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INITIAL ENVIRONMENTAL EVALUATION FOR GIANT YELLOWKNIFE MINES LIMITED SALMITA PROJECT

HATFIELD CONSULTANTS LTD
environmental and pollution management

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Prepared for

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1.0 OVERVIEW SUMMARY

1.1 Objective

This Initial Environmental Evaluation (I.E.E.) has been prepared to provide the government and other interested parties with all of the information available at this time relative to the Giant Yellowknife Mines Limited (Giant) proposed Salmita gold mine project at Matthews Lake, Northwest Territories. The evaluation contains details of the project as it now stands, a summary of existing physical and biological environmental information for the area of the proposed mine site, an analysis of the potential impacts which the project could have on this environment, and the mitigative measures proposed to minimize these impacts. Residual impacts are also discussed. In addition, this document provides a summary of social and economic considerations relative to the project, including practices to be implemented by Giant at the Salmita site.

Based upon this evaluation, Giant wishes to initiate formal discussions with government regulatory agencies, to define specific areas of concerns, as well as to develop short and long-term programs to fill information voids and to evaluate and resolve identified concerns. As Giant wishes to go into production in July, 1983, it is hoped that the detailed information provided in this report will provide an adequate base upon which recommendations for the required licenses and leases can be made. Additional information obtained in the future will be provided to government regulatory agencies.

1.2 Introduction

The history of mining industry interest in the Salmita property goes back to 1939. Giant obtained an option on the property in 1974 and initiated an exploration program in the summer of 1975. Giant's on-site activities have continued at various degrees of effort since that time. A detailed mine-mill feasibility study, completed in October, 1982, indicates that the project is economically viable based on known ore reserves. Giant are proposing to rehabilitate and operate the existing Tundra mill located 5.3 km south of the mine site. The anticipated mill production rate is 159 tonnes per day and the life expectancy of the operation, based on known ore reserves, is 2.5 years. Giant hopes to commence operation of the mine and mill complex in July, 1983.

1.3 The Need

Giant wishes to expand upon their mining and milling activities in the Northwest Territories through the development of the Salmita property. The feasibility study recently completed for this project indicates that despite its small size and short project life, the project is economically feasible and therefore obviously directly advantageous to Giant. Indirect benefits will accrue from the opportunity to carry out further exploration work in the Matthews Lake area. This project will create new employment opportunities for northerners during a period of recession. The project will not only benefit individuals finding work at the site but also the Northwest Territories as a whole.

1.4 Project Description

The principal components of the proposed project are an underground mine located at Salmita and a 159-tonne per day cyanide leach mill located at Tundra. Project support facilities include warehousing, maintenance facilities, engineering and production offices, a laboratory, accommodation and recreational facilities at Salmita and warehousing and maintenance facilities at Tundra. The Taurcanis airstrip has been upgraded such that it can be utilized by a Hercules aircraft. A local road network links the mill, the mine and the airstrip.

The only means of year-round access to the site will be by air. Giant plans to utilize the Echo Bay Mines Ltd., Lupin mine winter road from Yellowknife for transporting supplies to the Salmita site. Construction of a year-round road between Yellowknife and the site is not being considered.

Noting the short production life of the property (i.e. 2.5 years), no permanent town site is planned for the area. A camp will be established that will house a maximum of 80 people. The mine will operate on a rotational (fly in-fly out) basis.

1.5 The Existing Physical and Biological Environment

A considerable amount of information describing the environmental conditions near the Salmita mine site has been generated over the period from 1975 to 1982. The biological and physical environmental descriptions presented in section 4.0 are generally considered to be comprehensive considering the isolated nature of the site. Some data gaps do exist and have been identified.

From 1975 to the present, eight aquatic surveys have contributed to the water quality, limnology and fisheries data base for Matthews Lake, Courageous Lake and the Sandy Lakes. Generally, the water quality results indicate that the lakes contain very low concentrations of nutrients and heavy metals, have a near neutral pH, and are low in alkalinity and hardness. The water quality of these lakes is similar to that of other lakes in the N.W.T. Fish present in the lakes include lake trout, Arctic grayling, humpback whitefish and northern pike. Species composition and density of planktonic and benthic organisms are similar to those of other unpolluted lakes at comparable latitudes.

The Salmita site is situated in the boreal forest-open tundra transition zone and consequently supports a variety of plants and animals that are typical of both regions. Stunted black spruce, willow, birch and an occasional alder form a patchy shrub community, while mosses, lichens and labrador tea dominate the ground cover. Ravens, loons, gulls, ptarmigans and a snowy owl were observed near Salmita, while numerous waterfowl species may nest and stage in small area marshes.

Bathurst herd caribou are the most numerous and conspicuous mammals frequenting the area. Caribou in groups of 1000-2000 have been observed migrating through the area in the fall and small groups have been noted near Salmita during winter months. Barren ground grizzly bear, wolverine, Arctic fox, hare, ground squirrel and wolf have also been observed near the site.

Site specific physical environmental data is sparse. However, in section 4.4, available information with respect to climate, terrain, geology and soils, air quality and land use is presented.

1.6 Impact of the Project

Environmental impacts and mitigative measures are discussed in section 5.0 and residual impacts are discussed in section 6.0. The principal concern associated with any mining project is the disposal of mill tailings. Mill tailings will be discharged to a total retention tailings impoundment area, encompassing Russell Lake in the headwaters area of the Sandy Lakes system. Tailings from the Tundra mine were discharged to this area during the period from 1964-1968. Russell Lake is a shallow lake and freezes to the bottom during winter. It does not appear to support any resident fish populations. Minewater volumes are expected to be very small and this wastewater will be discharged to a marsh adjacent to the mine site. Salmita site domestic sewage will be ground and discharged to a bermed containment area within the marsh. Domestic sewage from the Tundra site will be discharged to the tailings impoundment along with the mill tailings. Implementation of these pollution control practices will ensure that freshwater environmental impacts are minimal.

Potential impacts of the proposed development on vegetation would be caused primarily by surface disturbance. Noting the relative uniformity and expanse of the boreal forest-open tundra transition zone, the small scale of the Salmita development and the mitigative measures that will be implemented to protect vegetation, the project impacts are a minor concern.

The proposed development, especially during the mill rehabilitation stage, may temporarily displace birds breeding close to the sites of activity and cause some mammals to avoid these areas. However, most animals can habituate to disturbances if they are not associated with other harmful stimuli such as hunting. Neither hunting nor the deliberate disturbance of wildlife will be permitted at Salmita.

1.7 Social and Economic Considerations

In full production, the Salmita operation will employ approximately 100 people, 78 of whom will be on site at any one time. A major benefit of the project is the creation of new jobs, many of which will be filled by northerners. The mine is located in an isolated area. As a result, a camp will be developed to house employees; no permanent town site is planned. A rotational work schedule will be formalized. Giant will give preference to the purchase of northern goods and services where price, delivery capability and quality are competitive.

2.0 PROJECT RATIONALE

2.1 Declaration

This Initial Environmental Evaluation (I.E.E.) primarily addresses the potential environmental effects resulting from the development of a gold mine and mill complex and support facilities at Giant Yellowknife Mines Limited (Giant) Salmita mine, located at Matthews Lake in the Northwest Territories. The location is illustrated in Figure 2.1.1. The plant complex includes an underground mine, a mill, a laboratory, maintenance facilities, warehousing space, and engineering and production offices. The facilities also include a residential complex which includes a cookhouse, recreational facility and a bunkhouse. Associated facilities include a gravel airstrip constructed to accommodate a Hercules aircraft, a system of roads linking the airport, mine and mill sites, water supply facilities, and tailings and sewage disposal facilities.

In order to determine the potential environmental effects of the proposed project and the mitigative measures necessary to protect the environment, a substantial amount of effort has been expended in describing in detail the proposed Salmita project (section 3.0) and the local Salmita environment (section 4.0). Project-related environmental issues and mitigative measures are discussed in section 5.0. This document also addresses project residual environmental impacts (section 6.0) and social and economic considerations (section 7.0) relative to the proposed undertaking.

2.1.1 Intent

This document has been prepared for a number of reasons, including the following:

1. to review the amount and quality of environmental data available for the Matthews Lake area in order to determine both the adequacy of the present data base and the necessity for further environmental studies and the environmental protection practices that should be incorporated in the project design;

2. to present a working document for the initiation of discussions with government regulatory agencies with the objective of defining:

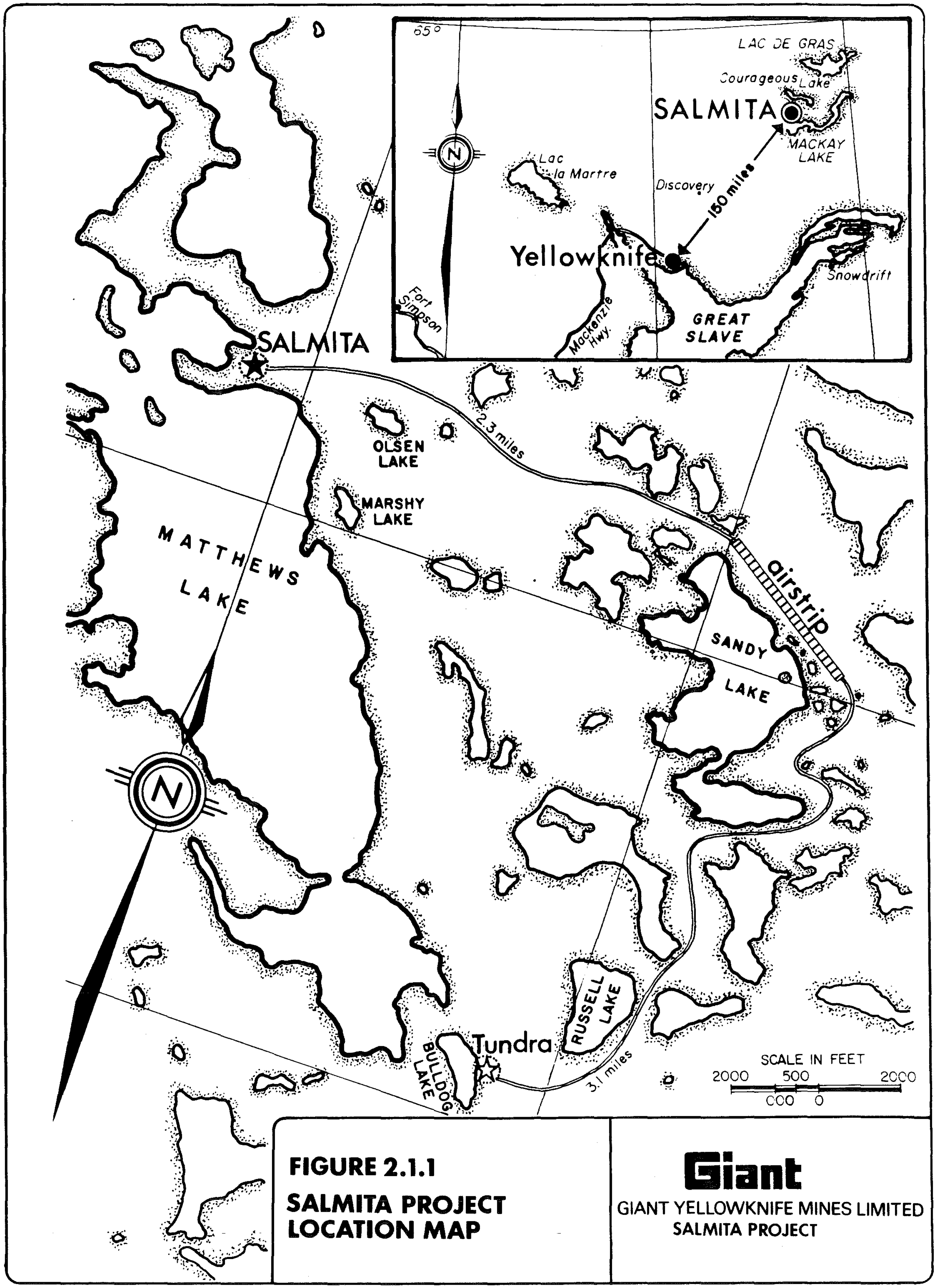

FIGURE 2.1.1
SALMITA PROJECT LOCATION MAP

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SALMITA PROJECT

- specific areas of concern to the regulatory agencies;

- short-term programs to be undertaken in parallel with the construction and the startup phases of the project;

- long-term programs aimed at evaluation and resolution of long-term potential concerns: eg. tailings impoundment and ultimate site reclamation and abandonment plans;

3. as a major step toward obtaining a water license for the proposed project.

2.1.2 Background

Gold was first discovered on the Salmita property in 1939. By 1945, Salermo had staked a total of 18 claims. By 1949, the total number of claims staked had increased to 31. During this period, Salmita Northwest Mines Limited, later changed to Salmita Consolidated Mines Limited, undertook considerable diamond drilling in the area. In 1951, a 44 m deep vertical shaft was sunk with 35 m of cross-cutting. In 1952, a wooden mill building was erected on the site and several pieces of milling equipment were brought in but never installed.

No further major activities appear to have been undertaken at Salmita until 1974. In 1974, Giant obtained an option on the Salmita project and during the summer of 1975, Giant drove a 290 m decline into the orebody for the purpose of exploration. In addition, more than 1500 m of diamond drilling was carried out on the Salmita property.

To accommodate the people working on the exploration and development program, Giant brought in five trailers by winter road from Yellowknife. Access to the site is gained by either float or wheel equipped aircraft. The existing Taurcanis airstrip, located about 4.0 km east of the Salmita mine site, is used all year round as a refuelling point by many companies and private pilots.

2.1.3 Statement on Project Limits

It is the intention of Giant Yellowknife Mines Limited to develop the Salmita orebody to the extent as delineated through the exploration work that has been completed. This would present Giant with the opportunity of developing approximately 140000 tonnes of ore with an average grade of about 28 g gold/tonne, and producing approximately 4.0×10^6 g of gold. With a mill design feed rate of 159 tonnes per day, the life expectancy of the mine is approximately two and one-half years.

It is the intention of Giant to evaluate extensions both to the north and to the south of the currently defined orebody, as well as to the full depth of the orebody in anticipation of being able to develop further ore reserves. More specifically, it is Giant's intent to explore the immediate region around the Salmita and Tundra properties with a view to finding new ore reserves and continuing the operation of the Tundra mill.

2.2 The Need

Giant wishes to expand upon their mining and milling activities in the Northwest Territories through the development of the Salmita property. The feasibility study recently completed for this project indicates that despite its small size and short project life, the project is economically feasible and therefore obviously directly advantageous to Giant. Indirect benefits will accrue from the opportunity to carry out further exploration work in the Matthews Lake area. This project will create new employment opportunities for northerners during a period of recession. The project will not only benefit individuals finding work at the site but also the Northwest Territories as a whole.

2.3 Alternatives

Basically, five project alternatives are available to Giant. These alternative are addressed below:

1. do nothing; the consequences of such lack of action are not beneficial to the company or the Northwest Territories as a whole;

2. construct a totally new mill at the Salmita mine site;

3. rehabilitate and reactivate the Tundra mill located 5.3 km south of the Salmita mine site and air freight the precipitate to Giant's refinery in Yellowknife;

4. construct a small pre-concentration plant on site and truck the concentrate to Yellowknife;

5. in conjunction with either a Salmita or Tundra mill, construct a refinery on site.

As discussed in subsequent sections of this report, alternative 3. was selected as the most desirable approach, based upon environmental, economic and technical criteria.

2.4 Associated Projects

As indicated in section 2.1.3, Giant intends to pursue exploration of claims in the area of the Salmita property with a view to expanding the ore reserves and thus the operating life of the project.

3.0 PROJECT DESCRIPTION

3.1 Development Concept

Gold was first discovered in the Salmita area in 1939 by Territories Exploration Ltd. In 1945, the Salerno claims were staked and prospected and the "B" showings were first drilled in 1946. On a small scale basis, underground development, including the sinking of a 44 m vertical shaft, took place during 1951 and 1952. Virtually no work was performed on the property between 1953 and 1974. Giant Yellowknife Mines Limited optioned the property in 1974 from Bluebell Enterprises Ltd. (who had the rights to the now 31 claims) and in 1975-1976, conducted comprehensive diamond drilling, airborne geophysics and underground development programs.

For various reasons, the property was shelved until a feasibility study conducted in 1981 indicated that the property could be put to a profitable account. However, this study recommended that prior to proceeding to full production, a substantial underground exploration and development program was necessary in order to confirm the tonnages and grades of ore present. The updated data obtained from this underground program has subsequently been used as the basis of a further feasibility study, completed in October, 1982, that indicates that a positive production decision is possible pending the granting of the necessary licenses and leases and the successful outcome of a number of relatively minor investigations.

A proposed development and production schedule is presented in Figure 3.1.1. This schedule indicates a probable mine and mill startup date early in the third quarter of 1983. The estimated life of the mine based on presently known ore reserves is approximately two and one-half years.

Based upon economic and environmental considerations, Giant are proposing to rehabilitate and reactivate the old Tundra Mines Ltd. ore processing plant located approximately 5.3 km south of Salmita. Ore would be trucked from the mine site to Tundra. The proposed tailings disposal area incorporates Russell Lake and has an estimated capacity that will, with limited dyke construction, completely contain the total production of mill tailings (i.e. the liquid and solids components) during 2.5 years of operation. Should the discovery of additional ore reserves prolong the life of the mine, the tailings dam height could

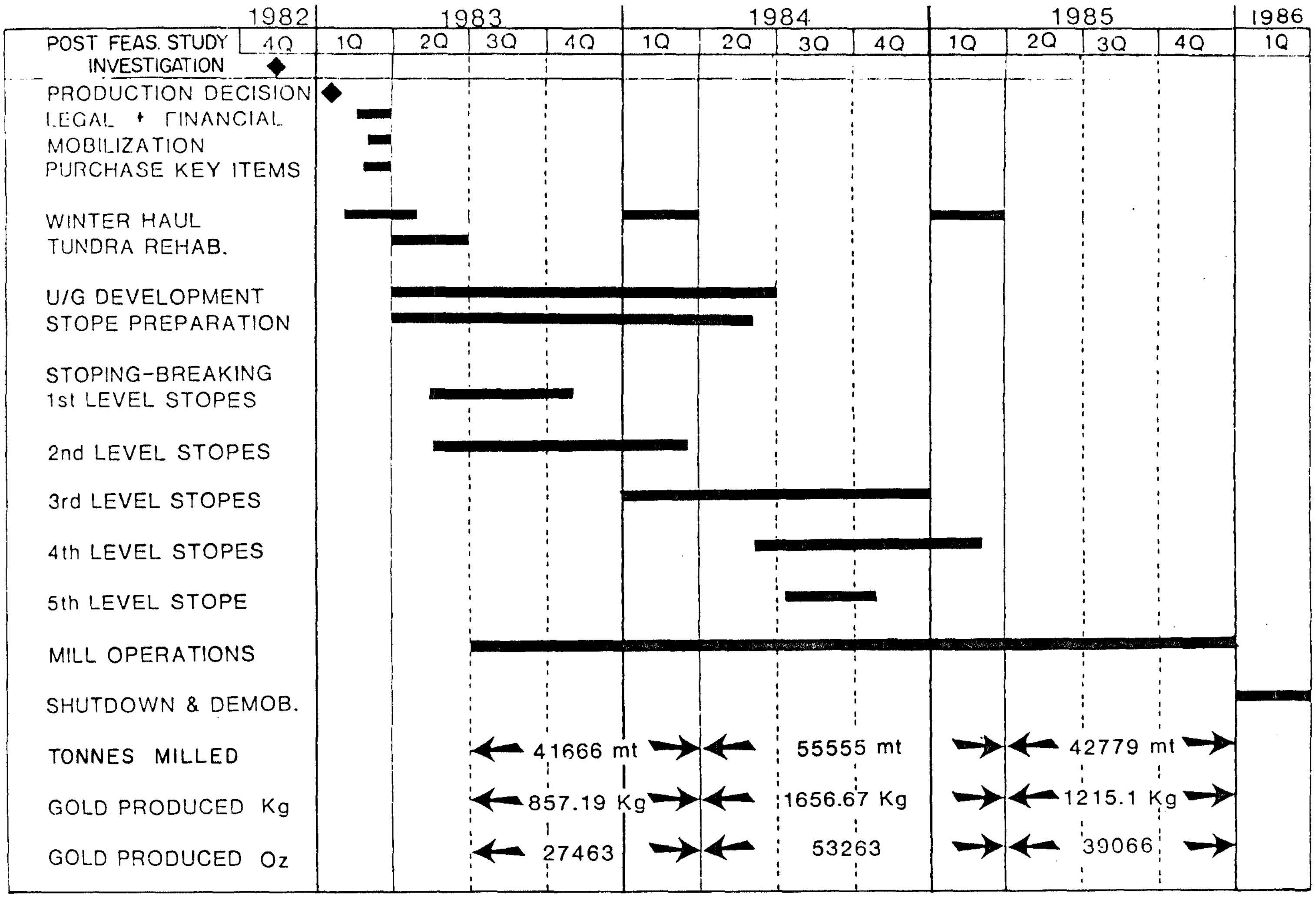

FIGURE 3.1.1
SALMITA PROJECT SCHEDULE

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be increased and the same tailings disposal area utilized for an additional 2.5 years. It is important to note the Giant plan to operate the tailings impoundment area in such a way that there will not be a tailings pond supernatant discharge to the environment.

The proposed site layouts for both Salmita and Tundra are shown in Figures 3.1.2 and 3.1.3.

3.2 Geology and Ore Reserves

The Matthews Lake area was mapped by Geological Survey of Canada in the late 1940's (Folinsbee 1949; Folinsbee and Moore 1950; Moore 1956). Banfield (1950) mapped the Salmita property while consulting for Salmita Consolidated Mining Ltd.

The eastern half of the property is underlain by sedimentary rocks, predominantly greywacke with slatey interbeds. These rocks contain the Olsen and Southeast showings, which are presently believed to be zones of brecciated greywacke in which later quartz veins have been emplaced. The western portion of the property is underlain by interbedded dacitic and more basic volcanics, slates and sericitic schists derived from the dacites. The dacites are well-laminated and, when schisted, show a good light and dark colour lamination. The more basic volcanic unit has been termed "brown/green volcanics" based on the drill logs and sections. This unit is persistent in the "B" showing, on the hanging wall of the "B" vein.

The slates are very fine-grained, sheared, fissile black rocks, and quite graphitic in places. They contain pods, veinlets and disseminations of pyrite and pyrrhotite.

On the Salmita property, the rocks form a homoclinal succession with youngest units to the east. The average strike is N20°W and dips are steep to the east. Late faults are common, usually in the slatey units and are approximately parallel to the regional strike.

The gold mineralization is confined to "late quartz veins." The quartz is white to grey, massive and clean with sparse metallic mineralization. Carbonate is common but a minor constituent. Common sulphides are pyrite and arsenopyrite. Where gold is seen, it is usually only just visible as individual grains or fine smears on fracture surfaces. The only other mineral of note is scheelite. Fragments of wall rock are often rafted within the quartz vein.

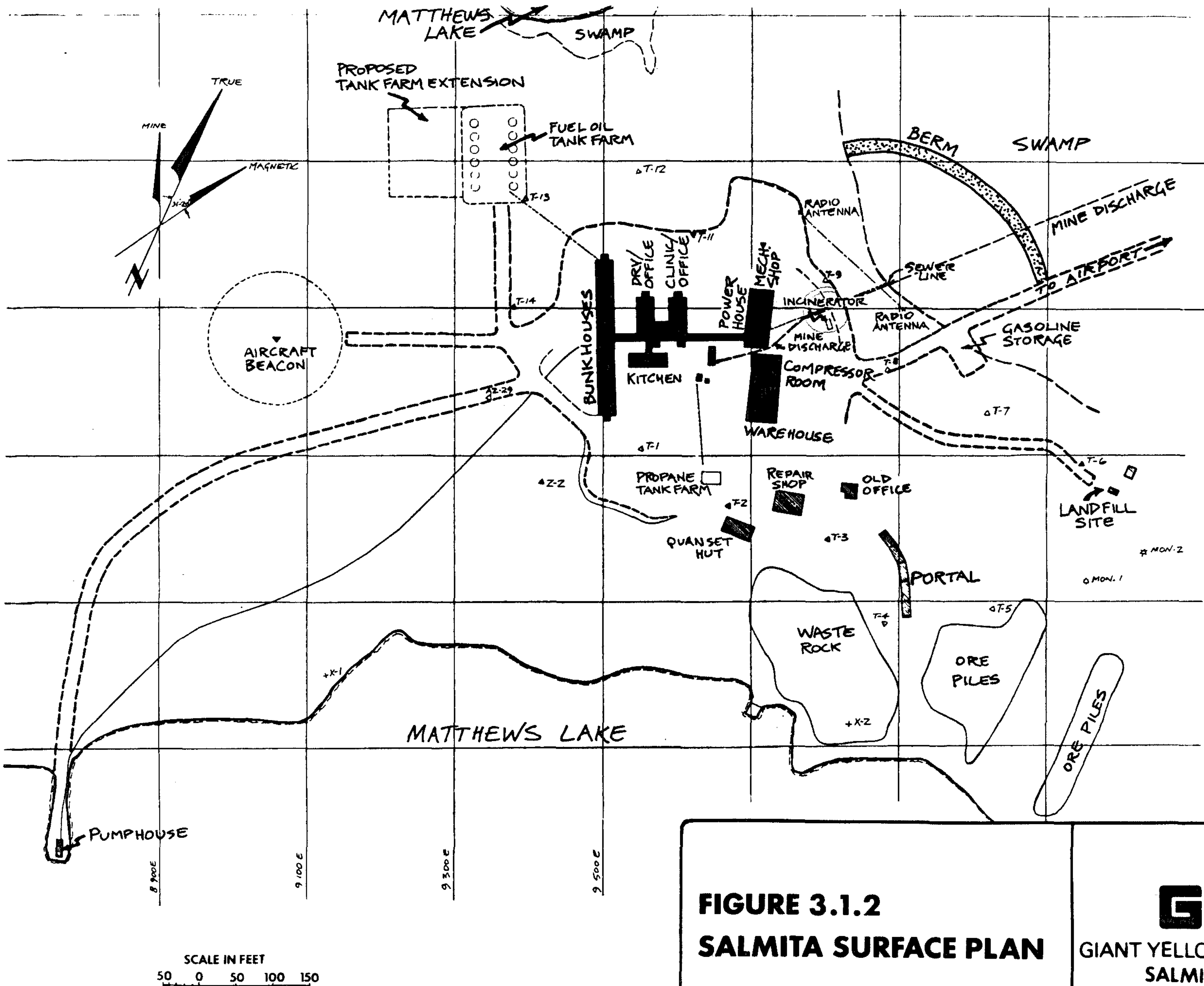

FIGURE 3.1.2
SALMITA SURFACE PLAN

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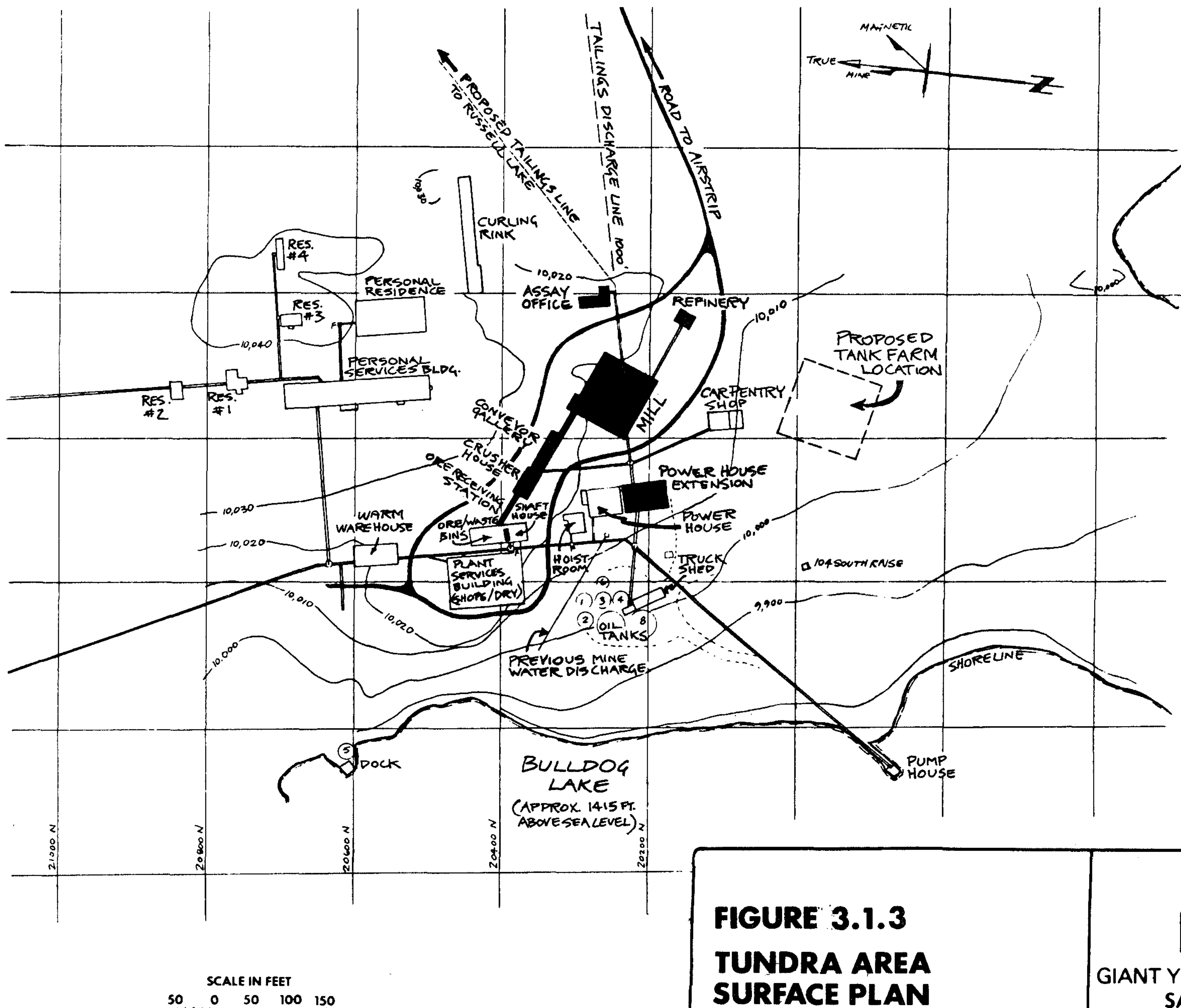

FIGURE 3.1.3

TUNDRA AREA SURFACE PLAN

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Microscopic examination of drill core sample rejects identified galena and chalcopyrite. In hand specimen, the gold is fine grained and a light yellow colour. It occurs as a dissemination throughout the quartz (Buchan 1975).

Structurally, the mineralization is contained in three shoots, the south shoot and the main shoot, separated by a major Salmita shear zone, and the north shoot, which is separated from the main shoot by a low grade zone associated with structural complexity (Figure 3.2.1).

Ore reserves have been calculated using the following main parameters:

1. minimum mineable stope width of 1.52 m;

2. block cut-off grade of 7 g/tonne gold (0.2 oz/ton);

3. for mining purposes, a 30% dilution factor has been introduced, the dilution tonnage being calculated at 0.349 g/tonne grade (0.01 oz/ton).

In-Situ Ore Reserves (no dilution)	110,500 tonnes at 35.83 g/tonne gold (121,800 tons at 1.046 oz/ton gold)
Mineable Ore Reserves	140,000 tonnes at 28.02 g/tonne gold (154,350 tons at 0.817 oz/ton gold)

3.3 The Mine

3.3.1 Mine Development Plan

3.3.1.1 Decline

A 3.7 m wide by 3.1 m high decline had previously been driven in the country rock for a total length of 710 m to a vertical depth of 94 m. The first 119 m of decline from surface had been driven at -15%, and the remainder at -13%. This decline has served as access to two levels of lateral development of the vein and to diamond drill stations. During future proposed development, the decline will be extended for a further 1052 m at the same dimensions and a grade of -13% to a vertical depth of 225 m. The decline will serve as access to stope development and for hauling of ore and waste rock to the surface.

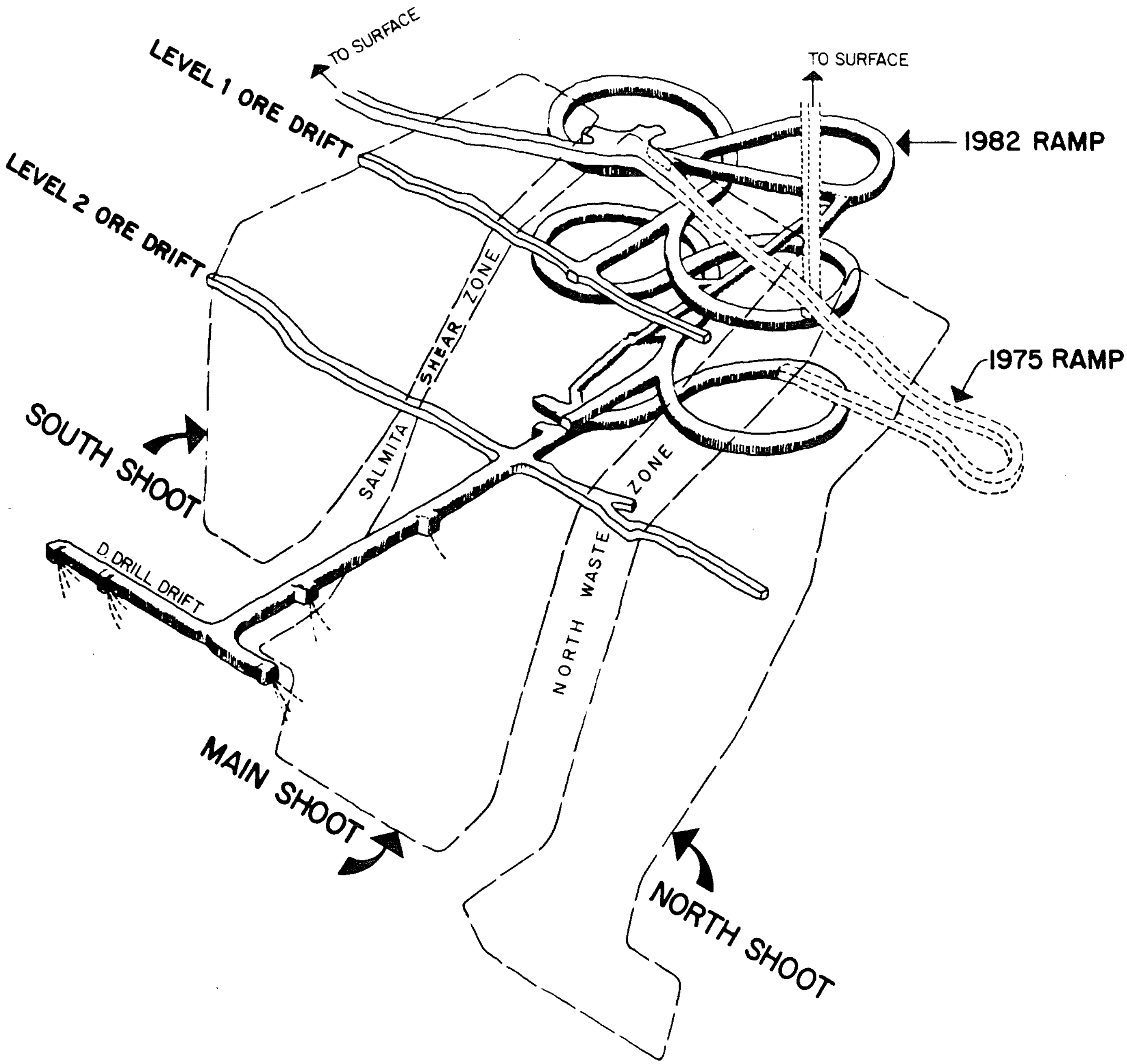

FIGURE 3.2.1
SALMITA PROJECT
UNDERGROUND DEVELOPMENT
ISOMETRIC DIAGRAM

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3.3.1.2 Mine Development Prior to Production

It is planned to utilize the shrinkage stope method for production. Level development will consist of drifting along the vein and driving a parallel extraction drift, with drawpoint cross-cuts between the two, spaced 8 m apart.

Prior to production, development work will be completed on six stopes above the second level, comprising extraction drifts and drawpoints on the two levels and service raises driven within the vein for each stope. This development will proceed on a three shifts per day basis, seven days per week during the pre-production period and is scheduled to take four and one-half months. Five men will be on each shift during lateral and raise development. The estimated daily advance rates are 9.5 m per day lateral and 3.0 m per day per raising.

The first level is located at 50 m and the second level is 95 m below the surface.

3.3.1.3 Ongoing Development

Upon completion of lateral development down to the second level, development of the decline down to the third (150 m), fourth (208 m), and fifth (225 m) levels will continue. The greatest level interval will be 58 m. After each 30 m of vertical descent, a ventilation raise will be driven at 50° to link up with the existing ventilation system. This system will also serve as an emergency exit route from the mine. Work will be carried out on a two shift per day basis with four or five men working per shift.

3.3.1.4 Development for Increased Depth

Recent drilling has indicated ore reserves to a depth of 225 m. This depth may be increased based upon the results of future diamond drilling from the lower production levels. If ore is found below the 225 m level, future production feasibility studies will be carried out to consider various development and production alternatives.

3.3.2 Mining Plan

Diamond drilling and previous development activities have delineated the "B" vein to a depth of 225 m. The vein appears to be segregated into three distinct shoots, the south, the main and the north shoots, by a shear zone cutting obliquely through the vein between the south and main shoots and by a waste zone between the main and north shoots. Development work to date has indicated mainly stable ground conditions, probably due in part to the frozen condition of the ground. Thermometer readings down boreholes indicate an average ambient rock temperature of -2.5°C above the 95 m level. Information from the nearby Tundra mine indicates that the permafrost may persist to a depth of 275 m, although some ground water has been encountered in a diamond drill hole at Salmita at a depth of 180 m.

Although the vein has a consistent general strike trend, its narrow width and slightly meandering course preclude lower cost, long hole, open stope mining methods. The average width of the vein is 1.69 m and the dip is between 80 and 85 degrees. Mining will probably take place under the following conditions:

1. The shrinkage stope mining method will be used. Extraction drifts will be driven on each level parallel to the vein drifts to permit mechanized loading of diesel trucks for haulage to the surface.

2. A 15 m crown pillar will be left between the first level stopes and the surface along the approximately 125 m strike length.

3. At least the top three levels will be dry due to permafrost and it is not anticipated that any ground water will be discharged from workings within this part of the mine.

4. A recirculating brine solution will be used for drill hole flushing when in permafrost conditions.

3.3.3 Underground Facilities

3.3.3.1 Ore and Waste Transportation

During all phases of mine development and production as currently designed, all ore and waste rock will be picked up by 1.5 cubic metre diesel-powered L.H.D. units and loaded into 12 tonne diesel-powered trucks for haulage to the surface via the decline. The ore will be stockpiled on the surface outside the decline portal prior to transportation by surface haulage trucks to the mill. The productivity of an L.H.D.-truck combination is calculated at 3640 tonnes per week from the first two levels, 2380 tonnes per week from the third level, and 1820 tonnes per week from the fourth and fifth levels.

3.3.3.2 Ore and Waste Rock Stockpiles on the Surface

In view of analytical results from 12 samples (Lakefield Research Lab, 1982; Giant Mill Lab, 1982) demonstrating that neither the ore nor waste rock are potentially acid-producing, the ore and waste rock brought to the surface will be stockpiled within designated areas outside the mine portal as shown in Figure 3.1.2. A very limited amount of the waste rock will be spread out in various locations around the camp to provide additional storage and yard areas.

3.3.3.3 Materials Transportation

All materials to be used in the mine will be shipped either to underground storage areas or directly to the working areas by diesel vehicles via the decline.

3.3.3.4 Explosives Storage

Underground powder magazines will be established with a total licensed capacity of 15000 kg. An underground fuse magazine will also be established.

3.3.3.5 Maintenance Garage

An underground maintenance garage for servicing underground vehicles and equipment will be established on the 95 m level, having a total floor area of approximately 150 sq. m.

3.3.3.6 Mine Drainage and Pumping

No significant inflows of ground water are anticipated above the 150 m level. Brine solution used for drilling in permafrost will be recirculated through various underground sumps back to the working areas for reuse. Inflows of water from the surface thaw zone during the summer will be collected in sumps located just below the surface and pumped back to the surface. In deeper areas of the mine, attempts will be made to isolate ground water inflows and pump these waters to the surface to avoid mixing with the brine drilling solution.

3.3.3.7 Mine Ventilation

The present ventilation infrastructure extends down to the 95 m level and consists of four feeder cross-cuts to a connecting series of 1.8 m by 1.8 m ventilation raises and also includes a shaft sunk in 1951. During future deepening of the mine, this system will be extended with ventilation across cross-cuts and raises being established at 30 m vertical intervals. Fifteen H.P. electric fans at each ventilation cross-cut will distribute air to the working areas and a 60 H.P. electric fan will supply air through 76 cm ducting to the decline development face.

A propane-fired makeup air unit capable of delivering 60000 cfm will be installed on the surface to provide primary ventilation. The air volume requirements, itemized in Table 3.3.1, are based solely on 100 cfm per horsepower of diesel equipment used underground.

Table 3.3.1. Anticipated air volume requirements.

Description	H.P.	Quantity	Total H.P.	CFM
12 T truck	130	2	260	26,000
1.7 cu. m L.H.D.	100	3	300	30,000
Jumbo Drill	36	1	36	3,600
Grader	36	1	36	3,600
TOTALS		7	557	63,200

3.3.3.8 Communications

A telephone system will be installed underground and on the surface to facilitate meeting requirements for supplies and safety. Phone links on the surface will be located in the mine office and in the maintenance shop.

3.4 The Process Plant

3.4.1 Background

Metallurgical testwork carried out in 1975 and 1982 indicates that the Salmita ore is free-milling and will yield overall gold recoveries of 95% when treated in a conventional cyanide leach precipitation circuit. Several alternatives, such as gravity separation, flotation concentration followed by leaching sulphide concentrates at Giant operations, and the use of a portable cyanidation mill, have been examined and rejected because of either poor technical or economic performance. The recovery of by-product tungsten is not technically feasible from Salmita ores with known data. As a result, the Tundra mill, powerhouse and water supply will be rehabilitated to treat Salmita ores.

3.4.2 Mill Flowsheet

A somewhat simplified Salmita mill flowsheet is presented in Figure 3.4.1. In Figure 3.4.2, a solids-liquids material balance is presented. Run of the mine ore would be trucked to the mill site, dumped into the receiving hopper and forwarded to the conveyor belt leading to the crushing plant. The ore is first screened on a 5.0 cm screen, followed by crushing the oversize in a jaw crusher to a nominal minus 5.0 cm size. The jaw crusher discharge, further reduced in size in a cone crusher operated in closed circuit with a screen to produce a fine ore of nominal minus 1 cm, is forwarded to the fine ore bin with a capacity of approximately 270-tonnes. Under normal conditions, crushing will be done during day shifts only. Fine ore from the bin is withdrawn and fed to the grinding circuit consisting of two ball mills operated in series. The first ball mill is operated in open circuit, while the second stage is operated in closed circuit with a cyclone to produce a grind of about 70% minus 200 mesh for cyanidation. Grinding circuit solutions will be recycled barren or mill solutions.

The cyclone overflow from the grinding circuit is fed to the thickener. The thickened pulp (55% solids) is forwarded to the cyanidation tanks equipped with airlift agitators. The cyanide and lime content is adjusted to appropriate concentrations before being added to the tank. The thickener overflow is forwarded to the pregnant solution storage tank.

The pulp leaving the last cyanidation tank is filtered in two stages on drum filters. The first stage filter will use barren solution for washing. The cake discharge from the first filter is repulped in barren solution, filtered and washed with barren solution or water on the second stage. The washed filter cake is discharged to the tailings area. The filtrates from both filters are forwarded to the pregnant solution tank.

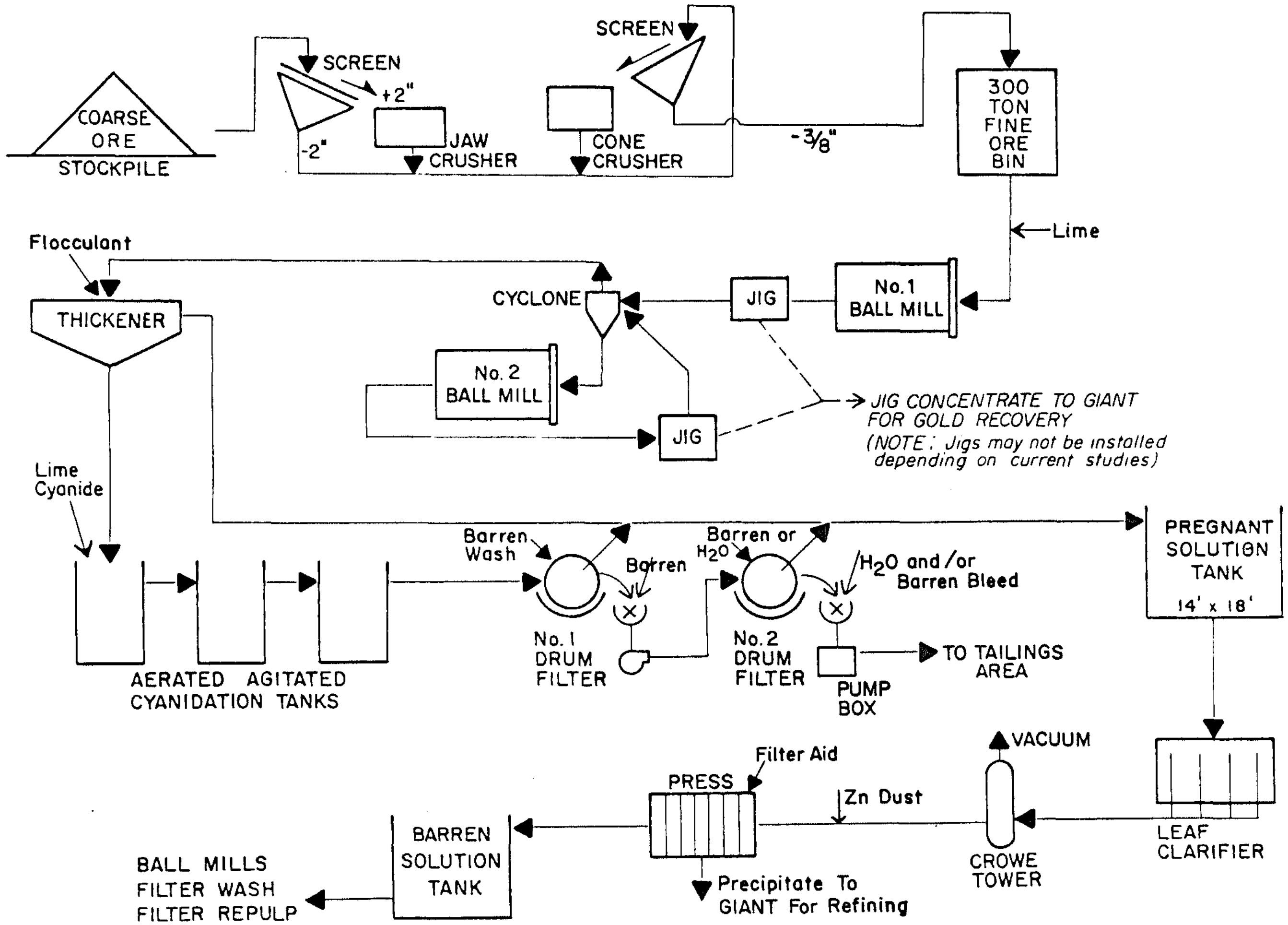

FIGURE 3.4.1
SIMPLIFIED SALMITA MILL FLOWSHEET

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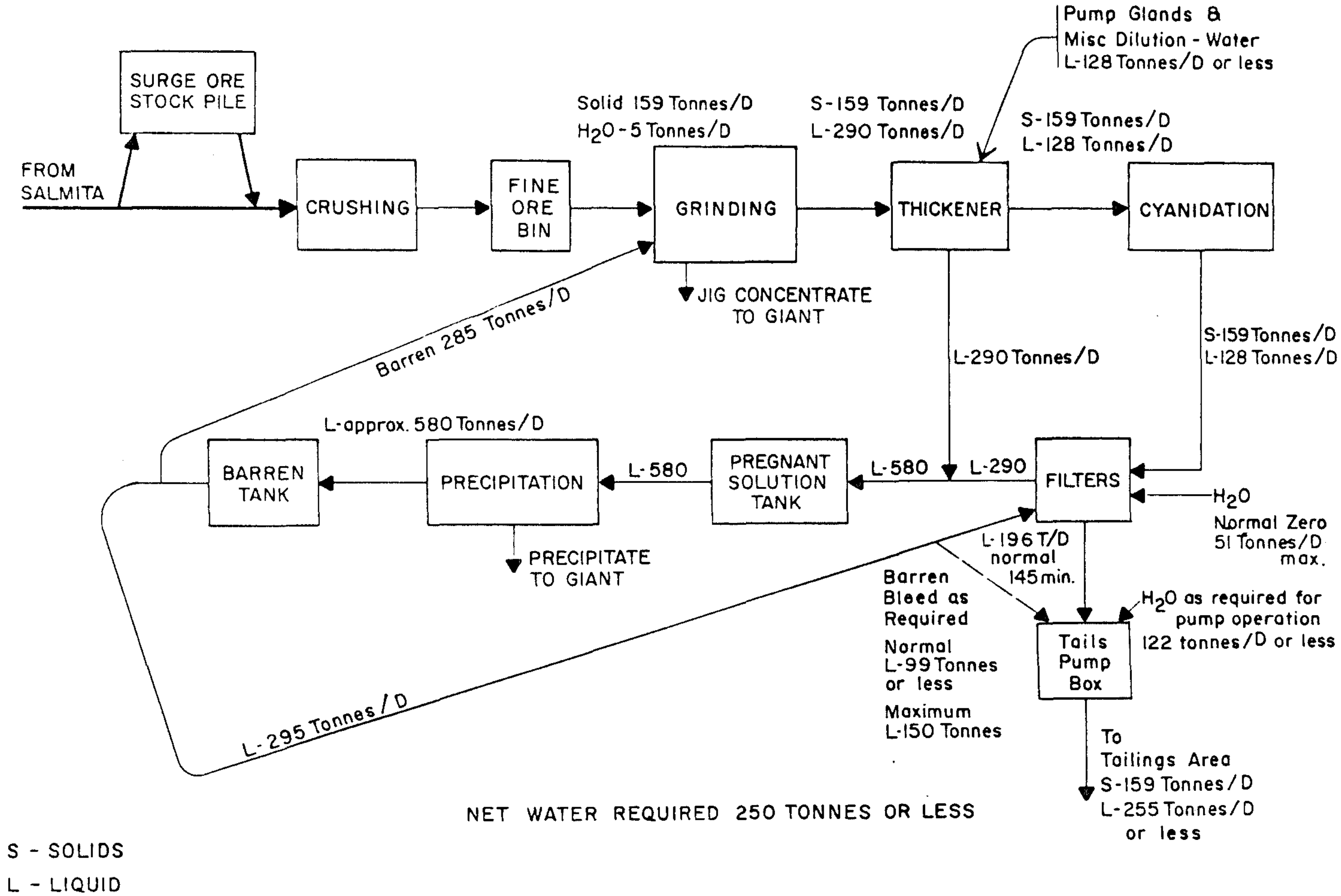

FIGURE 3.4.2

MILL MATERIAL BALANCE

Giant

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SALMITA PROJECT

The pregnant solution is clarified in a leaf clarifier and then subjected to the standard Merrill Crowe zinc precipitation. The precipitate is filtered in a filter press, packaged in drums and air shipped to Giant's operation at Yellowknife for refining. The barren solution is pumped to the barren solution storage tank and distributed for reuse at various points in the plant.

3.4.3 Crushing

The coarse ore is trucked from Salmita to Tundra. A new truck dump receiving hopper and conveyor to feed the ore into the existing crusher house is to be constructed. The original Tundra jaw crusher is no longer on site, therefore, another jaw crusher of similar or larger size must be installed. The cone crusher also is no longer on site. A replacement crusher of the same type and size must be installed. The final crusher product will be minus 1 cm material.

3.4.4. Fine Ore Storage

The original Tundra fine ore bin of 270 tonnes capacity has ample surge storage for current needs. The ore will be withdrawn at a controlled rate to the grinding area.

3.4.5 Grinding

All grinding will take place in cyanide solutions. The grinding circuit consists of two 1.5 m by 2.4 m ball mills. The primary mill with a 100 H.P. motor is operated in open circuit with the discharge going to the cyclone feed box. The secondary mill is a high discharge type with a 75 H.P. motor. It receives the underflow from the cyclone classifier as feed and discharges to the cyclone feed box. Provision will be made to install two jig concentrators if current mineralogical studies show they are desirable.

3.4.6 Thickening

The overflow from the grinding cyclone classifier at 70% minus 200 mesh flows to a 8.5 m diameter by 3.0 m high thickener. The settled solids will be withdrawn at 55% solids and fed to the cyanidation agitators. The clear overflow from the thickener flows to the 4.3 m diameter by 5.5 m high pregnant solution tank.

3.4.7 Cyanidation

The main dissolving of gold takes place in three air-lift agitated vessels (two 5.5 m diameter by 4.9 m high tanks and one 4.9 m diameter by 5.5 m high tank). Lime and makeup sodium cyanide is added to the first agitator to maintain proper leaching conditions.

3.4.8 Filtration

The last leaching agitator discharges to the first stage of filtration. This filter is 2.4 m by 4.9 m Dorr drum filter equipped with a string solids discharge system. Barren cyanide solution is used as a wash on this filter. The filtrate is pumped to the pregnant solution tank. The cake removed from the filter by the strings drops directly into a horizontal repulper where it is mixed with barren solution. This slurry is refiltered on the second stage drum filter which is identical to the first stage machine. The wash on this filter will be either barren or fresh water, or a combination of the two streams. The cake from the second filter will be repulped with a mixture of "barren bleed" and fresh water before being pumped to the tailings area. The volume of the necessary "barren bleed" will be governed by the amount of fresh water used as second stage filter wash and other mill uses such as pump seal glands.

3.4.9 Precipitation

The pregnant solution is filtered in a vacuum leaf clarifier to remove all suspended solids. The clear solution is deaerated in a vacuum "Crowe tower", then treated with zinc dust to precipitate the gold from the solution. This gold, zinc slurry is filtered in a plate and frame filter press. The filtrate passes to the barren solution tank for reuse.

The press will be cleaned periodically as required. The precipitate will be packed in drums for shipment to Giant in Yellowknife. In Yellowknife, this precipitate will be refined to gold bullion for marketing.

3.5 Tailings Disposal

3.5.1 Introduction

This section examines the parameters taken into account in order to arrive at concepts and construction details to achieve maximun isolation of mill tailings from the environment. To achieve satisfactory recovery, the Salmita ore will require a grind of approximately 70% passing 200 mesh. Therefore, there is not a sufficient quantity of coarse tailings available for dam construction. All dam structures required to form an impoundment area will be constructed of fine glacial esker sand obtained from a borrow area located at the airstrip.

3.5.2 Selection of Tailings Disposal Site

The selection of an economically and environmentally acceptable site for the location of a tailings impoundment area involves consideration of the following factors:

1. topography in favour of a natural basin;
2. absence of an important watercourse through the impoundment area;
3. proximity to the proposed plant site;
4. suitability for reclamation of the abandoned impoundment area upon termination of the tailings disposal system;
5. effects of permafrost on the impoundment structures and the tailings deposits;
6. capacity of the impoundment area;
7. geological features which could affect the structural integrity of the impoundment dams and subsurface foundation materials.

In addition to the above, one important factor taken into consideration is the existence of an established impoundment area, including Russell Lake, used by the former Tundra operation until 1968.

The Russell Lake area was selected as the tailings impoundment site. This tailings disposal site offers the following favourable features conducive to good tailings management practice:

1. as stated previously, the site has already been utilized as a tailings discharge area; tailings

produced at the former Tundra operation comprise material nearly identical to that which will be generated by Giant;

2. there are no streams flowing into Russell Lake;

3. a minor ephemeral stream flows out of Russell Lake;

4. complete isolation of Russell Lake by construction of a dam downstream of Russell Lake would eliminate any current ongoing influence of the existing Tundra as well as isolate future tailings from the downstream watershed;

5. simple dam structures are required for impoundment, with natural valley sidewalls being used for retaining disposed tailings;

6. high storage volume to dam volume and height ratio which indicates economic efficiency;

7. the Russell Lake tailings area is located partially within the Tundra Mine lease boundaries and its centre is roughly 1 km northeast of the Tundra mill;

8. Russell Lake does not appear to support any resident fish populations (discussed further in sections 4.0 and 5.0).

Figure 3.5.1. illustrates the location and conceptual design of the proposed tailings impoundment area. In order to minimize seepage through the tailings dam, existing Tundra tailings will be used to line the upstream face of the dam during dam construction. During summer operating periods, tailings from the mill will be used to expand upon the upstream dam beach dimensions and further reduce the permeability of the dam. Geotechnical analysis of sub-soil profile samples (sampling locations are illustrated in Figure 3.5.1), esker material to be used for dam construction and Tundra tailings fines are currently underway.

3.5.3 Design Criteria

The following are the basic criteria used to design the tailings disposal facilities required for the proposed mining development:

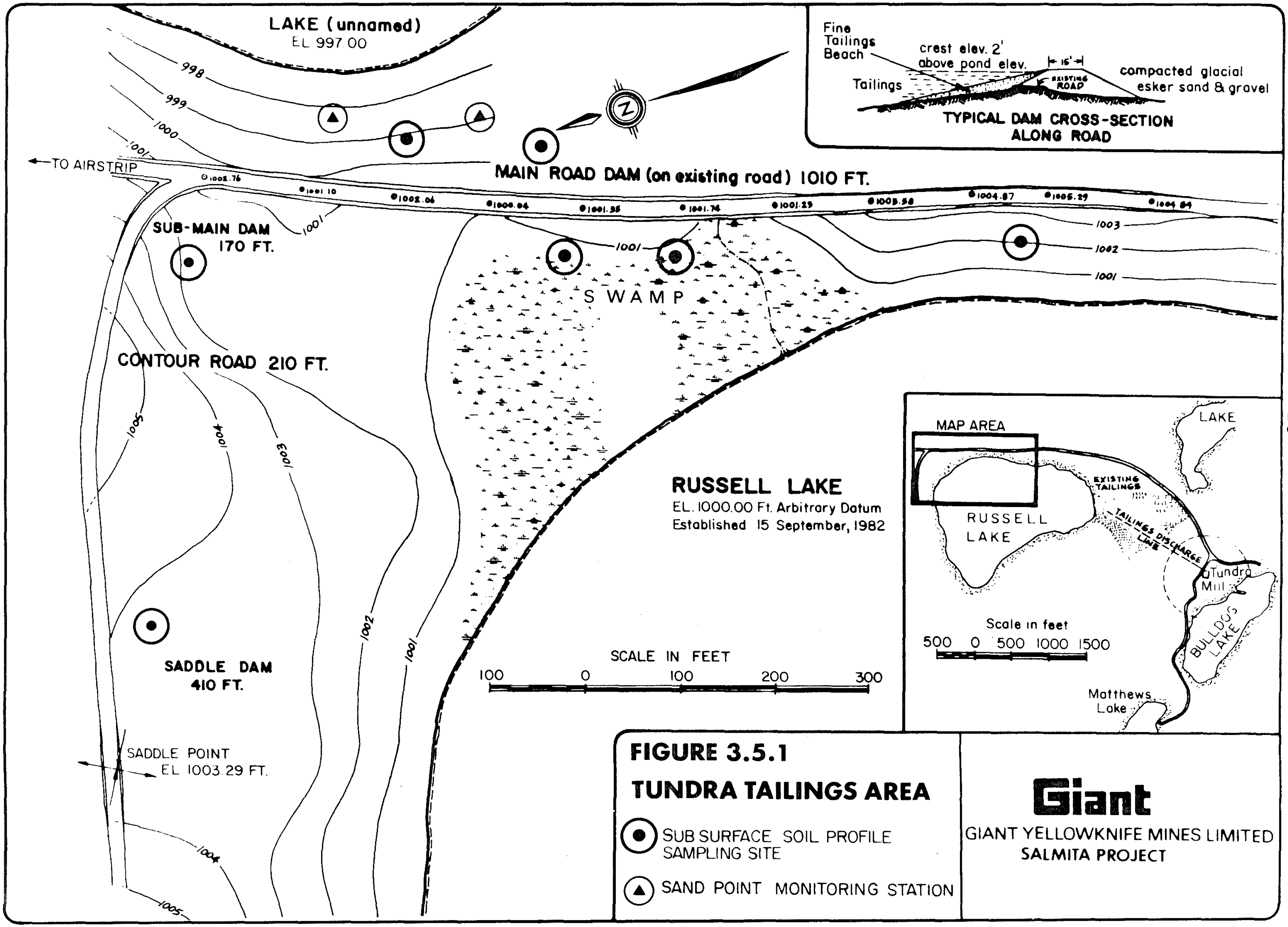


FIGURE 3.5.1

TUNDRA TAILINGS AREA

Total design production	160,000 tonnes
Anticipated life of mine	2.5 years
Nature of effluent	30% solids
Total area of Russell Lake	215,535 m^2
Total basin area	821,370 m^2
Annual precipitation (AES data)	297.9 mm/year
Annual evaporation (AES data)	745.0 mm/year

The above data reduces to a total maximum rise in the level of Russell Lake, relative to datum established in September, 1982, of 1.90 m. During the life of the mine, the dykes will be constructed to a height of 2.50 m above datum in order to provide a freeboard of 0.6 m. It is proposed that this construction be separated into two phases, as follows:

1. For the first year of production, the dykes will be constructed to a height of 1.50 m above the level of Russell Lake. Sand points will be strategically placed downstream to carefully monitor the amount and quality of seepage produced. Seepage will be collected and pumped back into the Russell Lake impoundment.

2. The second phase of dyke construction would raise the level to 2.50 m.

3.6 Miscellaneous Wastes

3.6.1 Sewage Collection and Disposal

All sewage discharged from the main Salmita complex (dry, washrooms, kitchen and accommodations) will be collected by gravity sewage lines and will flow directly to a sewage grinder pump tank. The grinder pump will be capable of handling up to 131000 litres per day. During the production phase of the project and when the camp is at or near total capacity, the estimated total volume of sewage produced per day will be approximately 30000 - 50000 litres per day.

After grinding, the effluent will be discharged via a 5 cm diameter pre-insulated and heat-traced polyethylene pipe into a bermed containment area within the marsh adjacent to the mine site. During winter months, as a result of the sewage effluent freezing and the berm becoming both frozen and impermeable, no effluent will reach Matthews Lake. During summer months, the sewage will be allowed to percolate through the berm and gradually work its way through the marsh approximately 75 m to Matthews Lake. The treated sewage will reach Matthews Lake at a point downstream of the Salmita water intake structure. This subject is addressed in more detail in section 5.1.1.

Sewage from the Tundra mill site will be discharged to the Russell Lake tailings impoundment system.

3.6.2 Garbage Disposal

All burnable garbage will be collected and burned in an incinerator at the Salmita site. Incinerator residue and non-burnable garbage will be deposited in a controlled landfill station located 80 m east of the Salmita decline portal as illustrated on Figure 3.1.2.

3.7 Supporting Industrial Services and Associated Projects

3.7.1 Fuel Handling and Storage

Fuel oil consumption at the Salmita mine and Tundra mill sites will average 3.3 million litres per year or about 9000 litres per day. This estimate includes the total fuel oil requirements for power generation and plant heating at both the Salmita and Tundra sites, and for residential heating, compressors and diesel equipment operating underground and on the surface at Salmita.

The transportation of fuel to the site will be a major cost account with the following transportation alternatives possible:

1. Hercules air transport to the site from Yellowknife;

2. winter road transport from Yellowknife to the site.

The concept of air transportation would involve savings in the amount of storage capacity at the sites. However, in addition to the prohibitively high cost per unit of material transported, this alternative would involve costly double handling of the fuel in order to transport it from the airfield, a distance of approximately 5 km both to the mine and mill sites. From a cost and convenience standpoint, truck haulage via winter road for all fuel and supplies has been selected. The alternative of air transportation has been fully studied, however, as a contingency should road transport delays arise, creating shortages on site.

Existing fuel oil storage facilities at Salmita consist of 12 skid-mounted 64000 litre tanks enclosed in a plastic-lined bermed storage area. An additional lined and bermed tank farm adjacent to the existing farm will be constructed with a storage capacity of 1.5 million litres. Two additional tanks with a capacity of 127000 litres are located at the airfield in a lined and bermed tank farm. The existing tank farm at Tundra has been found to be unsuitable for storage of the Tundra fuel requirements and a new lined and bermed tank farm will be constructed with a total capacity of 1.2 million litres. The location is illustrated in Figure 3.1.3. A 25% contingency in supply will be inherent due to the short trucking season.

Requirements for gasoline and other liquid fuels will be minimal and these fuels will be transported to the site in bulk as required.

3.7.2 Propane Handling and Storage

Propane consumption at Salmita is estimated to be 310000 litres per year. This estimate includes propane requirements for mine air heating and cafeteria operation and heating. Transportation to the site will be by means of 4400 litre skid-mounted tanks hauled by winter road. A main distribution and vapourization system will be fed directly by these tanks which, when empty, will be returned to Yellowknife for refilling.

3.7.3 Heating and Ventilating

3.7.3.1 Salmita Plant and Residential Complex

Heating and ventilation requirements for the Salmita residential, dry and kitchen complex are based on an extension of existing facilities and are presented in Table 3.7.1. Heat for the powerhouse and surface garage complex will be obtained from waste heat given off by the diesel power generators.

Table 3.7.1. Heating requirements.

Total Heat Requirements (BTUH)	Maximum During Winter (BTUH) (including contingency)
Residential area	0.83×10^6
Dry Complex	0.42×10^6
Office, Clinic, Walkways	0.76×10^6
Cafeteria	0.19×10^6
Hot Water	0.27 x 106
TOTAL	2.47×10^6

3.7.3.2 Salmita Underground

During extreme winter temperatures, underground mine air will require up to 5 million BTUH to heat the air to 0°C. It is estimated that during the coldest weather, 30% of this amount will be derived from waste heat given off by the diesel-driven air compressors and by underground mobile diesel equipment. The remaining heat required will be produced through a cluster of propane burners upstream of the ventilation fan.

3.7.3.3 Tundra Plant

The heat load for the Tundra mill facilities is being carefully evaluated. Depending on the outcome of this evaluation, either the 50 H.P. Napanee 15 P.S.I.G. boiler or the 150 H.P. Foster Wheeler boiler will be rehabilitated. Steam from the boiler, together with waste heat from the diesel generators, will heat water for the existing hot water heating system.

The dust collector system in the crusher house will be reconditioned and, if necessary, upgraded to ensure good working conditions. In the mill, the existing ventilation system will be reconditioned and adjusted to ensure a minimum of two air exchanges per hour. In reagent mixing areas, there will be at least six exchanges per hour.

3.7.4 Water Supply and Distribution

3.7.4.1 Salmita

Matthews Lake is the present source of fresh water for the Salmita site. As currently developed, this supply system will be adequate for all future camp and mine operations. Two jockey pumps, each with a capacity of 900 litres per minute (one serving as a standby unit), will provide sufficient water for the Salmita site. An electric-driven turbine fire pump with a capacity of 2200 litres per minute will be on standby for emergency heavy volume use. All intakes have been screened in accordance with the requirements of Fisheries and Oceans Canada. Drinking water will be chlorinated using calcium hypochlorite solution.

The pumping facility is located 300 m from the camp on the south side of the Salmita peninsula which juts westward into Matthews Lake. This location was chosen for the following reasons:

1. The water depth at the pumphouse is approximately 4 m which is well below the maximum ice thickness.

2. Sewage and mine water runoff from the marsh area would enter Matthews Lake on the north side of the peninsula. Matthews Lake flows northward, thus preventing any possibility of contamination of the Salmita camp water supply.

The main water line between the pumphouse and the camp is a 15 cm diameter pre-insulated and heat-traced polyethylene pipe.

3.7.4.2 Tundra

Fresh water for use in the Tundra mill will be obtained from the existing pumping location on Bulldog Lake to the west of the plant. Peak water usage for the mill is estimated at 500000 litres per day. The existing pumping facility at Tundra will be upgraded and modernized to include fire water pumping capacity of 2200 litres per minute. Fisheries and Oceans Canada intake screening requirements will be met. A sluice gate lake level control system exists between Bulldog Lake and Matthews Lake. This system was installed by Tundra in the 1960's. Giant is investigating the need to upgrade and utilize this system.

3.7.5 Compressed Air

3.7.5.1 High Pressure Compressed Air (Salmita)

High pressure (100 psi) compressed air will be supplied to the underground mine workings by two 1200 cfm portable diesel-driven compressors installed in the compressor room adjacent to the warehouse and powerhouse. One extra unit will be installed as a standby for periods requiring extra air and for servicing and maintenance downtime.

3.7.5.2 Low Pressure Compressed Air (Tundra)

The existing 130 cfm, 20 psig Holman air compressor will be reconditioned to provide the necessary air for the aerating agitators. An existing Gardner-Denver 100 psi compressor in the powerhouse will be reconditioned to provide backup for the low pressure unit and for incidental high pressure air supply.

3.7.6 Electrical Power Supply and Distribution - Salmita

3.7.6.1 Power Source

Two 200 kw diesel generating sets are presently installed at Salmita. During mine operations, one unit will operate and the other will be on standby or undergoing maintenance.

3.7.6.2 Distribution

Power will be generated at 600 volts in the powerhouse. Distribution will also be at 600 volts and will be fed through "Teck" cables to the residence substation and to the pumphouse, compressor room, ventilation plant, yard lighting, and the underground mine feeder.

3.7.6.3 Mine

The main mine distribution cable will run down the ventilation shaft and raises. At each level, the line will be tapped for local distribution for auxiliary ventilation fans and brine solution recovery pumps.

3.7.6.4 Lighting

Lighting throughout the camp will be generally fluorescent and incandescent with mercury vapour discharge type for high ceiling areas and exterior lighting.

3.7.7 Electrical Power Supply and Distribution - Tundra

The existing diesel generating equipment at Tundra is being carefully examined as to condition and suitability for current use. If the decision is to use part of this equipment, it will be reconditioned and thoroughly checked. If this equipment is found to be far too large or in poor condition, new diesel generators will be obtained. Current thinking is to use two 200 KVA units the same as are already installed at Salmita. A small skid-mounted high-speed diesel unit would also be obtained to act as an emergency source for both locations. In either case, the existing 600 volt distribution system would be reconditioned and, where necessary, modernized for use.

3.7.8 Laboratory

The existing assay laboratory will be reconditioned and modernized. The updated laboratory will consist of a sample preparation section (bucking room) and a standard wet chemical section based on an atomic absorption spectrophotometer. Any samples requiring specialized equipment or techniques will be sent to the Giant assay office in Yellowknife.

The sample preparation room will be separated from the main assay laboratory to eliminate noise and dust from the analytical section. It will contain a standard sample receiving station, bucking tables, drying ovens, laboratory jaw crusher, pulverizer and weigh scales. Equipment will be hooded and exhausted through a dust collection system.

The wet chemical section will include hotplates, balances, a water still, an assortment of laboratory glassware and an inventory of standard chemicals. This laboratory will have the capability of performing analysis for heavy metals, sulphur, chlorine, cyanide, as well as for gold.

Routine analysis for cyanide, lime and reducing power levels in the mill solutions will be carried out in an area located on the operating floor of the plant. Colour tests for gold in the barren solution will also be done on a routine basis. Equipment required in this area will consist of laboratory-sized pressure filters for removing solution from the pulp, and minor glassware such as beakers and titration burettes.

3.7.9 Equipment Maintenance Shops

All maintenance for surface facilities and surface mobile equipment will be performed in a shop area adjacent to the Salmita powerhouse. This facility will contain mechanical, electrical, carpentry, and equipment services in an area of approximately 110 sq. m. The shop area will be equipped to carry out routine maintenance services. For maintenance requiring highly-skilled personnel, equipment will be flown out for servicing in Yellowknife or Edmonton. An underground shop will be excavated to house adequate repair and maintenance facilities for underground equipment. Most maintenance of milling equipment will be carried out on site within the Tundra mill complex. Work requiring special machine servicing will be sent to the Salmita shop or flown to Yellowknife or Edmonton.

3.7.10 Warehousing

The main warehouse facility will be located adjacent to the Salmita compressor room in the old mill building and will be heated by waste heat discharged from the compressors. Bulk supplies such as timber, pipes and lubricants will be stockpiled in open yard areas at Salmita. Grinding media and reagents will be stored in enclosed cold storage areas at Tundra.

The main power magazine is currently located between the airfield and Tundra with an auxiliary magazine located 1 km from Salmita. An additional auxiliary magazine will be excavated underground at Salmita.

A warehouse agent will be employed to record freight manifests and to control warehouse stocks.

3.7.11 Fire Protection

3.7.11.1 Sprinkler System and Standpipe/Hose Station

The main sources of water for fire protection systems at Tundra and Salmita will be Bulldog Lake and Matthews Lake respectively. Basic fire protection will consist of automatic sprinklers and standpipe/hose stations located as required by hazard and occupancy ratings. All water-based fire systems will be inside heated building structures or designed as glycol-filled systems where exposed to freezing conditions.

3.7.11.2 Dry Chemical Systems

In addition to the water-based systems, stationary dry chemical extinguisher systems will be provided in the powerhouse/shop area, compressor room/warehouse area, and in the cafeteria. A trailer-mounted dry chemical extinguisher will be set up to be pulled by a 4 x 4 truck for fire supression in areas outside the complexes. Small handheld dry chemical extinguishers will be located throughout all building areas, as well as in mobile equipment.

3.7.12 Airstrip

The existing 1340 m airstrip located between Tundra and Salmita is a permanent facility and is maintained in a condition suitable for landing any propellor aircraft up to the size of a Hercules. The airstrip consists mainly of a natural glacial esker formation which has been lengthened to accommodate large aircraft. The surface is elevated with respect to the surrounding topography and, as such, is naturally blown free of snow in winter.

An aircraft signal beacon is located at Salmita to provide directional assistance to aircraft travelling to Salmita during periods of poor visibility. The landing strip will be equipped with portable flare pot markers for landing at night.

3.7.13 Communications

3.7.13.1 Salmita to Off-Site Locations

A communications system consisting of a high frequency single side band transmitter/receiver is presently established and operates on three channels:

1. Salmita to Giant office;

2. Salmita to Hay River phone channel;

3. Salmita to Fort Nelson phone channel.

3.7.13.2 Ground to Air

A VHF radio unit is installed at Salmita for communication with aircraft.

3.7.13.3 Salmita to Tundra

A local radio communication system will be set up for links between Tundra and Salmita and surface mobile units operating in between.

3.7.13.4 Aircraft Beacon

An aircraft radio directional beacon transmitter is presently established at Salmita to provide guidance to approaching aircraft during poor visibility.

3.7.14 Occupational Health and Safety

3.7.14.1 Safety

A safety officer located at Salmita will have jurisdiction over working practices and conditions at both the Tundra and Salmita sites. He will be qualified in fire training, mine rescue, advanced first aid, and will have actual working experience in milling and underground mining.

3.7.14.2 First Aid

All underground supervisors will be required to have had a minimum of five years' experience and will be qualified in mine rescue and advanced first aid. At least 10% of the total workforce will be trained in basic first aid.

Cyanide antidote will be located at certain points in the mill.

3.7.14.3 Mine Rescue

At least six people will be required on surface at any one time who have mine rescue training. In the event of a major disaster, mine rescue teams from mines in Yellowknife and elsewhere may be called upon to assist in rescue operations at Salmita.

A mine rescue room will be designated as such and will be equipped with breathing apparatuses, jacks, comealongs, ropes, stretchers, and all other equipment that would be necessary to evacuate trapped or injured personnel from the mine.

A stench warning device will be located at the surface and emergency procedures will be tested periodically.

3.7.14.4 Emergency Evacuation from Underground

The standard evacuation route from underground will be via the decline. An alternate route will be the system of ventilation raises and shaft. Refuge stations underground will consist of airtight bulkheads in deadend headings with an enclosed capacity for an entire single shift. The stations will be equipped with compressed air and water lines.

3.7.14.5 Work Environment

The working environment at both the Tundra and Salmita sites will be monitored by the supervisors and by the safety officer. Each shift, underground machines will be checked by shift supervisors for emission levels of NO_2, CO, methane and oxygen deficiency. Ground conditions will be under constant observation. Rock quality data from past development and diamond drilling is being studied to predict potential mine problem areas.

Periodic dust counts will be performed underground and in the mill area to isolate and deal with excessive levels. Dust masks and breathing apparatuses will be mandatory equipment under hazardous conditions. Reagent handling in the mill will be monitored and supervised to ensure the maximum safety of the operators.

3.8 Hazardous Material Control

3.8.1 General Considerations

Giant is investigating the possible implementation of a comprehensive hazardous materials control program based upon the program used by Falconbridge Limited in Sudbury, Ontario. The engineering design criteria for the Salmita project are based on current government requirements and have been developed to minimize gaseous emissions, liquid effluents and solid wastes by the use, where applicable, of capture, treatment, recycle and storage techniques. Dust control, scrubbing, spill containment, reclaim and maximum chemical and product recovery have been incorporated into the design of the complex. (It should be noted that tailings disposal has been discussed in section 3.5, domestic sewage in section 3.6.1 and mine water in section 3.3.6)

3.8.2 Solid and Gaseous Emissions

Solid emissions from equipment and transfer points in the crushing plant will be controlled by a dry dust collection system (i.e. a baghouse). Dust from the mixing of hydrated lime will be collected and treated in either a high efficiency wet collection system or by some other scrubbing technique. The cyanide mixing tank area will be well vented.

3.8.3 Cyanide

Excess barren solution from the milling process will contain cyanide and will be discharged with the solid tailings to the total retention tailings impoundment area.

3.8.4 Arsenic

The ore contains low concentrations of arsenopyrite (less than 3%) which will result in arsenic being present in the mill tailings. Since roasting is not part of the process circuit, the level of soluable arsenic should be minimal and hence most arsenic is expected to report to the tailings in an insoluable form. Noting that the tailings will be discharged to a totally enclosed tailings impoundment area with no effluent decant to a receiving body of water, additional treatment is not anticipated at this stage.

3.8.5 Calcium Hypochlorite

Calcium hypochlorite is not being utilized on site at the present time. However, it is Giant's intention to chlorinate the potable water supply for Salmita in the future. Calcium hypochlorite will be trucked to the site as a powder in 45 kg drums. The calcium hypochlorite will be dissolved in water and bled into the water supply line at such a rate as to ensure that drinking water standards are met.

3.8.6 Spillage

All process areas will be designed with curbs to contain chemical and slurry spills. Spills of this nature will be returned to the circuit for further processing.

3.9 Reagent Supply and Handling

3.9.1 Hydrated Lime

Hydrated lime will be delivered to the process plant in 25 kg bags stacked on pallets. The lime will then be mixed in an agitated mixing tank, the air from which will be exhausted through a scrubber system to the atmosphere. The milk of the lime slurry will then be transferred to a holding tank before being pumped to the cyanidation circuits through a circulating system.

3.9.2 Sodium Cyanide

Sodium cyanide will be received at the plant in 90 kg drums. The cyanide will then be added to an agitated mixing tank by means of a cyanide feeder. Air from the mixing tank will be exhausted to the atmosphere to prevent an accumulation of toxic fumes. The cyanide slurry will be transferred to a holding tank and then pumped to the cyanidation circuit. All process tanks are covered to minimize operator exposure.

Process plant workers will be educated relative to the dangers in handling sodium cyanide, and extreme precautions will be taken whenever the material is handled.

3.9.3 Chlorine

Current plans do not include the utilization of chlorine.

3.9.4 Zinc Dust

Zinc dust will be delivered in 45 kg drums and fed into the precipitation circuit by a belt feeder. A day's supply will be laid on the belt and fed slowly into the system.

3.9.5 Lead Nitrate

If required, lead nitrate will be delivered to the process plant in 180 kg drums. In this event, the dry lead nitrate will be added manually to the cyanidation circuit once an hour.

3.10 Personnel Requirements and Accommodation

The total personnel requirements for the operational phase of the project have been estimated at 100 people, 78 of whom will be on site at any one time. Allowing for visitors to the site, accommodation will be available on site for a maximum of 80 people. Separate accommodation will be provided for women staff and visitors. A more detailed estimate of the mining, milling and administrative positions to be filled appears in section 7.0, "Social and Economic Considerations."

3.11 Abandonment and Reclamation

The following summarizes the work to be carried out at both the Salmita and Tundra locations as a restoration program after the cessation of operations. The program provides a general outline of the rehabilitation work Giant is planning to undertake. A more detailed description of the work will be developed prior to closure, based upon discussions with regulatory agency staff.

3.11.1 Salmita

In an effort to comply with current environmental regulations, the following series of activities are proposed following the cessation of mining activities at the Salmita property:

1. Surface Structures

   All buildings will be sealed and entry secured. The yard surrounding the mine areas will be thoroughly cleaned and cleared. The site will be left in a state that will prevent erosion and not cause a disruption to the movement of migratory animals. Should the company abandon mineral rights and land leases, structures will be removed from the site, probably by burning, crushing and burying the materials. The burial site would be contoured and protected from erosion.

2. Mine

   To prevent unauthorized entry, the mine will be sealed by means of concrete plugs or by filling the entry way with a large rubble rock plug. The plug or plugs will be designed to be functional on a long-term basis.

3. Sewage and Minewater Disposal Area

   If deemed necessary by regulatory authorities, drainage ditches will be placed around the entire minewater and sewage disposal area so that surface runoff can be directed away from the area in order to prevent any major ponding or erosion of this containment area.

3.11.2 Tundra

1. The Plant

   The buildings, including the mill, offices, shops and bunkhouses have been in place for about 20 years and are currently in repairable condition. Should the project be authorized to use the Tundra facilities, it must be accepted that the plant will be returned to its current owners or successors in the same or better condition. Consequently, plans for the plant only include the sealing of all means of access to the buildings and the cleanup of the yard areas. Reagents and unused oil will be removed from the sites and transported to Yellowknife.

   The Tundra plant is a landmark in this area of the Territories, and nothing will be done to change the typical features of the facility except improve the equipment housed therein.

2. The Mine

   The mine at Tundra will not be part of any restoration plan as there are no intentions of reactivating this section of the property.

3. Tailings Disposal Areas

   The tailings will be deposited both over and adjacent to the former Tundra mill tailings in Russell Lake. If required, on the cessation of operations, surface drainage into the tailings area will be diverted around the impoundment area. The tailings pond dam will be extended, if necessary, to ensure that there is no runoff from the tailings into the downstream watercourse. Precipitation which falls directly on the impoundment area will be contained and due to higher evaporation than precipitation rates, the area will remain dry from year to year.

4. Roads and Yards

   Roads built between Salmita and Tundra for the project will be left for the use of others.

3.12 Energy Conservation

In view of the remoteness of the proposed mine and mill development and the limited access to the site (i.e. aircraft and winter road only), the entire complex has been designed to conserve energy, thereby minimizing the amount of fossil fuel required to be transported to the site.

3.13 Winter Road

Project development and operational phase plans include the operation of a winter road beginning at Tibbit Lake (i.e. at the end of the current all-seasons road east of Yellowknife). The Echo Bay Mines Ltd. winter road to Contwoyto Lake developed to service the Lupin Mine passes along the same route and will be used by both Giant and Echo Bay as far as the Salmita site. The winter road, an extension of the former Camlaren Road, will pass over Ross, Pensive, Gordon, Brown, Drybones, Lockhart and MacKay Lakes enroute to Salmita. The winter road extension is approximately 300 km in length. There are no plans to develop an all-seasons road to the site.

4.0 ENVIRONMENTAL DESCRIPTION

4.1 Introduction

Giant Yellowknife Mines Limited Salmita mine site is located approximately 240 air km northeast of Yellowknife on the east shore of Matthews Lake (Figure 2.1.1). The site is located approximately 70 km north of the tree line. The nearest large lake, Courageous Lake, is 6.0 km north of the mine site. The property is located at latitude 64°04'31"N, and longitude 111°15'04"W and is in the Mackenzie Mining District. The mine site is located near a height of land and at an elevation of 461.5 m above sea level. The Salmita mine site is located approximately 5.3 km north of the former Tundra mine and mill site. Giant is proposing to rehabilitate and reactivate the Tundra mill.

The Initial Environmental Evaluation for the Salmita project has been prepared based on guidelines provided by the Regional Environmental Review Committee chaired by D.I.N.A. The environmental baseline data contained in this document is based principally on the following sources:

1. published and unpublished site specific data obtained through a comprehensive library search or provided by various government regulatory agencies;

2. interviews in Yellowknife with regulatory staff of various federal and territorial government departments;

3. published data of a regional nature (eg. the Polar Gas environmental studies) that would be applicable to the Salmita site;

4. field data collected by Hatfield Consultants Ltd. for Giant during 1981 and 1982;

5. data provided by Giant.

The aquatic data base presented is based principally on items 1 and 4 and is considered to be substantive considering the isolated nature of the Salmita mine site. The terrestrial habitat and wildlife descriptions are based principally on items 1, 2 and 3 above and supplemented by a wildlife observation log book maintained by Giant at the mine site (item 5). The physical baseline environmental descriptions are generally less comprehensive and based on a variety of sources.

4.2 Aquatic Environment

As stated previously, the location of the Salmita mine site is illustrated in Figure 2.1.1. The mine is located immediately east of Matthews Lake between Matthews Lake and a series of lakes known locally as the Sandy Lakes. The mill site is located immediately east of Bulldog Lake. The Matthews Lake and Sandy Lake systems both drain into Courageous Lake and all of these water bodies are in the Lockhart River drainage area. The Lockhart River flows south and west into Great Slave Lake and is a part of the Mackenzie River watershed.

This aquatic environmental description addresses the existing information for Matthews Lake, the Sandy Lake system and Courageous Lake. Environmental studies at varying degrees of effort and emphasis have been carried out by a number of organizations since 1975. Table 4.2.1 has been presented to summarize and illustrate the studies undertaken to date. Moore (1978) has presented and interpreted the results of the 1975 D.I.N.A. study and the 1976 Environment Canada study and Hatfield (1982) have presented and discussed the results of the 1981 baseline survey. In reviewing the aquatic environmental baseline data base, it is important to note that during its brief period of production, Tundra mill tailings were discharged to a tailings disposal area, including Russell Lake, in the Sandy Lake system.

4.2.1 Water Quality

During the period from 1975-1982, seven water quality programs of varying magnitudes and designs were undertaken in the general area of the Salmita mine project. Table 4.2.2 has been presented to illustrate the design features of each of these study programs. Moore (1978) presented a map illustrating the sampling sites utilized by D.I.N.A. in 1975 and Environment Canada in 1976. Studies by Environment Canada in 1978, Giant in 1980 and D.I.N.A. in 1982, also utilized this map to illustrate their sampling stations. An upgraded version of this map has been utilized (Figure 4.2.1) to illustrate the locations of all of the sampling sites for the above-mentioned water quality programs. The locations of the sampling sites used by Hatfield Consultants Ltd. during their two studies are illustrated in Figure 4.2.2. It should be noted that the analyses performed varied somewhat from one survey to another, although during all surveys, comprehensive lab analyses were undertaken. As noted in Table 4.2.2, results obtained have been presented chronologically in Appendix Tables I to VII.

TABLE 4.2.1 <u>SALMITA MINESITE AQUATIC ENVIRONMENTAL STUDIES, 1975 to 1982</u>

	WATER QUALITY	LIMNOLOGY				FISH	
		Plankton	Benthos	Bathymetry	Sediments	Fish Resources	Heavy Metals in Fish
Department of Indian and Northern Affairs (1975)	X						
Environment Canada, Environmental Protection Service (1976)	X	X	X			X	
Department of Indian and Northern Affairs (1977)						X	
Environment Canada, Environmental Protection Service (1978)	X						
Giant Yellowknife Mines Ltd. (1980)	X						
Hatfield Consultants Ltd. (1981)	X		X	X	X	X	X
Hatfield Consultants Ltd. (1982)	X		X		X		
Department of Indian and Northern Affairs (1982)	X						

TABLE 4.2.2 SUMMARY OF WATER QUALITY STUDIES UNDERTAKEN IN THE AREA OF THE PROPOSED SALMITA MINE, 1975 TO 1982

	Total Number of Sampling Sites Established	Locations of Sampling Sites	Number of Sampling Surveys Conducted	Results	Comments
Department of Indian & Northern Affairs (1975)	6	Matthews Lake: 3 Sandy Lakes: 3 & August 1)	3 (June 19, July 22 Appendix	Results are presented in Table I	Data is also available (Moore, 1978) for a seventh site for the June 19, 1975 survey. However, the location of this site is unknown
Environment Canada, Environmental Protection Service (1976)	7	Matthews Lake: 3 Courageous Lake: 2 Sandy Lakes: 2	3 (July 5, August 9 & September 13)	Results are presented in Appendix Table II	During these studies, phytoplankton, phytobenthos, zoobenthos samples were also collected
Environment Canada, Environmental Protection Service (1978)	3	Matthews Lake: 1 Sandy Lakes: 2	1	Results are presented in Appendix Table III	Data available as a result of investigation of abandoned gold mines (i.e. Tundra). Station I results have been influenced by the apparent direct discharge in the past of Tundra tailings to this lake
Giant Yellowknife Mines Ltd. (1980)	3	Matthews Lake: 2 Sandy Lakes: 1	1 (August 11, 1980)	Results are presented in Appendix Table IV	One mine water sample was also collected and analyzed
Hatfield Consultants Ltd. (1981)	15	Matthews Lake: 14 Courageous Lake: 1	1 (September 16-20, 1981)	Results are presented in Appendix Table V	Triplicate analyses were performed on all samples, sites were selected in recognition of plans at that time to locate mill near the mine. Additional work undertaken included bathymetry, benthic sampling, heavy metals levels in sediment, fish tissue and liver samples.
Hatfield Consultants Ltd. (1982)	9	Matthews Lake: 6 Sandy Lakes: 3	1 (March 31-April 12, 1982)	Results are presented in Appendix Table VI	Samples were collected through the ice, additional work undertaken included benthic sampling and core sediment sampling
Department of Indian and Northern Affairs (1982)	10	Matthews Lake: 5 Sandy Lakes: 4 Courageous Lake: 1	1 (June 22, 1982)	Results are presented in Appendix Table VII	Ice still covered all but the nearshore areas, Tundra tailings also analyzed for heavy metals

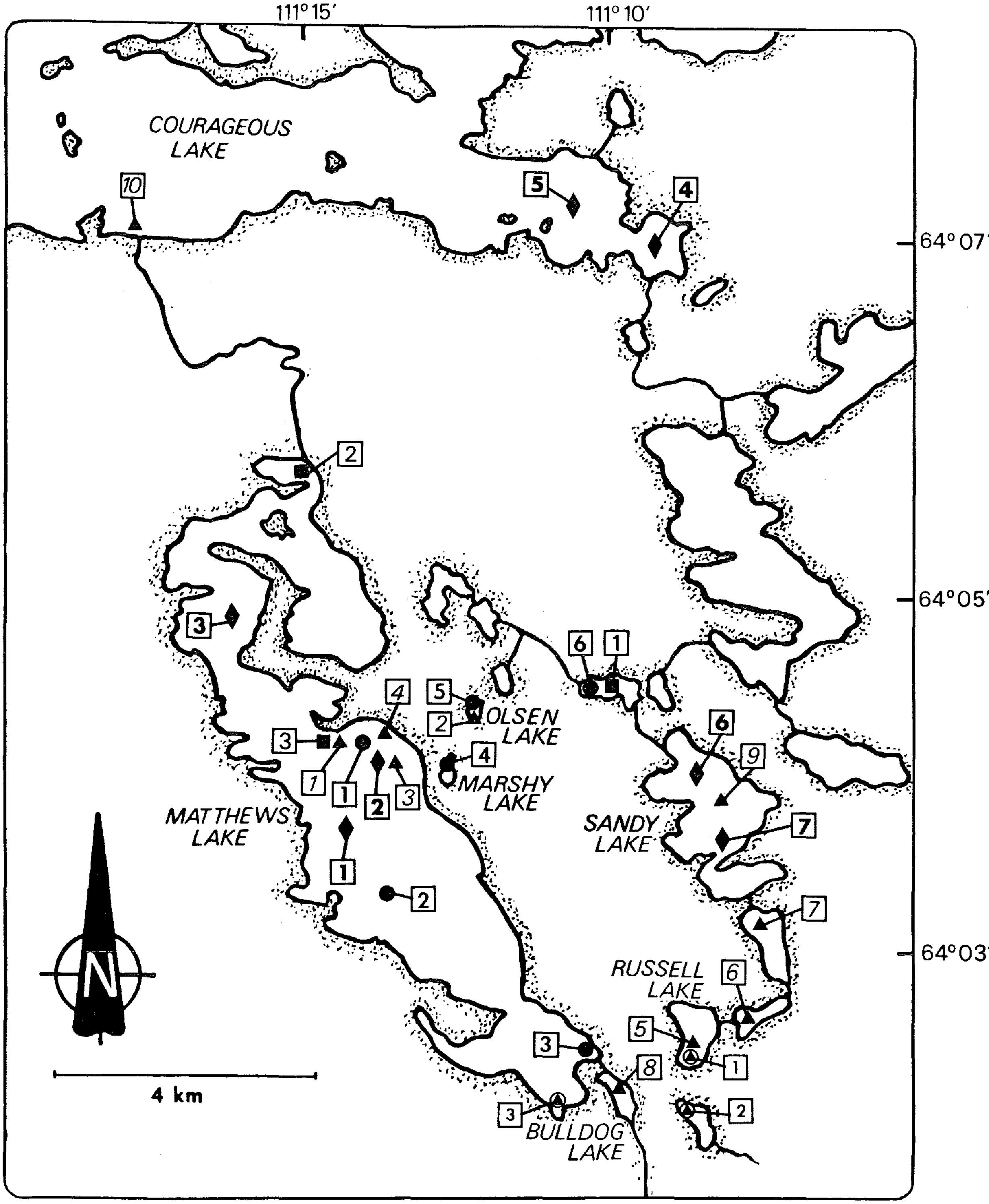


FIGURE 4.2.1 SALMITA AREA WATER QUALITY MONITORING STATIONS, 1975 - 1982

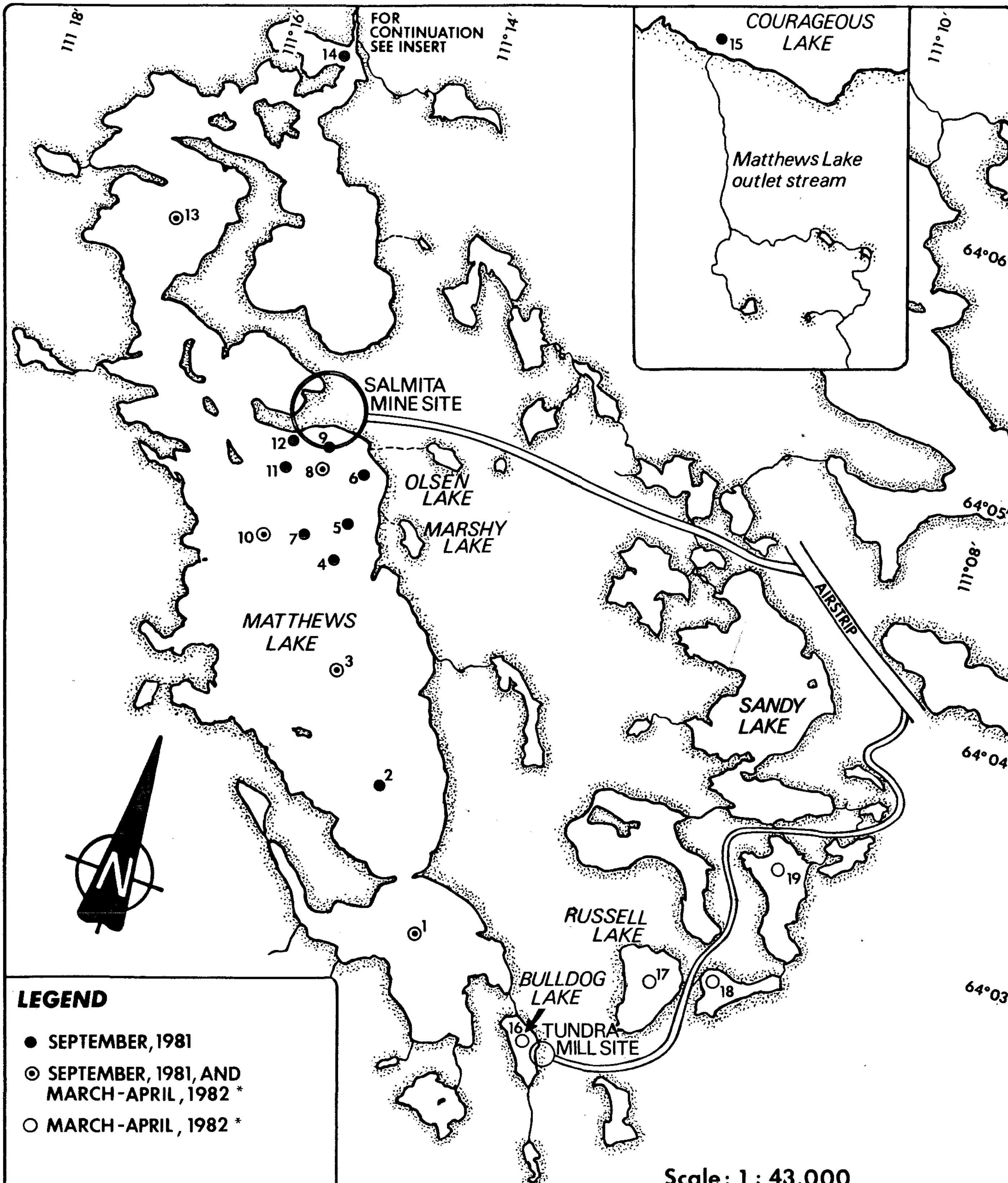
● 1-6 WATER QUALITY STATIONS UTILIZED BY DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS, 1975

♦ 1-7 WATER QUALITY STATIONS UTILIZED BY ENVIRONMENT CANADA, 1976

Ⓐ 1-3 WATER QUALITY STATIONS UTILIZED BY ENVIRONMENT CANADA, 1978

■ 1-3 WATER QUALITY STATIONS UTILIZED BY GIANT YELLOWKNIFE MINES LTD., 1980

▲ 1-10 WATER QUALITY STATIONS UTILIZED BY DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS, 1982



LEGEND

- ● SEPTEMBER, 1981
- ⊙ SEPTEMBER, 1981, AND MARCH-APRIL, 1982 *
- ○ MARCH-APRIL, 1982 *

* SEDIMENT SAMPLES WERE TAKEN ONLY AT SITES 10, 13, 16 AND 17 DURING THE MARCH-APRIL, 1982, FIELD STUDIES

FIGURE 4.2.2

WATER, SEDIMENT AND BENTHOS SAMPLING SITES, MATTHEWS LAKE AND SANDY LAKE SYSTEMS, SEPTEMBER, 1981, AND MARCH-APRIL, 1982, FIELD STUDIES

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An evaluation of the water quality results obtained leads to the following general conclusions with respect to the lakes in the Salmita area (excluding Russell Lake and the lake east of it since they received the tailings from the old Tundra milling operation in the 1960's):

1. the water quality meets the requirements of the "Guidelines for Canadian Drinking Water Quality, 1978;"

2. nutrient (nitrates and nitrites, orthophosphates) and heavy metal concentrations are low;

3. the pH of the lakes is in the neutral range (6.8 - 7.35); alkalinity levels are low indicating that the lakes have very limited ability to buffer pH changes that could occur as a result of an effluent discharge;

4. hardness is low; this is significant noting that the effective toxicity to fish of dissolved heavy metals decreases with increased hardness;

5. suspended solids, turbidity and colour levels were extremely low.

A review of published water quality data for other lakes in the Northwest Territories was also undertaken. Water quality data for Contwoyto Lake (Moore 1978) and Itchen Lake (Moore 1978) were assessed and compared to the data obtained for the lakes in the Salmita area. Although some parameters varied from lake to lake (not unexpectedly), no significant anomalies were noted in the Salmita area water quality data.

The water quality data base for Matthews Lake and Courageous Lake is substantial, and additional baseline water quality studies of these lakes do not appear to be necessary. The Sandy Lake system water quality data base is somewhat less comprehensive. Additional baseline water quality data gathering in the overall Sandy Lake system will be undertaken on a much reduced scale, recognizing that a total retention tailings pond system is planned for the headwaters area of this watershed.

4.2.2 Limnology

4.2.2.1. Plankton and Benthos

Phytoplankton, zooplankton, phytobenthos and zoobenthos studies were carried out by Environment Canada in 1976

(Moore 1978). In addition, benthic invertebrate sampling was also undertaken for Giant in September, 1981 and March-April, 1982 by Hatfield Consultants Ltd. The results of these studies are summarized below. It is important to note Moore's (1978) overall conclusion that the species composition and density of the phytoplankton, zooplankton phytobenthos, and zoobenthos were similar to those of other unpolluted lakes at comparable latitudes. Hatfield zoobenthos data from 1981 and 1982 generally supports the findings of Environment Canada.

Phytoplankton

Moore (1978) states that the total standing crop of phytoplankton in Matthews Lake decreased gradually from 17.0 x 10^7 to 9 x 10^7 cells/m^3 between July and September, 1976. The predominant species were Dinobryon bavaricum Imhof, D. cylindricum Imhof, D. divergens Imhof, and Ankistrodesmus falcatus (Corda) Ralfs. Diatoms were usually rare being represented mainly by Cyclotella glomerata Bachmann and C. ocellata Pantosek. This latter species attained maximum densities of 1.2 x 10^7 cells/m^3 in July. 1976. Courageous Lake contained slightly more algae than Matthews Lake with densities ranging from 13.1 x 10^7 to 19.5 x 10^7 cells/m^3. The predominant species were generally similar between the two systems. However, Courageous Lake contained far fewer specimens of A. falcatus, while maintaining large (up to 2.0 x 10^7 cells/m^3) populations of Asterionella formosa Hass. and Quadrigula lacustris (Chod) Smith.

Algal densities in the Sandy Lake system ranged from 11.0 x 10^7 to 18.0 x 10^7 cells/m^3 depending upon the month. D. bavaricum, D. cylindricum, D. divergens and A. falcatus were once again predominant. Diatoms were rare with A. formosa and C. ocellata reaching maximum respective densities of 0.4 x 10^7 and 1.4 x 10^7 cells/m^3.

Zooplankton

Moore (1978) states that the most frequently encountered zooplankton was the Chrysophyta Ceratium hirundenella O.F. Muller[1]. It occurred most abundantly in Matthews Lake reaching 9.3 x 10^4 cells/m^3. Noellicottia longispina (Kellicott) was the predominant rotifier, followed in importance by Keratella cochlearis Ahlstrom, Polyarthra vulgaris Carlin, Polyarthra remata

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1 Author's note: Chrysophyta Ceratium hirundenella O.F. Muller is actually not a zooplankton.

Shorikov and Asplanchna priodonta Gosse. The most common copepods were Cyclops scutifer Sars and Diaptomus sicilis Forbes, with the former species usually being predominant. Bosmina coregoni Baird was the most frequently encountered cladoceran. Other species that were encountered on occasion (<400 animals/m^3)included Holopedium gibberum Zaddach, Daphnia longiremis Sars, and D. middendorfiana Fischer.

Phytobenthos

Moore (1978) states that the predominant epilithic species in Matthews Lake throughout the study was Achnanthes minutissima accounting for 40% by numbers of the attached flora. It was followed in order of descending importance by Tabellaria flocculosa (18%) and Nitzschia frustulum (4%). T. flocculosa was the most common species in Courageous and Sandy Lakes, representing 32-49% of the microflora. A. minutissima was invariably second in importance, followed by N. frustulum.

Zoobenthos

Moore (1978) found that larval Chironomidae occurred abundantly in all three lakes, with average summer densities ranging from 1000 to 1500/m^2. Corynocera sp. was predominant in Matthews Lake, followed by Procladius denticulatus and Psectrocladius sp. Corynocera sp. was, however, either absent or rare in Courageous Lake being replaced by Polypedilum sp. and Microtendipes sp. Microtendipes sp., together with P. denticulatus, Stictochironomus sp. and Tanytarsus sp., were dominant in Sandy Lake. Molluscs were common in all three lakes. Valvata sincera helicoidea was always predominant with average densities of 350, 250 and 800 animals/m^2 in Matthews, Courageous and Sandy Lakes respectively. Pisidium subtruncatum was also common maintaining average population levels of 200, 300 and 500/m^2 respectively. Several other species, most notably Pisidium nitidum and P. casertanum, were also encountered. Oligochaetes were represented mainly by Lumbriculus variegatus and unidentified Tubificidae. Both occurred in all three lakes, the former always at densities of 200-300 animals/m^2. The Tubificidae exhibited a more hetrogenous distribution pattern. The population in Matthews Lake, for example, was near 350/m^2 while in Courageous and Sandy Lakes, the respective values were 250 and 500/m^2. The crustaceans Hyallela azteca and Mysis relicta occurred in all lakes but always at $<75/m^2$.

Hatfield Consultants Ltd. undertook zoobenthos sampling in September, 1981 and March-April, 1982 as part of an overall aquatic baseline monitoring program. The sampling sites employed have been illustrated on Figure 4.2.2. The benthic invertebrates samples were collected in triplicate during the September, 1981 study. Single samples were collected in March-April, 1982. Samples were sieved through a U.S. Standard No. 30 sieve before being preserved in a formalin solution and stained using Rose Bengal. The organisms were examined using a dissecting microscope in a laboratory and were identified and counted. Concentrations of animals (i.e. animals/m^2) for each taxonomic group and the total number of animals were determined. The results obtained during September, 1981 are presented in Appendix Table VIII. Results are provided for 42 samples from the 14 subsampling sites utilized. Samples were not obtained at Station 6 due to a cobble bottom.

Hatfield (1982) determined that the zoobenthos population concentrations are greatest at station 13 (Figure 4.2.2), averaging approximately 26,000 organisms/m^2, and lowest at station 12, averaging approximately 600 organisms/m^2. Overall, chironomidae were by far the most numerically significant taxonomic group. (Moore 1978 states that chironomidae were abundant.) The relationships between these taxonomic groups are presented in the legend of Appendix Table VIII.

In March-April, 1982, Hatfield Consultants Ltd. collected benthic invertebrate samples at nine stations (six in the Matthews Lake and three in the Sandy Lake system). At three stations (i.e. 17, 18 and 19), the lakes were frozen to the bottom and there were no benthic invertebrates present in the frozen sediments. The results for the other six stations are presented in Appendix Table IX.

4.2.2.2 Bathymetry

A bathymetric study of Matthews Lake was undertaken by Hatfield Consultants Ltd. in September, 1981 (Hatfield 1982). The depth contours of the main basin of Matthews Lake were derived from 93 depths that were measured at predetermined and fixed sample stations located along eight transect lines (Figure 4.2.3). The transect lines were approximately 500 m apart and the sample locations were approximately 100 m apart. Depth contours at 2 m intervals were developed and are presented in Figure 4.2.4.

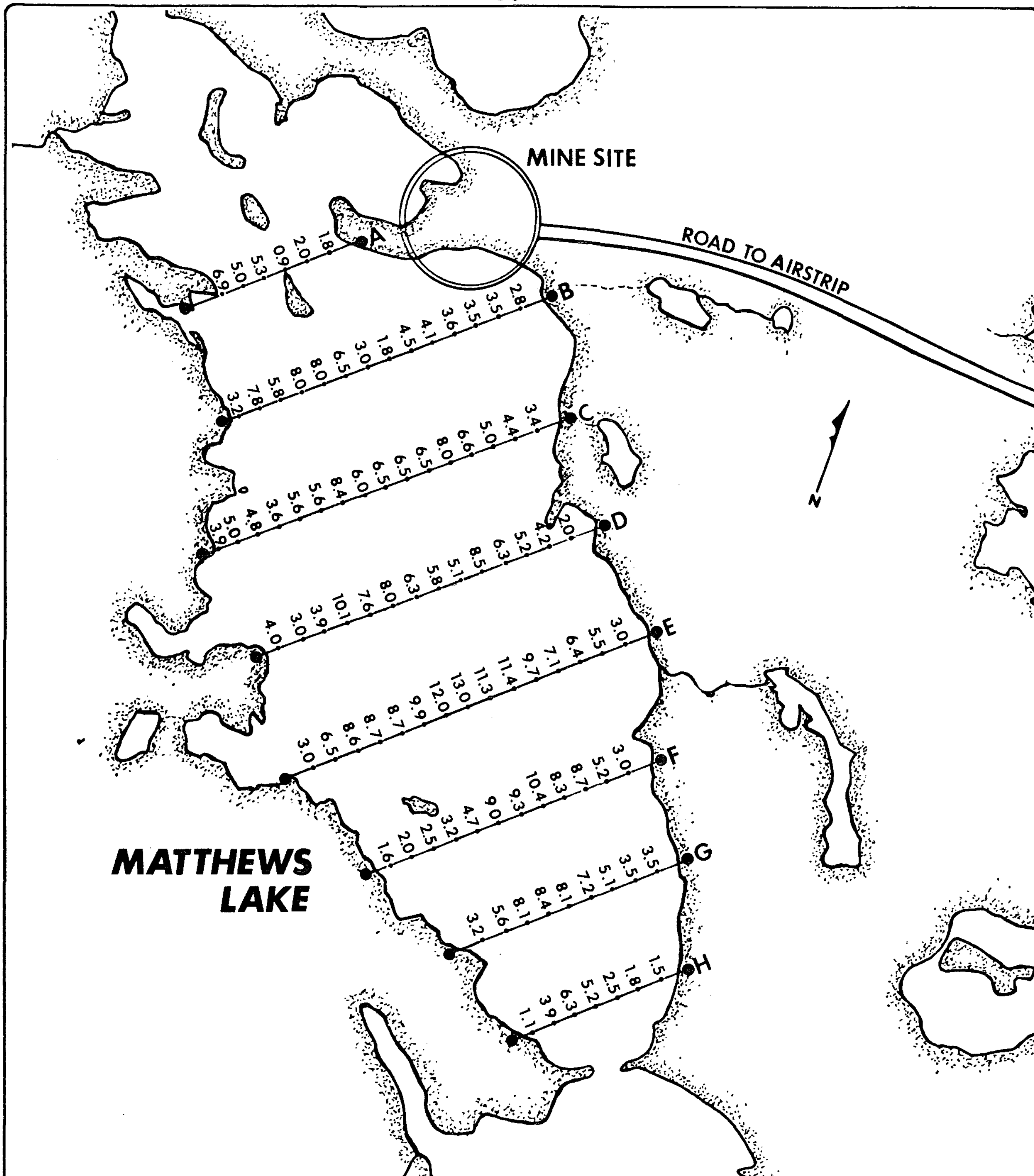

FIGURE 4.2.3 TRANSECT LINES AND DEPTH MEASUREMENTS FOR MATTHEWS LAKE

Scale: 1 : 24,500

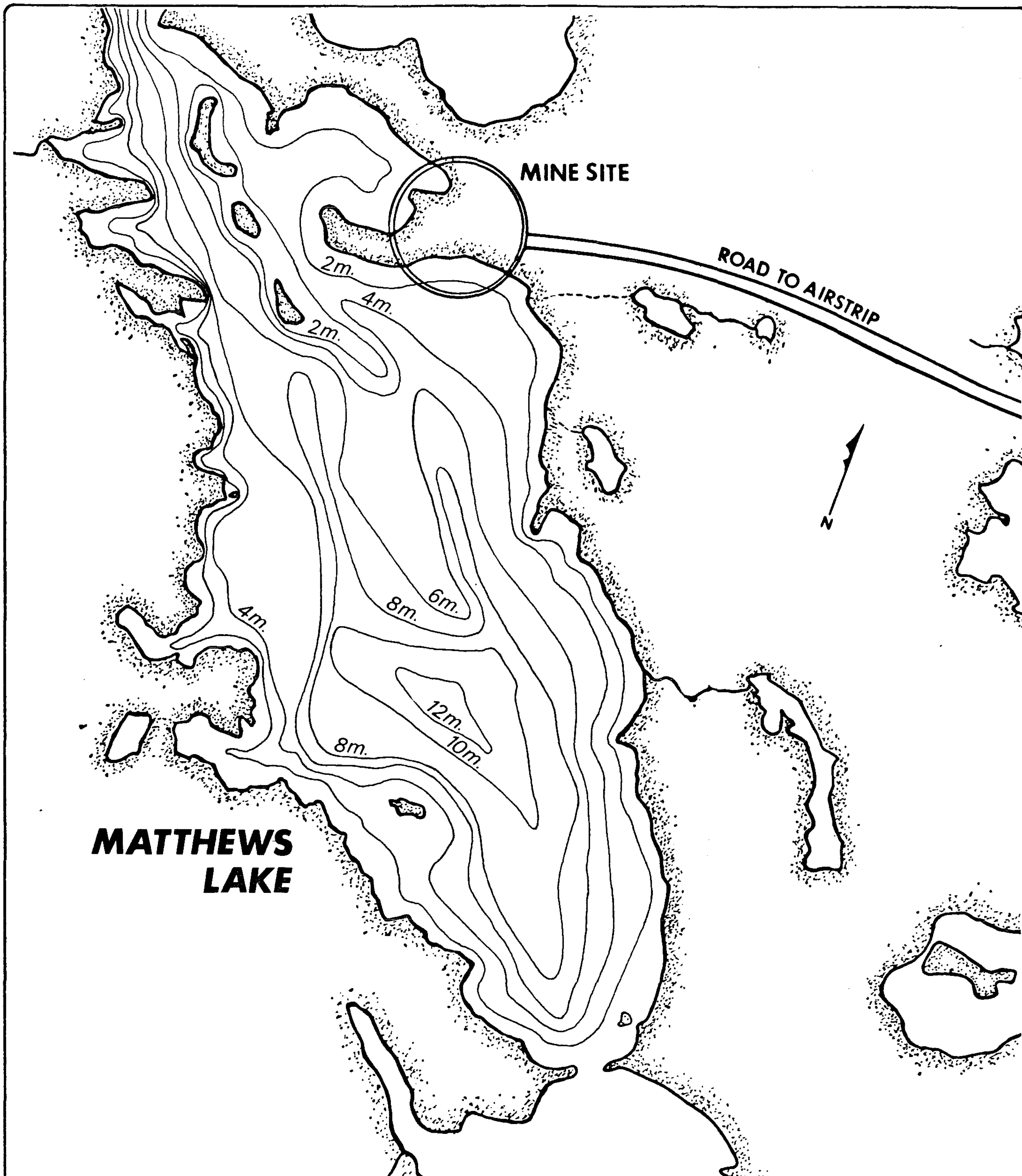

FIGURE 4.2.4 BATHYMETRIC CHART OF MATTHEWS LAKE (2 metre interval between contours)

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Detailed bathymetric surveys have not been undertaken at any other lakes in the Salmita area. However, Giant (pers. comm. 1982) reported that the maximum depth recorded in Olsen Lake was 1.9 m. The Hatfield Consultants Ltd. 1982 field survey results indicate that maximum depths in the three lakes upstream of Sandy Lake may not exceed 2.1 m. Additional bathymetric data will be gathered during the spring of 1983 in the Sandy Lake system.

4.2.2.3 Lake Sediments

Sediment samples were collected during the September, 1981 field survey carried out by Hatfield Consultants Ltd. Samples were collected in triplicate at the water quality stations shown on Figure 4.2.2. The chemical (heavy metals) and physical characteristics of the sediments were determined and the results are presented in Appendix Table X. Sediment samples were collected at 14 of the 15 sampling sites illustrated in Figure 4.2.2. At sample site 6, the substrate was cobble and no samples were obtained.

The physical characteristics and heavy metal concentrations presented in Appendix Table X provide baseline descriptions of the sediments. Heavy metal concentrations can be especially important to the biota, since high concentrations of some metals in the sediment have been known to affect physiological processes, life history activities, food web inter-relationships, etc. Lead and molybdenum concentrations fell below detectable levels at all sample sites. The concentrations of mercury and cadmium ranged from not detectable to 0.098 and 0.8 micrograms/gram dry wt., respectively. Moderate concentration ranges were noted for copper (3.07 to 92.8 micrograms/gram dry wt.), nickel (7.4 to 92.8 micrograms/gram dry wt.), cobalt (1.47 to 22.8 micrograms/gram dry wt.) and chromium (6.5 to 34.8 micrograms/gram dry wt.). Larger concentration ranges were recorded for arsenic (5.17 to 167 micrograms/gram dry wt.), zinc (9.3 to 250 micrograms/gram dry wt.) and manganese (44.7 to 395 micrograms/gram dry wt.).

Core samples were collected at the four stations shown in Figure 4.2.2 during a winter field study carried out by Hatfield Consultants Ltd. in March-April, 1982. Efforts were made to obtain three samples (surface, one-foot and two-foot) from each core sampling site. The samples were analysed by a commercial laboratory for arsenic and mercury. The results obtained are presented in Appendix

Table XI. Station 17 is in Russell Lake and within the proposed project tailings impoundment area. The higher results at this station are a result of the discharge of Tundra mill tailings during the 1960's.

4.2.3 Fisheries

4.2.3.1 Fish Species and Populations

Stewart and MacDonald (1978) describe the fish resources of the "Northeast Great Slave Lake drainages". Their description includes Courageous, Clinton-Colder, Aylmer and Mackay Lakes. They report that all of the large lakes in the area probably support populations of lake trout, Arctic grayling, round whitefish, lake cisco, burbot, longnose sucker and ninespine stickleback. During 1977, they report catching lake trout and Arctic grayling while angling in an unnamed lake adjacent to the Tundra airstrip.

Moore (1978) stated that lake trout *Salvelinus namaycush* were caught by angling in all three lakes (i.e. Matthews, Courageous and Sandy Lakes). The largest specimens in Matthews Lake and Courageous Lake weighed 3.5 kg but in the Sandy Lake system, the maximum size was 1.5 kg. Anglers working at the Salmita property have reportedly caught lake trout weighing up to 11 kg in Matthews and Courageous Lakes and 5 kg in the Sandy Lake system. Although whitefish *Coregonus clupeaformis* were not captured by Environment Canada during their 1976 study, they report that local fishermen have taken this species by angling in all three lakes. They also reported observing sticklebacks *Pungitius pungitius* L. near the shore throughout the summer of 1976. In addition, they reported that large numbers of young lake trout, less than 30 cm long, were collected from along the shore of Matthews Lake during July and September, 1976. Based on these findings, Moore (1978) concluded that:

1. large numbers of lake trout, whitefish and other species, suitable for the maintenance of a domestic and sports fisheries, were found in the immediate vicinity of the Salmita ore deposit;

2. the shoreline of Matthews Lake in the vicinity of the mine is probably a nursery area for lake trout;

3. the landlocked lakes (i.e. Olsen and Marshy Lakes) "probably" contained no fish and had potential as tailings pond sites.

During September, 1981, Hatfield Consultants Ltd. captured fish from Matthews Lake for heavy metal analysis. Research gang monofilament gillnets were utilized and humpback whitefish, lake trout, Arctic grayling and northern pike of various ages and sizes were collected. These fish are described in detail in section 4.2.3.2 dealing with heavy metal levels in fish.

There does not appear to be additional fishery resource data for the Sandy Lake system beyond that already presented. However, based on the March-April, 1982 field studies carried out by Hatfield Consultants Ltd., it is apparent that a number of the lakes upstream of Sandy Lake, including Russell Lake, freeze to the bottom during winter, either limiting their utilization by fish to certain times of the year or possibly totally preventing fish from utilizing these lakes.

Information with respect to fish populations in Courageous Lake, Matthews Lake and the Sandy Lake system does not exist. Important habitats in the lakes near the Salmita site have not been identified through detailed field studies. However, information has been developed with respect to the species of fish utilizing lakes in the Salmita area. The biology and life cycle of the important species have been discussed by Stewart and MacDonald (1978), Scott and Crossman (1973), and others.

4.2.3.2 Heavy Metals in Fish

Hatfield Consultants Ltd. (1982) report that several species of fish, including whitefish (Coregonus clupeaformis), lake trout (Salvelinus namaycush), Arctic grayling (Thymallus arcticus) and northern pike (Esox lucius), were collected from Matthews Lake during the September, 1981 field survey. Dorso-lateral muscle and livers were removed from the fish for heavy metal analysis.

To document heavy metal accumulation with age, specimens from different age groups were collected from both the humpback whitefish and the lake trout populations of Matthews Lake. The fish catch record showing species, sex, gonad condition, length, weight, age group and calculated age is presented in Appendix Table XII. The heavy metal analysis results for the fish are also presented in Appendix Table XII. (It should be noted that the heavy metal concentrations in tissues are expressed in dry weight units and heavy metal concentrations in livers are expressed in wet weight units.)

Concentrations of heavy metals in the fish tissue and liver samples were relatively high for some specimens. Mercury concentrations were highest in the large lake trout. The small humpback whitefish that were sampled contained the highest concentrations of a number of heavy metals including cadmium, zinc, nickel, molybdenum, chromium and manganese. Cobalt (17.8 micrograms per gram dry weight) and lead (17.12 micrograms per gram dry weight) concentrations were highest in a tissue sample from a 200 gm humpback whitefish. Copper (36.4 micrograms per gram wet weight) and arsenic (3.9 micrograms per gram dry weight) were highest in the liver sample from a large lake trout and in a tissue sample from a large northern pike respectively. Hatfield Consultants Ltd. (1982) concluded that mercury concentrations measured in tissues of small humpback whitefish and large lake trout from Matthews Lake were above the Canadian Food and Drug Directorate Standards. The concentrations of copper, lead and zinc in all the fish tissue samples were below the Canadian Food and Drug Directorate Standards.

Hatfield (1982) reported that the concentrations of mercury and lead in fish tissue samples were generally related to the age of the fish for humpback whitefish and for lake trout. Although metal concentrations generally increased with the age of the fish, an exception to this trend occurred in the 30 gm humpback whitefish group. These whitefish were found to hold higher concentrations of heavy metals in their tissue and liver than older and larger humpback whitefish. Hatfield (1982) suggested that this unusual trend could possibly be attributed to high metal concentrations in the small humpback whitefish food source and to their specific feeding patterns.

4.3 Terrestrial Environment

This section addresses three components of the terrestrial environment: vegetation, birds and mammals. The physical environment (i.e. climate, terrain, geology and soils, air quality and land use) is described in section 4.4. Terrestrial habitat and resources are significantly influenced by the physical environmental features of an area. It should be noted that Matthews Lake is situated in the boreal forest-open tundra transition zone. Therefore, plant and animal species that are typically found in either forest or tundra habitat can be expected to occur at Matthews Lake. The species lists included in the following subsections contain 52 plants, 118 birds and 16 mammals.

4.3.1 Vegetation

The Salmita area is located at the northern extremity of the transition zone between boreal forest and open tundra (Rowe 1972). Cody and Chillcott (1955) wrote the following account of the extent of forestation at Matthews Lake:

> On the west side of the lake, black spruce is fairly common in sheltered valleys, and sometimes attains a height of twenty feet. However, most of the trees in rocky exposed areas are severely twisted and stunted, and have well-developed branches only on the lower two feet of the trunk. Even in wet valleys, there is considerable dwarfing. Here the trees are well spaced, and numerous dead stumps, some of them much larger than the living trees, are scattered throughout the stands.
>
> On the east side of Matthews Lake, the spruce trees are little more than shrubs, rarely over two feet high, growing in compact clumps along the edges of lakes and ponds. These are apparently mature trees with dead spruce of similar size among them. Some of these dwarfed spruce had a few cones on the branches.
>
> Heavy willow and birch thickets, with the occasional alder tree among them are present along drainage areas. These grow as high as ten feet on the west shore, but rarely over six feet on the east shore. In these thickets, <u>Ledum</u> sp., <u>Lycopodium</u> sp. and <u>Polygonum viviparum</u> form a thick overgrowth.

Roycroft and Sutherland (1975) reported that the largest stand of black spruce at Matthews Lake covered 1.3 km^2. The average tree height was 7.6 m and tree diameters were about 5.0 cm. Spruce were found only in low lying areas. On higher, better drained ground, tundra cover predominated. In September, 1981, Hatfield Consultants Ltd. biologists obtained species composition data from transect grids near the Salmita mine site, that indicated that the dominant ground cover species were mosses, lichens and labrador tea. The composition of the plant community was found to be typical of the boreal forest-open tundra transition zone; rare or particularly sensitive floral species were not observed. As reported by Cody and Chillcott (1955), stunted black spruce were observed mainly in protected hollows and in lee areas on the west side of Matthews Lake, although a few individual black spruce were present on the more exposed east side of the lake. Alder and willow were present in nearly all low areas. A complete list of species expected to be encountered in the Salmita area is presented in Table 4.3.1.

The present level of information on vegetation at Matthews Lake appears to be sufficient. Additional details are available in Cody and Chillcott (1955); Larsen (1971); and Thomson, et al. (1969). Further vegetation studies should not be required.

4.3.2 Birds

No direct surveys of bird populations are reported for the Matthews Lake area. Hatfield Consultants Ltd. biologists recorded bird sightings during limnological and terrestrial surveys in September, 1981 and March-April, 1982. In September, ravens, common and red-throated loons, gulls, ptarmigan, and a few species of passerine birds were observed. The loons were present in pairs and/or groups of pairs and presumably were staging before migrating south. The maximum number of pairs observed during a single day was nine. There were no sightings in September, 1981 of important bird groups such as raptors, waterfowl, grebes, terns and cranes. In April, 1982, one snowy owl was sighted. In addition, a group of approximately 20 ravens were noted to have congregated near the mine buildings.

A list of important species expected to occur in the Matthews Lake area is presented in Table 4.3.2. Available information on species present in nearby areas, including the Great Slave Lake East Arm - Artillery Lake area (Kelsall et al. 1971; Kevan and Evernden 1969; Kuyt 1980) and the Point Lake - Contwoyto Lake area (Beak 1981; Searing and Allison 1979), indicates that the more important bird species that can be expected to frequent the Matthews Lake area include the following: peregrine falcon, gyrfalcon, golden eagle, bald eagle, osprey, merlin, rough-legged hawk, Eskimo curlew, snowy owl and sandhill crane, as well as 25 species of waterfowl.

Searling and Alliston (1979) documented the present and potential occurrence of rare, threatened and endangered bird species in a large study area (which encompassed Matthews Lake) between Great Slave Lake and Coronation Gulf. Three species, the peregrine falcon, the Eskimo curlew and the whooping crane, were identified as rare or endangered species that occurred or could occur in the study area. Matthews Lake did not lie within known nesting areas for peregrine falcons; the Eskimo curlew had not been

Table 4.3.1 Plants expected to be found at Matthews Lake

Scientific Name	Common Name
Various not identfied	mosses
Various not identified	lichens
Equisetum arvense L.	common horsetail
E. sylvaticum L.	horsetail
Lycopodium annotinum L.	club-moss
L. selago L.	club-moss
Woodsia gabella R. Br.	woodsia (fern)
Dryopteris fragrans (L.) Scholt	fragrant shield fern
Various not identified	grasses
Hierochloe alpina (Sw.) R. & S.	holy grass
Arctophila fulva (Trin.) Anders.	aquatic grass
Trisetum spicatum (L.) Richt.	a grass
Calamagrostis purpurascens R. Br.	reed-bentgrass
Juncus castaneus Sn.	bog rush
Eriophorum angustifolium Honckn.	cotton grass
E. vaginatum L.	cotton grass
Dryas integrifolia Vahl.	mountain avens
Carex membranacea Hook.	sedge
Picea mariana	black spruce
Scirpus caespitosus L. subsp. *austriacus* (Pallas) Asch. & Graebn.	sedge
Salex reticulata L.	willow
S. alaxensis (Anders.) Cov.	willow
Betula grandulosa Michx.	dwarf birch
Arctostaphylos alpina (L.) Spreng.	alpine bearberry
Empetrum nigrum L.	crowberry
Rubus chamaemorus L.	cloudberry
Oxycoccus microcarpus	small cranberry
Vaccinium uliginosum L.	bilberry
V. vitis-idaea L. var. *minus* Lodd.	mountain cranberry
Ledum decumbens (Ait.) Lodd.	Labrador tea
L. groenlandicum	Labrador tea
Stellaria monantha Hulten	chickweed
Epilobium latifolium L.	broad-leaved willow-herb
Polygonum bistortoides	american bistort

Table 4.3.1 (cont'd)

Scientific Name	Common Name
E. angustifolium L.	fireweed
Potentilla fruticosa L.	cinquefoil
P. nivea L. sl.	cinquefoil
Myriophyllum sp.	watermilfoil
Anemona richardsonii Hook.	anemone
A. parviflora Michx.	anemone
Pedicularis lanata Cham. & Schlecht.	fernwood
Cassiope tetragona (L.) D. Don	Arctic white heather
Loiseleuria procumbens (L.) Desv.	alpine azalea
Carex aquitilis Wahl.	sedge
Saxifraga tricuspidata Rottb.	prickly saxifrage
Silene acaulis L.	moss-campion
Rofieldia pusilla (Michx.) Pers.	false asphodel
Oxytropis arctica R. Br.	pea
Rhododendron lapponicum	lapland rosebay
Pyrola grandiflora Radius	large-flowered wintergreen
Antennaria sp.	everlasting
Andromeda polifolia L.	bog-rosemary
Phyllodoce coerulea	mountain heather

Table 4.3.2 Bird Species expected to be found at Matthews Lake

Common Name	Scientific Name
Common Loon	Gavia immer
Yellow-billed Loon	Gavia admasii
Arctic Loon	Gavia arctica
Red-throated Loon	Gavia stellata
Pied-billed Grebe	Podilymbus podiceps
Whistling Swan	Olor columbianus
Canada Goose	Branta canadensis
Brant	Branta bernicla
White-fronted Goose	Anser albifrons
Snow Goose (incl. Blue)	Chen caerulescens
Ross's Goose	Chen rossii
Mallard	Anas platyrhynchos
Black Duck	Anas rubripes
Pintail	Anas acuta
Green-winged Teal	Anas crecca
Greater Scaup	Aythya marila
Bufflehead	Bucephala albeola
Oldsquaw	Clangula hyemalis
Common Eider	Somateria mollissina
King Eider	Somateria spectabilis
White-winged Scoter	Melanitta deglandi
Surf Scoter	Melanitta perspicillata
Black Scoter	Melanitta nigra
Common Merganser	Mergus merganser
Red-breasted Merganser	Mergus serrator
Sharp-shinned Hawk	Accipiter striatus
Rough-legged Hawk	Buteo lagopus
Golden Eagle	Aquila chrysaetos
Bald Eagle	Haliaeetus leucocephalus
Marsh Hawk	Circus cyaneus
Osprey	Pandion haliaetus
Gyrfalcon	Falco rusticolus
Peregrine Falcon	Falco peregrinus
Merlin	Falco columbarius
Spruce Grouse	Canachites canadensis
Ruffed Grouse	Bonasa umbellus
Willow Ptarmigan	Lagopus lagopus
Rock Ptarmigan	Lagopus mutus
Sharp-tailed Grouse	Pedioecetes phasianellus
Sandhill Crane	Gras canadensis

Table 4.3.2 (Cont'd)

Common Name	Scientific Name
Sora	*Porzana carolina*
Semipalmated Plover	*Charadrius semipalamatus*
American Golden Plover	*Pluvialis dominica*
Black-bellied Plover	*Pluvialis squatorola*
Ruddy Turnstone	*Arenaria interpres*
Common Snipe	*Capella gallinago*
Whimbrel	*Numenius phaeopus*
Eskimo Curlew	*Numenius borealis*
Spotted Sandpiper	*Actitis macularia*
Solitary Sandpiper	*Tringa solitaria*
Lesser Yellowlegs	*Tringa flavipes*
Pectoral Sandpiper	*Calidris melanotus*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Least Sandpiper	*Calidris minutilla*
Dunlin	*Calidris alpina*
Semipalmated Sandpiper	*Calidris pusilla*
Sanderling	*Calidris alba*
Stilt Sandpiper	*Micropalama himantopus*
Red Phalarope	*Phalaropus fulicarius*
Northern Phalarope	*Lobipes lobatus*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Herring Gull	*Larus argentatus*
California Gull	*Larus californicus*
Ring-billed Gull	*Larus delawarensis*
Mew Gull	*Larus canus*
Bonaparte's Gull	*Larus philadelphia*
Sabine's Gull	*Xema sabini*
Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Snowy Owl	*Nyctea scandiaca*
Hawk Owl	*Surnia ulula*
Short-eared Owl	*Asio flammeus*
Belted Kingfisher	*Megaceryle alcyon*
Common (Yellow-shafted) Flicker	*Colaptes auratus*
Black-backed Three-toed Woodpecker	*Picoides arcticus*

Table 4.3.2 (Cont'd)

Common Name	Scientific Name
Northern Three-toed Woodpecker	Picoides tridactylus
Eastern Kingbird	Tyrannus tyrannus
Eastern Phoebe	Sayornis phoebe
Western Word Pewee	Contopus sordidulus
Olive-sided Flycatcher	Nuttallornis borealis
Horned Lark	Eremophila alpestris
Barn Swallow	Hirundo rustica
Cliff Swallow	Petrochelidon pyrrhonota
Gray Jay	Perisoreus canadensis
Common Raven	Corvus corax
Common Crow	Corvus brachyrhynchos
Boreal Chickadee	Parus hudsonicus
American Robin	Turdus migratorius
Gray-cheeked Thrush	Catharus minimus
Mountain Bluebird	Sialia currucoides
Water Pipit	Anthus spinoletta
Bohemian Waxwing	Bombycilla garrulus
Northern Shrike	Lanius excubitor
Tennessee Warbler	Vermivora peregrina
Yellow Warbler	Dendroica petechia
Yellow-rumped (Myrtle) Warbler	Dendroica coronata
Blackpoll Warbler	Dendroica striata
Wilson's Warbler	Wilsonia pusilla
Rusty Blackbird	Euphagus carolinus
Brewer's Blackbird	Euphagus cyanocephalus
Common Grackle	Quiscalus quiscula
Pine Grosbeak	Pinicola enucleator
Hoary Redpoll	Carduelis hornemanni
Common Redpoll	Carduelis flammea
White-winged Crossbill	Loxis leucoptera
Savannah Sparrow	Passerculus sandwichensis
Dark-eyed (Slate-colored) Junco	Junco hyemalis
Tree Sparrow	Spizella arborea
Chipping Sparrow	Spizella passerina
Harris's Sparrow	Zonotrichia querula
White-crowned Sparrow	Zonotrichia leucophrys
Fox Sparrow	Passerella iliaca
Lapland Longspur	Calcarius lapponicus
Smith's Longspur	Calcarius pictus
Snow Bunting	Plectrophenax nivalis

reported within the study area since 1831; and whooping cranes were not present, but there was data to indicate that whooping cranes could on occasion be present in the Matthews Lake area.

No sightings of whooping crane or Eskimo curlew were reported in the Salmita camp record or during Hatfield surveys. It is unlikely that the Eskimo curlew or the whooping crane would be observed. However, if a sighting did occur, it is very important that such an observation be reported immediately to staff of the Canadian Wildlife Service and Renewable Resources, G.N.W.T.

Records of peregrine falcons at Matthews Lake include an entry in the Salmita camp record of a single sighting at the Tundra property on September 24, 1981. There is no other data to indicate that peregrine falcons or falcon habitats are present at Matthews Lake. Field studies are required in the area to enumerate peregrine falcons and to assess the suitability of the area, particularly the more abrupt hillsides on the west side of Matthews Lake, for utilization by peregrine falcons.

The Matthews Lake area has several marsh areas, particularly at the extreme south and north ends of the lake, that appear suitable for nesting and staging activities for the numerous waterfowl species listed in Table 4.3.2. At this stage, surveys have not been conducted during waterfowl migration periods to identify species, numbers and important habitat areas. The data gaps identified in this subsection will be addressed during a subsequent field study planned for the spring of 1983. A program will be developed for the Salmita staff so they will be able to record more detailed information with respect to bird species, habitat utilization, and seasonal occurences.

4.3.3 Mammals

4.3.3.1 Caribou

Matthews Lake lies within the distribution range of the Bathurst herd of the barren ground caribou (*Rangifer tarandus groenlandicus*) which is reported to number 150,000 (Jakimchuk 1979). The winter range of the Bathurst herd extends from north of Great Slave Lake to south and east of Great Bear Lake, generally within the treeline (Jakimchuk 1979; Fleck and Gunn 1982). Traditional migration routes between wintering areas and calving grounds east of

- salt storage
- airstrip
- disturbance

Bathurst Inlet included concentrations in the Lac de Gras - Mackay Lake area (Banfield 1977). Recent surveys of Bathurst herd migrations indicate frequent use of routes to the northwest and southeast of Matthews Lake (Fleck and Gunn 1982).

Caribou population information specific to the Matthews Lake area is based upon a daily record kept at the Salmita camp of caribou sightings made by mine staff, and incidental data collected by Hatfield Consultants Ltd. biologists in September, 1981 and March-April, 1982. The camp records show that caribou were present in groups of 1,000 to 2,000 animals in September, 1981, and in smaller numbers in the winter months. Hatfield Consultants Ltd. personnel observed two groups of approximately 300 and 500 caribou respectively, on March 30, 1982, in the area between the airstrip and the Tundra property. Several migrating herds of approximately 300 to 500 animals were also noted during August, September and October of 1982.

The Bathurst herd is monitored regularly by the G.N.W.T. Wildlife Service. It is important that the annual herd count data be reviewed for any changes in the herd population and in the pathways followed during migrations. Giant staff on site will continue to monitor the frequency and number of caribou observed passing through the area. In addition, caribou activities (eg. feeding, resting, etc.) while in the area will be noted. The information will be mapped and provided to government regulatory agencies.

4.3.3.2 Other Mammals

Mammal species other than caribou that are expected to occur at Matthews Lake are listed in Table 4.3.3. The high number of species (16) reflects the ecological diversity of the boreal forest-open tundra transition zone, which provides habitat for both forest and tundra dwelling species. However, because the Matthews Lake area is situated in the northeastern fringe of this transition zone, many of the forest species would be present infrequently. The more important* species that are present or are expected to occur in the Matthews Lake area are wolf, Arctic fox, red fox, barren-ground grizzly bear, wolverine, Arctic hare, and Arctic ground squirrel.

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* based upon the lists of valuable fur bearers (Tinling, 1982). Arctic hare has also been included in the list because of the large numbers present in the Salmita area in September, 1981.

Table 4.3.3. Mammals expected to be found at Matthews Lake.

Scientific Name	English Name
Soricidae	
Sorex cinereus	masked shrew
Leporidae	
Lepus arcticus	Arctic hare
Sciuridae	
Spermophilus parryii	Arctic ground squirrel
Muridae	
Clethrionomys rutilus	northern red-backed vole
Lemmus sibiricus	brown lemming
Dicrostonyx torquatus	collared lemming
Microtus pennsylvanicus	meadow vole
Canidae	
Canis lupus	wolf
Alopex lagopus	Arctic fox
Vulpes vulpes	red fox
Ursidae	
Ursus arctos richardsoni	barren-ground grizzly bear
Mustelidae	
Mustela erminea	ermine
Gulo gulo	wolverine
Cervidae	
Rangifer tarandus groenlandicus	barren-ground caribou
Ovibos moschatus	muskox
Alces alces	moose

Detailed population surveys for these species have not been undertaken in the Matthews Lake area. However, since September, 1981, the Salmita staff have kept a record of all wildlife sightings. Sightings include fox, hare, wolf and ground squirrel in most months, with sightings of fox and wolf increasing during January and February of 1982. Wolverine and grizzly bear were also reported. In September, 1981 and March-April, 1982, Hatfield Consultants Ltd. biologists recorded incidental sightings of weasel, Arctic hare, Arctic ground squirrel, bear (scat only), wolf and red fox.

While the camp sighting record indicates regular occurrences of wolf, fox and hare, and occasional sighting of grizzly bear and wolverine, surveys have not been conducted to determine the population sizes and important habitat areas. However, observations will continue to be recorded over the life of the project to develop a data base with respect to populations. An aerial and ground survey will be carried out during the spring of 1983 (i.e. in conjunction with other planned study activities) to locate denning areas used by wolf, fox, bear and wolverine. It is felt that over the relatively short life of the project, a substantial amount of wildlife resource information will be gathered.

4.4 Physical Environment

This section briefly summarizes the physical environmental information (i.e. climate, terrain, geology, soils, air quality and land use) for the Matthews Lake area. Generally speaking, site specific, physical environmental information is very sparse. However, this is not considered to be a major concern recognizing the nature of the project that is proposed.

4.4.1 Climate

The Matthews Lake area lies within the Tundra climatic region. The mean annual temperature is approximately minus 8°C. Mean January temperatures for 1948 to 1973 ranged from minus 34°C to minus 25°C. In July for the same period, the mean minimum temperature was approximately 8°C, the maximum 19°C. The mean annual precipitation is less than about 30 cm. Evaporation exceeds precipitation on an annual basis. The mean length of the frost-free period is approximately 90 days (measured at Aylmer Lake). Westerly winds prevail during most times of the year; winds from other directions occur more frequently during summer months. The average wind speed based upon anemometer readings at Ennadai Lake between 1955-1972 was approximately 23.0 km per hour.

4.4.2 Terrain

Matthews Lake lies in an area of gently rolling topography, with elevations ranging between 425 m and 490 m above sea level (Roycroft and Sutherland 1975). Cody and Chillcott (1955) noted the presence of eskers as an outstanding feature, these eskers rise to thirty feet above ground level and generally run northwest to southeast.

The Salmita site is located in the relatively small Matthews Lake drainage area. Bulldog Lake, adjacent to the former Tundra mill site, and several other small lakes and ponds are located upstream (south) of Matthews Lake. The Tundra mill site is located on the crest of a ridge separating the Matthews Lake drainage on the west side from the smaller Sandy Lake drainage on the east. The Sandy Lake drainage is comprised mainly of a chain of small lakes that begin immediately east of the Tundra site. Both drainages flow northward to Courageous Lake, which in turn, drains eastward to Mackay Lake and the Lockhart River. (These aquatic systems have been discussed in more detail in section 4.2).

4.4.3 Geology and Soils

The Matthews Lake area lies in the Slave province of the Canadian Shield. The Slave province characteristically is composed of: archean pyroclastics, greywacke and shale overlain by Yellowknife volcanics, dolomites and limestone (Anon 1973). The bedrock at Salmita, as reported by Giant personnel, is altered felsic volcanics of the Yellowknife group. Mineralization occurs in quartz veins containing gold values and sulfides. Among the sulfides, pyrite, arsenopyrite, pyrrhotite and chalcopyrite are present. The gangue material consists of bluish grey quartz, veinlets of white carbonate, some scheelite and greenish grey schistose rafts.

Gold is contained in the ore as inclusions in quartz and to a lesser extent associated with arsenopyrite. Other sulphide minerals present in the ore include galena and some sphalerite. Generally, the chalcopyrite and sphalerite are associated with the pyrrhotite. The arsenopyrite is present as discrete grains. This subject has been discussed in more detail in section 3.2.

There is no specific information available for soil structure at Matthews Lake. However, a general overview of soil type was provided by Rowe (1972) in which soils over a large area of Canada, including the Matthews Lake area, were mapped. Grey luvisols, eutric brunisols, and organics were reportedly present in the Salmita area. Cody and Chillcott (1955) made the following observations:

> The region is fairly free of glacially transported rock. There are only scattered boulders and no moraine fields. The soil is gravelly and permafrost is found on the average at about the 6 inch depth. The marsh-land is hummocky, with niggerheads about a foot apart. There is little sorting of particles on the well-drained uplands, but in a few partially drained areas, frost action has opened crevices about two feet deep, blocking off large irregular polygons of heath tundra. Frequently the small hummocks are formed in a large ring ten to fifteen feet across with a flat gravelly centre. In some of the drier marshy areas frost action has brought the finer particles together to form little pockets of fine rich black soil about eight inches in diameter extending down to permafrost level.

The site lies in the zone of discontinuous permafrost; permafrost thickness at Matthews Lake was reported by Brown (1967) to be approximately 300 m thick near the Tundra mine.

4.4.4 Air Quality

Air quality monitoring data for the Salmita area as well as the remainder of the Northwest Territories is extremely sparse. The Salmita area is expected to have no measurable air contaminants other than moderately dense smoke from fires burning south and west of the site periodically during the summer and fall. Exhaust emissions from equipment on site in the Salmita area are small in magnitude. It is reasonable to assume that the Canadian ambient air quality objectives are being met in the Salmita area.

4.4.5 Land Use

An assessment of current and potential land uses was undertaken. The following conclusions result from the research:

1. Archaeological and heritage resource information for this area is virtually non-existent, the archaeological and heritage resource potential for the area is moderate (Arnold, pers. comm. 1982).

2. There are no plans with respect to developing a park or wilderness area anywhere within the zone of impact of this project (McKendrick, pers. comm. 1982).

3. The area around Salmita has not been utilized to a large extent for native hunting and trapping and is not considered to be special.

4. No commercial fishing and/or hunting camps are operating currently in the immediate area nor is there any interest expressed in developing camps in the area (McKendrick, pers. comm. 1982).

5. The area, as discussed in different sections of this report, has a substantive history of mining industry activities.

5.0 ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES

In reviewing this section and the subsequent section addressing residual impacts, it is important to note, at this stage of the overall project, the following points:

1. that the Salmita property is serviced by air in summer, and by air and winter road in winter. There are no plans to construct a year-round service road to the mine site;

2. that the airstrip has been in existence for more than 20 years and has been recently upgraded by Giant. Additional work on the airstrip will be minimal;

3. that a camp has been built at the mine site; in view of the short life of the mine (i.e. 2.5 years) a permanent town site will not be constructed;

4. that, as discussed in section 2.3, two mill sites, one adjacent to the Salmita mine and camp, and the old Tundra mill site, were evaluated on technical, environmental and economic grounds. The Tundra mill site was determined to be the most feasible site;

5. that tailings will be discharged to a total retention tailings impoundment system encompassing the former Tundra tailings area;

6. that service roads on the property have been constructed and that new roads are not necessary.

5.1 Aquatic Environment

5.1.1 Water Quality

Giant Yellowknife Mines Limited proposes to discharge mill tailings and domestic sewage from the mill site to a total retention tailings impoundment area in the upper watershed of the Sandy Lake system. The location is illustrated in Figure 3.5.1. A small lake, Russell Lake, the uppermost lake in the system, will be incorporated into the tailings impoundment area. In justifying the incorporation of Russell Lake in the impoundment area, it is important to note the following points:

1. that during the previous operation of the Tundra mill, tailings were discharged directly to Russell Lake;

2. that Russell Lake and the lake (Unnamed Lake) immediately downstream of it, are very shallow and freeze to the bottom during winter months;

3. that Russell Lake and Unnamed Lake are linked by a small stream that flows intermittently, i.e. flow has been observed only during the "spring thaw" period.

Noting items 2. and 3. above, it is reasonable to conclude that it is very unlikely that Russell Lake supports any kind of resident fish populations.

The tailings dam has been designed and the impoundment area sized such that all effluent flowing into the tailings disposal area can be retained (obviously there will be evaporation losses from the pond during summer months). Initially, (i.e. in the short-term) some seepage may be expected when mill tailings are discharged into a newly-constructed impoundment area. Degradation of the permafrost by the rising water levels will be minimized by constructing a fine tailings beach with a low angle of repose on the Russell Lake side of the dam structure using tailings from the former Tundra operation. This beach will serve to reduce dam permeability and insulate the permafrost. In the longer term, permafrost aggradation into the dam structure is expected and this will serve to prevent seepage. During summer months, mill tailings will be deposited in such a manner as to build up the beach area on the upstream face of the dam. As an additional environmental safeguard, Giant Yellowknife Mines Limited will install sandpoint monitoring stations between the tailings impoundment dam and Unnamed Lake to determine the quality and amount of any seepage. If necessary, a seepage collection system, containing a sump and a pump for returning any possible contaminated seepage water to the tailings impoundment area, will be constructed. Contaminated seepage will not be permitted to enter the Sandy Lake system. Impacts upon water quality in the Sandy Lake system are considered to be negligible.

Tailings impoundment dam construction is expected to take place during May and June of 1983. Assuming that the small intermittent stream joining Russell Lake and Unnamed Lake is flowing at the time of construction, some construction-induced siltation of this stream will occur. This impact will be of a short-term nature. Unnamed Lake will be the receptor of the silty waters and will act as a settling pond. Lakes downstream of Unnamed Lake will be unaffected by dam construction activities. The overall impacts on water quality as a result of this activity are considered to be minor.

At the Salmita site during the exploration and development phases of the project, minewater and sewage have been discharged to the marsh area between the work area and Matthews Lake. It is important to note the following with respect to these effluent discharges:

1. that minewater discharge rate is extremely low (i.e. 8,000 liters per day) although this may increase somewhat during the operational phase of the mine;

2. that testing of the ore and waste rock has indicated that neither the ore nor the waste rock is acid generating;

3. that recent monitoring of minewater quality indicates that it has a neutral pH and that heavy metal concentrations are very low;

4. that the domestic sewage is ground before discharge to the marsh;

5. that the volume of domestic sewage discharged during the operational phase of the development will be approximately 30000-50000 liters per day.

6. that during warm weather months there is an effluent discharge from the marsh area to Matthews Lake.

7. that this discharge enters Matthews Lake downstream of the Salmita water intake structure.

The existing sewage and minewater disposal scheme was considered acceptable by regulatory agencies during the development phase of the project. Giant Yellowknife Mines Limited propose to continue to handle minewater in the same manner during the operating life of the project. As discussed in section 3.6.1, during the operating life of the project, sewage will be discharged to a bermed containment area located within the marsh. During warm weather months, the sewage will be allowed to seep through the berm and gradually work its way to Matthews Lake. The treated sewage will enter Matthews Lake downstream of the Salmita water intake structure. Impacts, if any, upon Matthews Lake water quality would be very localized and are considered to be minor. Monitoring of the effluent and local Matthews Lake water quality will be undertaken in accordance with the requirements of the water license.

The only other wastewater streams with potential water quality concerns are associated with runoff from the waste rock and ore storage areas illustrated in Figure 3.1.2. Noting that the ore and waste rock are non-acid generating and occupy a limited area, the impact of this flow (i.e. 650 cubic meters per month during the peak precipitation month) on Matthews Lake water quality will be minor. The ore and waste rock storage areas have been in their current locations during the past seven years and no Matthews Lake water quality concerns have been noted.

Water quality could be seriously affected by an oil spill resulting from a storage tank rupture in the tank farms at either the Salmita or Tundra site. The locations of the tank farms are illustrated in Figures 3.1.2 and 3.1.3. The Salmita tank farm area is lined with an impermeable membrane and berms have been constructed around it to prevent spilled oil from reaching Matthews Lake. Similar precautions will be taken at the proposed Tundra tank farm site.

5.1.2 Limnology and Fisheries

With respect to effluent disposal, since the impact on water quality from the proposed Salmita mine and mill development effluents is expected to be minimal in the short and long-term, the impact on the lakes in the area (with the exception of Russell Lake) and their fish populations is expected to be minor. As stated in section 5.1.1, Russell Lake does not appear to support resident fish populations. The fact that tailings had been discharged to this lake previously make Russell Lake an excellent site for a tailings impoundment area.

Water intake structures, if improperly screened, can result in fish mortalities as a result of fish being drawn into the intake structure. The locations of the mine and mill water intake structures are illustrated in Figures 3.1.2 and 3.1.3. The Salmita intake structure on Matthews Lake has been designed in accordance with the screening requirements of Fisheries and Oceans Canada. The former Tundra mill intake structure in Bulldog Lake will also be reactivated in accordance with Fisheries and Oceans Canada requirements. Impacts upon fishery resources as a result of each of these intake structures are considered to be negligible.

5.2 Terrestrial Communities

In this section, impacts and mitigative measures relative to vegetation and bird and mammal populations are addressed. The overall impacts are considered to be minor.

5.2.1 Vegetation

Potential impacts of the proposed project on vegetation in the development area would be caused primarily by surface disturbance. Surface disturbance includes direct destruction of plants on all construction areas with the primary concern in this instance being elimination of rare plant species. Given the relative uniformity of boreal forest-open tundra transition zone vegetation and the small scale of the Salmita development, this is viewed as a relatively minor concern.

The other major category of vegetation impacts arising from surface disturbance are caused by changes in the permafrost regime. Permafrost melting and substrate instability (eg. arising from trenching activities) either buries plants or interferes with rooting. Ultimately, the effect is loss of communities over the affected area. The removal of plants from vegetated surfaces modifies the reflectivity (albedo) of the ground surface and allows for a deeper active layer and a thawing of permafrost. This results in slumping, solifluction, subsidence and collapse of surface features, the severity of which is determined by slope and moisture content of the substrate. In general, permafrost degradation is of concern primarily in ice-rich (wet) soils. Upland gravel areas are not as seriously affected.

Because most of the work area is situated on ice-poor, gravel uplands, the vegetation-permafrost degredation problem will be a relatively minor concern. In support of this contention, it should be noted that there has been activity at the Tundra site since the mid-1960's and at Salmita since 1975 and no significant vegetation problems have become apparent.

Changes in water quality can affect plants through the uptake of noxious chemicals into root systems and ultimately into the local food web. This is of concern only in the tailings disposal area. Design standards of the tailings control structures, which include seepage water collection and return, make this a relatively minor concern.

Impacts to vegetation arising from development of the Salmita project will be very localized and no major concerns are evident. Surface disturbance at the mine site and mill site will be kept to a minimum to prevent disruption of vegetation mats. This is particularly important where ice-rich soils are involved and during spring and summer seasons. Vehicles will be restricted to established roadways.

5.2.2 Birds

Information deficiencies with respect to resident and migratory bird populations in the Matthews Lake area, habitat and the utilization of habitat in the area have been identified in section 4.3.2. Only very general information is available. Studies were identified for the 1983 spring migration period. However, certain important considerations are presented at this time:

1. an immediate disturbance impact may be felt by any birds nesting close to the mill site during rehabilitation of the site. Most species will habituate to disturbance if not harrassed in any way, and this impact should thus be local and short-term since personnel will not be allowed to disturb birds nesting close to the mine or mill site;

2. disturbance of peregrines or eskimo curlew to the point of desertion could have serious repercussions on the species, especially in the case of the curlew;

3. a new building site could provide an artificial "cliff" for peregrines or other raptors. If not disturbed, this could increase the breeding population.

In order to minimize impacts on birds, Giant personnel, contractors and visitors to the Salmita site, will not be permitted to have firearms on-site. The spring 1983 field study will identify sensitive or important habitat in the area and determine whether special measures are required to protect this habitat. Data obtained will be provided to government regulatory agencies. Banning firearms from the site and developing measures to protect important habitat will ensure that environmental impacts are minimal and acceptable.

5.2.3 Mammals

Assessments of the impacts of industrial developments on mammal populations in Arctic regions generally include the following categories:

- direct disturbance or harassment of animals;
- interference with migration routes;
- habitat alteration or loss;
- increased exploitation of populations;
- attraction of nuisance animals to camp facilties;
- increased accidental mortality of animals.

The following discussion relates the above subjects to the environmental baseline conditions and project design at the Salmita site. The scope of potential concerns are provided for each impact category.

A number of general factors determine the nature and extent of impacts on mammals. One of the most important considerations is whether the proposed development provides unlimited access (and ultimately increased disturbance or exploitation) to previously isolated populations. Small, isolated projects without permanent road access are generally less deleterious to mammal populations than linear development corridors. Another factor is the duration of the impact. At Salmita, disturbances will be short-term and associated principally with mill rehabilitation. Other issues (eg. habitat loss through tailings impoundment) are longer-term and may be in effect throughout and after the operational life of the project. The latter are often of greater concern and relate to the overall size of the development and the area of impact. In this instance, the impacts upon habitat are localized and small.

In the subsections that follow, specific potential impacts on mammals as a result of the Salmita project are evaluated recognizing the following:

1. that the development will be relatively small in relation to alternative mammalian habitats available in the region;

2. that permanent road access will not be provided; Giant will be sharing the established Echo Bay Mines Limited, Lupin Mine winter road;

3. that mine and mill effluents will be contained and handled in an environmentally acceptable manner;

4. that resident mammal population densities in the area are small;

5. that barren-ground caribou of the Bathurst herd migrate through the Matthews Lake region between wintering areas near Great Slave Lake and the main calving area located east of Bathurst Inlet. Herds as large as 2000 animals have been observed in the area.

5.2.3.1 Direct Disturbance of Mammals

Giant will enforce a policy prohibiting deliberate and avoidable disturbance of wildlife. The only exception will occur when it becomes necessary to chase a bear out of camp in order to protect workers or mine property. Unavoidable disturbances (eg. construction noises) are of a short-term nature and are considered to be a minor concern.

5.2.3.2 Interferences with Migration Routes

This concern applies principally to caribou migration obstructions associated with linear development projects. This species relies on widely separated seasonal ranges for calving, post-calving, and winter use and many biologists fear that interference with movements between these areas will result in alteration of range utilization and subsequent population declines. This is not a concern at Salmita, principally because of the type and size of the proposed project. On a number of occasions, caribou have been noted migrating through the area between Matthews Lake and the airstrip. A winter road to the Salmita site has been operational the past two years and no migration problems have been reported.

5.2.3.3 Habitat Alteration or Loss

Because of the small scale of the project, and low population densities of mammals in the area, the effects of habitat loss will be minimal.

5.2.3.4 Increased Exploitation of Populations

This is typically a problem caused by hunting along newly-constructed access roads into previously remote areas and excessive hunting and trapping by staff in a localized area. Ungulates which occupy restricted habitats or which have small, localized populations, appear to be most susceptible to the latter. Because of the lack of a permanent access road to the Salmita site, exploitation is not considered to be a major problem. Historically, hunting and trapping have not been permitted at Salmita. It is Giant's intention to continue to enforce this policy.

5.2.3.5 Attraction of Nuisance Animals to Camp Facilities

Improper garbage disposal near construction camps and service facilities frequently leads to scavenging by bears and foxes. These animals readily become habituated to human presence and must then often be removed from the area or destroyed for reasons of human safety. In order to minimize these concerns, garbage will be collected and incinerated on a routine and frequent basis, generally daily.

5.2.3.6 Increased Accidental Mortality of Animals

While some accidental mortality of animals can be expected (i.e. in collisions with vehicles), the low number of animals near the site suggests that this will be a minor problem. It is also important to note that there will only be approximately 20 to 25 round trip vehicle (ore trucks and personnel carriers) passages per day.

5.3 Air Quality

As stated in section 4.4.4, baseline air quality data for the Salmita area is non-existent but it is reasonable to assume that the Canada Ambient Air Quality Objectives are being met. Emissions from the site will include crusher plant emissions and emissions from lime mixing area that will be treated prior to discharge, and other emissions such as incinerator and mine ventilation exhaust gases, vehicular emissions etc. that do not require treatment. The crusher plant emissions will be treated using a baghouse for control of particulate matter. The lime mixing area exhaust gases will be treated using a high efficiency wet scrubber system (or the equivalent) for the control of particulate matter. The overall site emission loadings are very small. Other mitigative measures are not considered to be necessary. The federal ambient air quality criteria will be met.

5.4 Geology and Soils

The long history of mining industry interests and activities at Salmita and Tundra have been discussed in this document (eg. section 2.1.2). As a result, many of the terrain changes associated with this overall development have been passed to Giant from previous property owners. Regardless of responsibility, the terrain alterations that have taken place are considered to be localized and minor.

The most significant terrain alteration proposed by Giant is the development of a tailings impoundment area, including a dam, in the Russell Lake area. It is expected that, during the initial phases of the operation of the tailings impoundment, there will be a warming of the soil resulting in permafrost subsidence. However, in the longer term, permafrost should aggrade into the tailings and dam structure as they increase in thickness and eventually act to further seal the impoundment.

6.0 RESIDUAL ENVIRONMENTAL IMPACTS

For the purposes of this document, residual enviromental impacts are defined as impacts, regardless of their overall magnitude that persist following the implementation of mitigative measures. This section of the report should be reviewed recognizing the very small area exposed to this project and recognizing that many of the structures and facilities present on site existed in some form prior to Giant's involvement at Salmita. Examples include the Tundra mill complex, the airstrip, other buildings and roads, etc.

6.1 Aquatic Environment

6.1.1 Water Quality

Residual impacts as a result of the operation of the tailings impoundment system described in this report, should be minimal. Permafrost will penetrate into the deposited tailings over a period of time and enhance their stability. However, by its continual presence after mining has ceased and the complex abandoned, the tailings disposal area will remain as a potential source of residual impacts on water quality. The fact that the ore body is non-acid generating greatly reduces short-term and long-term environmental concerns. The proposed reclamation program designed to further isolate the tailings impoundment area will ensure that water quality impacts will be minimal.

The discharge of minewater and domestic sewage to a marsh leading to Matthews Lake may result in a minor change in water quality in the lake area immediately adjacent to the marsh during the operating phase of the project. During the abandonment phase these discharges will be eliminated and no residual impacts will occur.

6.1.2 Limnology and Fisheries

Noting that significant residual impacts on water quality are not expected, residual impacts on limnology and fisheries are expected to be minor.

6.2 Terrestrial Communities

6.2.1 Vegetation

The elimination of vegetation communities from project activity areas such as roads, the tailings impoundment area etc. will persist in most instances on a permanent or at least an indefinite basis. The elimination of rare plant species is theoretically possible although unlikely.

6.2.2 Birds

Although not a great deal is known about bird species and populations in the area at the present time, noting the extent and type of project, no long-term negative impacts are expected. If, as in the case of other abandoned mines, owls and cliff-nesting birds use the taller buildings as artificial cliffs, certain positive impacts could be associated with the abandonment phase.

6.2.3 Mammals

Noting that staff on site will not be permitted to hunt or trap, impacts on wildlife will be minimal during the operational phase. Animal-vehicular accidents could result in a small number of animal deaths. The shooting of a bear may be necessary on occasion to protect workers and mine property. Neither of these events have taken place to date, but the longer the activities continue, the greater the probability. There will be a minor amount of permanent terrestrial habitat loss (eg. the area surrounding Russell Lake, the site of the proposed tailings impoundment). The areas involved are small and the habitat is typical of the boreal forest-open tundra transition zone.

6.3 Air Quality

There will be no residual impacts associated with air quality.

6.4 Geology and Soils

The major changes following abandonment will be the presence of finer surficial materials and a new landform at the site of the tailings disposal area. This may be considered a negative impact by some readers. The impact (if any) would be small.

7.0 SOCIAL AND ECONOMIC CONSIDERATIONS

This section of the Initial Environmental Evaluation addresses Giant's intentions with respect to the social and economic aspects of the proposed project. It is not considered to be or intended to be all-encompassing. It has been prepared recognizing the location, small size and short duration of the project. The reviews of Northwest Territories mining industry "Socio-Economic Action Plans" and discussions with federal and territorial government staff are the base upon which this section was prepared. This section has been prepared as the basis for future discussions with G.N.W.T. and the federal government relative to developing an "Action Plan" for this project.

7.1 The Setting

7.1.1 Background

Giant Yellowknife Mines Limited Salmita property is located 240 air km northeast of Yellowknife as illustrated in Figure 2.1.1. The mine site is located in an isolated and uninhabited area. During the past two years, a winter road has been constructed between Yellowknife and Salmita; this road is essentially an extension of the Camlaren Mine road. In the future, shared utilization of the Echo Bay Mines Limited, Lupin Mine winter road will provide access to the site. During the remainder of the year, transportation to the Salmita site is limited to chartered aircraft. Yellowknife is the closest community to the Salmita site and the community to benefit most by the operation of a mine at the Salmita site.

From March, 1964 until January, 1968, the Tundra gold mine operated approximately 5.3 km south of the present Salmita development. No permanent community was established on site probably because of two main factors:

1. the short anticipated life of the mine;

2. the small size of the development.

For similar reasons, Giant is planning to operate the Salmita property with no permanent town site. This subject is discussed in more detail in section 7.2.2.

7.1.2 The Communities

Yellowknife, the closest major community and the community with the potential for providing a large part of the northern workforce for the Salmita mine, as well as most goods and services, is considered to be a modern expanding city. In the past, Yellowknife was known to be primarily a mining town. Located on the north shore of Great Slave Lake, Yellowknife has a population of approximately 10,500 and has been the capital of the Northwest Territories since 1967. Historically significant points of interest for Yellowknife include the following:

1. the area was first explored in about 1771 by Samuel Hearne, who at the time was exploring for the Hudson's Bay Company;

2. gold was first discovered in the area in 1896;

3. by 1934, the true potential for the gold finds in the Yellowknife area became apparent and by 1938, several mines were operating.

The population of Yellowknife has increased from 3,000 in 1945 to over 10,000 in 1981 principally as a result of mining developments and the establishment of Yellowknife as the capital in 1967. The governments (territorial and federal) and mining are the two main employers in the city. Yellowknife is serviced by road from Edmonton. In addition, regular airline passenger and freight service is provided by airlines from southern cities such as Edmonton, Calgary, Vancouver and Winnipeg.

Many Yellowknife residents have worked in the mining industry in the past. As a result of the mining industry experience base in existence in Yellowknife, it is believed that a signficant number of the jobs at Salmita during both the development and operational phases of the project can be filled locally. Mining industry goods and services are also available in Yellowknife and these goods and services will be utilized by Giant at Salmita to as large extent as they are available. These subjects are discussed in more detail in subsequent sections.

Other communities such as Rae-Edzo, Lac la Martre and Rae Lakes could also benefit through employment and job training opportunities.

7.1.3 Previous Involvement in the Mining Industry

As stated in section 7.1.2, the City of Yellowknife's principal reason for development and expansion during the period from the 1930's to the 1960's was as a result of mining industry activity. Many individuals in Yellowknife work or have worked directly in the mining industry, most for either Cominco or Giant Yellowknife at their mines in the Yellowknife area. Many others have worked for companies providing goods and services to the mining industry. The history of mining in Yellowknife is extensive and is unlike that of any other community in the Northwest Territories. The Salmita mine will be operated on a rotational basis (i.e. a fly-in, fly-out system with a camp but no town site will be implemented). It is unlikely that many individuals in Yellowknife have experienced this situation, however, adjusting to this employment mode is not expected to cause undue concerns.

The experiences of the predominantly native populations of Rae-Edzo, Lac La Martre and Rae Lakes in the mining industry have not been investigated at this stage but are thought to be minimal. This will not necessarily be a problem since the opportunity for interested individuals to work and gain experience in the mining industry will be looked upon favourably by many. The rotational nature of the work is expected to be looked upon as advantageous to natives employed at the mine in that it will allow ample time for hunting, trapping and fishing during the extended periods away from the mine.

7.1.4 Resource Harvesting

Resource harvesting plays an important role in the communities of Rae-Edzo, Rae Lakes and Lac la Martre as well as for many members of the native community in Yellowknife. As well as cash income from fur sales, many residents hunt and fish to obtain country foods for personal consumption. Studies conducted by Dome Petroleum and Gulf Oil (Beak and Collins 1980) have indicated that the introduction of employment opportunities does not seriously affect hunting and trapping activities or the supply of country food. Salmita employees would return home every six weeks (approximate, ultimate scheduling will exhibit some degree of flexibility) and have ample opportunity to hunt, trap and fish during this time away from the job. In fact, northern experience indicates that native people strongly preferred a rotational work schedule.

7.2 The Project

7.2.1 Activities to Date

History of the Site and Current Undertakings

Territories Exploration Limited discovered gold in the Salmita area in 1939. In 1945, Salerno staked and prospected 18 claims in the area. By 1949, the total number of claims staked had increased to 31. During this period, Salmita Northwest Mines Limited, (later the name was changed to Salmita Consolidated Mines Limited), undertook considerable diamond drilling in the area. In 1951, a 44 m deep vertical shaft was sunk with 35 m of cross-cutting. In 1952, a wooden mill building was erected on the site and several pieces of milling equipment were brought in but never installed.

There appears to have been little or no activity at the Salmita site between 1952 and 1959. In 1959, Mack Lake Mining Corporation optioned the property and in 1961, absorbed Salmita Consolidated Mines Limited. No work appears to have been undertaken at Salmita between 1961 and 1974. In 1974, Giant obtained an option on the Salmita property and during the summer of 1975, drove a 290 m decline into the orebody for the purpose of exploration. In addition, more than 1500 m of diamond drilling was carried out on the Salmita property.

To accommodate the people working on the 1975 exploration program, Giant brought in five trailers by winter road from Yellowknife. Exploration and development related activities have taken place at various levels of activity since 1975. Giant is currently planning to rehabilitate the Tundra mill facilities to bring the Salmita property into production. To accommodate the schedule for operation by mid-1983, fuel, supplies, and some equipment must be moved to the area via the winter road in the winter of 1982 - 1983. Proven ore reserves indicate a mine life of about two and one-half years at a milling rate of 159 tonnes per day. The ore, as mined, will be trucked from Salmita to the Tundra mill for processing. All living facilities will be located at Salmita with the mill staff commuting daily to Tundra. The Tundra mill and the service buildings will be reconditioned and, where required, upgraded to meet project requirements.

Additional facilities that have been installed and are directly related to the development include the following:

1. Salmita fuel storage facilities, currently 900 cubic meters, will be expanded to 2900 cubic meters when in full production. At Tundra, storage for 1500 cubic meters will be provided.

2. A fresh water intake pump station located on Walsh Bay of Matthews Lake to service the Salmita site (approximately 610 m north of the mine site) has been developed, and at Tundra, the existing water pumping intake system will be reactivated.

No permanent town site is planned. Access to the Salmita mine site will be by float planes landing on Matthews Lake or by fixed undercarriage aircraft using the Salmita airstrip. The existing road between the Salmita airstrip, the Salmita mine site and Tundra mill has been upgraded to support existing vehicular traffic requirements. Day-to-day operating supplies have been flown into Salmita. As stated previously, a winter access road has been utilized the past two winters to supply the site with fuel and heavy equipment. No permanent road access to Yellowknife is planned.

Northern Business

The location of the mine favours the purchase of goods and services in Yellowknife. Hence, the contribution to northern business has been substantial to date. It has been estimated that Giant has spent over seven million dollars on goods, services and salaries related to the Salmita project since 1975, most of this in 1981 and 1982. In excess of 40% of the goods and services were purchased in the Northwest Territories; most of these purchases taking place in Yellowknife. Since logistics favour northern purchasing of goods and services, where feasible, it is expected that this trend will continue since it is in the best interests of the company, the City of Yellowknife, and the Northwest Territories as a whole.

Information and Community Relations

To date, the company has met with federal and territorial government staff on a number of occasions and are planning to continue this open information exchange. This approach is considered to be beneficial to both Giant and the government. Giant also arranged a public meeting in November, 1980 in Yellowknife to explain the project to all interested parties, to answer questions concerning the project and to determine any concerns or issues relative to the project. The exchange that took place was thought to be beneficial. Giant are willing to arrange further community meetings if government regulatory agencies feel that these meetings would be beneficial.

7.2.2 The Next Stage

Giant is planning the Salmita site as a mining camp operation not as a permanent town site. As the life of the mine could be as short as 2.5 years, and as the site itself, while isolated, is only one hour air time from Yellowknife, it is not appropriate to build and service a new town. This approach is believed to be consistent with the government of the Northwest Territories' "Policy on Single Resource Communities."

Giant has partially constructed a residential complex at the mine site for its employees. The complex upon completion will accommodate a maximum of 80 people. There will be a full-time nurse and first aid facilities at the camp site to deal with local situations. Persons requiring major medical attention would be flown to Yellowknife. Mine rescue equipment will be on site with trained mine rescue teams.

Manpower Requirements - Construction and Operation

Based upon current plans, it is expected that manpower requirements during rehabilitation of the mill and construction of camp facilities will reach a peak of approximately 70 during the spring of 1983. Most of these jobs will require skilled labour and each trade will be required for a relatively short period. It is anticipated that a number of northerners will be employed during construction. However, due to the short duration of the construction and rehabilitation phase of the work, major commitments to training are impractical. During the operational period, there will be opportunities to train northerners to participate in the operation of the mine and mill. The policy of Giant with respect to training is discussed further in section 7.4.3.

The total staff required on site at any one time for the operation of the mine, mill and administrative complex plus support services (eg. seven persons for the catering contractor) is estimated to be 78. The manpower complement includes 36 in the mine, 13 in the mill and 22 for the camp and administration. A comprehensive list of the positions that will be filled is presented in Table 7.2.1. The planned work and rotation schedules are as follows:

Table 7.2.1. Giant Yellowknife Mines Ltd. Staff On-Site - Full Production Phase

	Persons/ Shift	Shift/ Day	Persons/ Day
Mine			
Development Miners - Drift	3	2	6
Raise		1	1
Production Miners	5	2	10
Timbermen and Helpers	2	2	4
Scooptram Operators	1	1	1
Haulage Truck Operator	1	1	1
Mechanics and Electrical Tradesmen	2	2	4
Drill Doctor/Bit Sharpener	1	1	1
Dry/Toolroom/Yard Labour	1	2	2
Level Cleaner, Pumping, Salt Water Mixing, etc.	1	2	2
Ore Stockpile Loader Operator	1	1	1
Ore Trucking - Truck Driver	1	1	1
Road Maintenance, Yard Labour	1	2	2
	Total Hourly - Mine		36
Mill			
Lead Hand	1	2	2
Crusher	1	1	1
Grinding Operator	1	2	2
Solution Operator	1	2	2
Mill Labour, Ore Receiving, Reagents	1	2	2
Mechanics	2	1	2
Helpers	2	1	2
	Total Hourly - Tundra Operations		13
Staff			
General and Administration		9	
Mine Superv. + Eng. + Geol.		9	
Mill and Services		4	
	Sub-Total	22	

Table 7.2.1 (Cont'd)

Breakdown of Staff Positions		Number Required
General and Administration		
Project Manager		1
Account/Payroll Supervisor		1
Expeditor		1
Nurses		1
Safety/Environmental Supervisor		1
Fireguard/Security		2
Warehouseman		1
Clerk Communications, Weather, Steno		1
	Sub-Total	9
Mine		
Mine Superintendent		1
Mine Captain		1
Shift Boss		1
Geologist		1
Engineer		1
Surveyor/Vent Tech/Draughtsman		1
Surveyor Helper		1
Samplers		2
	Sub-Total	9
Mill and Services		
Mill Superintendent		1
Assayers		2
Master Mechanic/Services Supervisor		1
	Sub-Total	4

Mining operation	10 hours per day, 7 days per week, six weeks on, two weeks off
Mill operation	12 hours per day, 7 days per week, six weeks on, two weeks off
Administration and Camp	same as mill

For the underground mining operations, northerners should be able to fill a significant percentage of the positions available if a long-term operation can been established. In the mill, it is hoped that northerners could fill a number of the jobs in the crushing and grinding, milling and leaching operations and that as they gained experience, they could move into supervisory positions. Much of this work involves working with machinery, running tests, setting up and monitoring equipment. As many of the milling positions as possible, including the trades, will be filled by northerners.

For operation of the residential complex, cooks and kitchen helpers will be required and within the administrative operations, there will be some office and warehouse jobs. All of these jobs could be of interest to northerners and filled by northerners. Rotation schedules will be flexible, where feasible, in order to develop northerner interest in the jobs available.

7.3 The Effect of the Project on Northern Residents

7.3.1 Economic Impacts

The major economic impact of the Salmita project will result from the increased opportunities for employment. A conservative projection would provide an estimate of approx- imately one million dollars per year in employment income to northerners during the mine's operation. This figure is based upon a northern workforce of approximately 25, each earning approximately $3400 per month (in 1982 dollars). This would be a significant economic input to this region noting the current status of the economy and the downward trends being exhibited.

These jobs would provide a new and/or improved economic capability to many northerners. If past experience continues, most of this new earning power would result in increased purchases of goods and services in the Northwest Territories and thus an overall improvement in the northern economy. While there could be an initial upsurge in the purchase of alcohol, it is more likely that the attraction of a steady income would provide a stabilizing effect, and the workers and their families would learn to adjust to their new earnings level using it to increase their general standard of living.

Apart from the employment and employment-related economic benefits, Giant's purchases in Yellowknife of goods and services for Salmita will serve to bolster the economy of this city. Local purchasing projections are not available at this time, but it is expected that purchases of goods and services in Yellowknife will, in subsequent years, be substantial (i.e. several million dollars over the life of the project). Since 1975, Giant has spent large sums of money on northern purchases of goods and services and this trend will continue during the construction and operational phase of the project.

7.3.2 Social Impacts

The question is generally raised with respect to the impact of a new industrial activity on the social fabric of life in the north. As the mine site is located away from any communities, there would be no direct impact through daily interaction of the mine employees and an existing settlement. Potential concerns that exist relate to increased earnings and the utilization of these earnings and the absence from home of the northern employees. From the extensive studies done of the results of Gulf's program in Coppermine (Hobart 1979), it has been found that a similar employment mode did not result in any serious social problems. There was naturally loneliness experienced on the part of married employees, both from the point of view of the men who were working away from home and the wives and families left behind. On the whole, however, both coped well. The rotation cycle proposed has been designed to minimize disruption of family life.

It should be noted that the residents of Coppermine who participated in surveys conducted of Gulf and Dome operations, appeared to be prepared to cope with the inconvenience of rotation employment. The information obtained in these surveys indicated that rotation employment did not significantly reduce the involvement of native people in hunting, trapping and fishing activities. In fact, many employees used their earnings to purchase equipment to improve their ability to participate in these activities during their time off. These reviews concluded that there did not appear to be an increase in child neglect resulting directly from wage employment. However, there did appear to be an increase in liquor purchases during the initial stages of each of these major employment programs.

In all projects of this nature being introduced in the north, the objective is to maximize the benefits to northerners and minimize the negative impacts. It would appear, based upon the project design to date, that the benefits to the north far exceed the negative aspects of the project. The project offers very little prospect for negative social or economic effects, but does provide opportunities for increasing the economic activity and potential of the area. At the same time, it will provide opportunities for northerners to learn new skills, potentially transferable to other mining operations which will undoubtedly follow in the years to come. There is, and has been, a great deal of interest in mining in the north and this interest will continue. In section 7.4, the policies of Giant with respect to northern employment, purchasing, etc. are discussed in more detail.

7.3.3 Land Claims

Land claims in the Northwest Territories have not been resolved and are currently under negotiation. No definite predictions can be made on settlement terms. Plans for the project are proceeding under the existing conditions.

7.4 Giant's Policies and Practices for the Salmita Mine

The discussion that follows pertains to policies and practices that Giant will adopt for the Salmita mine. The policies and practices are based upon a review of agreements between other resource development companies (especially other small mines) and the G.N.W.T. and discussions with federal and territorial government staff in Yellowknife. These policies and practices have been outlined to verify Giant's position on a number of matters and to support Giant's position with respect to the overall positive socio-economic benefits of the project.

7.4.1 Northern Employment

Giant will give preference to qualified northerners in its hiring practices. A northerner for the purposes of this document is a person who has lived the past twelve consecutive months in the Northwest Territories. No jobs are reserved exclusively for northerners and none are reserved exclusively for others, but northerner preference will prevail. Once on the job, Giant will make no distinction between northerners and others with respect to benefits or other terms of employment and employees will be treated fairly and in a business-like manner. The laws of the Northwest Territories will apply in respect of hours of work, overtime and working conditions.

Salaries and wages will be competitive for the industry and area, and will be based upon job requirements and responsibilities, qualifications and experience. The annual payroll in full production is expected to be in excess of $4 million. While the employee is on the job, his room and board will be provided by and paid for by Giant. Generally speaking, Giant will pay reasonable travelling expenses for the employees from his point of hire to the job, and from the job to his point of hire after the completion of his work schedule. A fringe benefit package will be developed with a view to optimizing employee satisfaction with the terms of employment.

7.4.2 Hiring Procedures

It is Giant's intention to utilize local media for the advertisement of open positions in an attempt to solicit local (northern) candidates for available positions. It is Giant's intention to make full use of federal and territorial government agencies to assist in the identification of suitable candidates to fill open positions.

7.4.3 Training

Training opportunities and programs will be developed recognizing the short anticipated operating life of the mine (i.e. 2.5 years). On-the-job training will be employed to a large extent. The practicality for training employees for skilled trade positions is limited by the project life. However, Giant is willing to discuss joint training programs with government agencies and, if practical, to participate in jointly funded training programs.

7.4.4 Orientation and Employee Liaison

New employees are normally oriented to the operation by being exposed directly to it. The small size of the operation makes orientation a relatively direct and simple process. The company recognizes that there may be some adaptation problems for native northerners and will develop a liaison system within its infrastructure in order to assess problems that develop, to implement solutions and to determine the effectiveness of its efforts.

7.4.5 Promotion and Dismissal

Giant's policy is to assess its employees for training and promotion on a continuing basis. This activity is considered to be an important part of the management function. Promotions will be based upon job performance and other traditional criteria. The company requires that its employees be reliable and able to work together. Failure of an employee to achieve this necessary minimum standard is disruptive and places the effectiveness of the entire operation in jeopardy. The company, after due consideration, may find it necessary to terminate an employee as a result.

7.4.6 Medical Facilities

Medical facilities are available at the site and consist of a registered nurse and a well-equipped first aid station. All personnel must pass a full company medical examination (paid for by the company) prior to being hired for work at the Salmita site. The company maintains first aid facilities on site according to law. In the event of a medical emergency, evacuation will be by air, normally to Yellowknife.

7.4.7 Northern Purchasing

The company will utilize local northern business services to the greatest degree possible where price, delivery capability and quality are competitive. Where these conditions exist, the company will purchase goods and services from businesses located in the following areas in order of preference:

1. Northwest Territories
2. Canada
3. Foreign

Giant will also encourage contractors involved in the construction of the mine to hire northerners. In addition, bid packages will be developed in such a way that northern businesses will be able to meet standards and submit bids as much as possible. Giant will make information about its requirements for supplies and services for the construction and operation of the mine known to local businesses through Chambers of Commerce, other business organizations and to individual businessmen as requested. Bidder's lists will include local businesses that indicate an interest in and capability for providing goods and services. The company will work in cooperation with the Northwest Territories Department of Economic Development and Tourism to maximize northern purchasing.

7.4.8 Social and Cultural Considerations

The company operates in English but other languages may be spoken on the job. Signs must be posted in English by statute. International safety signs will also be posted where appropriate. The company considers that at least a basic knowledge of English is required of the employee for his own safety in working in a mine environment.

Recreational facilities will be available in camp for the use of employees. These could include satellite TV, games such as billiards, shuffleboard and darts, reading material, etc. Land foods will be made available from time to time as the number of native northerners on the job warrant and provided price and delivery are reasonable. Individuals are not permitted firearms on site. One rifle, together with ammunition, is maintained on site by Giant for protection from predatory animals. The camp will be dry and no drugs will be permitted. Offenders are subject to immediate dismissal. At present, the Company has not developed a procedure for searching individuals or their luggage. The company does not offer family accommodation on site nor does it contemplate any town site development. It is the intention of the company to provide employee services and infrastructure that will meet the existing requirements of the G.N.W.T.

7.4.9 Other Policies

Giant will require its contractors to conduct their operations in a manner consistent with the spirit and intent stated in this report. Giant will cooperate and provide assistance to the federal government and the government of the Northwest Territories in providing information to them on the socio-economic aspects of the Salmita operations and by conducting reviews required by the government.

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Appendix Table I. Physico-chemical characteristics of water collected from the Salmita area by personnel from Department of Indian Affairs & Northern Development on 19 June, 1975. Collection sites are illustrated in Figure 4.2.1. All parameters are expressed in g/m^3 unless otherwise specified. N.D. means that the analysis was not done.

PARAMETERS	STATION					
	1	2	3	4	5	6
Turbidity (JTU)	1.2	1.5	1.4	1.5	1.2	0.9
Specific Conductance (μmho/cm)	23.6	24.9	28.1	22.3	14.7	22.5
Colour	10	25	20	>100	65	20
Total Alkalinity	6.6	N.D.	6.0	2.5	2.2	4.4
Total Hardness	9.6	19.1	8.9	4.3	7.4	8.7
Calcium (dissolved)	3.6	3.6	3.3	<0.5	1.8	2.7
Sodium (dissolved)	0.7	1.0	0.3	0.8	0.7	1.0
Potassium (dissolved)	0.5	0.6	1.0	0.5	0.4	0.5
Chloride (dissolved)	0.85	1.25	0.4	1.05	0.50	0.45
Sulphate (dissolved)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silica (reactive)	0.16	0.20	0.20	0.80	0.32	0.10
Total Phosphorus (dissolved)	0.007	0.005	0.016	0.026	0.007	0.010
Nitrate, Nitrite (dissolved)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (dissolved)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (extractable)	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001
Cobalt (extractable)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (extractable)	0.002	0.002	0.002	0.002	0.002	0.003
Iron (extractable)	0.05	0.07	0.10	0.29	0.17	0.06
Lead (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	0.02	0.65	<0.01	<0.01	<0.001	<0.01
Nickel (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (extractable)	<0.001	0.001	<0.001	0.002	0.005	0.002
Chromium (extractable)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum (extractable)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Appendix Table I. (cont'd) Physio-chemical characteristics of water collected from the Salmita area by personnel from Department of Indian Affairs & Northern Development on July 22, 1975. Collection sites are illustrated in Figure 4.2.1. All parameters are expressed in g/m^3 unless otherwise specified. N.D. means that the analysis was not done.

PARAMETERS	STATION					
	1	2	3	4	5	6
Turbidity (JTU)	1.5	1.2	1.2	5.0	1.5	1.4
Specific Conductance (μmho/cm)	21.0	75.0	88.0	65.0	67.0	95.0
Colour	5	5	5	>100	60	10
Total Alkalinity	6.2	6.5	8.8	2.7	3.7	5.6
Total Hardness	11.1	10.3	12.9	15.7	9.4	11.2
Calcium (dissolved)	4.0	3.7	4.8	2.7	3.1	3.9
Sodium (dissolved)	0.8	0.9	1.0	1.0	0.9	1.3
Potassium (dissolved)	0.3	0.3	0.25	0.60	0.4	0.55
Chloride (dissolved)	0.9	1.4	0.3	1.4	0.80	0.60
Sulphate (dissolved)	3.5	4.0	3.1	2.5	1.7	6.5
Silica (reactive)	<0.1	<0.1	0.45	1.55	0.30	0.20
Total Phosphorus (dissolved)	0.005	0.005	0.014	0.047	0.016	0.010
Nitrate, Nitrite (dissolved)	0.075	0.04	0.095	0.39	0.048	0.035
Arsenic (dissolved)	<0.01	<0.01	<0.01	0.04	0.01	<0.01
Cadmium (extractable)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper (extractable)	0.003	0.002	0.003	0.003	0.006	0.004
Iron (extractable)	<0.05	0.30	0.18	0.51	0.40	0.10
Lead (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	<0.01	0.01	0.05	0.01	<0.01	<0.01
Nickel (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (extractable)	0.047	0.019	0.033	0.088	0.076	0.14
Chromium (extractable)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum (extractable)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Appendix Table I. (cont'd) Physio-chemical characteristics of water collected from the Salmita area by personnel from Department of Indian Affairs & Northern Development on August 1, 1975. Collection sites are illustrated in Figure 4.2.1. All parameters are expressed in g/m^3 unless otherwise specified. N.D. means that the analysis was not done.

PARAMETERS	STATION					
	1	2	3	4	5	6
Turbidity (JTU)	1.0	1.5	2.0	2.2	1.5	1.6
Specific Conductance (μmho/cm)	21.0	22.0	27.0	21.0	21.0	29.0
Colour	5	5	10	10	50	5
Total Alkalinity	6.2	6.0	9.3	2.9	3.6	6.3
Total Hardness	11.5	13.3	13.5	12.7	10.0	20.1
Calcium (dissolved)	3.8	3.8	4.7	3.1	2.6	4.1
Sodium (dissolved)	0.8	0.8	0.5	1.8	0.8	1.8
Potassium (dissolved)	0.6	0.6	0.7	0.7	0.6	0.8
Chloride (dissolved)	0.74	0.74	0.3	1.47	0.60	0.80
Sulphate (dissolved)	2.5	2.6	5.6	1.4	8.0	7.8
Silica (reactive)	0.15	0.15	0.42	1.40	0.30	0.22
Total Phosphorus (dissolved)	<0.005	0.005	0.013	0.026	0.008	0.006
Nitrate, Nitrite (dissolved)	<0.01	0.023	0.423	0.013	0.01	<0.01
Arsenic (dissolved)	<0.01	<0.01	<0.01	0.021	<0.01	<0.01
Cadmium (extractable)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (extractable)	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Copper (extractable)	0.001	0.001	0.001	0.012	0.020	0.004
Iron (extractable)	<0.05	0.23	0.15	1.0	0.37	0.24
Lead (extractable)	<0.005	<0.005	<0.005	<0.005	0.005	<0.005
Manganese (extractable)	<0.01	<0.01	0.05	0.02	<0.01	<0.01
Nickel (extractable)	<0.005	<0.005	<0.005	0.005	0.012	<0.005
Zinc (extractable)	<0.005	0.052	0.08	0.16	0.066	0.037
Chromium (extractable)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum (extractable)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Appendix Table II. Chemical and physical characteristics of water samples collected from Matthews Lake during 1976. All parameters are expressed in mg/l unless otherwise specified. N.D. means that the analysis was not done. Collection sites are illustrated in Figure 4.2.1.

DATE STATION DEPTH	5 JULY 1 2m	5 JULY 2 4m	5 JULY 3 3m	9 AUGUST 1 2m	9 AUGUST 2 4m	13 SEPTEMBER 1 2m	13 SEPTEMBER 2 4m
Turbidity (JTU)	1.6	1.3	1.7	2.2	1.5	1.9	5.4
Specific Conductance (μmho/cm)	23.4	23.4	28.0	35.0	24.0	26.5	38.0
Colour	5	5	5	5	5	5	5
Total Alkalinity	5.9	4.1	7.1	5.6	6.5	7.2	7.0
Total Hardness	12.3	15.3	12.4	18.5	11.1	12.8	12.9
Calcium (dissolved)	3.3	5.1	4.9	6.6	3.4	4.1	4.1
Sodium (dissolved)	0.7	0.7	0.5	0.7	0.7	0.4	0.8
Potassium (dissolved)	0.65	0.5	0.5	0.6	0.6	0.7	0.5
Chloride (dissolved)	0.65	0.6	0.25	0.7	0.6	0.8	1.1
Sulphate (dissolved)	1.9	1.9	2.5	2.4	2.2	2.1	2.8
Silica (reactive)	0.1	0.1	0.3	0.2	0.2	0.2	0.2
Total Phosphorus (dissolved)	<0.005	<0.005	0.006	0.005	<0.005	0.006	0.007
Nitrate, Nitrite (dissolved)	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.04
Arsenic (dissolved)	0.0013	0.0009	0.005	0.0005	0.0005	N.D.	N.D.
Cadmium (extractable)	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (extractable)	<0.001	<0.001	0.09	<0.001	<0.001	0.002	0.001
Copper (extractable)	0.002	0.001	0.003	0.003	0.007	0.002	<0.001
Iron (extractable)	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
Lead (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01
Nickel (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (extractable)	0.004	0.002	0.040	0.007	0.008	0.004	0.004

Appendix Table II (cont'd) Chemical and physical characteristics of water samples collected from Matthews Lake during 1976. All parameters are expressed in mg/l unless otherwise specified. N.D. means that the analysis was not done. Collection sites are illustrated in Figure 4.2.1.

DATE	5 JULY	5 JULY	9 AUGUST	9 AUGUST	13 SEPTEMBER	13 SEPTEMBER
STATION	4	5	4	5	4	5
DEPTH	2m	3m	2m	3m	2m	3m
Turbidity (JTU)	2.5	2.1	1.7	1.7	2.1	2.0
Specific Conductance (μmho/cm)	13.0	10.9	13.4	15.3	13.6	21.0
Colour	5	5	5	5	5	5
Total Alkalinity	1.2	2.7	3.0	2.9	8.4	4.0
Total Hardness	7.2	N.D.	4.7	4.5	3.1	3.8
Calcium (dissolved)	<2.0	1.9	1.7	1.8	3.1	3.5
Sodium (dissolved)	0.5	0.5	0.5	0.5	0.4	0.9
Potassium (dissolved)	0.5	0.5	0.4	0.4	0.3	0.6
Chloride (dissolved)	0.3	0.3	0.2	0.4	0.3	0.5
Sulphate (dissolved)	1.1	1.1	1.3	1.2	1.0	3.2
Silica (reactive)	0.2	0.2	0.2	0.2	0.1	0.3
Total Phosphorus (dissolved)	0.005	0.010	<0.005	<0.005	0.008	0.007
Nitrate, Nitrite (dissolved)	<0.01	<0.01	<0.01	<0.01	0.01	0.006
Arsenic (dissolved)	0.012	<0.0005	<0.0005	0.0002	N.D.	N.D.
Cadmium (extractable)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (extractable)	<0.001	<0.001	0.001	<0.001	0.001	0.001
Copper (extractable)	<0.001	0.001	0.002	0.009	<0.001	0.002
Iron (extractable)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead (extractable)	<0.005	0.008	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel (extractable)	<0.005	<0.005	0.002	0.002	<0.005	<0.005
Zinc (extractable)	0.041	0.014	0.019	0.016	0.001	0.004

Appendix Table II (cont'd) Chemical and Physical characteristics of water samples collected from Sandy Lake during 1976. (Results are in mg/l unless otherwise noted). Collection sites are illustrated in Figure 4.2.1.

DATE STATION DEPTH	5 JULY 6 2.5m	5 JULY 7 2m	9 AUGUST 6 2.5m	9 AUGUST 7 2m
Turbidity (JTU)	1.6	1.5	1.9	1.8
Specific Conductance (μmho/cm)	29.8	20.5	28.0	32.0
Colour	10	5	5	10
Total Alkalinity	1.9	2.1	4.8	5.8
Total Hardness	9.9	6.2	8.3	14.0
Calcium (dissolved)	4.0	2.5	5.0	3.3
Sodium (dissolved)	1.0	1.0	1.5	1.3
Potassium (dissolved)	0.5	0.5	0.8	0.8
Chloride (dissolved)	0.5	0.4	0.5	0.5
Sulphate (dissolved)	4.2	2.8	4.1	5.1
Silica (reactive)	0.4	0.2	0.5	0.5
Total Phosphorus (dissolved)	0.005	0.008	0.005	0.010
Nitrate, Nitrite (dissolved)	0.01	<0.01	<0.01	0.02
Arsenic (dissolved)	0.0006	0.0012	<0.0005	<0.0005
Cadmium (extractable)	<0.001	<0.001	<0.001	<0.001
Cobalt (extractable)	<0.001	<0.001	<0.001	0.001
Copper (extractable)	0.003	0.001	0.008	0.005
Iron (extractable)	0.10	<0.05	0.018	0.10
Lead (extractable)	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	<0.01	<0.01	<0.01	<0.01
Nickel (extractable)	0.052	0.021	0.008	0.006
Zinc (extractable)	0.052	0.021	0.008	0.006

Appendix Table III. Physico-chemical characteristics of surface water samples collected by Environment Canada near the Tundra Mine site, June 27, 1978. All values in mg/l unless otherwise specified. Refer to Figure 4.2.1 for location of sampling sites.

	1 (small lake at north end of tailings area)	2 (small lake south of tailings area)	3 (Matthews Lake at mine dock)
Arsenic	1.70	0.074	0.022
Mercury	<0.0002	<0.0002	<0.0002
Nickel	<0.03	<0.03	-
Copper	<0.02	<0.02	-
Lead	0.006	<0.005	-
Zinc	0.02	<0.01	-
Cadmium	0.002	<0.002	-
Cobalt	<0.05	<0.05	-
Iron	3.02	0.35	-
Manganese	0.10	<0.02	-
Magnesium	2.9	0.9	-
Temperature (^{o}C)	11	9	7
Specific Conductance (μmho/cm)	175	25	30

Appendix Table IV Physico-chemical characteristics of surface water samples collected by Giant Yellowknife Mines Ltd., August 11, 1980. All values in mg/l unless otherwise specified. Refer to Figure 4.2.1 for location of sampling sites.

	Site 1	Site 2	Site 3
Aluminum	0.10	0.49	0.27
Boron	0.04	0.02	0.03
Barium	0.010	.011	.007
Beryllium	<.005	<.005	<.005
Cadmium	<.01	<.01	<.01
Cobalt	<.01	<.01	<.01
Chromium	0.03	.02	.01
Copper	.028	.017	.012
Iron	0.36	0.28	0.16
Lithium	<.05	<.05	<.05
Manganese	.006	.013	<.005
Molybdenum	<.02	<.02	<.02
Nickel	.05	.03	.02
Lead	<.02	<.02	<.02
Tin	<0.1	<0.1	<0.1
Strontium	.017	.010	.008
Tellurium	<.05	<.05	<.05
Titanium	<.005	<.005	<.005
Vanadium	<.01	<.01	<.01
Zinc	<.02	<.02	<.02
Silver	<.02	<.02	<.02
Calcium	5.2	4.0	3.5
Magnesium	1.3	0.7	0.6
Sodium	1.0	0.9	0.8
Potassium	<0.1	0.3	0.3
Silicon	1.1	1.3	0.6
Cyanide	<0.02	<0.02	<0.02
Mercury	0.0004	0.0003	<0.00002
Arsenic	.004	.003	.003
Selenium	<.001	.001	<.001
Antimony	<.001	<.001	<.001

Appendix Table V — Chemical and physical characteristics of water samples collected at specific sites at Matthews Lake (September 16 - 20, 1981). Refer to Figure 4.2.2 for the location of the sample sites.

Site	Date (Sept. 1981)	Depth (m)	Surface Temperature (^{o}C)	pH		
				a	b	c
1	17	4.7	6.5	7.5	7.5	7.3
2	17	8.7	6.0	7.3	7.2	7.3
3	16 & 17	11.5	7.0	6.8	6.8	6.8
4	19	8.7	6.0	7.3	7.1	7.2
5	19	4.0	6.5	7.5	7.2	7.5
6	19	2.0	6.5	7.2	7.2	7.2
7	19	6.0	6.5	7.2	7.2	7.2
8	19	4.0	6.5	7.2	7.2	7.2
9	20	2.0	6.0	7.6	7.5	7.6
10	20	6.0	6.5	7.7	7.6	7.6
11	20	4.0	6.0	7.7	7.6	7.5
12	20	6.0	6.0	7.5	7.5	7.5
13	18	3.4	6.5	7.5	7.5	7.5
14	18	1.7	7.0	7.5	7.5	7.5
15	20	1.0	7.0		7.5	

Appendix Table V (cont'd)

PARAMETER	Atomic Symbol	Test Values at Sample Site Subsample 1A	Subsample 1B	Subsample 1C
PHYSICAL TESTS				
pH		7.15	7.25	7.20
Conductivity (micromhos/cm)		28.5	28.5	28.2
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.57	0.55	0.60
Hardness (mg/L)		12.0	12.0	12.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	20.	20.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.7	13.4	13.6
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.008	0.008	0.007
Cadmium	Cd	0.006	0.006	0.006
Calcium	Ca	3.79	3.78	3.80
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	0.008	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.65	0.63	0.63
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.52	0.55	0.55
Silicon	SiO2	0.25	0.22	0.25
Sodium	Na	1.44	1.31	1.28
Zinc	Zn	0.026	0.017	0.016
TOTAL METALS (mg/L)				
Arsenic	As	0.005	0.006	0.005
Iron	Fe	0.034	< 0.030	< 0.030
Manganese	Mn	0.003	0.004	0.003
Mercury	Hg	0.0004		

Appendix Table V (Cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 2A	Subsample 2B	Subsample 2C
PHYSICAL TESTS				
pH		7.20	7.20	7.20
Conductivity (micro mhos/cm)		27.1	27.2	27.2
Colour [Pt-Co scale] (CU)		5.	< 5.	5.
Turbidity (JTU)		0.58	0.56	0.48
Hardness (mg/L)		11.0	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	19.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.7	13.2	12.7
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	0.002	< 0.001
Cadmium	Cd	0.006	0.006	0.006
Calcium	Ca	3.57	3.55	3.59
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.59	0.59	0.59
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.52	0.54	0.54
Silicon	SiO2	0.25	0.19	0.17
Sodium	Na	1.34	1.36	1.26
Zinc	Zn	0.019	0.016	0.015
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	< 0.030	< 0.030	0.030
Manganese	Mn	0.003	0.003	0.004
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 3A	Subsample 3B	Subsample 3C
PHYSICAL TESTS				
pH		7.35	7.35	7.30
Conductivity (micromhos/cm)		27.4	27.3	27.4
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.49	0.57	0.47
Hardness (mg/L)		12.0	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		20.	20.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.1	13.6	12.7
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	0.002	0.002
Cadmium	Cd	0.002	< 0.001	< 0.001
Calcium	Ca	3.65	3.53	3.58
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.61	0.57	0.59
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.50	0.48	0.49
Silicon	SiO2	0.25	0.28	0.17
Sodium	Na	1.56	1.56	1.35
Zinc	Zn	0.025	0.028	0.029
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Manganese	Mn	0.004	0.004	0.003
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 4A	Subsample 4B	Subsample 4C
PHYSICAL TESTS				
pH		7.20	7.25	7.25
Conductivity (micro mhos/cm)		27.4	27.5	27.6
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.48	0.47	0.58
Hardness (mg/L)		11.0	11.0	11.5
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	20.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.6	13.9	13.0
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.003	0.002	< 0.001
Cadmium	Cd	< 0.001	< 0.001	0.001
Calcium	Ca	3.55	3.50	3.55
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.58	0.62	0.61
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.51	0.53	0.53
Silicon	SiO2	0.16	0.14	0.13
Sodium	Na	1.38	1.50	1.43
Zinc	Zn	0.021	0.023	0.019
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.002	< 0.001
Iron	Fe	0.034	< 0.030	< 0.030
Manganese	Mn	0.003	< 0.003	< 0.003
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 5A	Subsample 5B	Subsample 5C
PHYSICAL TESTS				
pH		7.30	7.25	7.30
Conductivity (micromhos/cm)		28.1	27.4	27.5
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.57	0.56	0.47
Hardness (mg/L)		11.5	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		18.	20.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.7	13.4	13.2
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.60	3.53	3.52
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.61	0.59	0.59
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.49	0.51	0.52
Silicon	SiO2	0.16	0.19	0.18
Sodium	Na	1.48	1.46	1.46
Zinc	Zn	0.026	0.019	0.015
TOTAL METALS (mg/L)				
Arsenic	As	< 0.001	0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Manganese	Mn	0.003	0.009	0.003
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 6A	Subsample 6B	Subsample 6C
PHYSICAL TESTS				
pH		7.20	7.20	7.25
Conductivity (micromhos/cm)		27.6	27.5	27.6
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.47	0.49	0.58
Hardness (mg/L)		11.5	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		18.	18.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.6	12.9	13.3
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	< 0.001
Cadmium	Cd	< 0.001	0.001	< 0.001
Calcium	Ca	3.59	3.58	3.56
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.59	0.59	0.58
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.53	0.52	0.52
Silicon	SiO2	0.17	0.16	0.23
Sodium	Na	0.55	0.58	0.57
Zinc	Zn	0.018	0.016	0.021
TOTAL METALS (mg/L)				
Arsenic	As	< 0.001	0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	0.035
Manganese	Mn	0.003	< 0.003	< 0.003
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 7A	Subsample 7B	Subsample 7C
PHYSICAL TESTS				
pH		7.30	7.25	7.25
Conductivity (micromhos/cm)		27.4	27.5	27.6
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.52	0.58	0.51
Hardness (mg/L)		11.0	11.0	11.5
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	18.	18.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.3	12.6	12.5
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	0.002
Cadmium	Cd	0.001	< 0.001	< 0.001
Calcium	Ca	3.54	3.57	3.56
Cobalt	Co	< 0.005	< 0.002	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.58	0.58	0.63
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.53	0.52	0.47
Silicon	SiO2	0.16	0.14	0.24
Sodium	Na	0.66	0.71	0.88
Zinc	Zn	0.016	0.019	0.028
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Manganese	Mn	< 0.003	< 0.003	< 0.002
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 8A	Subsample 8B	Subsample 8C
PHYSICAL TESTS				
pH		7.30	7.25	7.25
Conductivity (micromhos/cm)		27.5	27.5	27.5
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.50	0.55	0.48
Hardness (mg/L)		11.0	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	18.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.0	12.1	13.1
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.002	< 0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.54	3.55	3.58
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.61	0.61	0.60
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.026	0.007
Potassium	K	0.49	0.53	0.53
Silicon	SiO2	0.24	0.22	0.20
Sodium	Na	0.77	0.72	0.61
Zinc	Zn	0.016	0.012	0.012
TOTAL METALS (mg/L)				
Arsenic	As	0.001	< 0.001	0.001
Iron	Fe	< 0.030	< 0.30	< 0.030
Manganese	Mn	0.003	< 0.003	0.003
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 9A	Subsample 9B	Subsample 9C
PHYSICAL TESTS				
pH		7.00	7.30	7.35
Conductivity (micromhos/cm)		27.6	27.6	28.0
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.49	0.56	0.50
Hardness (mg/L)		11.0	11.5	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	19.	18.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.9	13.0	12.6
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.002	0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.59	3.65	3.58
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.030
Magnesium	Mg	0.60	0.60	0.58
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.54	0.54	0.52
Silicon	SiO2	0.24	0.28	0.27
Sodium	Na	0.61	0.55	0.55
Zinc	Zn	0.022	0.017	0.019
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	< 0.030	< 0.030	0.22
Manganese	Mn	< 0.003	0.007	0.003
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 10A	Subsample 10B	Subsample 10C
PHYSICAL TESTS				
pH		7.30	7.35	7.20
Conductivity (micromhos/cm)		27.9	27.7	27.6
Colour [Pt-Co scale] (CU)		5.	< 5.	5.
Turbidity (JTU)		0.52	0.56	0.53
Hardness (mg/L)		11.0	11.0	11.5
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		18.	19.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.6	12.9	12.9
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	0.002
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.56	3.58	3.63
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.58	0.59	0.60
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.55	0.47	0.52
Silicon	SiO2	0.25	0.29	0.23
Sodium	Na	0.63	0.72	0.62
Zinc	Zn	0.016	0.020	0.013
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.002	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Manganese	Mn	< 0.003	< 0.003	< 0.003
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 11A	Subsample 11B	Subsample 11C
PHYSICAL TESTS				
pH		7.30	7.30	7.30
Conductivity (micro mhos/cm)		27.5	27.7	27.5
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.57	0.53	0.49
Hardness (mg/L)		12.0	11.5	11.5
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		18.	18.	18.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	12.5	12.6	12.6
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.66	3.61	3.59
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.63	0.62	0.61
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.53	0.54	0.51
Silicon	SiO2	0.15	0.16	0.14
Sodium	Na	0.70	0.71	0.77
Zinc	Zn	0.014	0.011	0.014
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Manganese	Mn	< 0.003	0.007	0.012
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 12A	Subsample 12B	Subsample 12C
PHYSICAL TESTS				
pH		7.30	6.95	7.25
Conductivity (micro mhos/cm)		27.7	27.7	27.7
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.52	0.56	0.48
Hardness (mg/L)		11.0	11.0	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	19.	18.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.3	12.8	12.6
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.56	3.61	3.58
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.59	0.59	0.58
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.52	0.48	0.52
Silicon	SiO2	0.23	0.28	0.20
Sodium	Na	0.83	0.94	0.80
Zinc	Zn	0.018	0.022	0.020
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.002	0.001
Iron	Fe	< 0.030	< 0.030	0.032
Manganese	Mn	0.006	< 0.003	0.007
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Subsample 13A	Subsample 13B	Subsample 13C
PHYSICAL TESTS				
pH		7.15	6.85	6.75
Conductivity (micromhos/cm)		28.4	28.2	28.2
Colour [Pt-Co scale] (CU)		< 5.	< 5.	< 5.
Turbidity (JTU)		0.58	0.54	0.52
Hardness (mg/L)		12.0	12.5	11.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		19.	19.	19.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	13.3	12.6	13.3
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	0.001	< 0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	3.75	3.96	3.52
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	0.007
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.61	0.65	0.60
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.55	0.51	0.53
Silicon	SiO2	0.17	0.20	0.16
Sodium	Na	0.81	0.82	1.00
Zinc	Zn	0.017	0.020	0.020
TOTAL METALS (mg/L)				
Arsenic	As	0.001	0.001	< 0.001
Iron	Fe	0.031	< 0.030	< 0.030
Manganese	Mn	0.004	0.004	0.003
Mercury	Hg	0.0005		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 14A	Subsample 14B	Subsample 14C
PHYSICAL TESTS				
pH		6.95	7.05	6.95
Conductivity(micromhos/cm)		33.7	33.9	33.9
Colour[Pt-Co scale] (CU)		5.	5.	5.
Turbidity(JTU)		0.67	0.60	0.62
Hardness(mg/L)		14.0	14.0	14.0
SOLIDS(mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		22.	23.	22.
DISSOLVED ANIONS(mg/L)				
Alkalinity: Bicarbonate	HCO3	15.1	15.7	15.1
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	7.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS(mg/L)				
Arsenic	As	< 0.001	< 0.001	< 0.001
Cadmium	Cd	0.001	< 0.001	< 0.001
Calcium	Ca	4.40	4.43	4.38
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	0.007	< 0.001
Iron	Fe	< 0.030	< 0.030	0.033
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.72	0.77	0.74
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.001	0.001	0.001
Potassium	K	0.56	0.57	0.55
Silicon	SiO2	0.22	0.19	0.28
Sodium	Na	0.98	0.96	1.01
Zinc	Zn	0.022	0.022	0.019
TOTAL METALS(mg/L)				
Arsenic	As	0.001	0.001	0.001
Iron	Fe	0.047	0.051	0.044
Manganese	Mn	0.005	0.003	0.003
Mercury	Hg	0.0004		

Appendix Table V (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site Subsample 15A	Subsample 15B	Subsample 15C
PHYSICAL TESTS				
pH		6.80	6.70	7.05
Conductivity (micromhos/cm)		15.3	15.0	15.7
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.59	0.54	0.61
Hardness (mg/L)		6.0	5.5	6.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		11.	10.	12.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	8.20	6.94	8.13
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 5.0	< 5.0	< 5.0
Nitrates and Nitrites	N	< 0.002	< 0.002	< 0.002
Ortho Phosphates	o-PO4	< 0.030	< 0.030	< 0.030
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	< 0.001
Cadmium	Cd	0.001	< 0.001	0.001
Calcium	Ca	1.50	1.47	1.48
Cobalt	Co	< 0.005	< 0.005	< 0.005
Copper	Cu	< 0.001	< 0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	< 0.030
Lead	Pb	< 0.001	< 0.001	< 0.001
Magnesium	Mg	0.47	0.46	0.46
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	0.009	0.001	0.001
Potassium	K	0.45	0.44	0.37
Silicon	SiO2	0.15	0.21	0.20
Sodium	Na	0.92	0.95	0.93
Zinc	Zn	0.023	0.023	0.020
TOTAL METALS (mg/L)				
Arsenic	As	0.001	< 0.001	< 0.001
Iron	Fe	0.056	0.043	0.044
Manganese	Mn	0.003	0.004	0.004
Mercury	Hg	0.0005		

Appendix Table VI — Chemical and physical characteristics of water samples collected at specific sites in the Matthews Lake area (March - April, 1982). (Refer to Figure 4.2.2 for location of the sample sites)

Parameter	Atomic Symbol	Test Values at Sample Site: Site 1	Site 3	Site 8
PHYSICAL TESTS				
pH		7.10	6.95	6.90
Conductivity (micro mhos/cm)		51.3	32.8	52.2
Colour [Pt-Co scale] (CU)		5.	5.	5.
Turbidity (JTU)		0.55	0.42	1.8
Hardness (mg/L)	$CaCO_3$	21.8	16.0	22.0
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		44.	34.	42.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO_3	26.0	19.4	24.9
Alkalinity: Carbonate	CO_3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO_4	7.0	7.0	6.0
Nitrates and Nitrites	N	0.051	0.021	0.015
Ortho Phosphates	P	< 0.010	< 0.010	< 0.010
DISSOLVED METALS (mg/L)				
Arsenic	As	0.003	< 0.001	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	6.79	4.96	6.83
Cobalt	Co	0.002	0.002	< 0.001
Copper	Cu	< 0.001	0.002	0.003
Iron	Fe	0.031	< 0.030	0.040
Lead	Pb	0.001	0.006	< 0.001
Magnesium	Mg	1.15	0.85	1.17
Manganese	Mn	0.021	< 0.003	< 0.003
Nickel	Ni	< 0.005	< 0.005	< 0.005
Potassium	K	0.96	0.73	1.04
Silicon	SiO_2	0.43	0.095	0.24
Sodium	Na	1.09	0.89	1.25
Zinc	Zn	0.028	0.035	0.021
TOTAL METALS (mg/L)				
Arsenic	As	0.004	< 0.001	0.001
Iron	Fe	0.054	< 0.030	0.081
Manganese	Mn	0.027	< 0.003	0.003
Mercury	Hg	<.00005	<.00005	<.00005
POLLUTANT TESTS (mg/L)				
Total Cyanide	CN	< 0.01	< 0.01	< 0.01

mg/L = milligrams per liter
< = Less than = Not Detected

Appendix Table VI (cont'd)

Parameter	Atomic Symbol	Test Values at Sample Site: Site 10	Site 13	Site 16
PHYSICAL TESTS				
pH		6.85	6.85	6.80
Conductivity (micro mhos/cm)		35.1	54.3	68.1
Colour [Pt-Co scale] (CU)		< 5.	5.	10.
Turbidity (JTU)		0.35	1.3	1.0
Hardness (mg/L)	CaCO3	13.7	23.8	35.1
SOLIDS (mg/L)				
Total Suspended		< 0.5	< 0.5	< 0.5
Total Dissolved		27.	43.	56.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	17.9	27.0	26.5
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	2.5	5.0	12.0
Nitrates and Nitrites	N	0.017	0.020	0.046
Ortho Phosphates	P	< 0.010	< 0.010	< 0.010
DISSOLVED METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	0.013
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	4.26	7.42	11.0
Cobalt	Co	< 0.001	< 0.001	< 0.001
Copper	Cu	0.003	0.001	< 0.001
Iron	Fe	< 0.030	< 0.030	0.11
Lead	Pb	< 0.001	0.002	0.002
Magnesium	Mg	0.73	1.25	1.82
Manganese	Mn	< 0.003	< 0.003	0.062
Nickel	Ni	< 0.005	< 0.005	< 0.005
Potassium	K	0.63	1.00	1.09
Silicon	SiO2	0.32	0.30	1.14
Sodium	Na	0.86	1.21	1.42
Zinc	Zn	< 0.015	< 0.015	0.024
TOTAL METALS (mg/L)				
Arsenic	As	< 0.001	< 0.001	0.014
Iron	Fe	< 0.030	0.048	0.14
Manganese	Mn	< 0.003	0.011	0.066
Mercury	Hg	<.00005	<.00005	<.00005
POLLUTANT TESTS (mg/L)				
Total Cyanide	CN	< 0.01	< 0.01	< 0.01

mg/L = milligrams per liter

< = Less than = Not Detected

Appendix Table VI (cont'd)

Parameter	Atomic Symbol	Site 17	Site 18	Site 19
		Test Values at Sample Site		
PHYSICAL TESTS				
pH		6.35	5.90	6.30
Conductivity (micro mhos/cm)		9.25	3.73	4.96
Colour [Pt-Co scale] (CU)		< 5.	< 5.	< 5.
Turbidity (JTU)		0.68	1.0	1.7
Hardness (mg/L)	CaCO3	1.0	0.5	0.6
SOLIDS (mg/L)				
Total Suspended		1.5	< 0.5	< 0.5
Total Dissolved		6.	3.	4.
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	4.27	2.0	2.5
Alkalinity: Carbonate	CO3	Nil	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil	Nil
Chlorides	Cl	< 0.5	< 0.5	< 0.5
Sulfates	SO4	< 1.0	< 1.0	< 1.0
Nitrates and Nitrites	N	0.021	0.015	0.091
Ortho Phosphates	P	< 0.010	< 0.010	< 0.010
DISSOLVED METALS (mg/L)				
Arsenic	As	0.004	0.005	< 0.001
Cadmium	Cd	< 0.001	< 0.001	< 0.001
Calcium	Ca	0.37	0.16	0.23
Cobalt	Co	< 0.001	< 0.001	< 0.001
Copper	Cu	0.004	0.002	0.003
Iron	Fe	0.036	< 0.030	0.034
Lead	Pb	< 0.001	0.002	0.002
Magnesium	Mg	0.009	< 0.001	0.004
Manganese	Mn	< 0.003	< 0.003	< 0.003
Nickel	Ni	< 0.005	< 0.005	< 0.005
Potassium	K	0.16	0.051	0.035
Silicon	SiO2	0.25	0.25	0.33
Sodium	Na	0.58	0.17	0.11
Zinc	Zn	0.016	< 0.015	0.027
TOTAL METALS (mg/L)				
Arsenic	As	0.020	0.015	0.003
Iron	Fe	0.068	0.059	0.068
Manganese	Mn	< 0.003	< 0.003	< 0.003
Mercury	Hg	<.00005	<.00005	<.00005
POLLUTANT TESTS (mg/L)				
Total Cyanide	CN	< 0.01	< 0.01	< 0.01

mg/L = milligrams per liter
< = Less than = Not Detected

Appendix Table VII — Chemical and physical characteristics of water samples collected at specific sites at Matthews Lake, June 22, 1982. Refer to Figure 4.2.1 for the location of sample sites. All values in mg/l unless otherwise specified.

Parameter	Samples 1	2	3	4	5	6	7	8	9	10
pH (units)	6.8	6.7	6.3	6.9	7.9	7.5	7.4	7.2	6.9	7.1
Specific Conductance (umho/cm)	31	14	16	51	176	129	57	29	18	23
Suspended solids	<5	<5	<5	7.6	190.0	<5	10	<5	<5	<5
Calcium	5.12	2.55	3.42	7.80	31.1	18.8	5.15	4.72	3.17	4.40
Magnesium	0.95	0.87	0.91	1.10	3.08	2.60	0.96	0.90	0.88	0.85
Total Hardness	16.7	9.94	12.3	24.0	90.3	57.6	16.8	15.5	11.5	14.5
Total Alkalinity	8.4	0.93	3.7	11.2	2.9	0.24	7.4	7.4	5.6	5.6
Sulphate	3.5	4.6	4.6	3.4	45.0	39.0	12.0	3.5	3.3	2.8
Ammonia-Nitrogen	0.35	0.14	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate-Nitrite	0.12	<0.04	<0.04	0.33	0.04	<0.04	0.04	<0.04	<0.04	<0.04
Total Phosphorus	0.12	<0.05	<0.05	<0.05	1.41	0.14	0.04	<0.05	<0.05	<0.05
Total Arsenic (ug/l)	<1.0	<1.0	<1.0	<1.0	340.0	81.0	10.4	2.0	2.0	2.0
Total Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	0.009	<0.005	<0.005	0.015	<0.005
Total Copper	<0.02	<0.02	<0.02	0.02	0.06	0.02	<0.02	0.02	0.02	<0.02

Appendix Table VII (cont'd)

Parameter	Samples 1	2	3	4	5	6	7	8	9	10
Total Iron	0.55	0.41	0.36	0.79	58.0	0.56	0.34	0.24	0.27	0.17
Total Lead	<0.05	<0.05	<0.05	<0.05	0.12	0.11	<0.05	0.06	0.06	<0.05
Total Mercury (ug/l)	<0.01	<0.01	0.01	0.01	0.18	0.01	0.02	<0.01	<0.01	0.02
Total Nickel	<0.05	<0.05	<0.05	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.05
Total Zinc	0.02	0.02	0.02	0.03	0.22	0.03	0.02	0.02	0.04	0.08
Total Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	<0.02	<0.02	<0.02

Appendix Table VIII. Standing crop (numbers/m^2) of zoobenthos for Matthews Lake. (Refer to Figure 4.2.2 for the location of the sample site)

SAMPLE SITE	TAXON[a]												TOTAL
	Oligochaeta	Hirundinea	Nematoda	Acari (mites)	Trichoptera (caddisfly larva)	Chironomidae	Cladocera	Calanoida	Planorbidae	*Lymnaea*	Pelecypoda	*Pungitius pungitius*	
1A	1,200					5,244	44 *Daphnia* sp.		267		1,333		8,088
1B	1,333					6,400			178		1,556		9,467
1C	1,111		89		44	9,689			311		1,200		12,444
2A	133					7,289			222		933		8,577
2B	444		44	44		4,711	44 *Daphnia* sp.		267		756		6,310
2C	400		89			6,800			133		844		8,266
3A	311		44			3,200		44	89		178		3,866
3B	267	44				4,267			133		444		5,155
3C	533		89			5,022			222		622	44	6,532
4A	222		44			7,289			44		1,200		8,799
4B						1,156			89		44		1,289
4C	267					3,956				44	444		4,711

Appendix Table VIII. (Cont'd)

SAMPLE SITE	TAXON[a]: Oligochaeta	Hirudinea	Nematoda	Acari (mites)	Trichoptera (caddisfly larva)	Chironomidae	Cladocera	Calanoida	Planorbidae	*Lymnaea*	Pelecypoda	*Pungitius pungitius*	TOTAL
5A	222		267			11,333			44	44	133		12,043
5B	89		489		44	14,800			89		178		15,689
5C	356					10,578			133		89		11,156
6	No sample was collected[b]												
7A	444					8,711	89 *Chydorus* sp.		178	44	533		9,999
7B	178					8,489			133	44	356		9,200
7C	133					7,867			44		667		8,711
8A	400					9,111			89		400		10,000
8B	178		356		44	9,378	44 *Daphnia* sp.		89		222		10,311
8C	267		89			8,933			44		222		9,555
9A	1,333		178			5,822			89	44	667		8,133

Appendix Table VIII. (Cont'd)

SAMPLE SITE	TAXON[a]												TOTAL
	Oligochaeta	Hirundinea	Nematoda	Acari (mites)	Trichoptera (caddisfly larva)	Chironomidae	Cladocera	Calanoida	Planorbidae	*Lymnaea*	Pelecypoda	*Pungitius pungitius*	
9B	1,111		178			1,956	44 *Daphne* sp.				267		3,556
9C	844		89			1,156			44		89		2,222
10A	222		89			7,822	133 *Chydorus* sp.		133	89	667		9,155
10B	44		44			7,822			44		578		8,532
10C	89					756		89					934
11A	178		489			6,489			178		178		7,512
11B			356			6,533			89		89		7,067
11C	267		444			5,867			222		222		7,022
12A	44		222			122 44[c] 44[d]			44				520
12B	44		222			267			44				577
12C	44		222			356			44		44		710
13A	267					27,156 133[c]			44		933		28,533

Appendix Table VIII. (Cont'd)

SAMPLE SITE	Oligochaeta	Hirudinea	Nematoda	Acari (mites)	Trichoptera (caddisfly larva)	Chironomidae	Cladocera	Calanoida	Planorbidae	*Lymnaea*	Pelecypoda	*Pungitius pungitius*	TOTAL
						TAXON[a]							
13B	133					26,578 44[c]			311		1,467		28,533
13C	133		44			20,178			222		89		20,666
14A						4,444 1,111[c]					222		5,910
14B	222		44			4,889 844[c]			489		533		7,021
14C	178		44		89	9,333 1,289[c]			222		622		11,777
15A[e]						622							622
15B[e]	89					1,156							1,245
15C[e]			44			267							311

Appendix Table VIII. (Cont'd)

a) Classification of Taxon:

Phylum	Class	Order	Family	Genus
Annelida	Oligochaeta			
	Hirundinea			
Nematoda				
Arthropoda	Crustacea	Cladocera	Chydoridae	*Chydorus sp.*
			Daphnidae	*Daphnia sp.*
		Copepoda	Calanoida	
	Insecta	Acari (aquatic mites)		
		Diptera	Ceratopogonidae	
			Chironomidae	
			Empididae	
		Trichoptera (Caddisfly larva)		
Molluscs	Gastropoda	Basommotophora	Lymnaeidae	*Lymnaea sp.*
			Planorbidae	
	Pelecypoda			
Vertebrata	Osteichthyes	Gasterosteiformes	Gasterosteidae	*Pungitius pungitius*

b) samples were not collected since the benthic surface was rocky and the Birge-Eckman dredge could not effectively sample the benthos.

Appendix Table VIII. (Cont'd)

c) the family of Diptera was Ceratopogonidae not Chironomidae.

d) the family of Diptera was Empididae not Chironomidae.

e) it is difficult to compare this data to the data from other samples sites since these samples were obtained from Courageous Lake, at the mouth of the creek that drains Matthews Lake. The bottom was primarily composed of boulder and cobble in the vicinity of the sample site with small patches of sand.

Appendix Table IX Standing crop (number/m^2) of zoobenthos in Matthews Lake System sediment samples, March-April, 1982. Refer to Figure 4.2.2 for location of sample sites.

Site #	Chironomidae	Nematoda	Bivalvia	Pelecypoda	Total
1	50	0	10	0	50
3	30	0	0	0	30
8	0	10	0	0	10
10	40	0	0	0	40
13	460	0	0	0	460
16	0	0	10	10	20

Appendix Table X. Chemical and physical characteristics of sediment samples collected at specific sites at Matthews Lake (September 16 - 20, 1981). Heavy metal results expressed as micrograms per dry gram of sample. (Refer to Figure 4.2.2 for the location of the sample sites)

PARAMETER			Test Values at Sample Site					
			Sub-Sample 1A	Sub-Sample 1B	Sub-Sample 1C	Sub-Sample 2A	Sub-Sample 2B	Sub-Sample 2C
Moisture (105°C)		%	78.5	79.8	80.2	77.3	79.0	79.4
Loss in Ignition (1000°C)		%	26.2	25.4	27.4	27.2	28.0	24.3
Total Organic Carbon		%	3.78	3.31	3.46	3.10	2.78	2.69
Particle Size Distribution								
Wood	> 2 mm	%	-	-	-	-	-	-
Gravel	> 2 mm	%	-	-	-	-	-	-
Sand	≤ 2 mm> 63µ	%	10.8	11.1	14.6	31.0	30.5	29.4
Silt	≤ 63 mm≥ 4µ	%	58.9	58.3	58.5	46.0	43.3	48.0
Clay	< 4 µ	%	30.3	30.6	26.9	23.0	26.2	22.6
Metals								
Mercury		Hg	0.059	0.060	0.060	0.057	0.042	0.060
Arsenic		As	29.8	26.5	31.1	39.0	31.8	29.2
Cadmium		Cd	0.45	0.45	0.55	0.35	< 0.25	< 0.25
Copper		Cu	52.0	49.6	57.5	41.7	54.0	51.8
Lead		Pb	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Zinc		Zn	86.4	81.7	93.3	61.6	71.6	78.0
Nickel		Ni	29.8	28.7	35.1	27.3	33.7	32.5
Molybdenum		Mo	<2.00	<2.00	< 2.00	< 2.00	< 2.00	< 2.00
Cobalt		Co	14.0	10.0	8.55	11.0	4.50	7.80
Chromium		Cr	33.0	27.3	30.1	21.5	25.0	27.5
Manganese		Mn	177.	160.	198.	153.	161.	170.

Appendix Table X (cont'd)

PARAMETER		Test Values at Sample Site Sub-Sample 3A	Sub-Sample 3B	Sub-Sample 3C	Sub-Sample 4A	Sub-Sample 4B	Sub-Sample 4C
Moisture (105°C)	%	81.5	81.3	81.7	79.1	78.5	80.2
Loss in Ignition (1000°C)	%	26.8	25.8	25.8	31.6	27.2	32.3
Total Organic Carbon	%	3.64	2.48	3.19	3.64	3.20	4.64
<u>Particle Size Distribution</u>							
Wood > 2 mm	%	-	-	-	-	-	-
Gravel > 2 mm	%	-	-	-	-	-	-
Sand ≤ 2 mm > 63µ	%	18.3	16.4	18.0	32.6	27.1	22.0
Silt ≤ 63 mm ≥ 4µ	%	55.1	48.8	47.3	42.6	41.7	46.1
Clay < 4 µ	%	26.6	34.8	34.7	24.8	31.2	31.9
<u>Metals</u>							
Mercury	Hg	0.061	0.050	0.070	0.031	0.033	0.045
Arsenic	As	30.5	25.9	33.5	46.0	34.5	44.8
Cadmium	Cd	0.64	0.45	0.59	0.55	0.40	0.65
Copper	Cu	62.2	70.1	61.0	57.9	63.2	66.2
Lead	Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Zinc	Zn	105.	114.	110.	109.	117.	116.
Nickel	Ni	39.0	38.6	37.8	33.7	35.0	36.8
Molybdenum	Mo	< 2. 00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Cobalt	Co	18.1	16.0	18.4	14.2	11.0	9.50
Chromium	Cr	31.5	28.5	30.3	26.5	28.5	29.9
Manganese	Mn	375.	367.	395.	165.	190.	215.

Appendix Table X (cont'd)

PARAMETER		Test Values at Sample Site: Sub-Sample 5A	Sub-Sample 5B	Sub-Sample 5C	Sub-Sample 7A	Sub-Sample 7B	Sub-Sample 7C
Moisture (105°C)	%	27.9	33.2	53.9	80.2	80.6	80.1
Loss in Ignition (1000°C)	%	2.00	1.90	10.9	28.8	28.6	28.1
Total Organic Carbon	%	0.35	0.16	0.38	3.86	4.20	4.43
Particle Size Distribution							
Wood > 2 mm	%	-	-	-	-	-	-
Gravel > 2 mm	%	-	-	-	-	-	-
Sand ≤ 2 mm > 63µ	%	89.5	90.6	89.4	18.9	12.5	17.6
Silt ≤ 63 mm ≥ 4µ	%	7.3	6.8	6.4	49.0	50.5	44.0
Clay < 4 µ	%	3.2	2.6	4.2	32.1	37.0	38.4
Metals							
Mercury	Hg	< 0.025	< 0.025	< 0.025	0.053	0.059	0.070
Arsenic	As	10.9	12.6	23.8	148.0	88.6	135.0
Cadmium	Cd	< 0.25	0.35	< 0.25	0.60	0.80	0.79
Copper	Cu	8.80	12.0	9.20	89.0	83.5	84.9
Lead	Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	<5.00
Zinc	Zn	30.5	41.2	29.0	250.	183.	218.
Nickel	Ni	16.8	13.8	14.3	57.5	53.8	53.6
Molybdenum	Mo	<2.00	<2.00	< 2.00	< 2.00	<2.00	< 2.00
Cobalt	Co	3.30	4.00	3.70	16.5	12.5	11.9
Chromium	Cr	13.0	9.50	12.5	34.5	30.0	34.8
Manganese	Mn	76.5	62.5	80.0	310.	258.	283.

Appendix Table X (cont'd)

PARAMETER		Test Values at Sample Site					
		Sub-Sample 8A	Sub-Sample 8B	Sub-Sample 8C	Sub-Sample 9A	Sub-Sample 9B	Sub-Sample 9C
Moisture (105°C)	%	59.8	67.6	66.0	25.9	30.6	35.7
Loss in Ignition (1000°C)	%	21.4	24.5	12.4	2.00	3.70	4.90
Total Organic Carbon	%	2.35	2.71	2.28	0.23	0.17	0.15
Particle Size Distribution							
Wood > 2 mm	%	-	-	-	-	-	-
Gravel > 2 mm	%	-	-	-	-	-	-
Sand ≤ 2 mm > 63µ	%	73.8	60.0	67.3	92.6	89.4	93.8
Silt ≤ 63 mm ≥ 4µ	%	18.3	27.5	23.1	5.9	9.0	4.6
Clay < 4 µ	%	7.9	12.5	9.6	1.5	1.6	1.6
Metals							
Mercury	Hg	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Arsenic	As	26.0	13.5	32.0	6.95	6.41	13.5
Cadmium	Cd	0.40	0.45	0.57	< 0.25	< 0.25	< 0.25
Copper	Cu	41.7	37.5	31.8	14.5	6.50	6.20
Lead	Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Zinc	Zn	121.	82.5	102.	40.6	14.5	17.0
Nickel	Ni	26.2	26.8	23.2	12.2	7.40	8.20
Molybdenum	Mo	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Cobalt	Co	9.50	6.00	5.72	2.50	2.51	3.10
Chromium	Cr	17.5	16.2	17.2	6.5	10.7	10.7
Manganese	Mn	149.	90.2	101.	71.5	89.3	120.

Appendix Table X (cont'd)

PARAMETER			Test Values at Sample Site Sub-Sample 10A	Sub-Sample 10B	Sub-Sample 10C	Sub-Sample 11A	Sub-Sample 11B	Sub-Sample 11C
Moisture (105°C)		%	82.0	79.9	80.5	31.0	32.1	32.1
Loss in Ignition (1000°C)		%	30.6	26.7	25.1	2.3	2.7	1.4
Total Organic Carbon		%	3.74	3.55	3.09	0.22	0.32	0.16
Particle Size Distribution								
Wood	> 2 mm	%	-	-	-	-	-	-
Gravel	> 2 mm	%	-	-	-	-	-	-
Sand	≤ 2 mm > 63μ	%	18.1	24.0	23.4	93.3	93.1	93.1
Silt	≤ 63 mm ≥ 4μ	%	50.4	45.2	43.4	4.4	4.1	4.4
Clay	< 4 μ	%	31.5	30.8	33.2	2.3	2.8	2.5
Metals								
Mercury		Hg	0.053	0.094	0.055	0.013	0.014	0.013
Arsenic		As	108.0	167.	130.0	5.17	6.82	9.23
Cadmium		Cd	0.25	0.69	0.75	< 0.25	< 0.25	<0.25
Copper		Cu	76.1	75.4	75.5	7.46	7.00	6.90
Lead		Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	<5.00
Zinc		Zn	151.	188.	185.	18.7	17.2	18.5
Nickel		Ni	48.5	52.1	51.0	9.76	9.30	9.67
Molybdenum		Mo	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Cobalt		Co	13.0	11.4	12.5	1.87	1.60	1.47
Chromium		Cr	32.7	32.7	31.0	7.75	7.35	7.03
Manganese		Mn	300.	283.	274.	58.7	44.7	58.5

Appendix Table X (cont'd)

PARAMETER		Test Values at Sample Site					
		Sub-Sample 12A	Sub-Sample 12B	Sub-Sample 12C	Sub-Sample 13A	Sub-Sample 13B	Sub-Sample 13C
Moisture (105°C)	%	25.7	27.7	27.1	85.7	88.2	90.9
Loss in Ignition (1000°C)	%	1.8	2.00	2.2	29.0	32.7	39.4
Total Organic Carbon	%	0.22	0.16	0.29	4.66	4.95	6.51
<u>Particle Size Distribution</u>							
Wood > 2 mm	%	-	-	-	-	-	-
Gravel > 2 mm	%	-	-	-	-	-	-
Sand ≤ 2 mm > 63μ	%	93.6	92.4	92.5	19.8	19.6	13.7
Silt ≤ 63 mm ≥ 4μ	%	5.1	5.8	5.7	51.9	56.9	53.6
Clay < 4 μ	%	1.3	1.8	1.8	28.3	23.5	32.7
<u>Metals</u>							
Mercury	Hg	< 0.025	0.034	< 0.025	0.027	0.083	0.098
Arsenic	As	10.9	20.2	9.80	38.5	30.8	38.2
Cadmium	Cd	< 0.25	< 0.25	< 0.25	0.75	< 0.25	< 0.25
Copper	Cu	5.47	10.1	4.85	80.5	79.2	92.8
Lead	Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.0
Zinc	Zn	20.3	54.5	22.5	92.5	99.2	119.
Nickel	Ni	8.35	17.7	8.00	72.4	74.2	92.8
Molybdenum	Mo	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Cobalt	Co	3.26	7.65	2.65	15.5	18.3	13.1
Chromium	Cr	12.0	33.7	11.6	20.0	28.3	26.2
Manganese	Mn	84.3	162.	80.2	127.	143.	166.

Appendix Table X (cont'd)

PARAMETER		Test Values at Sample Site					
		Sub-Sample 14A	Sub-Sample 14B	Sub-Sample 14C	Sub-Sample 15A	Sub-Sample 15B	Sub-Sample 15C
Moisture (105°C)	%	81.5	82.6	82.3	18.6	19.7	15.3
Loss in Ignition (1000°C)	%	32.2	21.9	34.0	1.3	1.4	1.4
Total Organic Carbon	%	4.64	5.31	5.46	0.18	0.38	0.20
Particle Size Distribution							
Wood > 2 mm	%	-	-	-	-	-	-
Gravel > 2 mm	%	-	-	-	-	-	-
Sand ≤ 2 mm > 63µ	%	32.5	34.6	30.0	96.7	95.8	97.3
Silt ≤ 63 mm ≥ 4µ	%	40.3	45.1	43.0	2.1	3.2	1.8
Clay < 4 µ	%	27.2	20.3	27.0	1.2	1.0	0.9
Metals							
Mercury	Hg	0.044	0.062	0.028	< 0.025	< 0.025	< 0.025
Arsenic	As	67.5	56.5	81.5	11.8	15.4	15.5
Cadmium	Cd	0.65	0.62	< 0.25	< 0.25	< 0.25	< 0.25
Copper	Cu	50.8	53.8	54.3	3.07	3.05	3.25
Lead	Pb	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Zinc	Zn	112.	116.	122.	14.5	18.9	18.8
Nickel	Ni	50.2	54.3	54.3	7.49	35.1	9.80
Molybdenum	Mo	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Cobalt	Co	18.0	22.8	22.7	3.0	4.15	3.20
Chromium	Cr	26.0	29.3	28.3	13.5	15.7	13.8
Manganese	Mn	159.	181.	174.	77.2	98.4	96.5

Appendix Table XI — Arsenic and mercury levels in core samples collected at four locations in Matthews Lake and Sandy Lake systems, March-April, 1982. Results are presented in micrograms element per dry gram of sample.
Refer to Figure 4.2.2 for location of sample sites.

Site #	Location	% Moisture	Arsenic	Mercury
10	Top	79.2	32.3	0.037
	Middle	75.9	37.5	0.023
	Bottom	68.7	35.4	0.017
13	Top	83.6	23.6	0.031
	Middle	85.0	21.0	0.026
	Bottom	83.7	16.7	0.035
16	Top	79.1	72.1	0.074
	Middle	85.2	72.2	0.077
	Bottom	85.2	86.8	0.095
17	Upper	74.9	1100.	0.16
	Lower	74.0	299.	0.073

Appendix Table XII. Heavy metal analysis of fish tissue and liver samples from Matthews Lake. Data obtained is preceded by fish sample I.D. Index.

Sample ID #	Species[a]	Sex[b]	Gonad Condition	Length (cm)	Weight (gm)	Age Group[d]	Age Calculated (Approx)
1	HBWF	I	0	13.6	30	Y	1+
2	HBWF	I	0	14.2	30	Y	1+
3	HBWF	I	0	13.1	30	Y	1+
4	HBWF	I	0	13.0	30	Y	1+
5	HBWF	I	0	12.8	30	Y	1+
6	HBWF	I	0	19.9	100	Y	1+
7	HBWF	M	2	21.6	125	M	3+
8	HBWF	F	2	29.0	280	M	6+
9	HBWF	M	1	21.4	120	M	3+
10	HBWF	M	2	27.8	200	M	5+
11	HBWF	F	6	39.4	726	0	9+
12	HBWF	F	6	40.6	816	0	10+
13	HBWF	F	6	38.5	680	0	9+
14	HBWF	F	6	39.7	816	0	9+
15	LKTR	M	3	51.5	1450	M	16+
16	LKTR	M	5	62.5	2475	0	19+
17	LKTR	F	3	69.0	3220	0	21+
18	LKTR	M	6	64.0	2676	0	20+
19	LKTR	F	5	66.8	3039	0	21+
20	LKTR	F	7	65.4	2313	0	20+
21	LKTR	M	4,7	49.9	1361	M	15+
22	LKTR	M	6	53.7	1633	M	16+
23	LKTR	M	4	48.4	1270	M	14+
24	LKTR	M	0	15.7	40	Y	3+
25	GRAY	F	2	38.6	272	M	7+
26	PIKE	F	5	81.4	3969	0	15+

a = Species Names:

HBWF = humpback whitefish = *Coregonus clupeaformis*
LKTR = lake trout = *Salvelinus namaycush*
GRAY = Arctic grayling = *Thymallus arcticus*
PIKE = northern pike = *Esox lucius*

Appendix Table XII. (Cont'd)

b = Sex

I = immature
M = male
F = female

c = Gonad Condition:

0 = no gonad development
1 = less than 1/4 developed
2 = approximately 1/4 developed
3 = approximately 1/2 developed
4 = approximately 3/4 developed
5 = fully developed but not ready to spawn (green)
6 = ripe and ready to spawn
7 = spawned out

d = Age Group

Y = young
M = mature
O = old

e = Age calculated:

The age recorded for the individual fish are approximate and were determined by comparing the lengths of the fish to age - length tables in Hatfield et al. (1972) for humpback whitefish and Scott and Crossman (1973) for lake trout, Arctic grayling, and northern pike.

Appendix Table XII. (Cont'd)

Sample I.D.	Moisture (%)	Mercury	Arsenic	Cadmium	Copper	Lead	Zinc	Nickel	Molybdenum	Cobalt	Chromium	Manganese
1 (LIVER)	-	0.14	0.86	0.14	7.61	2.59	94.8	1.44	<0.70	<0.70	0.43	3.02
1 (TISSUE)	77.5	3.19	NES	0.40	2.19	0.92	28.2	<0.10	<0.10	<0.10	0.080	0.87
2 (LIVER)	-	0.58	0.46	0.18	3.37	<0.10	26.4	<0.50	<0.50	<0.50	<0.10	1.91
2 (TISSUE)	78.0	0.050	1.60	<0.10	8.80	5.00	97.2	11.0	<0.50	<0.50	0.40	2.00
3 (LIVER)	-	1.33	0.60	0.24	5.09	0.61	24.2	<0.60	<0.60	<0.60	<0.10	1.58
3 (TISSUE)	79.1	2.02	NES	0.25	3.60	0.33	36.8	<0.10	<0.20	<0.10	0.14	0.88
4 (LIVER)	-	1.13	NES	0.64	2.89	2.41	32.2	<0.80	<0.80	<0.80	1.93	4.02
4 (TISSUE)	77.8	0.047	1.03	<0.10	8.42	4.03	88.9	5.62	<0.50	<0.50	0.47	1.40
5 (LIVER)												
5 (TISSUE)	78.2	0.058	0.44	0.029	1.57	0.29	10.2	0.44	<0.20	<0.10	<0.03	5.82
6 (LIVER)	-	0.073	<0.04	0.036	1.56	0.11	26.2	<0.20	<0.20	<0.20	0.10	1.63
6 (TISSUE)	77.5	0.086	0.50	<0.050	2.29	0.53	29.9	3.68	<0.20	<0.20	<0.040	0.49

Appendix Table XII. (Cont'd)

Sample I.D.	Moisture (%)	Mercury	Arsenic	Cadmium	Copper	Lead	Zinc	Nickel	Molybdenum	Cobalt	Chromium	Manganese
7 (LIVER)	-	0.056	NES	0.056	2.22	0.48	23.2	<0.10	<0.10	<0.10	0.17	2.04
7 (TISSUE)	76.9	0.14	0.63	0.042	1.78	0.042	26.6	0.30	<0.20	<0.10	<0.04	0.68
8 (LIVER)	-	0.020	0.28	<0.040	5.61	1.57	54.9	0.72	<0.20	0.20	0.20	3.97
8 (TISSUE)	76.8	0.059	0.51	<0.050	1.23	0.76	27.9	1.01	<0.20	1.90	<0.04	0.47
9 (LIVER)	-	0.095	NES	0.057	2.29	0.10	23.5	3.63	<0.10	0.10	1.70	2.29
9 (TISSUE)	77.8	0.13	0.40	<0.050	2.05	0.13	25.9	1.92	<0.30	<0.30	1.06	2.19
10 (LIVER)	-	0.049	NES	0.012	0.65	0.036	8.59	0.24	<0.06	<0.10	1.48	0.76
10 (TISSUE)	79.2	0.15	0.25	<0.050	3.71	7.12	30.5	0.66	<0.25	17.8	<0.050	0.46
11 (LIVER)	-	0.13	0.071	0.10	3.85	0.58	24.1	0.40	<0.050	0.21	0.59	2.57
11 (TISSUE)												
12 (LIVER)	-	0.070	0.059	<0.010	2.26	0.092	21.1	<0.050	<0.050	0.29	0.10	1.93
12 (TISSUE)	75.6	0.080	0.41	0.34	1.43	0.41	23.3	<0.25	<0.25	<0.20	0.45	<0.15
13 (LIVER)	-	0.10	0.027	<0.010	1.30	0.33	18.7	<0.050	<0.050	<0.050	0.11	1.77
13 (TISSUE)	76.9	0.34	0.17	0.17	2.25	0.76	33.1	1.48	0.21	<0.20	<0.040	0.38

Appendix Table XII. (Cont'd)

Sample I.D.	Moisture (%)	Mercury	Arsenic	Cadmium	Copper	Lead	Zinc	Nickel	Molybdenum	Cobalt	Chromium	Manganese
14 (LIVER)	-	0.054	0.054	0.064	1.72	0.14	21.2	0.19	0.12	<0.20	0.15	1.72
14 (TISSUE)	76.0	0.087	0.23	<0.050	1.88	<0.040	36.9	0.79	0.19	<0.20	0.11	0.34
15 (LIVER)	-	0.030	0.050	0.17	28.3	0.064	42.3	0.31	0.092	<0.20	0.028	1.85
15 (TISSUE)	78.2	0.23	0.26	<0.050	2.47	1.04	19.5	2.21	0.20	0.52	<0.040	0.35
16 (LIVER)	-	0.22	0.058	0.26	27.9	0.13	40.7	0.58	0.13	0.20	0.21	1.75
16 (TISSUE)	79.1	1.95	0.068	<0.050	1.75	0.31	16.3	<0.25	<0.25	<0.20	0.40	<0.15
17 (LIVER)	-	0.75	0.022	0.22	28.6	0.10	39.8	<0.050	<0.050	<0.050	0.11	1.28
17 (TISSUE)	78.7	2.95	0.34	<0.050	2.84	0.29	22.1	<0.25	<0.25	<0.20	0.39	<0.15
18 (LIVER)	-	0.62	<0.010	0.12	15.8	0.075	29.5	<0.050	<0.050	0.20	0.15	0.81
18 (TISSUE)	76.0	3.00	0.068	<0.050	1.94	0.45	16.7	<0.25	<0.25	<0.20	0.37	<0.15
19 (LIVER)	-	0.80	<0.010	0.17	29.8	0.25	42.5	<0.050	<0.050	0.15	0.11	<0.050
19 (TISSUE)	77.4	3.28	0.26	<0.050	1.75	0.43	19.0	<0.25	<0.25	<0.20	0.46	<0.15
20 (LIVER)	-	1.65	0.024	0.25	36.4	0.15	42.5	<0.050	<0.050	0.22	0.11	<0.050
20 (TISSUE)	80.1	6.62	0.25	<0.050	1.85	1.80	25.8	<0.25	<0.25	<0.20	0.25	<0.15

Appendix Table XII. (Cont'd)

Sample I.D.	Moisture (%)	Mercury	Arsenic	Cadmium	Copper	Lead	Zinc	Nickel	Molybdenum	Cobalt	Chromium	Manganese
21 (LIVER)	-	0.17	0.14	0.19	0.75	0.30	6.20	0.15	0.16	0.19	0.075	1.82
21 (TISSUE)	75.8	1.40	0.13	<0.050	1.63	0.90	17.2	<0.25	0.30	<0.20	0.43	<0.15
22 (LIVER)	-	0.40	0.039	0.13	30.0	0.25	42.0	<0.050	<0.050	<0.050	0.19	1.20
22 (TISSUE)	75.5	2.17	0.16	<0.050	1.84	0.082	16.7	<0.25	<0.25	0.20	0.37	<0.15
23 (LIVER)	-	0.33	0.039	0.13	21.7	0.089	44.2	<0.050	<0.050	0.28	0.069	1.18
23 (TISSUE)	77.4	1.10	0.043	<0.050	1.85	0.50	15.0	<0.25	<0.25	<0.20	0.51	<0.15
24 (LIVER)	-	0.050	0.15	0.17	<0.030	<0.020	<0.40	<0.10	<0.10	<0.10	<0.030	<0.10
24 (TISSUE)	77.1	0.23	0.16	<0.080	2.87	0.16	26.3	1.83	0.40	<0.40	<0.080	0.72
25 (LIVER)	-	0.033	0.067	<0.030	5.65	0.23	50.9	0.17	0.16	0.37	0.23	0.40
25 (TISSUE)	77.1	0.16	0.043	<0.050	2.17	0.086	26.1	<0.20	<0.020	<0.20	<0.040	0.61
26 (LIVER)	-	0.11	1.16	<0.020	6.35	<0.020	26.9	0.046	<0.050	<0.20	0.020	1.90
26 (TISSUE)	78.8	1.26	3.90	<0.050	1.10	0.15	17.4	1.05	<0.20	<0.20	0.30	0.50

Appendix Table XII. (Cont'd)

Sample I.D.	Moisture (%)	Mercury	Arsenic	Cadmium	Copper	Lead	Zinc	Nickel	Molybdenum	Cobalt	Chromium	Manganese
NBS 1566 OYSTER TISSUE #1	-	-.059	13.0	3.15	61.0	0.47	840..	0.97	<0.50	<0.40	0.72	16.5
NBS 1566 OYSTER TISSUE #2	-	0.065	12.9	3.20	60.0	0.49	849.	1.10	<0.50	<0.40	0.75	16.0
CERTIFIED VALUES	-	0.057	13.4	3.50	63.0	0.48	852.	1.03	<0.20	0.4 (N.C.)	0.69	17.5

N.C. = Not Certified
Tissue = Results are expressed as micrograms element per dry gram of sample
Liver = Results are expressed as micrograms element per wet gram of sample