65	65	0	-12.6
February	0	50	50	0	-12.7
March	0	40	40	0	-7.2
April	5	25	30	0	-3.1 [0.4]
May	25	10	35	45	3.3 [6.7]
June	50	0	50	100	9.1 [10.5]]
July	60	0	60	100	12.1 [10.0]
August	60	0	60	55	10.3 [7.1]]
September	50	15	65	30	3.0
October	15	45	60	0	-4.5
November	0	75	75	0	-14.3
December	0	65	65	0	-12.5
Year	265	390	655	330	

* snowfall is expressed as water equivalent

\# based on Ketz River Mine which is at a similar elevation

[ ] 1995 records for the Kudz Ze Kayah low elevation station for comparison

3.4 SURFACE WATER HYDROLOGY

The surface water hydrology was characterized, for the purpose of the proposed project, using data from six monitoring stations installed on area drainages, and by regional analysis using data from Water Survey of Canada (WSC) and DIAND hydrometric stations in the region. The locations of regional stations are shown on Figure 3-5. The locations of stations installed in the project area are shown on Figure 3-6. All stations had staff gauges for manual measurement of stream stage (height). Additionally, the stations on Geona Creek and Lower Finlayson Creek were equipped with automated stage measurements and data storage devices. Measurements commenced in 1995 with the installation of some staff gauges by April 12, 1995. The automated stations were installed in late April. Measurements were continued until September 3, 1995, when the automated equipment was retrieved for the winter.

Peak flows occurred at the Fault, South and Geona Creek stations during May 3 to 14 as a result of snow-melt. Peaks at the other stations were a result of a storm event during June 4 to 6. The lowest flows recorded occurred in late July.

The drainage areas for hydrometric station are given below.

Table 2.- Drainage Areas

Catchment	Drainage Area (km^2)
South Creek	9.82
Fault Creek	1.94
Geona Creek	26.2
East Creek	73.4
Upper Finlayson Creek	153
Lower Finlayson Creek	191

Mean annual runoff (MAR) for the project area was estimated at 414 mm. The derived value for evapotranspiration in the area, determined by subtracting runoff from precipitation (655 mm), is therefore 241 mm per year. The estimated runoff is approximately 63% of precipitation. This agrees with data obtain from the Hydrological Atlas of Canada.

The estimated average monthly distribution of runoff is given in Table 3.

Table 3.- Average Runoff Depths

Average monthly Runoff Depths (mm)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
7.3	5.5	5.3	6.1	68.9	129	66.2	40.2	35.6	25.3	14.1	10.4	414

Based on regional data, maximum monthly runoff usually occurs in June, with the peak in the hydrograph occurring in late May or early June, due to snow-melt. Site records have also shown significant peaks during summer months due to rainfall events. The minimum runoff usually occurs in March or April just prior to the snow-melt freshet.

The above monthly runoff distribution is based on stream-flow records from regional stations, the majority of which have catchments with considerably more drainage area at elevations lower than Kudz Ze Kayah. The proposed tailings impoundment will be above an elevation 1370 m, with a median elevation of approximately 1505 m. At these elevations, the regionally derived runoff distribution will over-0estimate the proportion of runoff that occurs in the winter, and describe a freshet occurring too early. To accurately characterize winter flows into the tailings impoundment, and the timing of the freshet, the monthly runoff distribution from the regional analysis was adjusted. Data from other catchments in the region at similar elevations to the proposed tailings impoundment were used. The adjusted runoff distribution is given in Table 4.

Table 4.- Average Runoff Depths (Adjusted)

Average monthly Runoff Depths (mm)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
3.7	2.7	2.7	3.1	74.7	140	71.8	43.6	38.6	16.9	9.4	6.9	414

Frequency of analysis of long-term station records for the Liard River at Upper Crossing (10AA001) and the Ross River at Ross River (09BA001) were used to determine high and low annual runoff depths at the site. This analysis yielded 100-year high and low annual runoff depths of 564 mm and 264 mm, respectively. Corresponding 10-year high and low annual runoff depths were estimated at 497 mm and 330 mm, respectively. During the May to October period of scheduled water release from the tailings impoundment, the minimum monthly runoff would occur in October. A regional analysis of monthly flows indicated that the 25-year low monthly runoff in October would be 0.49 times the mean October runoff for the tailings impoundment drainage area. Near the mouth of Finlayson Creek, the corresponding 25-year low runoff factor would be 0.51 times the mean. Previous researchers have determined that the 25-year low monthly flow can be used as an approximation of the 10-year seven-day low flow (Faro Mine Down Valley Tailings Impoundment Decommissioning Plan, Curragh Resources, 1991).

An estimate of the Probable Maximum Flood (PMF) is required for design of outlet structures for the tailings impoundment. A prerequisite for development of the PMF is that the Probable Maximum Precipitation (PMP) can be determined. The Hershfield Method was used to derive a 24-hour PMP estimate of 205 mm. This estimate was found to be in reasonable agreement with estimates derived by other consultants for similar studies in the Yukon. The HEC-1 computer program was then used to translate the PMP estimate into a runoff hydrograph using the Soil Conservation Service (SCS) Dimensionless estimate into a runoff hydrograph using the Soil Conservation Service (SCS) Dimensionless Unit Hydrograph method. The peak of the resulting inflow hydrograph to the tailings impoundment was determined to be 200 m^3/s for the catchment area of 16.13 km^2 at mine closure.

Cominco initiated a baseline water quality monitoring program in July 1994. The program was expanded in December 1994, continuing through to September 1995. During that 14-month period samples were collected from twenty-three stream locations and six lakes/ponds (Figure 3-7). From April 1995 onwards, sites in the Geona, South, Finlayson and East Creek catchments were sampled. East Creek was included to give a better indication of baseline conditions, and because the valley had potential locations for tailings disposal. The water quality monitoring sites on Geona creek include five sites on the mainstem creek, three ponds on the mainstem creek, and four tributaries, two flowing from the west and two from the east. The frequency of sampling varied between sites. Sampling of several lakes occurred only in the summer of 1995.

Water temperature, dissolved oxygen, specific conductance and pH were measured in the field during each sampling trip. Samples for metals analysis were preserved with acid in the field. Filtration for dissolved metals analysis was also performed in the field. Samples were shipped to Zenon Environmental Laboratories in Vancouver, B.C. The results of the baseline water quality study are detailed in the IEE report in Section 3.3. Geona Creek water is slightly alkaline, moderately soft in the upper reaches, but hard downstream. Nitrate concentrations are generally low near Geona Creek headwaters while sulphate concentrations are elevated. Iron and zinc concentrations are also generally elevated, particularly in the ore zone. Average concentrations of both total iron and total zinc exceed the Canadian Council of Resource and Environment Ministers (CCREM) guidelines (1987) for protection of aquatic life (300 μg/l Copper and 30 μg/l, respectively).

Copper concentrations are variable. Total copper concentrations sporadically exceeded the applicable CCREM guidelines, which vary with hardness. These periodic exceedences occurred throughout most of Geona Creek but did not occur in any of the tributaries.

Total selenium concentrations in mainstem Geona Creek, Fault Creek and the east side tributaries periodically exceeded the 1 μg/l CCREM guideline. The highest selenium concentration measures was 2.4 μg/l in the headwater pond. Maximum selenium concentrations at all other sites were less than 2 μg/l. Maximum dissolved selenium concentrations also occurred during base flow, suggesting the selenium, like iron and zinc, leaches from the ore body.

Baseline water quality data was also established for Finlayson Creek, East Creek, South Creek and North lakes.

3.5 GROUNDWATER

Groundwater flows and elevations were evaluated on data collected from piezometers and boreholes in 1995. Descriptions and data for the proposed mill, dump and pit sites, and the proposed tailings dam site, are given in Golder Associates geotechnical reports.

The groundwater table is characterized as a subdued replica of topography, with shallow depths to groundwater in the valleys and much deeper depths below slopes. The Geona Creek valley bottom is a discharge area for groundwater from upslope. Hence, the artesian conditions were observed in many boreholes drilled.

In between periods of high runoff induced by either spring snow-melt or summer rain storms, the contribution of base-flow to creeks from groundwater is likely to be a significant proportion of the total creek flow. The valley overburden deposits likely act as a sponge, soaking up water during period of infiltration, and then releasing it at a declining rate after the infiltration period has passed. In late winter, and during dry summer spells, creek flow may be almost entirely groundwater discharge, mostly from the overburden deposits.

In many respects the groundwater quality does not differ greatly from that of the surface water. The groundwater pH is similar to that of surface water. Alkalinity, total dissolved solids and hardness are slightly higher in groundwater than in surface water, reflecting the higher concentration of dissolved ions that are typical of groundwater. Sulphate concentrations are variable, with two wells (one shallow, one deep) having sulphate concentrations more than double the concentrations in surface water and the remaining three having concentrations more similar to surface water.

Groundwater does not appear to be a major source of algal nutrients, except that the shallow groundwater provides phosphorus. Concentrations of nitrate, nitrite and ammonia were generally low except for a moderate level of nitrate (0.13 mg N/L) in shallow well 95-G-26. The two shallow wells (<10 m deep in the overburden) had phosphorus concentrations an order of magnitude or more above those measured in surface water.

For the most part metal levels in both shallow and deep groundwater are low. In particular, copper and lead concentrations in all groundwater samples were equal to or lower than the concentrations in surface water. Exceptions to the pattern of low metals were elevated levels of arsenic and iron in the three deep (bedrock) wells in the ore body (T94-49, T94-30 and T94-13) and elevated arsenic, iron, cadmium and zinc in one well from the overburden.

3.6 SEISMICITY

The project area seismicity was evaluated in conjunction with the preliminary design of the tailings facility and the waste dump. This evaluation is based on data obtained from the Geological Survey of Canada. The predicted horizontal accelerations are tabulated below.

Table 5.- Kudz Ze Kayah Project – Seismic Risk Calculation Results

Return Period	**1 in 100 years**	**1 in 200 years**	**1 in 475 years**	**1 in 1000 years**
Probability of exceedance per annum	0.010	0.005	0.00021	0.001
Peak horizontal ground acceleration (gravity)	0.034	0.042	0.056	0.072
Peak horizontal ground velocity (m/s)	0.077	0.094	0.121	0.149

The reciprocal of the annual probability of exceedance is often referred to as the event return period (i.e., 0.001 probability becomes the 1000 year return period event. Although this is not exactly correct, it serves to provide an indication of how often a specific event may occur. Detailed design of the tailings dam will be based on determination of the maximum credible earthquake (MCE), which is estimated to have a return period between 5,000 to 10,000 years. For the purpose of this study, the ground accelerations associated with the MCE have been estimated by extrapolating the Geological Survey of Canada data to an 8,000 year event. The 8,000 year event is estimated to cause peak horizontal ground acceleration of 0.12 times gravity (0.12 g), and has been used in the stability analyses presented below. This acceleration is estimated to be caused by a magnitude M6.5 event with five (5) cycles of loading.

3.7 VEGETATION

Vegetation mapping was undertaken by Norecol, Dames & Moore in August 1995. The following description is an excerpt from their report, prepared in support of Cominco's Water Use application. Additional data is also available in Appendix 3.8 of the IEE.

The project is located in the sub-alpine and alpine zones.

Vegetation maps were compiled from delineation of habitat map units on 1:40 000 scale black and white aerial photography flown on June 30, 1992. Vegetation types in the vicinity of the proposed mine site are shown on Figure 3-8. Vegetation types were named according to the best fit of the vegetation plot data at the project site to the vegetation types as described in Geomatics International (1995). Vegetation types identified in the south-east Yukon study were used due to the proximity of the project site to the Liard River. Additional site modifiers were added to these vegetation types to further describe the habitats found at the project site. The following modifiers were attached to the vegetation type used on the maps:

- k cool aspect (slopes >25%, aspect 285° to 135°)
- w warm aspect (slopes >25%, aspect 135° to 285°)
- x drier phase
- y wetter phase

Up to three vegetation types were mapped for each polygon (map unit). An estimation of the proportion of each vegetation type (to the nearest 10%) found in each polygon was also provided. Vegetation (habitat) types mapped for the study area are described below. The relative abundance covered by each vegetation type within the study area is provided. The following categories were used to assess abundance within the study area: rare (< = 1%, uncommon (2-5%), common (6-10%, abundant (<10%).

From a vegetation perspective, the Kudz Ze Kayah project area can be subdivided into two areas: Finlayson Creek north of the Geona Creek confluence (access road corridor) and Geona and South Creeks (mine development are). The access road corridor is generally predominated by boreal forest, grading into shrub vegetation types. The mine development area is comprised of shrub and herb vegetation types.

The primary forest types along the access road corridor are open canopy black spruce on mineral soils and open canopy sub-alpine fir. Dwarf birch tall shrub and willow dwarf birch tall shrub vegetation types predominate at higher elevations on the uplands above Finlayson Creek.

The mine development area is at a higher elevation and forest cover is generally sparse. The smaller shrub vegetation types which predominate are willow dwarf and alpine dwarf and herb vegetation types such as woodrush and mesic mixed.

The individual vegetation types and their relative abundance and significance in terms of wildlife habitat are summarized below.

Closed-Canopy Trembling Aspen Forest is dominated by trembling aspen, with sub-alpine fir. The shrub layer is poorly developed and composed of dwarf birch and willows. In the herb layer only kinnikinnick, fescues, and Arctic lupine are abundant. These forests develop on rapidly to well drained, dry sites on glaciofluvial material, such as in the Finlayson Creek valley. This habitat type provides limited food resources for ungulates and carnivores.

Open-Canopy Sub-alpine Fir Forest is discontinuous, on average 10 to 15 m high. The shrub layer is generally well developed, particularly in openings between trees. The main species include dwarf birch, willows, crowberry, and lingonberry. The herb component is variable, from poor to moderately rich, with bunchberry, altai fescue, Arctic lupine and twinflower. The ground is covered by a thick feathermoss carpet, with lichen (mostly reindeer lichens) patches in more open and dry areas. Soil texture is variable, usually fine to medium-textured. This type is commonly found along Geona and Finlayson Creeks above the valley floors. It is relatively common and accounts for about 6 to 10T of the study area.

This habitat provides cover for moose and caribou in summer and fall, and possibly into early winter.

Open-Canopy Black Spruce Forest developed on mineral soils in upland areas and is dominated by black spruce, with lesser amounts of other coniferous species such as sub-alpine fir. Trees are usually short (10 to 12 m), and have small diameters. Shrub layer development is good, with taller stature willows, Labrador tea, bog blueberry, and dwarf birch, and dwarf shrubs such as lingonberry and crowberry. Herb layer cover is typically low, with few species present. Feathermosses and reindeer lichens are abundant. This type is one of the most abundant, covers approximately 15% of the study area and is common along the northern portion of the tote road.

This habitat type provides early-summer range for moose and is utilized by caribou during spring and fall migrations; it provides good habitat for black bears, smaller carnivores, upland furbearers, and small bird species. North of the Kudz Ze Kayah project area, this habitat type provides winter range for caribou.

Open-Canopy Black Spruce Forest developed on organic soils, is dominated by black spruce. Trees are poorly stocked, reaching only 8 to 12 m in height and are of small diameter. The shrub layer is moderately well developed, the leading species being Labrador tea, willows and dwarf birch. Black spruce reproduction is also common. Herb cover is low to moderate. Feathermosses and reproduction is also common. Herb cover is low to moderate. Feathermosses and sphagnum form a thick carpet on the ground. This forest type typically occurs in topographical lows (depressions or swales associated with small streams) in complex with open-canopy black spruce forest that occurs on mineral soils. Soils consist of veneers or blankets of organic material. It occurs from the tote road crossing at Finlayson Creek north to the Robert Campbell Highway. This type accounts for about 2 to 5% of the study area.

Open Canopy White Spruce Forest apparently occurs along Finlayson Creek below its confluence with Geona Creek. White spruce is the dominant tree, however, black spruce and sub-alpine fir may also be present in this area. A maximum of 1 to 2% of the area is covered by this vegetation type in the general project area.

The forest habitat provides cover and food for moose in spring and summer. It is used during winter by moose traveling along adjacent riparian areas. Caribou utilize this forest habitat during spring and fall migrations. This type provides good habitat for black bears, carnivores, upland furbearers, and a wide variety of bird species.

In addition to these forest types, several shrub types were identified:

- dwarf birch tall shrub, covering about 10% of the area.
- willow tall shrub, accounting for only 2 to 5% of the area,
- wet willow tall shrub, also covering about 2 to 5% of the area,
- willow-dwarf birch tall shrub, either herb rich or herb poor and occupying some 12 to 20% of the area,
- dwarf birch dwarf shrub, relatively uncommon and covering some 2 to 5% of the area,
- willow dwarf shrub, also relative rare and occupying about 2 to 5% of the study area,
- sub-alpine fir tall shrub, relatively uncommon and covering some 2 to 5% of the area, and
- alpine dwarf shrub, covering some 6 to 10% of the area.

Samples of vegetation were collected from three riparian sites in July 1997 and two uplands sites in August 1997. The trip reports, the analytical reports and a summary of the results are presented in Appendix 3.9 of the IEE document. The target species from the riparian sites in July were *Salix* sp. (willows), *Carex* sp. (sedges) and *Equisetum* sp. (horsetails), all riparian species that are of value to wildlife. The target species from the uplands sites sampled in August were *Salix* sp. (willows), *Betula glandulosa* (bog birch), *Empetrum nigrum* (crowberry), *Ledum groenlandicum* (Labrador tea), Vaccinium sp. (blueberry) and *Cladina* sp (ground lichen), all potential food sources for moose and caribou.

3.8 WILDLIFE

The wildlife program was developed by Mr. Grant Lortie, a long-time Yukon wildlife specialist, and carried out by trained biologists and experienced wildlife specialists (Hatfield Consultants). Surveys were carried out in March, May, June, October and November 1995. members of the Ross River Dena and staff from YTG Renewable Resources' Fish and Wildlife Branch participated on several of the surveys.

In addition to the field surveys, a wildlife observation log was initiated at the Kudz Ze Kayah camp in May 1995 to record significant wildlife observations made by exploration personnel, helicopter pilots, contractors, and environmental survey crews. A map grid system was established to tie observations to general geographic locations.

Wildlife resources in the project area and surroundings include the Finlayson caribou herd, moose, black bear, grizzly bear, wolf, fox, coyote, wolverine, marten, mink, river otter, beaver, several raptors, ptarmigans, various waterfowl, and a variety of other birds. The lakes and small ponds/wetlands provide breeding and migratory habitats for waterfowl and other aquatic birds. The Finlayson Lake/River area and the east slope of the Pelly Mountains are also known as migration corridor for waterfowl and other waterbirds (including trumpeter swans and sandhill cranes).

The most notable wildlife resource in the area is the Finlayson caribou herd, which has been the subject of a significant management effort by the Yukon Government since the early 1980's. Their studies have included detailed population surveys and radio collaring. Annual rut surveys are flows by YTG Renewable Resources to monitor the caribou population. This herd has substantial value as a subsistence base for the Ross River Dena, for resident sport hunters, and for the Yukon guiding industry. The results of the work undertaken in conjunction with this mining project are summarized in the following paragraphs.

3.8.1 Caribou

The Finlayson caribou herd experienced a declining state during the early 1980's. This led to a wolf control program in 1982/83 and 1989/90. The wolf population was reduced and results of the 1994 survey indicate that the Finlayson herd has rebounded from a low of approximately 2,000 in the early 1980's to an estimated 8,000 caribou by the mid-1990's. Of the estimated 8,000 in the herd, approximately 1,000 to 2,000 inhabit the general region around the project area. As many as 552 caribou were counted in the project are during the annual rut surveys.

Caribou calve on ridges and upper slopes of basins in late May and by mid-June for aggregations in the uplands. They remain dispersed in small bands in the uplands and upper forests through summer. During late spring through summer, caribou utilize many of the shrub and herb vegetation types that were identified in the vegetation study as well as the open-canopy sub-alpine fir forest on valley slopes.

Caribou form rutting aggregations in early October and occupy the uplands (ridges and plateaus), including the upper elevations of the project area. At this time, caribou may utilize any of the alpine shrub vegetation types (e.g., dwarf birch dwarf shrub, willow dwarf shrub, alpine dwarf shrub) and alpine herb vegetation types (e.g., woodrush herb, mesic mixed herb). After the rut, caribou disperse throughout the area and inhabit the alpine, sub-alpine and upper forests until late fall (mid November). At this time, they utilize a wide range of vegetation types. By mid-November, caribou start to move down to the boreal forest which includes the open-canopy black spruce forest vegetation types.

By December-January, caribou have moved down to their traditional winter range in the Pelly River lowlands. Their winter range includes the boreal forest along the Robert Campbell Highway, to the north of the project area. By early to mid-May, caribou move upward, following the receding snow to the uplands on their way to calving areas.

3.8.2 Moose

Moose are the second-most abundant large mammal species in the project area. Moose are regionally important as a subsistence food source for First Nations and also for sport hunting. Moose populations in the region have been the subject of study by YTG since the early 1980's. Moose populations have also benefitted from the wolf control program carried out by the YTG between 1982 and 1989 and have increased since the wolf population is controlled.

Moose occur on the Kudz Ze Kayah property in the spring, summer, fall and early winter. It is estimated that 10 to 20 moose use the immediate project area at various times of the year. Winter ranges have not been clearly established.

Moose utilize the forested vegetation types (open-canopy sub-alpine fir, open-canopy black spruce mineral soil, open-canopy white spruce) during much of the year, although primarily in the winter when they inhabit the lowlands along Finlayson creek down to the Robert Campbell Highway. The tall shrub vegetation types (e.g., willow tall shrub) are also utilized into the winter period when moose occur in the upper Geona Creek valley. During spring to fall, moose are widely distributed throughout the area and can occur in any of the vegetation types, except that the alpine types receive little use (due to their poor cover and food availability for moose). During the rut and post-rut, moose occupy upper sub-alpine basins and utilize the tall shrub vegetation types (e.g., willow tall shrub, willow-dwarf birch tall shrub her rich, sub-alpine fir tall shrub) and the open-canopy sub-alpine fir forest.

3.83. Stone's Sheep

A population of Stone's sheep inhabits the uplands to the south of the North Lakes (approximately 7 km south of the project area) and toward the west side of Wolverine Lake (approximately 15 k southeast). Direct surveys for Stone's sheep were not flown as part of the Kudz Ze Kayah wildlife program in 1995, as sheep are not known to occur in the project area.

3.8.4 Bears

Grizzly bear (*ursus arctos*) and black bear (*Ursus americanus*) inhabit the region and were occasionally observed near the project area during the 1995 aerial surveys. Grizzlies range throughout the open valleys and sub-alpine of the region, and may occur in any portion of the project area. Grizzly home ranges are generally large. In the interior mountains of the southwestern Yukon, grizzly bear density was estimated as one grizzly per 25 km^2 (Pearson, 1975). It is likely that one or two grizzlies include the project area as part of their home ranges. No bear den sites were observed during the aerial surveys and none were reported during other project-related work in the area.

Only one black bear was reported in the Kudz Ze Kayah area in 1995. This was an adult on the slopes approximately 3 km southwest of the Kudz Ze Kayah camp. Black bears are more abundant in the lower forests toward Finlayson Lake and the Robert Campbell Highway. Black bear are not expected to be common in the project area because of the primarily sub-alpine and alpine habitats.

3.8.5 Wolves

Wolves (*Canis lupus*) have been the subject of study by YTG in conjunction with surveys of the Finlayson caribou herd. The wolf control program between 1983 and 1989 reduced the wolf population by 81 to 85% (Farnell and Hayes, 1992). The wolf population has been the subject of study to monitor its recovery after control (Hayes and Harestad, in progress). Numbers appear to have recovered to near the pre-control population.

Wolves or their sign were infrequently observed during the aerial surveys flown for the 1995 wildlife program. Wolves travel throughout the region and are expected to utilize the upper Geona Creek valley and adjacent uplands. Exploration-related activities in 1995 may have kept wolves out of the upper Geona Creek area.

3.8.6 Smaller Carnivores and Furbearers

Smaller carnivores observed in the project area, either through direct observation or through sign, include fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), and least weasel (*Mustela nivalis*).

Beavers (*Castor canadensis*) are moderately abundant in the project area's creeks, small lakes and ponds. The best beaver habitats occur along Finlayson Creek. The upper Geona Creek valley represents poor beaver habitat but is still utilized, as are small drainages throughout the lower to mid-elevations of the region. Beaver activity was observed on most of the small ponds in the upper Geona Creek valley and the North Lakes drainage to the south.

Other furbearers which were not recorded during the 1995 program but which are known too occur in the region (and are expected in at least parts of the project area) include coyote (Canis latrans), lynx (*Lynx canadensis*), marten (*Martes Americana*), ermine (*Martes erminea*), mink (*Mustela vison*), and river otter (*Lontra canadensis*).

3.8.7 Birds

Waterfowl use of the immediate project area is limited due to the extensive uplands. Ducks were reported on the lakes at the top of the North Lakes drainage (including mallard, scotters, mergansers, and harlequin). One pair of harlequin ducks was reported on lower East Creek.

Trumpeter swans were observed on lakes north of the project area and one pair on the easternmost of the North Lakes. Trumpeter swans are known to breed in the lakes and potholes throughout the Pelly lowlands and to migrate through the Finlayson River valley.

Whitefronted geese migrate through the Pelly River and Finlayson River valleys in significant numbers from late August until mid-September.

Approximately 200,000 Alaskan and Siberian breeding sandhill crane migrate through the study area in May and June and from late August into late September. Large numbers of these birds are particularly evident in the general Kudz Ze Kayah area during the fall migration along the Tintina Trench.

Golden eagles were observed on numerous occasions during the May 1995 caribou calving survey. A total of 25 golden eagle observations were recorded; however, some of these may have been repeat sightings. Golden eagles were recorded on several occasions in the uplands near the Kudz Ze Kayah camp. A bald eagle sighting was also recorded in the upper Geona Creek valley on May 3, 1995 and one was reported foraging for fish in the easternmost of the North Lakes on May 5, 1995.

Ptarmigan were observed frequently in the project area. Ptarmigan were observed in small flocks during the early December 1994 reconnaissance survey and during the March 10 and 12, 1995, aerial surveys. All three species of ptarmigan (willow, rock and white-tailed) may occur in the project area. Willow ptarmigan were abundant in the upper Geona Creek valley and were frequently seen around the Kudz Ze Kayah camp in April, when the males were establishing territories.

3.9 FISHERIES

The fisheries field work in the project area indicated that upper Geona creek, including two to three beaver ponds and the mainstem creek, contains Arctic grayling and slimy sculpins. No other species were observed in Geona Creek or in Finlayson Creek downstream. Fish appear to occupy the system in all seasons.

Geona Creek appears to contain few fish, based on extensive electrofishing in the spring and fall of 1995, and trapping with weir fences through the summer. The fish in the creek are generally young grayling and appear to be concentrated at the outlets (beaver dams) of the ponds. Finlayson Creek, below Geona Creek, contains some adult grayling. It appears likely that there are no resident salmonid species, other than Arctic grayling, in the creeks and ponds within the project area. The headwater lakes in South Creek contain Arctic grayling, including full-size mature fish, and burbot. South Creek flows to the North Lakes system which supports numerous fish species.

3.10 TRADITIONAL LAND USE

Traditional land use of the project area is primarily related to subsistence hunting, trapping and fishing activities of First Nations. Oral history interviews were collected by Doris Bob, an elder of the Ross River Kaska Dena, as part of the archaeological reconnaissance study, and translations of the interviews are available in the study report (Rutherford, 1995). Locations of summer and winter trails, cabins and camping areas have been compiled by the Ross River Dena Development Corporation (Figure 3-9).

The hunting of caribou, moose, sheep and small game, as well as fishing in the areas of North Lakes, Wolverine Lake and Finlayson Lake, were identified. The project area likely was used as one of the routes of travel to the North Lakes.

The Ross River Dena Council holds the group trapping rights for the project area. No one person owns a trapline, but trapping takes place on Group Traplines. The Ross River Dena Council has management responsibility for the Group Traplines (Figure 3-10). A detailed map shows areas used by Ross River Dena on Figure 3-11. The access road location lies within the Ross River Group trapping area. Furbearers taken in traps include marten, mink, river otter, wolverine, fox, coyote, wolf and lynx.

The commercial guiding rights for the project area are held by Doug Smarch of Teslin Outfitters. His operation consists of guiding non-resident hunters seeking trophy animals in a wilderness setting. His guided hunting takes place in August and September. The main camp is at Fire Lake, south of the project area, but there are also spike camps throughout the region. Activities are rotated over a six-year period so as not to spend more than two consecutive years in any one area. Teslin Outfitters have been affected by increased mine exploration activities (e.g., helicopters) throughout the general area which have affected the quality of the hunting experience and possibly the distribution of animals.

Mr. Warren LaFave operates a tourist facility called Inconnu Lodge on McEvoy Lake, north of Finlayson Lake. His facility caters primarily to non-resident tourists, for hiking, canoeing, fishing, viewing and photography. He also flies some resident hunters to camps and cabins in the region in the fall. Most of his activity is to the east of the project area and the mine will not impact his lodge directly.

A heritage resource survey was undertaken between May 4 and 24, 1995 as part of the Environmental Assessment of the Advanced Exploration Project. The study was completed in two phases: Phase 1 was the resource assessment of the tote road from the Robert Campbell Highway to the project site, and Phase 2 was an assessment of the proposed mine development area. The survey, undertaken by Doug Rutherford and a field assistant from the Ross River Band, consisted of an archaeological reconnaissance of the proposed road alignment and the mine development areas to assess the potential and test for the presence of archaeological resources. Concurrently, an oral history was conducted to determine traditional land use within the project area by an elder of the Ross River Dena Council. Seven elders were interviewed during the project. A final report was prepared by Rutherford and submitted to the Heritage Branch, Government of Yukon in early July of 1995 (Rutherford, D.E., June 1995, Archaeological Reconnaissance of the Kudz Ze Kayah Project, Central Yukon, Phases 1 and 2).

No cultural material was observed in the surface survey during Phase 1 and 2 assessments. A total of 15 areas were tested along the tote road route prior to construction and an additional 6 in the mine development area. Sites tested were selected as having the greatest potential for cultural material based upon maps, air photos, helicopter and foot surveys of the study area. Sampling sites selected also considered geographical factors such as proximity to water (including consideration of landscape change over time), drainage, and level surfaces for comfortable living or camping conditions.

4.0 EXISTING DEVELOPMENT

The Kudz Ze Kayah mining project is in a preliminary design stage and no mine infrastructure, such as concentrator, offices, electric power plant, shop, warehouses and similar facilities have been developed to date.

Work and studies undertaken to date included exploration drilling programs in 1994 and 1995, baseline environmental studies and geotechnical investigations, also conducted in 1994 and 1995. Other prospects in the vicinity of the Kudz Ze Kayah ore body were explored in 1996.

Exploration work in 1994 delineated the approximate extent of the ore body while drilling, undertaken in 1995, was used to provide a detailed characterization of the extent and variability in grade of the mineralization, assess mining methods and confirm the absence of important mineralization under possible locations for mill, tailings, and waste rock sites. NQ core drilling on predetermined grid spacings was undertaken. Additional drilling and trenching was carried out to provide sufficient quantities of ore to conduct a pilot plant metallurgical test program.

The majority of equipment and supplies for the Advanced Exploration Project (AEP) was transported into the property from the highway using Delta all-terrain vehicles over a winter trail. All other transportation was by helicopter. The trail included a snow bridge over Finlayson Creek.

To facilitate access to site later in the summer of 1995, a 4 m wide tote road was constructed. The tote road is 24 km long and represents the major linear disturbance within the project area. Several borrow pits were opened along this route. The road is gated at its junction with the Robert Campbell Highway with a guard trailer at the gate.

A network of exploration trails, drill pads and trenches represents another significant terrain disturbance in the project area. Similar disturbances occurred at the sites investigated for possible tailings pond and waste dumps. None of these locations were reclaimed.

An exploration camp was established at the mouth of Fault creek, on a gently sloping terrace. The camp comprised a kitchen/eating facility, a washroom, a toilet building, an office and nine tents. The tents had a wooden floor and sidings with cloth roof. The energy was provided by a generator, water intake was arranged in the Fault Creek channel and waste was burnt in an incinerator.

A heliport was established some 25 m east from the camp. The heliport was located on a relatively flat area not requiring any grading. Fuel was stored in steel drums.

Adjacent to the heliport is a series of core sheds and two wood buildings used by geologists to document, split and package cores.

A storage area was established (by a cut-and-fill method) approximately 1 km north from the camp at the tote road.

5.0 CLOSURE

The Kudz Ze Kayah project proposes to mine ABM deposit, which is located 100 km southeast of Ross River, Yukon Territory. The Kudz Ze Kayah site lies on the northern edge of the Pelly Mountains in an area characterized by moderate terrain which generally opens valleys and gentle slopes. The mine development area lies between 1,325 m and 1,450 m above sea level. The area drainage includes Finlayson Creek and its tributaries, and the Finlayson river which flows into the Francis River, which in turn empties into the Liard River. Geona Creek is a tributary of Finlayson Creek and flows through the valley within which the mine and facilities will be developed. The mine would be located close to the head of the valley. Another drainage is located just to the south, and contains South creek. The ABM deposit contains an estimated 11.3 million tones of massive sulphide ore containing 0.9% copper, 1.5% lead, 5.9% zinc, 1.3 g/t gold and 133 g/t silver. The project contemplates the construction and operation of an open pit mine, concentrator and infrastructure to support a production rate of 1,080,000 tonnes per year. The current estimated life of the mine is nine years.

Baseline environmental studies have been completed in support of this environmental evaluation. These studies have included climate and hydrology, surface water and groundwater quality, stream sediment quality, aquatic resources (fish, benthic invertebrate and zooplankton characterization), vegetation and terrain mapping, wildlife, and archaeological investigations.

Exploration activities and other investigations caused terrain disturbances, chiefly in the Geona Creek valley and along the 24 km long tote road.

Respectfully submitted:

GEO-ENGINEERING (M.S.T.) LTD.

M. Stepanek, M.Sc., P.Eng.
Principal Consultant

MS/hh
G1775R01

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IEE and Water Licence Application documents were prepared by Cominco personnel with the assistance of the following technical groups.

- H.A. Simons

  Feasibility engineering, mine site layout and process plant design.

- Golder Associates

  Geotechnical investigations and design work related to the open pit, rock dumps and tailings impoundment, physical hydrogeology and well water supply, terrain mapping.

- Norecol, Dames & Moore

  Geochemical characterization, baseline environmental and socio-economic studies, impact assessments and mitigation plans.

- Hay & Company

  Interpretation of climate and surface hydrology data, preparation of runoff and flood predictions.

- VIA-SAT

  Procurement and installation of climate and surface hydrology monitoring stations.

- Hatfield Consultants

  Technical support and write-up for wildlife studies

- Grant Lortie

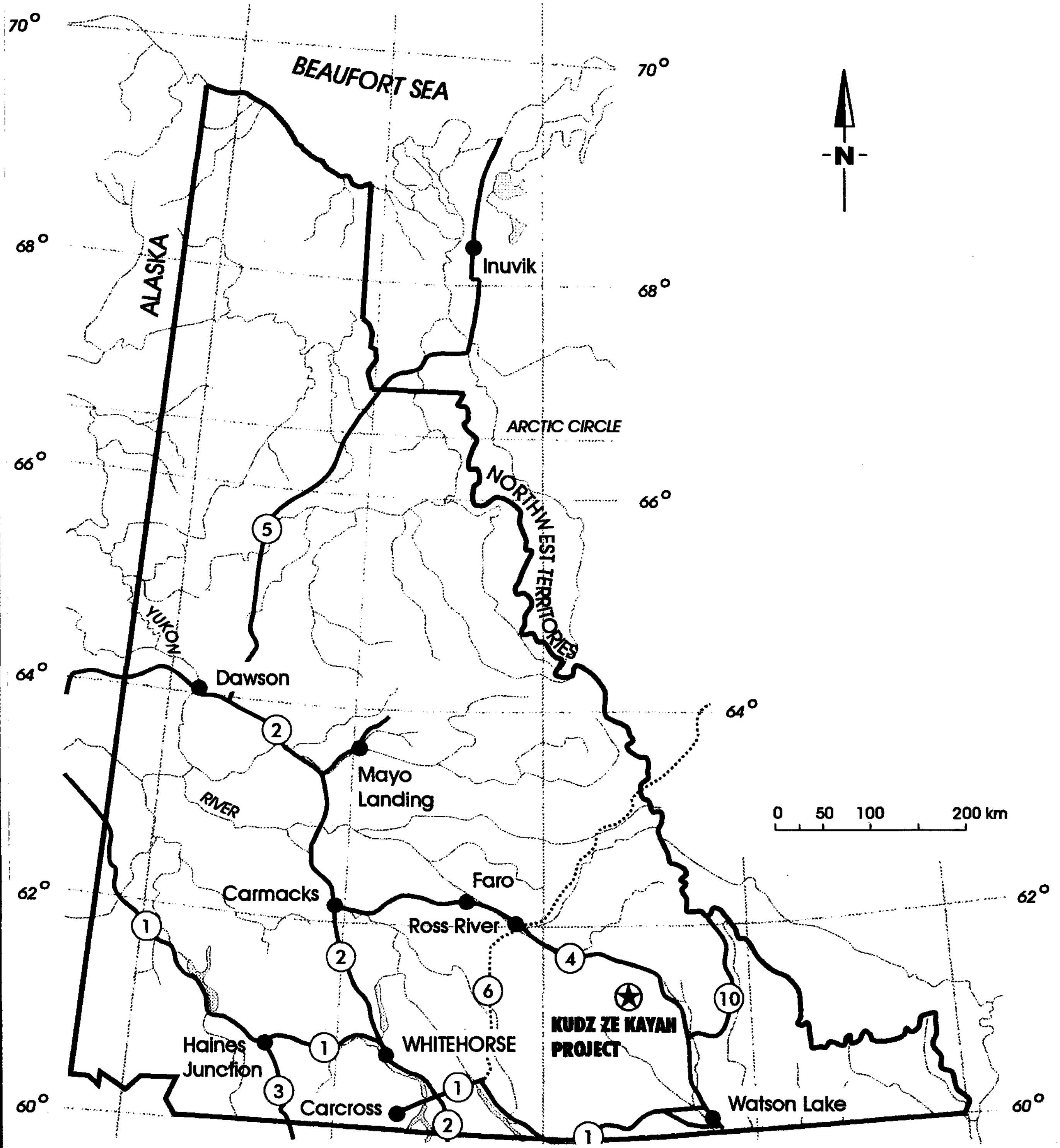
  Wildlife surveys

- Dougles E. Rutherford

  Archaeological reconnaissance

APPENDIX A

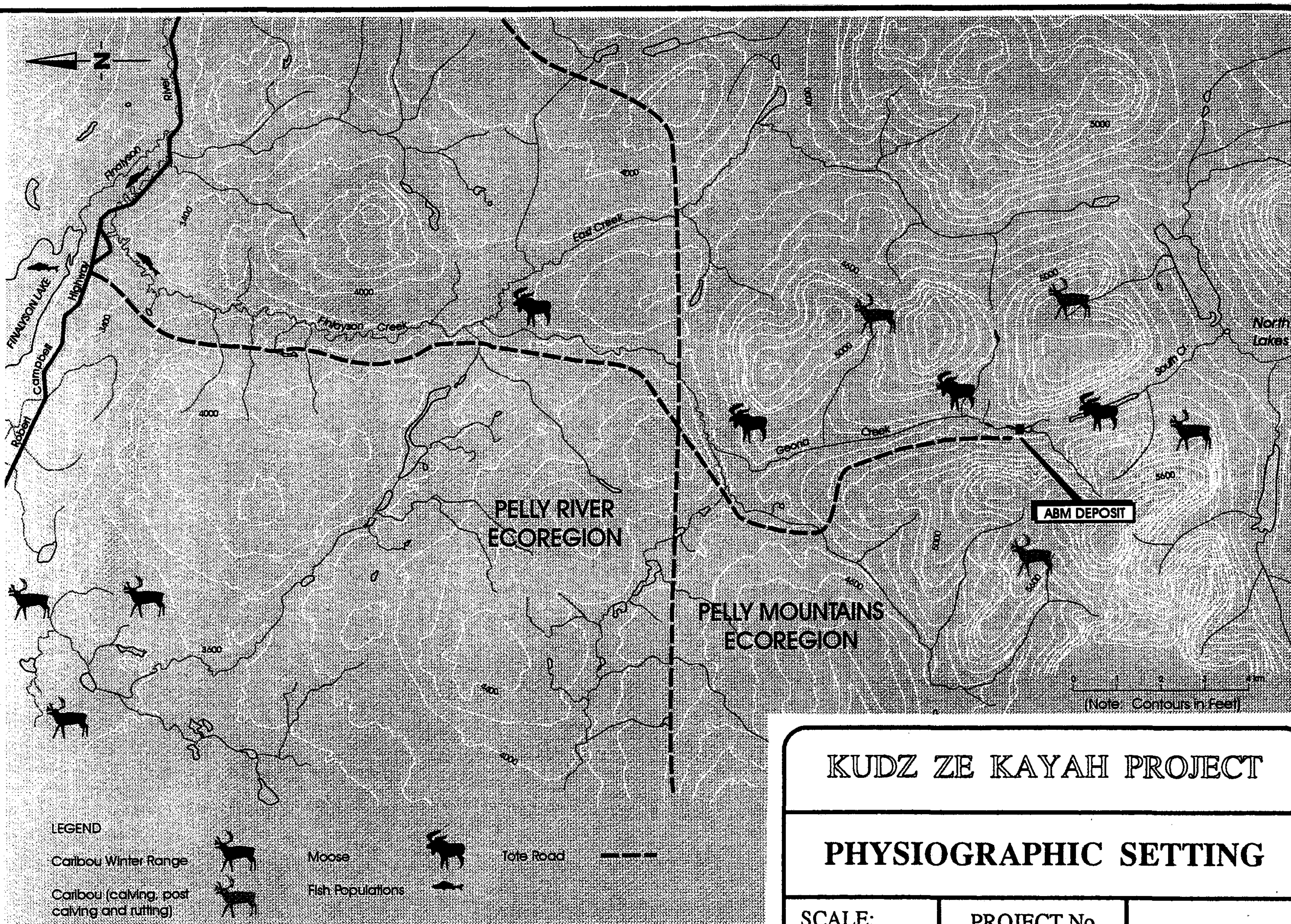
FIGURES



Note: Highway Route Numbers are referenced from Yukon Official Road Map

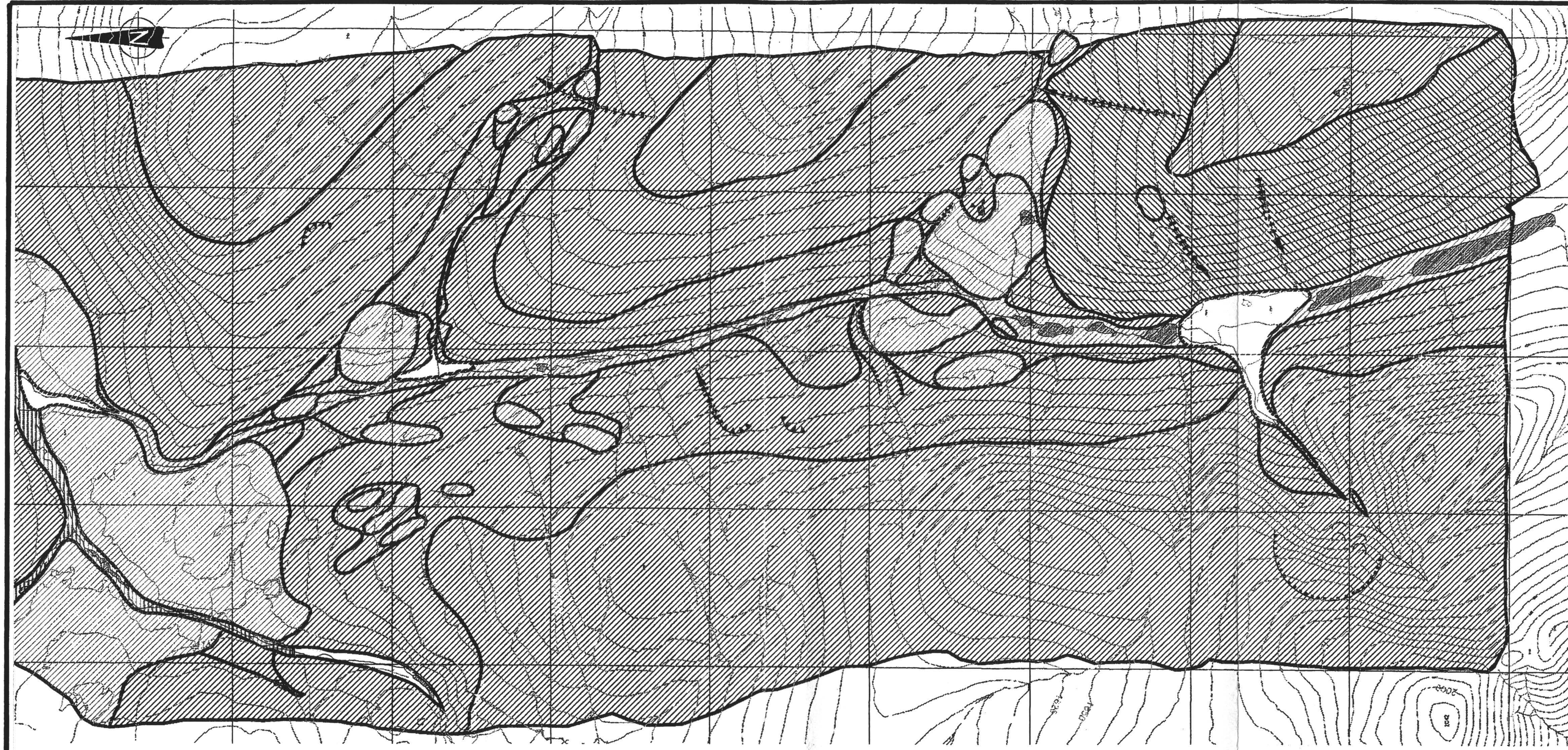
NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT		
GENERAL LOCATION		
SCALE: As Shown	PROJECT No. G1775	FIGURE 1-1



NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT		
PHYSIOGRAPHIC SETTING		
SCALE: As Shown	PROJECT No. G1775	FIGURE 2-1



LEGEND

MELTWATER CHANNEL (Major)

MELTWATER CHANNEL (Minor)

CIRQUE

LANDSLIDE

MORAINAL DEPOSITS

TILL APRON:
Till like material forming slope-toe complex of solifluction deposits, debris flow and avalanche fans over 10m thick.

TILL BLANKET:
Greater than 1m thck but conforming to to the underlying topography.

TILL VENEER:
Less than 1m thick or discontinuous; may contain extensive areas of thin and patchy colluvium.

NOTE:
Terrain Analysis by Golder Associates

GLACIOFLUVIAL DEPOSITS

GLACIOFLUVIAL COMPLEX:
Sand, gravel, diamicton, and minor silts and clay; greater than 5m thick; including minor elements of glaciofluvial terrace sediments.

GLACIOFLUVIAL FAN SEDIMENTS:
Gravel, sand, and minor silt, greater than 1m thick.

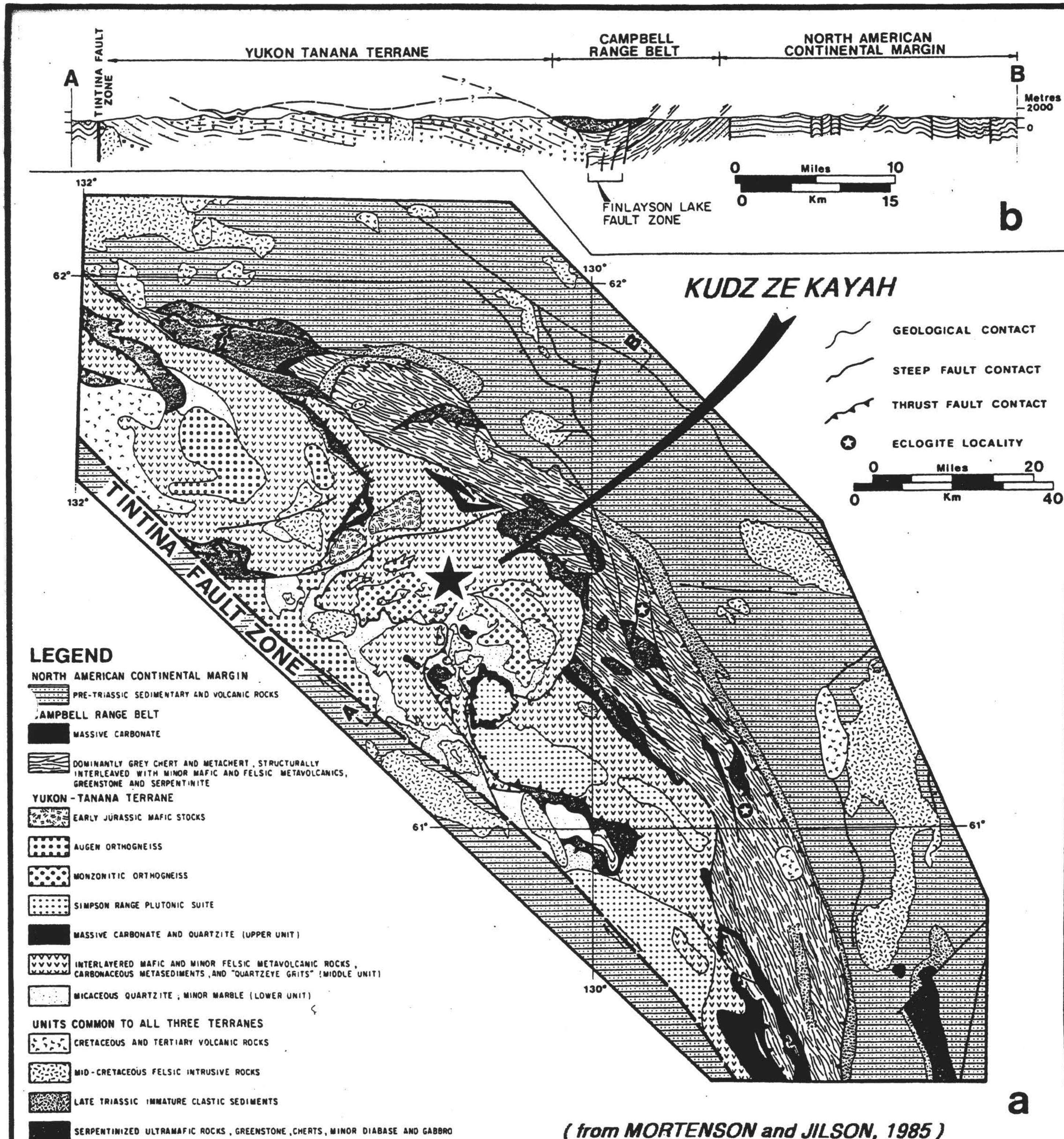
ALLUVIAL DEPOSITS

ALLUVIAL SEDIMENTS, UNDIVIDED:
of gravel and sand with minor silt, including lacustrine and organic sediments.

ALLUVIAL FAN SEDIMENTS:
Gravel, sand, silt, and diamicton up to 10m or more thick; on smaller and steeper fans subject to inundation by debris flows.

0 — 1250
SCALE (m)

KUDZ ZE KAYAH PROJECT		
SURFICIAL GEOLOGY of GEONA VALLEY		
SCALE: As Shown	PROJECT No. G1775	FIGURE 3-1

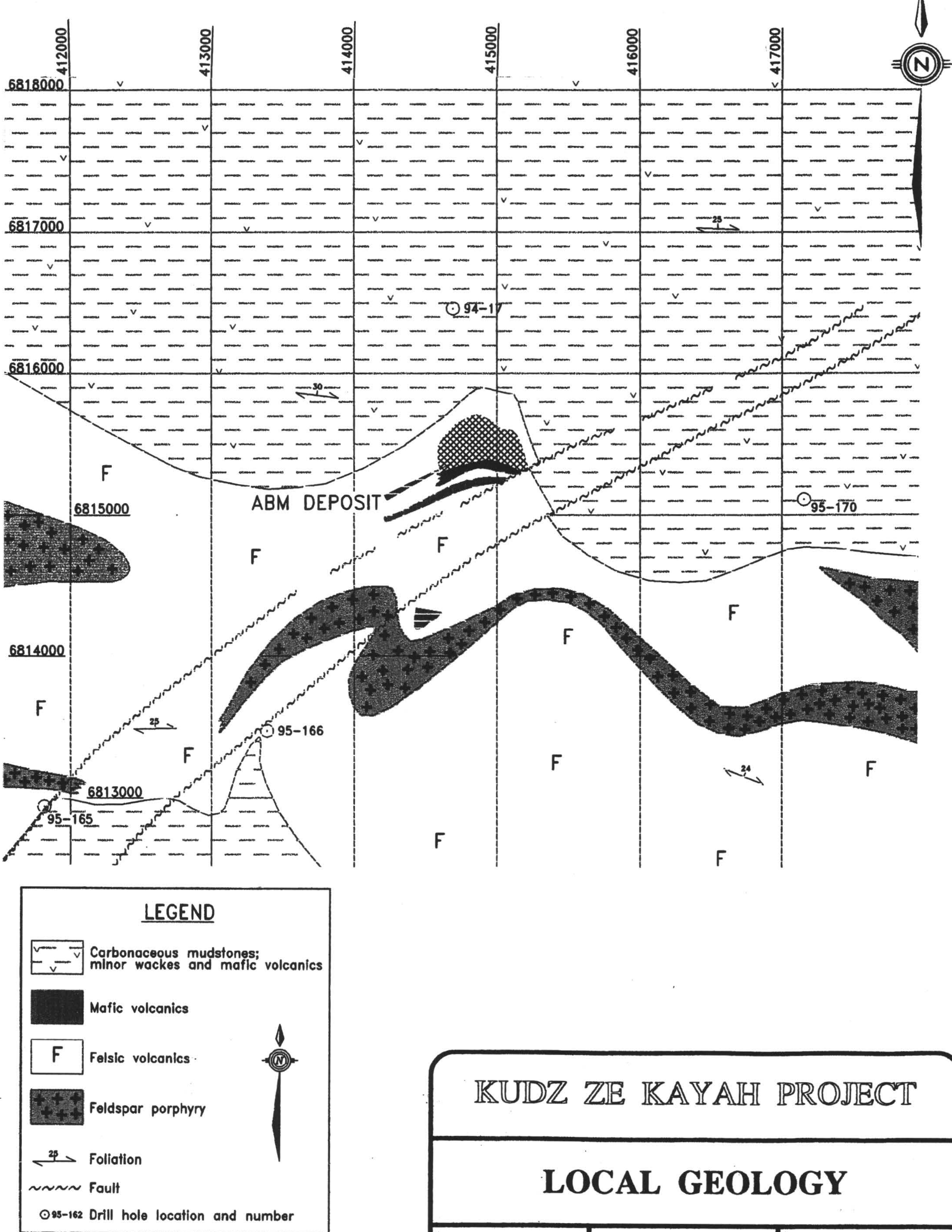


(from MORTENSON and JILSON, 1985)

KUDZ ZE KAYAH PROJECT

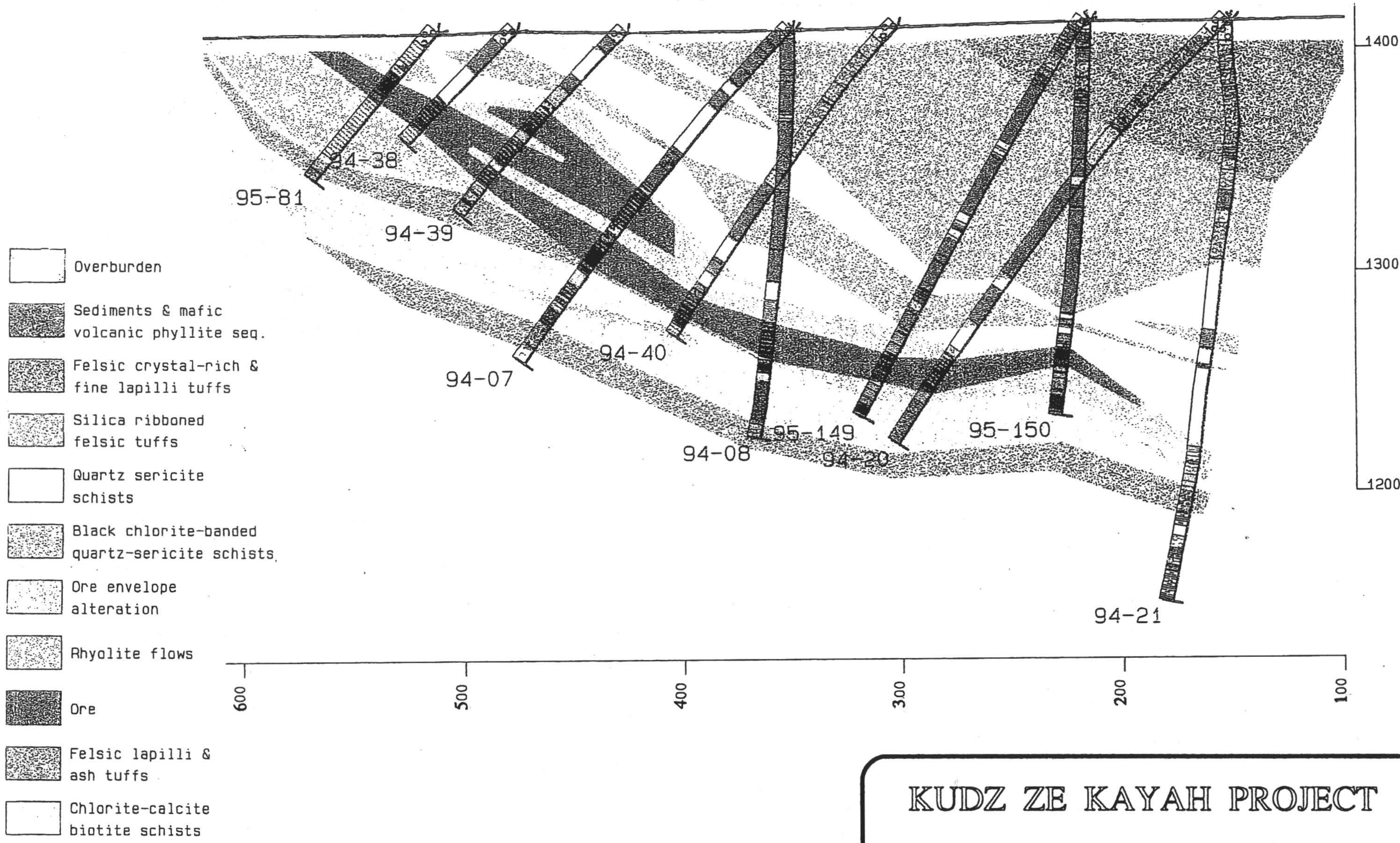
REGIONAL GEOLOGY

SCALE: As Shown	PROJECT No. G1775	FIGURE 3-2

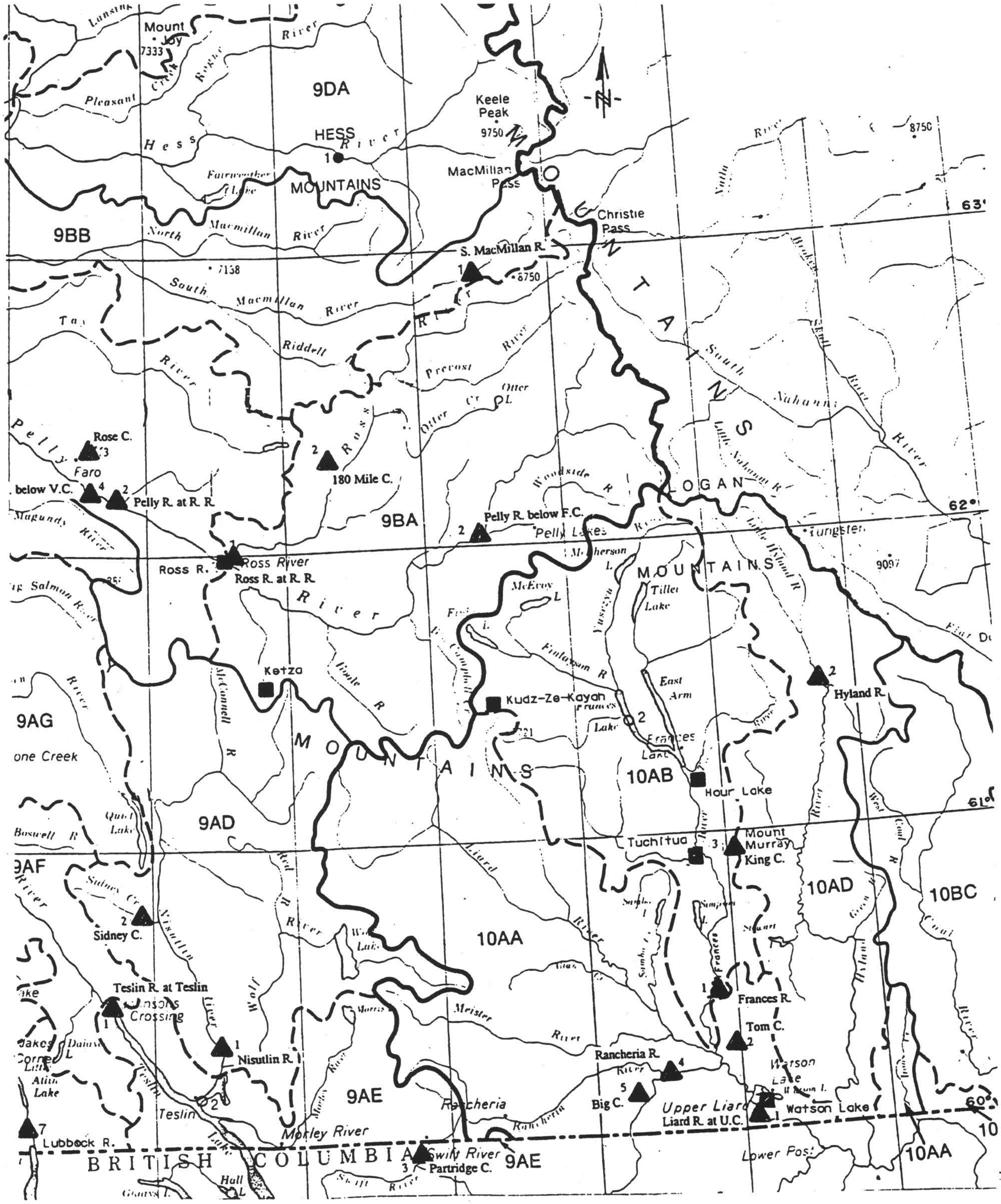


NOTE:
Prepared by Cominco

KUDZ ZE KAYAH PROJECT		
LOCAL GEOLOGY		
SCALE: As Shown	PROJECT No. G1775	FIGURE 3-3



KUDZ ZE KAYAH PROJECT		
CROSS - SECTION 4750 E		
SCALE: As Shown	PROJECT No. G1775	FIGURE 3-4



LEGEND

Hydrometric Station ▲

Climate Station ■

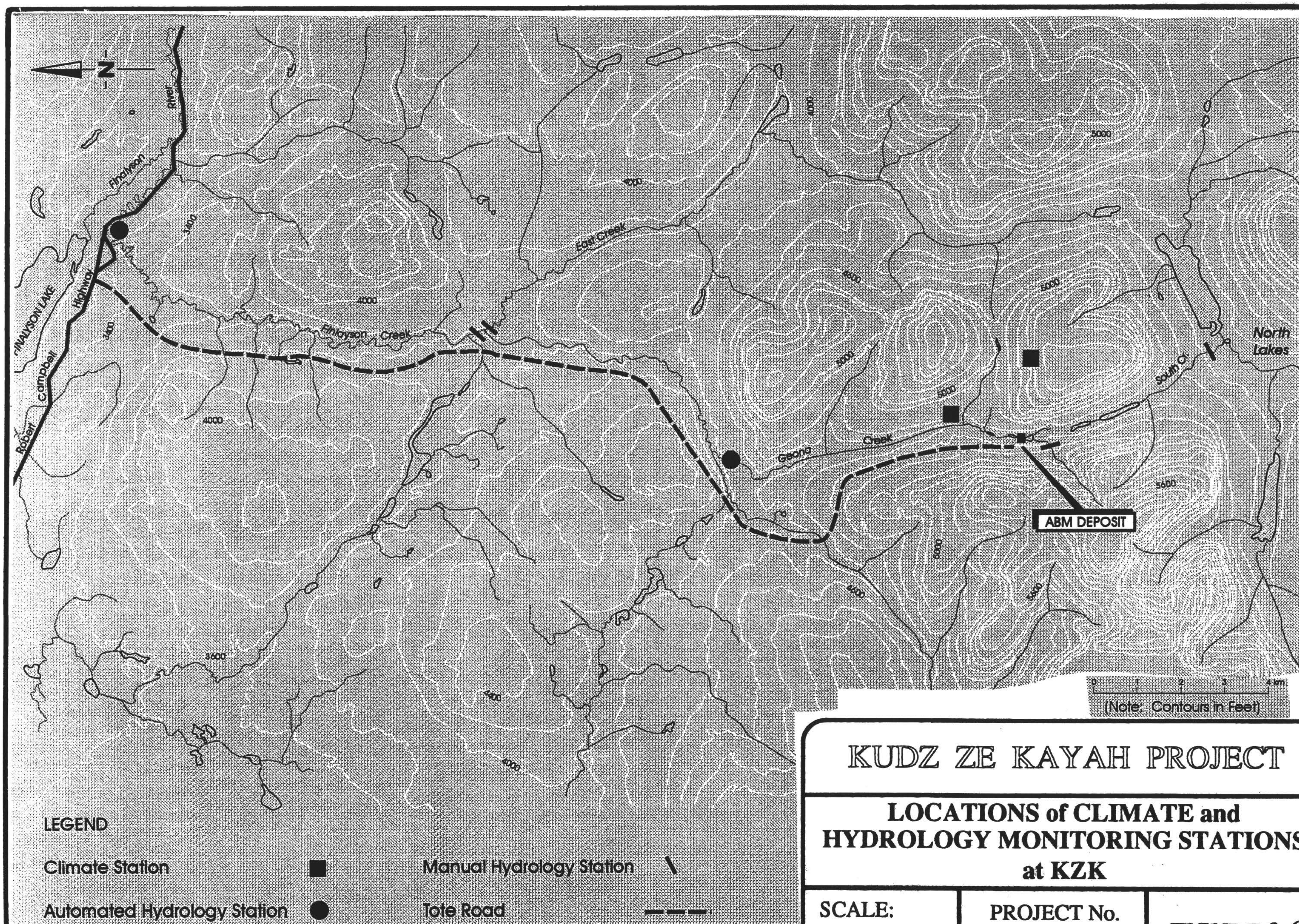
Watershed Boundary —

NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT

REGIONAL HYDROMETRIC and CLIMATE STATIONS

SCALE: N.T.S.	PROJECT No. G1775	FIGURE 3-5

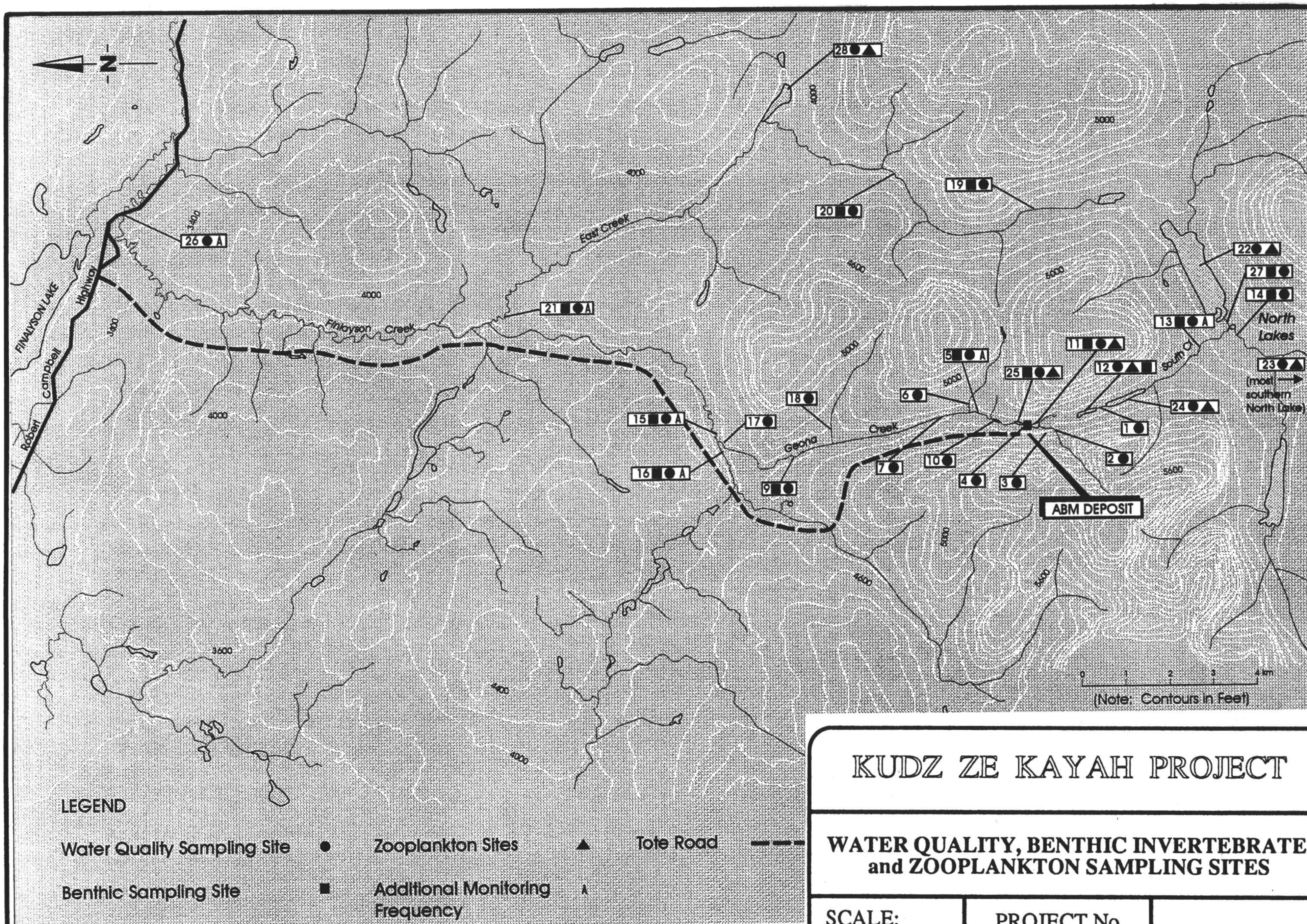


NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT

LOCATIONS of CLIMATE and HYDROLOGY MONITORING STATIONS at KZK

SCALE:	PROJECT No.	FIGURE 3-6
As Shown	G1775	

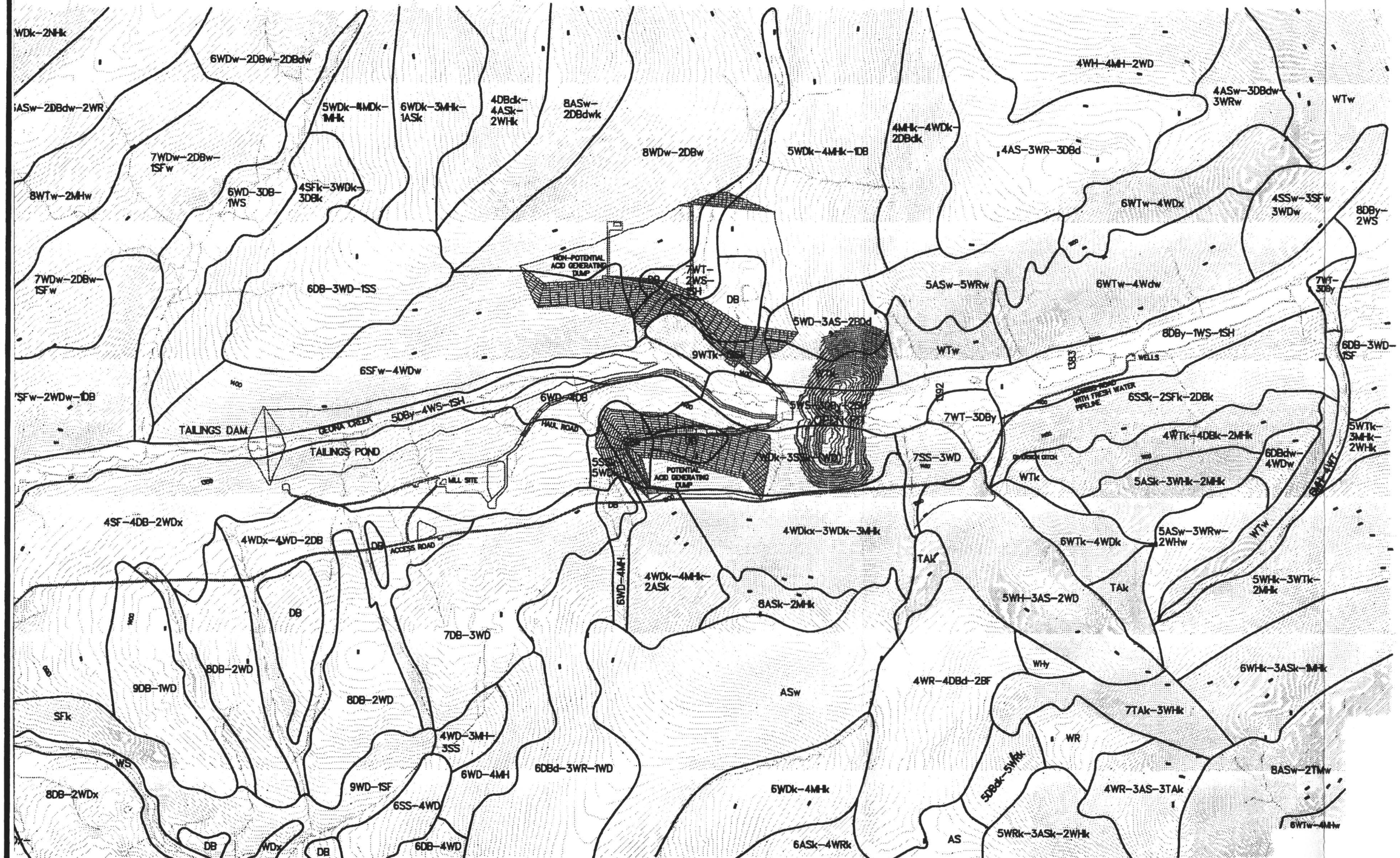


NOTE:
Prepared by Cominco

KUDZ ZE KAYAH PROJECT

WATER QUALITY, BENTHIC INVERTEBRATE and ZOOPLANKTON SAMPLING SITES

SCALE:	PROJECT No.	FIGURE 3-7
As Shown	G1775	



VEGETATION TYPES

TM	Trembling Aspen Forest
SF	Open Canopy Subalpine Fir Forest
BSm	Open Canopy Black Spruce Forest: mineral soil
BSp	Open Canopy Black Spruce Forest: organic soil
PC	Open Canopy White Spruce Forest
DB	Dwarf Birch Tall Shrub: herb poor, moss rich
DBy	Dwarf Birch Tall Shrub: wet phase
WT	Willow Tall Shrub
WS	Willow Tall Shrub: wetland (riparian)
WD	Willow – Dwarf Birch Tall Shrub: herb rich
WDx	Willow – Dwarf Birch Tall Shrub: dry, herb poor
DBd	Dwarf Birch Dwarf Shrub
WH	Willow Dwarf Shrub
WHy	Wil Dwarf Shrub: wet
SS	Subalpine Fir Tall Shrub
AS	Alpine Dwarf Shrub (misc.)
WR	Dry Wood rush herb
SH	Wet Sedge Herb: lowland (riparian)
MH	Mesic Mixed Herb
BF	Blockfield
TA	Talus/Rock
RO	Rock

MODIFIERS

k	cool aspect (slopes >25%, aspect 285 to 135 degrees)
w	warm aspect (slopes >25%, aspect 135 to 285 degrees)
x	drier phase
y	wetter phase

MAP SYMBOLS

60% of polygon — 40% of polygon

6SFw–4WDw

vegetation type — site modifier

site modifier — vegetation type

N

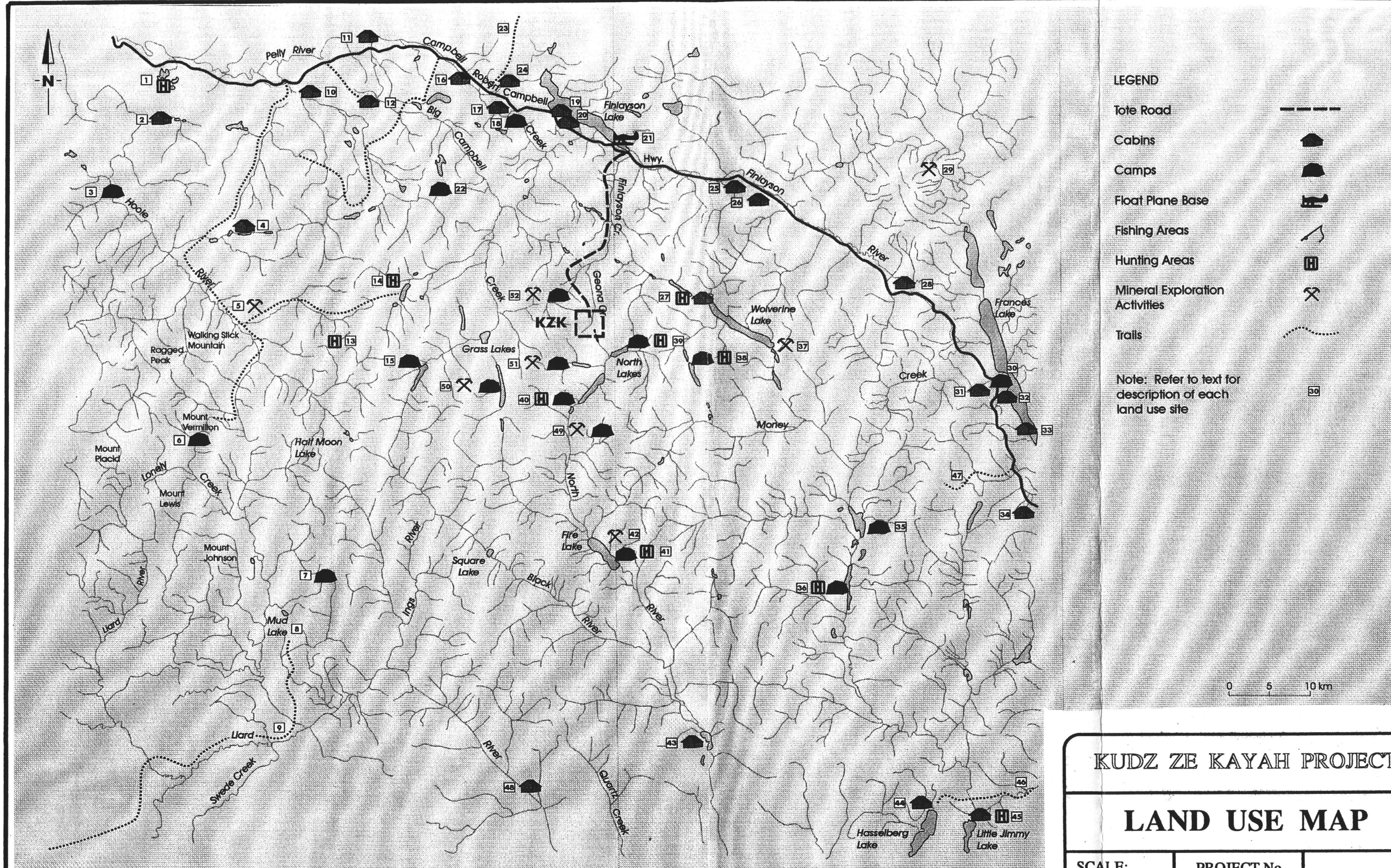
SCALE 1:26 000
metres
0 260 520 780 1040

NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT

VEGETATION MAP

SCALE:	PROJECT No.	FIGURE 3-8
As Shown	G1775	

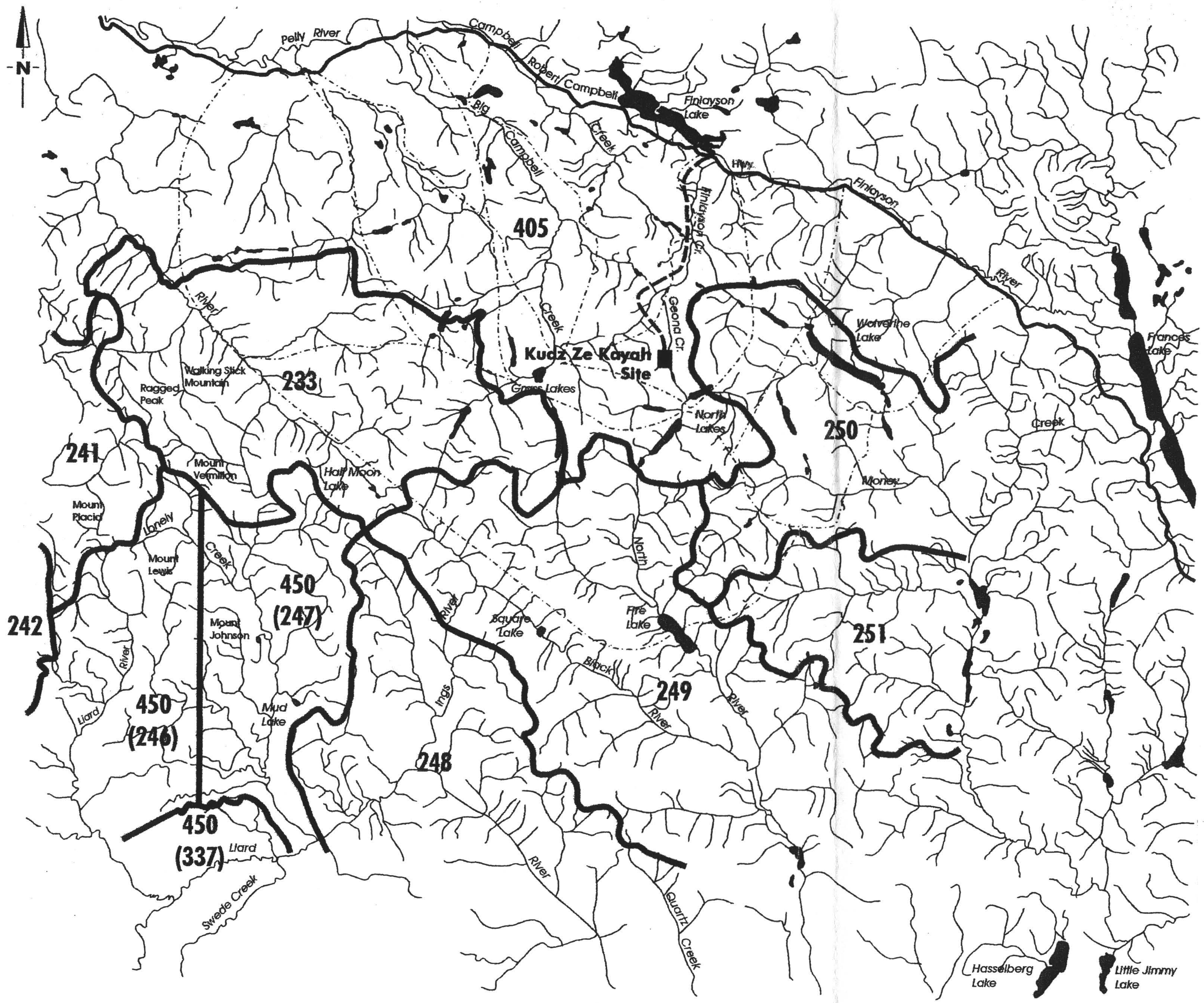


NOTE:
Compiled by Ross River Dena Developments Corp.

KUDZ ZE KAYAH PROJECT

LAND USE MAP

SCALE: As Shown	PROJECT No. G1775	FIGURE 3-9



LEGEND

Tote Road
Trails
Trapline Concession Boundaries

Trapline Number	Holder	Town
233	Dickson, Charlie	Watson Lake
241	Herzog, Alfred	Whitehorse
242	Hassard, R./Warren, M	Teslin
248	Carreau, Deb & Keith	Watson Lake
249	Open	
250	Charlie, Mary	Ross River
251	Larson, C/Tees, Mary	Watson Lake
405	Ross River Group	Ross River
450 (246)	Wolf Lake Group Line 450 - Wolf Lake Group	Teslin Teslin
450 (247)	Wolf Lake Group Line 450 - Wolf Lake Group	Teslin Teslin
450 (337)	Wolf Lake Group Line 450 - Wolf Lake Group	Teslin Teslin

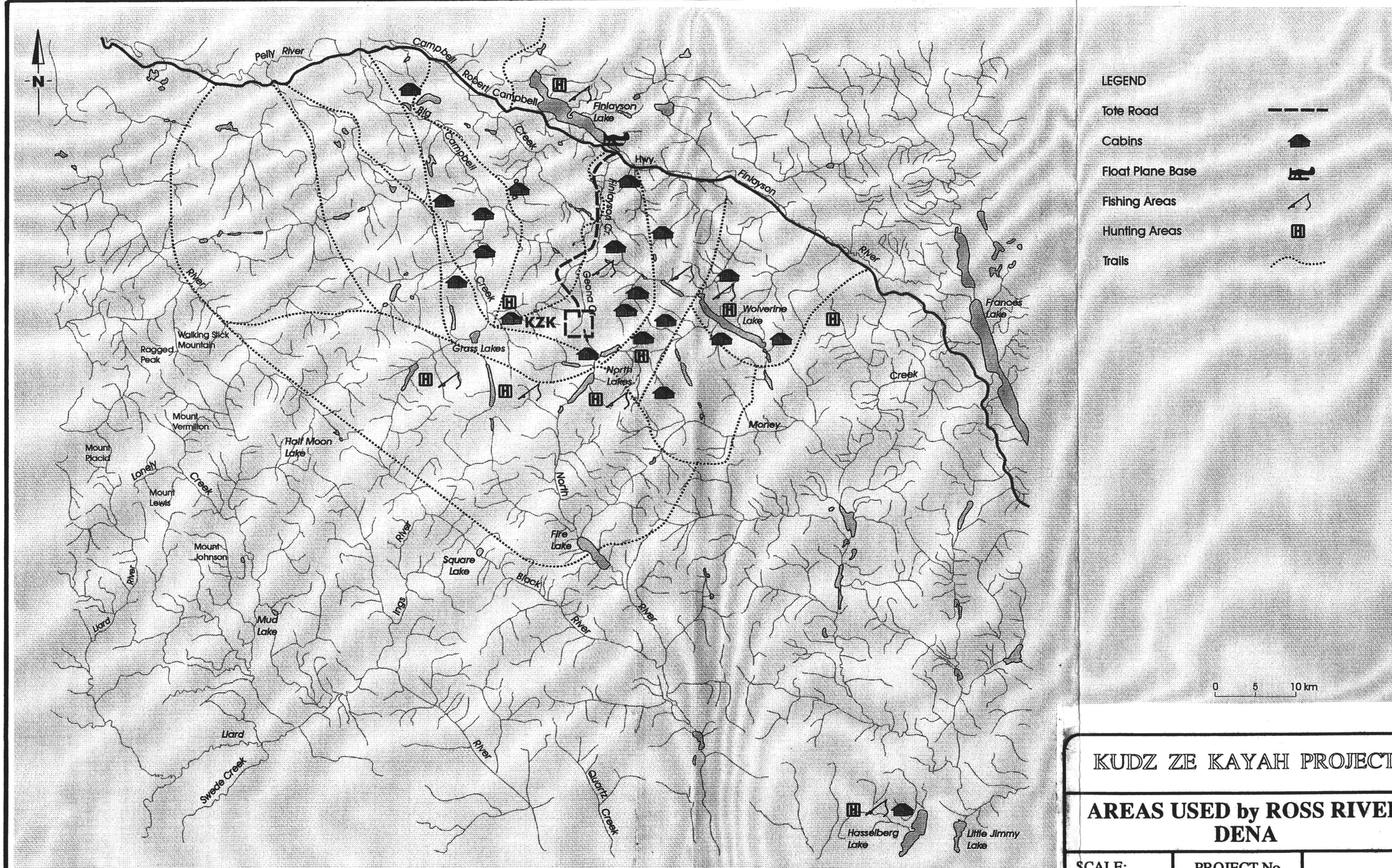
0 5 10 km

NOTE:
Compiled by Norecol, Dames & Moore Inc.

KUDZ ZE KAYAH PROJECT

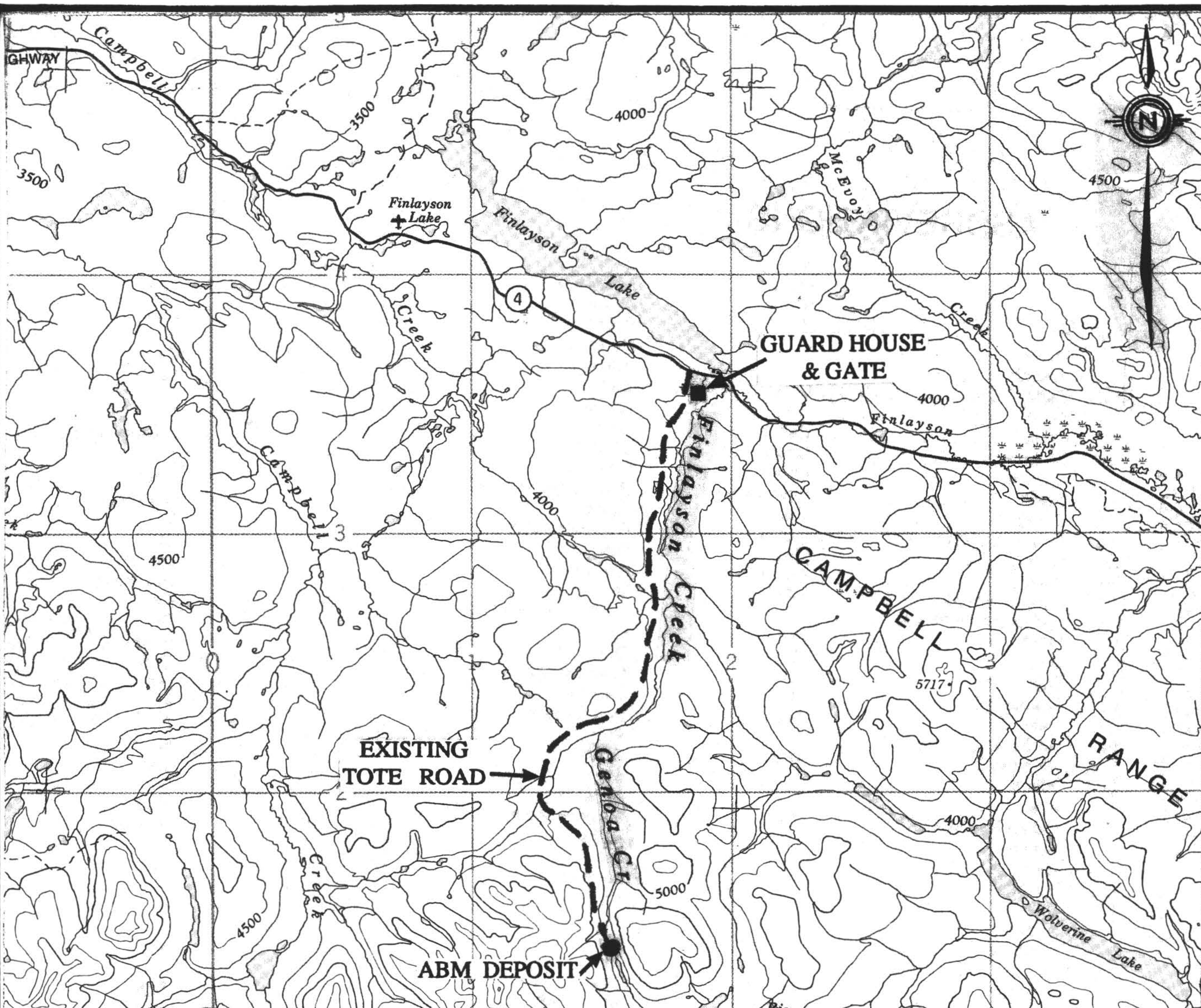
TRAILS and TRAP LINES

SCALE:	PROJECT No.	FIGURE 3-10
As Shown	G1775	



NOTE:
Compiled by Norecol, Dames & Moore Inc.

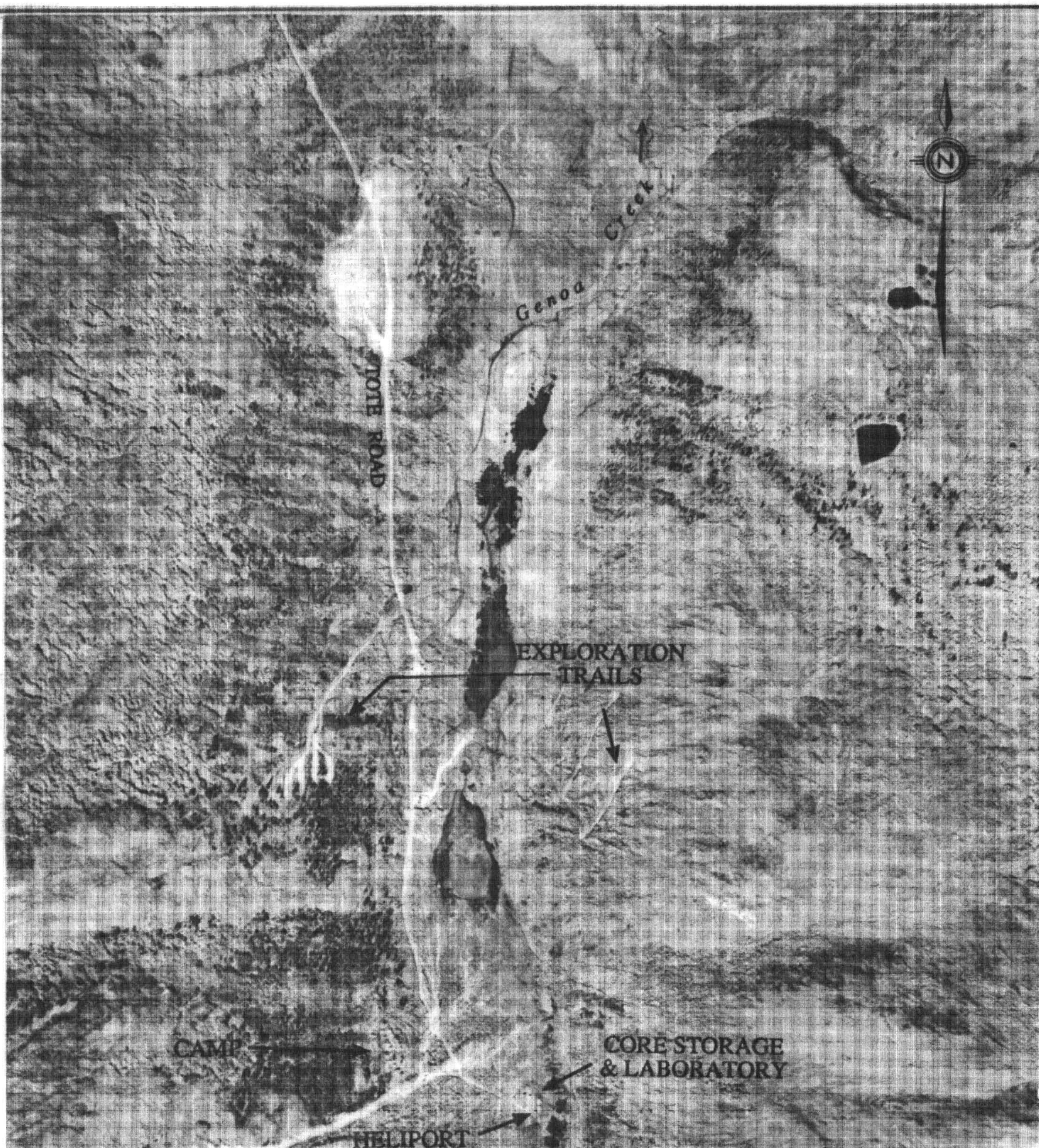
KUDZ ZE KAYAH PROJECT		
AREAS USED by ROSS RIVER DENA		
SCALE: As Shown	PROJECT No. G1775	FIGURE 3-11



KUDZ ZE KAYAH PROJECT

EXISTING TOTE ROAD

SCALE:	PROJECT No.	FIGURE 4-1
1:250 000	G1775	



KUDZ ZE KAYAH PROJECT

MINE and CAMP AREA

SCALE: 1:10 000 (approx.)	PROJECT No. G1775	FIGURE 4-2