ENVIRONMENTAL INVENTORY

HIGH LAKE AREA

, NWT

Submitted to

Covello, Bryan and Associates

Yellowknife, NWT

by

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1.0 INTRODUCTION

1.1 The Study

Covello, Bryan and Associates (CBA) requested that a preliminary environmental inventory or baseline study be done on the High Lake mineral property that is presently being assessed for development. Dr. David Rees was engaged to carry out such a study of both High Lake and its watershed.

Specifically, the purpose of the study was to develop an inventory of the terrestrial and aquatic environments of the High Lake area and to assess the findings with regard to environmental guidelines for preserving environmental quality and with regard to potential development of the ore body.

1.2 Scope of this Study

The scope of this baseline study is limited to a preliminary review of the physical and human environments in the immediate area of the High Lake deposits. At this time, only High Lake's watershed and some adjacent terrain and lakes have been researched. Most investigation has been done at a reconnaissance level with some detailed analysis conducted on High Lake itself.

The data presented in the study have been derived from field measurement and investigation as well as from library research and government sources. Two trips to High Lake were made in

July and August of 1993 to the CBA project to gather field data and to document lake and watershed conditions. Thus the scope of the study and therefore the data are somewhat temporally limited.

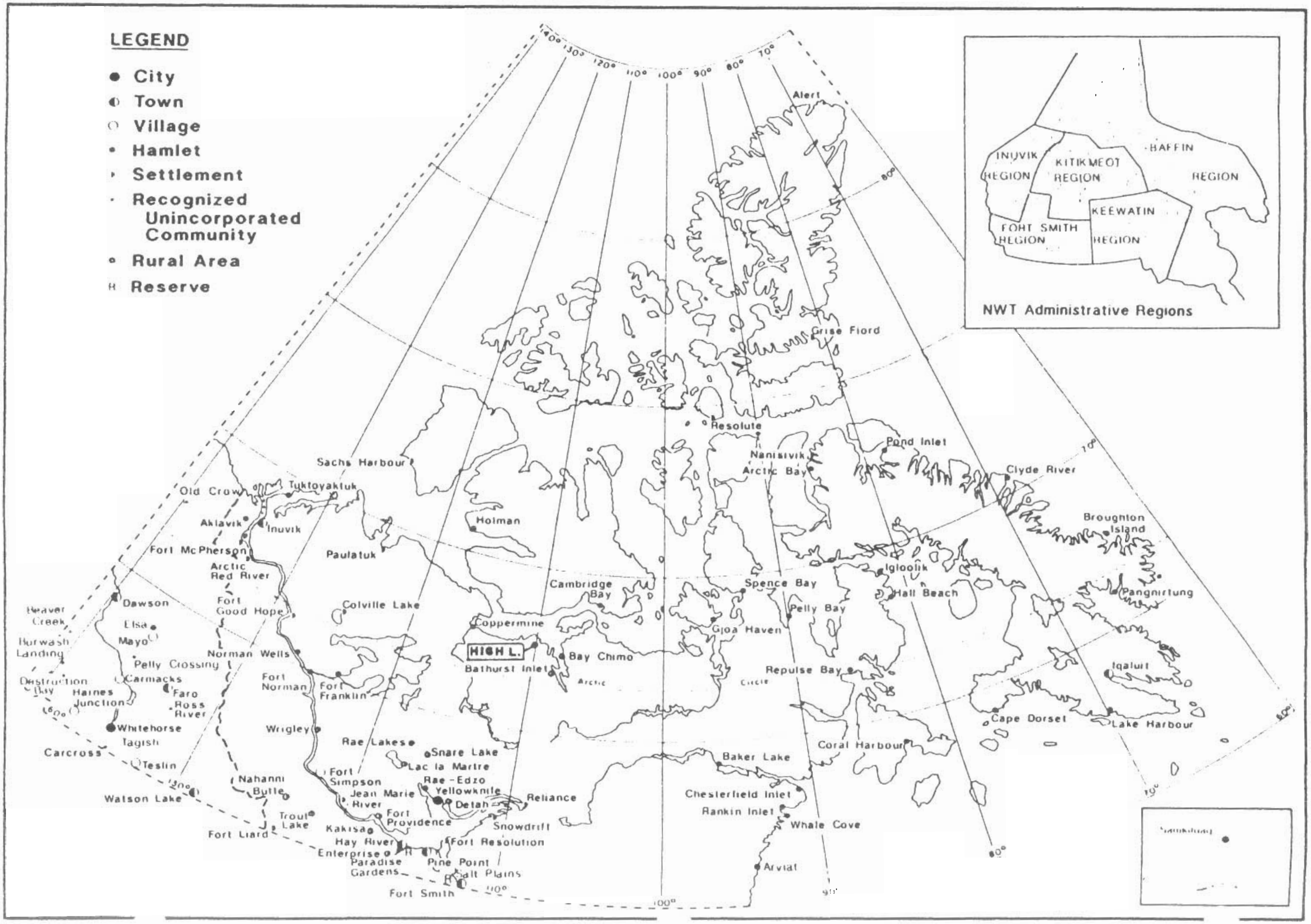
If the High Lake deposits are to be developed, a great deal more work will be required for the definition of the mine infrastructure and potential impacts. Issues concerning the biophysical, social and economic impacts of construction, operation, decommissioning and post-abandonment as per Section 3.2 of the N.W.T. Regional Environmental Review Committee (RERC) guidelines will have to be addressed in detail, through the environmental assessment process.

2.0 LOCATION

2.1 Geographic Location

High Lake area is in the Kitikmeot Region of the MacKenzie District just south of the Coronation Gulf coast of the Arctic mainland of the Canadian Shield. It lies just to the west of Bathurst Inlet, midway along the coast comprising the northern mainland coastline of the Northwest Territories (NWT) of Canada (see Map #1). More specifically, High Lake itself is situated at 67° 23′ 14" N and 110° 50′ 33" W and can be found on the NTS mapsheet 76 M/7 at grid coordinates 506500/7474500. The area is included in the newly established Nunavut Territory of Canada.

Map # 1 : Location of High Lake



Source Gover[...]t of Yukon, Community and Transportation Services; Govern[...]t of the NWT, Municipal Affairs; Government of the NWT, Annual [...]port

The closest communities to High Lake are those of Bay Chimo (Umingmaktok) lying about 128 km to the east across Bathurst Inlet and Bathurst Inlet (Kingaok) at 135 km to the south-east. Larger communities such as Coppermine, Cambridge Bay and Yellowknife are situated at about 175 km to the west, 300 km to the north-east and 600 km to the south-west respectively.

The closest mine site at this time is Lupin which is situated some 225 km to the south. Izok Lake, which is presently under review for development, also lies about 250 km to the southwest and the proposed port for Izok Lake lies about 156 km due west, near Coppermine.

At this time High Lake is a remote location accessible only by aircraft, landing on ice, water or tundra. It is situated about 0.5 km to the west of the Kennarctic River which flows northwardly into the Coronation Gulf at Gray's Bay.

2.2 General Setting

The High Lake area lies within the Bear-Slave Upland Region of the Canadian Shield. The barren shield terrane is characterized by water filled ice-scoured basins and glaciated troughs generally trending northwest or southeast and separated by barren rocky ridges in places strewn with glacial erratics. Most of the overburden, where it exists, consists of a thin veneer of glacial till and occasionally morainic or fluvioglacial materials.

The area lies well within the zone of continuous permafrost resulting in poorly developed drainage which is characterized by many small lakes and wet areas. Nevertheless, several major rivers have developed in the area, many of which drain northwardly to the Arctic coast or to the east into Bathurst Inlet. The whole area lies within the Arctic watershed. Where the major rivers run northwardly, they have downcut into the rim of the Shield in response to the isostatic recovery of regional rock to the removal of the Wisconsin glacial ice sheets.

A: THE NATURAL ENVIRONMENT

3.0 PHYSIOGRAPHY AND GEOMORPHOLOGY: HIGH LAKE AREA

3.1 Physiography

The High Lake mineral area is situated in the low Arctic in the northwest mainland part of the Canadian Shield. Several erosion surfaces have been identified in this region (Bird, 1962). The main one is the Contwoyto surface which begins about 80 km inland from the Coronation Gulf and can be traced at elevations of 440 to 550 m. to Northern Saskatchewan. The Contwoyto Surface is flanked by the Buchan Surface (150-165 m.) on the N.E. side of Bathurst Inlet and the Middle Bathurst surfaces which rise from 230 m. near Gordon Bay on the Inlet to 335 m. some kms to the west. A lower level of the Bathurst surface is found just west of the Inlet at elevations of 220-260 m. but most elevations on the middle Bathurst surfaces range from 290-300 m..

Thus High Lake rests in a region at the northern edge of the Contwoyto upland which slopes upwards from the Arctic Coast and upwards to the southwest into the highest regions of the Contwoyto upland surface.

Also to the south is a region of highlands represented by the wide interfleuve betwen the Hood and Burnside Rivers which in some places achieves elevations of 550 m.. These have been called the Bathurst Hills.

Locally, the terrain within the High Lake watershed is typical of the well glaciated shield topography mentioned above. Rivers and lakes have north or northwest trends as a result of glacial scouring although structural control is evident as well. Rocky ridges strewn with glacial erratics have similar trends. High Lake itself has an axial bearing of approximiately N 13° W.

Most of the terrain in the High Lake watershed consists of ice scoured ridges with occasional frost-rived cliff faces and resultant scree slopes. However, in the southwest portion of the watershed there is a "plateau" area, an upland area of gently sloping or reasonably flat terrain which appears to be covered by deeper till. The plateau is poorly drained and has no fewer than eleven small lakes and ponds of a permanent nature.

To the east the terrain drops very sharply into the deep ravine cut by the Kennarctic River. Several remnants of fluvial terraces are evident along the river generating relatively flat areas on the flanks of the ravine.

3.2 Elevation and Slope.

The High Lake area consists of rugged terrain. The highest elevation in the watershed is 350 m. and the lowest is High Lake itself at 276±. From the lake outlet the terrain drops 76 m. to the Kennarctic River below which has an elevation locally of about 200 m..

Generally the relief in the watershed consists of ridge tops which sit 45-50 m. above the level of High Lake.

Several slopes were sampled in the watershed (see Map #2) and are listed in the table below.

Map # 2 : High Lake Watershed and Lakes

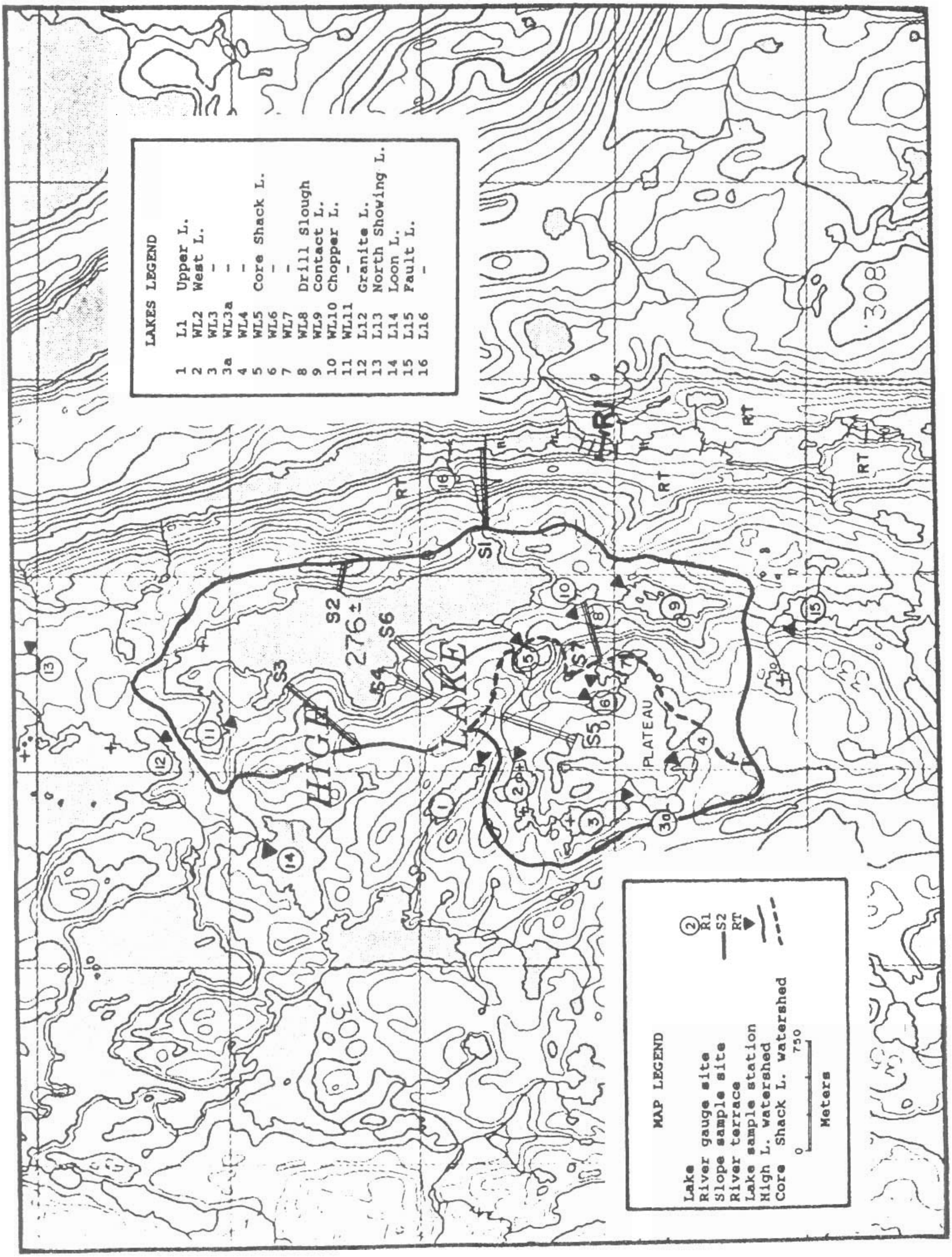


Table #1: Sample Slopes High Lake Watershed

Slope	Description	%	Ratio	Degrees
S1	High L. to Kennarctic R.	12.6	1:5	11.3
S2	-	20.4	1:3	18.4
S3	-	7.3	1:8.6	6.6
S4	Middle gossan	8.9	1:7	8.0
S5	South gossan	12.6	1:5	11.3
S6	Middle gossan	6.7	1:9.4	6.0
S7	Plateau area	5.1	1:12.5	4.6

From Table #1 it is apparent that slopes are generally steep in the area of High Lake except on the plateau area in the southwest corner of the watershed. Slopes on the areas of gossan tend to be steep as well and therefore well drained. Soluble metals and mineral are therefore moved downslope to lower elevations and ultimately High Lake itself.

3.3 Glacial and Periglacial Aspects

3.3.1 Glacial Aspects

The High Lake area along with the N.W. part of the Canadian Sheld has been well glaciated by the Keewatin section of the Wisconsin Age Laurentide Ice Sheet. The major ice centre of this glacial period had its greatest thickness in central Keewatin to the S.E. of High Lake and Bathurst Inlet began to wane and melt back nine to ten thousand years ago. A minor ice centre, the M'Clintock Dome, existed in the N.W. near the High Lake area with a lobe of ice filling the Coronation Gulf as little as 10,000 years ago. The High Lake area lies just to the west of the ice divide of the M'Clintock Dome, which trended north from the mainland south of High Lake into the Arctic Islands across the very eastly end of Victoria Island (Dyke and Dredge, 1989).

Ice advanced outward to the west and northwest from this and the Keewatin ice divides scouring the underlying shield terrane, leaving a legacy of rocky basins, troughs, grooves and polished, plucked and striated surfaces. High Lake itself is likely a legacy of ice excavation of a previously structural weakened section of Shield terrane.

Melting of the ice left a legacy of tills, moraines and fluvio-glacial eskers, kames and outwash features.

The High Lake area became ice free between 9 and 10 thousand years ago and melting ice left a legacy of sparsely distributed and thinly bedded tills, and a profusion of glacial erratics. These tills subsequently suffered deflation through weathering and erosion, leaving behind bare rocky ridges with erratics sitting on pedestals of smaller boulders. Deflated materials infilled some of the troughs and basins providing parent materials for some minor soil development.

No fluvio-glacial features are apparent in the High Lake watershed. An esker lies to the south about 15 km but apart from this feature immediately accessible sources of aggregate and sand seem to be lacking.

During maximum Wisconsin glaciation, the earth's curst was severely downwarped and with the removal of the ice in the last 9,000 years or so, isostatic recovery has occurred. The average rate of uplift per 100 years has been about 2.5 m. and the present rate is estimated to be about 0.9 m/100 years (Andrews, 1970).

Also during ice retreat, the sea encroached onto this depressed landscape depositing thin beds of silts, clays and fine sands. The marine transgression limit has been established at Coppermine at 145 m. present elevation and at 215 m. on the Tree River to the east. This increase in elevation eastwardly is in keeping with the thicker ice sheet as one approaches the area of the N.E. ice centre mentioned earlier. Thus, at Bathurst Inlet, just a few kilometres east of the High Lake area, elevations of the marine limit range from 220 m. at its mouth to 225 m. at its south end.

Thus it is unlikely that High Lake itself was affected by marine inundation and no evidence of marine sediment was encountered in the watershed, but it is possible that the lower elevations in the Kennarctic River valley may have been influenced, depending on the amount of glacial fill in the river valley and its subsequent erosion and transport as the river downcut in response to uplift and diminishing run-off volumes.

3.3.2 Periglacial Aspects

In Northern Canada and the Cordillera some 5.7 million km are underlain by permafrost which is divided into three types, continuous, discontinuous and sporadic (French, 1976). The High Lake area lies well within the continuous zone of permafrost or permanently frozen ground which is defined by a mean annual air temperature of -6°C to -8°C and an annual ground temperature at zero amplitude (i.e. depth at which there is no seasonal effect) of -5°C.

High Lake mean temperatures (see section 5.2 later) certainly place it in the continuous zone. No ground temperatures were measured but temperatures at Izok Lake to the south have been reported at -5°C, below the zone of seasonal flux.

Permafrost has been encountered in all drilling done on the mineral deposit at High Lake. No ice lenses have been reported. Depths of permafrost are not known and neither is the effect of High Lake on frozen ground below the lake bed. Generally larger lakes which do not freeze to their beds tend to have an unfrozen zone beneath them.

Generally thicknesses of permafrost in the continuous zone vary from 100 m. in the south to 750 m. in the far north. At the Lupin Mine on Contwyoto Lake, permafrost exists to 500 m. with a ground temperature of -9.0°C and at Coppermine thicknesses of 300 m. to 450 m. with temperatures of -4.5°C to -8.0°C have been reported (G.S.C. Permafrost Research Section, 1989, in Canada's North: A Reference Manual). Thus it would seem reasonable to estimate the permafrost thickness at High Lake in the range of 400-500 m..

Surface evidence of permafrost at High Lake is manifested in occasional patches of weakly patterned ground, especially in the soil and mud generated from the leaching of the mineralized zones. As well, minor mud circles and tussocks exist on the plateau area to the southwest of High Lake. Generally though, due to the large amount of bedrock and the thin and reasonably well drained tills, few organized periglacial features exist.

Frost rivation is prevelant on the rocky ridges and where the rock is well jointed, rivation is most extreme. Likely many of these joints will contain ice but their depth and extent are unknown.

The active layer was estimated by measuring the depth of unfrozen water in nine drill hole casings and adjusting these measures to ground surface and to the vertical. In July 1993 the active layer varied from a minimum of 25 cm in an area of well developed tundra vegetation to a maximum of 185 cm in exposed bedrock. No account was made for the conductivity of the casing on the lowering of the permafrost level therein, but it is likely minimal.

3.4 Fluvial Aspects

Drainage in the northwest part of the Canadian Shield can be described as being a generally deranged system feeding several rather linear major river systems. The area lies well within the Arctic Watershed and drains northwardly to the Arctic Ocean into various gulfs and inlets.

Locally near High Lake, the major rivers drain northwardly but this drainage has been truncated in the south by eastwardly flowing rivers such as the James and the Hood, which flow into Bathurst Inlet. The larger northwardly flowing rivers were once part of a much larger high Arctic drainage system now flooded by rising sea levels since the last glaciation. They presently slope gently to the Arctic Coast (e.g., Tree River with a slope of .00225).

Likewise ponding of meltwaters produced major proglacial lakes in some areas of the northwest near Great Bear Lake and in the Coppermine area, but no such ponding appears to have occurred in the High Lake area. These proglacial lakes have long been drained by postglacial uplift forcing water to drain into the Arctic Ocean.

River flows vary from annual to seasonal with larger basins generating annual flows. Some rivers freeze to their beds entirely during winter and others carry only nival flow from spring snow melt. Few of the rivers are navigable by more than canoe.

Regional runoff data is scanty and often conflicting. Gauged rivers flowing to the Arctic coast in the study region include the Coppermine, Ellice and Tree Rivers. Of these, the Tree River is likely the most representative of High Lake and the Kennarctic River as its length is 196 km compared to 145 km for the Kennarctic although their catchment areas differ considerably with the Tree at 5,960 km and the Kennarctic estimated to be 1,169 km (see Map #3). The Tree River receives a mean annual precipitation of 210 mm. Mean annual discharge is 333.0 m^3/s with lowest occurring in April (5.61) and highest in July (99.7) (Canadian Hydrographic Services). This discharge represents an annual runoff of 175 mm (Acres, 1982) or a runoff coefficient of about .83 based on the flow gauge and precipitation records quoted above. From this same reference the runoff for the Kennarctic can be interpreted to be 138 mm. However, other data (Korzun, 1974) suggest lower runoff coefficients around .44 to .50 for the same basin. This issue is addressed in greater detail later in section 6.1.

River freeze-up and break-up dates vary from basin to basin. Data (27 years) are available for the Coppermine River at Coppermine which show a mean freeze up date of October 24 and a mean breakup date of June 19. Ice thickness grows linearly from October, thickening to a mean of 174.0 cm (218 cm max and 145 cm min) AES, 1991). Possibly the Kennarctic River would portray similar trends but may freeze earlier and have a thinner ice due to its lesser flow.

Generally rivers with catchments 1,000 - 3,000 km^2 freeze in December and breakup in late May. Smaller ones freeze in October and break up in late May. Spring runoff is generally for 3-5 weeks in June and peak flows usually last only one week (Metall, 1993).

3.5 Soils

Soils in the Canadian Arctic are generally poorly developed, immature or truncated soils underlain by permafrost. They develop from the weathering of glacially deposited tills, silts and sands or they may develop on fluvial lacustrine or moraine sediments exposed to the weathering environment.

Chemical activity is slowed by the cold, desert-like climate of the Northern latitudes and this action retards the growth of soil from the parent materials mentioned above. Likewise, the presence or absence of water also enhances or impedes soil production. Well drained soils on slopes tend to be more mature with better horizon development than poorly drained soils developed in low, flatter areas.

The Canadian Soil Classification System identifies several orders of Arctic soils underlain by or containing permafrost such as lithosols, regosols, gleysols and immature podzols. The presence of permafrost allows each of these orders or their derivatives to be prefixed with the term "cryic".

In the High Lake watershed overburden depths range from 0 to an estimated maximum of 3 to 5 m. and soil development was found to be very poor. Some soil development has occurred on better drained tills but because of the lack of soil horizon development and the presence of coarse boulders it must be classed as cryic regosol. A sample was taken of this type of soil and it is described as a light brown coloured cryoturbid soil with a Munsell value of 7.5 YR 3/2. On the plateau in the southwest corner of the watershed, cryic humic gleysols have developed in wet areas while cryic gleysols with a thin peat layer have developed in dryer areas. The ubiquitous grasses and sedges of this plateau area contribute fibrous materials to produce the thin peat layer. In this region some mud circles have developed in the grey fine grained gleysols.

Fine grained (gleysolic?) orange coloured cryoturbid soils have also developed downslope of the various gossans through vigorous leaching of the gossan. These soils in places display the typical polygonal cracks and patterns of permafrost-rich ground. A sample of this iron rich soil was taken and is described as a bright orange, ochre coloured cryoturbid soil with a Munsell value of 5YR 4/8. Where drainage from melting snow banks trickled into this "gossan" soil, mud developed to depths of 10-15 cm. (see Map #7 later).

4.0 GEOLOGY

4.1 Regional Geology

Much as been written on the geology of the northern Canadian Shield. The following is a short summary of the Slave Structural Province which lies in the northwest part of the Shield area. The geology is given in some detail in the many reports of the Geological Survey of Canada and this short summary has been compiled from Douglas, 1970. Map #4 gives a summary of the Slave Province geology.

The High Lake area sits within the northern part of the Slave Province of the Canadian Shield. Structural trends are mainly northwardly. The oldest rocks are archaean volcanic

Map # 4 : General Geology of the Slave Province

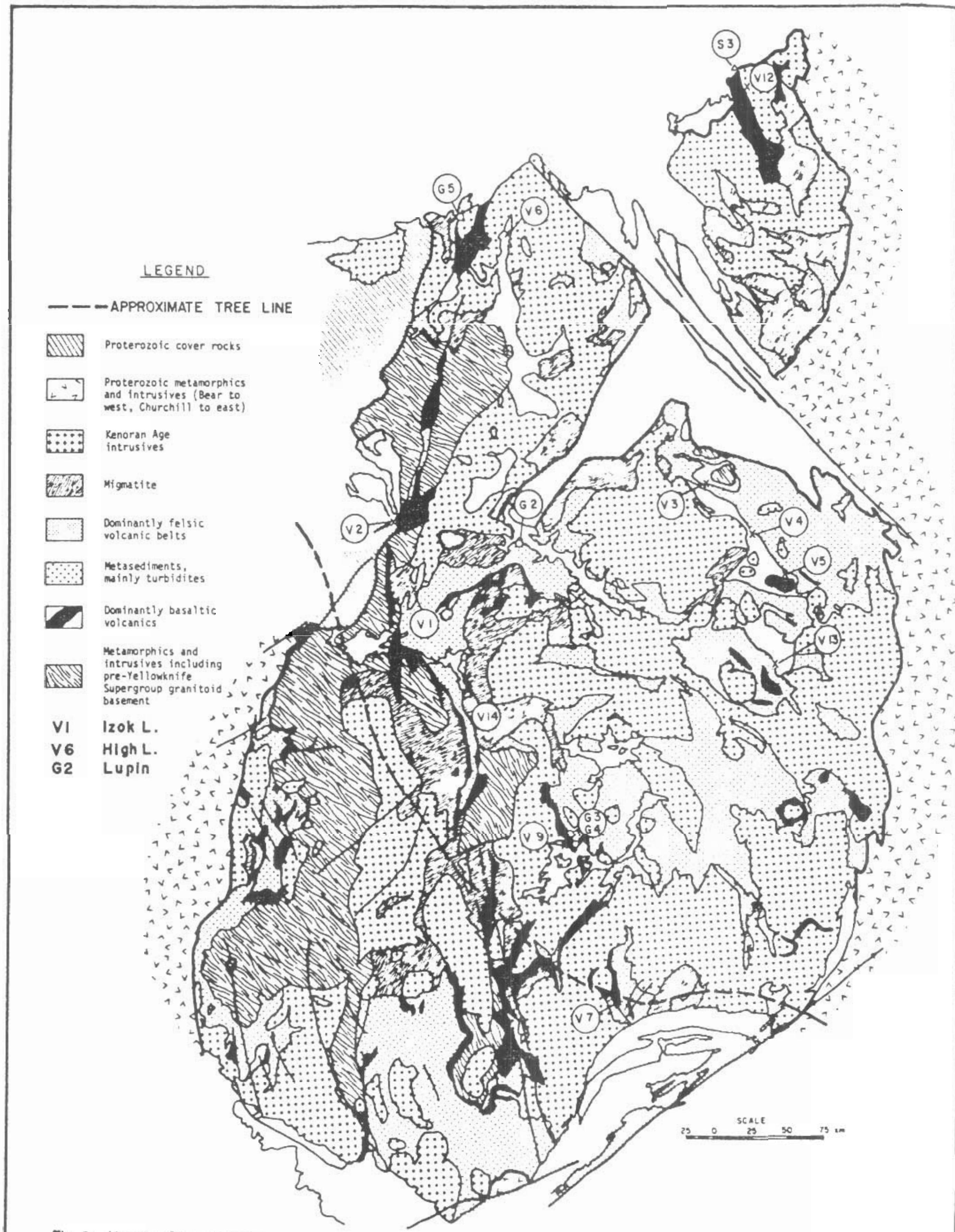


Fig. 6. Northern Slave Province

From W.A. Gibbins, 1982 in Arctic Geol and Geophysics, CSPG, Mem 8.

flows, greywackes and shales. The volcanic flows were extruded in a mostly subaqueous environment. These sequences were subsequently intruded by granite during the Kenoran Orogeny. The mean age of these volcanic, sedimentary and intrusive rocks is 2,480 my.

After a period of deep erosion Aphebian sediments were deposited in a geosyncline which was subsequently deformed during the Hudsonian Orogeny about 1750 my. ago. In addition three diabase dyke swarms dated at 2150, 2100 and 1200 my. respectively and several fault sets dated from 2000 to 1300 my., transect the Slave Province geology.

The economic geology of the Slave Province centres at present around gold which occurs in a wide variety of rocks. Over 1,000 occurrences have been documented. In addition and more recently deposits containing copper, lead, silver, cobalt and nickel are being investigated. High Lake is one of those deposits of interest.

4.2 High Lake Geology

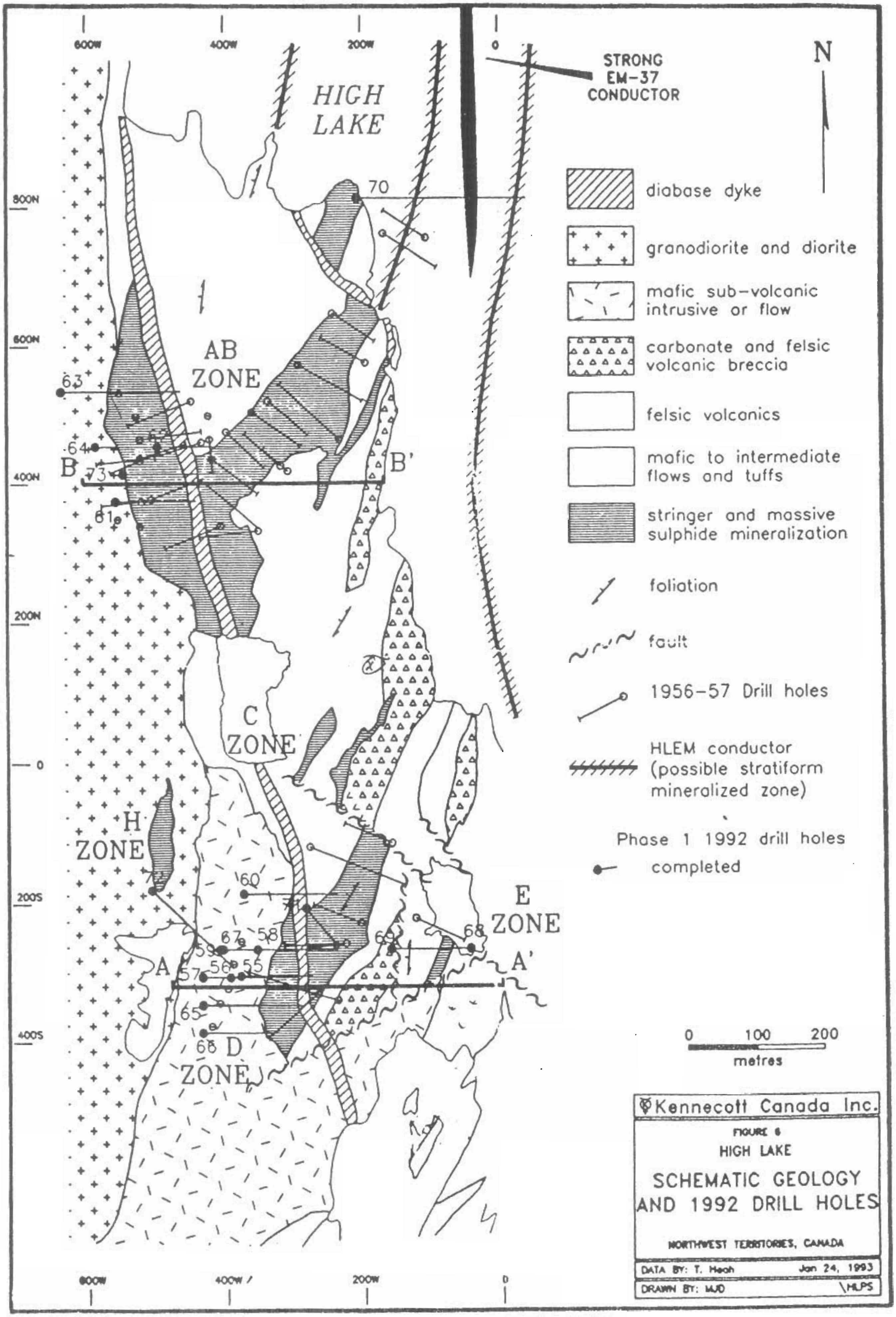
The High Lake mineral deposits have been of interest for some years and were drilled as far back as 1956-57. The deposits consist of Cu-Zn-Pb-Au-Ag volcanogenic sulphide deposits set in Archean age exhalite and volcanic rocks of the northern Slave Province (Heah, Cranswick and Covello, 1993).

The main deposits consist of a copper rich AB zone and a zinc-silver rich D zone in metamorphosed felsic and mafic volcanic rocks (see Map #5). Other zones, the E and H, also have shown substantial mineralization. In addition other zones such as under High Lake itself, the west and C zones and the north and south showings have promise. Details of the magnitude and quality of the mineral deposit are reported by Heah, Cranswick and Covello, 1993.

The major zones, the AB and D, outcrop extensively at surface and have undergone considerable leaching to produce major gossans (see Map #7 later). Runoff from these gossans has, over the millenia, carried metal laden water to High Lake of low pH, thus degrading the water quality of High Lake. This process has likely been on-going since the deglaciation of the High Lake area some 9,000 years ago.

The seismicity of Northern Canada is little known due to the lack of settlement and seismological stations. However, extrapolations in the National Building Code of Canada show that the probability of exceeding a 1 in 475 year earthquake event is 10% at Izok Lake 250 kms to the southwest (Metall, 1993). Izok Lake is in zone 1 and likely the High Lake area would have similar probabilities.

Map # 5 : Geology of High Lake Mineral Zone



5.0 CLIMATOLOGY

5.1 General climate

The Canadian Arctic climate is characterized by long cold winters, short and often cool summers, strong winds and minimal precipitation. Evapotranspiration is low due to the lack of vegetation and the cool summers. Likewise runoff rates are high during a short period and often snowbanks persist well into the summer and might, in some years, remain until winter arrives again.

Locally, elevation, exposure and proximity to water or ice can alter climatic variables. Likewise the number of hours of daylight can also have a profound effect on both the climate and the environment overall.

Climate data for High Lake itself are non-existent. Some sporadic temperature and wind direction data were collected in the summer of 1993 but any comprehensive assessment of the character of High Lake climate must be interpolated from surrounding stations and the various climatic isolines for the arctic regions generated by the Canadian Atmospheric Environment Services (AES) and other agencies.

Stations with reasonably long term records in the High Lake area exist at Byron Bay, Cambridge Bay, Contwoyto Lake (Lupin), Coppermine and Lady Franklin Point (see Map #6).

Data from these stations are used here to try to calibrate and corraborate the interpolations taken off isoline charts of northern climate produced by Korzun (1974), Maxwell (1980) and Acres (1982). The Korzun charts were derived through water balance studies with contribution of information from Russian studies whereas the Maxwell and Acres charts are based on AES site data. Some of the information is conflicting and reasonable value judgement must be used to rationalize the effect on High Lake climate. For example, precipitation data, especially snowfall, may often be underestimated by 130-300% (Woo et al., 1993 and Brian Latham, Water Resources, D.I.A.N.D., personal communication, 1993).

The above problem was obvious when rain was collected for chemical quality analysis. An ordinary funnel type rain collection system caught very little and it was necessary to build a flat collector oriented perpendicular to the rain and wind direction to collect sufficient rain.

Station data taken from AES records are summarized in Table #2 below for the various stations surrounding High Lake. The data show clearly that precipitation values are greater at inland sites which are at considerably higher elevations. This fact seems reasonable in light of the well known positive correlation between precipitation and elevation. Coppermine also has more precipitation than its neighbouring coastal

TABLE #2: SELECTED WEATHER RECORDS, HIGH LAKE AREA

PRECIPITATION DURING PERIOD 1951-1980

Weather Station	Elev.	Mean annual rain	Days with rain	Mean annual snow	Days with snow	Total ppt
Byron Bay	112 m.	62.2 (mm)	-	45.8 (mm)	-	108.0 (mm)
Cambridge Bay	27 m.	68.1	29	76.8	73	136.3
Contwoyto Lake	451 m.	128.8	41	122.0	86	251.3
Copper-mine	9 m.	102.7	37	100.7	75	202.3
Lady Franklin Point	21 m.	63.8	-	45.8	-	109.9

TEMPERATURES DURING PERIOD 1951-1980

Weather Station	Mean Annual	Mean January	Extreme minimum	Mean July	Extreme maximum	Average first frost	Average last frost	FFD
Byron Bay	-14.2	-32.8	-	8.9	-	Aug 19	June 29	50
Cambridge Bay	-15.1	-33.6	-52.8	7.9	28.9	Aug 21	June 28	53
Contwoyto	-12.0	-32.1	-53.9	9.7	27.2	Aug 19	July 2	47
Coppermine	-11.6	-30.1	-50.0	9.7	32.2	Aug 23	June 24	59
Lady Franklin Point	-12.9	-30.6	-	6.6	-	Aug 13	July 5	38
Bathurst Inlet (elev 13m)						Aug 27	June 15	72

WIND SPEEDS DURING PERIOD 1957-76

Weather Station	Mean/yr (Km/hr)	Mean January	Mean July	Mean Max	Mean Min
Byron Bay	21.6	26.2	18.2	26.2 Jan	20.0 May/Aug
Cambridge Bay	20.5 N.W.	21.6 N.W.	20.0 W.	23.0 Oct	18.9 Dec
Contwoyto L.	17.6 N.W.	18.6 N.W.	15.7 N.W.	22.9 Sept	14.9 Feb
Coppermine	16.5 S.W.	20.5 S.W.	14.7 N.E.	20.5 Jan	13.3 June
Lady Franklin Pt.	22.6	25.1	20.0	25.1 Jan	20.0 Mar/Jul

HOURS OF SUNSHINE DURING PERIOD 1957-76

Weather Station	Mean/year (hrs)	Mean January	Mean July
Byron Bay	-	-	-
Cambridge Bay	1599.0	1.1	304.6
Contwoyto Lake	-	-	-
Coppermine	1629.4	4.0	318.1
Lady Franklin Point	-	-	-

sites. It is the only one on the mainland coast. Contwoyto Lake is at 451 m. and has about 20% more precipitation (both rain and snow) than Coppermine at 9m.. High Lake lies at about 62% of the elevation difference between Coppermine and Contwoyto so one might estimate from this data (i.e. that in Table #2), using elevation as the only control, that High Lake should receive about 232 mm. of annual total precipitation.

Temperature data seems to be reasonably consistent over the stations and altitude seems to have little effect likely due to the uniformity of Arctic air masses and the lengthy periods of ice cover in the Coronation Gulf. High Lake mean annual temperature should likely be about -12°C.

Wind data do show differences in prevailing direction with Coppermine having a prevailing southwest direction, likely due to positions of storm tracks. This southwest source of air for most of the time likely explains the higher precipitation values at Coppermine. At this time it is difficult to say what the prevailing wind might be at High Lake without further information on the boundary between prevailing southwest and northwest winds which must lie to the east of Coppermine. However, anecdotal evidence and snowbank orientation suggest a northwest direction for prevailing winds (Covello, 1993, personal communication). More discussion of wind occurs later in section 5.4.

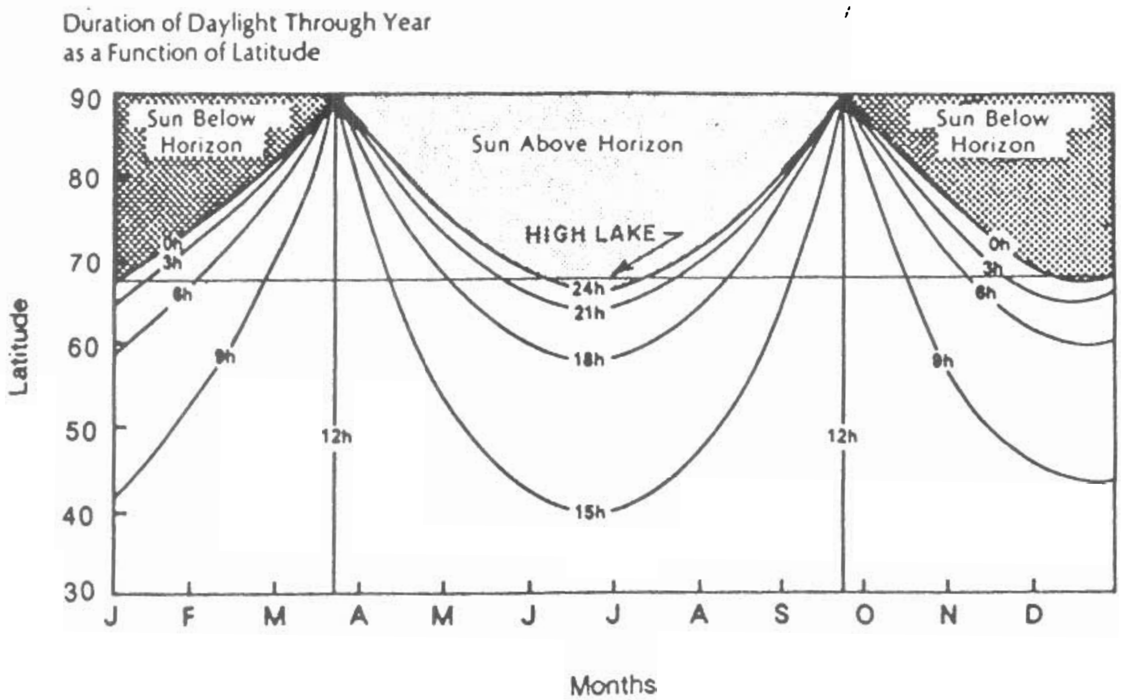
5.2 High Lake Air Temperatures

High Lake air temperatures are dependent on the typical Arctic air masses and to a lesser extent likely on local effects such as the presence of ice or open water in the Coronation Gulf. As well, its latitudinal position controls the potential insolation received throughout the year. Freezeup of the Gulf occurs on average on November 8 and colder, drier conditions would likely exist after this date whereas conditions should moderate after mean breakup on July 8-11. As well, the mean position of the continental Arctic front lies over the High Lake area in July (Rouse, 1993).

The insolation at 68^0N can be seen in figure #1 taken from French and Slaymaker, 1993. For almost 3 months, there is no heat derived from insolation during the Arctic winter while during the Arctic summer a little over 500w/m^3 is received.

Of course, insolation is modified by cloud cover and although, again, there are no data for High Lake specifically, data are available for Coppermine. Based on a record from 1955-67, clear skies (<2/10 cloud cover) existed 28% of the time; whereas, overcast conditions (> 2/10 cloud cover) existed 56% of the time. Cloudiest months are September and October and the clearest months are from December through April as expected (Canadian Hydrographic Service, 1970).

Figure # 1 : High Lake Illumination



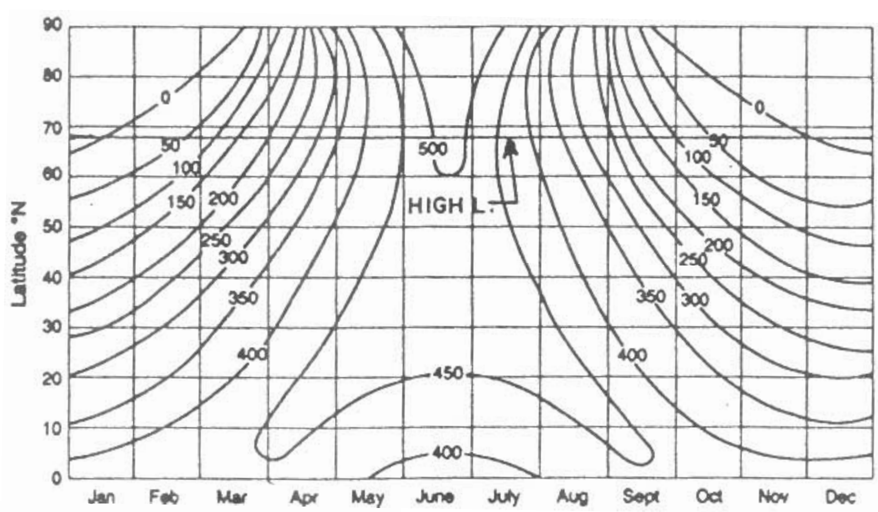


Figure 3.1
Latitudinal distribution of potential insolation, Northern Hemisphere. Units are in W/m^2. *Source*: List (1958).

All sources for temperature data seem to closely agree on the mean annual temperatures for the High Lake area. The mean annual daily temperature for High Lake is estimated to be 12.5°C .

Temperatures were randomly recorded during the field work at High Lake for this study during ten days in July 1993 and for a shorter period in August 1993. These data are listed below in Table #3 as background to summer temperature values but represent only one time-limited data set. The ice was completely off High Lake on July 10 and it began snowing again by August 26.

Table 3: Various High Lake Temperature Data, 1993

Date	Time	Temp	Wind
July 9	3:13 pm	12.1	NNW
July 10	10:00 am	5.5	N
	3:00 pm	5.5	N
July 11	8:00 pm	14.5	N
July 13	11:13 am	7.0	-
	12:50 pm	6.8	-
	5:27 pm	10.5	-
July 14*	3:00 pm	8.9	N
July 15*	11:30 pm	6.0	N
July 16	9:30 am	9.0	S
	11:00 pm	13.1	S
July 17	11:00 am	15.5	S
Aug 25	10:00 pm	4.0	N
Aug 26**	9:00 am	2.6	N
Aug 27	8:30 pm	2.5	N
	10:00 pm	1.5	N
Aug 28	10:00 am	4.0	N

* rain
** snow

The mean date on which the mean daily temperature becomes greater than 0°C is June 1 for Coppermine and is estimated to be June 2-3 for High Lake. Likewise, the date on which the mean daily temperature becomes less than 0°C is estimated at September 15 for High Lake (Hydrological Services, 1970).

5.3 Precipitation at High Lake

5.3.1 Quantity

Precipitation values for High Lake are more difficult to estimate due to conflicting data already mentioned. Earlier in Section 5.1, an annuual mean total precipitation was rationalized by the influence of elevation alone, using the gradient between Coppermine and Contwoyto (Lupin) Lake to be 232 mm. Values estimated from the isohyetal data in the Acres report and the Korzun report for High Lake are 200 and 300 respectively. The Acres report was based on AES data. In view of the likely underestimation of total precipitation by AES stations as discussed earlier, it would seem reasonable to suggest a mean annual total precipitation for High Lake of 232-235 mm. of which approximately just less than half may be snowfall.

Data on snowfall are not too reliable. Again, using isohyetal data (Maxwell, 1980), an estimated value of 80 cm is suggested for High Lake which is similar to Coppermine. Actual snow cover at Coppermine develops from 0 cm on October

15 to 25.5 - 29.5 cm on April 15 to May 15.

Snow depth data is somewhat misleading when applied regionally because of the windiness of the area. Snow is driven off the ridges and gets trapped in hollows and in the lee of the ridges creating often larger and persistent snowbanks. In the High Lake area, several of these large snow banks exist well into summer and do not disappear until August (see Map #7).

Nevertheless, Maxwell (1980) has produced isoline charts of snow cover for the Arctic and estimates again can be made for High Lake by interpolation. The earliest date of snow cover is estimated to be September 15 and the latest at October 15 - November 1, with a mean date of betwen 1st and 15th of October.

Minimum snow depth is estimated to be 20cm and maximum 60 cm with a mean of about 40 cm.. This snow is lost usually by June 15th or at the latest by July 1st, except for the major snowbanks mentioned above.

5.3.2. Quality

A sample of rain was collected from a storm over July 14-15, 1993 and analyzed for several chemical parameters. As well, a snow bank sample taken at about 30 cm depth from the snowbank bordering the northwest corner of Core Shack Lake was collected, melted and analyzed for the same parameters. Results are reported in Table #4 below.

Table #4: High Lake Precipitation Quality, July 15, 1993

Parameter	Rain	Snowmelt
Temp (°C)	8.5	11.5
pH	4.64	4.75
Cond. (umhos)	12.86	12.66
TDS*	5.36	6.39
TSS	4	2
SO_4	<10	<10
TKN	0.38	0.18
As	0.002	0.002
Cd	0.0006	<0.0001
Cu	0.030	<0.001
Fe	0.161	0.072
Pb	<0.005	<0.005
Hg	0.00036	0.00013
Zn	0.175	0.022

All units in mg/l unless specified otherwise.

Table #5 outlines various water quality objectives and limits for good quality water for consumption and aquatic life to which the chemical water qualities measured for this report are compared.

None of the rain and snow parameter values are high enough to be threatening to humans or environment according to quality standards set by N.W.T.. However, pH, cadminum, copper, mercury and zinc all display values above maximum values for the safety of aquatic life according to some provincial standards and other references (Welch, 1980). Snowbank data

TABLE #5:VARIOUS WATER QUALITY STANDARDS

Parameter	NWT Effluent	NWT Drinking Water	Ontario/Other[1] for aquatic life
Temp °C	-	15	<12[2]
pH	-	-	5.20
Cond (umhos)	-	-	-
TDS	-	-	-
TSS	-	-	-
SO_4	500	500	500
TKN	-	10	<10
Arsenic (As)	0.05	0.05	0.10
Cadmium (Cd)	0.005	0.005	0.0002
Copper (Cu)	0.2	1.0	0.005
Iron (Fe)	0.3	0.3	0.3
Lead (Pb)	0.05	0.05	0.005
Mercury (Hy)	0.006	0.001	0.002/.00005
Zinc (Zn)	0.5	5.0	0.03/0.005

[1]Welch, 1980

[2]For cold water fish such as char, trout, whitefish, etc..

display lower values than the rain which displays significant amounts of cadmium, copper, iron, mercury and zinc. Although these data represent information from one sample in time, it would appear that surface water in the High Lake area does receive contaminants from atmospheric sources.

5.4 Wind

Wind frequency and velocity in the northern N.W.T. are substantial. Temperature differences between the Arctic Archipelago and the northern mainland create pressure gradiants which create strong and often sustained winds especially during the changing seasons and the movement of the Continental Arctic and Maritime Arctic weather fronts.

Some wind data have been given in Table 2 earlier and a prevailing north to northwest direction is surmised for the High Lake area. Wind directions depend on the presence, location and movement of pressure cells in the atmosphere with air moving from high pressures to low. Wind speed is a function of the strength of the pressure gradients between cells and the friction imposed by the surrounding terrain. Terrain geometry can locally enhance or reduce wind velocities and generally wind velocities increase with height into the atmosphere to 1,500 m..

From Table #2 it is apparent that wind velocities are greater in the Arctic Island sites than at mainland sites. Winds tend to be lighter in mid to late winter and strongest in the autumn and early winter. In terms of wind velocities for High Lake, as an inland site with rather rugged terrain it would likely have similar values to Contwoyto Lake in the neighbourhood of a mean wind speed of 17-18 km/hr.

Wind power is of interest as an alternate source of energy for remote sites. A study has been done by Janz et al (1982) on the potentials for N.W.T. and the following monthly mean potentials have been estimated for High Lake from their contour charts of wind power:

Table #6: Estimated Mean Monthly Wind Power KWh/m^2 at 10 m.

J	F	M	A	M	J	J	A	S	O	N	D	Year
122	90	90	90	105	90	90	95	125	130	92	95	1214

As wind velocity exerts the largest influence in the calculation of power (i.e. V^3), the above values of Table #6 also give a reasonable idea of the seasonal distribution of wind speed at High Lake.

5.5 Inversions

One of the phenomena of Arctic climate is the ground level temperature inversion where the air is warmer aloft and thereby traps pollution from engine exhaust or other warm, gaseous or aerosol effluents. From Maxwell (1980) the following information in Table #7 on the existence of ground inversions has been interpolated for High Lake. Data are based on records taken at stations surrounding High Lake and over the years 1967-76.

Table #7: Estimated Occurrence of Low Level Inversions, High Lake

Period (Month)	Time (G.M.T.)	Occurrence (% of time)
Dec-Feb	1100	70
	2300	65
Mar-May	1100	70
	2300	<30
Jun-Aug	1100	45
	2300	15
Sep-Nov	1100	41
	2300	31

6.0 Hydrology and Aquatic Environments

6.1 Surface Drainage at High Lake

6.1.1 General

Surface drainage in the High Lake watershed is both glacially and structurally controlled. A series of ill-defined stream channels drain waters from a series of ill-defined lakes and ponds (see Map #2) through boulders and glacial debris into High Lake. Water from High Lake then flows over a rather broad sill of bedrock and cascades in a series of ill-defined channels to a small lake which occupies an ancient river terrace formed by an ancestral Kennarctic River.

From this lake water flows visibly out the north end and down to the Kennarctic River. However, the northern outlet soon dries up after much of the water in this lake appears to filter through the porous alluvial terrace downslope to the Kennarctic River. By mid-summer or early August when outflow from High Lake ceases, this lake dries up completely.

The watershed of High Lake is rather small with an overall surface area including all lakes of 3,586,875 m^2. High Lake has an area of 714,063 m2 and the remaining lakes and ponds (10) have a total area of 239,060 m^2. Thus the watershed consists of a total of 9,553,123 m^2 (26.5%) of lakes and ponds and a total of 2,633,753 m^2 (73.4%) of land.

Apart from High Lake, most of the smaller lakes and ponds appear, based on the surrounding physiography, to be shallow. No soundings were taken during this study. However, there is no doubt that these lakes provide storage of water and would reduce the intensity of spring runoff somewhat.

6.1.2 Inflow Water Quality and Quantity

Several of the inflows into High Lake were sampled for discharge and water quality during July, 1993. The results are listed in Table #8 below. Sampling sites are found on Map #7. Discharges were done by measuring stream cross-sections and using a float timed over fixed distances and multiplied by a factor of 0.8 to determine velocities. Several runs were averaged to use in the discharge calculations. As well, the outflow from High Lake was measured in a similar way.

The Kennarctic River has not been gauged so it was necessary to locate a convenient cross section and estimate the flow. (See Map #2).

The Kennarctic River width was estimated by triangulation and a section was chosen with a nearly equant depth across the channel. Velocity was again estimated with a fishing bobber cast into various reaches at the channel section and timed over a fixed distance and an average calculated. These

TABLE #8: HIGH LAKE INFLOW/OUTFLOW - KENNARCTIC RIVER QUALITY

Parameter	S1	S2	S3	S4	S5	HLO	K.River	MDL
Date	Jul 09	Jul 09	Jul 09	Jul 09	Jul 10	Jul 10	Jul 16	
Water Temp (°C)	9.0	10.1	7.0	11.1	8.8	4.8	9.2	
pH	5.62	3.65	5.44	4.98	4.86	5.61	5.53	
Cond.	310	224	92.3	47.9	26.8	69.1	33.7	
TDS	156	?	17.6	23.6	12.9	29.3	16.8	
TSS	<1	<1	<1	<1			<1	
DO (conc)	(sat)	(sat)	(sat)	(sat)	(sat)	(sat)	(sat)	
Chloride	-	-	-	-	-	110	-	
Sulphate	<10	54	<10	<10	<10	<10	<10	10
TKN total	0.26	0.35	0.28	0.28	0.25	0.24	0.40	0.03
Chlorophyll a	-	-	-	-	-	0.0220	-	0.0010
Arsenic	0.003	0.003	0.001	0.001	0.003	0.005	0.002	0.001
Cadmium	<0.0001	0.0019	0.0004	0.0004	<0.0001	0.0007	0.0001	0.0001
Copper	0.024	1.788	0.011	0.011	0.026	0.103	0.003	0.001
Iron	0.028	0.792	0.025	0.025	0.028	0.012	0.109	0.005
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0002
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	0.0001
Zinc	0.022	0.924	0.186	0.186	0.022	0.276	0.026	0.001
Aluminum	<0.035	1.97	<0.035	0.128	<0.035	0.049	<0.035	0.035
Discharge (m^3/s)	Diffuse low	Diffuse low	Diffuse low	0.05	0.04	0.07	14.76	-

results are also listed in Table #8 above.

Inflows S2, S3 and S4 all drain directly or indirectly from highly mineralized areas or off or through gossan material. As expected, these inflows exhibit the lowest pH values and highest metal values. Site S2 is the worst whereas S3 flows diffusely through the tundra and some metal adsorption occurs in peat and vegetation. Likewise, attenuation occurs in S4 waters through dilution by water flowing from Contour Lake through to High Lake. These small seasonal inflowing streams along with generally surface drainage off gossan materials have definitely affected High Lake quality over the several thousand years of leaching and transport of metals from the mineralization zones proximal to the lake.

Many of the metal values exceed the standards for the success of aquatic life in one or all of these inflows, especially cadmium, copper, iron and zinc (see Table #5 earlier). Cadmium, copper and zinc are particularly toxic to egg and larval stages of most aquatic life as well as the fry stages of fish.

The outflow from Core Shack Lake (S5) seems to be dilute with respect to metals. The pH is low, but is likely due to the effect of snowmelt from the large snowbank that collects on the northwest side of the lake each year.

The water quality of the Kennarctic River also appears to be very dilute. Zinc values are somewhat elevated but not critical.

Kennarctic River discharge was estimated to be 14.76m^3/s on July 16. As mentioned earlier, estimates of the runoff coefficients for the Arctic mainland coast are variable, ranging from .44 to about .83. A total annual runoff can be estimated for the river by using the interpolated runoff High Lake value of 138 mm and the estimated precipitation value of 232 mm arrived at in earlier sections. The runoff coefficient would be about .60 and the estimated annual Kennarctic River discharge would be about 1.63×10^8 m^3.

6.2 High Lake

6.2.1 Physical Limnology

A summary of the morphometry of High Lake is given in Table #9. A discussion of the methods and results is given below. High Lake is a small, linear, deep lake which occupies a rocky basin. The shoreline drops off quickly for the most part although there are several rocky shoals and a small circular shallow bay about mid-length on the lake's westerly shore. The lake is approximately 2 km long and on the average 200 - 300 m. wide.

Lake area was determined by use of a polarizing digital

TABLE #9: HIGH LAKE MORPHOMETRY AND BATHYMETRY

Watershed area (WA):	3,586,875 m^2 (incl. lakes)
High Lake area (A):	714,063 m^2
Area of other lakes (AL):	239,060 m^2
High Lake Volume (V):	7,321,835 m^3
High Lake Perimeter (S):	6,375 m
High Lake Shoreline Development (SLD):	0.37
High Lake Orientation	N. 13° W.
High Lake Max Depth:	36.6 m (120 ft)
High Lake Mean Depth:	10.25 m
High Lake Flush Rate:	14.7 years
Evaporation/year:	222,074 m^3

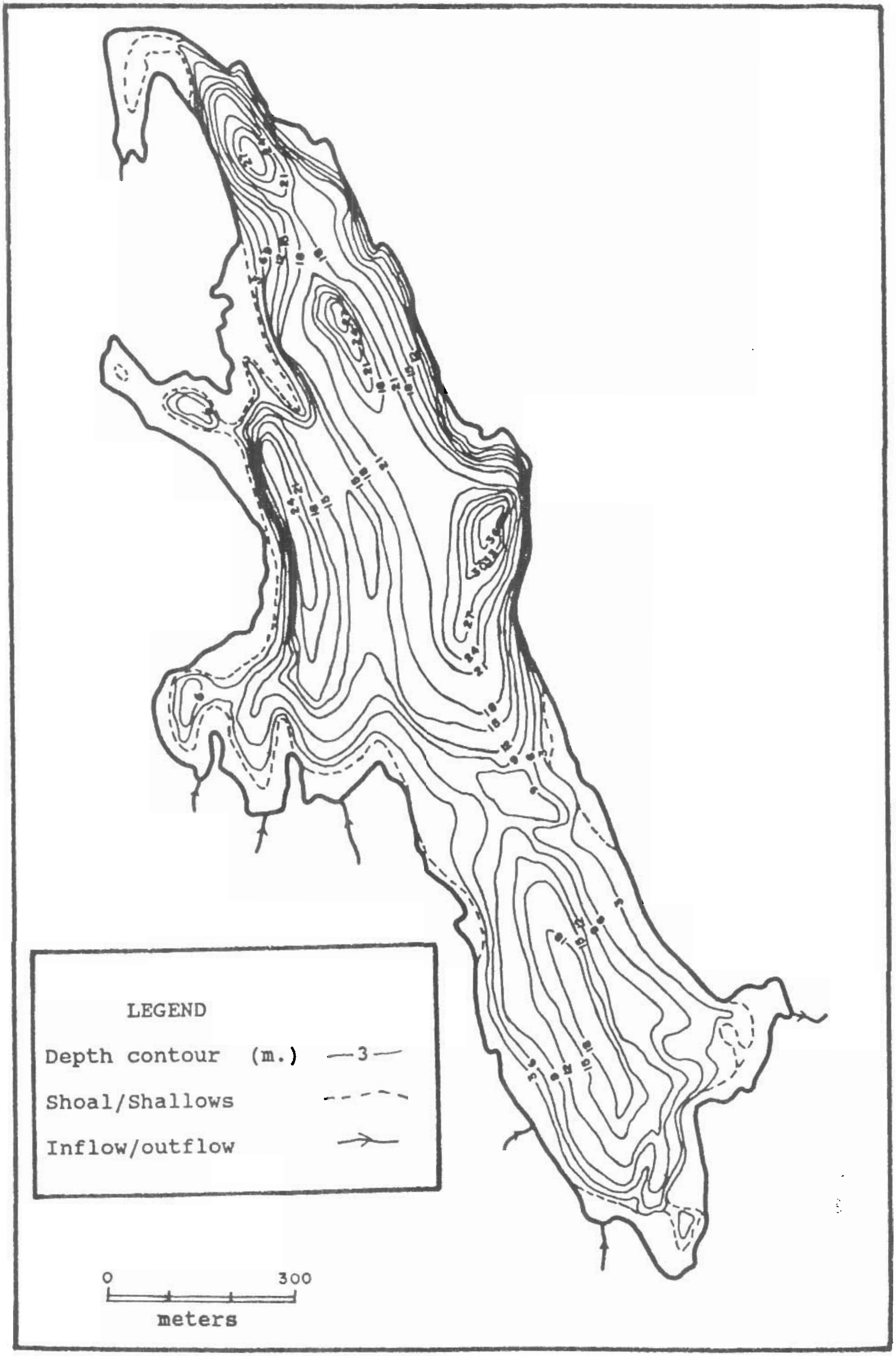
planimeter off a map created from 1:10,000 aerial photographs of the High Lake area and then enlarged to 1:625. Lake perimeter was measured by use of a map wheel (cartometer).

The morphometry of the lake was established by running a series of cross-sections to measure depth, perpendicular to its long axis using a Trimble GPS corrected by reference to prominent shoreline features and a depth sounder (fish finder) calibrated by use of a weight and measured rope.

From this information, the bathymetry was created by plotting and contouring depth data at 3 m. intervals. The resultant map is given below (see Map #8). The deepest point located in the survey was about 36.5 m. (120 ft) and it can be seen that the lake consists of several basins and shoals of varying depths.

Lake volume was determined using the frustrum method and the surfaces defined by the contours were used to define the tops and bottoms of the frustra (conical segments). The volume is determined by summing the conical volumes or frustra between depth contours using the following relationship (Lind, 1979).

Map # 8 : High Lake Bathymetry



$$V_f = h/3\ (a1 + a2 + \sqrt{a1\ a2})$$

where h = contour interval

a1 = area of top of frustrum

a2 = area of bottom of frustrum

V_f = frustrum volume

Areas were again determined by a polarizing digital planimeter.

Other physical aspects of High Lake are given in Table #9 and their derivations are self-explanatory.

6.2.2. Water Balance and Flush Rate

Through the use of climate data estimated earlier and some data on evaporation collected at the Lupin Mine near Contwoyto Lake, a water balance is attempted here for High Lake. An attempt is made to evaluate imputs against losses of water for High Lake and thereby estimate the time required for a total exchange of water in the lake basin (flush rate).

A conservative runoff coefficient of 0.5 is used here rather than the 0.6 estimated for the Kennarctic River because of the storage ability of the several small lakes feeding High Lake.

These lakes would hold back runoff to High Lake and lose some of that water to evaporation. Needless to say, this water budget is a very general estimate as there are no data on the timing and amounts of water movements but no doubt that much of the input/loss activity occurs in the spring runoff period.

Evaporation data in the north is limited but studies at Lupin suggest that a pond there experienced losses of 3.2-3.7 mm/day over about 90 days when evaporation could occur (Metall, 1993). This evaporation rate would generate an average loss of about 311 mm over the 90 days. This average value of 311 mm was also assumed for High Lake.

Outflow for High Lake was determined on July 10 at 0.07 m^3/s, well after peak flow from spring runoff. If the outflow is considered to be active for five weeks or sreasonable for Arctic runoff regimes, and the July 10 flow estimated to be an an average flow then it is possible to calculate and rationalize loss from High Lake to the Kennarctic River. To be sure, more gauging is needed to increase confidence in these projections.

With all of the above in mind, the following has been developed:

A/Inflow:

1.	Directly on to High Lake	165,663
2.	From the watershed	333,246
3.	Total inflow	498,909 m^3

B/Losses:

1.	Evaporation from High Lake (based on 3.45 mm/day)	222,074
2.	Outflow (+/- 5 weeks)	211,680
3.	Possible evaporative loss from watershed lakes (based on 3.45 mm/day)	74,347
		508,101 m^3

Inflow and outflow are nearly balanced and the difference could easily by due to over or under estimation in the various parameters used.

Inflow to High Lake has been estimated at 498,909 m^3 per year from all sources. Given that the lake has a volume of 7,321,835 m^3, it should take about 14.7 years for the water in High Lake to renew itself.

6.2.3 Chemical Limnology

The chemistry of High Lake was investigated through the selection of 4 sampling sites and two sampling events. Four sites were chosen for reasons of proximity to drainage from gossans (i.e. HL1 and HL3) and for variation of depth. The deepest site was at HL4 and the shallowest at HL3 whilst HL1 and HL2 were of intermediate depths (see Maps #5 and #7). These sites were sampled on July 12-14 and August 26-27, 1993.

Four, one litre samples were taken with a Van Doorn sampler and transferred to two 1 litre polypropylene bottles at each site in both July and August, 2 samples at surface and 2 from near the lake bed at the greatest possible depth. One of each set was acifified with concentrated nitric acid for preservation and later analysis for metals. In addition, a 500 ml sample was collected from 2 m deep at each site for chlorophyll analysis. These samples were put into brown polypropylene bottles and were frozen on site in a freezer for later analysis.

All samples were shipped south in coolers with ice packs to Near North Laboratories in North Bay, Ontario by courier. They were analyzed for a number of parameters considered to be important in generating environmental toxicity and as well they were chosen as ones possibly expected from a sulphide mineral deposit such as that at High Lake.

Certain other parameters such as temperature, pH, conductivity, dissolved oxygen (DO) and total dissolved solids (TDS) were measured in the field on site with portable metering equipment. Water clarity was measured by secchi disk and water temperature with a laboratory grade mercury thermometer.

The results of the laboratory and field analyses are given in Tables #10a, b, c and d and have been graphed (see Appendix A)

TABLE #10(a): HIGH LAKE: LAKE WATER QUALITY, 1993

SITE: HL-1

PARAMETER	JULY		AUGUST	
	Surface	9.5 m.	Surface	11.0 m.
Date	July 12	July 12	Aug 26	Aug 26
Water Temp (°C)	6.0	6.0	9.0	7.4
pH	5.76	5.51	5.7	6.1?
Cond (umhos)	58.4	57.7	81.0	63.6
TDS	28.4	29.2	38.4	31.5
TSS	<1	<1	<1	<1
Do (conc.)	11.5	11.7	9.9	10.9
Chloride	110	113	-	-
Sulphate	<10	13	22	21
TKN (Total)	0.24	0.19	<0.02	0.08
Chlorophyll a[a]	0.0220	-	0.0176	-
Arsenic (As)	0.005	0.005	<0.001	<0.001
Cadmium (Cd)	0.0007	0.0006	0.0008	0.0010
Copper (Cu)	0.103	0.097	0.118	0.108
Iron (Fe)	0.012	0.267	0.642	0.017
Lead[b] (Pb)	<0.005	<0.005	<0.0020	0.002
Mercury (Hg)	<0.00010	<0.00010	<0.00010	<0.00010
Zinc (Zn)	0.276	0.326	0.261	0.321
Aluminum (Al)	0.049	<0.035		

[a] - taken at 1 m. deep
[b] - Note lead MDL changed July to August .005 to .0002 mg/l

TABLE #10(b): HIGH LAKE: LAKE WATER QUALITY, 1993

SITE: HL-2

PARAMETER	JULY		AUGUST	
	Surface	17.0 m.	Surface	16.0 m.
Date	July 13	July 13	Aug 27	Aug 27
Water Temp (°C)	6.0	5.5	8.3	8.5
pH	5.85	5.70	5.98	5.74
Cond (umhos)	58.5	60.9	69.1	62.1
TDS	28.7	30.5	34.1	30.3
TSS	<1	<1	<1	<1
Do (conc.)	11.4	8.5	10.6	10.3
Chloride	110	113	-	-
Sulphate	12	18	20	20
TKN (Total)	0.08	0.34	<0.02	<0.02
Chlorophyll a[a]	0.0210	-	0.0117	-
Arsenic (As)	0.003	0.002	<0.001	<0.001
Cadmium (Cd)	0.0007	0.0008	0.0006	0.0010
Copper (Cu)	0.090	0.108	0.107	0.102
Iron (Fe)	0.033	0.080	0.046	0.042
Lead[b] (Pb)	<0.005	<0.005	0.0004	<0.002
Mercury (Hg)	<0.00010	<0.00010	<0.00010	<0.00010
Zinc (Zn)	0.250	0.275	0.262	0.259
Aluminum (Al)	<0.035	<0.035		

[a] - taken at 1 m. deep
[b] - note lead MDL changed July to August .005 to .0002 mg/l

TABLE #10(c): HIGH LAKE: LAKE WATER QUALITY, 1993

SITE: HL-3

PARAMETER	JULY		AUGUST	
	Surface	7.0 m.	Surface	5.5 m.
Date	July 12	July 12	Aug 26	Aug 26
Water Temp (°C)	7.5	5.5	9.1	9.0
pH	5.66	5.52	5.72	5.51
Cond (umhos)	54.8	59.1	61.1	62.9
TDS	26.9	30.0	30.3	31.0
TSS	<1	<1	<1	<1
Do (conc.)	12.3	12.2	11.3	8.5
Chloride	110	-	-	-
Sulphate	<10	18	23	19
TKN (Total)	0.40	0.16	<0.02	<0.02
Chlorophyll a[a]	0.0054	-	0.0114	-
Arsenic (As)	0.003	0.002	<0.001	<0.001
Cadmium (Cd)	0.0006	0.0006	0.0006	0.0010
Copper (Cu)	0.106	0.103	0.105	0.099
Iron (Fe)	0.148	0.167	0.059	0.034
Lead[b] (Pb)	<0.005	<0.005	<0.0002	<0.0002
Mercury (Hg)	<0.00010	<0.00010	<0.00010	<0.00010
Zinc (Zn)	0.286	0.295	0.259	0.255
Aluminum (Al)	<0.035	0.037		

[a] - taken at 1 m. deep
[b] - note lead MDL changed July to August .005 to .0002 mg/l

TABLE #10(d): HIGH LAKE: LAKE WATER QUALITY, 1993
HL-4

PARAMETER	JULY		AUGUST		MDL
	Surface	28 m.	Surface	28 m.	
Date	July 13	July 13	Aug 26	Aug 26	
Water Temp (°C)	5.5	5.1	9.5	5.7	
pH	5.89 (5.30)	5.11	5.99	5.81	
Cond (umhos)	61.3	61.6	69.4	61.2	
TDS	30.2	30.7	34.4	30.5	
TSS	<1	<1	<1	<1	1
Do (conc.)	11.8	11.3	14.4	9.5	
Chloride	114	-	-	-	
Sulphate	14	17	20	19	10
TKN (Total)	0.17	0.36	<0.02	<0.02	0.03
Chlorophyll a[a]	0.0050	-	<0.0010		0.0010
Arsenic (As)	0.001	0.001	<0.001	<0.001	0.001
Cadmium (Cd)	0.0008	0.0008	0.0006	0.0006	0.0001
Copper (Cu)	0.102	0.103	0.103	0.104	0.001
Iron (Fe)	0.788	0.198	0.216	0.099	0.005
Lead[b] (Pb)	<0.005	<0.005	<0.0002	<0.0002	0.005 (July) 0.0002 (Aug)
Mercury (Hg)	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Zinc (Zn)	0.418	0.336	0.288	0.267	0.001
Aluminum (Al)	<0.035	0.035			

[a] - taken at 1 m. deep
[b] - note lead MDL changed July to August .005 to .0002 mg/l

to show variation both amongst sites and between the two sampling events.

In addition to sampling the surface and at depth, profiles of changes in the field measured parameters were created for each site by sampling through depth to the bottom. These results are listed below in Table #11.

Each of the parameters in the above two tables is discussed below with respect to its toxicity and spatial and temporal variance over the Study period. Spatial variance is investigated both horizontally and vertically in the lake.

From the toxicity standpoint, arsenic, lead, mercury and aluminum appear to be well below the maximum limits for the preservation of aquatic life. Cadmium values are slightly above acceptable limits and copper and zinc values are well above acceptable limits. Iron is also well above the acceptable limit in some samples; whereas pH is just acceptable everywhere except at site HL4 at depth. Temperatures and dissolved oxygen values are very suitable for cold water species of flora and fauna. Even though several parameters are toxic for aquatic life, all values fall within the maximum limits for drinking water (see Table #5 earlier). Chloride values are somewhat high for a remote lake but might be explained by proximity to salt water of the Coronation Gulf

TABLE #11: CHEMICAL FIELD DATA, HIGH LAKE, 1993

Site	Depth (m)	O_2 (mg/l)		Conductivity (umhos)		pH		Temperature (°C)		Secchi (m)	
		July	Aug	July	Aug	July	Aug	July	Aug	July	Aug
HL 1	Sfce	11.5	9.9	58.4	81.0	5.76	5.70	6.0	9.5	9.5	9.0
	2	10.2		60.5		5.56		6.0			
	5	11.0		61.8		5.47		7.0			
	9.5	11.7		57.7		5.51		6.0			
	11.0	-	10.9	-	63.6	-	6.10	7.6			
HL 2	Sfce	11.4	10.6	58.5	69.1	5.85	5.98	6.0	8.2	11.0	10.0
	2	12.3		58.0		5.84		6.0			
	5	10.4		60.2		5.89		6.0			
	10	10.3		59.7		5.74		5.5			
	13	12.6		60.8		-		5.8			
	15	12.5		61.3		5.54		5.5			
	17	9.1	10.3	62.1		5.70	5.74	5.5	8.6		
HL 3	Sfce	12.3	11.0	54.8	61.1	5.66	5.72	7.5	9.0	N/A	N/A
	2	12.5		60.1		5.59		6.0			
	5	12.2	8.5	60.6	62.9	5.78		5.5			
	7	12.0	-	59.1		5.52	5.51	5.5	9.0		
HL 4	Sfce	11.8	12.4	61.3	69.4	5.89	5.99	5.5	8.9	11.0	9.0
	2	11.2		61.2		5.30		6.0			
	5	11.5		63.3		5.36		5.8			
	10	12.7		63.4		5.60		5.5			
	15	12.2	11.7	61.9	60.8	5.68	5.95	5.5	8.1		
	17	11.7		62.8		5.72		5.2			
	20	11.6	10.1	62.4	60.2	5.83	5.61	5.2	5.9		
	25	11.4		61.1		5.73		5.1			
	28	11.3	9.8	61.6	61.2	5.61	5.81	5.1	5.6		

and wind blown salt.

It should be noted here that the presence of a toxic metal does not necessarily equate to a toxic environment. The chemical speciation of the metal which is often pH controlled is critical. Some metals have restricted ranges of pH and ionic or compound forms in which they are toxic. Aluminum is a good example and while it occurs in High Lake in minimal amounts, it could increase its deep water concentration in winter when, potentially, oxygen levels drop and if pH drops to 4.2 aluminum might be released from bottom muds where its concentration is very high. In solution at such low pH it becomes very toxic to aquatic life. Similarly, copper, zinc and other metals can also be exchanged with bottom mud under anoxic conditions (Salomon and Forstner, 1984). Further study is needed to determine the extent of such processes in High Lake and the speciation of the metals.

Trends in the spatial and temporal variation in the chemical parameters can be seen in the data presented in Tables #10 and #11 and Appendix A.

In July the water of High Lake was nearly isothermal. Conductivity and DO values were fairly consistent with depth. The ice had just gone out and the water had turned over so vertical mixing was reasonably complete. However, temperatures were slightly colder in the deeper part of the lake.

By August, a weak thermocline was beginning to develop at about 20 m. at HL4, the deepest site. Likewise, D.O. values were slightly less that those of July and generally decreased with depth as did pH, but only slightly. Conductivities showed a strong decrease with depth in August even though, over all, values were much higher than in July. Copper and zinc display lower values at depth in August which may account for the decreasing conductivity although cadmium values are higher.

Sulphate values increase with depth in July but are overall greater in August and equilibrated throughout the water column. This change is likely due to the oxidation of the sulphide present to sulphate over the summer which would also explain the degrading of deep oxygen values toward the end of August.

TKN values are much greater in July than in August and this trend, coupled with the high July and low August chlorophylla values suggests uptake by algae in July and early August with the nitrogen being nearly exhausted by the end of August.

Other than the above, there are no real strong differences between sites or with depth amongst the various parameters measured. No strong patterns are present but some classical limnological changes do occur in the lake over the summer. Further data on lake chemistry after a winter of ice cover would complete the information base on High Lake limnology.

6.2.4 Biological Limnology

Aquatic life in High Lake is very limited in both species and numbers. The fauna are restricted to a few mosquito larvae (family Culicinae), a few phantom midge larvae (family Chaoborinae, genuus Chaoborus) and a more prolific copepod population. The flora is restricted to the algal level of plant life, some free floating with the majority being a filamentous bottom dwelling variety. No vascular plant life was found.

In all of the sampling done, the number of individuals found was very small. The sampling for chemical analysis and the four plankton net uphauls at the sampling sites HL1 to HL4 turned up only 3 or 4 mosquito larvae and 3 larvae of Chaoborus. Surprisingly, though, given the metal levels in High Lake (especially copper and zinc), a fairly large number of copepods were collected.

The copepods turned up in the July Van Doorn samples so a plankton net (Wisconsin net) uphaul program was instituted for

TABLE #12: COPEPOD POPULATION OF HIGH LAKE, 1993

Site	Depth (m)	Row Number		Volume Sampled (litres)		Ratio #1 1 copepod/litre		Ratio #2 copepods/litre	
		July 12-14	August 26-27	Jul	Aug	Jul	Aug	Jul	Aug
HL1 S[1]	0.0	0		0.6		-		-	
HL1 U[2]	0-11		63		89		1/1.4 l		0.71/l
HL1 D[3]	9.5	7		0.6		1/.09 l		11.1/l	
HL2 S	0.0	1		0.6		1/0.6 l		1.7/l	
HL2 U	0-20		58		162		1/2.8 l		0.36/l
HL2 D	17.0	8		0.6		1/.08 l		12.5/l	
HL3 S	0.0	10		0.6		1/.06 l		16.7/l	
HL3 U	0-7		76		57		1/0.75 l		1.3/l
HL3 D	7.0	17		0.6		1/.04 l		25.0/l	
HL4 S	0.0	0		0.6		-		-	
HL4 U	0-20		18		162		1/9.0 l		0.11/l
HL4 D	28	2		0.6		1/0.3 l		3.3/l	

[1] - Surface
[2] - Uphaul
[3] - Deep

the August set of samples to better quantify the numbers present. The results are presented in Table #12 below. In addition an attempt was made to classify the copepods and based on the position of the lateral seta on the caudal ramus and the general shapes of the copepods, the High Lake variety closely resembles a Great Lake variety called Diacyclops thomasi (Balcer, Korda and Dodson, 1984). The High Lake copepods were smaller than their Great Lakes cousins as might be expected for an Arctic environment and the chemical environment of High Lake. In fact, the copepod resistance to the metal contamination might suggest some adaptation of the species. However, further research is needed to confirm this possibility.

The evidence in Table #12 certainly points out that the copepods are generally more successful in the shallower lake basins. The greatest numbers occur in July at HL3 which is the shallow embayment on the west shoreline of the lake. July samples, as expected, produced the largest numbers as food was abundant in the algae production which was very high as well (see discussion below).

The presence of the free floating algae is confirmed also by the chlorophyll a values in High Lake (see Table #10 earlier). July samples had greater levels of chorophyll a than late August samples except for HL3 where the restricted basin still had warmer water temperatures, warmer by 2C° or so. Also there was a very definite gradient of chlorophyll **a** (especially for July) from low in the north end to high in the south end of the lake, likely due to plankton drift before the prevailing northerly winds during the sampling period.

No other life was discovered in High Lake. Even though the temperature and dissolved oxygen levels are excellent, the pH is marginal and the metal concentrations too high for fish to survive, especially in the egg and fry stages of development. Anecdotal evidence of many-time visitors to the lake and of local Inuit confirmed the lack of fish. As well, several fishing attempts failed to confirm any presence of fish. In addition, no surface fish activity was ever observed on the lake, even in periods when activity was occurring at nearby watershed lakes. Without a netting program for absolute confirmation, it would appear at this point that High Lake is devoid of any fish.

6.2.5 Bottom Sediment

Lake bottom sediment was sampled at sites HL1 to HL3 using an Eckman dredge and the samples analyzed for several metals. The Eckman dredge is a grab sampling device and therefore mixes the possible sedimentary horizons or layering in the lake bed so distinctive bedding is not preserved.

Even so, the samples collected did suggest layering of darker black and green organic sediments and lighter ochre coloured and grey mineral sediments. No doubt the dark green is the algal growth and the ochre sediment an iron hydroxide; whilst the grey materials are likely residual clay. The black organic material is likely decayed algae and the residue of wind-carried detritus from the surrounding tundra.

The presence of the hydroxides suggests a use of the oxygen in deep water which would contribute to anoxic conditions during the long period of ice cover and no doubt, under such conditions, metal transfer occurs between bottom sediment and the water column. Bottom sediment cores and a thorough ice sampling program in late winter would potentially confirm this scenario.

The sediment analyses are summarized in Table #13 below.

Table #13: Bottom Sediment Chemistry, High Lake, 1993

Site	HL1	HL2	HL3	
Date	Jul 15	Jul 15	Jul 15	
Parameter:				MDL
Organic (%)	21.10	9.20	20.80	0.01
Aluminum (%)*	1.20	0.70	1.10	0.01
Cadmium (ppm)*	22.80	8.14	10.60	0.003
Copper (%)	1.23	0.51	0.83	0.001
Iron (%)	4.16	7.78	3.45	0.006
Lead (ppm)	117	50.7	84.1	0.005
Zinc (%)	0.80	0.30	0.21	0.001
Arsenic (ppm)	0.383	0.404	0.540	0.001
Mercury (ppm)	0.0128	0.0075	0.0220	0.001

Notes: *ppm is in mg/kg
% can be converted to mg/kg by multiplying by 10^4

The data in Table #13 show clearly that the lake bottom sediment is very highly charged with heavy metal. Values are larger for the shallower sites, HL1 and HL3, which also receive the brunt of the runoff from the gossans. However, values at HL2, a relatively deep site in mid-lake, are also high which proves the dispersion of metals throughout the lake bottom. The vertical distribution of metals in the sediments is unknown but certainly a large portion will be adsorbed in the organic layer as in other lakes (Warren, 1981).

The amounts of the various metals roughly reflect the water column concentrations except for Al which is skewed in the sediment by the presence of the clay. High Al values were found in streams S2 and S4, which contribute inflow to the basins HL1 and HL3 which also have highest Al sediment values. There may well be a connection between these two observations.

6.3 Other Watershed Lakes

6.3.1 General Characters

A total of 15 lakes proximal to High Lake were given reconnaissance level observation and sampling. All but 5 lakes were within the High Lake watershed and contributed water at some time during the year to High Lake. One "lake" was actually a small shallow pond of about 150m^2 into which drilling mud had been emptied.

Several field parameters were measured by thermometer and portable metering equipment and the results are shown in Table #14 below. Likewise observations on flora and fauna related to these lakes were made and these data are reported in section 7.0 later.

Lake temperatures ranged from 9.0^{0}C for deeper lakes to 14.5^{0}C for shallow ones and pH values ranged from 3.53 in the drill slough to 6.16 in WL6. Generally, the warmer and less acidic waters yielded the most life signs.

Conductivities were generally lower than those of High Lake but two sites stand out with very high values. The drill slough is very high and was obviously articifial but WL7 is also high and no explanation is forthcoming at this time for the anomalous value as the value was replicated again after recalibration of the instruments.

6.3.2 Potable Water Supply

Core Shack Lake is of interest with a rather low pH likely due to snowmelt influence from the major long lasting snowbank that had developed on its northwest flank. This lake has been used as a potable water supply for the camp situated

TABLE #14: HIGH LAKE WATERSHED LAKES DATA, 1993

Lake	Name	Date July	Area (M^2)	Water Temp (°C)	pH	Cond. (umhos)	TDS (mg/l)
L1[1]	Upper L.	11	-	9.0	5.51	28.5	12.8
WL2[2]	West L.	11	39,062	11.0	5.76	21.1	9.8
WL3	-	11	31,250	9.0	5.94	38.5	16.7
WL3a	-	-	7,812	-	-	-	-
WL4	-	11	7,812	11.0	6.15	41.3	19.1
WL5	CS L.[3]	10	15,625	8.8	4.86	26.8	12.9
WL6	-	13	15,625	11.0	6.16	40.2	20.0
WL7	-	13	7,812	10.5	5.89	196.2	94.8
WL8	Drill S[4]	13	-	10.0	3.53	276.0	147.0
WL9	Contact L.	13	62,500	11.0	6.00	33.0	13.7
WL10	Chopper L.	13	7,812	11.5	5.32	47.9	24.2
WL11	-	17	32,812	11.5	5.83	42.2	21.0
L12	Granite L.	17	-	9.3	5.04	24.8	11.9
L13	N.Showing	17	-	12.0	5.33	24.8	12.2
L14	Loon Lake	17	-	11.0	5.76	32.4	15.9
L15	Fault Lake	17	-	14.5	5.67	29.2	13.8

[1] L = Lake outside High Lake Watershed
[2] WL = High Lake Watershed Lake
[3] CS L = Core Shack Lake
[4] Drill S = Drill Slough

downslope on the southwest shore of High Lake.

A rough water balance is done here to see what potential WL5 has to supply water to some future development. The same hydrologic parameters are used as for High Lake earlier.

Table #15: Water Balance, Core Shack Lake, 1993

A/	Watershed area (incl. lakes)		$820,313m^2$
	Watershed lakes area		$104,686m^2$
	Core Shack Lake area		$15,626m^2$
	Mean annual ppt.	.232	
	Mean annual evap.	.311	
B/	Inflows to lake		
	1) Directly	15625 x 232 =	3,625
	2) Indirectly	820,313 x .232 x .5 =	95,156
		TOTAL =	$98,781m^3$
C/	Losses		
	1) Evap. from C.S. Lake		4,859
	2) Evap from watershed lakes		32,557
		TOTAL	$37,416m^3$

D/ Balance

1) Water available for use 61,365m^3

(if all water is dammed at outlet)

The quality of the water in Core Shack Lake is similar to that measured in stream sample S5 data in Table #8 earlier. All parameters are well within drinking water standards.

6.4 Groundwater

The High Lake area watershed is relatively dry. Where there is coarse overburden the majority of sites are dry, as evidenced by the numerous ground squirrel (siksik) burrows. Certainly, the permafrost table controls water penetration and percolation into the deeper parts of the substrate.

There are some areas where throughflow through tills and rock occurs from snowbank melt. In addition, the outflows from both High Lake and Core Shack Lake are thought to find pathways through fractured bedrock and deflated till respectively.

No evidence of deep groundwater or taliks was encountered in this study.

6.5 Fisheries

Species of fish expected in the High Lake area include the broad whitefish (Coregomus nasus), the lake cisco (Coregonus artedii), round whitefish (Prosopium cylindraceum), artic grayling (Thymallus arcticus), mainly in rivers, lake (grey) trout (Salvelinus namaycush), arctic char (Salvelinus alpinus) and northern pike (Exox lucius) (Scott and Crossman, 1973).

As discovered earlier, there are no fish in High Lake itself; however, fish and evidence of fish were seen in other watershed lakes. Fish were actually seen in WL9 and L15 and they are thought to be round whitefish. Fish were breaking water in WL11 and again they were likely whitefish. In L14, Loon Lake, a yellow billed loon was seen fishing so one might assume that this lake also has fish. None of the observed fish were very large.

7.0 Terrestrial Environment

7.1 Vegetation

The vegetation and vegetation associations of the High Lake area typical of the Tundra Biome which consists of a number of lichens in bedrock areas and mosses, grasses, sedges, flowering herbs and dwarf shrubs where there is some soil or overburden (Young, 1989).

The rocky ridges of High Lake are vegetated with lichens and the more gentle slopes and the plateau area are covered with tussock tundra and wet sedge meadow consisting of single headed (Eriophorum vaginatum) or multiple head (E. Angus-tifolium) tussocks of the sedge called "cotton grass".

At the edges of these meadows often there is mesic tundra consisting of rock gardens with intercalated grasses and some flowering herbs.

Protected slopes which are south or east facing tend to support shrub tundra which is dominated by dwarf willow and birth with a heath understory. Many of the heaths are berry producers.

On the steeper slopes and more exposed slopes, fell fields develop consisting of stony and rocky surfaces which may support the odd flowering plant such as the arctic poppy.

A complete listing and classification of the vegetation observed in the High Lake terrestrial environment is given in Table #16 below. Burt (1991) was used for the majority of the classifying.

7.2 Wildlife

Wildlife in the High Lake area is restricted to few species and generally small numbers of individuals. The exception seems to be the ground squirrel or siksik which is quite ubiquitous in the area of High Lake itself.

TABLE #16: PLANT SPECIES, HIGH LAKE 1993

Common Name	Latin Name
Arctic Cotton	Eriophorum sp.
Blueberry	Vaccinium uliginosum
Arctic Bell Heather	Cassiope tetragona
Moss Campion	Silene acaulis
Cuckoo flower	Cardamine digitalis
Arctic bladderpod	Lesquerella arctica
Mountain avens	Dryas integrifolia
Crowberry	Empetrum nigrum
Bearberry	Arctostaphylos rubra
Labrador tea	Ledum decumbens
Antler lichen	Masonfalsa richardsonii
Worm lichen	Thamnolia subuliformis
Map lichen	Rhizocarpon geographicum
Willow	Salix reticulata
Dwarf birch	Betula glandulosa
Bog rosemary	Andromeda polifolia
Yellow oxytrope	Oxytropis maydelliana
Horsetail	Equisetum arvense
Richardson's Milk Vetch	Astragalus richardsonii
Prickly saxifrage	Saxifraga tricuspidata
Alpine daisy	Arnica alpine
Fragrant shield fern	Dryopteris fragrans
Birdfoot buttercup	Ranunculus pedatifidus
Arctic lousewort	Pedicularis arctica
Capitate lousewort	Pedicularis capitata
Club moss	Lycopodium selago
Lapland rosebay	Rhododendron lapponicum
Dwarf fireweed	Epilobium latifolia
Arctic poppy	Papaver radicatum
Shrubby cinquefoil	Potentilla fruitcosa
Richardson's Anemone	Anemone richardsonii
Snow cinquefoil	Potentilla nivea
Large flowered wintergreen	Pyrola grandiflora
Bublet saxifrage	Saxifraga cernua
Lichen (brown)	Cetraria nivalis

The two major animals of note to occupy the region are the caribou and muskox. The caribou of the region comprise the Bathurst Herd which is reported to contain some 150,000 animals (Calef, 1979).

The calving grounds for this herd are mainly to the northeast of Bathurst Inlet well away from the High Lake area. However, some calving has been reported in the hills west of Bathurst Inlet in 1951, 1977 and 1979 (Fleck and Gunn, 1982).

Winter ranges include a large one to the south in the treeline, one in the Coppermine and Ellice River areas and a small range south of High Lake. Spring migrations from the last two appear to be eastwardly to and across Bathurst Inlet. However, there is no evidence of very large migrations through the immediate High Lake area and only one single and a pair were observed during the study period.

The study area lies within the Bathurst Muskox management unit. Numbers of animals in a 1970 survey were estimated to be 96 in total around the Bathurst Inlet area (Monaghan, 1970). A more recent survey in 1965 put the number at 450 (Dickensen and Herman, 1979). Again, around the High Lake area, there is scanty evidence of large numbers of these animals. None were sighted and only a few hoofprints and droppings indicated their presence.

A listing of the wildlife in the area is given in Table #16 below.

Table #17: Wildlife, High Lake, 1993.

	Status	Common Name	Latin Name
A.	Observed		
	1) Mammals	caribou (3)	Rangifer tarandus
		ground squirrels	Spermophilius sp.
	2) Birds	raven (2)	Corvus corax
		lark (1)	Eremophilia alpestris
		sanderling	Crocethia alba
		sparrow type	-
		snow bunting	Plectrophenax nivalis
		herring gull	Larus argentatus
		tern	Sterna paradisaea
		yellow billed loon	Gavia adamsi
		common loon	Gavia sp.
		ducks (5)	various
	3) Insects	Beetles/diving	Hydrophilius sp.
		butterfly/moth	lesser Fritillary
		bees	
		flies (mosquito/blackfly)	
		(mayfly/caddisfly)	
		aquatic invertegrates - various	

B/ Indirect Evidence

1) Mammals muskox (tracks and faeces) Ovibos sp.

wolf (faeces)	Canus lupus
hare (droppings)	Lepus arcticus
lemming (nest and droppings)	Lemmus sp.
vole (droppings)	Microtis sp.

C/ Reported

1) Mammals muskox (by pilot - 1 old, single) Ovibos sp.
(by geologist - herd of 9, 15 km west of High Lake).
grizzly (in past - s. of camp) Ursus arctos

B: THE CULTURAL ENVIRONMENT

8.0 LAND CAPABILITY AND USE

8.1 Historical Perspective and Archeological Potentials

The First Nation Peoples make up 58% of the population of the N.W.T. and their ancestors first arrived some 11,500 years ago (DIAND, 1990). Up to the treeline was inhabited about 8,000 years ago, and the tundra beyond was inhabited about 4,500 years ago by Paleoeskimo. By 500 B.C. these people had developed the Dorset culture, a coastal economy which lasted for 1,500 years.

By 1,000 AD the Dorset culture was displaced by Inuit immigrants from the west who developed the Thule culture which lasted in its traditional format until the end of the little Ice Age from 1600 - 1850 AD and the arrival of the Europeans.

The Inuit in the Bathurst region and High Lake area are known as the Copper Inuit. They principally occupied coastal sites but were known to have travelled inland to the barrens in summer in search of caribou (McGhee, 1978). It is possible that they used the relatively flat Kennarctic River terraces as an easy terrain to gain access to the barrens and caribou south of High Lake. A search of the archeological files at the Prince of Wales Northern Heritage Centre in Yellowknife turned up nothing in the way of archeological sites or information on the High Lake area. However, a stone circle was found on such a terrace just to the east of High Lake but its age and orgins are unknown at this time.

Presently the Inuit of Northern Canada are represented by the Inuit Tapirisit of Canada (ITC). The ITC works with regional associations and the two major associations, the Inuvialuit (Western Arctic) and the Tungavik Federation of Nunavut (TFN).

High Lake is situated in the Kitikmeot Region within the newly formed Nunavut Settlement Area. The Kitikmeot Inuit Association (KIA) is the designated Inuit organization (DIO) with which negotiations of impacts and benefits must be made if a mineral site such as High Lake is to be developed.

8.2 Adjacent Settlements

The West Kitikmeot Region which contains the High Lake area has the lowest population density in the world and it is all "urban". All persons live in settlements in the region.

The population totals 4,386 (June, 1991) of which 89% are Inuit and the population has grown rapidly by 17% from 1986-91. Still it is only 7.6% of the population of the N.W.T. and only 39.2% of the population are under 15 years (Metall, 1993). In the population over 15 years there is a labour force of 1,225 (52% of total over 15 years) of which 22% are unemployed (N.W.T. Data Book, 90-91).

In the Kitikmeot Region there are a number of mainland settlements and data for those closest to High Lake are organized in Table #18 below. Each of the settlements had its beginnings in the traditional era as a gathering site for hunting, trapping and/or trading. With these pursuits on the decline several of the settlements have somewhat depressed economics.

8.3 Land Tenure and Use

The lands in the High Lake Region are public lands

TABLE #18: COMMUNITY PROFILES, HIGH LAKE AREA, 1993

Community	Location from High Lake	Population 1988		Population Age				Ethnic		
		Total	M/F	(%)				Dene/ Metis	Inuit	Non-Native
		persons	(%)	0-4	5-14	15-64	65+			
Bathurst Inlet (Kingaok)	135 km South East	18	50/50	15	15	70	0	-	100	-
Bay Chimo (Umingmak-tok)	128 km East	53	?	?	?	?	?	-	100	-
Cambridge Bay (Ikaluktiak)	300 km North East	1027	53/47	14	22	62	2	2	72	26
Coppermine (Kuglugtuk)	175 km West	956	48/52	16	20	60	4	1	92	7

Community	Average Income ($)	Economy
Bathurst Inlet (Kingaok)	- Mainly social assistance - 1,543 per capital (1992)	- seasonal employment by Bathurst Lodge - 49% Inuit owned
Bay Chimo (Umingmaktok)	- mainly social assistance - 1,332 per capita (1992)	- traditional pursuits - some seasonal work with mineral exploration
Cambridge Bay (Ikaluktiak)	36,522 (household) (1985)	- government - fishing - trapping - prices 52% above Yellowknife
Coppermine (Kuglugtuk)	24,181 (household) (1985)	- handicrafts - trapping - hunting - sealing - oil and gas exploration - prices 48% above Yellowknife

administered in part by both the Governments of the Northwest Territories and Canada. Recently, on July 9, 1993, the Federal Government and the TFN entered into a land claim agreement, the Nunavut Land Claim Agreement, which has defined the new territory of Nunavut. Nunavut will become fully functional in 1999.

Essentially the purpose of the agreement is to clarify Inuit rights to the lands and waters in the Nunavut Settlement area and to ensure that Inuit are involved in decisions about using and conserving the land and the offshore and natural resources throughout Nunavut.

In essence, the Inuit also have the right to own 354,000 km^2 of land and 36,000 km^2 will include ownership of mineral properties, some of which lands are delineated in a publication by the Inuit Ratification Committee, 1992. Also the Inuit will have equal membership with government in new institutions of government to manage the land, water, offshore and wildlife of Nunavut and to assess the environmental impacts. In this regard, the Nunavut Water Board, the Nunavut Planning Commission and the Nunavut Impact Review Board have all been proposed.

The Inuit will also have the right to share in royalties paid to Government from mineral developers on Crown lands and finally the Inuit will have the right to negotiate with industry for economic and social benefits from non-renewable resource development. These negotiations will lead to Inuit Impact and Benefit Agreements which can address Inuit training, housing, preferrential employment, employment rotation and language of the workplace.

The cultural environment is rapidly changing in the Northwest Territories and any development of High Lake will necessarily be breaking new ground with the new Territory of Nunavut.

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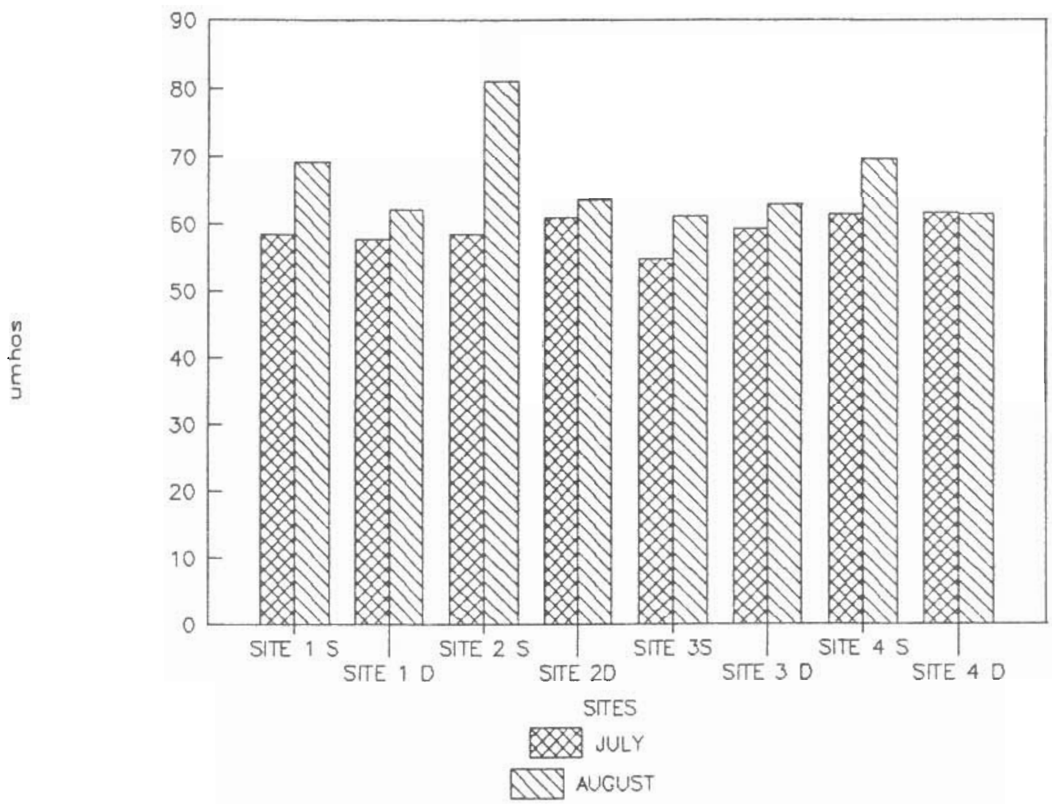
APPENDIX

CONDUCTIVITY CONCENTRATIONS



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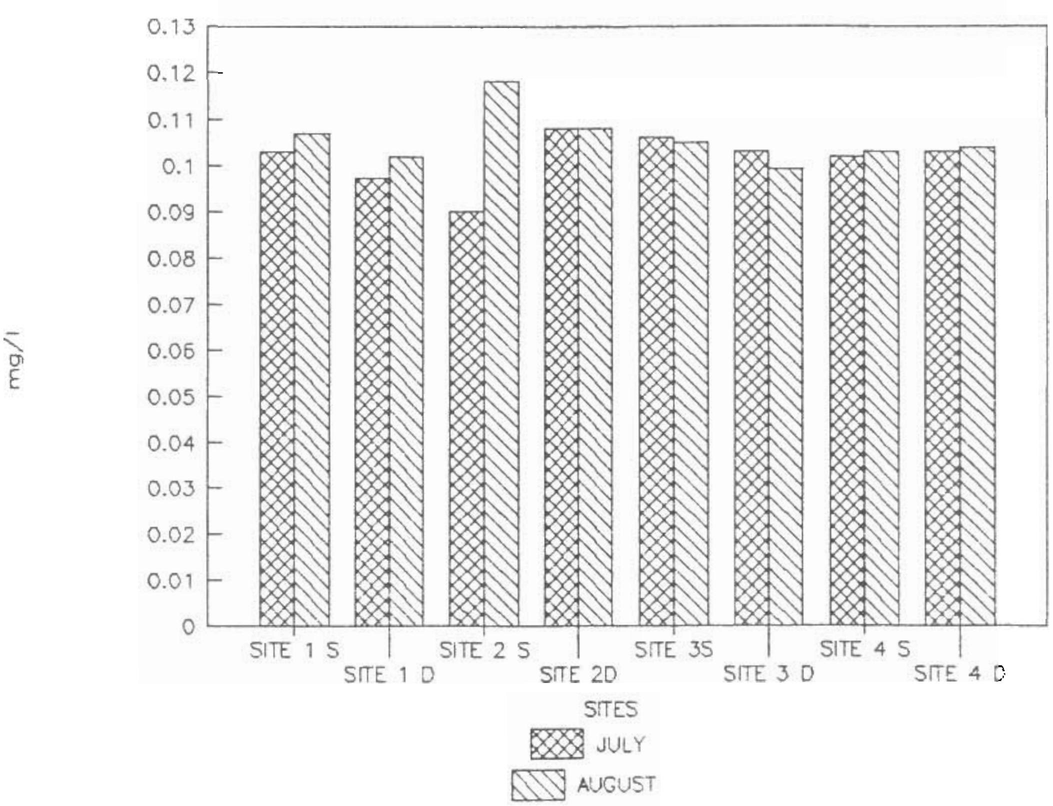

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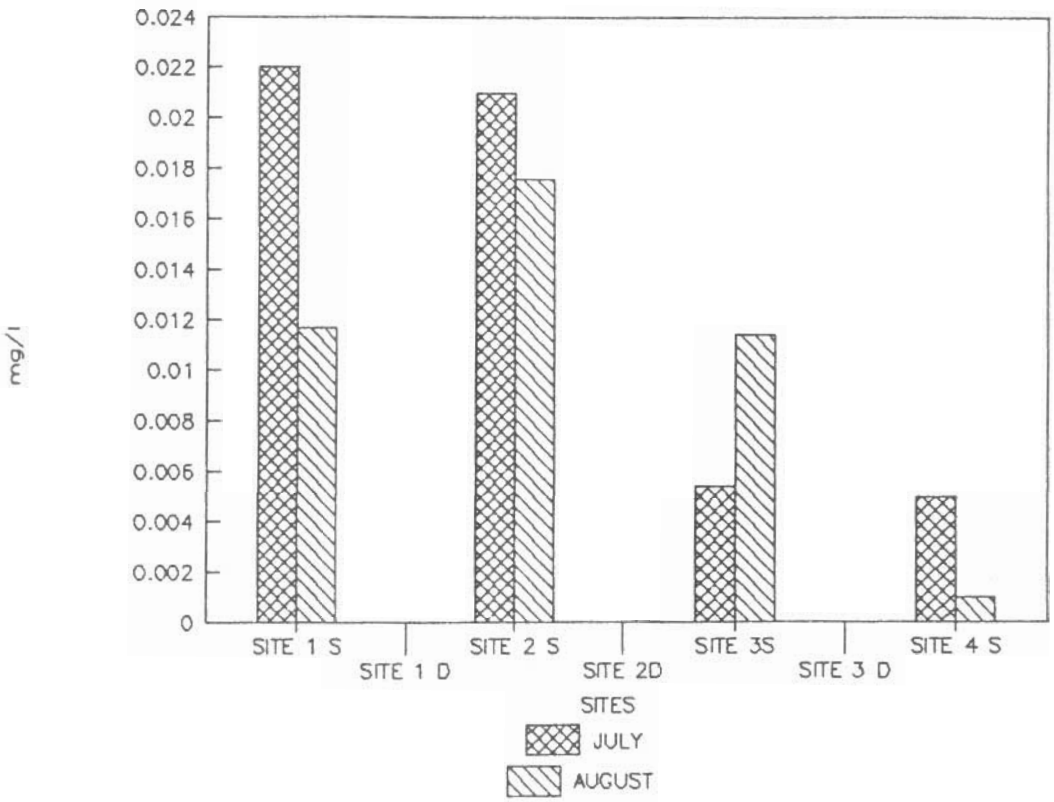

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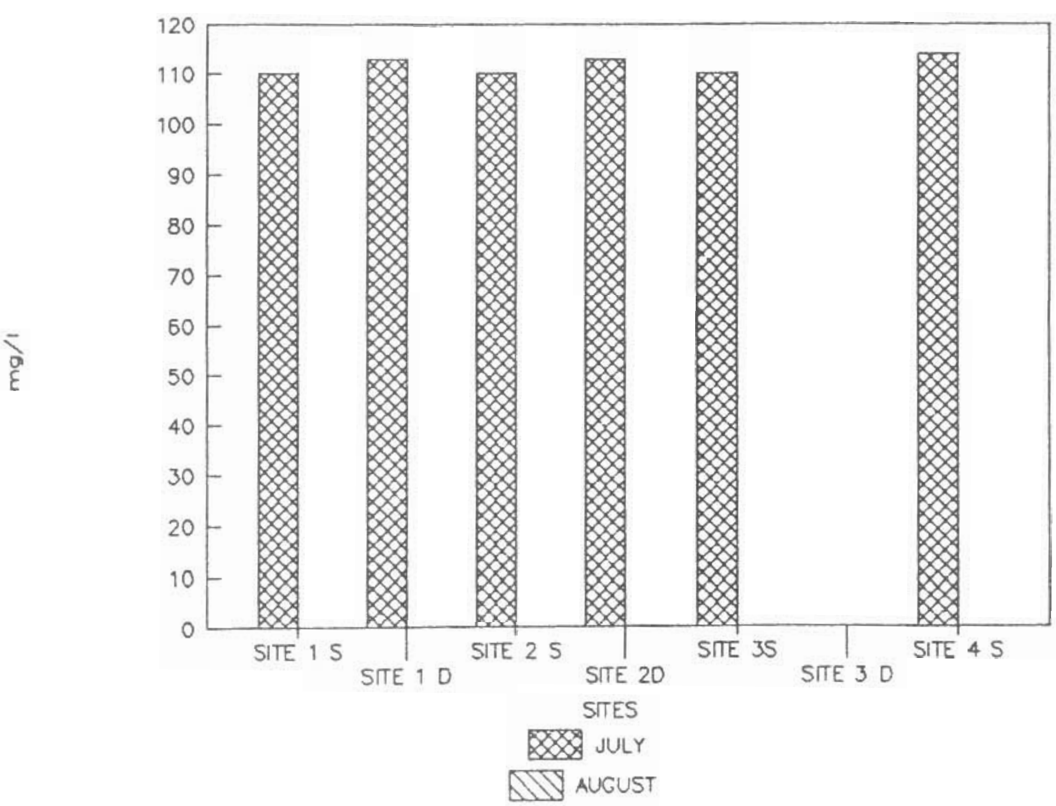

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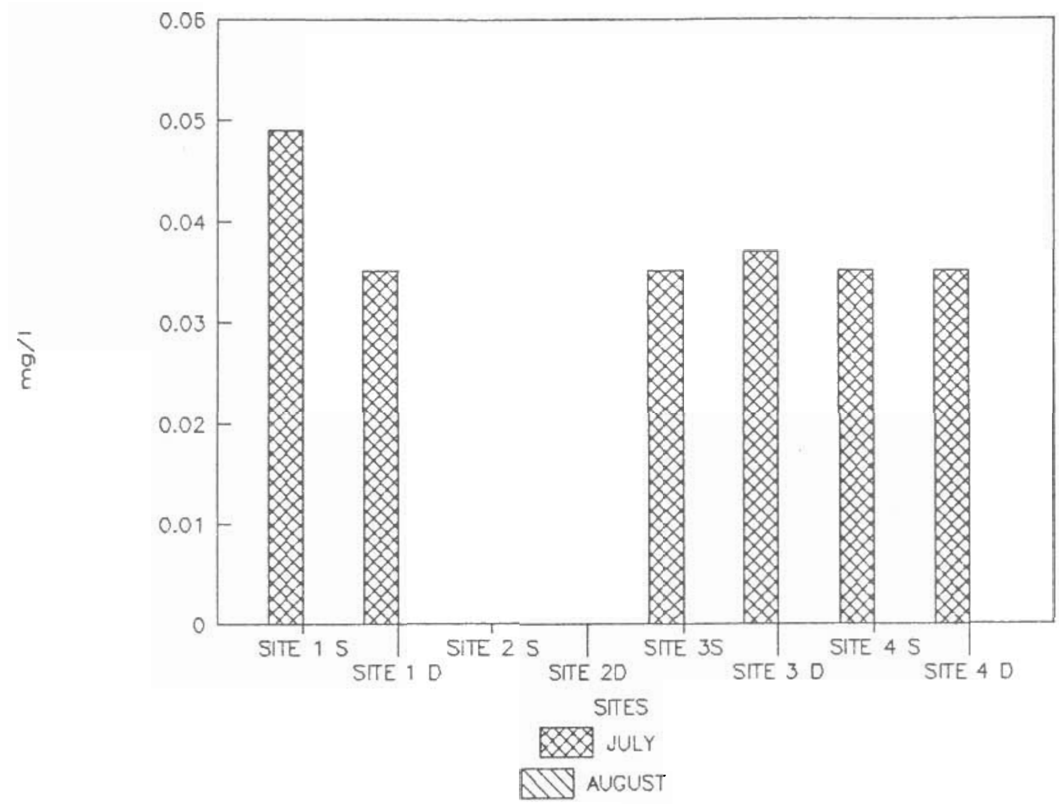

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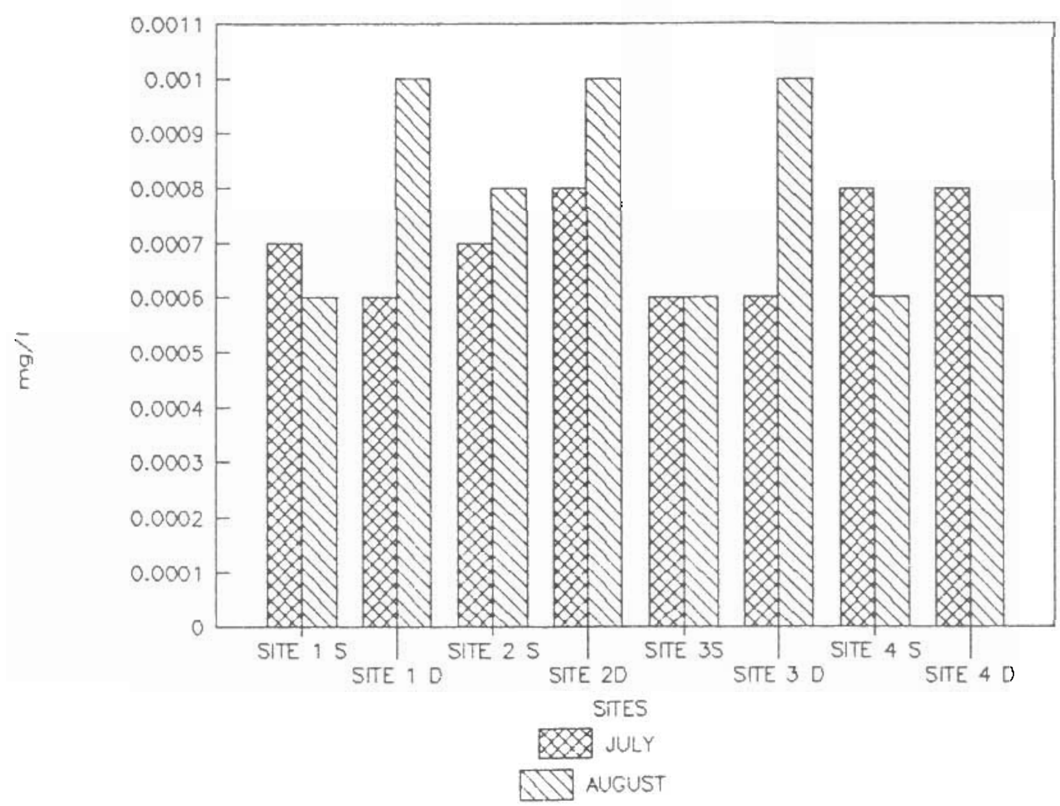

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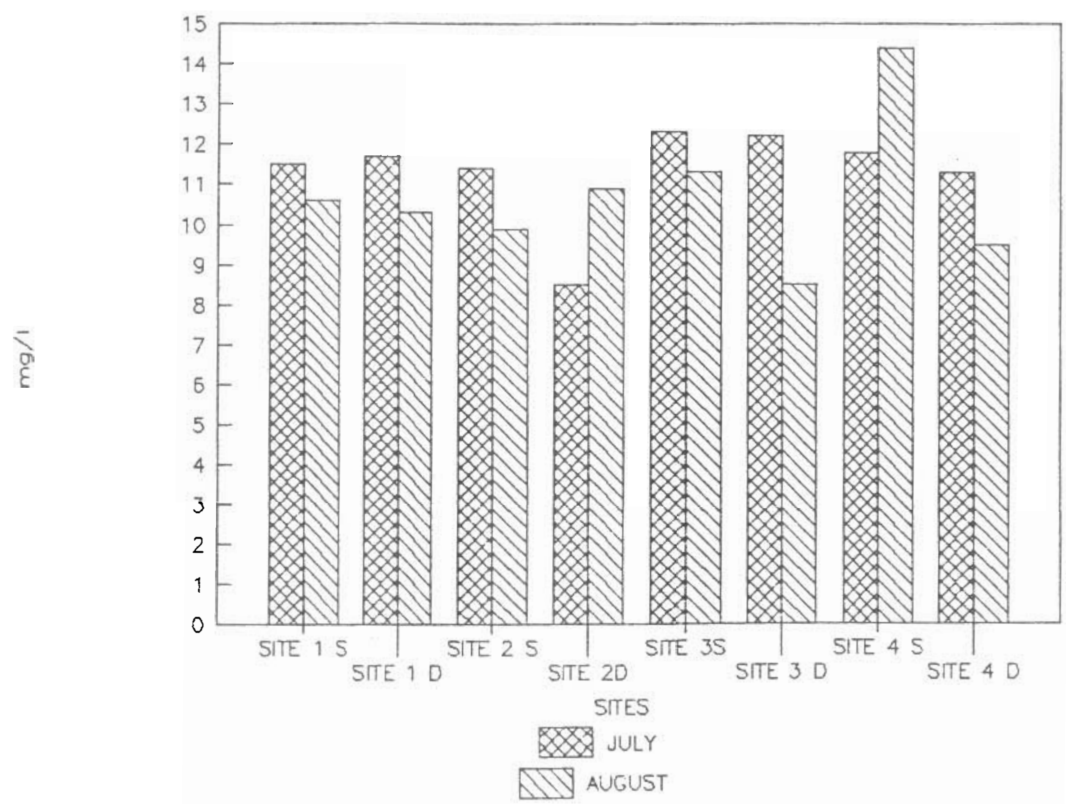

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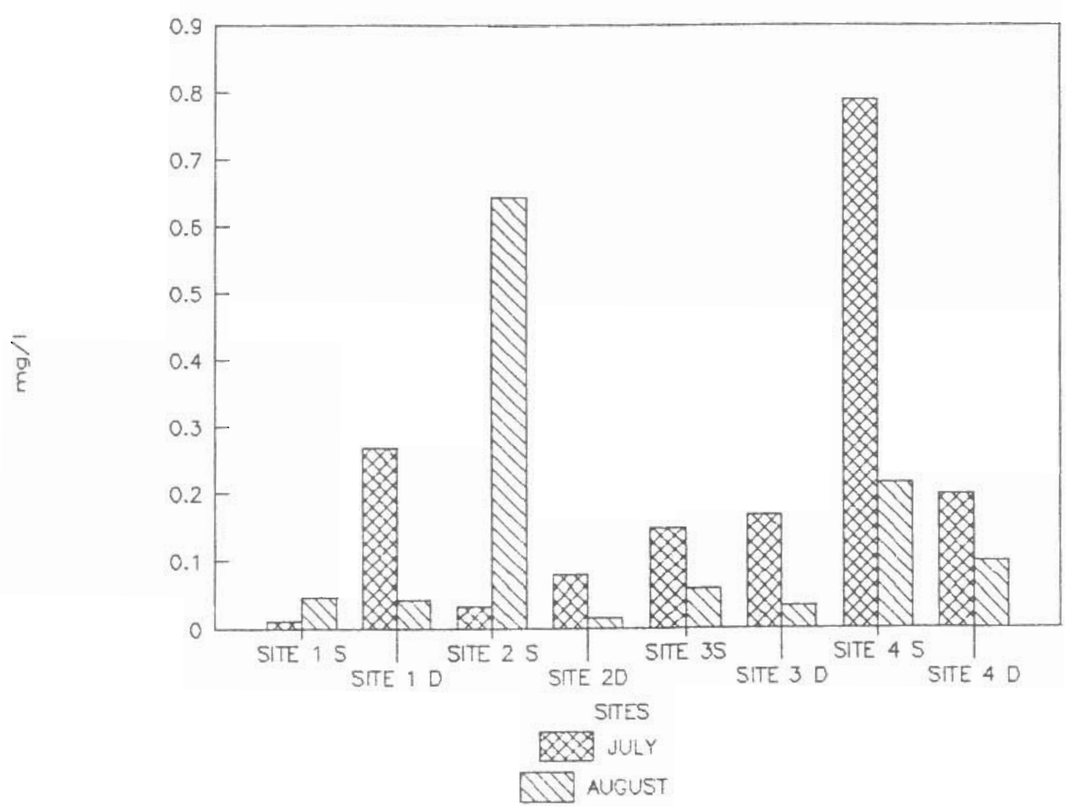

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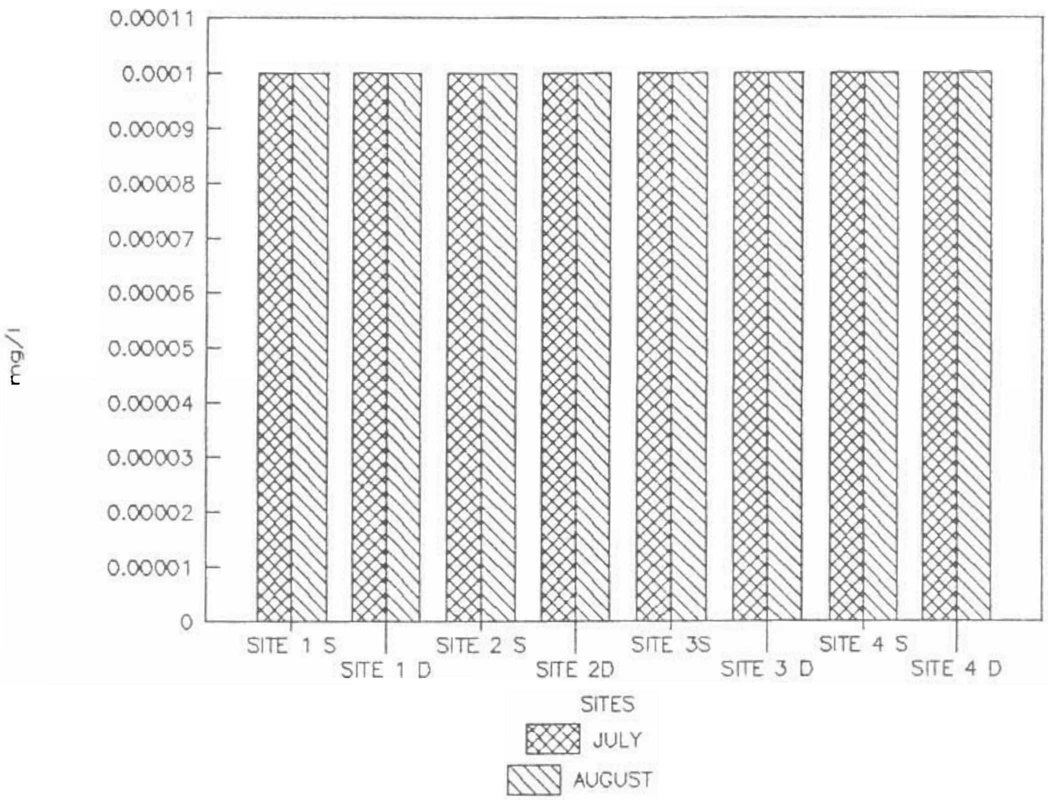

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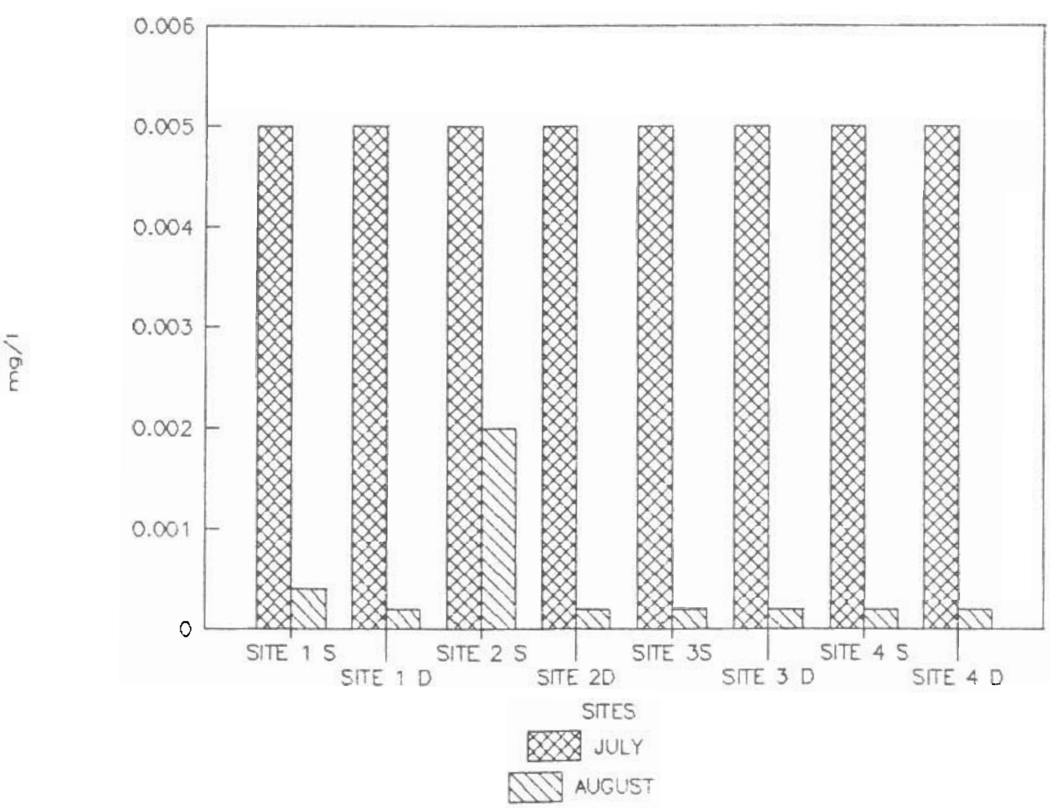

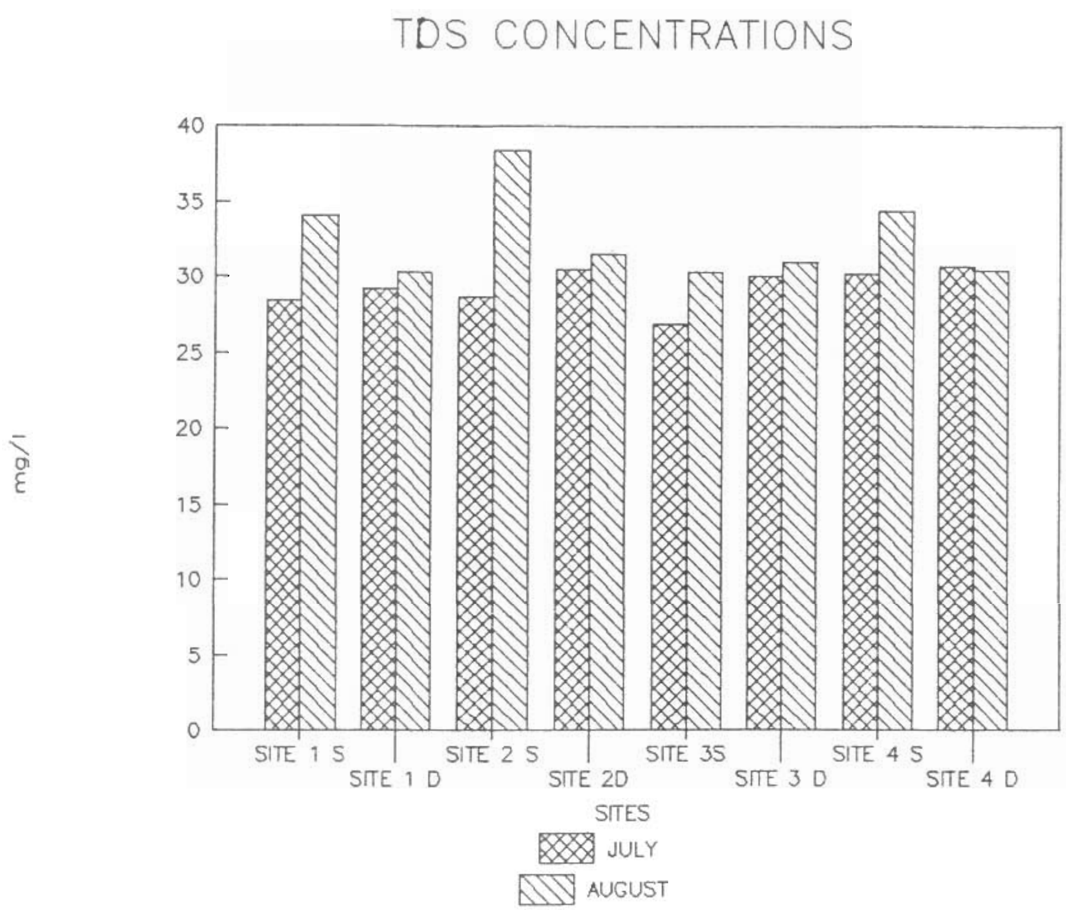

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30
25
20
15
10
5
0
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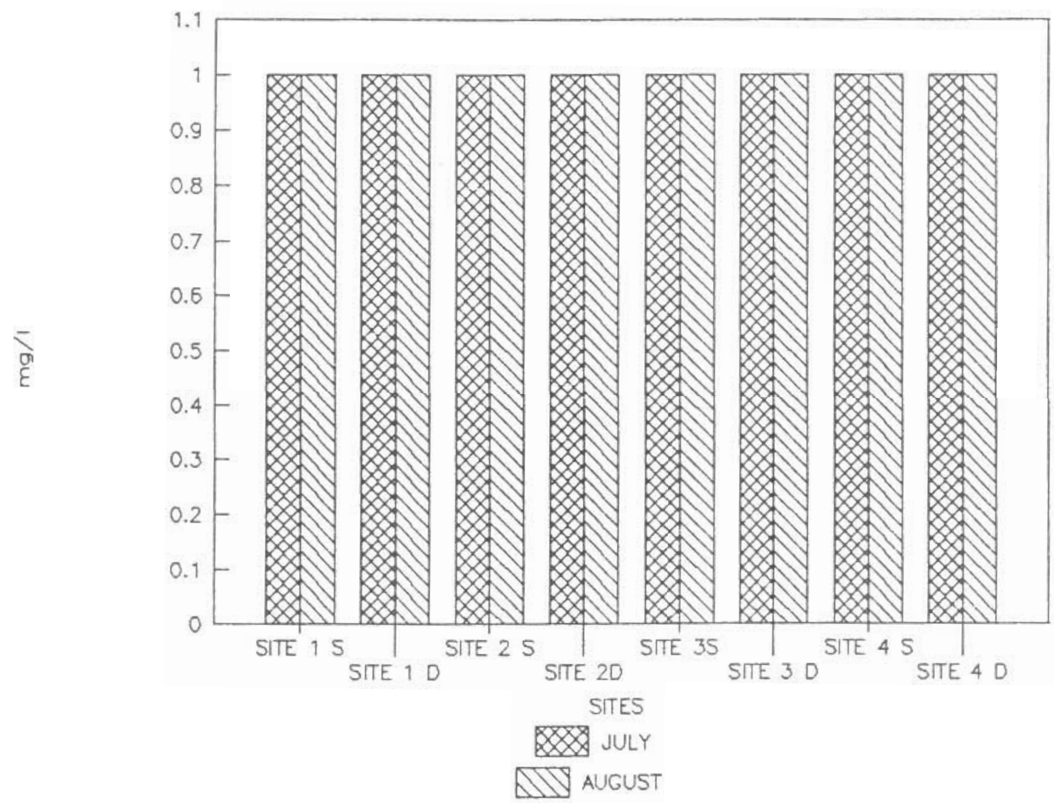
SITE 1 D
SITE 2 S
SITE 2D
SITE 3S
SITE 3 D
SITE 4 S
SITE 4 D
SITES
JULY
AUGUST

TSS CONCENTRATIONS



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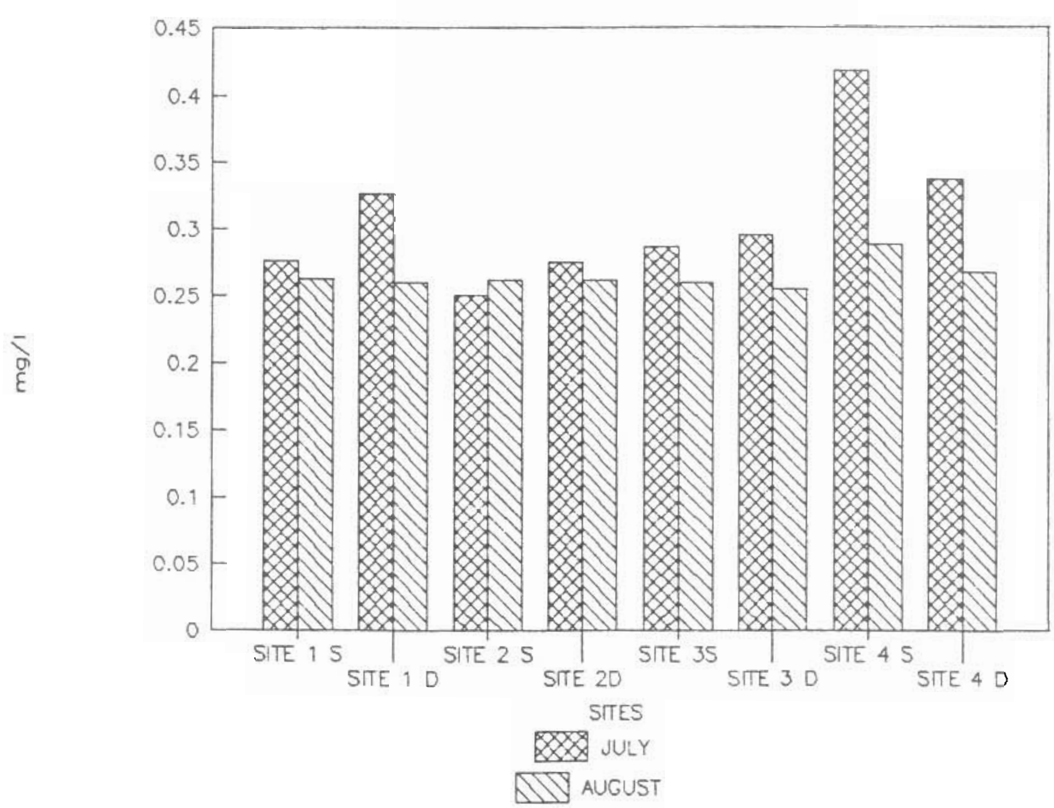

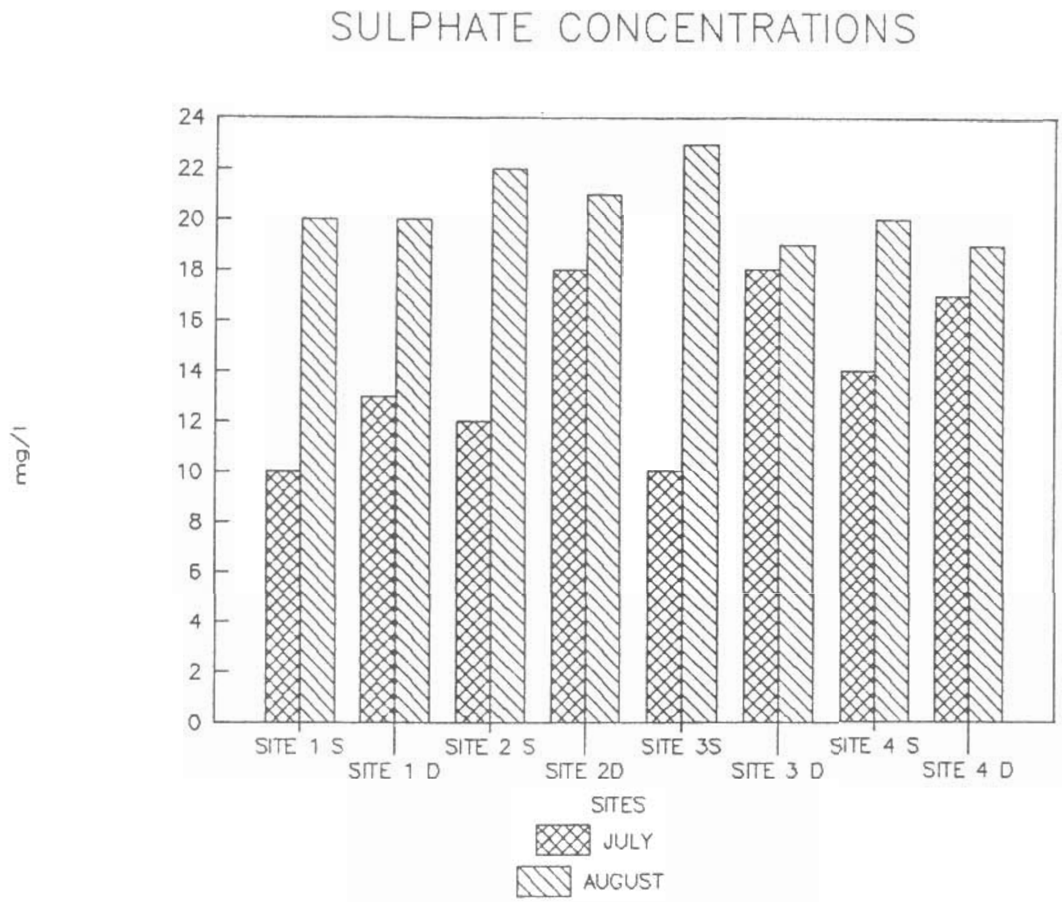
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16
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10
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6
4
2
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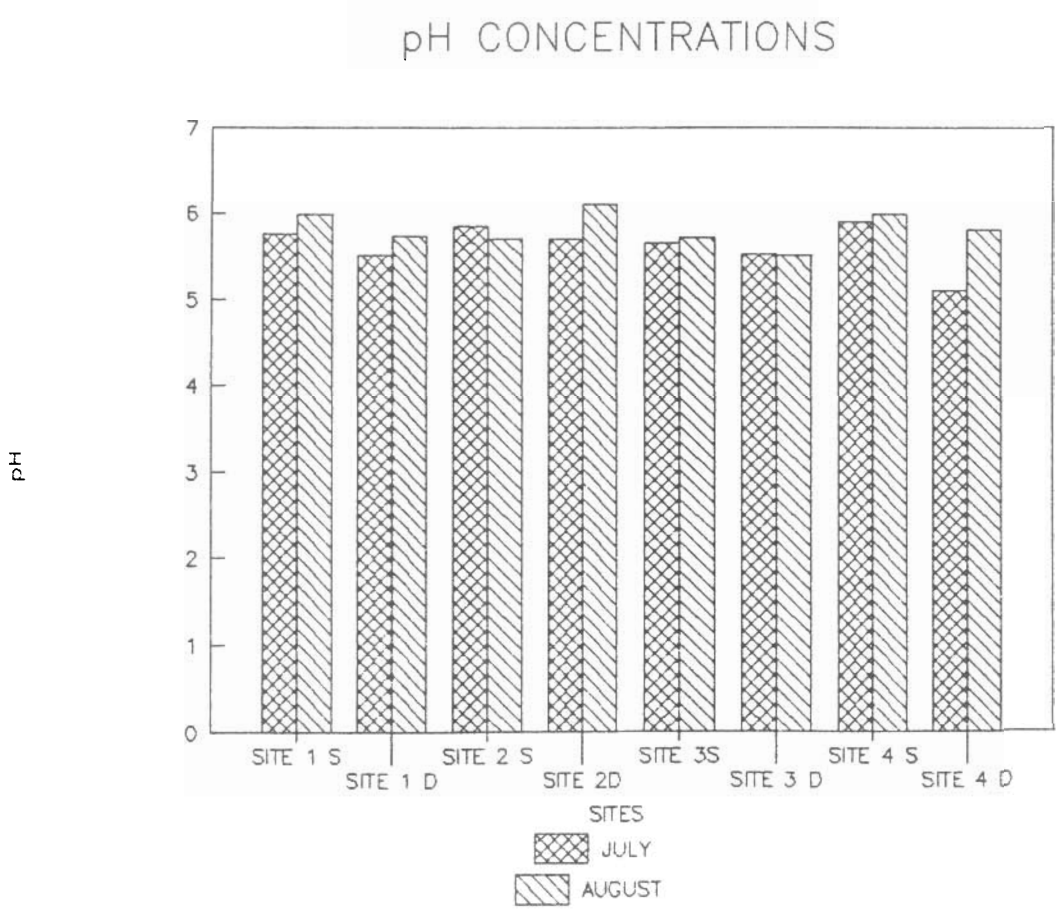
SITES
JULY
AUGUST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SITES
JULY
AUGUST

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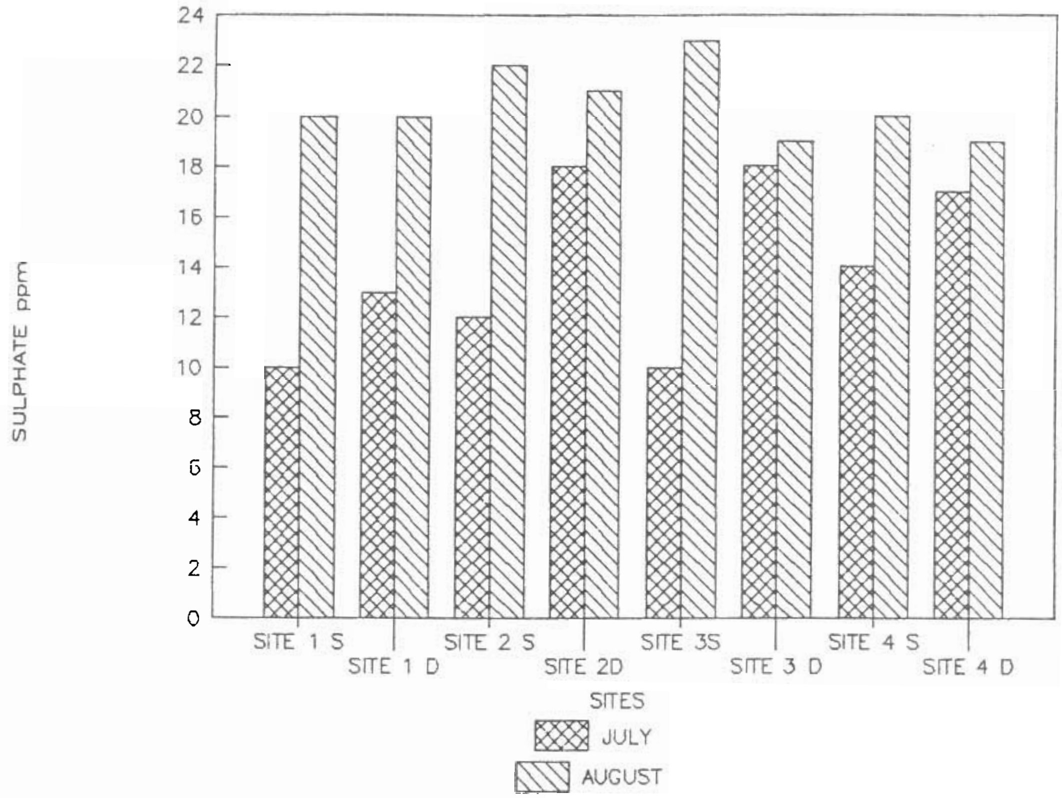

TKN CONCENTRATIONS