

B.Y.G.

Natural Resources Inc.

**Initial Environmental Evaluation
Mt. Nansen Development**

Volume 1

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Executive Summary

B.Y.G. Natural Resources Inc. (BYG) is currently developing its Mount Nansen property as an open pit mine with start-up in early 1995. The site is located approximately 60 kilometres west of Carmacks, Yukon. BYG plans to mine approximately 300 tonne of gold-bearing oxide ore per day using open pit mining methods and to process this ore in an on-site mill using the Carbon-in-Pulp (CIP) process. Proven reserves on the property, located in the Brown-McDade zone, allow for a project life of about four years, including one year of preproduction work. It is expected that the three year operating life of the project will be extended by the discovery of additional oxide ore in the other deposits on the property (Webber and Flex). Extension of mine life could also result if viable metallurgical processes are developed for potential sulphide ore on the property (Huestis).

The strategy developed for the project will minimize both short-term and long-term impacts and ensure that the mine can be decommissioned in a safe environmentally sound manner.

The waste rock extracted from the Brown McDade pit will be placed in a dump adjacent to the pit. The dump will be designed to provide for total control and monitoring of surface run-off. The bulk of the waste rock, Altered Granodiorite, is a non-acid generating waste with mean Net Neutralization Potential (Net NP) of +25 kg CaCO₃/tonne. The other waste rocks which consist of Feldspar Porphyry and Footwall Granodiorite are also non-acid generating. The dump will be constructed to allow for reclamation after closure.

A water management system will be installed to ensure that all contaminated water will be retained and treated to appropriate limits prior to release to the environment.

The project will involve conversion and rehabilitation of the existing flotation mill to a cyanidation circuit. Mill tailings will be treated for cyanide and metals using the Inco SO₂-Air process. This will reduce the tailings cyanide concentration to the 10 mg/L range.

The tailings system will consist of an impoundment dam, a slurry pipeline, a reclaim pump, a reclaim water pipeline, diversion ditches, an emergency spillway (if required), and a seepage collection dam. A reclaim pump station will pump water back to the mill to maximize recycle and minimize freshwater consumption. This will result in a zero discharge system under normal conditions for at least the first two years of operation. The tailings dam design, completed by Klohn-Crippen, has been based on a frozen core that will eliminate seepage loss. Excess reclaim water stored in the tailings pond will be treated, if required, in secondary treatment facilities to comply with discharge criteria, and released to Dome Creek on a seasonal basis. The secondary treatment

system will involve either the SO_2 -air or H_2O_2 processes for cyanide and the high density sludge process for arsenic and other metals removal.

The tailings placement method will ensure that the tailings are deposited on as flat a profile as possible. The area of tailings beach left at closure will be minimized and covered with overburden to aid revegetation. ARD assessment of tailings has indicated that the tailings should not be a concern in regards to acid drainage due to low sulphur content, particle size and the deposition method used.

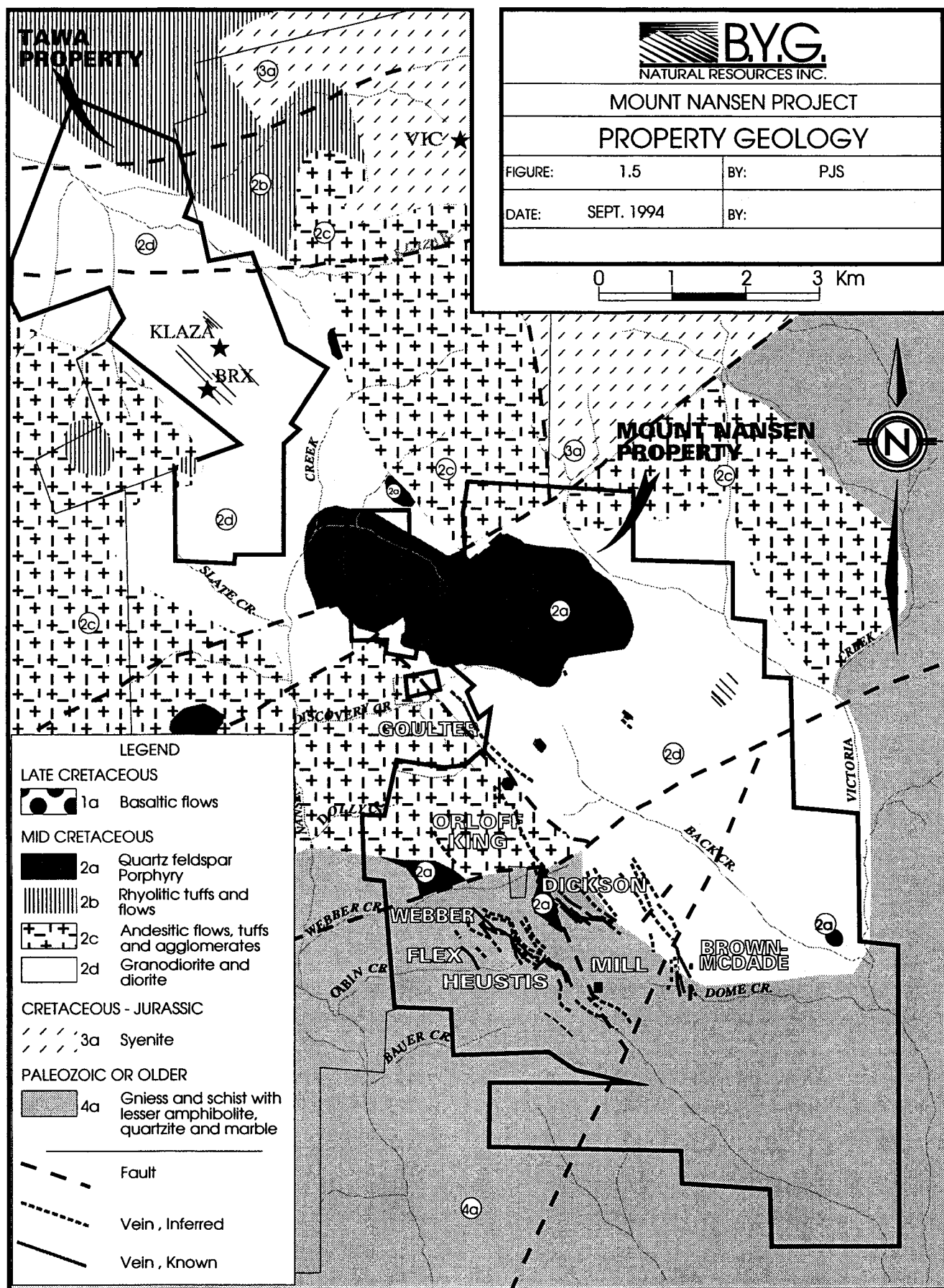
Initial environmental studies for the Mount Nansen Project started in October, 1985. A number of baseline data collection programs were conducted by the company, its consultants and the government agencies up until the fall of 1989. This work included water quality sampling, hydrology, stream sediment sampling, collection of rock samples for acid-base accounting tests, and reconnaissance for wildlife. This work has been compiled and is included in this document. The original environmental baseline data has recently been supplemented by collection of additional data which has included stream flow measurements in Dome Creek, a surface water sampling program, a comprehensive waste rock ARD assessment program and a tailings characterization and treatment program.

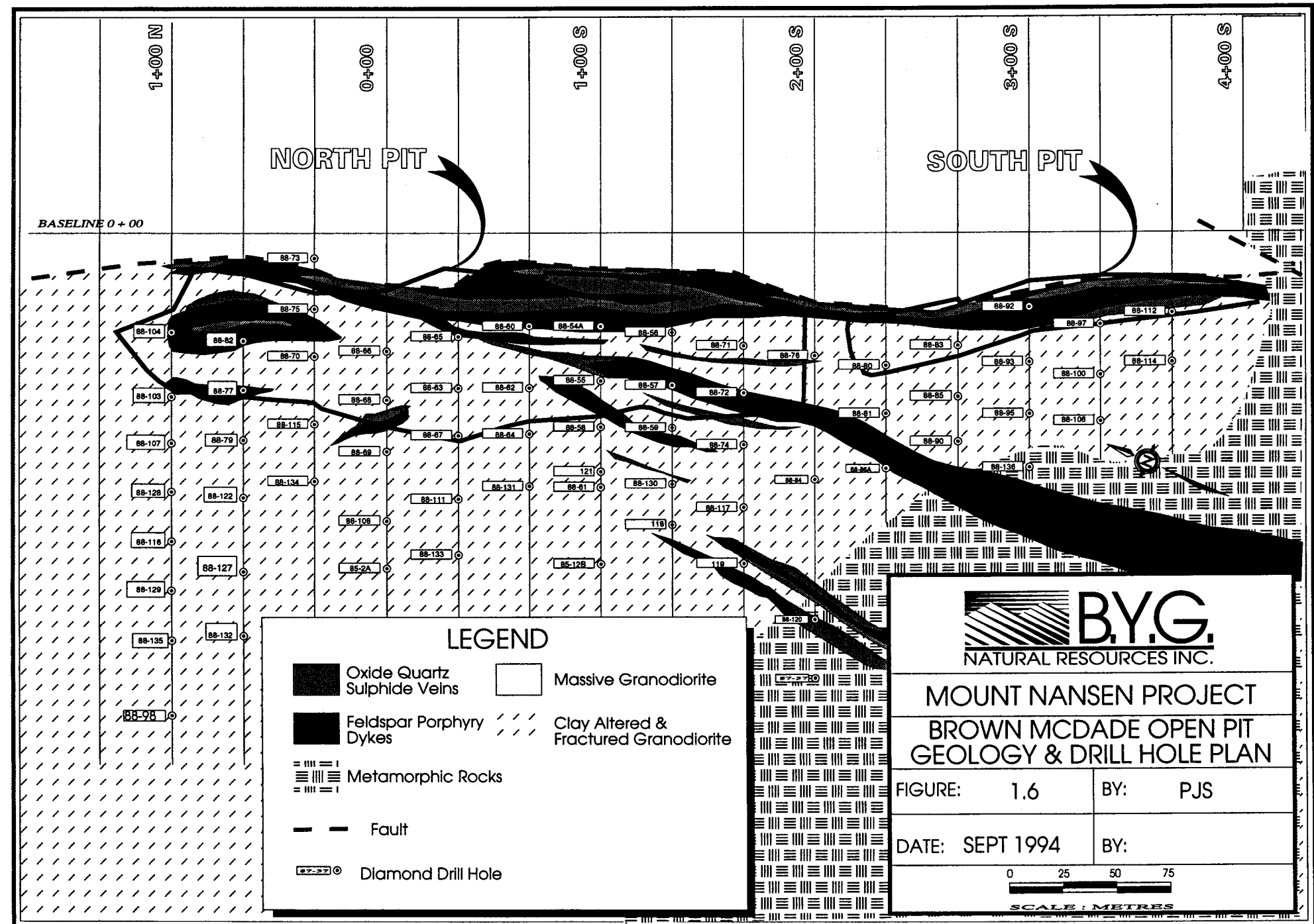
A draft monitoring plan has been prepared to provide a means of demonstrating compliance with permit and license requirements and to provide a mechanism for early detection of contamination, if necessary. A draft Spill Contingency Plan has been assembled to document response strategies to spills of potentially hazardous substances on the access road or the mill site area.

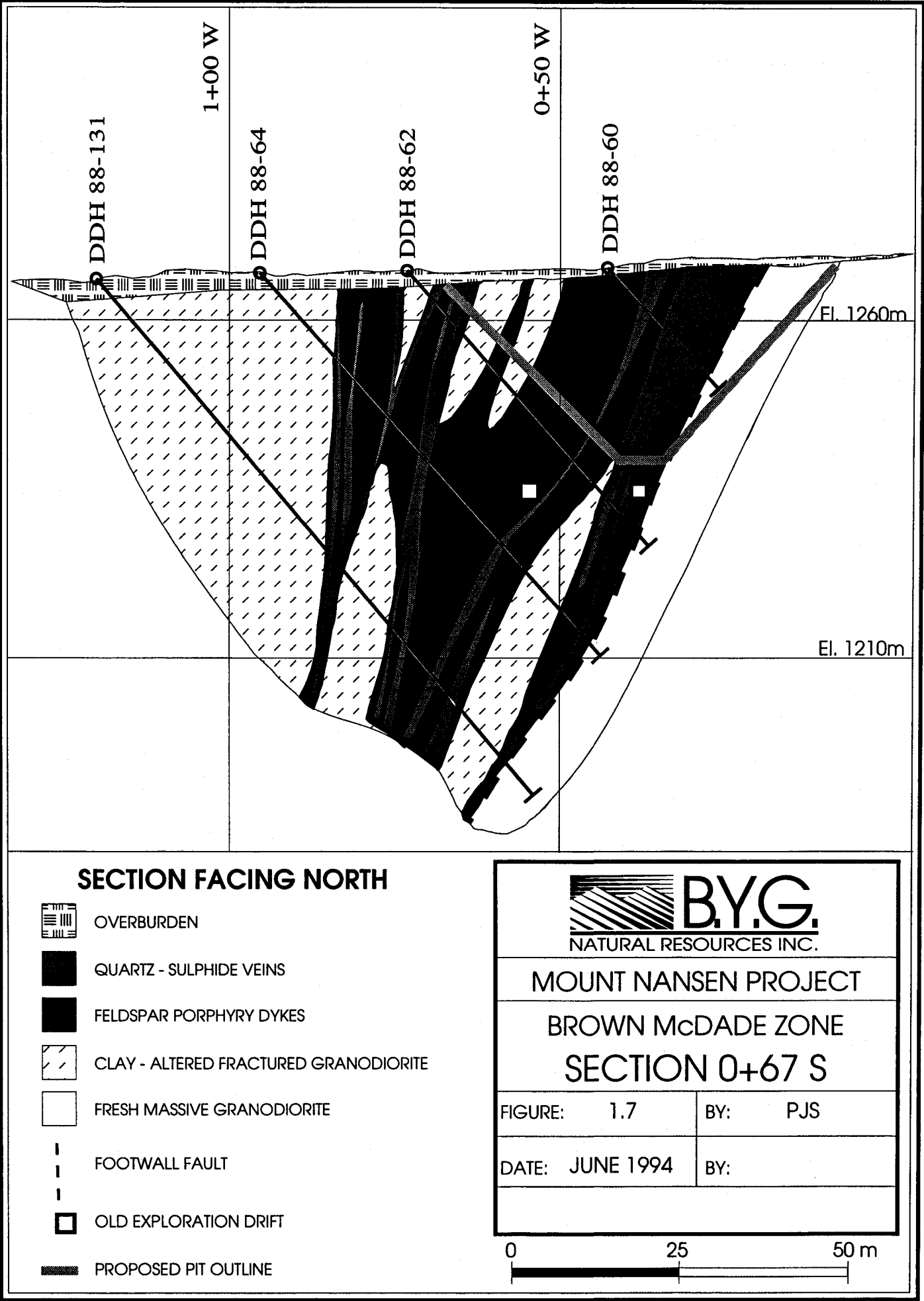
A conceptual Reclamation Plan has been assembled to provide a means of returning disturbed lands to their original use and capability once the project is complete. There are a number of site disturbances in the Mount Nansen area related to previous exploration and mining activities outside of the current project area. BYG will endeavor to carry out reclamation activities in disturbed areas outside the current project area where feasible once agreements are reached on how the reclamation efforts should be prioritized. Reclamation scheduling will be dependent upon the timing of development of the other mineralized zones and the requirement for additional tailings impoundment, waste rock dumps, and other facilities.

In accordance with the requirements of the Environmental Assessment and Review Process (EARP) an Initial Environmental Evaluation (IEE) has been prepared by BYG to identify environmental and socio-economic impacts of the project.

The Mount Nansen property is situated in an area with a long history of mining activity. Mining activity in the region continues today in the form of placer mining operations. Due to both the mining history of the area and the relatively small scale of this project, the expected environmental impacts of the project are minimal.







Footwall rocks are relatively massive and unaltered, while hanging wall rocks are fractured and clay altered. A plan view of the geology and the drill holes for the Brown-McDade open pit is provided in Figure 1-6 while a cross section of the ore body at Line 0+67S is provided in Figure 1-7.

The strongest veins occur in a 3 to 40 metre wide band directly adjacent to the Footwall Fault, while weaker subsidiary structures are common further out on the hanging wall. The highest assays are normally found within the quartz veins, and adjacent fractured or gougy wall rocks are often weakly to moderately mineralized. Supergene weathering has converted near surface sulphide minerals to limonite and other oxides. The oxidation gradually diminishes with increasing depth and depth of total oxidation ranges from 5 metres at the north end of the zone to at least 75 metres at the south end.

A variety of reserve and inventory calculations have been carried out over a number of years on the various zones on the property. For the purposes of economic evaluation, and for reference in this report, the term "mineable ore reserve" shall only apply to material that has been classed as "proven" or "probable" by a professional engineer/geologist, and can be mined and processed economically. Other mineralized material, which does not pass all of the above criteria, will be classed as "mineral inventory". At Mount Nansen, over 90% of this inventory has been classed as "proven" or "probable".

The following table presents all of the mineralized material, including currently economic "mineable ore", as well as material which could prove to be economic in the future. The criteria most likely to result in a change from "inventory" to "ore", is improved metallurgy.

Table 1-1: Mt. Nansen Mineral Inventory

TYPE OF ORE	ZONE	TONNES	GMT GOLD	GMT SILVER
Oxide Ore	Brown-McDade	318,830	5.22	53
	Flex	62,600	7.40	178
TOTAL OXIDE:		381,430	5.58	74
Sulphide	Brown-McDade	272,070	7.50	70
	Webber	85,432	9.40	583
	Huestis	123,842	14.10	291
	Flex	52,245	7.70	226
	Dumps	65,658	5.06	126
TOTAL SULPHIDE:		599,247	8.88	190
Total All Oxide and Sulphide:		980,677	7.60	145

At this time, the only zone which can be classified as "mineable ore reserve" is the oxide portion of the Brown-McDade zone. This mineralization can be included as "ore" because it meets the required criteria for geometry and tenor of metal content to qualify as "proven & probable", and also demonstrates economic value and returns.

The following ore reserve was calculated by C.M. Armstrong, an independent geological engineer (Armstrong, 1994). In conjunction with the calculation of this reserve, an open pit mining plan was developed to determine the quantity of the calculated reserve that could be economically mined. This exercise resulted in the final reserve calculation on which the investment was justified.

Table 1-2: Mt. Nansen Mineable Ore Reserves

TYPE OF ORE	CATEGORY	TONNES	GMT Gold	GMT Silver
Oxide Ore	Proven	130,936	5.74	69
	Probable	173,655	5.67	75
PROVEN & PROBABLE		305,591	5.70	72
RECOVERABLE BY PIT		259,850	6.31	70

1.6.2.2 Lithology

The oldest rocks in the Mount Nansen area belong to the Upper Paleozoic to older metamorphic assemblage that underlies most of the southern part of the property. This unit is the dominant wallrock at the Webber, Flex, Huestis and Dickson Zones and occurs at the south-west end of the Brown-McDade Zone. The most common rock is a light coloured quartz-feldspar-chlorite gneiss that grades locally to quartzite. The chlorite content is generally low, but where present in higher amounts it is concentrated in narrow bands with a striped appearance. Porphyroblasts of pink feldspar up to 1 cm diameter are occasionally seen. Other rocks in the metamorphic assemblage include: Augen gneiss, which is common in the extreme southwestern part of the property and occurs in some trenches near the north end of the Webber Zone and in the Dickson Zone; black to dark green amphibolite which is widely distributed and consists of equal amounts of plagioclase and actinolite; and quartz-chlorite schist with minor quartz-graphite horizons, which has only been observed in trenches at the south-east end of the Brown-McDade and Huestis Zones. The augen gneiss and amphibolite are resistant to weathering and are often abundant in talus. However, trenching has shown that the talus is normally derived from a few horizons that are only a few metres wide. Foliation within the metamorphic rocks generally strike northeast and dips moderately to steeply to the northwest.

Most of the northern and eastern parts of the Mount Nansen property are underlain by coarse-grained granodiorite that grades locally to quartz diorite or quartz monzonite.

1.0 Project Description

1.1 Location and Access

The Mount Nansen Project is located approximately 60 km west of the Village of Carmacks, which in turn is 180 km north of Whitehorse, on paved Highway 2. A gravel road from Carmacks to the property is maintained by the Yukon government highways department. The location is on NTS mapsheet 1151/3W at latitude 62° 05' North, and longitude 137° 08' West. It lies within the traditional territories of the Little Salmon/Carmacks First Nations Band. The property claims occur at an elevation of about 1200 metres in the Dawson Range. A general location map for the Mount Nansen Project is provided in Figure 1.1.

The mine can be reached from Whitehorse via paved Highway 2 to Carmacks, and via a gravel access road from Carmacks to the mine. The gravel road will be upgraded in conjunction with the Yukon Government to upgrade creek crossings and improve sight lines through clearing. The Yukon Government currently maintains this road from April to November of each year, to provide access to a number of placer operations active in the area. Negotiations are underway to extend the maintenance to year round.

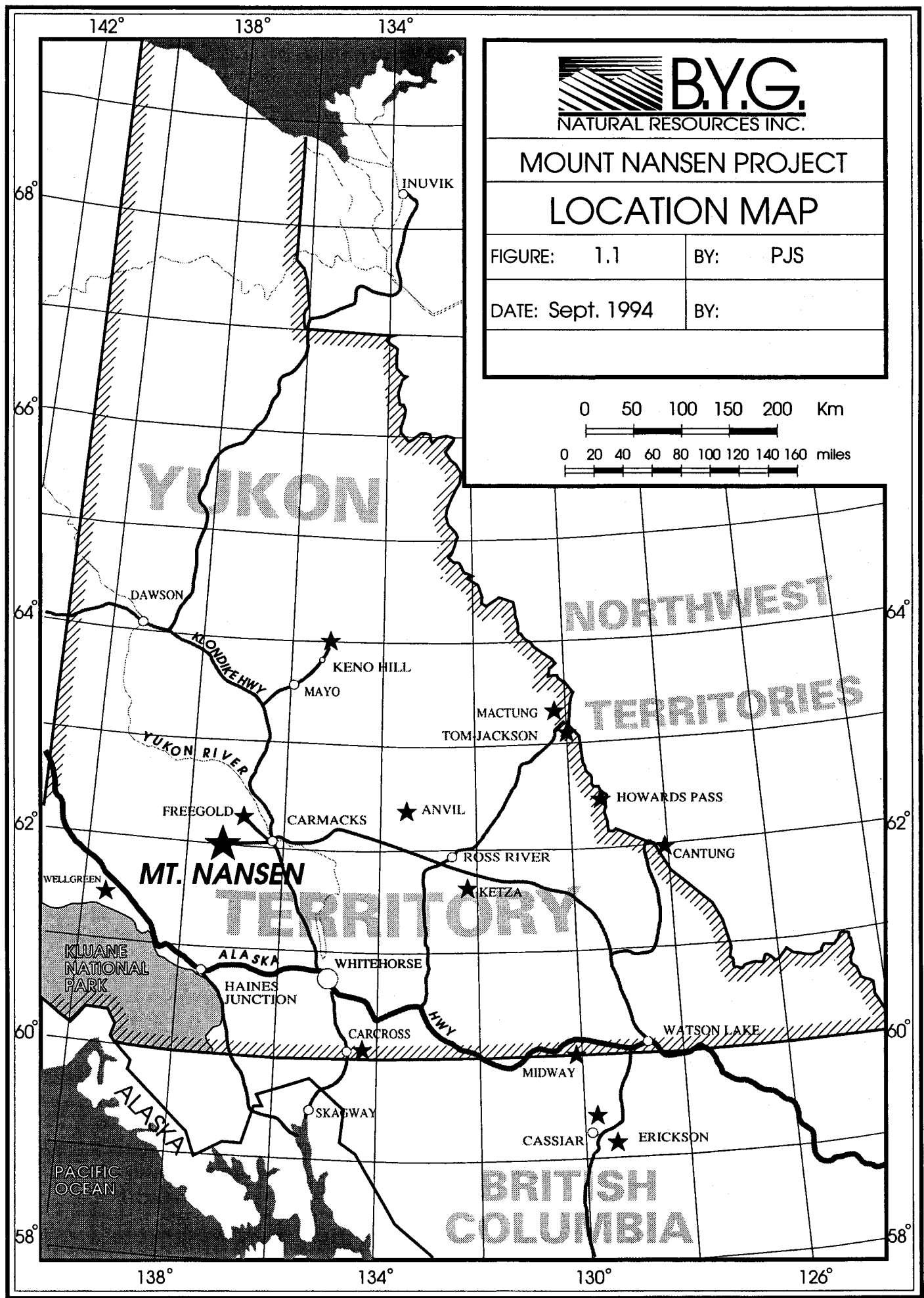
The road currently runs past the Brown-McDade zone and within 200 metres of the mill. It also provides access to the Huestis and Webber zones. Roads on the mine site will require upgrading to handle anticipated traffic from operation.

1.2 Site Description

The Mount Nansen claim group consists of 257 mineral claims and 30 mineral leases with a total area of 5,300 hectares (13,095 acres). The general study area along with the main deposits in the claim group are provided in Figure 1.2. Additional detailed drawings showing the site layout and the mill facilities areas are provided in Figures 1.3 and 1.4.

Mining activities, both placer and hardrock, have occurred on this claim group since the turn of the century. Most creeks in the area have been or are currently being placer mined.

The terrain consists of rounded ridges and shallow valleys, with a light cover of vegetation and small trees. Permafrost is fairly extensive in this area being classified as discontinuous. The presence of permafrost is influenced by degree of protective cover and slope orientation. A dry climate and light forestation permit ready access to most site locations.



TAWA
PROPERTY

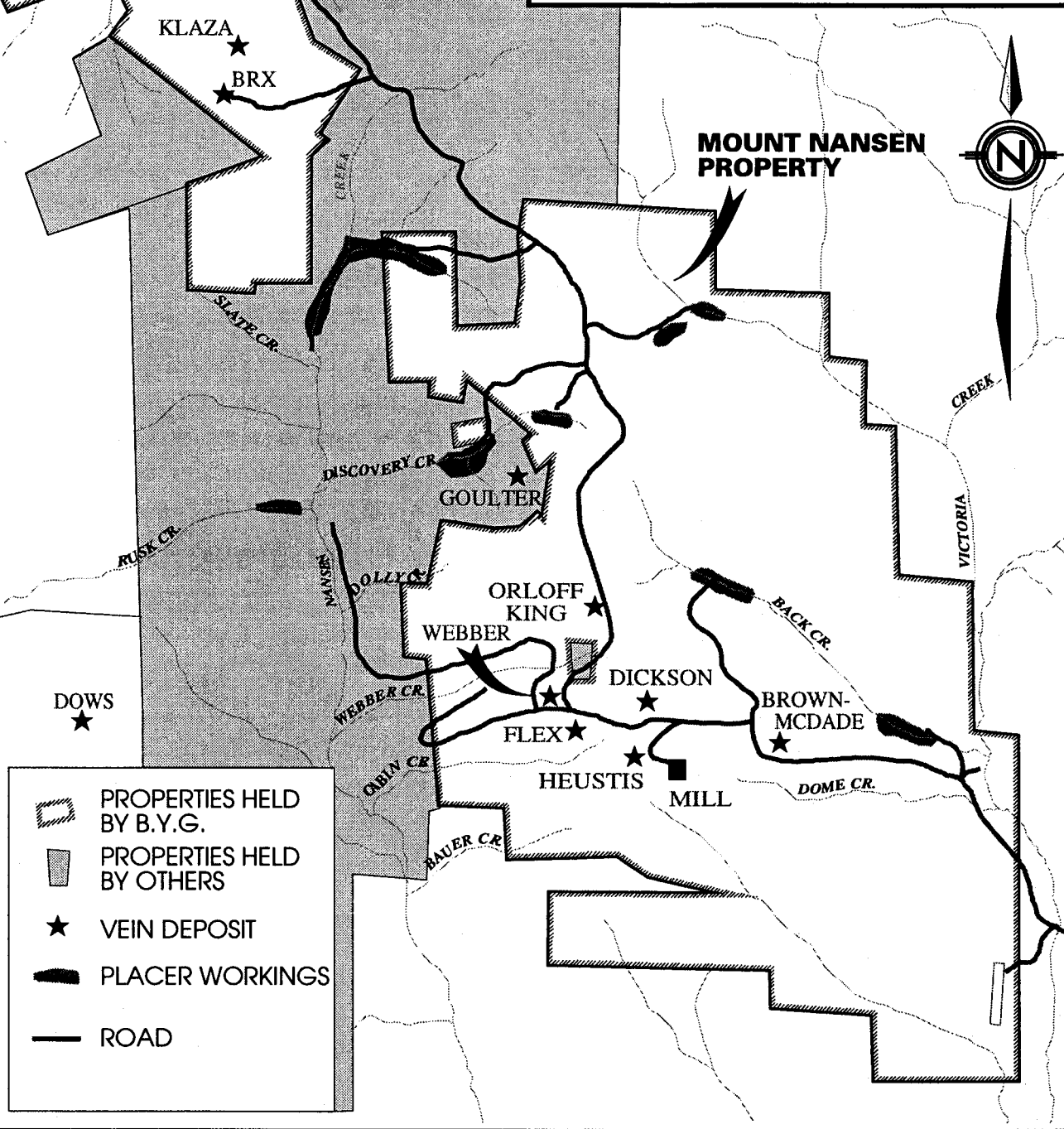


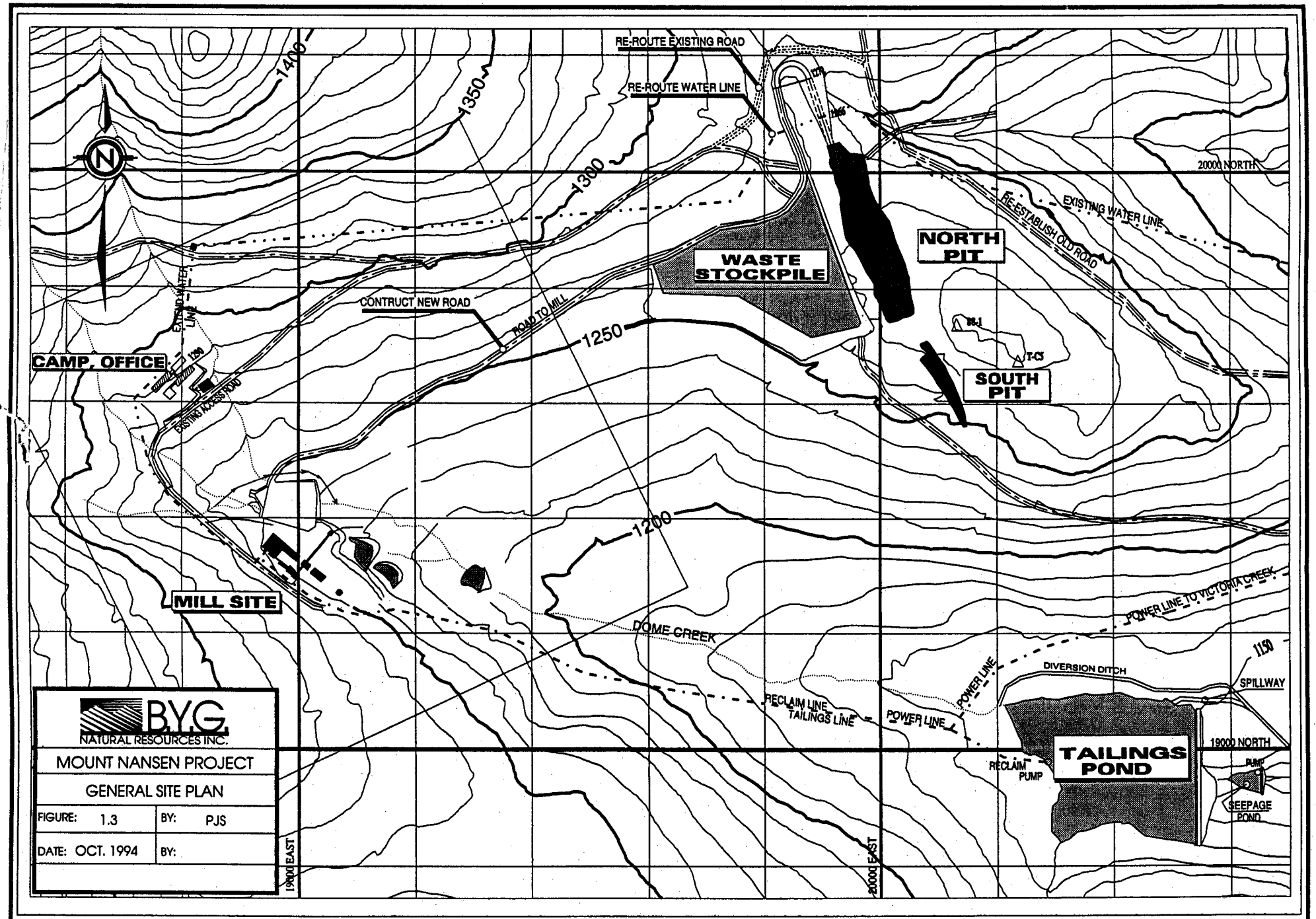
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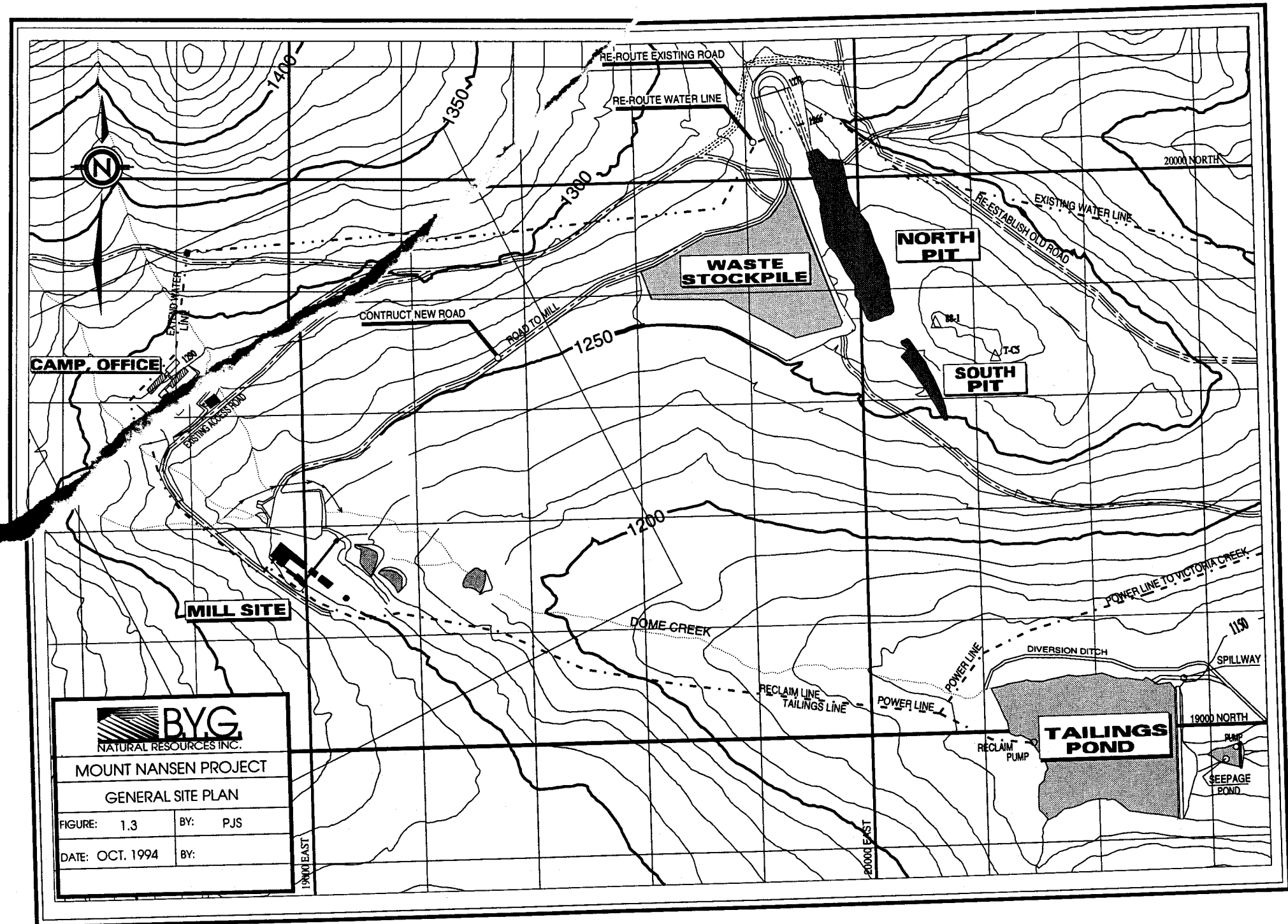
CLAIM LOCATION & ACCESS

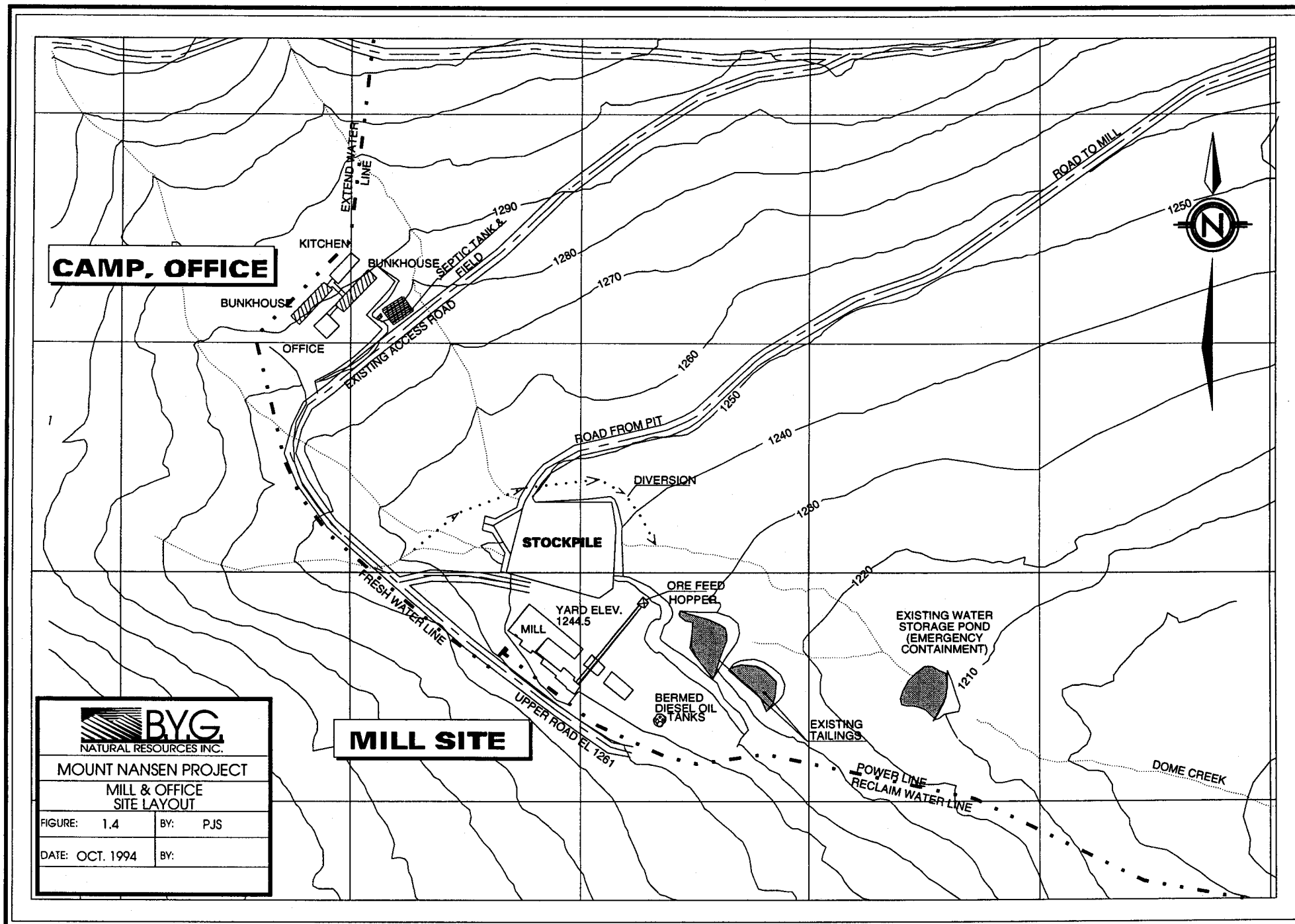
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 NATURAL RESOURCES INC.	
MOUNT NANSEN PROJECT	
MILL & OFFICE SITE LAYOUT	
FIGURE: 1,4	BY: PJS
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1.3 Local Resources

The Village of Carmacks has a population of approximately 500, with about 60% members of First Nations. A number of these individuals will be capable of working on-site, although very few will be experienced in milling operations. Some will likely be equipment operators available for open pit and site work. The majority of skilled employees will likely have to be sourced from the rest of the Yukon and B.C.

Whitehorse is serviced by regular air service to Vancouver, Edmonton as well as other parts of the Yukon and Alaska. Whitehorse is on the Alaskan Highway, and within 130 km of tidewater at Skagway, Alaska. The city can provide virtually all supplies and services required for mine operation.

1.4 Exploration and Development History

Placer operators were probably the first to work the immediate area. Hardrock exploration started in the period of 1930 to 1943, and the first recorded discovery of gold on the current site was by prospectors Brown and McDade in 1943.

The first underground work was conducted on the Brown-McDade zone in 1947. This was followed by underground mining on the Huestis and Webber zones in 1964 to 1969. Production from stoping activities on the Huestis zone was carried out from 1968 to 1969. The mine was returned to production in 1975 and 1976. Ore was treated in a 300 ton/day flotation mill during that period.

In all, over 15,000 feet of underground development has been completed on the three veins. Approximately 25,000 tons of ore were treated in the flotation mill in 1975 and 1976.

B.Y.G. Resources Natural Inc. (BYG) acquired the properties and combined them with additional claims to form the current property in 1984. BYG then carried out an exploration program in conjunction with Chevron Minerals during the period of 1985 to 1989. Over \$5,000,000 was expended on exploration during this time-frame, resulting in the discovery of significant oxide reserves in the Brown-McDade and Flex zones. BYG currently owns 100% of the Mount Nansen project, subject to royalties.

There are currently three other deposits being considered for production in the general area, as well as one former producing mine (La Forma).

1.5 Scheduling

The general activities leading up to a production start-up in the early summer of 1995 are listed below. Discussion of some of the detailed aspects of these activities are provided below.

A system of veins swarm in a generally NW-SE direction across the property. Surface trenching has been completed on over 10 different veins systems. Underground work was carried out previously on three of the vein systems (Huestis, Webber, and Brown-McDade). These three vein systems on the property have been explored and developed to varying degrees. The previous mine produced gold from one of these systems (Huestis), which was processed in an on-site flotation mill. This mill was constructed in 1967, and operated in 1968 and 1969 as well as in 1976. The mill and much of the support plant remains intact on site. The two other systems (Webber and Brown-McDade) were subjected to underground exploration programs, but have not yet produced gold.

All of the previous mining work focused on quartz-sulphide veins. Two small tailings ponds containing the waste from the production activities remain intact on site. Approximately 25,000 tons of tailings were impounded.

An exploration program was conducted on the claim group by BYG in conjunction with Chevron Minerals during the period 1985 to 1988. This effort resulted in the discovery and definition of a mineable gold oxide deposit of commercial stature. This deposit was located above the sulphide portion of the Brown-McDade zone, and in fact is simply the oxidized upper part of the same zone.

The Brown-McDade ore zone, proposed tailings pond and plant and mill site, drain to two small creeks, Dome and Pony, which in turn flow to Victoria Creek and ultimately into the Nisling River.

In addition to the mill building and equipment and the mine development openings, the following useable assets remain on site:

- Water well, 4" steel water line, 35,000 gallon tank
- Covered in steel building for cyanide plant
- Boiler room,(concrete and steel)
- Power house,(steel and concrete)
- Compressors, piping
- Warehouse, shop area(steel and concrete)
- Cold storage building (steel and concrete)
- Wood frame, two story administration building with concrete vaults
- Wood frame, cafeteria and kitchen building.

- Complete economic evaluation, continue financing actions
- Submit Initial Environmental Evaluation
- Continue metallurgical investigations, complete design of mill retrofit
- Complete engineering designs
- Assemble and submit Water License Application
- Construct tailings dam
- Carry out mill modifications
- Commence production in early 1995

Based on current oxide reserves in the Brown-McDade Zone the mine will operate for 2.5 years. Exploration for additional oxide reserves from the adjoining deposits is currently underway and will continue during operation. The probability of extending mine life through development of additional oxide ore is good. Metallurgical testwork aimed at developing methods for extraction of gold from the currently defined sulphide mineral inventory will commence within the next few months and could continue during operation depending on the level of success accomplished. A further activity during active mine life will be to carry out reclamation work as dictated by an approved Reclamation Plan.

The detailed physical activities leading up to start-up have been identified as follows:

- Construct a 50 person kitchen-bunkhouse complex to accommodate work crews by either installing new facilities or rehabilitating existing buildings.
- Retrofit the existing flotation mill, to a cyanidation/carbon-in-pulp (CIP) gold recovery circuit capable of processing 300 tonne/day of oxide ore from the Brown-McDade ore zone.
- Install a diesel power plant capable of providing mill and plant power and heat. The power plant will have a capacity to generate about 2,000 kW of power and be located in the existing power plant building on-site.
- Rehabilitate water line from Victoria Creek, re-establish wells, provide power and pumps.
- Construct a tailings dam capable of containing approximately 300,000 tonnes of oxide tailings.
- Develop the open pit operation on the Brown-McDade zone by removing and storing 737,000 tonnes of waste in conjunction with extraction of approximately 300,000 tonnes of oxide ore for processing in a CIP mill.

1.6 Geology

1.6.1 Regional Geology

The Mount Nansen property is located within the Yukon Crystalline Terrane, which consists of Upper Paleozoic or older metamorphic rocks; foliated Upper Triassic and unfoliated Jurassic diorite, granodiorite and syenite batholiths; and foliated Mid to late Cretaceous, mafic to felsic volcanic, pyroclastic, hypabyssal and plutonic rocks. Triassic and older rocks belong to an island arc that was accreted to North America during mid-Jurassic time, while the younger igneous rocks are related to the Coast Plutonic Complex.

The structural history of the area is complex and not well understood. The major feature is the Big Creek Fault which lies about 10 km north of the property and marks the boundary between the island arc assemblage and adjacent para-cratonic rocks belonging to the Yukon Cataclastic Terrane. This northwest trending structure is anomalous as it appears to be a linear, steeply-dipping fault in some areas and a sinuous west-dipping thrust elsewhere. A series of north-east-trending cross faults offset the Big Creek Fault, but the absence of reliable marker units and the fact that some igneous activity postdates early fault movement makes the magnitude of the offsets and exact relative motion difficult to determine. The overall impression obtained from studying the geology is that the area underwent compression and metamorphism in Jurassic times and then entered a post-orogenic extensional regime characterized by block faulting and mafic to intermediate volcanism.

1.6.2 Property Geology

1.6.2.1 Overview

The Mount Nansen property is underlain by highly deformed Upper Paleozoic or older gneiss and schists that are intruded by Upper Triassic and Jurassic granodiorite and syenite batholiths. These are in turn intruded or overlain by Mid- to Late Cretaceous, mafic to felsic stocks, dykes, volcanic flows and pyroclastic rocks related to the Coast Plutonic Complex. The geology of the property is illustrated in Figure 1.5. A series of subparallel anastomosing veins occur in a 6 km long by 2.5 km wide belt extending the length of the property. The veins strike northwesterly, and exhibit steep northeasterly to moderate southeasterly dips and cut all rock types.

The Brown-McDade Zone lies at the southeasterly end of the belt. It is 500 metres long by 200 metres wide and consists of quartz veins and associated feldspar porphyry dykes developed in the hanging wall of a strong fault (Footwall Fault), which strikes 160 degrees and dips 50 to 70 degrees to the southwest. The fault cuts obliquely across a contact between granodiorite and metamorphic rocks and is best mineralized where granodiorite forms both walls.

Although the most recent GSC maps assign these rocks a Mid-Cretaceous age, weak foliation observed in them suggests that they may belong at least in part to the Late Triassic Klotassin granodiorite. The granodiorite is medium to coarse grained and commonly exhibits pink feldspar phenocrysts and up to 25% stubby hornblende crystals. Pegmatite and aplite dykes comprised of quartz, plagioclase and orthoclase, with minor biotite and hornblende, cut the granodiorite at high angles. The granodiorite normally exhibits a greenish tinge caused by weak pervasive saussuritization and chloritization. Contacts between the granodiorite and metamorphic rocks are rarely observed but in one trench at the southeast end of the Brown-McDade Zone, the gneiss has been partially assimilated and granitized. The Goulter Zone, which is an extension of the vein system being explored by Aurchem, occurs along the contact between the granodiorite and a finer-grained diorite (possibly a chilled margin).

Jurassic and Cretaceous hornblende syenites occur immediately north of the property and host veins occurring on Kerr Addison's claims. The older syenite is coarse grained and often porphyritic while the younger one is generally fine grained and is thought to be a subvolcanic equivalent of the Mount Nansen Group andesite. Porphyritic syenite float is found in a few areas on the Mount Nansen property but no outcrops are known.

The youngest rocks are volcanic flows, pyroclastics, feeder dykes and plugs belonging to the Mid-Cretaceous Mount Nansen Group. Two suites are present, one is predominantly andesitic and the other dacitic to rhyolitic.

The andesitic rocks are widespread and include porphyritic flows and breccias plus related feeders. The unit is massive and resistant to weathering, often forming caps on ridge tops. When fresh, the rock has a dark green colour and consists of 1 to 2 mm feldspar phenocrysts in a medium-grained groundmass. The volcanic breccias consist predominantly of rounded volcanic fragments up to 10 cm across but include rare gneiss and granodiorite cobbles at the base of the section (agglomerate?). Faults often form contacts between volcanics and other units. The largest concentration of volcanics lie north of Webber Creek in a downdropped block bounded on the south and east by large faults. The Orloff King and Spud Zones occur within this block.

Drilling and trenching in various parts of the property have intersected a number of fine-grained intrusions that appear to be feeders to the andesitic volcanics. These dykes range from 0.5 to 10 metres in width and average about 2 metres. They are dark green and grade from aphanitic to porphyritic. The groundmass is normally a microcrystalline mixture of quartz and feldspar while the phenocrysts are andesine plagioclase with lesser amphibole and pyroxene. Magnetite is more abundant in this unit than any other rock type on the property.

Dacitic to rhyolitic volcanics are limited to a few small centres north and west of the property but related porphyritic intrusions are widespread. Although the intrusions are not volumetrically abundant, they are highly significant as they are closely associated with porphyry copper mineralization and some precious metal veins. The rocks are typically buff to tan coloured and consist of 1 to 3 mm quartz and feldspar phenocrysts in an aphanitic to fine-grained felsic groundmass. Biotite is the only mafic mineral present, occasionally occurring as euhedral flakes that comprise up to 5% of the rock. Minor finely disseminated pyrite is ubiquitous. Most porphyry intrusions form narrow dykes but there are two large and several small plugs on the property. In general, the dykes are feldspar porphyry while the plugs are quartz-feldspar porphyry.

The largest plug is approximately 3.5 by 1.5 km with its long axis trending northwesterly along the north side of Discovery Creek. This plug was explored as a porphyry copper deposit and exhibits classic hypogene porphyry alteration centred on two quartz-tourmaline breccia zones, the largest of which is 300 metres in diameter. The other large plug is approximately 500 meters in diameter and forms a prominent dome between the headwaters of Pony and Webber Creeks.

Dykes belonging to the porphyry unit cut all other rock types on the property and range in width from 10 cm to 12 meters, averaging about 1.5 meters. Most are oriented either northwesterly or northeasterly. In general, the northwest-trending dykes exhibit brecciation and montmorillonite or kaolinite alteration while the others are unbrecciated and relatively fresh. At the Brown-McDade Zone, most porphyry dykes are aligned northwest, parallel to the main fault zone and are intimately associated with the precious metal-bearing veins. It is common for dykes to grade into vein faults along strike and/or downdip. Breccia fragments within the dykes are usually well rounded and consist principally of porphyry with occasional pieces of wallrock. Flow banding is sometimes seen and chilled margins are common. In many instances breccia zones up to 25 metres wide are developed in wallrocks surrounding dykes that are less than 2 metres across. The wallrock breccia fragments are typically angular and contacts with enclosing fractured wallrocks are gradational.

1.6.2.3 Alteration

Five hypogene alteration facies can be seen in trenches and drill core. Each facies is defined by an index mineral or mineral assemblage. Contacts between facies are usually transitional and supergene overprinting tends to elevate hypogene alteration to a higher facies near surface. Intensity and depth of supergene alteration depends upon fracture density and rock type.

Propylitic alteration is the weakest facies and is defined by slight saussuritization of plagioclase, chloritization of hornblende and the presence of minor epidote. Fine pyrite often wholly or partially replaces mafic minerals and interstitial calcite is locally abundant.

Argillic (clay) alteration has been subdivided into montmorillonite and kaolinite facies. Montmorillonite facies is lower grade and is characterized by soft, greenish feldspars and mafic minerals that are altered to a medium or dark green mixture of chlorite, montmorillonite and calcite. Rocks belonging to kaolinite facies exhibit a uniform strongly bleached appearance due to total destruction of mafic minerals. Kaolinite is the principal clay mineral and calcite is absent. In the supergene zone, rocks exhibiting montmorillonite facies hypogene alteration normally prograde to kaolinite facies. Argillic alteration, usually montmorillonite facies, is common in feldspar porphyry dykes and in halos surrounding vein zones. In steeply-dipping vein zones such as Huestis and Webber, alteration is relatively symmetric about the veins, but in moderately dipping zones such as Brown-McDade and Flex, it is best developed in the hanging wall.

Phyllic alteration occurs when the original rock-forming minerals are totally altered to an extremely fine-grained mixture of quartz and sericite. The result is a light grey, aphanitic matrix surrounding residual quartz grains that are slightly enlarged by silica overgrowths. Where this alteration is pervasive, the rock mimics quartz porphyry dykes and where it is mottled, it takes on a pseudobrecciated appearance. Phyllic alteration is the dominant facies within a 7 to 30 metre wide breccia zone immediately in the hanging wall of the Footwall Fault at the Brown-McDade Zone, and commonly forms 0.1 to 2 metre halos that flank the veins at the Webber Zone.

Silicic facies is the most intense alteration and occurs when the rocks are almost wholly replaced by quartz. This alteration is rare and is usually found directly adjacent to mineralized quartz veins. Contacts with the surrounding phyllic facies rocks are often gradational and irregular.

1.6.2.4 Mineralization

Two types of mineralization have been recognized on the Mount Nansen property:

- Precious metal vein zones
- Disseminated and stockwork porphyry copper mineralization

Precious metal vein zones occur throughout the Mount Nansen area and are found in all rock types. Although the vein structures show considerable lateral and vertical continuity, their mineral content is highly variable in grade and width. Ore and gangue mineralogy differ from one vein zone to another but are relatively consistent within a single structure. The strike of individual veins commonly ranges between 130 and 180 degrees, averaging about 150 degrees. Dips range from 30 degrees SW to 45 degrees NE but most are between 60 degrees SW and 80 degrees NE. The widest, highest grade zones are normally found where a vein splits, takes a bend or intersects a northeast trending cross fault, thus creating more open space for mineralizing fluids.

While a wide variety of veins are present, most fall into one of two end member categories:

- Narrow, relatively simple vein systems (Webber, Huestis, Spud, Dickson and Vic); and
- Complex vein systems (Brown-McDade, Goulter, BRX, Klaza, Rusk and Dows).

The Orloff King and Flex Zones share some characteristics of both groups.

Narrow precious metal veins occur along anastomosing, steeply-dipping, northwest-trending faults and are best developed within the metamorphic rocks although they have been found in all major rock types. They range from a few centimetres to 5 meters in width and consist of quartz and sulphide rich cores, surrounded by narrow, intense phyllic and kaolinitic facies alteration envelopes. Wallrocks within 5 metres of the veins are often bleached and exhibit weak montmorillonite alteration. Higher grade precious metal values (greater than 0.1 opt Au) are confined to quartz-rich zones and values drop rapidly in the surrounding altered wallrocks. Depth of weathering is variable, with total oxidation (aside from occasional sulphides encapsulated in quartz) ranging from less than 5 metres in the Huestis Zone to about 30 metres in the Webber Zone. The weathering is deepest in south-facing and shallowest on north-facing slopes. Primary sulphides include, in approximate order of abundance: pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, sulfosalts and stibnite. Gold is extremely fine grained and occurs as inclusions in sulphide grains or interstitial to them. Silver to gold ratios are normally in the range of 20 to 30:1.

Complex precious metal zones share many characteristics with the narrow precious metal veins but also exhibit some features that suggest a close affinity with the porphyry copper mineralization. Mineralization and alteration in these zones is more widely distributed than in the narrow vein zones, and there is spatial, and probably genetic link with feldspar porphyry dykes. These zones are up to 150 metres wide and consist of a series of subparallel faults separated by fractured and altered wallrocks. The mineralization is best developed where the faults cut igneous rocks. The highest assays (greater than 0.1 opt Au) are obtained from quartz, sulphide, calcite veins that occur with sericite and kaolinite in the fault zones. The wallrocks typically exhibit montmorillonite or kaolinite alteration and grade between 0.01 and 0.05 opt Au. Kaolinite altered, frequently brecciated feldspar porphyry dykes often intrude along or subparallel to the faults and it is common for a mineralized vein to grade into a breccia zone and then into a porphyry dyke either along strike or downdip. The dykes normally range from 10 cm to 5 metres wide and grade between 0.01 and 0.06 opt Au. Ore mineralogy and metal ratios in the complex precious metal zones are variable probably reflecting different depths of erosion into the hydrothermal system. For example, the Goulter Zone, which is thought to be high level, contains a wide range of ore minerals including realgar in a mixed calcite, quartz and barite gangue while the

presumably deeper Brown-McDade Zone contains predominantly pyrite and arsenopyrite with quartz. Silver to gold ratios for complex precious metal zones are slightly lower than those in the narrow precious metal veins, typically ranging between 5 and 20:1. Oxidation in these zones is usually slightly deeper than might be expected from a narrow vein in a comparable geomorphological setting due to the increased permeability in the highly fractured wallrock.

The porphyry copper zone is probably related to the same hydrothermal cell as the veins, but represents a deeper and hotter part of the system. The mineralization is weak (average grade of less than 0.1% Cu) but extensive, covering a 4.5 sq. km area. The zone exhibits classic porphyry alteration zonation, with localized silicic and potassic cores surrounded by advanced argillic and phyllic halos giving way to weak argillic and propylitic margins.

Primary mineralization consists of pyrite and chalcopyrite, which are usually oxidized to limonite within 30 metres of surface. Precious metal sampling has not been conducted systematically throughout the zone but preliminary indications are that the values are low, averaging less than 0.003 opt Au and 0.01 opt Au.

1.6.2.5 Brown-McDade Summary

The Brown-McDade Zone lies at the southeasterly end of the belt. It is 500 metres long by 200 metres wide and consists of quartz veins and associated feldspar porphyry dykes developed in the hanging wall of a strong fault (Footwall Fault), which strikes 160 degrees and dips 50 to 70 degrees to the southwest. The fault cuts obliquely across a contact between granodiorite and metamorphic rocks and is best mineralized where granodiorite forms both walls. Footwall rocks are relatively massive and unaltered, while hanging wall rocks are fractured and clay altered.

The strongest veins occur in a 3 to 40 metre wide band directly adjacent to the Footwall Fault, while weaker subsidiary structures are common further out on the hanging wall. The highest assays are normally found within the quartz veins, and adjacent fractured or gougy wall rocks are normally found within the quartz veins, and adjacent fractured or gougy wall rocks are often weakly to moderately mineralized. Supergene weathering has converted near surface sulphide minerals to limonite and other oxides. The oxidation gradually diminishes with increasing depth and depth of total oxidation ranges from 5 metres at the north end of the zone to at least 75 metres at the south end.

Below this level of oxidation and supergene enrichment, three distinct suites of sulphide minerals have been recognized. The first consists of finely intergrown pyrite, arsenopyrite, sphalerite, galena and sulphosalts. The second suite is characterized by medium to coarse grained pyrite and arsenopyrite occurring in narrow veinlets within

highly fractured wallrock. The third suite is comprised of coarse grained sphalerite, galena and pyrite.

1.6.2.6 Brown-McDade Oxide Ore Zone Geometry

The Brown-McDade oxide zone occurs as a tabular zone, lying parallel to the Footwall Fault, but separated on strike into two sections, the North and South Lens.

The South lens, is a very simple single zone contacting the Footwall granodiorite. Strike length is 100 metres, average width 4 metres, and it will be mined to a maximum of 15 metres in depth. The depth cut-off is determined by economics, and the oxide zone actually continues to a further depth of 50 metres at this end of the deposit.

The North lens is more complex, with several ore shoots located either close enough to each other to be mined as one, or having sufficient grade to carry the additional pit width. In essence however, the zone geometry is still tabular, and the primary mining objective is 200 metres long, has a mining width of 15 metres, and though the zones are continuous for some depth (drilled to 100 metres below outcrop), it will be mined only to an average depth of 20 metres in the open pit.

1.7 Mine Plan

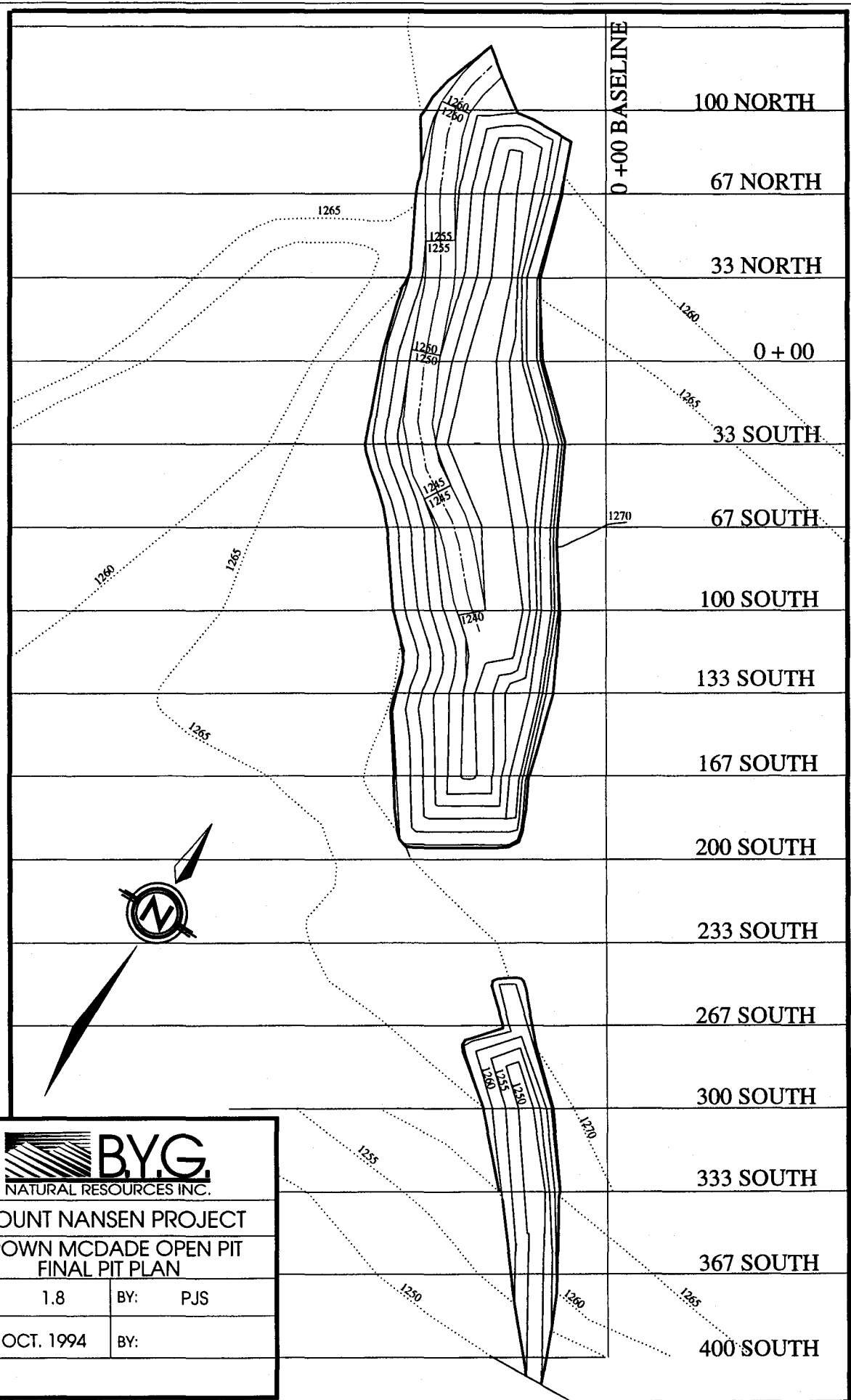
The oxide portion of the Brown-McDade zone will be extracted by means of an open pit. The open pit plan was developed to provide a reasonable basis for calculating waste removal requirements, low grade reserves that would be excavated during removal of the "milling" ore, and a production schedule to provide a means for estimating pre-production costs.

A Final Pit layout drawing is provided in Figure 1-8 while Bench plans for the 1260, 1250 and 1240 levels in the North and South Pits are included in Figures 1-9 through 1-11

1.7.1 Planning Parameters

The oxidized portion of the Brown-McDade zone lies within a shattered and fractured altered granodiorite. There are also bands of friable claylike material lying generally parallel to the strike of the ore zone. The footwall contact of the ore zone is either directly up against, or within a few metres of, a very competent fresh (unaltered) granodiorite.

The footwall of the ore zone has a fairly steep inclination, ranging from a 65 to 70 degree dip in the South Lens, to a fairly consistent 62 degrees in the main or North Lens. The zone at the extreme north end of this section, flattens to about 54 degrees.



 BY.G. NATURAL RESOURCES INC.	
MOUNT NANSEN PROJECT	
BROWN MCDADE OPEN PIT	
FINAL PIT PLAN	
FIGURE: 1.8	BY: PJS
DATE: OCT. 1994	BY:

Clay Altered &
Fractured
Granodiorite

Massive
Granodiorite

LEGEND

-  High Grade
-  Low Grade
-  Feldspar Porphyry Dykes
-  Metamorphic Rocks
-  Massive Granodiorite
-  Clay Altered & Fractured Granodiorite
-  Fault
-  Pit Outline
-  Oxide Quartz Sulphide Veins



BY.G
NATURAL RESOURCES INC.

MOUNT NANSEN PROJECT
BROWN MCDADE OPEN PIT
1260 BENCH PLAN

FIGURE: 1.9	BY: PJS
DATE: OCT. 1994	BY:

1+00 N
0+66 N
0+33 N
0+00
0+33 S
0+66 S
1+00 S
1+33 S
1+66 S
2+00 S
2+33 S
2+66 S
3+00 S

Baseline 0+00

Clay Altered &
Fractured
Granodiorite

Baseline 0+00

Massive
Granodiorite

LEGEND

- High Grade
- Low Grade
- Feldspar Porphyry Dykes
- Metamorphic Rocks
- Massive Granodiorite
- Clay Altered & Fractured Granodiorite
- Fault
- Pit Outline
- Oxide Quartz Sulphide Veins



BYG
NATURAL RESOURCES INC.

MOUNT NANSEN PROJECT
BROWN MCDADE OPEN PIT
1250 BENCH PLAN

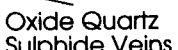
FIGURE: 1.10	BY: PJS
DATE: OCT. 1994	BY:

1+00 N
0+66 N
0+33 N
0+00
0+33 S
0+66 S
1+00 S
1+33 S
1+66 S
2+00 S
2+33 S
2+66 S

Clay Altered &
Fractured
Granodiorite

Massive
Granodiorite

LEGEND

-  High Grade
-  Low Grade
-  Feldspar Porphyry Dykes
-  Metamorphic Rocks
-  Massive Granodiorite
-  Clay Altered & Fractured Granodiorite
-  Fault
-  Pit Outline
-  Oxide Quartz Sulphide Veins

 NATURAL RESOURCES INC.	
MOUNT NANSEN PROJECT	
BROWN MCDADE OPEN PIT	
1240 BENCH PLAN	
FIGURE: 1.11	BY: PJS
DATE: OCT. 1994	BY:

1+00 N
0+66 N
0+33 N
0+00
0+33 S
0+66 S
1+00 S
1+33 S
1+66 S
2+00 S
2+33 S
2+66 S
3+00 S

Baseline 0+00

It is highly probable that the altered granodiorite waste can be removed without drilling and blasting, and that a cat tractor with ripper will free the muck for loading. It is possible that the ore material will require a minimum of drilling and blasting. It is certain that any mining in the fresh granodiorite footwall rock will be by drilling and blasting. Any blasting that is required will make use of ammonia nitrate/fuel oil blasting agents, with occasional use of gelatin dynamite for priming and wet holes.

The general approach to mining the North Lens, was therefore to locate the access roadway in the hangingwall (east) of the ore zone. A roadway in effect flattens the average slope of an open pit wall, a desirable effect in this case were a low angle wall will likely be a requirement from a slope stability point of view.

The South Lens would be accessed from the south end directly off the hill side, and simply excavate a series of horizontal cuts until the waste/ore ratio reaches its economic limit. This will be at about elevation 1250 metres.

1.7.2 Layout Parameters

Layout parameters considered in the planning of the open pit included:

- Maximum berm to berm slope, in altered granodiorite, to be 45 degrees.
- Maximum berm to berm slope, in fresh granodiorite, to be 73 degrees.
- Bench height at 5 metres, single bench hangingwall and triple bench footwall. A 5 metre berm width will be left every third bench in the footwall.
- Roadway to be developed to a width of 12 metres, at a maximum grade of 10 %.
- Final wall slope on hangingwall side to be 30 degrees at roadway, and 45 degrees elsewhere.
- Final slope wall on the footwall to be 57 degrees at the steepest point, and 45 degrees at its flattest.
- Maximum vertical depth on footwall side to be 30 metres.
- Maximum vertical depth on hangingwall side to be 25 metres, and average depth of about 22 metres.

1.7.3 Design Approach

A preliminary pit was initially prepared to provide the geological consultant with an estimate of controlling economic parameters, and therefore the cut-off grade required to define final ore outlines. Following the geologists' ore interpretation and reserve calculation, a set of bench plans were prepared at 5 metre vertical intervals through the zone. These plans provided ore outlines and quantity for each 5 metre mining lift (See Figures 1-9 through 1-11).

A first effort at developing a pit plan was made, using the layout parameters described above and using the 1250 elevation as a base. Subsequent attempts were made at 1230 and 1240 elevations. The 1240 elevation was selected for primarily economic reasons, but it also coincided with the bottom of the oxide ore at the north end of the pit. The recovery of any oxide material below the 1240 pit bottom, would have to be done from underground.

1.7.4 Waste Disposal

The access roadway will emerge from the pit excavation at the north end. This roadway will be extended further north from the pit at a plus 10% grade and then south, in order to gain elevation to the saddle between the Pony Creek and Dome Creek drainage systems. The waste will be deposited on the Dome Creek drainage side, after stripping and stockpiling any overburden which could be later used for mine reclamation.

The pit waste will be end dumped in a series of 5 metre vertical lifts, the objective being to leave the final slopes at an approximate 30 degree slope.

An intercept ditch will be installed downstream of the waste pile to provide a means of monitoring run-off quality. Figure 1-12 shows the relative location of the waste pile to the mine.

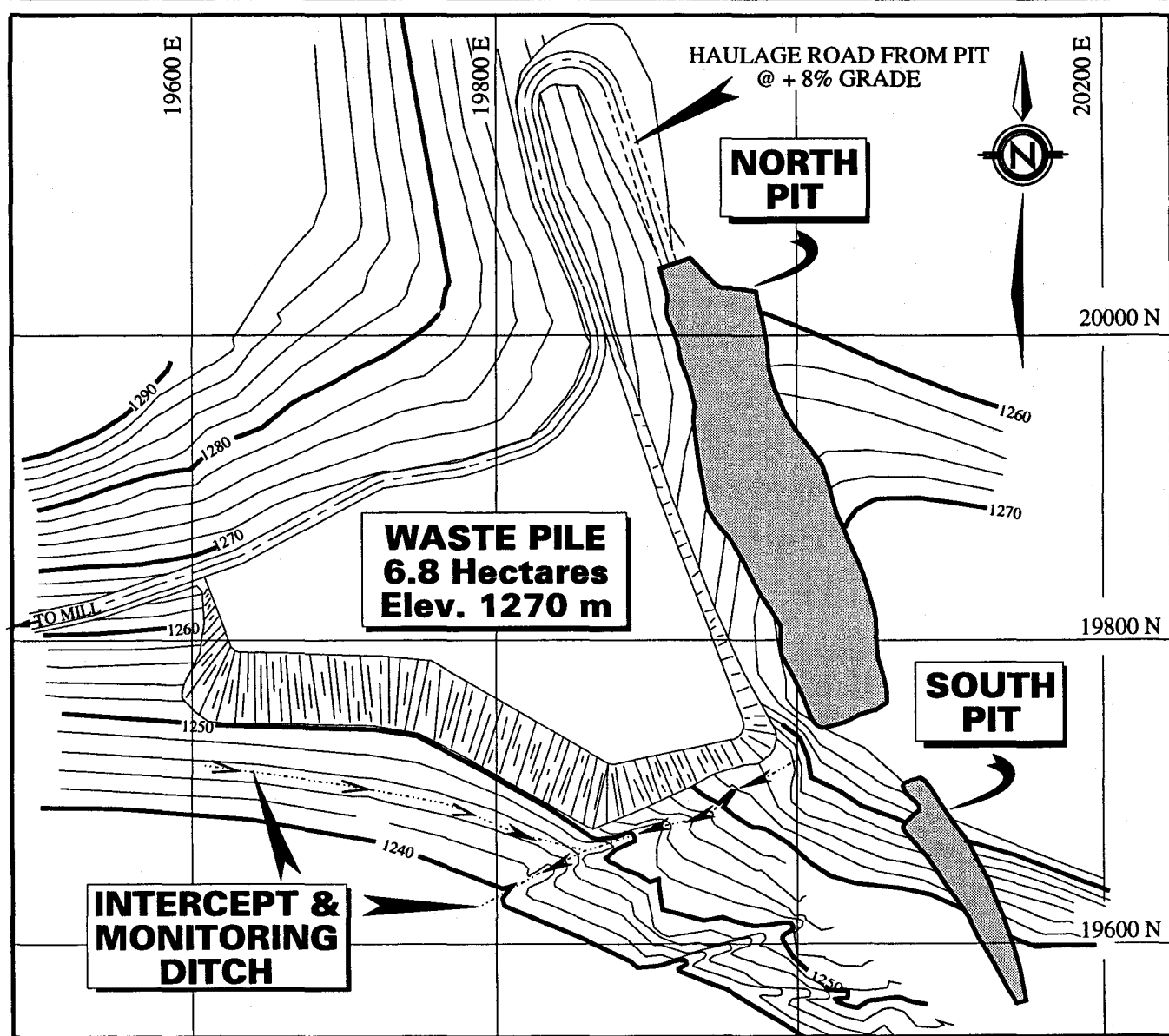
The area for disposal of mine waste has been examined by geotechnical engineers, and it is considered an acceptable location for the relatively small amounts of waste (Klohn-Crippen, 1994c, see Appendix I). Slopes are gentle, soils are competent, and the pile will eventually assume permafrost characteristics.

1.7.5 Features of Final Pit Plan

- Ore recovered and trucked to mill: - 259,850 tonnes
- Waste mined and dumped in pit area: - 737,250 tonnes
- Average haul distance waste to dump: - 600 metres
- Average haul distance ore to top of ramp: - 150 metres
- Final pit bottom (North Pit) - Elevation: 1240 metres

1.7.6 Pit Dewatering

Water inflows to the pit are expected to be from precipitation and from the drilling of blastholes. Blasthole drilling will be quite minimal, as it is expected that a large percentage of both ore and waste can be ripped with tractors.



NOTES

1. Topsoil to be stripped and stored for future reclamation of waste pile before waste rock is dumped
2. Maximum slope of waste rock pile not to exceed 28 degrees



MOUNT NANSEN PROJECT

BROWN MCDADE OPEN PIT SITE PLAN

FIGURE:	1.12	BY:	PJS
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DATE: Oct. 1994

BY:

Water inflows into the pit from precipitation over a three year period would total approximately 25,000 m³. The bulk of this water will be absorbed by the broken rock and removed by truck to either the mill or the waste dump. There will be occasions during the runoff period, or during heavy rainfall when it will be necessary to pump water from the pit. On these occasions, the water will be piped directly to the tailings pond.

1.7.7 Alternatives to Open Pit Mining

Given the shallow depth of the orebody, the extremely fractured character of the waste rock in particular, open pit mining presents the only safe and reliable approach to extraction of this reserve.

1.8 Milling

Previous process development work on Mount Nansen area ores has been conducted on both oxide and sulfide ore present on the Mount Nansen claims (Hazen Research, 1986; Lakefield Research, 1985 & 1987; Chevron Research, 1988). This work has shown that gold extraction efficiencies via cyanidation appear to be related to the sulfide content in the ore (Melis, 1989). Consequently, a metallurgical feasibility assessment was initiated by determining baseline cyanidation extraction efficiencies on bulk samples taken from different areas of the Brown-McDade ore deposit.

The potential for heap leaching of the Brown-McDade ore was also examined but was found to be an inefficient approach (Melis, 1989; BYG, 1994).

This feasibility assessment was followed up by cyanidation tests on drill core composites made up to represent different ore types from the Brown-McDade orebody along strike and at different depths. The results from these tests were then used to delineate both oxide and sulfide ore composites for Brown-McDade and in turn used to identify process design criteria for retrofitting the existing Mount Nansen mill.

1.8.1 Background

This property previously produced and processed approximately 25,000 tons of ore through the existing on-site flotation mill. Virtually all of this ore came from the underground workings on the Huestis vein, a narrow high grade massive sulphide vein. Material from the Webber zone could not be treated economically because its sulphide vein material was partially oxidized. The underground sulphide ore from the Brown-McDade zone was also considered, but its occurrence was more of a sulphide stringer than a vein and it did not yield a saleable concentrate when processed through the flotation mill. Previous operators recognized that a cyanidation section should be added to the flotation mill to provide the flexibility needed to treat the

different ore types on the property. A portion of the proposed cyanidation plant (i.e., building) was constructed in 1969 prior to mine being shut down due to lack of funds.

The major exploration effort launched by BYG in the period 1985 to 1989, focused on delineation of oxide ore, which previously had been ignored. The first efforts lead to the discovery of the oxidized portion of the Brown-McDade zone followed by the discovery of similar oxidized ore in the Flex zone and others.

Metallurgical test work began in 1985, and included tests for both conventional cyanide plant treatment, and for heap leach technology. This was carried out under the direction of Chevron Resources at the Hazen Research labs. Additional laboratory work was conducted in subsequent years at Coastech Research Inc. and at Lakefield Research. This work, conducted under the direction of Melis Engineering, included an examination of the sulphide ores, and more in depth testing for both conventional cyanidation and heap leaching of oxide ores.

The metallurgical projections used to develop this project, resulted from the Melis interpretation of the Coastech work on several composite samples of the orebody reported in Melis, 1989. The projections also included the results of bottle roll tests that were conducted on individual drill hole composites from the Brown-McDade ore zone (see Table 1-4). Additional metallurgical test work aimed at predicting the performance of an SO₂-Air cyanide treatment system for mill tailings was recently completed by Process Research Associates Ltd. This report is included in Appendix IV.

1.8.2 Metallurgical Tests

Since the closure of the operation in 1969, a significant amount of metallurgical testwork has been completed on the oxide ore of the Brown-McDade zone. This work was presented in the following test work reports: Hazen Research (1986), Coastech Research Inc.(1989), Lakefield Research (1988 & 1989), and Process Research Associates (1994a).

1.8.2.1 Bulk Samples

The first phase of metallurgical testwork involved bottle roll and column tests using drum quantities (bulk samples) of surface trench materials from the Brown McDade zone. These test were aimed at evaluating both conventional agitated cyanide leaching as well as the heap leaching process. The bulk samples, representing clay-bearing ore, siliceous ore and fractured low-grade ore, along with clay-bearing and siliceous underground ore, were sent to Coastech Research in Vancouver, B.C. for testing in 1989. The bulk samples of ore selected for the initial bottle and column leach tests are described in Table 1-3. The test results from this work are summarized in Table 1-4.

Table 1-3: Brown-McDade Bulk Ore Samples

Barrel No.	Trench	Description	Au(g/t)	Ag(g/t)
1	BM 85-2	clay bearing ore	4.66	20.57
2	BM 85-2	siliceous ore	14.64	80.49
3	BM 85-2	fractured, low grade ore	1.09	3.23
4	BM 85-10	mixture	4.04	48.52
5	Underground	clay-bearing ore (Sampling Point # 5 to 7)	7.60	70.04
6	Underground	siliceous ore (Sampling Point # 2 to 5)	7.03	48.65

The basic findings of this first phase of work on Brown-McDade ore were that an agitated cyanide leach with a fine grind would give close to 90% gold extraction on the surface trench ore accompanied with a 60% silver extraction. The samples taken from the underground cross-cut resulted in an 80% gold extraction and a corresponding 20% silver extraction. Although reasonable gold extractions (i.e, 80%) could be obtained by heap leaching of siliceous and fractured surface ore, the claybearing surface ore and the underground ore were not amenable to heap leaching. Reagent consumptions for an agitated cyanide leach were 0.5 kg NaCN/tonne and 5-10 kg CaO/tonne for surface ore and 1.3 kg NaCN/tonne and 15 kg CaO/tonne for underground ore.

1.8.2.2 Drill Core Samples

The second phase of testwork consisted of a series of bottle leach tests on various drill core composite samples of the Brown-McDade orebody as selected by Archer Cathro from the 1988 summer drilling program. These tests were aimed at determining maximum cyanide gold extraction efficiencies for different areas of the orebody and at differentiating oxide (leachable) ore from the more refractory sulfide ore. These baseline tests used a fine grind to maximize leaching efficiency. The test results are summarized in Table 1-5.

Table 1-4: Brown-McDade Bulk Ore Samples - Test Conditions and Results

ITEM		1	2	2	3	4	5	6	6
Sample Trench		Clay BM 85-2	Siliceous BM 85-2	Siliceous BM 85-2	Fractured BM 85-2	Mix BM 85-10	Clay U/G	Siliceous U/G	Siliceous U/G
BOTTLE ROLL - FINE									
Calc. Head	Au, g/t	5.14	14.56		1.30	4.10	8.56	7.09	
	Ag, g/t	22.08	83.19		2.76	49.49	76.92	44.67	
Au/Ag Ratio		0.23	0.18/1		0.47/1	0.08/1	0.11/1	0.16/1	
Grind, % -75 um		96.2	63.3		84.7	76.5	87.4	77.7	
% Extraction	Au	87.9	94.8		89.2	90.0	89.6	80.7	
	Ag	59.2	59.7		63.8	34.3	35.0	21.6	
Residue Au, g/t		0.62	0.75		0.14	0.41	0.89	1.37	
Leach Time, hours		48	48		48	48	48	48	
NaCN Consumption, kg/t		0.5	0.3		0.6	0.4	1.3	1.4	
CaO Consumption, kg/t		8.1	3.0		11.3	5.2	13.7	16.0	
BOTTLE ROLL - COARSE									
Calc. Head	Au, g/t	4.17	14.72		0.88	3.97	6.63	6.96	
	Ag, g/t	19.05	77.79		3.70	47.54	63.15	52.62	
Au/Ag Ratio		0.22/1	0.19/1		0.24/1	0.08/1	0.10/1	0.13/1	
Grind, % 3.35m		95.3	90.8		87.5	90	89.6	93.8	
% Extraction	Au	85.1	94.4		84.0	89.7	78.3	58.6	
	Ag	29.1	37.6		32.3	24.3	28.7	9.7	
Residue Au, g/t		0.62	0.82		0.14	0.41	1.44	2.88	
Leach Time, hours		72	72		72	72	72	72	
NaCN Consumption, kg/t		0.6	0.4		0.7	0.5	1.2	0.9	
CaO Consumption, kg/t		9.5	4.8		7.4	5.0	8.4	14.2	
COLUMN LEACH									
Head Assay	Au, g/t	4.29	13.20	13.20	0.89	4.79	6.88	6.26	6.26
Ore Size, mm		12.7	25.4	12.7	12.7	12.7	12.7	25.4	12.7
% Extraction, Au		8.6 ⁽¹⁾	78.6	81.6	79.5	50.3	-(2)	-(2)	-(2)
Leach Time, days		6	32	32	32	32	42	42	42
NaCN Consumption, kg/t		0.22	1.13	1.17	1.51	1.08	-	-	-
CaO Consumption, kg/t		0.075	1.03	0.99	0.98	0.99	2.23	2.89	2.85
Average pH		10.3	9.6	9.6	9.4	9.4	7.1	5.1	5.0

⁽¹⁾ Column No.1 test terminated after 6 days due to plugged column(clay Material)⁽²⁾ Leach not initiated since alkali still being consumed after 42 days

Table 1-5: Bottle Leach Test Results on Brown-McDade Drill Core Samples

Composite No.	Head Grade (g/t)					% Extraction		Consumption (kg/t)		Residue (g/t)	
	Au		Ag		%S2-	Au	Ag	NaCN	CaO	Au	Ag
	Calc.	Assay	Calc.	Assay							
54-A	7.95	8.09	91.39	82.0	1.42	75.0	69.9	1.69	6.81	1.99	27.5
54-B	10.94	16.60	171.78	164.0	0.29	89.7	47.6	1.32	5.13	1.13	90.0
55-A	2.72	5.31	143.12	189.0	13.68	28.3	23.1	6.08	70.9	1.95	110.0
55-D	11.35	15.90	245.94	238.0	4.77	66.8	37.4	2.73	4.87	3.77	154.0
56-A	6.88	4.66	37.76	35.8	0.03	91.0	23.5	1.67	13.62	0.62	28.9
56-B	22.46	24.62	69.13	70.7	0.25	94.8	35.2	1.19	10.95	1.17	44.8
57-A	1.41	1.03	13.39	12.0	0.32	70.8	26.0	1.83	26.12	0.41	9.9
57-C	4.58	4.52	41.24	42.8	0.68	89.5	56.4	1.12	21.70	0.48	18.0
58-A	4.56	4.59	133.24	142.0	5.02	61.0	69.6	3.70	8.19	1.78	40.5
58-B	24.46	25.10	60.09	49.5	6.85	91.9	66.2	2.34	5.74	1.99	20.3
59-A	1.78	2.98	16.89	18.0	0.61	86.5	44.9	1.69	9.59	0.24	9.3
59-C	10.16	9.33	48.55	36.8	1.95	85.5	54.7	2.54	5.80	1.47	22.0
60-A	6.77	6.34	152.17	134.0	1.25	86.9	44.8	1.85	6.48	0.89	84.0
62-A	2.49	2.95	58.18	30.5	3.86	65.5	74.6	2.40	10.10	0.86	14.8
63-C	6.02	5.28	23.13	23.8	0.60	92.0	27.4	0.72	5.39	0.48	16.8
65-A	4.93	5.04	154.51	134.0	1.43	88.9	80.6	0.66	4.71	0.55	30.0
65-B	7.69	8.91	46.96	34.8	0.10	94.1	28.7	0.36	7.04	0.45	33.5
66-A	11.71	10.90	67.34	64.5	0.09	85.4	45.1	1.37	4.00	1.71	37.0
68-A	9.60	11.80	93.60	90.0	1.89	87.2	33.2	2.83	25.78	1.23	62.5
69-A	12.56	12.70	58.79	56.5	8.63	63.9	42.3	2.77	12.91	4.53	33.9
70-A	16.23	20.10	30.96	33.0	8.80	90.3	34.1	0.45	2.79	1.58	20.4
70-B	2.01	1.85	8.85	8.5	3.41	69.1	51.4	1.06	6.36	0.62	4.3
71-A	2.45	1.99	29.29	27.5	0.45	89.0	28.3	1.14	9.55	0.27	21.0
72-A	2.96	3.36	19.43	20.6	3.89	93.2	48.0	1.80	12.61	0.20	10.1
73-A	6.39*	6.31*	41.22	40.0	16.72	81.9*	0	2.59*	5.9*	1.17*	41.2
74-A	2.09	1.85	16.98	16.0	0.75	64.1	15.8	1.87	16.05	0.75	14.3
75-A	4.57*	4.11*	41.51	41.5	17.09	19.1*	0.5	3.98*	19.0*	3.70*	41.3
75-B	1.53	1.65	28.19	29.5	0.40	86.3	23.0	2.46	23.43	0.21	21.7
76-A	2.32	2.26	19.85	22.4	0.12	82.3	40.6	0.52	7.32	0.41	11.8
77-A	26.29	26.19	43.13	43.1	8.18	96.3	65.7	1.76	8.59	0.96	14.8
78-B	4.73	4.90	35.83	40.7	0.04	91.3	7.3	0.66	7.74	0.41	33.2
79-A	5.55	6.03	68.33	70.0	4.49	61.6	47.6	1.40	5.86	2.13	35.8
80-A	3.35	2.67	14.18	11.7	0.04	94.0	33.7	0.43	6.75	0.20	9.4
81-A	6.66	5.89	48.22	40.7	0.07	83.5	14.1	0.67	7.14	1.10	41.4
82-A	1.14	1.03	19.80	18.5	0.32	91.2	84.8	1.71	5.27	0.10	3.0
83-A	7.97	7.89	99.92	103.2	0.19	85.3	29.1	0.28	4.01	1.17	70.8
85-A	2.67	2.26	31.06	27.9	0.05	79.4	17.9	0.86	4.64	0.55	25.5
92-A	6.85	2.13	20.86	22.6	0.00	94.0	21.9	0.26	1.74	0.41	16.3
93-A	1.72	1.99	20.77	20.0	0.23	87.8	28.3	0.97	4.52	0.21	14.9
95-A	2.89	2.88	15.30	13.0	0.02	71.6	25.5	1.44	2.92	0.82	11.4
97-A	15.31	13.20	101.17	94.3	0.04	89.7	26.8	0.39	3.61	1.58	74.1
100-A	2.20	1.71	32.34	33.9	0.08	81.3	20.8	1.83	4.39	0.41	25.6
103-A	4.17	4.18	12.56	11.6	7.86	16.0	24.3	0.99	2.24	3.50	9.5
104-A	3.30	3.84	8.23	7.3	2.63	93.6	51.4	0.72	3.52	0.21	4.0
104-B	16.64	20.80	155.25	142.0	3.32	95.1	89.2	0.36	6.84	0.82	16.8
106-A	3.83	3.36	32.80	29.6	0.04	87.5	15.9	0.70	3.75	0.48	27.6
109-A	3.08	3.15	7.68	7.5	2.20	36.7	50.50	0.65	5.69	1.95	3.8
Average	7.02	7.32	58.1	55.9	2.88	78.9	38.9	1.55	9.75	1.14	32.62

The average leach residue grade obtained for the 47 tests was 1.14 g Au/tonne (0.033 oz/ton) and 32.62 g Ag/tonne (0.951 oz/ton). The sulfide content in the composites varied from zero to as high as 17.1% with the average content being 2.88%. Gold extractions varied from 19.1% to 96.3% with the average extraction being 78.9%. Silver extractions varied from 7.3% to 89.2% with the average extraction being 38.9%. Reagent consumptions averaged 1.55 kg NaCN/tonne and 9.75 kg CaO/tonne.

Gold extractions were generally related to sulfide content with lower gold extractions being obtained with increasing sulfide content. The same relationship held true with residue gold grades, the lowest residue grades were obtained on the drill core composites with the lower sulfide content. Silver extractions did not appear to be related to sulfide content since low silver extractions were obtained on both low and high sulfide material. Sodium cyanide consumptions were highest for the higher sulfide samples. The good agreement between head assays and calculated head grades, for both gold and silver, suggests that a gravity recovery step would not be required in the milling circuit since the ore does not contain coarse gold.

1.8.2.3 Ore Composites

Contour representations of the drill core leach results, described in the previous section, were then plotted on orebody cross-sections to select two oxide composites and three sulfide composites of the Brown-McDade orebody. These composites were used to optimize the process for the Brown-McDade oxide ore and to provide a primary evaluation of sulfide ore metallurgy.

The make-up of the two oxide composites is presented in Table 1-6. Composite A represents the northern section of the Brown-McDade surface ore (the north pit) and Composite B represents the southern section of the surface orebody (the south pit). These two composites were used in testwork at Coastech Research to develop the process design criteria for the Mount Nansen mill retrofit described in the Section 1.8.2.4. The baseline cyanidation tests on these two composites resulted in an average residue gold grade of 1.00 g Au/tonne and an average gold extraction of 86.2% from a head grade of 7.14 g Au/tonne (Melis, 1989).

Table 1-6: Oxide Composite Make-Up*

Item		Composite	
		A	B
Samples		54-A, 54-B, 55-D, 63-C, 65-A, 65-B, 66-A	92-A, 97-A
Area		North Pit	South Pit
Head Assay	Au (g/t)	8.07	6.21
	Ag (g/t) est.	114.4	61.0
	% S ²⁻	0.58	<0.01
Residue Grade	Au (g/t)	1.17	0.82
	Ag (g/t) est.	55.5	45.2
NaCN Consumption (kg/t)		1.16	0.07
CaO Consumption (kg/t)		8.6	4.4
Baseline Gold Extraction (%)		85.5	86.8
Estimated Silver Extraction (%)		48	24

* data from bottle-roll test

The make-up of the three sulfide ore composites is presented in Table 1-7. These three composites were submitted for testing at Lakefield Research in Lakefield, Ontario to identify primary sulfide ore metallurgy. The baseline cyanidation tests on these three composites, completed by Coastech, gave residue gold grades of 2.40, 1.07 and 3.06 g Au/tonne with gold extractions of 44.8%, 95.2% and 78.3% being obtained from head grades of 4.35, 22.5 and 14.1 g Au/tonne respectively (Melis, 1989). Poor extraction efficiency at lower head grades, high sodium cyanide consumption at higher grades and higher mining costs for the sulphide ore via underground methods significantly reduced the feasibility of processing sulphide ores.

Table 1-7: Sulfide Composite Make-Up*

Item		Composite		
		A	B	C
Samples		55-A, 69-A, 79-A, 103-A, 109-A	58-B, 70-A, 77-A	127-A, 132-A
Head Assay	Au (g/t)	4.35	22.5	14.1
	Ag (g/t)	30.0	150.0	180.0
	% S ²⁻	8.2	8.0	9.9
Residue Grade Au (g/t)		2.40	1.07	3.06
NaCN Consumption (kg/t)		0.89	1.81	2.64
CaO Consumption (kg/t)		6.5	8.0	5.2
Baseline Gold Extraction (%)		44.8	95.2	78.3

* data from bottle-roll test

Typical barren solution analyses for oxide ore are provided in Table 1-8. This data indicates the contaminants that can be expected in raw untreated tailings.

Table 1-8: Typical Barren Solution Analysis for Oxide Ore

Analyte (mg/L)	Composite A	Composite B
Ca	610.0	80
Cd	0.14	0.09
Co	0.04	<0.02
Cu	69.0	3.5
Fe	2	1
Mg	1.10	0.05
Mo	0.11	0.08
Na	290	155
Ni	0.06	0.02
Sb	0.45	0.15
Sr	0.64	0.06
Zn	59.0	1.8
CNT	157	148

1.8.2.4 Result Summary

Basic metallurgical testwork was completed at Coastech Research on the two oxide composites (A and B) to derive the design criteria for the Mount Nansen mill retrofit. These results were used to establish the process design criteria described in Section 1.8.4 Process Description.

A grind of 70% minus 74 microns (80% passing 100 microns) would give a cyanidation residue grade of 1.1 g Au/tonne (0.032 oz/ton) or better which infers a gold extraction efficiency of 88.9% for a head grade of 9.87 g Au/tonne (the weighted average head grade of the drill core used to make up Composite A and Composite B). The bond work index obtained for Composite A and Composite B was 14.5 and 16.4 respectively.

Grinding-in-cyanide, pre-aeration, and addition of lead nitrate did not lead to any significant improvement in gold extractions. A low cyanide solution concentration (0.3 g NaCN/L) gave acceptable gold extractions while minimizing cyanide consumptions. A 24-hour leach retention time would be sufficient to give the required gold extraction.

Filtration of cyanide leach slurry gave poor filtration unit rates which precludes the use of filtration ahead of zinc precipitation for the Mount Nansen mill. The alternative carbon-in-pulp process will be acceptable for the Mount Nansen mill, in spite of the relatively high silver content of the ore, but zinc precipitation for final gold recovery is recommended instead of electrowinning to accommodate the high silver content of the leach solution.

1.8.3 Mill Feed Composition

The Brown-McDade ore is made up of different ore types. The ore near surface consists of clay-bearing ore, siliceous ore and lowgrade fractured ore while deeper ore can either be clay-bearing or siliceous.

The anticipated mill feed composition from an open pit mining operation of the Brown-McDade surface ore would be generally as indicated for Composite A and B in Table 1-9.

The gold and silver content of Composite A and B are average values expected for these composites obtained from analysis of individual drill core composites.

Table 1-9: Oxide Ore Composites - Head Analysis

Elements (ppm)	Oxide	
	A	B
Au	8.66	11.08
Ag	114	61
S ²⁻	0.58	<0.01
As	4990	9830
Ba	100	530
Be	<0.5	<0.5
Bi	30	38
Cd	37.5	4.5
Co	4	2
Cr	19	27
Cu	540	150
Ga	<10	<10
Hg	<1	<1
La	20	<10
Mn	2320	156
Mo	1	1
Ni	9	3
P	400	470
Pb	4160	2200
Sb	345	330
Se	2	2
Sr	61	77
Tl	<10	10
U	<10	<10
V	13	14
W	<5	<5
Zn	2780	408
Element (%)		
Al	0.38	0.28
Ca	0.67	0.09
Fe	5.36	7.08
K	0.33	0.72
Mg	0.12	0.02
Na	0.01	0.01
Ti	<0.01	<0.01
SiO ₂	N/A	N/A
LOI	N/A	N/A

1.8.4 Process Description

1.8.4.1 Introduction

The selected Mount Nansen gold mill flowsheet for processing Brown-McDade surface ore is depicted on Figures 1-13 and 1-14.

Oxide ore from the open pit, will be trucked to the coarse bin dump, crushed to minus 2 cm, ground at the rate of 300 TPD to minus 74 micron particle size. The process then proceeds to leach the gold into solution, recover the gold from solution onto carbon in C.I.P. tanks, strip the gold from the carbon and recover using the Merrill Crowe system of zinc precipitation, and pour a dore bar of gold and silver on site.

The process consists of reclaiming run-of-mine ore from an open pit stockpile at the mill. The ore will be crushed, wet ground, classified, and thickened prior to being processed through a cyanidation/carbon-in-pulp gold recovery circuit. Zinc precipitation will be used for final gold recovery. The CIP tailings will be treated for cyanide destruction prior to discharging to the tailings containment area.

1.8.4.2 Ore Preparation

Ore will be reclaimed from the run-of-mine ore stockpile with a frontend loader and dumped through a grizzly into a dump hopper. A feeder belt will transfer the ore from the dump hopper to the 450-ton coarse ore storage bin. Ore will discharge from the bottom of the ore storage bin via a vibrating feeder to a conveyor belt feeding the jaw crusher. The jaw crusher discharges to a conveyor belt which also receives the cone crusher discharge.

The combined jaw and cone crusher products are transferred to another belt that feeds a vibrating screen. Minus 10 mm (3/8") material passing the screen is transferred to the fine ore storage bins via another belt conveyor. The screen oversize (+3/8") material returns directly by gravity to the cone crusher.

A reversing conveyor on top of the fine ore storage bins permits the discharge of crushed ore to either bin. Each fine ore storage bin has a 250-ton live load capacity. The crushing and storage capacity is adequate for one 12-hour shift per day crushing cycle with approximately 2 hours per shift available for clean-up and maintenance.

1.8.4.3 Grinding

Fine ore from each bin will be fed to individual grinding circuits via a slot feeder and variable-speed conveyor belt. The ore will be ground in single stage ball mills in close-circuit with hydrocyclones to give a 70% minus 74 micron (200 mesh) grind. Cyclone underflow is recycled to the ball mill for further grinding and cyclone overflow from each grinding circuit is discharged to a 40 ft. diameter thickener equipped with a high-rate feedwell for thickening to 50% solids prior to cyanidation. Lime will be added in the grinding circuit for pH adjustment.

1.8.4.4 Cyanidation

The thickened slurry will be leached in a series of three cyanidation tanks to give in excess of 24 hours overall leach retention time. Additional lime will be added to result in a pH of 10.5 to 11 for cyanidation, and sodium cyanide will be added to give a solution cyanide concentration of 0.3 g NaCN/L. Low pressure air will be added in each tank to give the required oxygen content in the leach pulp.

1.8.4.5 Gold Recovery

The cyanidation slurry will flow by gravity to a five stage carbon-in-pulp (CIP) circuit to recover the dissolved gold. Total retention time in the CIP circuit is approximately 5 hours.

Carbon will be retained in each tank by utilizing equalized-pressure launder screens. Carbon transfer between tanks (counterflow to slurry flow) is accomplished with air-lifts. Transfer of gold-loaded carbon to the loaded carbon screen is accomplished with a recessed impeller pump.

Loaded carbon discharges from the screen to an acid wash tank and after washing is transferred via an eductor to the atmospheric carbon strip tanks. Gold is stripped from the carbon with a hot caustic/cyanide solution. The resulting pregnant solution is precipitated with zinc dust and the gold-bearing zinc is collected in a filter press. The resulting sludge is then fluxed and smelted to produce dore bullion.

Anticipated gold and silver production will require the movement of 1.65 tons of carbon per day. Every third batch of stripped carbon will be acid washed to maximize carbon loading efficiencies. Stripped carbon will be screened on a sizing screen to remove any carbon fines prior to re-using in the CIP circuit. Fresh, pre-soaked carbon will be added as required.

In order to minimize front-end capital costs, the present design does not include a carbon reactivation kiln. The installation of a kiln may become necessary for reactivating stripped carbon if the requirement for fresh carbon replacement becomes excessive.

1.8.4.6 Reagent Handling

- Lime will be received in bags and stored on pallets. Lime slurry will be mixed to 20% solids and stored in a holding tank and fed to the grinding, cyanidation and tailings treatment circuits through a ring loop.
- Sodium cyanide will be received in drums and made up as a 15% NaCN solution for addition to the cyanidation and carbon stripping circuit.
- Flocculant will be made up with an aspirator and metered to the thickener as required.
- Copper sulfate will be made up in a mix tank and stored as a 10% solution in a holding tank. Due to the acidic nature of this solution this reagent make-up will be contained within the curbed carbon acid wash section of the mill.
- Sulfur dioxide will be stored as a liquid in a bulk storage tank located outside the mill in a fenced enclosure. Liquid sulfur dioxide will be fed directly to the tailings treatment tanks.
- Sodium hydroxide, received in bags or drums, will be added directly to the caustic make-up tank as required.
- Hydrochloric acid will be added to the acid tank manually and diluted with water to the required strength. The acid tank and acid wash vessel will be curbed separately in the mill to avoid mixing acid solution with cyanide-bearing solution.
- Zinc dust and lead nitrate will be added directly to the zinc feeder as required.
- Fresh carbon will be presoaked, attritioned and screened before addition to the CIP circuit.
- Flux reagents will be stored in the furnace area and used as necessary.

1.8.5 Alternatives

The following alternatives to the metallurgical and tailings dam proposals have been examined.

1.8.5.1 Ore Treatment

The cyanidation of the oxide ores is the only realistic option available. However, within the proposed 300 Tonne per day option, the use of Merrill-Crowe zinc precipitation method was considered. Filtration of the leached tailings material is a prime

consideration in this design, and the filtration tests run on the ore projected very poor results.

Some preliminary column tests were run on oxide zone material to determine whether "heap leach" technology might be a consideration. Recoveries were quite high from the surface trench material tested. There were some concerns about clay like material that would be mixed with the zone, but essentially heap leaching was not pursued because of uncertainties about operating in the Yukon cold weather conditions. The possibility of using "heap leach" in the future is not discounted.

Similarly, "vat leach" was also considered. This approach uses heap leach as a basis, but the material is dumped into vats, leached with cyanide, the material removed by loader to a dump, and the vat recharged. The costs of this method come close to a full cyanidation approach, and the recoveries are less certain.

1.8.6 Spill Control

Spill control will be provided for by both design of the facilities and through training of the operators.

Spill control measures are as follows:

- Physical sumps and containment areas will be designed into the mill to collect spills within the mill. Spills in the mill will be either recycled back to the process or discharged to the tailings treatment system.
- Fuel and oil storage tanks will be installed behind lined berms, as specified by current regulation, with sufficient containment for stored volume of the largest unit should a rupture occur.
- A spill control plan will be assembled to provide staff with information required to both prevent spills and to contain and clean-up spills if they occur. This plan will address spills that could occur either on-site or off-site. Employees will be trained in spill control measures as outlined in the spill control plan.
- Diversion ditches above the mill and plant will intercept run-off water and divert it past the mill to Dome Creek.
- Local ditches adjacent to the mill and plant area will direct run-off from the plant site to the three existing tailings containment areas to intercept contaminants resulting from direct spills in the plant site area.

1.9 Tailings Pond

1.9.1 Site Selection

Work on different tailing pond sites has been conducted since 1985 - several of these investigations have been undertaken by Klohn-Crippen geotechnical consultants on behalf of BYG. Four different sites were examined in reasonable detail, the work including geotechnical drill holes, excavation of test pits, topographical surveying, and background engineering (Klohn Leonoff, - 1985, 1988 & 1990; Kohn-Crippen - 1994; see Drawings Appendix I). Ultimately a site was selected about 1600 metres below the mill in the Dome Creek valley. This site, referred to as Site #4 is described in the following sections.

Three potential dam sites (Site #1, Site #2 and Site #3 - see Drawing D-3002) have been considered in the past. Those three sites are all located on relatively steep slopes and offer relatively low storage volumes in proportion to the size of the dams required. Because of the lack of permafrost in the foundations, Site #1 was chosen as the best of the three in the previous studies (see Kohn Leonoff, 1988 and 1990).

1.9.1.1 Basis for Selection of Site #4

Part of the scope of the 1994 study was to investigate the entire property for additional potential tailings dam sites. A new location, named Site #4 (see Drawing D-3002 and Drawing D-3003) was identified on Dome Creek, downstream of the previously identified sites. Although the site does have frozen foundations, it is superior to the other sites (1, 2 and 3) in the following respects:

- The smallest dam volume for tailings volume stored. The three other sites examined were all on fairly steep slopes and offered low storage volumes in proportion to size of dams.
- A relatively low dam is required to impound the necessary tonnage of tailings. In addition to the improved costs, the dam would therefore reduce potential seepage through the dam.
- Good capacity to increase storage with modest future dam construction. This would reduce the number of locations for tailings storage if future reserves are confirmed.
- Source of granular materials for construction close to site.
- Potential to locate a closure spillway in bedrock.

- The location lies downstream of all existing and future mining impacts of the Dome Creek drainage system, thereby offering an excellent monitoring and control point.

In addition to the above benefits, there is a source of granular soils in the area which would make good construction materials. There is also potential to locate a closure spillway on the left abutment at Site #4 with its crest excavated in bedrock. Consequently, Site #4 was chosen for assessment by test pitting and drilling during the 1994 site investigation.

1.9.1.2 Site #4 Conditions

Site #4 is located in the Dome Creek valley at about elevation 1130 m. Topographically, Site #4 is the best available site on the property. The south side of the valley (right abutment) is quite steep (slopes of about 3:1 on the abutment and 2:1 higher on the slope). On the north side of the stream, there is a sand terrace, with its top elevation about 12 m above the creek level (see Drawing D-3003).

Three boreholes were drilled and 14 test pits were dug in the area of Site #4 during the July, 1994 site investigation. The approximate locations of the test pits and boreholes are shown in plan and section on Drawing D-3003. The boreholes were drilled with a Nodwell mounted CME-750 rig using solid stem augers. Sampling was carried out using a CRREL (Cold Regions Research Engineering Laboratory, US Department of the Army, Hanover, NH) tube sampler which produced cores of 7.6 cm (3 inch) diameter. Because all of the holes drilled were in frozen ground, no SPT tests were carried out. Drawing D-3003 gives a sectional interpretation of the foundation geology along the proposed dam centreline. Test pit logs and borehole logs are included in Appendix I-II. No test pits were dug south of the creek because it was considered too risky to attempt access across the creek with the backhoe.

In natural outcrops and where exposed in test pits and trenches, bedrock is highly fractured. This is a result of freeze thaw action and is accentuated in this area of the Yukon which was not glaciated in Pleistocene times.

A layer of apparent glacial till exists over bedrock in the deepest part of the valley. The till is typically a silty fine sand with numerous angular to sub-rounded pebbles and cobbles.

Overlying the glacial till is a grey silty fine to medium sandy material up to about 15 m thick. The fines content of the silty grey sand varies between about 10% and 40%. Within this silty sand, layers of varying organic content were observed. More organic-rich soils were noted on the right abutment than on the left abutment or in the valley centre. The more highly organic layers contain higher percentages of fines, a higher ice content, and exhibit a distinctive organic odour when thawed. The grey sand exists

immediately below surface in most of the area and, where present at surface, it is generally covered by a thick layer (about 20 cm to 30 cm) of moss. The active layer in this unit is very shallow. In mid-July 1994, the soil immediately below the moss layer was frozen.

Terraces of clean, well rounded fine to medium sand occur along the sides of the valley in some areas. The left (north) abutment of Site #4 is formed on one of these terraces. The local sand terrace deposits are apparently remnants of more extensive deposits which once filled the valley bottom. They consist of fine to medium sand with about 5% to 10% fines. Cross bedding, indicating that the sand was originally deposited in water, is evident in test pits and drill core samples. The terrace sands are well drained and, although frozen, contain no visible ice. The active layer in the terrace sands is deeper than in the finer-grained soils. In mid-July 1994, this soil horizon was thawed to a depth of about 1.5 m to 2.0 m.

Minor thicknesses of organic soils (usually less than about 15 cm) occur at surface in most areas. Along the creek in the valley centre, peat of up to about 0.9 m was encountered. Moss covers the ground surface throughout the Site #4 area, except on the terrace sand deposits where aspen trees and lichens indicate the better drainage provided by the sandy soil.

1.9.1.3 Summary and Conclusions

The following summary and conclusions were drawn from the 1994 study:

- Of the four sites studied to date, Site #4 is the most attractive site for development of a tailings storage dam.
- It is both technically feasible and practical to build a tailings dam at Site #4 to impound 300,000 tonnes of tailings.
- The foundations at Site #4 consist of sandy soils with varying amounts of fines. Occasional gravelly layers exist within the sandy soils. Some organic rich horizons are present, especially on the right abutment.
- If the foundation materials thaw, only very minor settlement will occur in the sandy soils. The organic-rich soils will consolidate significantly if melted, but because of their limited thickness, total settlement in the dam will not be large.
- Significant ice occurs in about the upper 1.5 m of the overburden at Site #4.
- The estimated annual precipitation values for a mean year, 200-year wet year, and 10-year dry year are 271 mm, 370 mm and 200 mm respectively. The statistically estimated 1 hour, 6 hour and 24 hour Probable Maximum

Precipitation(PMP) depths are 63 mm, 76 mm, and 108 mm. The estimated annual evaporation is 452.9 mm.

- A diversion channel should be constructed to divert Dome Creek around the tailings pond. During a dry year, water could be diverted from the diversion channel into the pond to make up possible water deficits.
- An operational emergency spillway 5 m wide could be constructed in Year 2 or 3 to pass the 200 yr storm in the event that pond has insufficient storage capacity. Initial siting could be on the left abutment but it could also be located on the right abutment, based on subsequent investigations. The invert of this spillway should be set a minimum of 1.7 m below the crest of the dam. This elevation will depend on the actual dam elevation when it becomes necessary to construct the emergency spillway. A rock lined discharge channel would be provided.
- A closure spillway approximately 10 m wide with an invert 2.0 m below the dam crest should be built. It may be possible to construct the closure spillway during Year 2 to provide for the 200 yr storm event thereby eliminating the need for an emergency spillway during operation.
- The annual water balance indicates that, with the diversion in place and, under somewhat drier than normal conditions, discharge may be avoided. However, to allow for less than perfect diversion efficiency, higher than average rainfall, or other water balance upsets, provision should be made to allow discharge from the pond.

Detailed design will require the following items:

- a detailed site-specific PMP and Probable Maximum Flood (PMF) study, including an assessment of PMF seasonal variation and maximized snowpack conditions;
- sizing and locating of the closure spillway; and
- a detailed survey of the impoundment area is required to refine the impoundment volume and dam geometry.
- test pits or other methods should be employed to investigate soil depth and condition on both abutments, and particularly the right (south) abutment.

1.9.1.4 Comparison of Dam Volumes

Approximate dam volumes were calculated for Site #1, Site #2 and Site #4 to provide a rough comparison of the three sites on the basis of construction volumes. Previous work (Klohn Leonoff, 1990) determined that a dam of about 20 m in height would be

required at either Site #1 or Site #2 to store approximately 300,000 tonnes of tailings. The approximate dam height required for storage of a similar volume at Site #4 is 12 m. Table 1-10 shows approximate construction volumes for the three options.

Table 1-10 Comparison of Construction Volumes for Site #1, Site #2 and Site #4

SITE	APPROXIMATE CONSTRUCTION VOLUME
Site #1	115,000 m ³ to 140,000 m ³
Site #2	125,000 m ³ to 150,000 m ³
Site #4	50,000 m ³ to 65,000 m ³

Site #4 is the best choice of the sites under consideration for a tailings facility, because the construction fill volume with roughly half the volume of the other two sites.

1.9.2 Tailings Dam Design

A summary of the major points in the design of the tailings pond are as follows.

- The dam is designed to contain 300,000 tonnes of tailings, plus 2 metres of freeboard, designed to meet a 200-year return period wet year, and a 10-year return dry year.
- Construction materials would be sourced on site and generally be composed of silty fine to medium sand.
- Design would be aimed at providing an ultimate frozen dam, which would have the effect of greatly reducing seepage and permitting the development of a flooded pond.
- Provision would be made in the design to accommodate the possibility that the dam would not freeze.
- Potential seepage will be intercepted by a pond downstream of the dam proper. Seepage would be reclaimed from this pond and returned to the dam, if necessary, on a continuous basis.
- A diversion channel would be incorporated into the pond design, to divert as much natural drainage as possible around the system.
- Based on average precipitation years, the pond could operate through the projected 3 year life of the operation with a release to the environment required in Year 3.

- It is noted that a water treatment plant may be necessary to ensure that all release to the environment meets regulatory standards.

1.9.2.1 Description

A tailings facility capable of storing 300 000 tonnes of tailings is required. Based on the best topographic map available (10 m contours), a storage-elevation curve was drawn for Site #4 to determine the probable height of dam required. It appears that a dam approximately 12 m high will be required to store the 300 000 tonnes. In addition, freeboard of about 2 m was assumed for preliminary design purposes, resulting in a total dam height of about 14 m. These values are preliminary, subject to a more detailed topographic survey of the impoundment area.

The dam would be constructed primarily of the silty fine to medium sand available on site. Although compaction of this material may be more difficult than some other soil types, this sand is the best material available for dam construction for several reasons. It is available in abundant quantities on site. Because of its well drained nature, it is a material well suited for excavation. Test pits excavated in July indicated that it was thawed to a depth of approximately 2 m below surface. Other soils were frozen just below the moss layer at that time. Borrow pits in this material would be relatively easy to reclaim following construction.

Several different dam design concepts have been considered. Because of uncertainties regarding the thermal conditions and permafrost in the dam and dam foundations, it was necessary to assess dams for frozen and unfrozen states.

The frozen dam condition is one where, following construction, the permafrost moves up into the dam and causes the main body of the dam to become permanently frozen. Ideally, the dam should be constructed so that the top of the permafrost (the bottom of the active zone), is above the maximum pond elevation. In this case, seepage is effectively eliminated, and the structural strength of the dam is high. Development of frozen dams has been successfully carried out at some arctic mines, and generally requires a very broad-crested dam to avoid three-dimensional conditions imposed by heating of the dam faces during the summer months. Two well-documented case histories of frozen earthfill dams are the Crescent Lake Dam near Thule Air Base, Greenland (Fulwider, 1973) and the tailings dams at the Lupin Mine located in the Northwest Territories (Geocon, 1990). These dams consist of low, earthfill dam structures which are constructed in continuous permafrost zones.

The unfrozen case assumes a semi-permeable dam. Appropriate placement and compaction of the dam fill material would ensure adequate strength of the structure itself. Stability of the foundations may be related to the degree of thawing of the permafrost underlying the dam. If the dam foundations thaw, zones of loose sand may result which could be susceptible to liquefaction under seismic conditions. To ensure

adequate stability of the dam under these conditions, a dam with gentle side-slopes is required to avoid excessive deformation in the unlikely event of liquefaction of the foundation material. A situation may result where initial seepage causes shallow thawing of foundations, which would later re-freeze as seepage diminishes.

A one-dimensional thermal analysis has been carried out to assess the thermal conditions following dam construction. Stability analyses have been carried out for the above cases (frozen and unfrozen). The thermal and stability analyses, and the required dam cross sections are discussed in the following sections.

1.9.2.2 Thermal Analysis

A one-dimensional thermal analysis was carried out for the dam using the computer program THERM1 (Nixon, 1990). The program uses the finite difference method to solve one-dimensional heat transfer problems in soils with freezing or thawing. A wide-crested tailings dam can be considered as a one-dimensional problem. The program produces data which has been plotted (see Appendix I-III) to illustrate the variation of temperature with depth over the course of the year. The primary intent of the modelling is to determine the depth of the active layer in the dam and/or foundations. The active layer is determined as the soil which, at some time of the year, reaches a temperature at or above the freezing point. The active layer freezes each winter and below the active layer, the soil is assumed to remain permanently frozen.

The modelling program requires input data including mean monthly air temperatures throughout the year. Detailed temperature data are available for Carmacks, 700 m lower than the site. Based on discussions with Environment Canada personnel in their Vancouver weather office, adjustments were made to the Carmacks data to account for the higher elevation of the site. Initially, average values of 4°C less than the Carmacks data were used. However, Carmacks data less 3°C produced results more closely matching those observed on site. Consequently, 3°C less than the Carmacks data was adopted for subsequent modelling.

To calibrate the model, input values including soil parameters and temperature data were adjusted until results agreed with observed field conditions. For the clean terrace sand, which is the preferred construction material, an active layer of about 2 m to 3 m is expected to develop, as seen in the in situ deposits. Where the silty grey sand exists at surface, the modelling shows an active layer of less than about 0.5 m, as observed on the right abutment.

Based on the above results, it is concluded that the active layer in the dam may penetrate to about 3 m below the crest elevation. Where the dam height lessens on the abutments, there is potential for the active layer to penetrate into the foundations. On the left abutment, where the foundations are formed in clean terrace sand, or rocky colluvium, this will not be a problem. However, on the right abutment and valley

bottom, and part of the left abutment beneath the low section of the dam, some fine-grained, ice-rich soils exist in the foundations. To avoid thawing of fine-grained, potentially ice-rich soils, raising of the crest will be required in these areas. By providing a minimum fill thickness of 4.0 m in all areas of fine grained soils where the foundation surface is at or below the design dam crest elevation, thawing of these critical zones can be avoided.

1.9.2.3 Stability Analysis

Unfrozen Dam Condition

Stability analyses were carried out to determine the cross sectional geometry required to ensure adequate stability of the dam under static and seismic conditions, for the worst case (unlikely) where both the dam and the foundations are thawed.

For the chosen cross sectional geometry, the minimum factor of safety against failure under static conditions is about 2.2.

A stability analysis has been carried out to assess the possibility of failure for a case where foundation soils thaw. This could result in loose sands which may be subject to liquefaction under seismic conditions. Details of the analysis are given in Appendix I-IV. The results indicate that, to achieve a factor of safety of 1.1, considered reasonable for this case, requires a dam with a base width of at least 80 m. The dam configuration given in Drawing D-3003 meets the necessary criteria, with a base width of about 90 m.

Frozen Dam Condition

A relatively broad-crested dam is required to avoid three dimensional heating effects and allow freezing of the dam. It is generally accepted in the literature that a dam width to height ratio of about 3:1 is acceptable. The width is taken as the horizontal distance between upstream and downstream faces of the dam at the elevation of the pond water level. In a situation where a tailings beach exists against the dam, the horizontal thickness of the tailings can be included in the calculation. If we assume that the tailings beach is developed to within 1.0 m of the dam crest elevation, and the freeboard above the pond level is 2.0 m, then, the horizontal tailings thickness will be about 100 m, providing adequate effective dam width. Consequently, a conventional dam crest width of about 6 m would be acceptable. These calculations are conservative, because the pond level would normally be kept much lower than 2 m below the dam crest.

1.9.2.4 Dam Cross Section

Two stability analyses were carried out, as described above, to determine geometric design parameters for a frozen dam and an unfrozen dam. The results indicate that the cross sectional geometry required to ensure stability for the two conditions are very

similar. Consequently, for this level of design, the following basic cross sectional geometry has been chosen:

- Crest Width - 6 m
- Upstream Slope Angle - 2.5H:1V
- Downstream Slope Angle - 3.5H:1V
- Minimum fill thickness over fine grained soils - 4.0 m

In addition, a minimum fill depth of 4.0 m should be maintained in all areas where the foundation surface is at or below the design dam crest elevation, except where the foundation is formed of the clean terrace sands.

This geometry results in a dam which meets stability requirements for both frozen and unfrozen states. Drawing D-3004 illustrates the proposed dam cross sectional geometry of the dam.

The dam is a homogeneous earthfill structure constructed from the fine to medium grained yellow-brown sand located as a terrace deposit at the site. Grain size tests indicate that this sand contains up to about 10% silt. The siltier grey sand located beneath the terrace deposit is also suitable for construction, but, because of poorer drainage, contains more ice and therefore may be more difficult to excavate. Test pits indicated that in July, the terrace sands were thawed to a depth of about 2 m and that the grey silty sands (insulated with moss) were thawed to a depth of only about 0.5 m or less.

Alternatively, the downstream portion of the dam could be constructed from mine waste rock. If this option is pursued, a suitable filter would be required between the sand fill and the rock fill portions of the dam.

The dam foundations should be excavated to below the active zone, or about 1.5 m to 2.0 m. Below this depth, no significant ice lenses were noted in drill holes, except on the right abutment. Within the active zone, significant ice was noted in drill cuttings and test pits.

Erosion protection will be required on the downstream face of the dam, on the crest, and on the upstream face above the tailings beach. Waste rock from the open pit will be suitable for this purpose. A layer of rock about 0.5 m thick will be sufficient.

1.9.2.5 Spillway and Water Diversions

The tailings facility may require an emergency spillway during mine operation to avoid any potential for overtopping of the dam during extreme storm events. The need for an

emergency spillway would be dictated by the storage capacity available during the project. If constructed, emergency spillway would be upgraded to a permanent spillway following closure of the mine. At that time, because water discharge from the system would be acceptable (following degradation of any remaining cyanide), Dome Creek would be allowed to flow through the pond and over the spillway.

The best location for the spillway is on the left (north) abutment. Overburden depths are relatively shallow in that area, probably allowing the spillway crest to be developed in bedrock. Overburden in the area consists of terrace sands and rocky colluvium. Development of the spillway trench in these soil types will avoid problems associated with open excavations in permafrost-rich fine grained soils. Portions of the spillway, such as the outlet channel, to be excavated in sandy soils would require riprap available from the open pit waste. A preliminary alignment and typical cross section for the spillway are shown on Drawing D-3003.

Alternatively, the spillway may be developed in the right abutment. Because of the steep slopes, neither the drill or the backhoe could access this area during the 1994 site investigation. However, if soil conditions permit, a spillway on the right abutment may require a smaller excavation than on the left abutment. Further site investigation will be required to determine overburden depths and the soil types in the area south of the dam (right abutment) to confirm feasibility of this option.

1.9.2.6 Seepage Control

Cyanide destruction will take place in the mill prior to tailings discharge to the tailings pond. However, some residual cyanide may remain in the tailings and it will be desirable to maintain a zero discharge system. For this reason seepage should be minimized through the dam. The dam, being built from fine to medium sand with a low percentage of fines, will be a semi-pervious structure. However, the tailings to be stored in the impoundment will be quite fine due to the grind in the mill and the high proportion of clay minerals in the ore. By developing a tailings beach on the upstream face of the dam, a very low-permeability structure can be realized and seepage will be greatly reduced.

A seepage analysis was carried for an unfrozen dam condition out using the two dimensional finite element computer program SEEP/W. The results of the seepage analysis (see Appendix I-V) indicate that the dam will be well drained with all seepage occurring in the lowermost 1 m of the dam. Total seepage through the dam is estimated to be less than 1 l/sec. This is dependant on development of a tailings beach on the upstream face of the dam. Hydraulic conductivities of the various materials used in the analysis are given in Table 1-11.

Table 1-11 Summary of Hydraulic Parameters Used in Seepage Analysis

MATERIAL DESCRIPTION	HYDRAULIC CONDUCTIVITY
Deep foundation soils - will remain frozen and essentially impermeable	1×10^{-9} m/s
Shallow foundation soils - assumed to be thawed to a depth of about 5 m - consist of fine to medium sands with varying silt content	1×10^{-5} m/s
Dam - compacted clean fine to medium sand with up to about 10% fines	1×10^{-4} m/s
Tailings - high fines content - (permeability as low as 1×10^{-7} m/s)	1×10^{-6} m/s

In the most probable event that the permafrost front moves up into the dam to a height higher than the pond level, seepage will be reduced to near zero.

To avoid seepage through the thawed portion of the dam (active zone) the pond level should be kept at least 3 m below the dam crest elevation. This value (3 m) may be adjusted based on monitoring of the active zone as the permafrost develops in the dam. However, the tailings beach can be developed above pond level, essentially up to dam crest elevation, to reduce seepage.

Summer Operation

To reduce the permeability of the dam and to increase the effective horizontal width of the dam, it will be necessary to develop a tailings beach against the dam. This must be accomplished during the first summer of operation. The beach will be created by spigotting tailings from the crest of the dam. Tailings discharged at the dam are expected to slope away from the dam at approximately 1%. During operation, tailings should be spigotted from the dam during summer months each year. This will likely be possible from about May to September.

Water separated from the tailings slurry will form a pond where it can be reclaimed for use at the mill. A minimum water depth of 2.0 m should be maintained in the pond to allow enough depth to float the pump station and allow the fines in the reclaim water to settle.

Winter Operation

During winter operations, ice lens formation or glaciation could interfere with the tailings discharge. This could lead to a reduction in the reclaim water as ice freezes into the beach causing a decrease in the in situ density of the tailings deposit. Possibly of even greater importance, significant volumes can be taken up by ice, reducing the

available storage for tailings. To avoid this problem, single-point, subaqueous deposition of the tailings through the ice-covered pond will be required during the winter months.

Placement of the tailings subaqueously in the water will reduce the average in situ density of the tails. The solids will tend to build up a flat cone in the pond area, reducing the depth of reclaimable water and reducing the beach areas. Controlled spigotting in the summer will be necessary to re-create the beaches for the following year.

1.9.2.7 Tailings Disposal Alternatives

As discussed in Section 1.9.1, several dam sites were examined and tested prior to the selection of Site #4. The possibility of using a "dry tailings" storage method was also considered. This method has been used in relatively dry areas such as Mount Nansen. Following extraction of all of the precious metals, the tailings are filtered to 15% to 20% moisture and moved by conveyor or truck to a hillside site, with a liner underlay. The tailings are dumped and spread by tractor, slopes are contoured and the edges are rip-rapped to prevent erosion. The poor filtering qualities of the tailings, work against the employment of this method at Mount Nansen. Reductions in the moisture content to 15-20% via filtration could not be easily accomplished during the testwork. However the primary reason for rejecting the dry tailings approach, was the discovery of Site #4, which permits long-term storage of the tailings in a permanent impoundment.

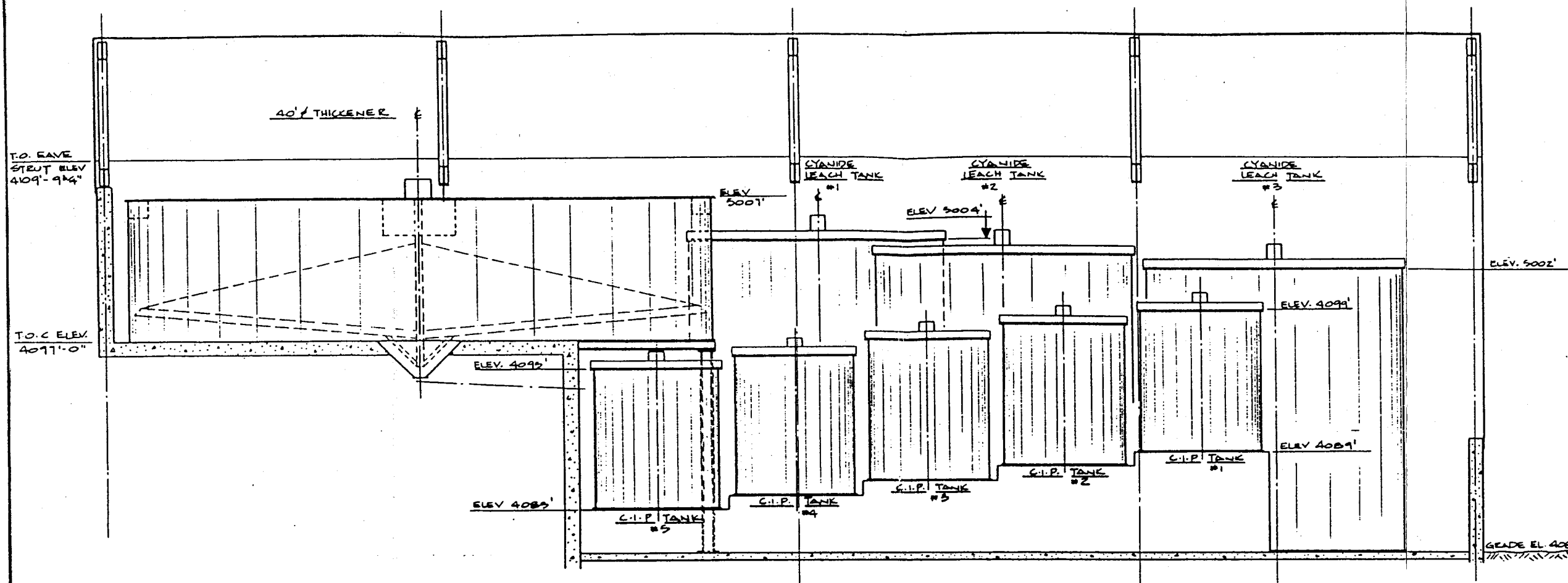
1.10 Site Facilities

1.10.1 General

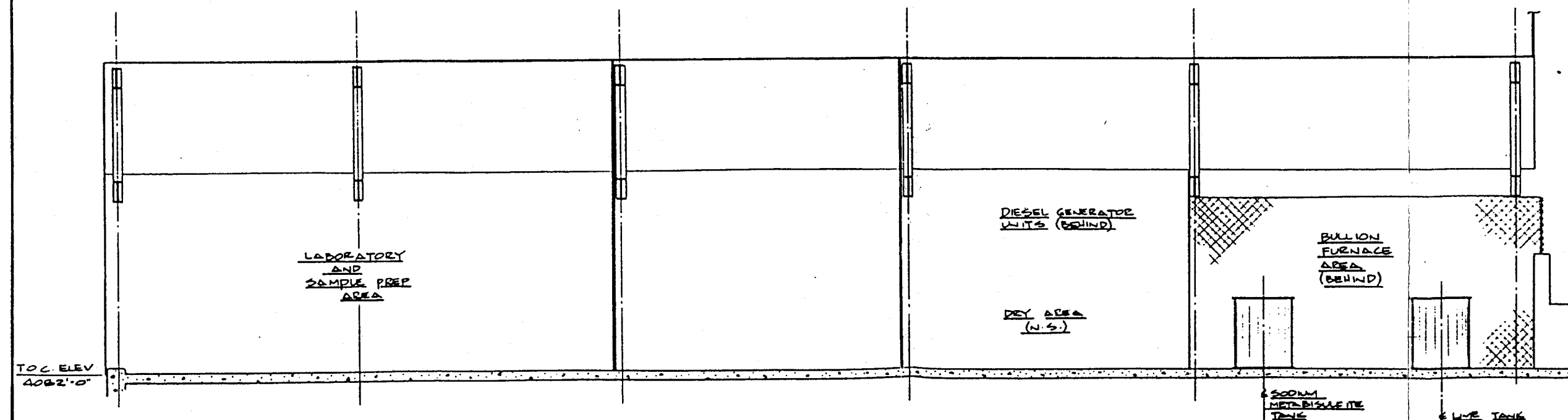
The plant layout for the Mount Nansen mill retrofit is shown on Figures 1-15 through 1-17.

The existing building structures at the Mount Nansen mine site are essentially in sound condition and can be used without major modifications. Insulation will be replaced where missing and existing doors and windows will be returned to usable condition. Areas to be partitioned off will be done basically with lumber and plywood construction.

The coarse ore storage bin, crushing section, conveyors, fine ore storage bins, conveyor belts and ball mills are essentially intact and will be returned to service by installing new motors, drives, liners, etc. as required. The existing flotation cells are not required, hence they will be removed to make room for other process equipment. The existing structural steel at floor level will be utilized as is.



SECTION D
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SECTION E
001

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NO	DATE	REVISION	BY	APP
DETAIL SYMBOL A DETAIL NUMBER B DRAWING WHERE DETAIL SHOWN C CROSS REFERENCE TO DRAWING WHERE DETAIL TAKEN OR SHOWN				
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VANCOUVER, B.C.

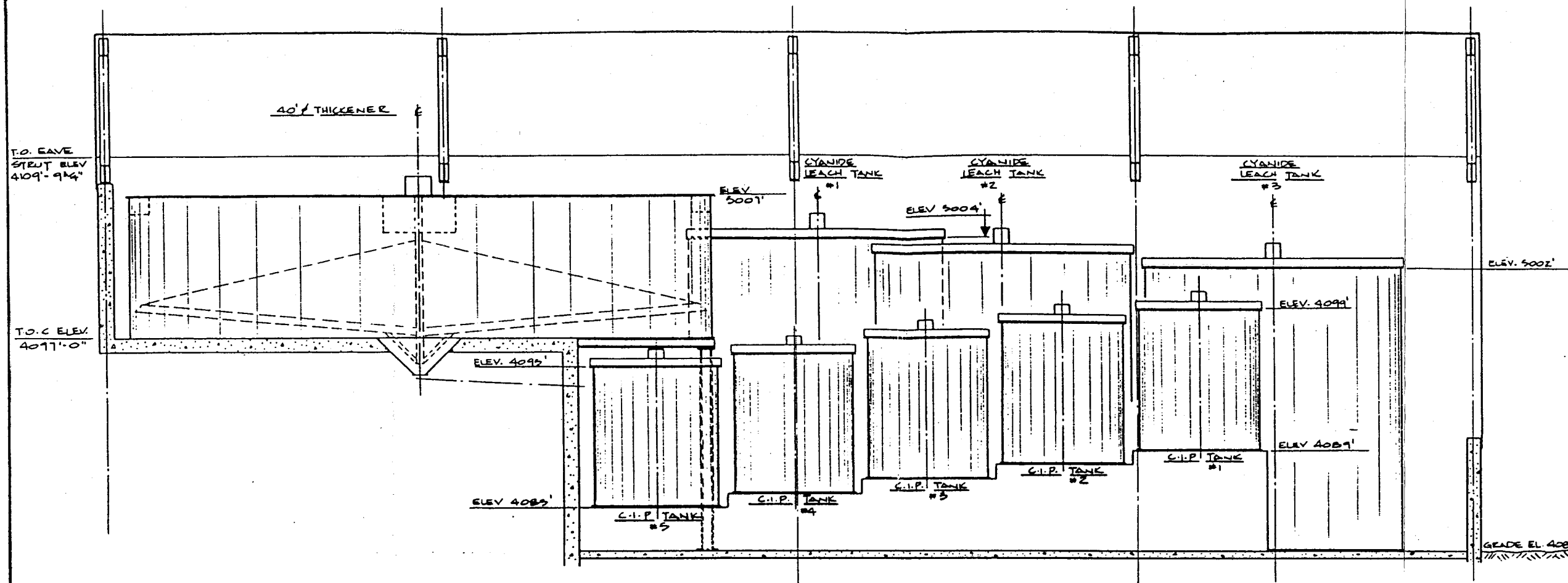
PROJECT No. 164

MELIS
ENGINEERING LTD.

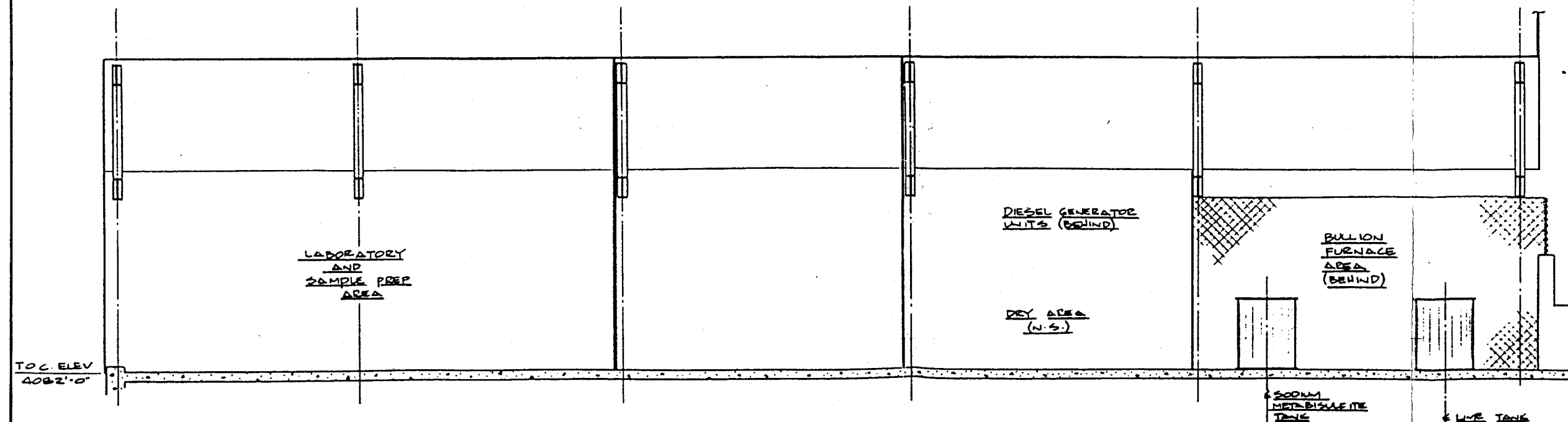
PROJECT
MOUNT NANSEN GOLD MILL
CARMACKS, YUKON
Figure 1-17

GENERAL ARRANGEMENT
SECTION D-D
SECTION E-E

DESIGN LAM/EDH	SCALE 1/4" = 1'-0"	DATE 21-11-88
DRAWN DJF		
CHECKED EDH	DRAWING NO. 164 - G - 003	BY 1
APPROVED LAM		



SECTION **D**
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SECTION **E**
001

1	JAN 1988	ADDED THICKENER AND LAB.	LAM	LAM
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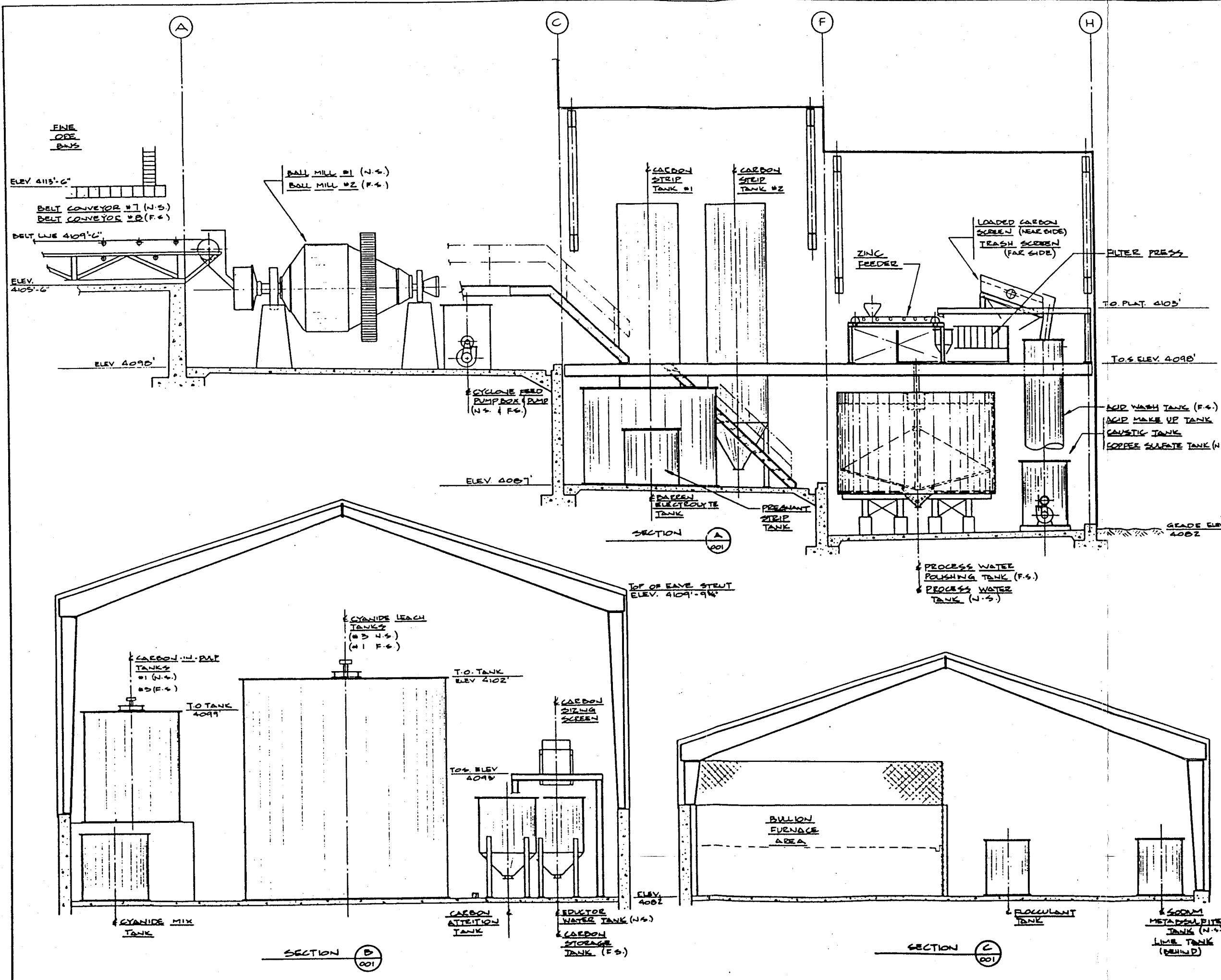
PROJECT No. 164

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PROJECT
MOUNT NANSEN GOLD MILL
CARMACKS, YUKON
Figure 1-17

GENERAL ARRANGEMENT
SECTION D-D
SECTION E-E

DESIGN LAM/EDH	SCALE 1/4" = 1'-0"	DATE 21-11-88
DRAWN DJF		
CHECKED EDH	DRAWING NO. 164 - G - 003	BY 1
APPROVED LAM		



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DETAIL SYMBOL A-B C A DETAIL NUMBER B DRAWING WHERE DETAIL SHOWN C CROSS REFERENCE TO DRAWING WHERE DETAIL TAKEN OR SHOWN		
ARCHER CATHRO ASSOCIATES (1981) LTD. (CHEVRON MINERALS LTD.) (BYG NATURAL RESOURCES INC.) VANCOUVER, B.C.		
PROJECT No 164		
MELIS ENGINEERING		
PROJECT MOUNT NANSEN GOLD MILL CARMACKS, YUKON Figure 1-16		
GENERAL ARRANGEMENT SECTION A-A SECTION B-B SECTION C-C		
DESIGN LAM/EDH	SCALE 1/4" = 1'-0"	DATE 21-11-88
DRAWN DJF	CHECKED EDH	
APPROVED LAM	DRAWING NO 164-G-002	
	REV 1	

A new dump hopper, grizzly and feeder belt are required for loading the coarse ore storage bin to; 1) avoid surcharging the bin unevenly, 2) maintain the existing live storage capacity and 3) avoid surcharging the bridge retaining wall with heavy wheel loads adjacent to the bin.

The building originally installed for a cyanidation circuit will be used to house the thickener, leach tanks, CIP tanks, and tails treatment circuit.

The diesel generators, refinery area and laboratory facilities will be housed in the existing warehouse building adjacent to the mill building.

1.10.2 Plant Buildings

The support plant for the proposed mining and milling operation will be generally located around and in close proximity to, the existing mill building. The lone exceptions being the pumphouse on Victoria Creek, and the powder and cap magazines. The following buildings and installations will be used.

- Mill building - currently in place, will make internal alterations, including the installation of a new cyanide circuit.
- Power Plant - new generating units will be installed in the existing warehouse.
- Assay laboratory - new installation within existing warehouse building.
- Shop - Existing steel storage shed will be modified for equipment repair.
- Pumphouse - This building on Victoria Creek will be rehabilitated with new pumps installed.
- Water Storage Building - This building will be reinstalled and the 35000 gallon storage tank installed.
- Powder and Cap Magazines - Portable trailer units will be established in Pony Creek drainage.
- Camp/Kitchen Complex - Portable trailer units to provide bunkhouse, kitchen, recreational hall for 50 personnel. These units will be located in the area of the old mine office and cafeteria.
- Mine Offices, First Aid Room - Portable trailer units will be located north of the mill at the entrance to the mill yard.

The existing buildings were engineered buildings and appear to have retained their integrity. However, prior to start-up, they will be inspected by a professional engineer, and all improvements required to bring the buildings up to code will be carried out.

For new construction, final drawings will be reviewed by a professional engineer and approved. The cyanide sections will all be designed to contain spills.

1.10.3 Plant Services

The following services will be installed (or rehabbed) for the operation:

- Fresh Water - will be pumped from existing water wells on Victoria Creek, through a rehabbed 4" steel continuous welded pipe line to a 35,000 gallon wood stave water tank. Fresh make-up water to the mill will be gravity fed from this tank via newly installed 4" water line.
- Potable Water - a feeder line off of the 4" fresh water line, will feed a water treatment system in the existing warehouse section, which will supply potable water to the mill, office and camp.
- Reclaim water - water will be reclaimed from the tailings pond for use as make-up water in the mill. A submersible pump will be installed in a culvert in the pond, feeding a supply pump to the mill. The line will be an insulated 4" steel line. The approximate distance is 1600 metres from dam to mill.
- Wastewater within the mill will be collected in sumps in the mill returned to the appropriate part of the mill or discharged to tailings from treatment and disposal.
- Domestic sewage from toilets, washrooms and kitchen/camp will be directed to a septic tank and tile field designed according to current standards.
- Power - newly installed diesel generating sets will generate power for all operations. Provision will be made to provide an average load of 1000 kw per hour. Diesel units have not yet been selected, but will probably consist of 3 units generating about 635 kw each, with one on stand-by and two units operating.
- BYG plans to incorporate heat exchange units on the power units to provide a significant part of the winter heat requirements.
- Power distribution - The major load in the mill will be probably cable fed as the generators will be a very short distance away.

- The Fresh Water pumps at Victoria Creek will be powered by an overhead power line from the gen sets in the mill. This line is partly in place now, but will require extensive rehabilitation.
- The reclaim pumps at the Tailings Pond will be powered by a drop off from the "Fresh water pump" powerline.
- Communications - Provision for two business lines and one for the camp via radio telephone or satellite are currently being negotiated.

1.10.4 Site Roads

The Brown-McDade open pit and waste storage operations will cut off access to the mill and to several placer operations north and west of the property. It will therefore be necessary to relocate a portion of this public road beginning south and east of the pit, and rejoining the existing road north and west of the pit. Total new length of road will be about 1000 metres. Road design will equal current standards, with a maximum gradient of 8%.

A one lane access road will be necessary to install and service the reclaim line, tailings line, and power line between the mill and the tailings pond.

Temporary roads will be necessary to access the tailings dam and pond area during the construction phase. These roads, will remain available for future use in the event additional reserves are confirmed, and future additional dam construction if required.

1.10.5 Power Generation

Power for the Mount Nansen gold mill will be provided by three new diesel powered 635 kw (prime rating) generators. Two generators on-line will provide the power requirements for the mill, camp and general surface facilities. The third generator will serve as a standby unit. A synchronizing gear is not necessary and hence has not been included. A crossover switch will be included to insure that two generators are on-line at any one time.

The engines will be located in the present warehouse-dry area to minimize the piping required for heat recovery and to simplify supervision and operation by the mill operating personnel. Heat recovery from the engine jacket cooling system is adequate to meet mill heating requirements when the mill is operating at capacity. In the unlikely event that engine reject heat is not sufficient, (such as during a mill shutdown period), construction-type propane heaters will be used as back-up. An estimate of power generation requirements for specific areas both within and outside the mill is provided in Table 1-12.

The remote-mounted engine fans and radiators will be piped, valved and ducted to permit discharging preheated ventilation air to the mill building during winter operation and cool air during summer operation. Large amounts of fresh make-up air to the mill building are desirable to maintain a healthy working environment. Adequate fresh air make-up will help confine any dust generated in the crushing and ore storage areas to those areas.

Table 1-12 Diesel Power Generation Estimates

Operating Area	Connected H.P.	Connected K.W.	Annual Hours	Annual K.W. Hours
Crush	158	118	3500	411432
Grind	375	279	8400	2343600
Leach	45	33	8400	281232
CIP	30	22	8400	187488
Acid Wash	8	6	2800	16666
Strip & Precip	16	12	8400	99994
Refine	3	2	200	446
Carbon Handling	5	4	3500	13020
Tailings	40	30	8400	249984
Reagent Handling	10	7	8400	62496
Process Water	8	6	8400	49997
Reclaim Water	25	19	8400	156240
Fresh Water	75	56	8400	468720
Line Heating	100	74	5000	372000
Laboratory	25	19	3500	65100
Compressed Air	125	93	8400	781200
Mill Lighting	50	37	8400	312480
Offices	20	15	3500	52080
Camp	30	22	8400	187488
Misc	10	7	8400	62496

1.10.6 Heating and Ventilation

Heating for the mill building and adjacent buildings will be provided by hot water unit heaters operating directly off a glycol system connected to the diesel engines. A circulating pump will be utilized to circulate the hot glycol through the plant heater piping loop. Ventilation within the mill building will be provided by wall-mounted exhaust fans and louvres. Heating for the camp trailer units will either be propane or oil-fired heaters.

1.10.7 Water Supply System

Fresh water will be supplied via a refurbished steel water line from Victoria Creek. A maximum of 6.1 L/S will be required to supply the fresh water requirements. Reclaim water from the tailings pond will be used in the mill to the maximum degree possible.

Water for the process plant and surface facilities will be supplied from the existing well system, some 12,000 feet from the mill building.

Approximately 20% of the existing 4-inch steel water supply line is missing as well as the water storage tank. It is therefore proposed to locate the new water storage tank about 3,000 feet closer to the well pumphouse and install a new 6-inch Sclairpipe from the storage tank to the mill. The larger size of this line will improve the fire water supply capabilities at the mill. All of the existing 4-inch steel line requires new heat tracing and insulation. The 6-inch Sclairpipe can be factory insulated and heat traced.

It has been assumed that the existing wells are serviceable and will adequately supply the water requirements. A pump test should be done prior to proceeding with the project to ensure an adequate water supply is in fact available from this source.

A diesel generator (approximately 80 HP) will be utilized to power a multi-stage submersible well pump and a portion of the 4-inch pipeline heat tracing at the pumphouse. Since the heat tracing is required only during very cold weather (about 40°F and colder) it is proposed to provide 4 portable diesel-generating sets (about 10 HP per unit) along the pipeline to power the heat tracing when required. If the insulation remains intact and the water supply line is not shut down, it is unlikely that the heat tracing will be required, however it has been included as a precautionary measure.

The well pumphouse building is basically intact but requires extensive insulation and sheeting as well as new doors and windows.

1.10.8 Camp

Camp facilities for the construction and operating phase will consist of portable ATCO-style units. A 50-person camp complete with kitchen facilities has been included in the cost estimate. This will meet the accommodation requirements for both construction and operations.

1.10.9 Laboratory Building

The laboratory will be housed within the existing warehouse building. It will include sample preparation facilities as well as a fire assay and atomic absorption unit to meet the basic analytical requirements of the mill operation. Any special analytical requirements will be contracted out to a commercial laboratory.

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1.11 Work Force

With an expected project life of 4 years, the open pit would operate for eight months of the year and employ about 15 personnel. The mill would operate 12 months of the year and employ an additional 23 personnel. Management and support personnel would number about 11. Total personnel will be approximately 50, with 30 of these on a year round basis. An employment summary for the Mount Nansen Project is provided in Table 1-13.

There will be a total of three mill operators on each shift, with the lead hand operator being responsible for the shift operation. It is anticipated that a twelve hours/day crushing operation will be sufficient, hence loader operators and crusher operators will work on nightshift to feed ore from the stockpile to the coarse ore bin and to run the crushing circuit. This will allow crusher maintenance to be done on the dayshift as well as allowing periodic operation of the crushing plant by dayshift personnel when necessary. A dayshift operator will be required to run the refining operation and complete other mill tasks as necessary.

An expeditor and clerk are needed to cover site administration duties. One laboratory technician and one assayer will meet the site analytical requirements, with only the laboratory technician present on site in the absence of the assayer.

1.11.1 Project Manpower Schedule

The Mount Nansen project will operate year round. However, it is expected that the open pit mining operation will only operate for 7 months of the year. The mill will continuously operate through the winter months, being supplied from a stockpile.

A listing of the type of job openings and skills required to operate the mine is provided in Table 1-14.

Table 1-13: Mt. Nansen Employment Summary

POSITION & JOB TYPE	YEAR ROUND	APRIL To OCTOBER
Equipment Operators	6	14
Mill Operators	12	12
Tradesman	6	10
Labourers, Trainees	6	8
Technical Staff	5	9
Accounting, First Aid	4	4
Kitchen	4	4
Manager, Superintendents	3	4
TOTAL	46	65

Table 1-14: Mt. Nansen Manpower Requirements

Labour Type	January-March	April-October	November-December
MINING OPERATIONS			
Pit Superintendent	0	1	0
Drill Blast	0	1	0
Loader Operator	0	2	0
Rip & Bulldoze	0	2	0
Pit Haul	0	4	0
Mill Haul	0	2	0
Tradesmen	0	4	0
Labourer	0	2	0
Sub-Total	0	18	0
MILLING OPERATIONS			
Superintendent	1	1	1
Metallurgist	1	1	1
Assay Technicians	2	2	2
Crusher Operators	2	2	2
Mill Operators	8	8	8
Lead Hands	2	2	2
Tradesman	6	6	6
Loader Operator	2	1	2
Labourer	2	2	2
Sub-Total	26	25	26
PLANT OPERATION			
Electrical Mech. Foreman	1	1	1
Equipment Operator	4	2	4
Labour Crew	4	4	4
Sub-Total	9	7	9
SUPPORT STAFF			
Manager	1	1	1
Office Manager	2	2	2
Engineer	1	1	1
Geologist	1	1	1
Technicians	0	4	0
First Aid	2	2	3
Kitchen Staff	4	4	4
Sub-Total	11	15	11
GRAND TOTAL	46	65	46

1.11.2 Preproduction Employment

The construction period will last about 6 months. During this period, the mill will be rehabilitated and adapted to the new process, a tailings dam constructed, bunkhouse and kitchen established, open pit preparation work completed, and the necessary infrastructure for operation put in place.

Approximately 7,000 personshifts of employment will be provided through this period.

1.12 Site Access/Transportation of Materials

1.12.1 Site Access/Haul Roads

The project site is accessed via a public 60 kilometer gravel road, maintained for about 8 months of the year by the Yukon Territorial Government. The road is maintained open primarily to provide access to several placer miners working in the area during the spring to fall season. The road provides access for exploration work for hardrock mining companies each summer. The road is also used by hunters and trappers, as well as some casual tourist traffic.

The number of one way trips per day crossing the first mile of road averaged 17 during the summer months of 1991, the only year for which figures are available. Most of the current traffic would be of light vehicular type. However, fuel trucks and equipment transport for back hoes, loaders and tractors, also make use of the road.

The road requires improvements for both environmental and safety reasons. BYG engaged Boreal Consulting Services Ltd. to conduct a study of the road in 1988. A report identified work and cost requirements to improve the road to acceptable standards. In August of 1994, BYG engaged Klohn-Crippen consultants, who, in conjunction with Engineering and Maintenance representatives of the Y.T.G., inspected the road again. Klohn-Crippen report is included in the appendix outlining the improvements which should be made. The major improvement for environmental reasons would be replacement of the ford on Victoria Creek with a culvert crossing. Brush clearing along the road and improved sight lines generally, would be primary safety factors.

1.12.2 Projected Traffic

The chart following illustrates the expected additional load and traffic on the road with the advent of production from Brown-McDade oxide ore. In summary, over 65% of freight tonnage and about 60% of the freight trips, will be for fuel for diesel power generation. This traffic will account for 0.9 one way trips per day of the total of 1.6 freight trips per day on an annual basis.

A more difficult estimate to provide is the additional light traffic which will develop with the mine. This traffic will be composed of two components: service trips for materials and manpower for the operation; and personal trips to Carmacks by employees living in camp on site. Projections of 11.5 additional one way trips per day have been assumed.

In summary, in terms of trips per day on the road, traffic could increase 75% over current usage during the summer. Virtually the same additional traffic will be maintained year round so that mine traffic will be virtually the only traffic during the winter months.

Table 1-15: Material Consumption and Transportation Estimates

Material	Consumed Annually (Tonnes)	Monthly (Tonnes)	Return Trips Per Year	Estimated Daily 1-Way Trips
Steel	85	7.0	4.0	0.03
Lime	517	43.0	17.0	0.13
Cyanide	121	10.0	5.0	0.04
Hydrochloric Acid	22	2.0	4.0	0.03
Sodium Hydroxide	22	2.0	4.0	0.03
Zinc Dust	11	1.0	4.0	0.03
Lead Nitrate	1	0.1	1.0	0.01
Copper Sulphate	33	2.8	3.0	0.02
Sodium Metabisulphite	330	27.5	12.0	0.09
Other Mill Supplies	24	2.0	12.0	0.09
Diesel Fuel	2500	210.0	120.0	0.92
Propane	30	2.5	5.0	0.04
Explosives	110	9.0	4.0	0.03
Misc. Other	30	2.5	12.0	0.09
Total Major Freight	3836	321	207	1.59
Service Trips (Vans, Pickups)			300	2.31
Personal Trips			1200	9.23
Estimated Total Trips			1914	14.71

All commodities listed in Table 1-15 will be trucked in from Whitehorse. Some shipments will originate in Whitehorse (fuel), and other will originate from Alberta and British Columbia, and reach Whitehorse via the Alaska Highway.

The only material to be shipped off-site will be gold bullion.

distance, (nominally less than 50 m) due to sharp bends, were logged. The first one, at Sta. 0+045, is particularly dangerous because it is combined with a vertical curve and a steep high bank. In many cases the height of materials obstructing vision is only a metre or two, in other instances a 1 to 2 m high cut bank is combined with a rising slope. Thus, the quantity of material required to be removed will vary depending on bank/slope geometry. Most materials can and should be used to widen the road so that vehicles may pass one another around the bend. Surplus materials should be used in grade raises where appropriate. If scheduling permits, brush clearing should be carried out first. This should both simplify construction activities and slightly reduce their costs.

A few instances of exceptionally narrow grade were noted where widening is recommended. Other miscellaneous measures pertaining to road safety entail:

- Retention of the 50 km/h speed sign at the junction near Carmacks, as well as placement of a new sign at the mine site;
- Placement of two new signs, one at either end of the access road, to read "CAUTION NARROW WINDING ROAD WATCH FOR TRUCK TRAFFIC"; and
- Straightening out the Carmacks' junction to improve site distance, and retention of the STOP sign.

Features pertaining to practical functioning of the road itself are mostly water related; that is, they generally entail low wet grades that are soft and unable to sustain repeated truck traffic without breaking down and rutting, or inadequate drainage. Several grade raises are recommended for low-lying segments of road surface, some of which are combined with recommendations for culvert upgrades. Borrow sources of varying quality, generally in the form of fluvial sands and gravels or fragmented rippable bedrock, are in abundance. Consequently, suitable borrow materials, where needed, should be found nearby; possibly only a few hundred metres to a few kilometres away.

Drainage improvements will entail the following:

- Culvert replacements, typically due to damage or inadequate sizing;
- Addition of culverts at new locations;
- Extension of an existing culvert length; riprap placements, either at the inlet or outlet ends of culverts; clean out of existing culverts; and
- Addition or clean out of ditching adjacent to culverts.

traffic would generate only about 20 large truck movements per month along with miscellaneous pickup truck, crew travel, and other associated light-vehicle activity.

The following points were understood and accepted by BYG and the YTG:

- The road will remain open to public traffic. Any new mine traffic will have to mix with any public use of the road;
- YTG Transportation Branch will continue to maintain the road during summer months, and will also endeavour to keep it open in the winter to accommodate year-round mining activities;
- Although the YTG Transportation Branch may be able to incorporate a few of the minor proposed upgrades into its enhanced maintenance program, it does not have sufficient budget to fund all the road upgrades required to support the proposed mine plan;
- Regardless of any proposed road upgrades, it is expected that road-use bans (especially restricting heavy truck traffic) will have to be imposed during spring breakup, normally a period of about one month. Winter maintenance, especially snow clearing and mitigation of glaciation growth, will allow BYG to stock up on basic supplies (food, fuels, etc.) and operate with minimal use of the road until the ban is lifted.
- The road is presently signed and thereby restricted to a 50 km/h speed limit. This limit is not expected to be changed.

1.12.4.2 Upgrade Recommendations

Generally, upgrade requirements may be divided into two categories: safety and functional necessity. In many cases, the two are interrelated. The prime concern, both from a safety and a functional perspective, is the restricted site distance due to over growth of brush along both sides of the road and in many sharp bends. The two main recommendations given to improve site distances are:

- Brush clearing a minimum distance of 4 m back from both edges of the road; and
- Cutting back the slope along the inside shoulder of tight bends, thereby opening up the site distance, as well as providing a wider road surface, which will often be sufficient for two vehicles to pass one another.

Brush clearing, as indicated in Appendix II, is required along about 45 km, or approximately 76% of the road's length. Besides improvement of site distance, this clearing is also necessary for snow removal. Fifty-nine occurrences of too little site

The two major drainages which are crossed by the access road, Rowlinson and Victoria Creeks, require special attention. The Bailey-style bridge across Rowlinson Creek needs repair, including the installation of missing or deficient braces and bearing plates. Specific details of these requirements are provided in the Boreal Consulting report. Victoria Creek, presently a ford crossing, is in need of perhaps two or three culverts, preferably combined with a lower-level control section to be sacrificed in the event of overtopping, as might occur during an extreme storm event. Some riprap protection, or possibly guidebanks, is also needed. Formulating the details of these requirements will require a site-specific ground survey and some engineering analyses.

Problems associated with glaciation, winter ice formations often due to freezing of groundwater seepages, will generally be controlled by the addition of a few extra over-sized culverts and winter maintenance operations.

A record of the observations upon which the above recommendations are based is included in Appendix II.

1.13 Future Operations and Development

1.13.1 General

The Brown-McDade oxide reserves provide the company with an economic project on a stand alone basis. Current projections indicate that an acceptable return on investment can be won from the "proven and probable" ore reserves, during a 3 year operating life.

However, as demonstrated in Table 1-16, considerable previous exploration and development work on this site has identified significant additional potentially economic reserves. The bulk of these reserves can be placed in a "proven and probable" reserve category by professional geologists, at least in terms of existence. In other words, underground development, diamond drilling, previous production mining, has confirmed that they occur in a real and geometric fashion. What is at question, is whether a metallurgical method is available or can be developed that will permit their extraction in an economic way.

Other mineral inventory, such as the Flex oxide zone, are categorized as "possible" ore. In this case, the reserves could be metallurgically treated in an economic way, but there is insufficient information to project that they occur in a geometric, and therefore mineable fashion.

Table 1-16: Current Total Inventory

Ore Type	Tonnes	Ounces Gold	Ounces Silver
Oxide	381,000	68,000	900,000
Sulphide	599,000	171,000	3,660,000
GRAND TOTAL	980,000	239,000	4,560,000

1.13.2 Additional Oxide Inventory

All currently known zones, with the exception of the Huestis zone, contain oxide ore near surface.

In the case of the Flex zone, drilling at 50 metre spacing has indicated the presence of "possible" oxide ore, that could be reclassified as "mineable ore" should additional drilling confirm its geometry and grade. A start on this confirmation is currently underway.

The Webber zone, has been classed as "mixed" oxide and sulphide. There is a distinct possibility that the upper part of this zone will provide some straight oxide ore. Definition work is required to prove this potential.

The oxide portion of the Brown-McDade appears to be closed off in the area of the proposed pit, but future exploration might uncover more on strike, particularly to the south.

Several other zones, not currently included in the mineral inventory, have been identified by surface trenching and sampling. Oxide gold mineralization has been confirmed, but additional work is required to improve grade and geometry.

Should additional oxide reserves be confirmed, they will likely be mined and treated in the proposed cyanide circuit, and the tailings contained within the currently proposed pond, by increasing dam height. Tests to confirm characteristics of both ore and waste rock material will be completed prior to mining and milling.

1.13.3 Sulphide Inventory

1.13.3.1 Brown-McDade Zone

The down dip extension of the Brown-McDade ore zone is classed as "sulphide" ore. This zone has been confirmed to a large degree by both underground development and surface diamond drilling. At this point in time, it contains the largest inventory of potentially additional reserves. Drilling is underway to increase the confidence in grade and geometry of the rocks. Under the flot/cyanide method, it is likely that the tailings would be deposited in the proposed tailings dam for the oxide ores, with some potential, depending on scheduling, to deposit it in a mined out pit, or in underground workings.

1.13.3.2 Webber Zone

The Webber zone would be mined by underground means. This zone is "mixed" oxide and sulphide, and as is indicated above, the likely optimum method of extraction is probably flot/cyanide. Tailings disposal would be either in the currently proposed storage pond, or underground in likely permafrost conditions. Further testing is required on this zone to prove up the process, and to identify characteristics of waste rock, ore zone rock, and possible future waste water effluent.

1.13.3.3 Huestis Zone

All past mill production was derived from this zone. The ore occurs as a narrow massive sulphide vein. Mining would be by underground methods. It is likely that future production from the Huestis zone would be by flot/cyanide process. A saleable flotation concentrate would be produced for shipment off site, and the tails from that process would be treated with cyanide on site.

Approximately 30,000 tons of tailings from the previous operation remain on site. Despite the potential to generate acid, indications are that these tailings do not. In the future, tails from this zone would be either stored in the currently proposed pond, or stored underground in a permafrost condition.

1.14 Conceptual Reclamation Plan

1.14.1 Reclamation Objectives

The general objective of the Reclamation Plans are to return disturbed lands to their original use and capability. For the proposed mine site, this would be wildlife habitat with sufficient undergrowth to serve as available browse. In the case of the Mount Nansen project, there are a number of site disturbance related to previous exploration and mining activities outside of the current project area. Reclamation of all disturbances in the project area is beyond the responsibility of BYG. BYG will assume full responsibility for reclamation of the current project area which includes the Brown-McDade open pit and waste dump, the camp/office area, the mill site area, the tailings pond and all other ancillary facilities such as site roads, wells and stockpiles. The company will however endeavor to carry out reclamation activities in disturbed areas outside the current project area if it is feasible. It will be essential to reach agreements with the Regulatory agencies in order to prioritize reclamation efforts outside the current project area. In general the reclamation objectives would include:

- to return disturbed land to a form consistent with the surrounding terrain to ensure an acceptable, productive land use following project abandonment
- to establish a vegetative cover wherever possible to prevent surface erosion and to encourage the development of productive ecosystems on reclaimed land
- to establish wherever possible, self sustaining communities on reclaimed lands in terms of both vegetative cover and productivity, and
- to establish vegetative conditions suited to the same degree of wildlife use as was experienced prior to development.

Procedures recommended for reclamation relevant to hardrock exploration in EBA *et al.* (1994) have been considered in the preparation of this conceptual plan. A more detailed reclamation and decommissioning will be assembled once agreement has been reached with the regulatory agencies regarding reclamation priorities and objectives for the overall Mount Nansen mineral claim area. At this point, the Reclamation Plan should remain sufficiently flexible to allow for future changes.

Reclamation scheduling will be dependent upon the timing of development of the other mineralized zones and the requirement for additional tailings impoundment, waste rock dumps, and other facilities.

1.14.2 Reclamation Activities

1.14.2.1 During Operation

A program of reclaiming current impacts, such as trenches, old access roads, waste piles from previous underground activities, etc., will be started during the first full operating year. This work will generally involve backfilling, recontouring, removal of culverts and re-establishing drainages, and test programs for revegetation.

The following activities will be carried out during operation to support and facilitate ultimate closure and reclamation of the site. Some of these activities may overlap functions required as part of the other permits such the water and waste permits.

- Monitor stream water quality, waste dump water quality, tailings dam water elevations and tailings pond seepage.
- Establish priorities and objectives for reclamation activities outside the current project site.
- Investigate options for reclamations of the exploration trenches.
- Contour overburden slopes around final pit.
- Establish pit waste dump slopes at proper angle during placement of waste.

1.14.2.2 Upon Mine Closure

The following activities would be carried after closure. Some of the activities associated with the pit and waste dump listed below could be conducted before closure, depending on the availability of the required equipment and manpower.

- Dispose of all toxic materials and fuels.
- Complete preparation of waste dumps for revegetation.
- Scarify plant site, site roads for revegetation.

Remove Dome Creek Diversion

- Remove all culverts on site roads and reestablish natural drainages.
- Construct a closure spillway for the tailings pond

On final abandonment, old adit portals will be backfilled and sealed, buildings removed to ground level, trenches and roads reclaimed, and in general return the disturbed land to a form consistent with the surrounding terrain.

The mill facilities will be removed and the site revegetated, if required, but after opportunities for future development have been abandoned.

1.14.3 Area of Disturbance

Surface disturbance for the present scope of the development will be relatively small. The open pits (2.3 ha), waste rock dump (6.8 ha) and tailings impoundment (4.39 ha) will not result in any significant effects on soils or vegetation of the area.

All disturbed areas would be re-contoured, seeded and stabilized, as required.

1.14.4 Overburden Stockpiling

Any overburden stripped during construction of the tailings dam and other areas will be stockpiled for latter use in reclamation.

The open pit area was stripped in 1985 and therefore does not contain appreciable topsoil. However any finer grainer materials that may be useful for reclamation will be stockpiled at the northend of the waste dump area for future use.

1.14.5 Tailings Impoundment

During active operation, mill effluent will be treated and stored in the tailings pond. Reclaimed water from the tailings pond will be used to supply over 90% of the mill needs. When the tailings pond reaches its design capacity for storage, excess reclaimed water will be treated if necessary in the mill and discharged to Dome Creek on a seasonal basis. Based on the current water balance a release to the environment will be required in the third year of operation.

Tailings disposal will start from the dam with deposition along the upstream face to seal the base of the dam. As the impoundment fills with tailings the discharge point will be moved to ensure that the tailings are deposited on as flat a slope as possible.

Some tailings beach may remain exposed after closure. Acid base accounting tests have demonstrated that the tailings are non-acid generating. However the intent will be to leave the pond in a partially flooded condition with the tailings material impounded by an impervious frozen dam. The Dome Creek diversion upstream of the pond would be breached to allow the creek to flow into the pond. The water elevation in the pond will be controlled by a closure spillway constructed at the north side of the tailings dam. This spillway will be 10 m wide with an invert 2.0 m below the dam crest and will discharge into the rock-lined diversion channel. All exposed tailings beaches will be covered with overburden to assist in revegetation and inhibit leaching of the tailings by the ponded water and by precipitation. The edges of the tailings area will

be seeded with plants if feasible. The result will be a wetland-type environment with good potential to support wildlife and waterfowl.

1.14.6 Seepage Collection Pond

Assuming that the quality of water in the seepage collection pond is acceptable at closure, the seepage pond dam will be removed and the area will be recontoured and revegetated.

1.14.7 Structures and Equipment

All buildings and equipment will be dismantled and removed from the site. Any remaining reagents or chemicals will be disposed of in compliance with Government Regulation. Concrete foundations will be levelled and backfilled with overburden.

1.14.8 Waste Dump Reclamation

Waste dump slopes will be constructed at 27 degrees during operation. Final reclamation of these slopes will be effected by a combination of cover applied if and revegetation methods. Test-work and research on seed mixtures, fertilization and planting techniques and vegetation will commence in early production years as will monitoring of drainage waters.

1.14.9 Water Courses

During operation Dome Creek will be diverted around the tailings pond. This diversion will be maintained during operation. After closure the diversion will be breached and the water in Dome Creek will flow into the tailings pond. The flow out of the tailings pond will be controlled by a closure spillway designed for a 200 year return storm event. Run-off from the waste-dump will be collected by a small pond during operation and released to Dome Creek. However the quantity of water collected by this pond will be very minor. The pond will be removed at closure after the dump has been reclaimed.

1.14.10 Reclamation of Pits

The pit may ultimately fill with water after closure. The overburden slopes around the periphery of the open pit will be stabilized and revegetated where feasible to reduce hazards to wildlife.

1.14.11 Reclamation of Roads

All site roads, not required for future activity in the area will be scarified and revegetated. Any culverts will be removed and stream banks restored to reestablished

drainage. All abandoned roads will be ditched at their junction with permanent roads to prevent access.

1.14.12 Exploration Trenches

Exploration trenches in the Mount Nansen claim area from previous activity are readily identifiable example of surface disturbance. Some of the trenches were cut as early as the 1950's. These trenches were originally cut to bedrock. Bedrock exposure is evident in the top segment of some of these trenches (EBA *et al.*, 1994) while the toes show evidence of gullying and accumulation of fine sediments. A number of species of wild flowers and grasses have successfully colonized areas where fines have accumulated. The EBA study recommended that exploration trenches be backfilled and recontouring to the previous slope if possible. However the study further recommended that if recontouring was not possible that erosion be controlled with riprap or other means. Clearly at Mount Nansen recontouring of the exploration trenches from previous activity is both not feasible or desirable. Areas where active erosion is taking place may require stabilization and revegetation but other areas that have been successfully colonized by plants should not be distributed if possible. A study should be conducted to determine the best approach to reclaim the exploration trenches. This will require the input of specialists from both industry and government, experienced with reclamation in northern climates.

1.14.13 Existing Tailings Ponds and Ore Dumps

There are two existing tailings ponds in the Dome Creek valley, that will require reclamation.

The downstream pond would be left in place during operation to act as spill containment facility for emergency spills. The upper tailings pond would be drained and reclaimed during operation by either processing the tailings through the mill or by moving the tailings to the new tailings pond.

Upon closure the lower tailings pond would be drained and moved to the new tailings pond. The embankments of the old tailings ponds would be recontoured after closure.

The existing ore dump from previous mining of the sulphide ore from the Brown-McDade zone which is located in the Pony Creek, drainage would be re-processed during operation or buried in the new tailings pond. This activity would be priority since it is currently a source of contamination to Pony Creek.

1.14.14 Prevention and Control of Acid Mine Drainage

1.14.14.1 Acid Rock Drainage (ARD) Characteristics of Tailings

The tailings from the Brown-McDade oxide ore contain approximately 0.6% sulphide and has slight Net Neutralization Potential (Net NP) of around -6 kg CaCO₃/tonne. Despite its negative Net NP the level of sulphide in the tailings, acid generation is not expected due to the fine particle distribution of the tailings. Reclamation and revegetation of the tailings beaches should eliminate any future concern with acid generation from tailings. A more significant factor is the presence of a minor amount of leachable arsenic in the tailings. Submergence of the tailings under water, coupled with covering of the beaches and shoreline revegetation will eliminate any future concern with both acid generation and release of arsenic into the water. Monitoring instituted during operation will be continued after closure to demonstrate the success of the water cover. In addition, tests will be conducted during operation to evaluate the feasibility of adding ferric sulphate directly to the tailings to stabilize leachable arsenic in-situ.

1.14.14.2 ARD of Waste Rock

The waste rock from Brown-McDade is generally low in sulphide with almost all the samples analyzed in 1994 containing less than 0.5% S. There were two samples of footwall granodiorite and one sample of lower altered granodiorite with sulphide sulphur above 1% analyzed during the 1994 program (PRA, 1994b). However these samples contained sufficient alkalinity to eliminate the theoretical potential for acid generation.

Due to the nature of the waste rock, generation of acid from the waste dump or the pit walls is not expected. Waste rock can be safely used for construction purposes. Monitoring of seepage and run-off during operation will be conducted to verify the ARD prediction from testwork.

1.14.15 Disposal of Chemicals

Virtually all chemicals brought on site are associated with the mill and assay labs. During operation these chemicals will be stored in accordance with Federal and Territorial regulations. Any spills that may occur during operation will be controlled as follows:

- primary containment in the mill sumps followed by re-use or treatment and disposal with the tailings
- secondary containment provided by natural drainage to the tailings pond
- spill contingency plan in place with regular training for all personnel.

- all chemical discharge from the assay office to be directed to a containment tank for neutralization and release to mill tailings.

1.14.16 Reagent, Fuel Storage

All reagent and fuel storage facilities will be located in the watershed emptying into the tailings pond. Fuel storage tanks will be protected by an impervious berm. Mill reagents will be stored in specified storage areas in the mill or a separate storage shed. A Spill Contingency Plan will be in place prior to start-up. Mill design will accommodate containment for internal spills.

1.14.17 Refuse, Sewage, Chemical waste

All metal, glass, paper and wood products will be separated at source and stored. Combustible waste will be incinerated on-site using an approved fuel oil fired incinerator. Noncombustible material and residue from incineration will be disposed of in an approved landfill. Domestic sewage will be treated in a conventional septic tank and tile field system. Chemical waste from the assay and metallurgical labs will be contained, treated or neutralized and released to the tailings pond.

1.14.18 Reclamation Costs

A preliminary reclamation cost estimate and expenditure plan is provided in Table 1-17. Prior to start-up, the total liability for reclamation will be \$231,000, due mainly to liabilities from previous operators. Once the new construction is completed and the operation has started up, an additional liability of \$71,550 will have accrued due to a number of items including the open pit, waste dump, tailings pond, diversions and monitoring requirements. However approximately \$50,000 of reclamation work will have been completed prior to start-up that was associated with the previous operations. In addition a salvage value of approximately \$300,000 would be credited to the bonding requirements for reclamation. The incurred liabilities for Year 2 and 3 have been estimated at \$54,000 and \$102,850, with offsetting expenditures of \$50,000 per year. The cost of reclamation work undertaken after closure would be \$299,500. This cost would be covered by the salvage of the mill facilities.

To satisfy the bonding requirements for reclamation, B.Y.G. Natural Resources Inc. will post a bond of \$150,000 plus pledge the new facilities constructed prior to start-up. This will ensure that approximately \$450,000 is available to cover the cost of reclamation should BYG fail to carry out the reclamation work as planned. This is an appropriate level of security given current status of the site and degree of impact expected from mining and milling of the Brown-McDade oxide deposit. In the event that additional oxide reserves are delineated on other deposits in the claim group or milling of sulphide proves feasible, the reclamation costs and related bonding requirements will be revised to ensure that sufficient funds are set aside for reclamation.

Table 1-17

B.Y.G. NATURAL RESOURCES INC.
MT. NANSEN PROJECT
RECLAMATION COST INCURRED AND EXPENDED

EXISTING IMPACTS	IMPACT AREA HECTARES	RECLAIM COST/HEC	YEAR 0	YEAR 1 CONST.START	YEAR 2	YEAR 3	YEAR 4	TOTALS
- OLD TRENCHES - DOME CREEK VALLEY	5.5	\$6,000	\$33,000					\$33,000
- OLD ROADS, NOT IN USE	1.2	\$3,500	\$4,200					\$4,200
- MINE ORE DUMPS, WASTE DUMPS	0.7	\$25,000	\$17,500					\$17,500
- EXISTING ADIT PORTALS								\$0
- MILL BUILDINGS, SHOPS, WAREHOUSE								\$0
- OLD BUNKHOUSE TRAILERS								\$0
- OFFICE, CAFETERIA								\$0
- TAILINGS AND WATER PONDS	0.5	\$25,000	\$12,500					\$12,500
- VICTORIA CREEK WATER & POWER LINE	1.3	\$3,500	\$4,550					\$4,550
- VICTORIA CREEK PUMPHOUSE	0.3	\$3,500	\$1,050					\$1,050
- EXISTING MILL SITE	2.7	\$6,000	\$16,200					\$16,200
- OLD OFFICE SITE	0.6	\$3,500	\$2,100					\$2,100
TOTAL EXISTING & TOTAL COST	12.8	\$91,100						
NEW IMPACTS								
- OPEN PIT	2.3	\$4,500		\$2,000	\$4,000	\$4,350		\$10,350
- PIT WASTE DUMP	6.8	\$9,000		\$12,000	\$24,000	\$25,200		\$61,200
- TAILINGS POND	4.4	\$4,500		\$4,000	\$8,000	\$7,600		\$19,600
- SEEPAGE POND	0.1	\$4,500				\$450		\$450
- DOME CREEK DIVERSION	0.3	\$3,500				\$1,050		\$1,050
- NEW MILL EQUIPMENT	0.0							
- NEW BUNKHOUSE, CAFETERIA	0.0							
- PIT ACCESS ROAD	1.1	\$5,500		\$6,050				\$6,050
- REHAB OLD ROADS TO TAILS, VICTORIA CK.	0.7	\$4,500		\$3,150				\$3,150
- MODIFIED WATER AND POWER LINES	0.3	\$4,500		\$1,350				\$1,350
TOTAL NEW IMPACT AND TOTAL COST	16	\$103,400						
OTHER WORK ADDITIONAL TO ABOVE RECLAIM		UNIT COST						
- TOXIC DISPOSAL		\$10,000		\$3,000	\$3,000	\$4,000		\$10,000
- CULVERT REMOVAL		\$15,000		\$15,000				\$15,000
- INSTALL PERMANENT SPILLWAY		\$45,000				\$45,000		\$45,000
- REMOVE BUILDINGS		\$125,000	\$125,000	\$10,000				\$135,000
- SEAL MINE PORTALS		\$15,000	\$15,000					\$15,000
- MONITORING WATER QUALITY		\$45,000		\$15,000	\$15,000	\$15,000		\$45,000
OTHER ADDITIONAL RECLAMATION WORK		\$255,000						
TOTAL FINAL RECLAMATION COST		\$449,500						
RECLAMATION COST INCURRED BY YEAR			\$231,100	\$71,550	\$54,000	\$102,850		
RECLAMATION WORK COMPLETED BY YEAR				\$50,000	\$50,000	\$50,000	\$299,500	
VALUE OF PLANT @ 20% NEW EQUIPMENT				\$300,000				
BONDING REQUIRED AT END OF YEAR			\$231,100	\$0	\$4,000	\$56,850	\$0	

1.15 Environmental Protection and Contingency Plans

A monitoring and surveillance program will be included as a requirement of the Water License. An outline of a proposed monitoring program for the Mount Nansen project is provided in Section 5. An outline of a spill contingency plan is provided in Section 6. The water balance for the project assumes the need for a release of excess treated water during the third year of operation. In the event that the water balance proves to be more positive than the predicted wet case, it may be necessary to treat and release water during both the second and third years of operation. The water balance will be updated on a regular basis as stream flow and climate data are collected.

2.0 Environmental Baseline Conditions

2.1 Status of Environmental Studies

Initial environmental studies for the Mount Nansen Project were carried out by Norecol Environmental Consultants Ltd. starting in October, 1985. Additional baseline data collection work has been conducted by the Environmental Protection Service (EPS, 1989) and by Water Resources up until 1988. Field studies conducted by Norecol in the 1985 to 1989 period included water quality sampling, hydrology, stream sediment sampling, collection of rock samples for acid-base accounting tests, and reconnaissance for wildlife. Norecol prepared a report in February 1989 that was a compilation of information for the project area collected by Norecol as well as Chevron Minerals Ltd., B.Y.G. Natural Resources Inc., Archer, Cathro and Associates (1981) Limited (Norecol, 1989a).

The Environmental Protection Service (EPS) examined water chemistry and biological conditions in the Victoria Creek watershed in 1976 and 1977. EPS found that the tributary receiving mine decant water had reduced bottom fauna, but there was little impact on the bottom fauna and fish populations in Victoria Creek.

During 1982, EPS conducted leaching experiments on tailings from the Mount Nansen mine to determine oxidation potential (Davidge, 1984). It was found that the tailings remained alkaline, did not oxidize appreciably, and leaching bacteria were prevented from becoming established due to acid consuming properties of the tailings.

Water quality monitoring was carried out by the Water Resources Division, Northern Affairs Program (Indian and Northern Affairs Canada) and some of these data have been reviewed. Their sampling was done to monitor operational mines or active exploration areas and their data for 1986, 1987 and 1988 are available from the Whitehorse Office.

Environmental Protection instituted a sampling program in the Mount Nansen project area in 1988. Samples of water quality were taken at 12 sites along with stream flow of most of these sites in July and August 1988. Benthic invertebrate sampling was also carried out in August, 1988.

Norecol's environmental studies were initiated in 1985 and consisted of seasonal sampling of water quality of a network of sites. Initial acid-base accounting (ABA) and reconnaissance level wildlife studies were also carried out. The program of hydrologic studies was initiated in June 1988 and limited data were collected to September 1988.

The environmental baseline data collected previously and reported in Norecol (1989a) has been supplemented recently as follows:

- Refurbishment of the flow measurement weir on Dome Creek at Site D2 in September, 1994
- Flow measurement at D2 on September 11 and 12, 1994
- Collection of a set of water quality samples on September 12, 1994 at 7 reference sites utilized previously
- Collection of 37 samples from Drill Core to characterize waste rock in the North and South Pits of the Brown McDade Zone in terms of Acid Generation Potential and metals
- Simulation of mill tailings and determination of tailings characteristics after Inco SO₂-Air treatment.

An updated table from Norecol (1989a) has been included as Table 2-1 in this report. These tables outline all previous and recent environmental studies that have been conducted on the project.

Table 2-1: Synopsis of Environmental Studies for the Mt. Nansen Project

Component	Date of Studies	Work Completed	Status
Water Quality	September 21, 1976 August 31, 1977 August 27, 1986	Sampling network of 5 stations by EPS (3 sampled in 1976, 5 in 1977). Limited sampling by Water Resources Service, Northern Affairs Program.	Adequate level of sampling has been completed to form the basis for impact assessment and project permitting.
	July 11-14, 1988 August 22-24, 1988 October 11, 1985 March 4, 1986 June 9 1986 September 4, 1986 July 4, 1987 August 28, 1987 May 27, 1988 September, 1994	Additional sampling was carried out by EPS at 12 sites. Total of 11 surface water sample sites plus 1 adit water site were established and sampled by Norecol on a seasonal basis. Water quality samples collected by D. Mehling.	
Stream Sediment	September 4, 1986 August 22-24, 1988	Samples collected at 10 surface water sample sites by Norecol. Sediment samples were collected by EPS at most of their 12 sample sites.	Sufficient samples have been collected for assessment of project impacts.
Hydrology/ Climate	May 25-27, 1988	Established continuous flow recorder and did flow measurements on Victoria Creek. (Instrument was a Stevens A-71 recorder provided by Water Resources, DIAND). A V-notch weir was installed on Dome Creek below the main road. Staff gauge on Victoria Creek was monitored by camp staff. Precipitation and temperature were also measured at camp on an on-going basis.	A-71 recorder should be reinstalled in spring 1989 (after break-up) and at least 3 discharge measurements should be taken to provide a complete record during the open water season. Staff gauge records on Victoria Creek should be monitored twice weekly during open water; daily during storm events. Daily records of precipitation and temperature should be continued when camp is open. Complete records from A-71 recorder should be processed and estimated flows calculated in conjunction with the Water Resources Division. Additional hydrology and climate analysis may be required for engineering design.
	July 11-14, 1988 August 22-24, 1988 September 21, 1988 September 29, 1988 September, 1994 September 11 & 12, 1994	EPS also did flow measurements at most surface water sites. Flows on Victoria Creek and Dome Creek were measured and recorder was serviced. Recorder had been operating intermittently, with some significant gaps in the record. Flow recorder removed by the Water Resources Division, Northern Affairs Program. V-notch weir at Dome Creek site refurbished. Flow measurements at D2 conducted by D. Mehling.	
Hydrogeological			A hydrogeological program should be carried out in conjunction with engineering design. Piezometers should be installed down gradient

Component	Date of Studies	Work Completed	Status
Benthic Invertebrates	September 21, 1976	Limited sampling carried out by EPS using a Surber sampler (1 site in 1976, 3 sites 1977)	of the tailings impoundment for monitoring purposes.
	August 31, 1977		
	August 22-24, 1988	Artificial substrates were placed at 9 of the 12 EPS stream sample sites in July and removed in late August, 1988.	Sampling and analysis by EPS is adequate.
Fisheries	August 31, 1977	Sampling at two sites was carried out by the EPS; limited analysis of fish tissues for metals was conducted.	
		Data compilation and review have been undertaken by Norecol, including discussions with Fisheries and Oceans staff. Field reconnaissance were done during various water quality sampling.	Site investigation of main project streams is required in summer to document presence, distribution and relative abundance of fish.
Acid-Base Accounting	1984	EPS did test on Mount Nansen tailings; tests indicated acid consumption.	Preliminary tests indicate that the Brown-McDade Zone should not be an acid producer; this requires confirmation. Further test work is advised on future zones to be mined and on simulated tailings material.
Wildlife	October 11, 1985	Eight samples collected by Norecol from Brown-McDade, Heustsis and Webber zones. Analysis completed on ore and rock.	
	October, 1994	37 samples of waste rock from Brown-McDade Zone assayed for ABA and Metals.	Results confirm preliminary results that tailings and waste rock should not be acid producers.
	March 4, 1988	Aerial survey flown by Norecol-small numbers (3) of wintering moose seen in project area. Observations have also been recorded during the course of other environmental work and by camp staff.	Detailed ground work is not considered necessary for the present scope of the project.
Soils/Vegetation/ Surficial Material			Site reconnaissance and mapping of surficial materials, and description of soil types for reclamation planning and materials handling may be required.
Land Status/ Resource Use/ Heritage	1994	Site inspection by YTG Heritage Branch	No archaeological sites found on the development site or the present access road. Borrow materials for road upgrades should not be taken from ridges or terraces in the area.
Government, Liason, Public involvement	March, 1988	Program was initiated in March 1988 - met with RERC, Northern Affairs, Water Resources, Fisheries and Oceans, Economic Development, Yukon Water Board, and Yukon Conservation Society. Project information package was submitted in March 1988.	Follow up required with respect to project approvals and permitting through the RERC and the Yukon Water Board.
Waste Management	August, 1994	Tailing Characterization	

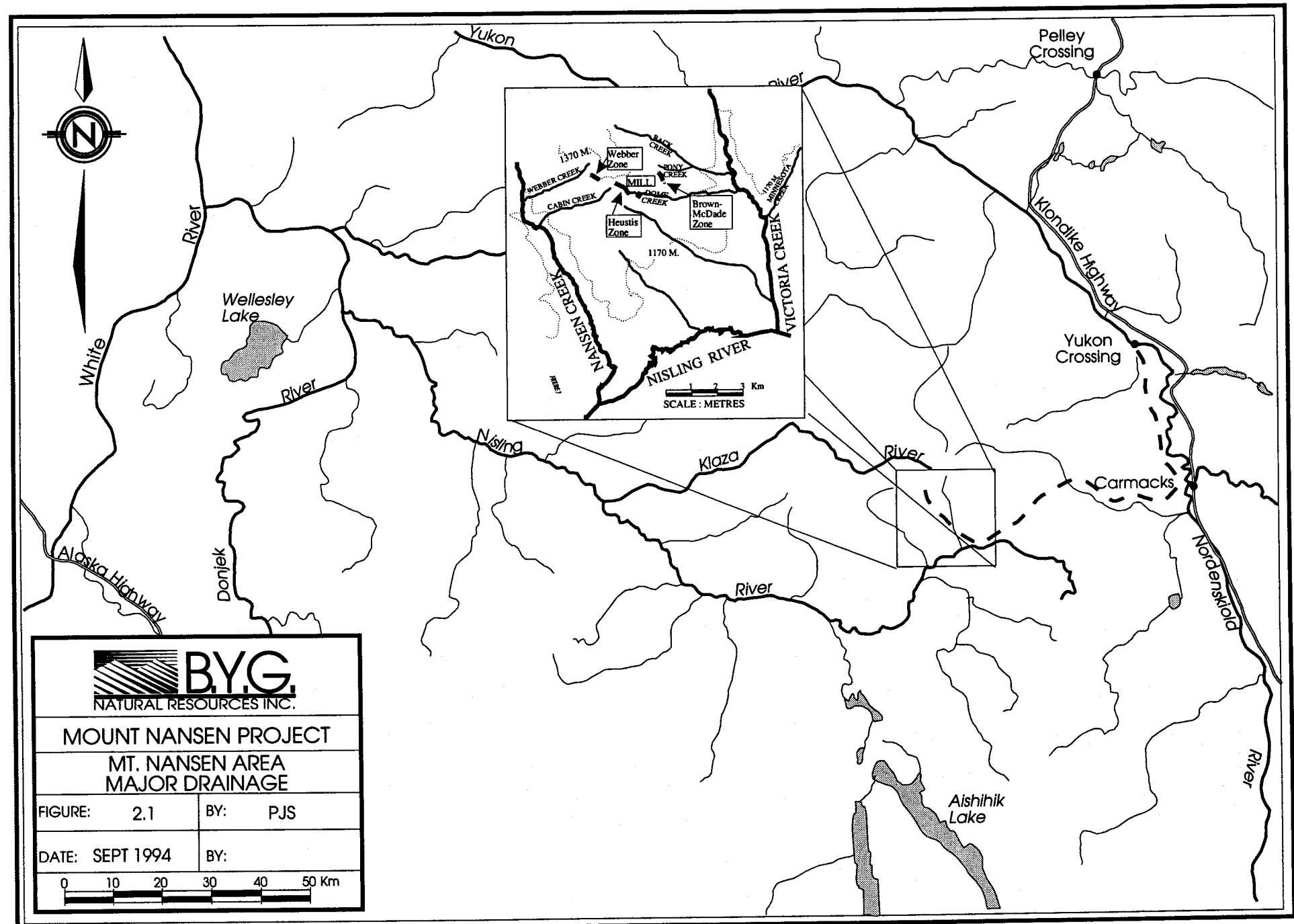
2.2 Environmental Setting

The Mount Nansen claims are located in the Dawson Range at elevations ranging between 945 m and 1525 m. The area is drained by the Nisling River, which empties into the Yukon River via the Donjek and White Rivers as illustrated in Figure 2-1. Drainage from the property flows into two moderate sized tributaries of the Nisling River, Nansen Creek to the west and Victoria Creek to the east (Figure 2-1, inset). Back and Dome creeks are tributaries of Victoria Creek which drain the east side of the property, while Webber and Cabin creeks are tributaries of Nansen Creek which drain the west side of the property (Figure 2-1, inset).

Average monthly temperatures in the Mount Nansen area range from about 15°C in July to -15°C in January. Frost is rare from late May to early September. Annual precipitation averages about 25 cm, most of which falls as rain in the summer months. Late winter snow pack is normally 30 to 40 cm deep.

The property lies in the Dawson Range Ecosystem with vegetation characteristics described by Oswald and Senyk (1977). Open stands of black spruce (*Picea mariana*) and white spruce (*Picea glauca*) occur in the valley along Victoria Creek and Nansen Creek; black spruce is predominant on wetter sites. Stunted black spruce and trembling aspen (*Populus emulioies*) occur on the lower slopes while the upper slopes and ridges are largely devoid of trees. Birch (*Betula* spp.) and willow shrubs form extensive cover from valley bottom to above treeline. Labrador tea (*Ledum groenlandicum*), mosses and lichens are dominant in the understory.

Geotechnical and permafrost information has been gathered in the project area by Klohn-Crippen (previously Klohn Leonoff) (1985, 1988, 1994). In general, the ridge tops and steeper hillsides have either no tree cover and bedrock outcropping or there is a cover of 1 to 3 m of weathered rock over intact bedrock. Extensive deposits of grey-brown sand occur in the valley bottoms and in the benchland near Dome Creek. Permafrost is evident at shallow depths (about 0.4 m) where the rock has an organic or moss cover. Where this cover has been removed the permafrost layer occurs at greater depths (about 5.0 m). The permafrost layer in this region is 30 to 60 m thick. Mean annual temperature at the site is approximately -6°C.



2.2.1 Permafrost

The site lies within the discontinuous permafrost zone, close to the southern boundary of widespread areas of permafrost islands. Because of the high elevation of the site, permafrost is more widespread than is generally true in this region. The -4°C mean annual air isotherm passes through Carmacks. Taking into account the fact that the elevation of the site is between 600 and 700 m higher than Carmacks, the mean annual air temperature for the site is expected to be at least 2°C colder than that in Carmacks, or at most -6°C , and possibly -8°C (pers. comm. Environment Canada). At the time of the site investigation (mid-July, 1994), the soils beneath Site #4 were frozen. Where a thick layer of moss exists, such as over most of the north facing side of the valley, the soils were frozen immediately beneath the moss layer. In the sandy terrace soils where the insulating layer of moss does not exist, the soil was thawed to a depth of about 2 m (active zone), below which the soil was solidly frozen. In the areas of sandy terrace soils, only a thin layer of lichen occurs at ground surface, and in some places, sand is exposed over areas of up to tens of square metres.

2.2.2 Seismicity

The Mount Nansen minesite lies within a seismically active area of the Canadian north in Seismic Zone 2, as defined by the National Building Code of Canada, 1990. The site lies within the Northern British Columbia (NBC) source zone between the McKenzie (MKZ) zone and the Denali Shaktwak (DSK) zone. A probabilistic assessment of the seismic risk at the site has been undertaken by the Pacific Geoscience Centre for the Mount Nansen site (October 1988). The results are enclosed in Appendix I-I. A peak horizontal ground acceleration of approximately 10% g is expected with probability of exceedance no greater than 0.0021, or one in 475 years, while a peak horizontal acceleration of 12% g is expected with a return period of .001, or one in 1,000 years. The tailings dam will be founded on medium dense granular soils overlying bedrock. Extensive deposits of loose soils, if they exist, will be removed from the foundation to minimize any potential for liquefaction under earthquake loading.

2.3 Climate and Hydrology

2.3.1 Climate

Climate data collected at the Mount Nansen exploration camp during 1985, 1986 and 1988 (generally end of May to September) consisted of daily temperature (maximum, minimum) and precipitation. Long term climate data for temperature and precipitation are available for Carmacks, 45 km to the east (Station No. 2100300).

The mean annual precipitation for the project site is about 270 mm. Snow begins falling in October or November and usually remains on the ground until May. The typical snowpack is about 1 m. Approximately 40% of the precipitation falls as snow.

Some rainfall occurs as early as April, but the majority of rainfall occurs from June to August. The most intense rainfall occurs in July.

2.3.2 Extreme Events

Climatological data, obtained from the nearest Environment Canada meteorological station, No. 2100300, was used to estimate extreme events. This station is located 60 km east of the site at Carmacks at an elevation of 524 m, 776 m below the minesite elevation of 1300m. Evaporation data was obtained from Fort Selkirk, Environment Canada Station No. 2100600, located approximately 80 km northwest of the minesite at elevation 454m.

Precipitation at Mount Nansen falls in the form of both rain and snow. Snow begins falling in November and remains on the ground until May. We understand that typically, a snowpack of 1m occurs. Approximately 40% of the annual precipitation falls as snow. Some rainfall occurs as early as April, but the majority of rainfall occurs from June to August. The most intense rainfall occurs in July. Mean annual precipitation values on a monthly basis are summarized in Table 2-2 along with a 200-year return period wet year and a 10 year return period dry year.

The evaporation data for Fort Selkirk is presented in Table 2-2. The highest evaporation rate occurs in June. Water losses due to evaporation drop off significantly in the winter as temperature drops. During the summer months of May through August, evaporation is nearly five times the value of the average precipitation.

Table 2-2 Summary of Monthly Precipitation and Evaporation

MONTH	EVAPORATION	PRECIPITATION		
	Mean Monthly (mm/month)	Mean Year (mm/month)	10-Year Return Period Dry Year (mm/month)	200-Year Return Period Wet Year (mm/month)
January	0.0	19.0	14.0	25.9
February	0.0	13.6	10.0	18.5
March	0.0	10.8	8.0	14.8
April	0.0	8.1	6.0	11.1
May	107.6	16.3	12.0	22.2
June	120.3	40.7	30.0	55.5
July	108.0	46.1	34.0	62.9
August	79.8	35.2	26.0	48.1
September	37.2	27.1	20.0	37.0
October	0.0	19.0	14.0	25.9
November	0.0	19.0	14.0	25.9
December	0.0	16.3	12.0	22.2
TOTAL	452.9	271.2	200.0	370.0

2.3.3 Surface Hydrology

A hydrology program for the project was initiated in late May 1988. A continuous water level recorder (Stevens A-71) was installed by Norecol on Victoria Creek above Minnesota Creek on May 24, 1988. Figure 2-1 shows the major drainages in the area. The recorder was provided on loan by the Water Resources Division, Northern Affairs Program, for use during the 1988 season. The site was gauged on three occasions in 1988: May 26, June 23 and September 22. (Table 2-3). Staff gauge readings were taken by Mount Nansen exploration camp personnel on a regular basis. Problems arose with the water level recorder around June 23 and it stopped recording shortly after that date. The station was inspected on September 21 and again operated until September 29 when the recorder was removed by Water Resources Division staff.

Table 2-3: Mt. Nansen Project Area 1988 and 1994 Hydrology Data

Site	Date	Staff Gauge Level	m ³ /s	L/S/km ²
Victoria Creek above Minnesota Creek ^(a) (1988)	May 26	0.495	0.976	11.9
	June 23	0.33	0.211	2.57
	September 22	0.35	0.277	3.38
Dome Creek ^(b) 1988	May 26	0.172 ^(c)	0.0169	3.48
	May 27	0.165	0.0153	3.15
	May 29	0.230	0.0350	7.20
	June 2	0.210	0.0279	5.74
	June 12	0.166	0.0155	3.19
	July 4	0.271	0.0528	10.9
	August 4	0.311	0.0744	15.3
	September 22	0.155	0.0131	2.70
Dome Creek 1994	September 11	0.110	0.00536	1.10
	September 12	0.130	0.0082	1.69

^(a) 82 km² drainage area

^(b) 4.86 km² drainage area

^(c) 90° V-notch weir

A 90° V-notch weir was installed on Dome Creek on May 26, 1988 and measurements were taken by Norecol and exploration camp staff. These measurements were used to calculate estimated discharge for Dome Creek (Table 2-3).

The 90° V-notch weir at Station D2 on Dome creek was refurbished in September 1994 and flow measurements were taken on September 11 and 12, 1994. The results are included in Table 2-3 above.

Spot measurements were also done by Environmental Protection at 12 water sample sites on July 13 and August 24, 1988.

Although the data record is incomplete, some data were obtained for Dome Creek during peak rainfall events during July and August 1988. The project area received above average rainfall during July of 1988 (sited as Steele pers. comm. in Norecol

(1989a)) and this is reflected in the high discharges given for July and August in Table 2-3

2.3.4 Groundwater

Four groundwater monitoring wells were established in the area of the original proposed tailings pond in September of 1989. Recovery and observational data are noted in Table 2-4.

Table 2-4: Groundwater Borehole Observations - Site #1

Well Number	Stickup (m)	Depth to Water (m)	Notes
01	0.20	8.30	Most water was removed from well using stainless steel bailer (to 8.50 m). Well showed slow tendency to recover (depth rose to 8.44 m in four hours). No sample collected.
02	0.82	3.38	Six well volumes removed for development. Very rapid recovery. Samples collected. Field conductivity = 600 umhos.
03	0.87	8.55	Ten well volumes removed for development. Very slow recovery. Samples collected. Field conductivity = 600 umhos.
04	0.80	2.24	Seven well volumes removed for development. Recovery slower than pumping. Samples collected. Field conductivity = 220 umhos. Very strong H ₂ S odour in water.

Drill holes and test pits installed as part of the 1994 geotechnical program for a tailings dam at Site #4 (see Section 1.9) did not encounter groundwater since the ground was frozen.

2.3.5 Hydrogeology

The open pit and the tailings dam are the only areas of significant impact for this project. Both are in permafrost conditions. The tailings dam is dealt with other sections. The open pit is in permafrost as well, with the frozen layer to at least below the old Brown-McDade underground workings. This opening is in a totally frozen state.

2.4 Physiography and Surficial Geology

2.4.1 Physiography

The Mount Nansen site is located on the Yukon Plateau, within the glaciated southeastern tip of the Klondike Plateau. The limits of several advances of the

Pods) can be expected in fine-grained sediments with a thick organic cover. Disruption of the organic cover will reduce the insulation that preserves the frozen soil and will initiate or enhance soil creep, solifluction and slope failure. In fine-grained sediments containing large ice lenses, such disruption may trigger thermokarst collapse activity as well as very poor drainage conditions for several years.

Surficial soils in the Dome Creek valley area consist mainly of colluvial, residual and granular glacial outwash soils overlying bedrock. The soil cover is thin on the steeper valley sides, increasing in the valley bottom to about 20 m deep. Upper slopes are covered in a thin veneer of colluvial soils. The Mount Nansen minesite is situated within the Nansen drift. At least 2,000 years ago, volcanic ash fell on this area up to 30 cm in depth. Remnants of this ash are visible at many locations on the property. The ash occurs at surface or just below the organic soils, and typically has a depth of less than 10 cm. Some glacial till has been noted at depth in the main valley bottom.

The soils vary from a sandy gravel to a fine sandy silt. The material is generally medium dense with some pockets of loose material.

2.4.3 Terrain Mapping

A terrain map for the Mount Nansen Site, including soils, vegetation, landforms and drainage, is currently in preparation (EBA Yukon, Personal Communication, 1994).

2.4.4 Terrain Assessment

Most of Mount Nansen is considered to contain permafrost below a thick (up to 1.5m) active layer. However the residual nature of the overburden (weathered bedrock) and the well-drained conditions infers that ground ice contents will be negligible on the mountain tops and valley sides. The accumulation of fine-grained sediments in valley bottoms, covered with organics, suggests that the potential for excess ground ice is high. Ground temperatures will also likely be warmer than 1.0 C, therefore any minor changes to surface heat flux (traffic, excavation, etc.) will initiate permafrost thaw (EBA et al., 1994).

The replacement of primary minerals in the country rock by a variety of clays enhances the unstable nature of upper slopes and Quaternary deposits in the Mount Nansen Area. The supergene and hypogene alterations make the country rock friable, unstable, and generally more susceptible to weathering and erosion.

However the mill site and tailings pond area are not subject to terrain hazards from unstable slopes. An assessment of the terrain in the areas of the camp, mill, and Brown-McDade open pits was conducted by EBA Engineering Consultants in 1993 (EBA et al, 1994).

Cordilleran ice sheet are evident in the form of successive southeasterly retreating glacial deposits and ice marginal features. North of the area the Yukon Plateau is unglaciated, and consists of deep, narrow valleys separated by long, smooth ridges of uniform elevation. Ridges are mainly continuous or connected by high saddles. The plateau exhibits a relief of 600m or more, with a markedly even skyline interrupted only occasionally by prominent peaks or mountain ranges. Several modifications in drainage have been noted in the area, and are indicated by the presence of certain geomorphic features. Many valleys contain disproportionately small streams, and several broad valleys in the area contain no streams at all. Open-system pingos, which often form in small valleys with relatively narrow valley floors, are abundant within the unglaciated and ancient glaciated parts of the Yukon Plateau, and are rare within the limits of recent glaciations. The drainage of the area is generally trellis-type, with two directions, northwest and northeast being predominant.

2.4.2 Surficial Geology (EBA et al., 1994)

The Mount Nansen area is located within the area covered by Pre-Reid glaciation and it is believed that the only areas which escaped the Pre-Reid glaciation ice were the high peaks of Mount Nansen and Victoria Mountain. Four glacial advances have been defined across the central Yukon Territory. These are, from oldest to youngest, the Nansen, Klaza, Reid and McConnell advances. However, the area was not glaciated during the most recent (Pleistocene) ice age. It is possible that Pre-Reid morainal blankets are present at high elevations in the area. Morainic deposits most often consist of diamicton which is a mixture of clay, silt, sand and gravel to boulder size clasts. No attempt has been made to differentiate between slope generated diamicton deposits or glacially derived diamicton deposits such as till. On the surface geology map provided, colluvial blankets or veneers (map units Cv, Cb, and C) can be interpreted as including till of pre-Reid age and residual bedrock.

Although the Reid and McConnell glaciers did not cover the Mount Nansen area, it was subject to the same climatic conditions as the glaciated portions of the Yukon Territory. The limit of the Reid glacial advance is located a few kilometres east from Victoria Creek and proglacial deposits related to advancing and retreating glacial advance are found at lower elevations in the major valley floors. The Mount Nansen area was also subject to changes in stream base level during glaciation where rising base levels caused considerable aggradation, downcutting and dissection of pre-existing alluvial landforms such as fans and terraces. These base level cycles may have occurred several times during either or both of the Reid and McConnell glaciations, impacting both valley bottom alluvial deposits and higher level colluvial slope deposits.

Colluvial or slope processes are quite active in the area and permafrost is widespread in both valley bottoms, on north facing slopes and at higher elevations in sub-alpine to alpine areas. At lower elevations, permafrost with high ice content (large ice lenses or

According to the EBA report, the undisturbed areas around the camp site contained natural vegetation, completely covered by shrubs (willows, Labrador Tea), mosses and lichens, and by spruces. There was no evidence of instability or erosion in the area of the camp. Permafrost was presumed to be present. The overburden consists of a thin and discontinuous veneer of colluvium (gravel, sand, silt and clay) overlying parent bedrock. In the distributed areas of the camp, it was noted that the buildings rest on a pad of granular fill up to 4 m thick. No visible signs of damage to the buildings due to ground instability or erosion by surface water was noted.

The mill was constructed on a thick gravel pad. Several steep slopes in the hillside behind the mill are cut in bedrock and appear stable. No geological processes or soil development in any areas of the site were noted.

Based on the above assessment, there are no terrain hazards to any of the proposed structures or sites at the project site.

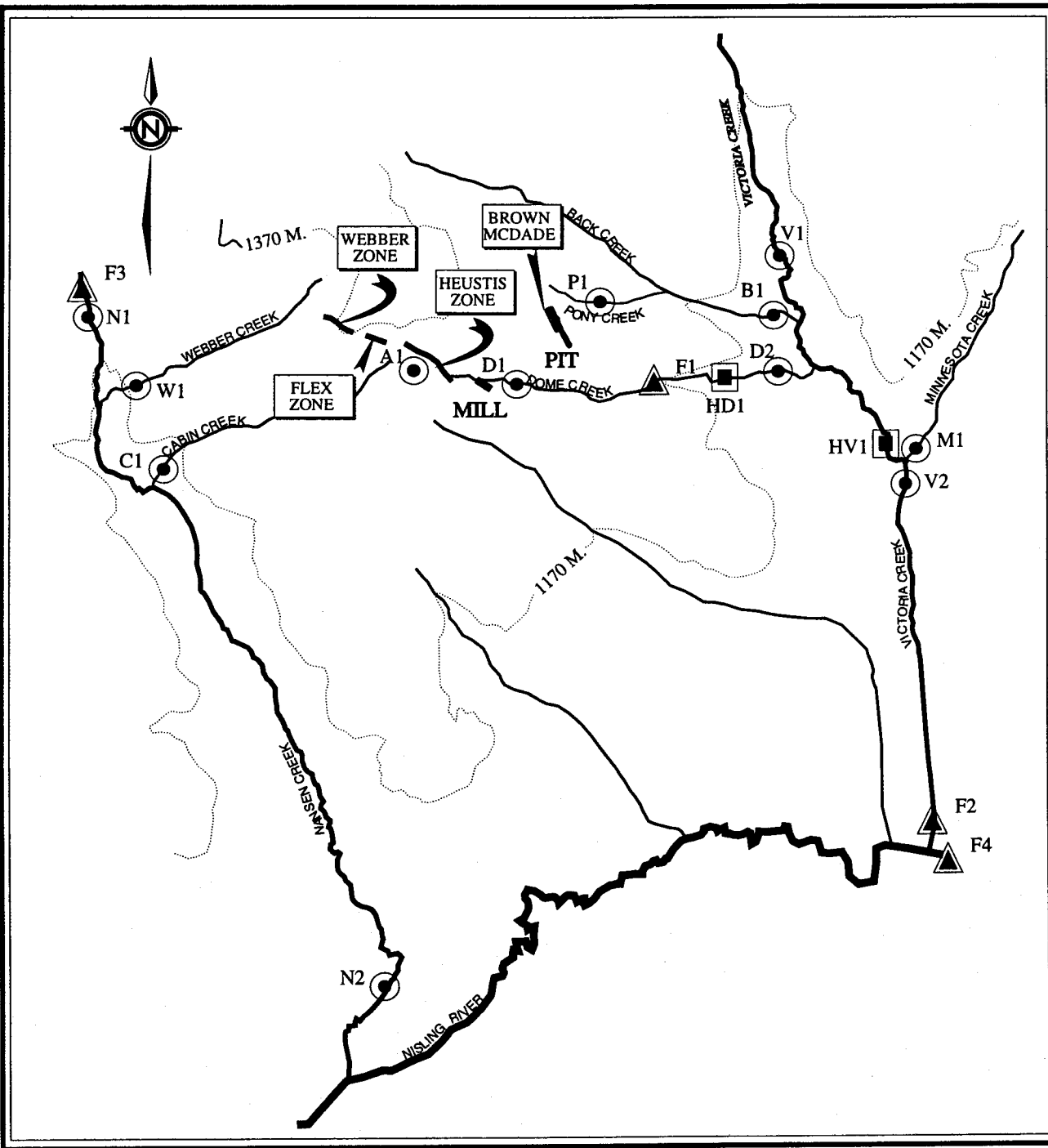
2.5 Water Quality

2.5.1 Overview of Water Quality Programs

The majority of the water quality sampling programs were conducted by Norecol. Norecol collected samples in the Mount Nansen Project area on October 11, 1985, March 4, June 9 and September 4, 1986; July 4 and August 28, 1987; and on May 27, 1988. Water quality sites used by Norecol are shown in Figure 2-2, and are described as follows:

- A1 - Lower Huestis Adit.
- N1 - Nansen Creek, 1.0 km upstream of Webber Creek.
- N2 - Nansen Creek, 1.2 km from mouth.
- W1 - Webber Creek, 0.6 km from mouth (drains Webber Zone).
- C1 - Cabin Creek, 0.3 km from mouth (drains Huestis Zone).
- V1 - Victoria Creek, 0.8 km upstream of Back Creek.
- V2 - Victoria Creek, approximately 5 km from mouth.
- M1 - Minnesota Creek, 0.1 km from mouth.
- B1 - Back Creek, 0.2 km from mouth.
- P1 - Pony Creek, Back Creek tributary, 0.6 km from mouth (drains Brown-McDade Zone).
- D1 - Dome Creek, 3.5 km from mouth (drains Huestis Zone and old mill and tailings area).
- D2 - Dome Creek, 0.4 km from mouth.

Analytical parameters and laboratory detection limits used by Norecol are provided in Table 2-5. On March 4, 1986 water was collected only from Webber Creek (W1) due to ice conditions and lack of water at the other sites; most sites were covered with 1 to 2 m of ice which was continuous to the creek bottom. Webber Creek was sampled where groundwater recharge had softened the ice.



LEGEND

- M1 Water Quality
- HV1 Hydrology
- F1 Fish Sampling Site



MOUNT NANSEN PROJECT AQUATIC SAMPLING SITES

FIGURE:	2.2	BY:	PJS
DATE:	Oct. 1994	BY:	



Table 2-5: Water Quality Parameters For The Mount Nansen Project. Norecol, 1985 to 1989

Characteristics	Detection Limits
Temperature	field
pH	0.1
Total Solids	1 mg/L
Suspended Solids	1 mg/L
Turbidity	0.1 NTU
Specific conductivity	1 umhos/cm
EDTA Hardness	1 mg/L
Total Alkalinity	1 mg/L
Sulphate	1 mg/L
Nitrate	5 ug/L as N
Nitrite	2 ug/L as N
Ammonia	5 ug/L as N
Total Phosphorus	3 ug/L as P
Total Cyanide	1 ug/L
Total Mercury	0.05 ug/L
Total and dissolved metals:	
Aluminum*	10 ug/L
Arsenic	1 ug/L
Barium	5 ug/L
Cadmium	0.2 ug/L
Copper	0.5 ug/L
Iron	5 ug/L
Lead	1 ug/L
Silver	0.2 ug/L
Zinc	0.5 ug/L

*May 1988 samples only

The analytical results from the Norecol water quality programs are included in Appendix VI.

Additional water quality work was done by EPS in July and August of 1988. This work consisted of samples collected in triplicate from 12 additional sampling sites. Water temperature, conductivity, pH, and flow measurements were made in situ, at the time of sample collection. The sampling sites used by EPS are shown in Figure 2-3, and described as follows:

- S1 - At head of Dome Creek
- S2 - On Dome Creek, 100 m upstream of confluence
- S3 - On Dome Creek, 25 m upstream of road crossing
- S4 - On Dome Creek, 300 m upstream of roadway culvert
- S5 - On Back Creek, 500m upstream of Pony Creek
- S6 - On Pony Creek, 60 m upstream of confluence with Back Creek
- S7 - On Back Creek, 200 m upstream of confluence
- S8 - On Victoria Creek, upstream of Back Creek confluence
- S9 - On Victoria Creek, 250 m upstream of confluence with Dome Creek
- S10 - On Victoria Creek, 400 m downstream of Dome Creek
- S11 - On Minnesota Creek
- S12 - On Victoria Creek, 300 m downstream of Minnesota Creek

Analytical results from the EPS water quality program are provided in Appendix VI.

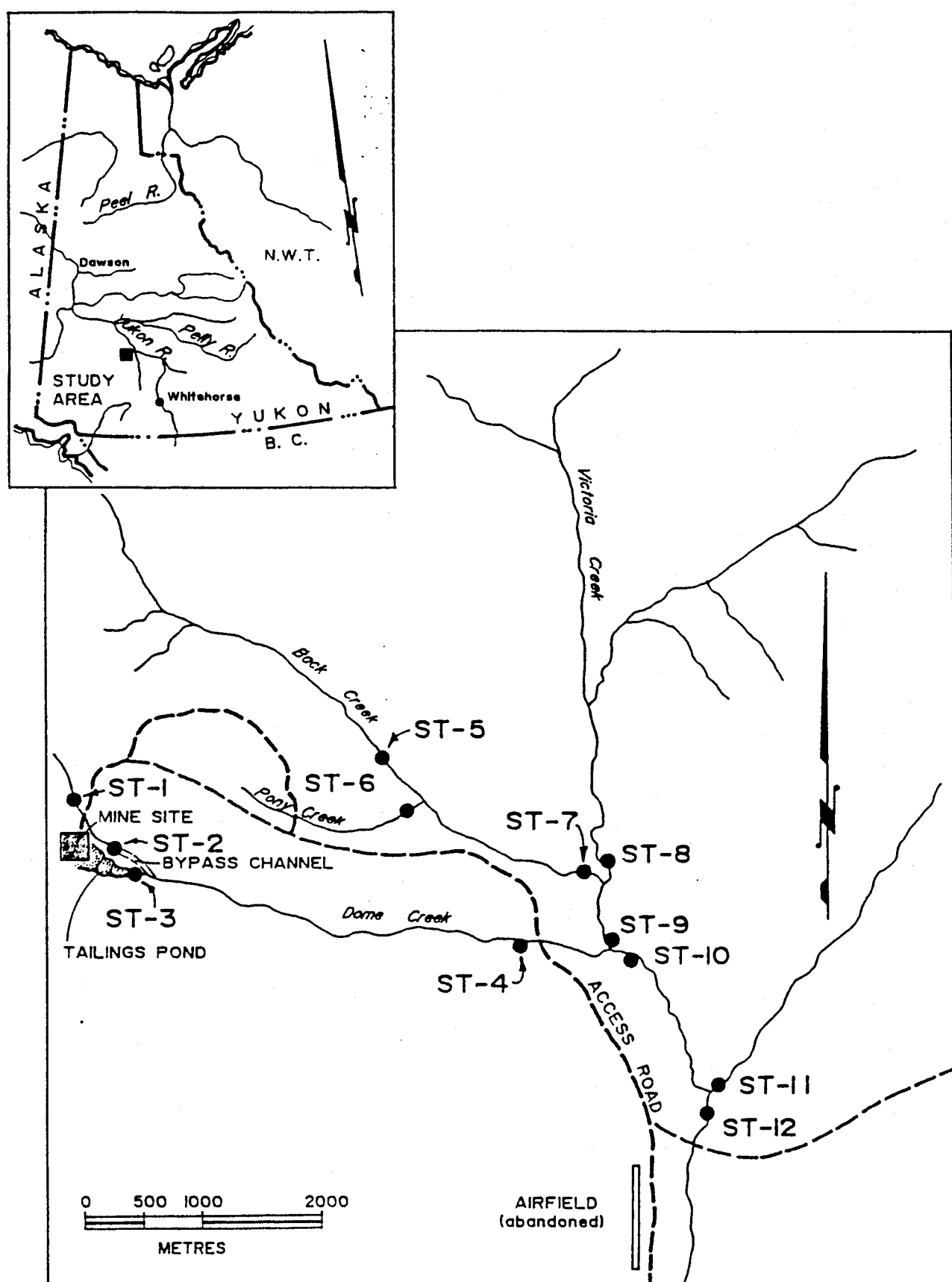
2.5.2 Recent Water Quality Results

A series water quality samples were collected by D. Melling on September 12, 1994 at 7 reference sites utilized previously by Norecol and others. These samples were collected to verify previous results. Lower detection limits were utilized for some of the metals such as Ag, As, Cu and Zn than may have been available when the Norecol program was conducted. The analytical results for the September 12, 1994 samples, based on analyses by ASL Laboratories, are summarized in Table 2-6.

Table 2-6: Water Quality Data Collected on September 12, 1994

		Site A1	Site B1	Site D1	Site D2	Site P1	Site HV1	Site V2	Detection Limit
Physical Tests									
Conductivity	umhos/cm	1100	365	880	470	589	226	204	1
Hardness	CaCO ₃	556	166	457	226	289	107	96.5	0.1
pH		7.18	7.87	7.86	7.27	7.69	7.88	7.76	0.02
Total Suspended Solids		1	19	4	<1	3	27	19	1
Turbidity	NTU	1.36	26.8	4.49	2.15	6.52	62.6	48	0.1
Dissolved Anions									
Alkalinity - Total CaCO ₃		245	113	177	86.5	171	86.9	81.3	0.5
Sulphate (SO ₄)		402	73.1	326	150	135	25.9	23.3	0.1
Nutrients									
Ammonia Nitrogen	N	0.028	0.033	0.037	0.018	0.069	0.038	0.033	0.005
Nitrate Nitrogen	N	0.169	0.128	0.15	0.062	0.068	0.063	0.055	0.005
Nitrite Nitrogen	N	0.003	0.006	0.006	0.003	0.003	0.02	0.016	0.001
Total Phosphorus	P	0.021	0.07	0.051	0.019	0.033	0.055	0.051	0.001
Total Metals									
Aluminum	T-Al	0.009	0.258	0.022	0.016	0.026	0.72	0.56	0.005
Arsenic	T-As	0.088	0.01	0.0068	0.0107	0.0312	0.0035	0.0031	0.0001
Barium	T-Ba	0.011	0.075	0.046	0.03	0.063	0.085	0.078	0.01
Cadmium	T-Cd	0.0048	<0.0002	0.0002	<0.0002	0.0011	<0.0002	<0.0002	0.0002
Copper	T-Cu	0.004	0.005	0.003	0.001	0.005	<0.001	0.004	0.001
Iron	T-Fe	0.202	1.71	0.855	0.654	1.56	0.835	0.955	0.005
Lead	T-Pb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Mercury	T-Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005
Silver	T-Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Zinc	T-Zn	0.836	0.007	0.067	0.006	0.083	0.015	0.012	0.001
Dissolved Metals									
Aluminum	D-Al	<0.005	0.01	0.012	0.015	0.012	0.035	0.046	0.005
Arsenic	D-As	0.037	0.003	0.0014	0.0058	0.0147	0.0011	0.0011	0.0001
Barium	D-Ba	0.011	0.066	0.046	0.03	0.061	0.063	0.063	0.01
Cadmium	D-Cd	0.0046	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0002	0.0002
Calcium	D-Ca	145	47.2	120	56.2	83.4	27.7	25	0.05
Copper	D-Cu	0.004	0.002	0.001	<0.001	0.004	<0.001	0.003	0.001
Iron	D-Fe	<0.030	0.067	<0.030	0.269	<0.030	0.072	0.172	0.005
Lead	D-Pb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Magnesium	D-Mg	47	11.7	38.3	20.8	19.7	9.23	8.3	0.01
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005
Silver	D-Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Zinc	D-Zn	0.835	0.001	0.04	0.003	0.051	0.005	<0.001	0.001

Figure 2-3: Environment Canada Sampling Stations (EPS, 1989)



2.5.3 Discussion of Water Quality Data

2.5.3.1 Discussion of Norecol Water Quality Data

The following discussion has been extracted in part from Norecol (1989a).

The water quality data presented in Appendix VI, that was collected by Norecol, indicated that the surface water in the Mount Nansen Project area was generally soft to moderately soft and moderately alkaline. Water from the lower Huestis adit (A1) was hard, very alkaline, highly conductive, and high in total solids. Since Dome Creek receives water from the lower Huestis adit it exhibited similar hard, alkaline conditions. The upstream site on Dome Creek (D1), which also receives decant from a tailings impoundment, sometimes had higher conductivity, hardness and total solids than Site A1.

Elevated levels of suspended solids occurred in certain streams in the area, particularly during periods of peak runoff. Concentrations of suspended solids in excess of 100 mg/L were found during high flows in Nansen Creek (N1) in June 1986 and in Dome (D1), Nansen (N1), and Victoria (V2) creeks in July 1987. Levels greater than 300 mg/L were found in Victoria (V2) and Webber (W1) creeks in September 1986. The highest levels of suspended solids were found in Back Creek (B1), where Norecol recorded 1418 mg/L in June 1986 and 965 mg/L in September 1986. The source of these sediment loads was an operating placer mine upstream on Back Creek. The high sediment levels in Nansen and Victoria creeks may also reflect the historical placer activity on these streams.

Levels of nutrients are highly variable in study area streams. In most samples, nitrate concentrations were less than 0.06 mg N/L, and ammonia levels were below 0.02 mg N/L. However, levels of both substances in excess of 0.1 mg N/L were sometimes found in upper Dome Creek (D1), Back Creek (B1), Pony Creek (P1) and the lower Huestis adit (A1). Nitrate concentrations exceeded 0.3 mg N/L in the adit on two occasions. A maximum ammonia concentration of 0.342 mg N/L was measured in upper Dome Creek. Nitrate concentrations generally were below the detection limit (0.002 mg N/L).

Total phosphorus concentrations varied from undetectable to a few mg/L as P. The highest total phosphorus concentrations (0.113 to 2.18 mg P/L) were measured in Back Creek (B1), the maximum level being recorded on June 1986. The elevated phosphorus levels in Back Creek are probably associated with sediments from placer mining. The effect of the phosphorus loading to Victoria Creek from the Back Creek drainage was evident during the summer of 1986 at the lower Victoria Creek sampling location. Phosphorus concentrations above 0.3 mg P/L were recorded occasionally in Dome Creek (D1), Minnesota Creek (M1), Nansen Creek (N1, N2) and Webber Creek (W1), and usually were associated with increased levels of suspended solids.

A summary of the water quality parameters that exceeded the CCREM objectives for aquatic life based on the Norecol water quality data is provided in Table 2-7.

2.5.3.2 Discussion of EPS Water Quality Data

The following discussion has been extracted from EPS (1989).

Discharges measured in July at all sites ranged from 0.002 m³/sec (S2 and S3), to 1.7 m³/sec (S9). In August, discharges were measured only at sites S4, S5, and S7 through S12. The range in August was from 0.01 m³/sec (S5) to 0.66 m³/sec (S12). Stream flow from July to August was reduced by a factor of 3, therefore winter flows above the stream substrate are likely negligible (EPS, 1989). This corresponds with data collected by Norecol in March, 1986.

The pH ranged from 6.2 (S1) to 9.4 (S3, tailings pond discharge) for all samples taken during July and August. The extreme values recorded in August are outside the range recommended for aquatic life. July measurements showed a slightly moderated pH and were within the recommended range. The potential for high ionic concentrations under low flow conditions (from October to May) is evident here, and would extend to other water quality parameters.

Muddy water at sites S5, S7, and S8 observed during both sampling periods was attributed to upstream placer mining activity. Samples were characterized by high suspended solids, colour, turbidity, total hardness, phosphorous and nitrogen levels. Physiological stress has been observed in underyearling Arctic Grayling at suspended solid levels of 50 mg/l and levels of 100 mg/l resulted in reduced growth rates and feeding success (McLeay et al., 1983, 1984). This is significant as the sediment load can be traced downstream through sites S9, S10, and S12 on Victoria Creek where suspended solids ranged from 56 mg/l at S12 to 540 mg/l at S10, where fish habitat has been identified (EPS, 1979).

The sediment loading in Back Creek and Upper Victoria Creek has also resulted in elevated total metals during both July and August. At S5 and S7 on Back Creek, silver, aluminum, arsenic, cadmium, chromium, copper, iron, manganese, lead, selenium, and zinc were elevated. Samples at S6 on Pony Creek were relatively devoid of high concentrations except for slightly elevated levels of copper, iron, and zinc. Norecol (1989a) also indicated high levels of these metals at Pony Creek, as well as silver, arsenic and cadmium. Again, results of placer mining activity can be traced downstream at sites S9, S10, and S12. The persistence of these metals at the lower sample sites on Victoria Creek, coupled with the reduced suspended solids, is an indication that these metals are dissolved and therefore bio-available. Norecol's (1989a) analyses for dissolved metals confirms this assumption.

Table 2-7: Summary of Water Quality Parameters ^{(a)(b)} Exceeding CCREM Objectives (Norecol, 1989a)

SITE	Total Ag (mg/L)	Total As (mg/L)	Total Cd (mg/L)	Total Cu (mg/L)	Total Fe (mg/L)	Total Pb (mg/L)	Total Zn (mg/L)
A1	0.0002(2)	0.050 - 0.094(3)	0.0049 - 0.007(4)	0.0053 - 0.0064(2)	0.62 - 2.89(5)		0.01 - 1.36(5)
B1	0.0004 - 0.0028(2)	0.056 - 0.42(3)	0.0004 - 0.00046(5)	0.0063 - 0.080(6)	1.80 - 45.5(6)	0.0035 - 0.08(5)	0.07 - 0.27
C1				0.0022 - 0.0023(2)	0.37 - 0.80(4)		
D1	0.0003(1)	0.061 - 0.072(2)	0.0021 - 0.0050	0.0042 - 0.030(2)	0.96 - 11.8(6)		0.19 - 2.47(5)
D2					0.34 - 1.37(4)		
M1				0.0025 - 0.0034(5)	0.54 - 1.33(5)		
N1			0.0003 - 0.0010(4)	0.0083 - 0.020(5)	0.64 - 3.02(5)	0.005(1)	
N2	0.0003(1)		0.0003 - 0.0008(3)	0.0058 - 0.040(5)	0.54 - 10.5(5)	0.004 - 0.009(2)	0.06(1)
P1	0.0002 - 0.0003(2)	0.095(1)	0.0004 - 0.020(6)	0.0027 - 0.34(6)	0.81 - 3.52(8)		0.14 - 1.44(5)
V1			0.0003(1)	0.0025 - 0.016(3)	0.33 - 2.99(5)	0.003(1)	
V2			0.0003 - 0.0010(3)	0.0228 - 0.018(5)	0.77 - 4.74(6)	0.003(1)	
W1	0.0005(1)		0.0006(1)	0.0021 - 0.010(2)	1.18 - 6.16(4)		

^(a) Recommended levels for protection of aquatic life (Canadian Council of Resources and Environment Ministers 1987)

Silver 0.0001 mg/L
 Total Arsenic 0.05 mg/L
 Total Cadmium 0.0002 mg/L at hardness <60 mg CaCO₃/L to 0.0018 mg/L at hardness >180 mg CaCO₃/L
 Total Copper 0.002 mg/1L at hardness <60 mg CaCO₃/L to 0.004 mg/L at hardness >180 mg CaCO₃/L
 Total Iron 0.3 mg/L
 Total Lead 0.001 mg/L at hardness <60 mg CaCO₃/L to 0.007 mg/L at hardness >180 mg CaCO₃/L
 Total Zinc 0.03 mg/L

^(b) Values in parentheses represent number of samples exceeding guidelines

Sample sites S2 and S3 on Dome Creek had the highest conductivity and suspended solids values of all the samples. S2 is situated at the end of the by-pass channel, and S3 is the tailings pond effluent station. Given the low levels of conductivity and suspended solids higher up on Dome Creek (S1), it is assumed that there is seepage from the adjacent ponds, along the by-pass channel.

Metals elevated at sites S2 and S3 include silver, iron, lead, and zinc. Silver and lead were higher in the effluent stream and zinc was higher in the by-pass channel. Site S1 was generally devoid of elevated metals, although copper, lead, and zinc levels were borderline with respect to the guideline levels recommended for aquatic life.

2.5.3.3 Discussion of Recent Water Quality Data

The results from the recent water quality program are similar to the data collected by Norecol and EPS based on the time of year the samples were collected. It was noted that stream flows were low as would be expected. Suspended sediment levels were low with some potential impact of placer activity evident in the Back Creek and Victoria Creek samples. The samples from Site A1 and D1 contained a moderate amount of hardness. There was some metal (mainly iron) in particulate form in the samples from B1, D1 and P1. It was also noted that the drainage from the Huestis adit contained a measurable amount of dissolved zinc (0.835 mg/L).

2.6 Stream Sediments

Stream sediment samples were collected by Norecol at the water quality sites identified in section 2.6.1 on September 4, 1986. The analytical results of these samples are shown in Table 2-8.

The Pony Creek (P1) sediment samples contained the highest levels of metals relative to the other sites. With the exception of iron, mercury and silver, the Pony Creek sediment metals concentrations were all at least 10 times greater than those at the other sites; lead and arsenic reached levels of over 100 times those of the other sites. The high metal levels at Site P1 are attributed to material eroding from the old ore dumps at the Brown-McDade adit.

Sediment metal concentrations are higher in the Victoria Creek drainage than in the Nansen Creek drainage. The area of highest metal enrichment is likely from the Brown-McDade Zone and the Back Creek placer mining area.

Stream sediment samples were also collected during August, 1988 by EPS. Particle size analysis was also done. Dome Creek was found to have a large portion of fine sediments, up to coarse and very coarse sand on the lower reach (S4). The by-pass channel was characterized by a large proportion of gravel. Sample sites on Back Creek, Pony Creek, and Victoria Creek had a large proportion of gravel with the exception of S12, which showed the largest substrate component as very fine clay/silt and fine sands.

Elemental composition of sediments are given in ug/g, dry weight. Generally, levels were comparable with background ranges found in other stream sediments in the Yukon (Mathers et al., 1981). Sites S2 and S3 on Dome Creek were the only sites exhibiting high sediment metal concentrations, namely: arsenic, cadmium, copper, manganese, lead, and zinc. Traces of these higher levels are evident at S4. values within the triplicate sample sets tended to be uniform.

In comparison with sediment values recorded in 1985 (Godin and Osler), arsenic sediment concentrations in Dome Creek have increased by 10 to 40 times. Norecol (1989a) cites sediment composition on Pony Creek as having the highest levels of metals relative to all other sites they sampled. The Pony Creek site used by EPS showed only slightly higher levels of zinc in the sediments. The location of these two sites is estimated to be in the same area on Pony Creek, in that both are below the Brown-McDade mine site. The contrast in levels may indicate the variability of sediment deposition to the streambed. High metal concentrations in Pony Creek sediments result from rill erosion of the waste rock pile at the Brown-McDade mine site (Duffy and Mahoney, 1982).

Table 2-8: Total Metal Concentrations In Sediment Samples (Norecol, 1989a)

Sample*	Total Metals: (ug/g Dry Weight)							
	Cu	Zn	Pb	Cd	As	Fe	Ag	Hg
B1	11.5	59.4	14.9	<1.25	22.1	19223	<1.25	<0.05
C1	5.46	39.0	<2.5	<1.24	10.7	33009	<1.24	<0.05
D1	5.46	43.4	3.47	<1.24	12.2	9927	<1.24	<0.05
D2	5.93	47.4	8.90	<1.23	25.2	12112	<1.23	<0.05
N1	26.0	51.5	18.1	<1.22	21.1	14216	<1.22	<0.05
N2	14.9	41.6	9.13	<1.20	13.0	10333	<1.20	<0.05
P1	456	702	1268	11.8	2093	49994	8.13	0.122
V1	13.6	42.2	6.33	<1.17	9.60	13138	<1.17	<0.05
V2	21.1	91.9	21.8	<1.22	50.4	18384	<1.22	<0.05
W1	5.59	28.7	3.89	<1.21	14.2	17015	<1.21	<0.05

*Sites shown on Figure 2-2.

2.7 Fisheries

The Nisling River appears to have moderate fisheries capability, but little is known of the fisheries resources in the vicinity of the Mount Nansen area. Radio tagging studies have been conducted by Fisheries and Oceans which have tracked chum and chinook salmon approximately 30 km and 80 km, respectively, up the Nisling River from its confluence with the Donjek River (Etherton, pers. comm.). It is unlikely that chum salmon would migrate upstream as far as the project area, but chinook salmon could reach the general area providing that there are no fish barriers.

Fisheries information for the mine development area is extremely limited. Arctic grayling (*Thymallus arcticus*) and sculpins (*Cottas* spp.) have been captured in Victoria Creek (EPS, 1979). These may be the only species occurring in Nansen and Victoria creeks, but both streams have moderate fish habitat capability and may be capable of supporting other fish species.

Nansen and Victoria creeks have no sport fishing potential, but the Nisling River may offer angling opportunities.

2.7.1 Fish Sampling Results

Fish sampling was conducted by Norecol on August 21 and 22, 1989. The objectives of the sampling were to evaluate the fisheries resources in Nansen and Victoria creeks and the Nisling River.

Sampling on Dome Creek was conducted by electroshock downstream of the camp access road at Site F1. No fish were captured in moderate to good fish habitat suggesting that Dome Creek does not contain fish.

Victoria Creek has moderate to good fish habitat capabilities, but may be limited to some extent by placer activity. The channel is about 6 m wide, with a wetted width of 5 m. Pool-riffle-glide sequences are well established; the gradient is about 1%; pools are numerous to 1 m deep; the substrate is mostly gravel but is highly sedimented from placer activity (reduction of spawning potential). Willows provide about 5% cover to the stream; bars up to 5 m wide are numerous. Cut banks, overhangs, and pools provide most of the fish cover.

Victoria Creek was sampled at site F2 (about 100m upstream of main road ford) several times. Once using a 2" stretch mesh gill net and two minnow traps baited with roe, and twice using electroshock sampling. Fish densities appear moderate, which is surprising given the high sediment load.

Nansen Creek was sampled about 1 km upstream of Webber Creek (Site F3). The stream in this area is only slightly turbid and appears to support spawning and rearing of Arctic Grayling. The fish habitat characteristics are similar to Victoria Creek, except that more side channeling and gravels make it more suitable for spawning.

The Nisling River was not sampled due to lack of access.

Both Victoria and Nansen creeks contain moderate densities of Arctic Grayling and both have moderate to good habitat potential, although the overall potential of Victoria creek may be diminished by high sediment loads from placer mining (Norecol, 1989b). Seasonal use by other species still remains to be studied.

2.8 Benthic Studies

A taxonomic list of benthic organisms found in the study area is shown in Appendix VII, Table 1. Sample site enumeration is in Appendix VII, Table 2. Taxonomic orders have been grouped and presented as a percentage of total organisms counted at each sample location (Appendix VII, Table 3). A total of fifty four taxa were identified.

Sites S1, S3, and S6 were not sampled for benthic invertebrates due to a lack of site suitability. Site populations ranged from 13 at S5 on Back Creek, where only one sample basket was recovered, to 797 at S8 on Victoria Creek. One and two baskets respectively were recovered at sites S7 and S9. All three baskets were recovered at all other sites.

The dominant order found overall was Plecoptera. Podmosta sp. comprised over 85% of this order at each site. Ephemeropter, the second most abundant order, was absent

in Back Creek, Pony Creek, and Dome Creek, but represented approximately 20% of the sample at stations on Victoria and Minnesota Creeks. At site S10, just below Dome Creek, Ephemeroptera was dominant, composing 43% of the sample.

Diversity and evenness indices were low in Dome Creek, as was found in previous EPS studies done in 1976 and 1977 (EPS, 1979). Two other stations above and below Dome Creek sampled in those studies conformed with results at comparable sites (S9 and S10) in this study. A summary of results from the benthic fauna samples is shown in Table 2-9.

Table 2-9: Summary of Benthic Fauna Samples (EPS, 1989)

Station Numbers	Baskets Recovered	Number of Individuals	Individuals per Basket ⁽¹⁾	Diversity Index (H')	Evenness (J')
2	3	531	177	0.21	0.19
4	3	110	37	0.06	0.13
5	1	13	13	0.39	0.82
7	1	16	16	0.82	0.91
8	3	797	257	0.54	0.41
9	2	110	55	0.73	0.66
10	3	263	88	0.70	0.60
11	3	186	62	0.73	0.62
12	3	433	144	0.56	0.46

⁽¹⁾ Basket Volume = 0.0057 m³

2.9 Wildlife

The property generally has low to moderate capability for wildlife. It is identified as key habitat only for the Klaza herd of Woodland Caribou. Key habitats for moose, and Wood Bison are located a considerable distance (10-15 km) south of the mine site, beginning at the Nisling River valley (Yukon Fish and Wildlife, 1994).

The area has not been subject to extensive wildlife surveys. However studies on adjacent areas indicate that moose occur throughout the area in low numbers in summer and fall, favouring the valley bottoms and riparian edges of streams. The area generally has one of the lowest moose densities in the Yukon (Yukon Fish and Wildlife, 1987, 1991). During the winter period, some moose may utilize the lower elevations, in particular the floodplain and lower slopes along Victoria Creek, for at least part of the winter.

A Norecol wildlife survey conducted in March of 1986 along the major creeks on the Nansen property recorded 3 moose, and the presence of occasional moose tracks along the Victoria Creek flood plain. One moose was observed near the confluence of Back and Victoria Creeks and a cow moose and yearling were seen further downstream in the wide Victoria Creek valley south of the airstrip. Scattered moose

tracks were also observed along the floodplain of Victoria Creek. The low snow depth and availability of browse, primarily willows, offer limited winter range for low densities of moose. The only other ungulates that are likely to be found on the property in winter are caribou which may occasionally move through the area.

The property falls within range of the Woodland Caribou, Klaza herd. However the Mount Nansen area represents the southeastern most portion of their range and is less used than the core area, further to the northwest.

As part of the Canadian Wood Bison Recovery Program, a herd of Wood Bison has been established by the Yukon Game Branch in the Nisling River area, approximately 10 to 15 km downstream (southwest) of the Mount Nansen property. The herd, originally maintained in pens, was released into the wild in 1988. Since then, more animals have been brought to the area and released. The herd is now becoming well established in the Nisling River Valley and the Aishihik Lake area (Yukon Fish and Wildlife, 1994). This herd is sufficiently removed from the Mount Nansen project area that it would not be affected by project development.

Other large mammals which may occur in low numbers include black bear and wolf. The area appears to have generally low productivity for furbearers. Very little sign of furbearers was observed during field visits, including helicopter flights and reconnaissance during March, 1986.

The small scope of the present project is not expected to affect local wildlife populations and will not result in any significant reduction of available habitat. the small populations of moose and caribou which range through the area and are not dependent upon any of the sites to be developed. There is an abundance of similar habitats on the property and in adjoining areas. Effects on riparian habitat, notably the valley bottom along Victoria Creek, will be minimal (Norecol, 1989a).

2.10 Other Land Uses

Most of Dome Creek, from an area just south and east of the mill, is currently staked for placer mining. The creek has no recorded history of placer mining having been carried out. The creek has insufficient water to operate on an economic scale.

The proposed tailings dam for the project, overlies several of the placer claims. During the course of field investigations for the tailings dam, three geotechnical testholes were drilled through to the valley bottom. This material was sent for assay with gold results barely at detection limits.

The proposed development at the Brown-McDade Zone should not have any effects on land use or status. The property is presently owned by BYG through mineral claims and surface leases. Mineral exploration and mining has been a long standing land use

of the area. There are no significant recreation features or users in the area. Angling potential at Victoria Creek is limited and would not be affected by development. The property is a considerable distance by road from Carmacks (60 km) and does not have a high enough number of resident moose or caribou to attract significant levels of sport hunting.

2.11 Socio-Economic Conditions

2.11.1 Background

2.11.2 Village of Carmacks - General Description

The village is located 60 kilometres east of the mine-site via a public gravel road maintained by the Yukon Government during the spring to fall months.

Carmacks is located 180 kilometres north of Whitehorse on paved Highway 2. The village proper sits on the banks of the Yukon River with most of the service and commercial buildings on the south bank, and the First Nations residential area and band offices on the north bank. The village has been established in one form or another since 1893, when a commercial coal deposit was found and brought to production. In the intervening years, Carmacks has provided fuel for river steamboats, a roadhouse on the Whitehorse to Dawson stage run, and an area service centre.

The population of Carmacks is generally as follows:less than

18 years old:	157
19 to 35 years old:	149
36 to 49 years old:	104
over 50 years:	79
TOTAL:	489

2.11.3 Local Industry, Services and Employment

2.11.3.1 Private Industry

The primary industry in the community continues to be supplying goods and services to travellers and local members of the community. Services include heavy equipment supply, welding, freight service to Whitehorse, two general stores, two gas stations, one automotive garage, one motel and one hotel (each with a licensed lounge) and one licensed restaurant.

Total employment in private industry is about 35 people.

2.11.3.2 Government Services and Employment

2.11.3.3 Federal Government

- R.C.M.P. detachment (3 members)
- National Health and Welfare, nursing station providing 24 hour service
- Regional office of Department of Indian and Northern Affairs, year round operation
- Newly upgraded airport and cargo shelter

2.11.3.4 Yukon Government

Education is provided by a 10 teacher school with grades provided from Kindergarten to Grade 12. In addition, Carmacks is also home to a campus of Yukon College, providing programs of interest and practical needs to the community at large.

- Community library in the school
- Highway maintenance yard
- Social Services office
- Yukon Government Agent, native language interpreter
- Social Housing office

Total employment from the Federal and Yukon, 45 full time jobs.

2.11.3.5 Village of Carmacks

- Parks, swimming pool, skating rink
- Volunteer fire department
- Volunteer Emergency Measures Organization Search and Rescue Team

Total full time employment by Village of 6.

2.11.3.6 Little Salmon/Carmacks First Nation

The band maintain an administration office and a recently constructed Heritage Hall, used to host meetings and cultural events. The band run most of their own affairs, and have an elected Chief and Council. The band has a population of about 300 resident in Carmacks and area. Total full time employment is 25.

2.11.3.7 Summary of Employment

Approximate full time employment provided by the Village of Carmacks:

Private industry:	35
Federal and Yukon Governments:	45
Village of Carmacks:	6
First Nations Band:	25
TOTAL:	111

2.11.3.8 Unemployment and Social Assistance

The following information was made available by agencies responsible for unemployment and social assistance, and apply to the Village of Carmacks.

Number on Unemployment Insurance, Sept. 94:	31
Number on Unemployment Insurance, Jan. 94:	41
Number receiving social assistance:	85

2.11.3.9 Other Carmacks Comment

There are three churches in the community. The many volunteer organizations within the community provide entertainment and service to the community, such as, television service, curling rink, recycling depot and community hall.

2.11.3.10 Carmacks Area Activities

The other economic activities in the area west of Carmacks out to the Mount Nansen project area are summed up as follows.

Hard rock mining - The area is the scene of a fairly active exploration activity each year. There are several other deposits at a stage of development close to the Mount Nansen project. One of these is in the permitting process, with a Project Overview filed, and preparation for an Initial Environmental Evaluation under preparation. This project is the Western Copper heap leach project.

Placer mining - There are several producing placers in the area, three of which are operating within 5 miles of Mount Nansen.

Trapping - The area is generally covered by traplines. The holder of the trapline covering the Mount Nansen project area is Mr. Terence Hanlon of Carmacks. Harvesting information is not available for individual traplines, however, the Department of Renewable Resources did provide a 10 year harvest for 10 traplines centered on Mount Nansen. They also illustrate the relative harvest between this area and the balance of the Yukon Trapline. The group represents 1.9% of Yukon traplines

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by area, while providing about 0.5% of the harvest over the last 5 years, and less than 1% over the last 10 years. The surrounding traplines have harvested an average of 5.8 animals per trapline per year for 10 years ending in 1993, and 3.6 animals per trapline per year during the last 5 years. (These numbers exclude squirrels, which were heavily trapped in the early part of this 10 year period.)

2.12 Current Use of Site and Local Area

The property is presently owned by BYG through mineral claims and surface leases. Mineral exploration and mining has been a long standing land use of the area. There are no significant recreation features or users in the area. Angling potential at Victoria Creek is limited and would not be affected by development.

2.13 Heritage Resources

The area has been impacted over many years by placer mining, hard rock mining, previous production, hunting and trapping. The current access road generally follows a trail that has been in existence since the turn of the century.

A site visit conducted by a representative of the Yukon Government Heritage Branch in 1994 resulted in the following observations:

"Our inspection of the present road into the Mount Nansen Project area did not result in the discovery of any archaeological sites. Outside the development area, however, one site was found on an old terrace southwest of the ford across Victoria Creek. I point this out to indicate that ridges and terraces in this area, which may be viewed as potential borrow sources for road improvement, are often archaeologically sensitive areas as well?

At this stage, I would appreciate additional information on the scope of the planned road improvements and improvements to the ford crossing of Victoria Creek. Impacts to the terraces on both sides of Victoria Creek should be avoided. If this is not possible, archaeological impact assessment will have to be carried out."

Plans for road improvements call for some grading and road widening for which borrow sources will be required. However, as outlined in Section 1.12.4.2 Upgrade Recommendations, there is likely to be sufficient borrow material available in the immediate vicinity of the road. There is therefore no impact foreseen on any of the areas with potential archaeological value.

3.0 Water Management

3.1 Objectives

The key objectives of the water management system will be as follows:

- Ensure that all water at contaminant concentrations above acceptable water quality criteria will be retained and treated to appropriate limits prior to release to the environment.
- Collect and divert all clean uncontaminated water around distributed areas
- Maintain acceptable flows in streams impacted by mining to minimize environmental impact.

3.2 Description of the Water Management System

Surface water management of the mill site and tailings impoundment will be achieved by a system of drainage collection ditches which will divert clean surface runoff around the sites and into Dome Creek (see Figures 1.3 and 1.4). Runoff from the mill area and ore stockpile will be collected in ditches and flow to a settling pond downstream of the mill. Decant from this will be directed toward Dome Creek. Detailed design will occur prior to construction and will follow general guidelines required for such structures (see Klohn Leonoff (1988) report for general design of ditch around the tailings impoundment). Precipitation into the tailings impoundment has been incorporated in Klohn Leonoff's feasibility design for the impoundment (Klohn Leonoff 1988). Water recycle from the tailings to the mill process will reduce the need to release excess water from the impoundment.

The Brown-McDade open pits will be dug into highly fractured rock and are not likely to fill with water. The north pit will likely break into the old adit and water could drain through the adit. The rock in the footwall of the pits has low sulphide and is impermeable, thereby minimizing the potential for acidification of seepage draining through the old workings. Once mining is complete, permafrost will likely intrude the base of the pit and eliminate seepage concerns. However, seepage from the old adit may require monitoring to determine if any changes are occurring in water quality during mining and to confirm the absence of acid generation. In the absence of acid generation, this water could be discharged directly to Pony Creek.

The water management system will consist of:

- 1) diversion ditches around the mill site, ore stockpiles, waste dump and tailings pond
- 2) sedimentation ponds as required to remove sediment from run-off

- 3) tailings pond including, dam, reclaim system and seepage pond
- 4) fresh water supply from wells adjacent to Victoria Creek.

The components of the water management system are illustrated in Figure 1.3 and 1.4.

3.3 Design Basis

For diversion channel design, a 200-year return period one hour rain storm was developed from the data at Carmacks (see Section 2.3.2) and is presented in Table 3-1. This high intensity storm is expected to occur in July when no snow is on the ground. Thus no allowance was made for snowmelt during this event. Rain on snow events are not expected to be as severe.

Table 3-1 One-Hour 200 Year Return Period Storm

TIME (minutes)	INTENSITY (mm/hr)
5	5.2
10	5.2
15	5.2
20	5.2
25	5.6
30	30.6
35	121.2
40	30.6
45	5.6
50	5.6
55	5.2
60	5.2

3.4 Diversion Channel Design

To divert the flow of Dome Creek around the tailings pond, a diversion channel will be constructed on the left abutment of the dam, as shown on Drawing D3003 (Appendix I). A catchment area of approximately 2.26 km² contributes flow to the diversion channel. Based on the 200-year return period 1 hour storm, the peak discharge in the channel was estimated to be 9.1 m³/s. A trapezoidal channel 3 m wide at the base, 2 m deep with 2H:1V side slopes and a longitudinal slope of 0.1% is adequate to convey the peak discharge. Flow velocities in the channel are such that lining of the channel should not be required. It will be possible to construct a gated outlet from the channel into the tailings pond to allow water into the pond if a water deficit in the reclaim system occurs.

In the spring, when snowmelt begins or when infrequent rainstorms may occur, excessive ice, snow and snow drifts must be cleared from the channels to allow for the safe diversion of surface runoff. Every spring and fall, the channel must be checked for

vegetation build-up and subsidence due to frost action. Either of these may render the channels useless for runoff control and therefore must be monitored.

3.5 Spillway Design

For the purposes of preliminary sizing of a closure spillway a statistical Probable Maximum Precipitation (PMP) was estimated using data from Carmacks. This methodology (National Research Council of Canada) uses the mean and standard deviation of the annual extreme precipitation values. The resulting 1, 6 and 24 hour PMP rainfall depths were 63 mm, 76 mm, and 108 mm respectively. These estimates are adequate to assess feasibility. For final design a detailed site specific PMP and Probable Maximum Flood (PMF) study will be likely be required, including an assessment of seasonal variation and maximized snowpack conditions.

A waste rock lined spillway discharge channel is required to carry the spillway flow down the slope and into Dome Creek. The diversion channel could tie into the spillway discharge channel downstream of the spillway crest.

As discussed in the following section on water balance, it may be possible to manage the water resources to minimize or eliminate discharge during operation. An emergency spillway may be required during operation to prevent dam overtopping during an extreme inflow flood event. If it becomes necessary, the closure spillway could be constructed prior to shut-down to provide the capacity to handle peak storm events. Alternatively, the dam could be raised approximately 1.5 m to provide sufficient storage capacity. With the proposed diversion channel, the pond catchment area will be approximately 0.5 km². The estimated peak flood inflow resulting from a 200-year return period rainfall event is 2.9 m³/s. A 3 m wide emergency spillway could carry this discharge with a flow depth of 0.7 m.

For mine closure, the closure spillway should be capable of passing the PMF. Using the Rational Method with a runoff coefficient of 0.7, the 1 hour PMP of 63mm and a catchment area of 2.76 km² (including the pond area of 0.04 km²), resulted in a peak PMF inflow of 34 m³/sec. This is an approximate value for this prefeasibility level of study. Further studies would be required for detailed design of the closure spillway. To carry this discharge, a closure spillway 10 m in width would have a depth of flow of 1.6 m.

As shown on Drawing D-3003 (Appendix I), the closure spillway has been located on the left abutment. This is subject to the field confirmation of bedrock location on this abutment. The location of the spillway should be reevaluated if, based on additional field investigation, bedrock and soil conditions are more favourable on the right abutment.

3.6 Water Balance

A preliminary water balance was carried out to determine if a diversion ditch was required to minimize discharge from the pond. Using annual water volumes it was determined that a small surplus of water would result if a diversion ditch was constructed. Based on this analysis, a monthly water balance analysis, including a diversion ditch, was carried out and is presented in Appendix I-VI. For final design purposes, refinements to the monthly water balance including detailed mill water requirements should be carried out to determine the variation in pond level to ensure sufficient freeboard during operation and to minimize discharge. The water balance assumes a water reclaim system would be used continuously, to recycle water to the mill. Domestic sewage would not be discharged with the tailings since a conventional septic tank/tile field system will be installed, as described in Section 4.7.

The annual precipitation values of 271 mm, 370 mm and 200 mm, corresponding to mean year, 200-year wet year, and 10-year dry year, were used. A catchment runoff coefficient of 0.6 was used for the mean and dry years while a value of 0.8 was used for the wet year. The natural pond catchment area was estimated to be 0.46 km², with the Dome Creek diversion channel in place. The pond area was estimated to be 0.04 km² for this preliminary monthly analysis. An annual evaporation loss of 452.9 mm was used. Seepage losses were assumed to be zero. The loss of water to voids was estimated to be approximately 44,000m³/year based on a daily deposition rate of 300 tonnes/day, in-place dry density of 1.25 tonnes/m³ and a specific gravity of 2.75. A volume of tailings of 40,000 m³/yr was assumed to enter the tailings pond raising the pond water level.

The results of the monthly water balance are provided in Appendix I-VI. Results indicate that, with a stream diversion in place, there may be an annual net gain of water in the pond of about 20,000 m³ to 30,000 m³, in an average year. The pond level rises from a starting level of El. 1137 m in August of Year 1 to El. 1146.2 m at the end of July in Year 3. In the winter months the monthly water balance indicates a water deficit. Once tailings transport water and reclaim requirements are clearly defined, the pond level water level in the fall must be estimated to ensure that sufficient water is available to supply the reclaim requirements over winter.

To minimize excess water, a diversion channel will be constructed in Dome Creek. During a dry year water could be spilled from the diversion channel into the pond to add water, if required.

Annual balances for average and wet conditions are illustrated in Figures 3-1 and 3-2. Under average conditions the tailings pond will have sufficient capacity to store water for the first two years requiring a release of approximately 58,000 m³ during Year 3. The release could be carried out at a rate of 4.2 L/sec over a 160 day period when dilution capacity is available. Alternatively the release of excess water could take place

over a two year period which could reduce the rate to 2.1 L/sec. Wet conditions, which assume two average years and one 200 year return wet year would require the release of approximately 116,000 m³ during Year 3 at a rate of 8.4 L/sec. All excess water in the tailings pond would be treated to comply with permit criteria prior to release. The impact of the release of excess treated effluent on the water quality in Victoria Creek is assessed in Section 7.1.

3.7 Seepage Collection

There may be some seepage through the dam, particularly in the early part of the operation, prior to freezing of the dam. A small seepage recovery pond, as illustrated on Figure 1.3, will be constructed to catch any seepage that by-passed the dam. If the water collected in this pond has contaminant levels above discharge limits, it will be pumped back into the tailings pond. The water balances presented in Figures 3.2 and 3.3 assume that all water collected in this pond will be pumped back to the tailings pond. This ensures that the water balance used for design is conservative since this water will likely be released to Dome Creek

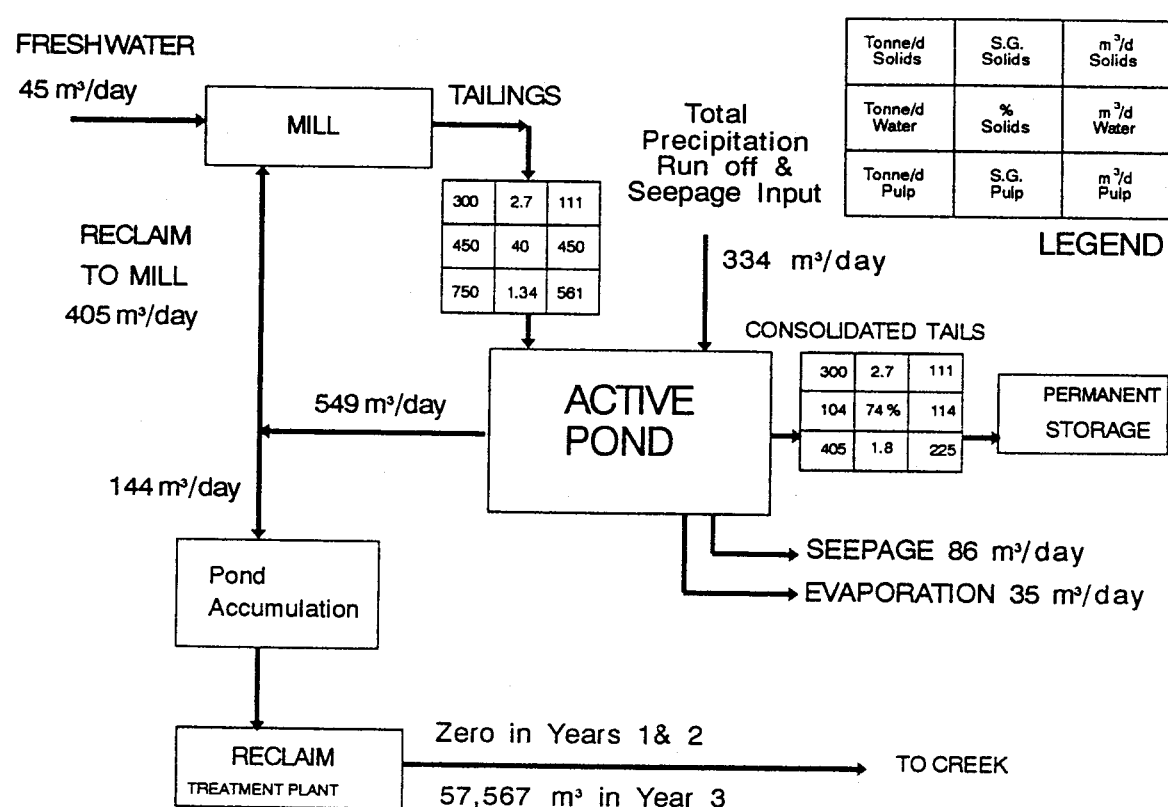


Figure 3-1
Water Balance for the Mount Nansen Project - Mean Case

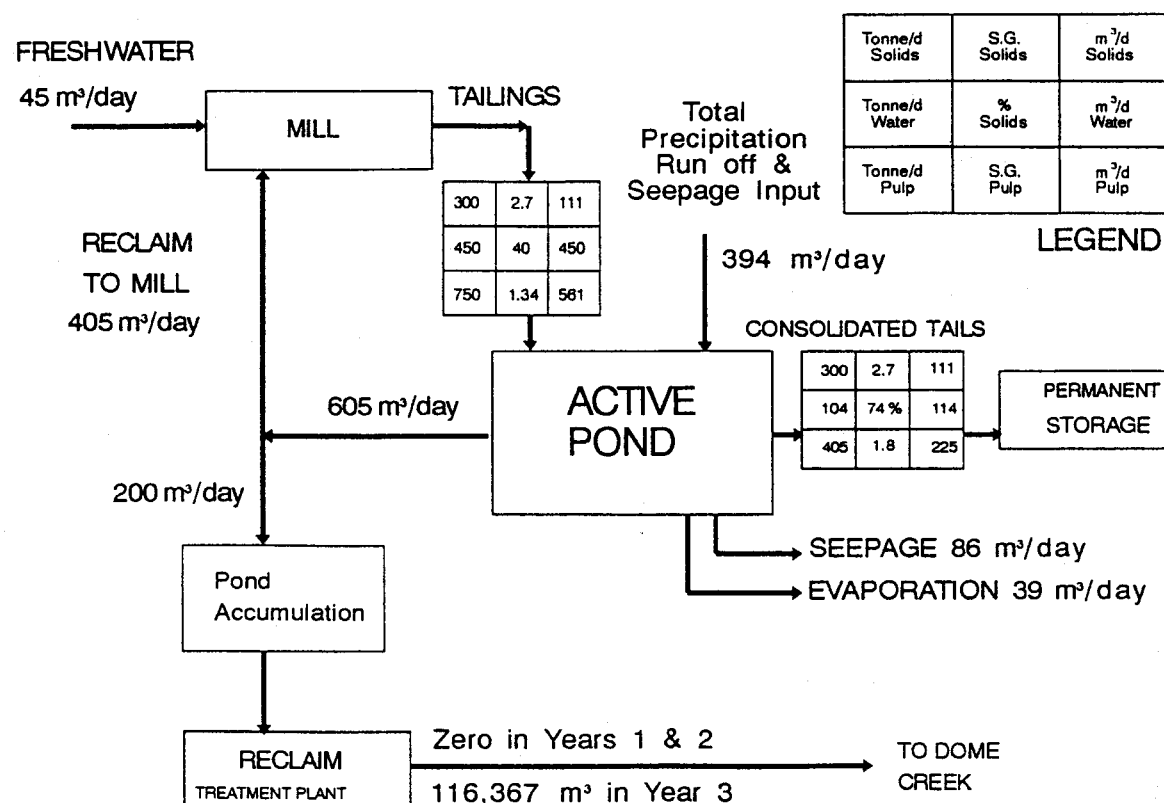


Figure 3-2
Water Balance for the Mount Nansen Project - Wet Case

A preliminary design for the seepage collection dam has been prepared and is presented in Drawing D-3003 (See Appendix I - Drawings). The dam would be built of compacted sand, from the same borrow as the main dam. The dam would be about 2 m high above original topography, and would be founded in an excavation about 1.5 m deep.

Both the tailings pond dam and the seepage collection dam would be lined with an impermeable geosynthetic membrane to reduce seepage losses. The membrane would be anchored in a trench extending below the active zone into permanently frozen ground to provide a positive seepage cutoff.

The seepage recovery impoundment also would act to store runoff from a design storm. To minimize this requirement, diversion ditches would be provided to divert slope runoff from adjacent valley sides. Only seepage and runoff from the immediate area and main dam would be collected in the seepage collection pond. Based on preliminary design the dam for the collection pond would be 2 m above original ground elevation in order to provide adequate storage capacity.

4.0 Waste Management

4.1 General

The objectives of the waste management plan are

- 1) ensure that all environmental criteria are met at the point of release to the environment
- 2) ensure the long-term stability of all waste rock and tailings in terms of acid generation, sediment release and physical stability

Three specific wastes will require disposal;

- 1) mill tailings which be permanently stored in the tailings impoundment
- 2) waste rock from the Brown-McDade zone that will be stored in dump adjacent to the pit and
- 3) sludges from the reclaim water treatment plant that will be deposited with the tailings.

The result of testwork, conducted to characterize tailings and waste rock, are reported in the following sections with the detailed results provided in Appendices IV and V.

4.2 Tailings System

The tailings system will consist of an impoundment dam as described in Section 1.9, a slurry pipeline, a reclaim pump (s), a reclaim water pipeline, diversion ditches, an emergency spillway (if required), and a seepage collection dam. Tailings will initially be spigotted along the upstream side of the tailings dam to ensure sealing of the dam foundations. Once this is complete the tailings discharge location will be moved to ensure that the tailings are deposited on as flat a profile as possible. The area of tailings beach left at closure will be minimized. A reclaim pump barge or fixed station will be placed at a location in the pond away from tailings discharge point. All tailings discharged to the pond will be treated for cyanide using the Inco SO₂-Air process. Reclaim water will be pumped back to mill to maximize recycle and minimize freshwater consumption. This will result in a zero discharge system under normal conditions for at least the first two years of operation, depending on the actual water balance for the site. Based on the dam design involving a frozen core, seepage loss should be zero. Any excess water that must be released from the tailings pond system to maintain water balance will be treated, if required, in secondary treatment facilities to comply with Permit criteria. This treatment system will involve either the SO₂-air or H₂O₂ processes for cyanide and the ferric sulphate-high density sludge process for arsenic and other metals removal.

4.3 Mill Feed and Tailings Characteristics

Representative oxide ore head assays from the Brown-McDade Zone from the testwork conducted by Melis Engineering in 1988 are presented in Table 1-9. The head assays for the composite sample generated for the evaluation of the Inco SO₂-Air process, conducted by PRA, is presented in Appendix IV. In terms of metals, the oxide ore contains high concentrations of iron and aluminum, medium concentrations of arsenic, lead and zinc and minor amounts of cadmium, copper and antimony. The sulphide content is low at less than 0.6%. The mill process will be an agitated cyanide leach, followed by adsorption on carbon in a conventional CIP circuit. The untreated mill tailings will be a slurry (at 30-50% solids) containing cyanide at approximately 100 mg/L. An analyses of the untreated solution from mill tailings is included in Appendix IV. Based on these analyses, the untreated waste will contain free cyanide, cyanide complexed with copper as well as cyanate, thiocyanate and sulphate. Based on the analyses the untreated waste will also contain minor amounts of arsenic and antimony in solution.

4.4 Tailings Treatment

The CIP tailings slurry will be treated using the SO₂-air process to reduce cyanide levels prior to discharge to the tailings containment area. The laboratory process evaluation testwork, presented in Appendix IV, indicated that the cyanide portion of the slurry could be treated using the process. Aging of the sample for 7 days was necessary to precipitate copper that remained in suspension/solution after treatment of cyanide. The process increased the arsenic concentration in solution from 1.95 to 5.15 mg/L (after 7 days) - potentially due to the decomposition of ferric arsenate in the ore under alkaline pH conditions. At this point it is assumed that a secondary treatment system will be required to remove arsenic from the tailings pond water prior to release to the Dome Creek. The Inco SO₂-Air process for cyanide treatment employs a combination of sulphur dioxide and air in the presence of a copper catalyst to oxidize both free cyanide and metal cyanide complexes to cyanate. The optimum pH range is 8 to 10 using lime for pH control. Retention times of 60 to 90 minutes are required for mill tailings. A simplified process flow diagram for the SO₂-Air treatment system for mill tailings is provided in Figure 4.1.

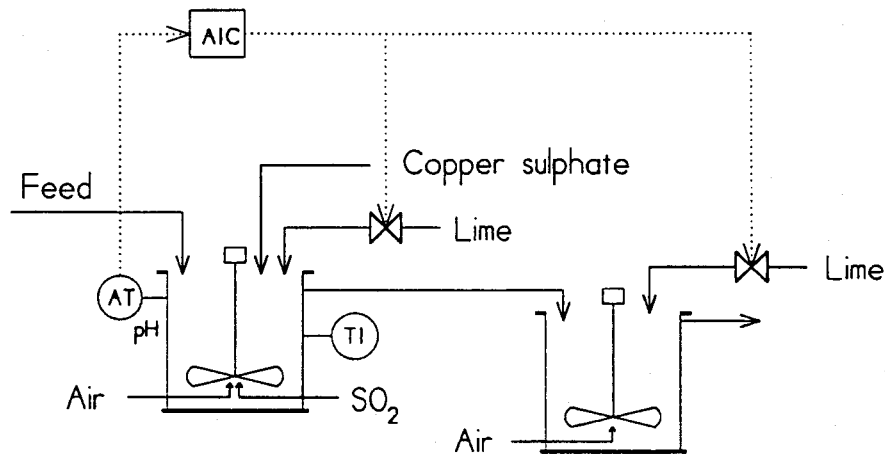


Figure 4.1
SO₂-Air Process Flow Diagram

The treated tailings slurry will be fed by gravity to the tailings containment area at Site #4. This area is located 1500 m distant and 100 m below the mill.

4.5 Reclaim Water Treatment

Reclaim water from the tailings disposal area will be pumped back to the mill once several months of operation raises the tailings pond water level to a depth that will ensure ice free recovery. Current projections, assuming average climactic conditions, suggest that there will not be a release of effluent from the tailings pond during the first two years of operation. This reclaim water treatment system will consist of a two agitated tanks. Sulfuric dioxide and air would be fed to the first tank to destroy residual cyanide while ferric sulphate and lime would be added to the second agitated tank to co-precipitate arsenic and antimony with ferric hydroxide. Alternatively hydrogen peroxide will be used for cyanide treatment, depending on which process provides the lowest cyanide residual. The resultant slurry would be flocculated with polyelectrolyte and clarified in a thickener prior to discharge. The underflow thickened sludge would be recycled to the second reactor to maintain sludge density. Excess sludge would be wasted to the tailings pond. Bench scale piloting of the process will be conducted prior to implementation. Both hydrogen peroxide and SO₂ will be tested for cyanide treatment to ensure that the lowest possible discharge limits are met. A typical flowsheet for this treatment system is provided in Figure 4.2.

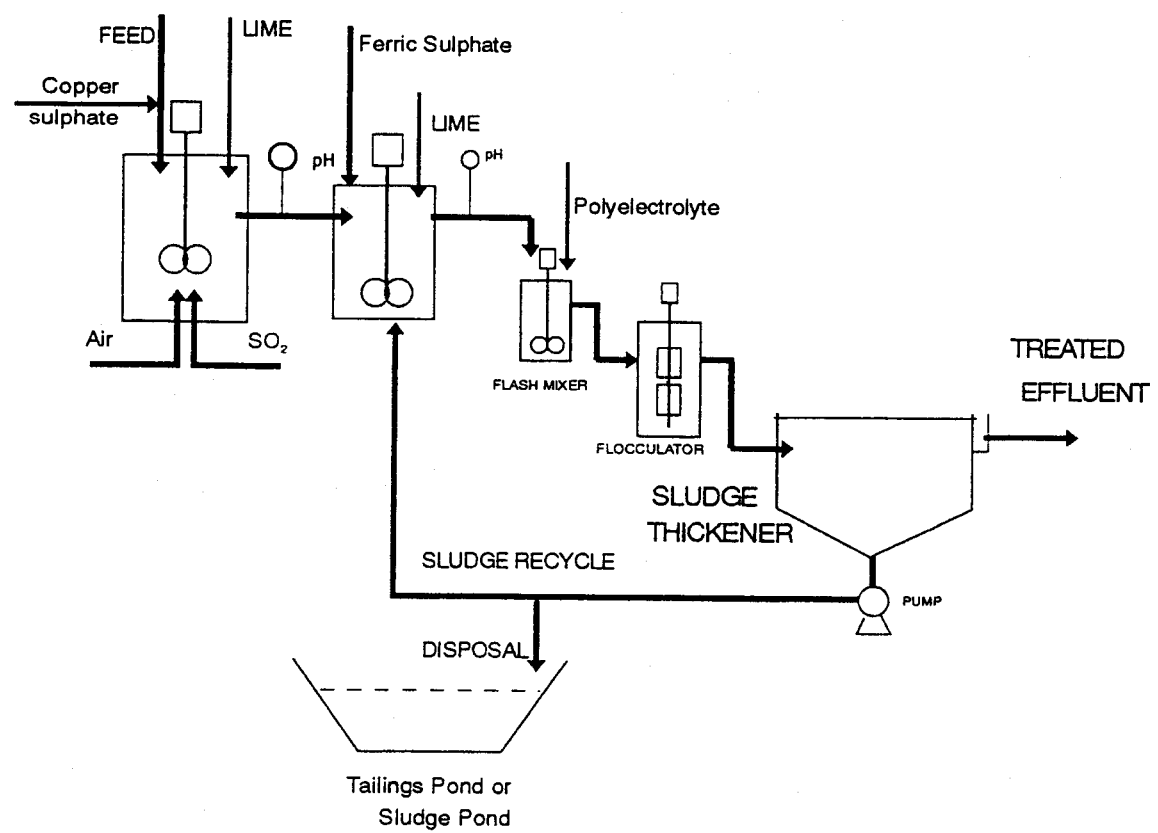


Figure 4.2
Flowsheet for Typical Secondary Treatment System for Cyanide and Arsenic

4.6 Waste Rock, Ore and Tailings ARD Assessment

The waste rock from the Brown-McDade open pit will consist mainly of altered granodiorite which is a weathered friable material without any significant potential for generation of acidic drainage or release of metals due to leaching. This waste rock can be safely used for construction purposes. The pitwall remaining after completion of the pit will consist either of altered or massive granodiorite, both of which are non-acid generating rock-types. Finally due to the oxidized nature of the ore (substantiated by testwork) it is not expected to generate acid in the ore stockpile at the mill or to result in an acid generation concern in the tailings pond once it is converted to tailings. The following sections provide the results from a number of programs conducted to substantiate the above conclusion.

4.6.1 ARD Tests - 1985

The first assessment of acid generation potential of waste rock was conducted on eight samples of ore, waste rock and tailings from the Huestis, Webber and Brown-McDade Zones. The ABA results for these samples are presented in Table 4.1 (Norecol, 1989a).

Table 4-1: Acid Generation Potentials of Ore, Waste Rock and Tailings (Norecol, 1989a)

Sample Number	Source	Material	Percent Sulfur %	Acid Generation Potential ⁽¹⁾	Acid Consuming Potential	Net Acid Generation Potential
1	Huestis Zone (upper adit)	Ore	7.56	236.9	38.10	198.80
2	Huestis Zone	Ore	16.90	529.4	3.50	525.90
3	Webber Zone	Wall Rock	0.11	3.3	8.68	-5.38
4	Webber Zone	Wall Rock (with pyrite)	0.84	25.8	57.60	-31.80
5	Brown-McDade Zone	Marginal Ore	0.38	11.8	20.70	-8.90
6	Brown-McDade Zone	Wall Rock	0.09	2.6	19.80	-17.20
7	Brown-McDade Zone (hangingwall)	Marginal Ore	0.46	14.3	6.20	8.10
8	Huestis Zone (lower adit)	Tailings	4.53	141.8	30.20	111.60

⁽¹⁾ All units in kg CaCO₃/tonne unless otherwise specified.

4.6.2 ARD Assessment - Brown McDade - 1989

A second sampling and analyses program was conducted by Norecol in 1989 that involved collection of 11 representative waste rock and ore samples from the Brown-McDade Zone. This sampling program was designed to assess geological variability of each rock type. A copy of the results was issued as a memo and is included in Appendix V (Norecol, 1989c). The samples consisted of selected intervals varying between 0.1 and 1.5m in length. The ABA results for these samples are provided in Table 4-2. Samples T-2755, T-2768 and T-0284 from DDH's 88-68 and 88-55 were overlapped by samples of drill core collected in the 1994 program as outlined in Section 4.6.3. In reference to Table 4-2, it is noted that samples T-0217, S-01192 and S-01826 are outside the current pit. In addition, samples T-0207 S-01334, S-01159 and S-01177 are oxide ore that will ultimately report to tailings and not be deposited in the waste dump. Finally the sample of vein material S-01188 from DDH 88-55 is sulphide ore from the pit bottom that will either report as dilution with the oxide ore or be left behind. The only waste rock samples collected in 1989 that were representative of pit are the three samples mentioned above that were eventually overlapped by the samples collected in 1994.

Additional previous studies also showed that the tailings from the abandoned Mount Nansen mine had the ability to consume acid, had little or no oxidation potential, and remained alkaline (Davidge, 1984).

Table 4-2: Waste Rock Characterization - (Norecol, 1989c)

Rock Type/ Drill Hole	Sample Length (m)	Section	S (tot) %	Paste pH	MPA ¹	NP ²	Net NP ³	Inorganic CO ₂	HCl Soluble Sulphate (%)	Sulphur as Sulphate (%)	HNO ₃ Soluble Sulphide (%)	NP(S) ⁴	MPA (S) ⁵	Net NP (S) ⁶
(kg CaCO ₃ /t of rock)											(kg CaCO ₃ /t of rock)			
Altered Granodiorite														
88-68	1.1	0-00	0.028	8.6	1	7	6	0.2	0.05	0.2	0.01	4.5	0.31	4
88-68	1.5	0-00	0.063	8.1	2	8	6	0.2	0.21	0.07	0.01	4.5	0.31	4
88-61	1.5	1-00S	0.112	8.2	4	54	51	4.4	0.09	0.03	0.01	100	0.31	100
Feldspar Porphyry Dykes														
88-55	1.3	1-00S	0.299	8.7	9	59	50	4.1	0.01	0.00	0.02	93.2	0.63	93
88-55	0.9	1-00S	0.508	4.2	16	1	-15	0.2	1.63	0.54	0.01	4.5	0.31	4
88-55	0.9	1-00S	0.542	4.1	17	-6	-23	0.2	1.65	0.55	0.01	4.5	0.31	4
Unaltered Granodiorite														
88-60	0.6	0-67S	1.350	7.9	42	32	-10	1.4	1.57	0.52	0.42	31.8	13.13	19
88-66	1.5	0-00	0.302	8.1	9	17	8	0.5	0.89	0.30	0.07	11.4	2.19	9
Vein														
88-54A	0.6	1-00S	0.033	6.4	1	-3	-4	0.2	0.15	0.05	0.01	4.5	0.31	4
88-54A	0.1	1-00S	2.770	5.6	87	4	-83	0.3	3.58	1.19	1.05	6.8	32.81	-26
88-55	1.2	1-00S	14.600	3.0	456	-7	-463	0.2	2.45	0.82	13.08	4.5	408.75	-404

Notes:

1. MPA = Maximum potential acidity
2. NP = Neutralization potential
3. Net NP = Net neutralization potential
4. MPA(S) = Maximum potential acidity from sulphide
5. NP(S) = Neutralization potential from CO₂
5. NNP(S) = Net neutralization potential from NP(S) and MPA(S)

4.6.3 ARD - Confirmation Program - 1994

A comprehensive ARD assessment program was conducted in 1994 to provide additional information on the rock types to be encountered during mining and to confirm the previous preliminary results for Brown McDade Zone waste. This program involved the collection and assay of 37 drill core samples representative of major rock types from the Brown McDade pit and the actual waste to be removed during mining. All samples were subjected to ABA assays and both ICP and Whole metals analyses. The testwork report is included in Appendix V.

4.6.3.1 Sample Collection

The waste rock samples for the 1994 ABA program, were obtained from "HQ" sized diamond drill hole (DDH) core, drilled in 1988. The cores had been logged, labeled and stored in racks on the property. None of the DDHs selected for sampling showed any evidence of missing core due to either vandalism or sampling for any purpose other than assaying or specific gravity determinations.

The diamond drill holes (DDH) selected for sampling spanned the strike length of the deposit (433 m). At least one DDH was chosen from each section line (section line spacing is 33 m). The samples were selected randomly from pieces of broken core over the designated intervals. For the wider intervals, (10-15 m) core was sampled at roughly 0.5 m intervals. For shorter intervals (1-5 m) a tighter sampling density was used to obtain a reasonable sample size.

Spatially, the samples fell into three broad categories of waste rock:

- From 0-15m for each hole in the hangingwall (H/W) of the mineralized zone;
- From 15m to the mineralized contact in the H/W of the mineralized zone;
- Samples from the footwall (F/W) of the mineralized zone.

Rock types fell into three general lithological categories:

- Altered (weathered, partially oxidized) granodiorite; (1)
- Altered (weathered, partially oxidized) feldspar porphyry (2);
- Fresh (least altered, unoxidized) granodiorite (3).

Rock types 1 and 2 are characteristic of the H/W lithologies while rock type 3 is restricted to the F/W of the mineralized zone. Note that rock types 1 and 3 are both locally present in the F/W and thus may occur in the same samples.

Based on the assessment of available data, personal inspection and sampling of the drill cores, it was believed that these samples adequately reflected the range of lithologies which will collectively compromise the waste rock to be mined from the proposed open pit (Melling, 1994). These samples, are summarized in Table 4-3

The estimated precentages of each rock type as a percentage of total waste are as follows:

- Upper Altered Granodiorite	-	60%
- Lower Altered Granodiorite	-	10%
- Upper Feldspar Porphyry	-	15%
- Lower Feldspar Porphyry	-	5%
- Footwal Granodiorite (Unaltered)	-	10%

4.6.3.2 Testwork Results

Acid Base Accounting and Metal Results

The acid base accounting testwork data, completed by Process Research Associates, is reported in Table 4-4 while the metal data is provided in Table 4-5. The drillholes used for the ABA samples are shown on Figure 4-3. The ABA assessment testwork conducted in 1994 confirmed the previous results from samples collected in 1988. The waste rock is generally low in sulphide with almost all the samples less than 0.5% S. There were one sample each of Lower Altered Granodiorite, Lower Feldspar Porphyry and Footwall Granodiorite that exhibited theoretical potential for acid generation. Only the Footwall Granodiorite sample contained appreciable sulphide . i.e. 1%. However, this sample was collected at the footwall contact with the mineralized zone - therefore it is likely that this material will be included as dilution with the ore and not be deposited in the waste dump. Concerns regarding the potential for acid generation from waste rock are negligible.

To illustrate variability within each rock type grouping frequency distribution plots were generated to illustrate the number of samples in individual Net NP ranges. These figures, provided in Figure 4-4 through 4-8, illustrate that there is very little variability within each rock type grouping.

Table 4-3: Sample Locations and Descriptions for ABA Test Work

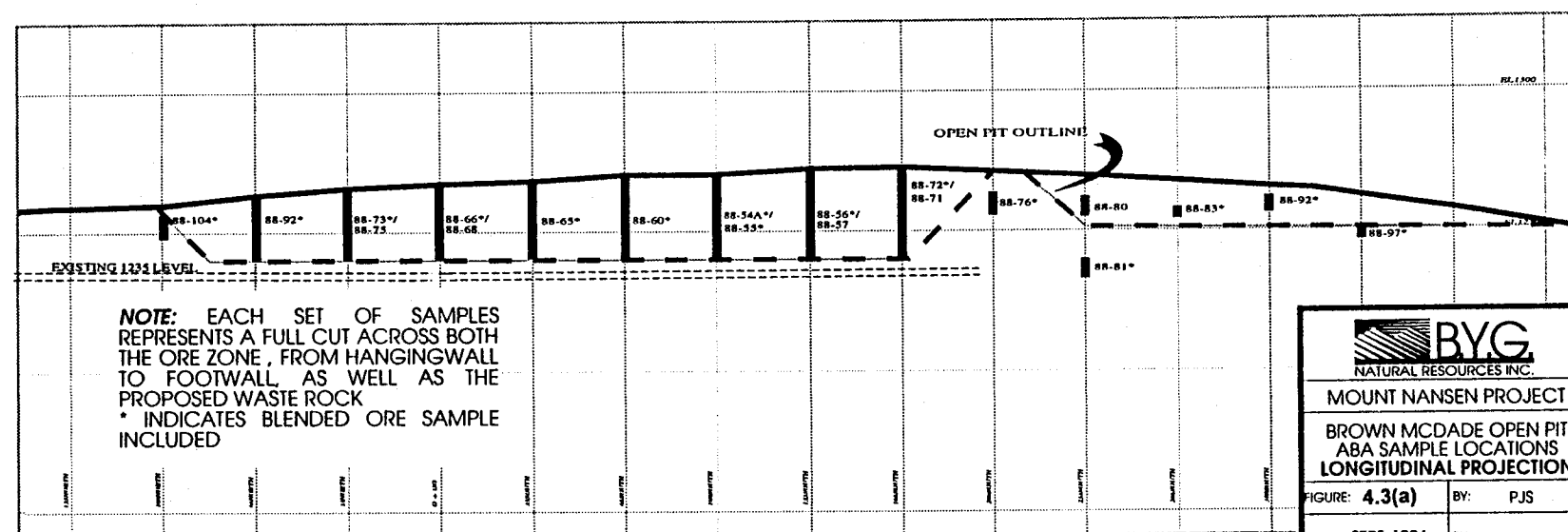
Section	Sample ID		Comments
	DDH#	Depth	
1+00 S	88-55	0-15 m	HW: 70% GD, 30% FP
	88-55	15-24 m	HW: 50% GD, 50% FP
	88-55	50-54 m	FW: 100% Fresh GD
1+33 S	88-56	0-7 m	HW: 35% GD, 65% FP
1+33 S	88-57	0-15 m	HW: 100% GD
	88-57	15-30 m	HW: 100% GD
	88-57	47.4-48.6 m	FW: 90% Fresh GD, 10% Altered
0+67 S	88-60	0-5 m	HW: 100% FP
0+33 S	88-63	0-15 m	HW: 100% GD
	88-63	15-20 m	HW: 100% GD
0+33 S	88-67	0-15 m	HW: 100% GD
	88-67	15-22 m	HW: 100% GD
0+00	88-68	0-15 m	HW: 100% GD
	88-68	15-35 m	HW: 65% GD, 35% FP
	88-68	54-55 m	FW: 100% Fresh GD
1+66 S	88-71	0-12 m	HW: 100% GD
	88-71	22-24 m	FW: 100% Fresh GD
1+66 S	88-72	0-15 m	HW: 100% GD
	88-72	15-32 m	HW: 97% GD, 3% Semi-massive pyrite
	88-72	40-42 m	FW: 100% GD, 80% Fresh, 20% Altered
0+33 N	88-73	0-15 m	HW: 100% GD
	88-73	15-20 m	HW: 50% GD, 50% FP
	88-73	29-34 m	FW: 100% GD, 60% Fresh, 40% Altered
0+33 N	88-75	0-15 m	HW: 100% GD
	88-75	15-30 m	HW: 100% GD
0+67 N	88-77	48-52 m	FW: 100% Fresh GD
2+33 S	88-80	23-33 m	FW: 100% GD, 30% Fresh, 70% Altered
0+67 N	88-82	0-15 m	HW: 60% GD, 40% FP
	88-82	15-20 m	HW: 100% GD
	88-82	29-33 m	FW: 100% GD, 75% Fresh, 25% Altered
2+67 N	88-83	0-15 m	HW: 100% FP
	88-83	24-30 m	FW: 100% Fresh GD
3+30 S	88-92	0-5 m	HW: 100% FP
	88-92	12-15 m	FW: 100% GD, 50% Fresh, 50% Altered
3+33 S	88-97	0-14 m	HW: 60% GD, 40% FP
	88-97	23-27 m	FW: 100% GD, 50% Fresh, 50% Altered
1+00 S	88-104	0-9 m	HW: 100% GD

Table 4-4: Waste Rock Characterization - (PRA, 1994)

Rock Type	Sample I.D.	S (tot) %	S (SO ₄) %	S (S ²⁻) %	Paste pH	NP	MPA	Net NP	NPR
Upper Altered Granodiorite									
	88-57 0-15 m	0.37	0.12	0.25	7.9	33.2	7.8	25.4	4.3
	88-63 0-15 m	0.34	0.01	0.33	8.0	56.4	10.3	46.1	5.5
	88-67 0-15 m	0.14	0.03	0.11	8.2	31.6	3.4	28.2	9.2
	88-68 0-15 m	0.06	0.03	0.03	8.1	13.1	0.9	12.2	14.0
	88-71 0-12 m	0.25	0.15	0.10	7.4	8.6	3.1	5.4	2.7
	88-72 0-15 m	0.24	0.07	0.17	8.0	45.4	5.3	40.1	8.5
	88-73 0-15 m	0.27	0.01	0.26	8.2	30.4	8.1	22.2	3.7
	88-75 0-15 m	0.14	0.04	0.10	8.1	44.7	3.1	41.6	14.3
	88-104 0-9 m	0.33	0.01	0.32	8.1	30.8	10.0	20.8	3.1
	Mean	0.24	0.05	0.19	7.98	32.7	5.8	26.9	
Lower Altered Granodiorite									
	88-57 15-30 m	0.39	0.08	0.31	7.9	52.1	9.7	42.4	5.4
	88-63 15-20 m	0.20	0.02	0.18	6.6	4.3	5.8	-1.5	0.7
	88-67 15-22 m	0.52	0.05	0.47	7.9	23.0	14.7	8.3	1.6
	88-72 15-32 m	1.45	0.67	0.78	6.8	44.9	24.4	20.5	1.8
	88-75 15-30 m	0.30	0.03	0.27	8.0	37.9	8.4	29.5	4.5
	88-82 15-20 m	0.22	0.01	0.21	8.2	54.6	6.6	48.0	8.3
	Mean	0.51	0.14	0.37	7.57	36.1	11.6	24.5	
Upper Feldspar Porphyry									
	88-55 0-15 m	0.35	0.04	0.31	8.0	30.4	9.7	20.7	3.1
	88-56 0-7 m	0.20	0.14	0.06	7.6	30.9	1.9	29.0	16.5
	88-60 0-5 m	0.38	0.05	0.33	8.0	31.0	10.3	20.7	3.0
	88-97 0-14 m	0.04	0.04	0.00	8.3	34.0	1.3	32.7	27.2
	88-83 0-15 m	0.23	0.10	0.13	7.8	47.4	4.1	43.3	11.7
	88-92 0-5 m	0.08	0.14	-0.06	8.0	57.3	2.5	54.8	22.9
	88-82 0-15 m	0.66	0.01	0.65	8.2	85.8	20.3	65.5	4.2
	Mean	0.28	0.07	0.20	7.98	45.2	7.1	38.1	
Lower Feldspar Porphyry									
	88-55 15-24 m	0.56	0.35	0.21	5.8	2.8	6.6	-3.7	0.4
	88-68 15-35 m	0.33	0.12	0.21	7.4	27.2	6.6	20.7	4.1
	88-73 15-20 m	0.83	0.01	0.82	8.4	90.8	25.6	65.2	3.5
Footwall Granodiorite									
	88-73 29-34 m	0.42	0.15	0.27	7.1	10.7	8.4	2.3	1.3
	88-83 24-30 m	1.02	0.01	1.01	8.8	17.7	31.6	-13.9	0.6
	88-71 22-24 m	0.12	0.01	0.11	9.0	22.2	3.4	18.8	6.5
	88-68 54-55 m	0.60	0.07	0.53	8.6	26.7	16.6	10.2	1.6
	88-92 12-15 m	0.11	0.12	-0.01	8.2	27.2	3.4	23.8	7.9
	88-97 23-27 m	0.07	0.01	0.06	8.5	47.1	1.9	45.2	25.1
	88-77 48-52 m	0.50	0.01	0.49	8.5	36.0	15.3	20.6	2.3
	88-57 47.4-48.6 m	0.31	0.01	0.30	7.9	40.4	9.4	31.0	4.3
	88-72 40-42 m	0.50	0.04	0.46	7.8	40.6	14.4	26.2	2.8
	88-80 23-33 m	0.11	0.01	0.10	8.6	43.1	3.1	40.0	13.8
	88-82 29-33 m	1.16	0.01	1.15	8.5	53.4	35.9	17.4	1.5
	88-55 50-54 m	0.96	0.07	0.89	8.1	73.7	27.8	45.9	2.7
	Mean	0.49	0.04	0.45	8.29	36.6	14.3	22.3	

Notes:

1. Analytical methods employed according to procedures described in "Field and Laboratory Methods. Applicable to Overburden and Minesoils", EPA 600/2-78-054, pp. 45-55, 1978
2. NP = Neutralization Potential as determined by acid consumption test
MPA = Maximum Potential Acidity (%S²⁻ × 31.25) except where S_(tot) < SO₄²⁻
Net NP = NP - MPA
3. NP, MPA and Net NP are expressed in tonnes CaCO₃ equiv. per 1000 tonnes sample
4. Samples with negative Net NP are potential acid producers.
5. NPR = NP/MPA



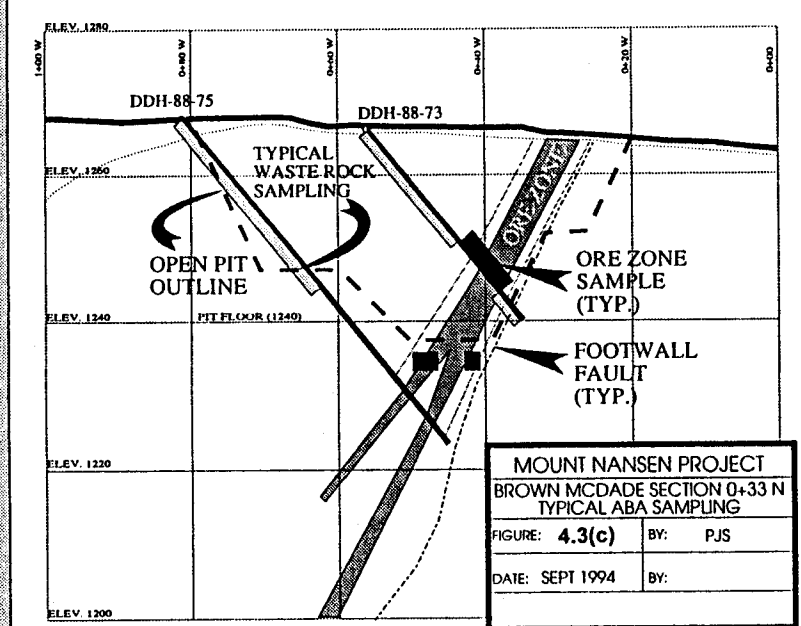
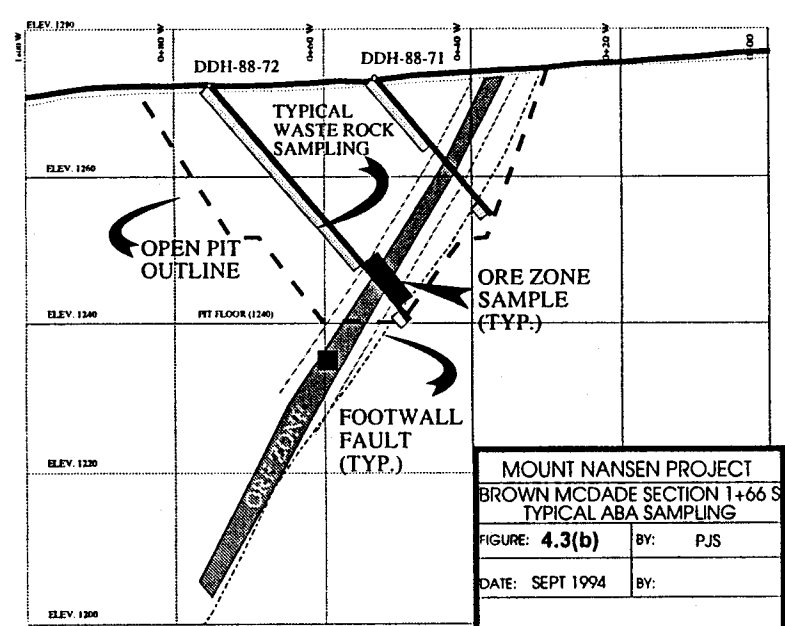
BYG
 NATURAL RESOURCES INC.

MOUNT NANSEN PROJECT

BROWN MCDADE OPEN PIT
 ABA SAMPLE LOCATIONS
 LONGITUDINAL PROJECTION

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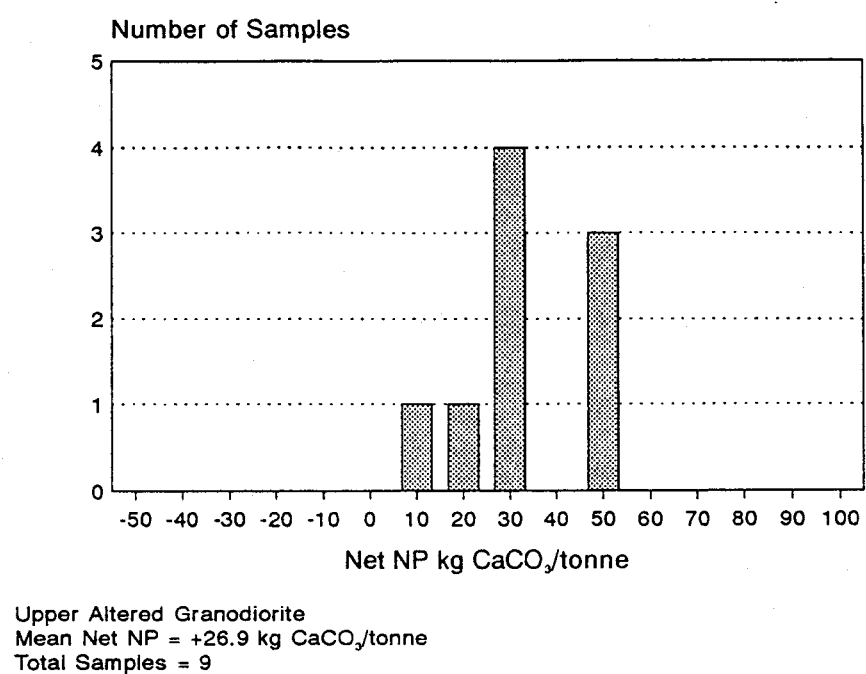


Figure 4.4
 Distribution of Net NP Values for Upper Altered Granodiorite

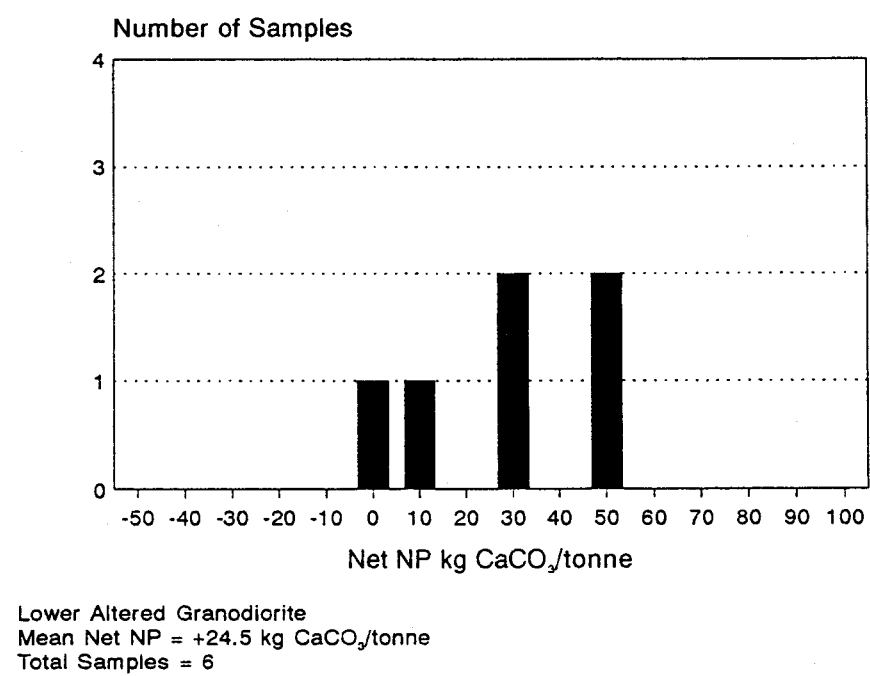
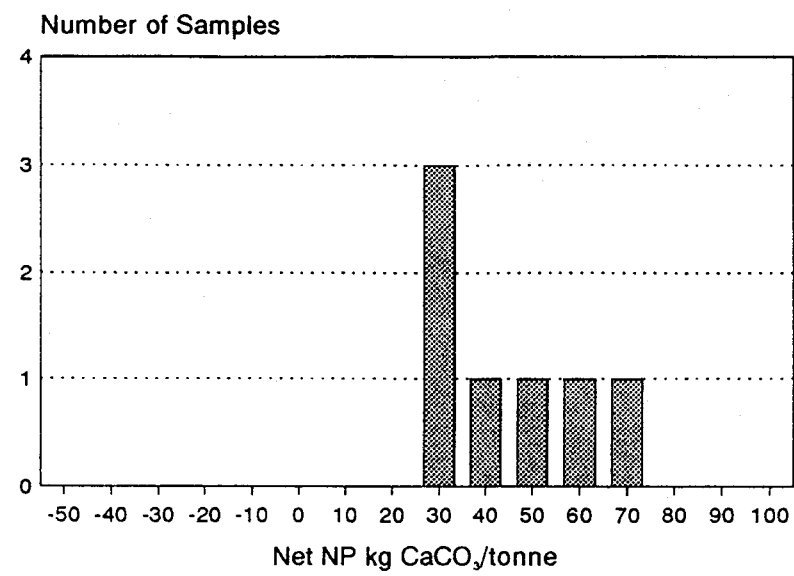
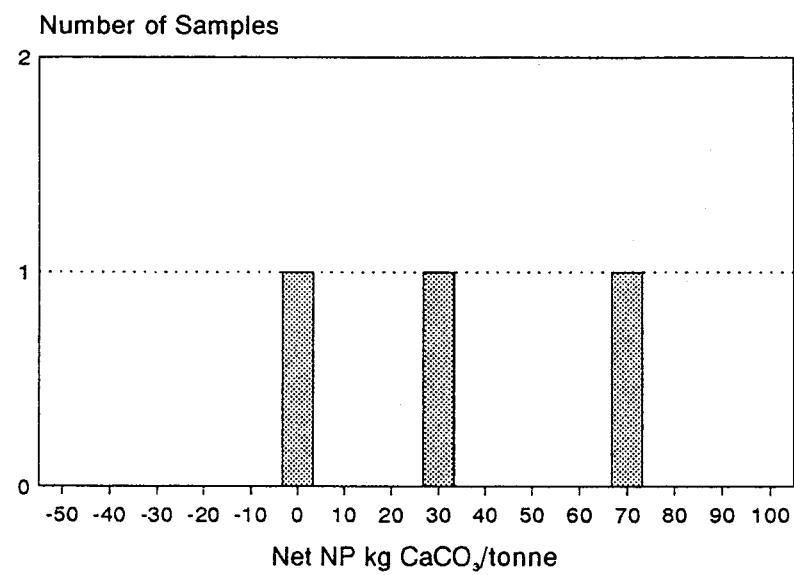


Figure 4.5
 Distribution of Net NP Values for Lower Altered Granodiorite



Upper Feldspar Porphyry
Mean Net NP = +38.1 kg CaCO₃/tonne
Total Samples = 7

Figure 4.6
Distribution of Net NP Values for Upper Feldspar Porphyry



Lower Feldspar Porphyry
Mean Net NP = +27.6 kg CaCO₃/tonne
Total Samples = 3

Figure 4.7
Distribution of Net NP Values for Lower Feldspar Porphyry

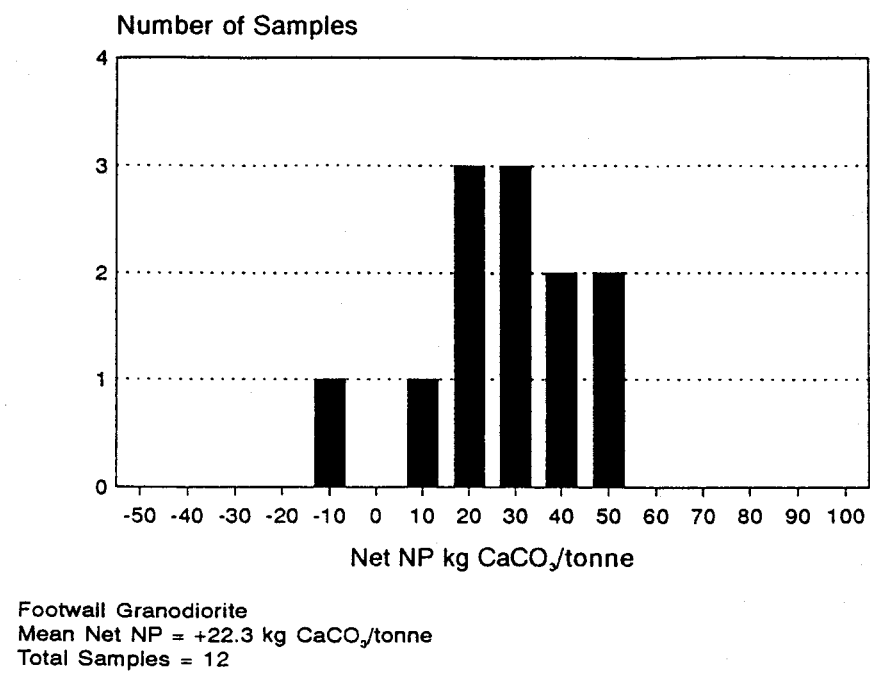


Figure 4.8
 Distribution of Net NP Values for Footwall Granodiorite

Table 4-5 Waste Rock Characteristics - Metals

Sample#	Ag µg/g	Al %	As µg/g	B %	Be µg/g	Ba %	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %	La µg/g	Mg %	Mn %	Mo µg/g	Na %	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Si %	Sr µg/g	Ti %	V µg/g	W µg/g	Zn µg/g	
Upper Altered Granodiorite																														
88-57 0-15 m	2.6	4.28	316	0.01	1	0.09	1	1.19	15	6	123	41	2.09	1.20	13	0.25	0.36	2	0.06	4	214	669	1	26.9	134	0.36	37	4	2097	
88-63 0-15 m	1.6	3.91	96	0.01	1	0.13	1	1.85	15	5	198	47	1.51	1.37	9	0.37	0.23	3	0.04	7	76	215	1	29.5	84	0.20	19	5	1201	
88-67 0-15 m	0.2	3.81	75	<0.01	1	0.14	1	0.96	4	6	123	14	1.24	1.25	6	0.25	0.13	1	0.15	9	2	105	1	30.4	106	0.13	20	2	526	
88-68 0-15 m	0.1	4.17	32	<0.01	1	0.16	1	0.84	1	5	109	3	0.92	1.10	11	0.13	0.04	1	0.57	3	37	33	1	29.7	211	0.16	23	1	229	
88-71 0-12 m	0.9	3.88	206	<0.01	1	0.18	1	0.25	34	10	106	45	1.15	1.74	8	0.11	0.23	2	0.06	5	50	164	10	31.4	113	0.17	14	1	3597	
88-72 0-15 m	1.2	3.54	279	<0.01	1	0.11	2	1.51	65	8	106	46	1.27	1.58	6	0.31	0.44	1	0.04	3	109	111	10	31.8	56	0.15	7	1	5406	
88-73 0-15 m	0.3	4.47	30	<0.01	1	0.14	1	1.84	11	10	109	67	1.56	1.10	17	0.41	0.15	2	0.87	5	122	81	1	28.6	310	0.23	32	2	1011	
88-75 0-15 m	0.4	4.43	27	<0.01	1	0.16	2	1.86	1	8	130	12	1.33	1.21	20	0.28	0.04	1	0.24	3	79	23	1	30.1	169	0.22	40	2	93	
88-104 0-9 m	0.4	3.38	87	<0.01	1	0.09	1	0.95	7	5	89	92	1.11	1.42	33	0.36	0.10	3	0.03	2	76	119	10	32.1	42	0.21	10	2	660	
Mean	0.9	3.99	128		1	0.13	1	1.25	17	7	122	41	1.35	1.33	14	0.28	0.19	2	0.23	5	85	169	4	30.1	136	0.20	22	2	1647	
Lower Altered Granodiorite																														
88-57 15-30 m	1.1	4.49	86	0.01	1	0.09	1	1.70	11	4	127	40	2.09	0.99	12	0.33	0.23	2	0.05	1	170	152	5	26.6	162	0.34	57	4	1842	
88-63 15-20 m	1.4	3.45	135	<0.01	1	0.09	1	0.11	16	4	161	87	1.79	1.39	7	0.17	0.21	3	0.03	9	59	172	2	31.3	49	0.15	15	4	1264	
88-67 15-22 m	0.5	4.17	86	0.01	1	0.16	1	0.85	1	10	157	30	1.64	1.16	10	0.19	0.12	1	0.04	10	175	90	4	29.8	77	0.25	34	1	413	
88-72 15-32 m	10.2	3.11	262	0.02	1	0.05	4	1.81	40	5	144	116	2.46	1.14	5	0.48	0.32	1	0.03	8	87	1952	23	28.4	49	0.21	22	1	4570	
88-75 15-30 m	1.3	4.52	36	<0.01	1	0.18	1	1.54	3	8	86	13	1.34	1.25	15	0.28	0.04	2	0.18	3	83	104	1	28.6	134	0.23	40	2	427	
88-82 15-20 m	1.0	4.10	40	<0.01	1	0.09	1	1.96	15	16	195	106	2.35	0.52	19	0.28	0.30	1	0.04	5	185	69	5	28.1	63	0.34	66	7	2079	
Mean	2.6	3.97	108		1	0.11	2	1.33	14	8	145	65	1.95	1.08	11	0.29	0.20	2	0.06	6	127	423	7	28.8	89	0.25	39	3	1766	
Upper Feldspar Porphyry																														
88-55 0-15 m	2.0	3.76	137	0.01	1	0.13	6	2.36	11	7	99	45	1.15	1.37	14	0.27	0.17	2	0.09	1	103	346	1	31.4	106	0.17	9	1	1068	
88-56 0-7 m	3.9	3.43	145	<0.01	1	0.06	1	1.06	5	4	137	84	1.71	1.25	14	0.34	0.07	3	0.05	1	81	900	4	29.5	176	0.18	14	3	1087	
88-60 0-5 m	1.8	2.76	687	0.01	1	0.08	1	1.18	39	7	113	207	1.21	1.21	22	0.12	0.54	4	0.03	3	35	152	45	32.5	28	0.20	7	2	3122	
88-97 0-14 m	0.1	4.25	89	<0.01	1	0.13	1	1.46	1	6	113	21	0.96	0.91	11	0.15	0.09	1	0.03	3	87	28	5	32.3	91	0.21	19	1	344	
88-83 0-15 m	11.1	3.84	5899	<0.01	1	0.07	1	1.99	51	7	140	86	2.70	1.35	26	0.36	0.40	2	0.09	13	146	3354	22	25.9	91	0.39	41	1	3747	
88-92 0-5 m	1.4	3.74	537	<0.01	1	0.10	1	2.18	8	7	157	82	1.72	0.81	3	0.30	0.31	1	0.02	10	35	653	75	30.2	70	0.15	46	2	1219	
88-82 0-15 m	1.7	3.93	71	0.01	1	0.11	1	2.86	16	13	130	71	1.87	1.25	22	0.51	0.31	2	0.04	3	124	406	3	27.9	106	0.30	33	5	1318	
Mean	3.1	3.67	1081		1	0.10	2	1.87	19	7	127	85	1.62	1.16	16	0.29	0.27	2	0.05	5	87	834	22	30.0	96	0.23	24	2	1701	
Lower Feldspar Porphyry																														
88-55 15-24 m	5.9	3.40	550	0.01	1	0.08	6	0.36	18	6	123	79	1.36	1.58	13	0.22	0.14	2	0.04	1	7	554	38	31.1	84	0.13	4	1	961	
88-68 15-35 m	1.8	4.18	71	<0.01	1	0.10	1	1.03	60	12	123	256	1.98	1.19	17	0.19	0.44	1	0.11	10	168	206	4	29.3	99	0.25	34	1	4566	
88-73 15-20 m	2.1	3.63	48	0.01	1	0.08	1	3.05	22	10	103	151	1.97	1.08	18	0.82	0.24	2	0.36	3	137	730	8	27.3	204	0.27	34	6	2003	
Mean	3.3	3.74	223		1	0.09	3	1.48	33	9	116	162	1.77	1.28	16	0.41	0.28	2	0.17	5	104	497	17	29.2	129	0.22	24	3	2510	
Footwall Granodiorite																														
88-55 50-54 m	1.6	4.16	82	0.01	1	0.07	1	3.05	6	4	109	113	1.88	1.00	8	0.78	0.19	2	1.33	2	116	77	1	26.3	401	0.25	32	4	753	
88-57 47.4-48.6 m	1.1	4.14	41	0.01	1	0.09	1	1.57	12	3	92	64	1.24	0.95	108	0.54	0.16	4	0.76	1	70	47	3	27.8	204	0.31	16	4	1236	
88-68 54-55 m	0.1	4.28	22	0.01	1	0.21	1	2.64	2	8	109	11	1.24	0.83	6	0.64	0.06	2	1.65	5	96	20	1	29.8	598	0.21	28	5	276	
88-71 22-24 m	0.5	4.53	44	<0.01	1	0.10	1	4.00	2	13	116	53	2.31	1.03	5	1.34	0.10	3	1.45	5	183	15	5	27.3	563	0.42	57	4	229	
88-72 40-42 m	0.9	4.19	41	0.01	1	0.08	1	3.02	12	10	178	38	2.01	0.94	8	0.92	0.21	1	0.80	7	205	88	1	26.5	260	0.35	46	2	1722	
88-73 29-34 m	0.3	4.52	192	0.01	1	0.08	1	1.76	11	10	103	207	1.63	0.83	11	0.63	0.19	2	0.81	7	92	82	15	28.6	310	0.25	32	2	1242	
88-77 48-52 m	0.1	4.22	36	0.01	1	0.14	1	3.09	1	7	116	7	1.46	1.04	5	0.90	0.08	2	1.48	5	116	12	1	28.8	528	0.23	36	1	50	
88-80 23-33 m	0.4	3.73	30	<0.01	1	0.14	4	2.09	6	7	113	15	0.65	1.78	3	0.22	0.09	1	0.77	1	2	33	3	31.8	246	0.08	10	1	321	
88-82 29-33 m	0.5	4.20	32	0.01	1	0.10	1	3.11	1	10	109	9	1.78	0.81	32	0.93	0.10	1	1.33	2	155	14	7	26.5	443	0.26	44	5	165	
88-83 24-30 m	0.2	3.82	257	<0.01	1	0.22	1	1.70	2	2	109	8	0.56	1.41	3	0.29	0.02	1	1.42	1	2	148	1	32.8	443	0.09	16	1	192	
88-92 12-15 m	0.3	4.51	104	<0.01	1	0.07	1	4.69	1	10	120	56	2.62	0.74	7	1.07	0.10	3	1.54	2	33	37	3	26.0	873	0.41	60	1	248	
88-97 23-27 m	0.2	3.71	28	<0.01	1	0.09	1	2.01	3	12	123	33	1.75	1.21	10	0.73	0.11	1	0.66	6	61	24	1	30.5	183	0.29	44	4	411	
Mean	0.5	4.17	76		1	0.11	1	2.73	5	8	117	51	1.59	1.05	17	0.75	0.12	2	1.17	4	94	50	4	28.6	421	0.26	35	3	570	

Metals analyses conducted using both ICP and Whole Rock methods

Waste Rock Leaching Characteristics

A secondary concern with the waste rock is the potential for leaching of metals once the dump is exposed to increased weathering. Therefore all waste rock samples were assayed for metals by both ICP and Whole Rock methods. The metal results, for the Brown-McDade waste rock samples, summarized in Table 4-5, utilized both ICP data and whole data since ICP results are generally unreliable for elements at the present level such as Ca, Mg, Si and Fe. These metal analyses were conducted to evaluate variability and provide a basis for the leaching tests discussed below. Arsenic levels in the individual samples ranged from a low of 22 ppm in Sample 88-68 (54-55 m) which was Footwall Granodiorite to a high of 5899 ppm in Sample 88-83 (0-15m) which was Upper Feldspar Porphyry. All other samples had arsenic levels less than 687 ppm. In general the arsenic levels in the waste rock are an order of magnitude less than the ore (see Appendix V). The levels of antimony in 31 of the 37 samples were less than 10 ppm while copper, lead and zinc levels were in the range of 3 to 256, 12 to 3354 and 50 to 5406 respectively.

In order to conduct leaching test, composite samples were prepared for each of the five rock types by combining equal weights of each sample according to the groupings in Table 4-4. The metals in these composite were assayed by both ICP and whole rock methods. The results of the metals analyses, summarized in Table 4-6 (also see Appendix V), indicate that the metals in composites were in-line with the results from the individual samples. The distilled water leaching test results, included in Table 4-6 (also see Appendix V), demonstrate that the waste rock does not contain appreciable leachable metals. Arsenic and antimony concentrations were less than 0.05 ppm. The Lower Feldspar Porphyry contained a small amount of leachable zinc, which is to be expected given the neutral pH leaching conditions and the assumed presence of zinc in an oxidized form. Minor amounts of calcium, potassium and sodium also reported in the leach solutions.

Table 4-6 Waste Rock Composite Samples – Metals and Leach Test Results

Solids																											
	Ag	Al	As	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	Sb	Si	Sr	Ti	V	W	Zn
Composite Samples	µg/g	%	µg/g	%	µg/g	%	µg/g	µg/g	µg/g	µg/g	%	%	µg/g	%	%	µg/g	%	µg/g	µg/g	µg/g	µg/g	%	µg/g	%	µg/g	µg/g	µg/g
Upper Altered Granodiorite	1.1	3.84	111	0.12	12	1.60	15	2	99	51	1.33	1.32	15	0.37	0.17	1	0.22	6	327	149	1	31.1	120	0.18	19	1	1450
Lower Altered Granodiorite	2.2	3.88	105	0.10	6	1.29	14	4	127	70	1.78	1.07	12	0.36	0.18	1	0.06	8	412	408	1	30.8	63	0.23	37	1	1658
Upper Feldspar Porphyry	3.7	3.55	1076	0.09	7	1.84	20	4	109	91	1.49	1.17	15	0.34	0.16	3	0.06	5	275	820	17	32.1	70	0.21	24	1	1692
Lower Feldspar Porphyry	4.2	3.56	257	0.08	6	1.51	34	5	116	165	1.68	1.29	14	0.49	0.25	3	0.16	8	393	489	18	31.2	113	0.20	22	1	2404
Footwall Granodiorite	0.3	3.94	56	0.10	1	2.66	5	4	113	55	1.49	0.99	17	0.85	0.11	3	1.14	6	445	46	1	29.9	394	0.24	31	1	553

Metals analyses conducted using both ICP and Whole Rock methods

Leach Solutions																											
	Ag ppm	Al ppm	As ppm	Ba ppm	Bi ppm	Ca ppm	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe ppm	K ppm	La ppm	Mg ppm	Mn ppm	Mo ppm	Na ppm	Ni ppm	P ppm	Pb ppm	Sb ppm	Si ppm	Sr ppm	Ti ppm	V ppm	W ppm	Zn ppm
Upper Altered Granodiorite	<.01	<.1	<.05	0.07	<.05	36	<.01	<.01	<.01	<.01	<.5	18	<.01	7.4	0.01	<.01	8	<.01	<.05	<.1	<.05	ND	0.11	0.13	<.01	<.05	<.01
Lower Altered Granodiorite	<.01	<.1	<.05	0.03	<.05	240	<.01	<.01	<.01	<.01	<.5	23	<.01	36.8	0.24	<.01	13	0.03	<.05	<.1	<.05	ND	0.47	0.10	<.01	<.05	0.10
Upper Feldspar Porphyry	<.01	<.1	<.05	0.06	<.05	40	<.01	<.01	<.01	<.01	<.5	29	<.01	6.5	<.01	<.01	13	<.01	<.05	<.1	<.05	ND	0.20	0.08	<.01	<.05	0.03
Lower Feldspar Porphyry	<.01	<.1	<.05	0.04	<.05	219	<.01	<.01	<.01	<.01	<.5	49	<.01	36.6	0.43	<.01	14	0.04	<.05	<.1	<.05	ND	0.77	<.01	<.01	<.05	0.28
Footwall Granodiorite	<.01	<.1	<.05	0.02	<.05	48	<.01	<.01	<.01	<.01	<.5	15	<.01	10.4	0.06	<.01	21	<.01	<.05	<.1	<.05	ND	0.23	<.01	<.01	<.05	0.03

4.6.2.3 ARD of Tailings

The previous metallurgical test work for the Brown-McDade ore indicates that the tailings would have had a low sulphide content (0.58%) and that acid generation should not occur from the oxidized ore (Melis, 1989). Confirmatory test work conducted by PRA confirmed that the tailings contained 0.59% sulphide, had a Maximum Potential Acidity of 18.4 kg CaCO₃/tonne, a Neutralization Potential of 12.8 kg CaCO₃/tonne and a Net Neutralization Potential of -5.61 kg CaCO₃/tonne (see Appendix IV). Despite a negative Net NP, at the level of sulphide in the tailings and assuming a very fine particle size, acid generation is not expected from the tailings. Reclamation and revegetation of the tailings beaches should eliminate any future concern with acid generation from tailings.

4.7 Domestic Sewage/Public Health Issues

Domestic sewage from the camp will be treated in a septic tank/tile field system designed for a 50 person camp. This system will be designed to comply with Health and Welfare Canada and YTG regulations. An application for a Permit to Install a Private Sewage Disposal System will be submitted to Health and Welfare Canada once the site inspection, soils investigation and percolation tests have been completed. The septic tank/tile field system will receive only domestic sewage and kitchen waste to ensure that the adsorption field remains free of chemical wastes that could contaminate the soil in the vicinity of the field.

The drinking water supply will be analyzed prior to start-up to ensure compliance with the "Guidelines for Canadian Drinking Water Quality" (1978). Since the drinking water will be supplied by existing wells in a deep aquifer on Victoria Creek, the water will be free from any potential contamination prior to start-up and during operation. A separate potable water system in the camp, offices and mill will ensure that the drinking water is completely isolated from potential sources of contamination. The camp cookhouse facilities will be designed and operated in compliance with Health and Welfare Canada regulations. The camp facilities will be inspected regularly to ensure that the public health of the BYG employees is adequately being protected.

5.0 Environmental Monitoring Program

The objectives of a monitoring plan are;

- Provide a mechanism for early detection of contamination to allow mitigation measures to be taken if necessary.
- Collect baseline data to provide an assessment of natural variability and support impact assessment during operation and after closure.
- Provide a means of measuring potential environmental impact of contaminant releases on the receiving environment.
- Demonstrate compliance with permit and license requirements.

The following provides an outline of a proposed monitoring plan for the Mount Nansen project. A detailed monitoring plan will ultimately be incorporated into the Water License Surveillance Schedule.

5.1 Surface Water Quality Monitoring Program

A series of water quality monitoring stations would be established prior to construction to provide a basis for assessing environmental impact. Some of these sites coincide with stations established previously. Proposed sites would include:

- Dome Creek (D1) upstream of the mill and 3.5 km from mouth to provide an upstream control site (previous site).
- Dome Creek (D2) 0.4 km from mouth at the Nansen Road Creek to act as distant downstream monitoring station (previous site).
- Dome Creek (D3) 100m downstream of the tailings pond to monitor impact of seepage and effluent discharge (new site).
- Pony Creek (P1) 0.6 km from mouth to monitor impact of sediment from the ore dump from previous mining of the Brown-McDade sulphide ore and potential seepage from the existing adit.

Water quality monitoring would be carried out quarterly on all water quality stations.

5.2 Effluents

A series of 7 stations will be established to characterize individual effluent streams at the minesite. A detailed sampling frequency and analytical schedule for monitoring effluent will be developed as part of the Water License Application. Description of the

stations and the proposed analyses are provided in the following sections. Some of stations are not expected to generate sufficient flow to permit sampling during much of the year due to either winter or summer conditions. The proposed stations are as follows;

- E1 Reclaim Water Intake
- E2 Tailings Pond Seepage
- E3 Ore Storage Run-off
- E4 Waste Dump Run-off
- E5 North Pit Mine Water
- E6 South Pit Mine Water
- E7 Final Effluent/Polishing Pond Overflow to Dome Creek*

*E7 would not be activated until Year 3 based on the current water balance and operating plan.

5.3 Tailings Pond Supernatant/Reclaim Water - E1

Tailings pond supernatant will be pumped and metered on a continuous basis to the mill to provide process water for mill use. A flow meter with a totalizer will measure flowrate continuously - total flow will be recorded daily. In addition, tailings pond elevation will be measured and recorded weekly using a staff gauge in the pond. This station will have a maximum allowable total cyanide limit of 10 mg/L. Grab samples of reclaim water would be collected at the mill discharge point on a weekly basis and analyzed for pH, conductivity, temperature, turbidity and total cyanide. The following analyses would be conducted monthly in addition to the weekly analyses - WAD-CN, NFR (non-filterable residue/suspended solids), alkalinity, sulfate, nitrate plus nitrite. Total and dissolved metals would be analyzed quarterly.

5.4 Tailings Pond Seepage - E2

Groundwater collected by the seepage collection pond would be sampled and analyzed on a monthly basis during operation to demonstrate the integrity of the tailings pond operation.

Water collected by the tailings pond seepage collection system will be required to comply with the proposed discharge limits listed in Table 7-1. In the event that the water in the collection pond seepage does not comply with these limits it will be pumped continuously either to the mill or to the tailings pond. A pump will be installed

in the collection pond to provide for return of contaminated water if necessary. The seepage return pump would operate either continuously or be controlled by a float-switch, depending on water availability.

Due to the addition of chemicals such as NaCN, SO₂, Cu(SO₄) and Ca(OH)₂ to the reclaim water during milling and waste treatment and due to the continuous recycle of water, the salinity/conductivity of the tailings pond supernatant will increase markedly above the background levels evident in the local groundwater and surface water. This difference in conductivity between the tailings pond supernatant and groundwater will be used to detect the presence and quantity of tailings pond seepage in the seepage collection system and in Dome Creek and provide an early indication of potential seepage problems. A grab sample of seepage water would be collected on a weekly basis and analyzed for conductivity. TCN analyses would be conducted monthly. The following analyses would be conducted quarterly - WAD-CN, cyanate, thiocyanate, NFR, alkalinity and total and dissolved metals and ammonia.

Measurement of flowrate and sodium concentrations at D3 could be used to estimate the quantity of seepage entering Dome Creek by comparing the concentration at D3 to that at E1. Conductivity readings tend to increase proportional to Na concentrations. Significant changes in conductivity in the seepage water would be reported to the appropriate regulatory agency.

5.5 Site Drainage

5.5.1 Ore Storage Area Run-Off - E3

Run-off from the ore storage area will be directed to a collection ditch and drain to one of existing tailings pond. A grab sample of ore storage drainage would be collected on a regular basis during the run-off period and analyzed for pH, specific conductivity, alkalinity, sulphate and ammonia. Sample collection will focus on spring-run-off since the quantity of drainage from the ore storage area may be negligible during parts of the winter and summer. In the event that the quality of the ore storage run-off is unacceptable, it will be collected, pumped to the mill and neutralized with lime prior to disposal in the tailings pond.

5.5.2 Waste Dump Drainage - E5

A grab sample of Waste Dump Drainage will be collected at an appropriate drainage ditch location on a weekly basis during run-off and analyzed for pH, specific conductivity, alkalinity, sulphate, ammonia and total and dissolved metals.

5.6 North and South Pit Mine Water - E6 & E7

During open pit mining, pit water will be pumped and directed to drainage ditches. A grab sample will be collected at an appropriate drainage ditch location on a weekly basis during run-off and analyzed for pH, specific conductivity, alkalinity, sulphate, ammonia and total and dissolved metals.

5.7 Final Effluent - E8

Mill tailings will be treated for cyanide and metals using the Inco SO₂-Air process to maintain a cyanide concentration in the tailings pond below 10 mg/L. A secondary treatment plant using either hydrogen peroxide or a SO₂-Air will be installed in the mill and used to treat excess reclaim water once it becomes necessary. This system will also include a ferric sulphate HDS treatment component. The combined treatment system will remove residual cyanide remaining in the tailings pond water, precipitate metals complexed with cyanide and remove arsenic. Treated effluent will be discharged to a polishing pond (24 h retention time) prior to release to Dome Creek. During operation of the secondary treatment system, the polishing pond overflow will be sampled weekly for pH, conductivity, sulphate, temperature, turbidity, total cyanide, alkalinity, sulphate and ammonia. The following analyses will be conducted on a monthly basis - cyanate, thiocyanate, NFR and nitrate plus nitrite. Total and dissolved metals would be determined on a quarterly basis. Metal analyses would utilize (HVAAS) Hydride-Vapour Atomic Absorption Spectrophotometry for arsenic, antimony and selenium in order to obtain a more precise determination of these elements if present, than provided by ICAP-AES.

Polishing pond overflow will be defined as a Compliance Point in the Water License.

5.8 Groundwater

Since the tailings pond area is in permafrost, the presence of groundwater is not anticipated. This will be verified during construction of the tailings facility. In the unlikely event, that groundwater is detected, a series of three wells would be installed downstream of the pond. These stations could be analyzed for cyanide, metals and other constituents on a quarterly or twice annual basis. Monitoring frequency would be increased if the seepage collection pond samples indicated that contamination of the groundwater was occurring.

5.9 Analytical Laboratory

The analytical work will be conducted using a combination of on-site lab facilities and a certified commercial lab(s). The environmental lab facilities set-up for the Mount Nansen Mine will provide in-house assays for some of the internal effluent streams where quick turnaround time is required. The on-site facilities will be responsible for

most of the physical parameters that can be measured using instruments. A QA/QC program will be established between the commercial lab(s) and the on-site facility to verify results. All of the Surface Water samples will be sent to external commercial labs due to low detection limits and QA/QC requirements.

5.10 Biomonitoring

Pass/Fail Bioassay Tests will be conducted twice annually on polishing pond overflow (E7)(if applicable) during discharge period.

Bioassay determinations would be completed according to procedures described in "Biological Test Methods: Reference Method for Determining Acute Lethality of Effluent to Rainbow Trout" (Environment Canada (EC), 1990).

6.0 Spill Contingency Plan

6.1 General

A detailed Spill Contingency Plan for the Mount Nansen project will be assembled prior to construction start-up. This plan will outline response strategies to spills of potentially hazardous substances on the access road or the mill site area, which may affect the environment. The Spill Contingency Plan will facilitate the rapid deployment of personnel and resources to spills, so that environmental impact and risk are minimized and the health and safety of the workers and public are protected.

The plan will provide the Mount Nansen personnel with the essential information necessary to assess and mitigate potential hazards and set relative responsibilities of each of members. The plan will identify resources available, reporting procedures, and the action to be taken for each respective hazardous substance.

The following section provide the background information that will be used to assemble the Spill Contingency Plan.

6.2 Chemical Substances Utilized

A mining and milling operation utilizes a number of chemical substances in varying quantities. Primary emphasis will be placed on those chemicals which by virtue of the large quantities used, combined with their high toxicity or complex cleanup warrant special attention. In order of priority, this includes:

Large Scale Usage

- i) Sodium Cyanide
- ii) Diesel Fuel
- iii) Lime
- iv) Ammonium Nitrate
- v) Sulphur Dioxide

Smaller Scale Usage

- i) Copper Sulphate
- ii) Lead Nitrate
- iii) Hydrochloric Acid
- iv) Zinc Dust
- v) Sodium Hydroxide
- vi) Hydrogen Peroxide
- vii) Propane
- viii) Gasoline
- ix) Antifreeze
- x) Greases, hydraulic fluids and lubricating oils
- xi) Waste oil from mobile equipment - collected and shipped for recycling if possible
- xii) Cleaning agents and solvents.

Non-Toxic Chemicals

- i) Polyacrylamide flocculants, used as coagulating agents, are environmentally safe polymers used for removal of suspended solids in thickener.
- ii) Gold refining fluxes such as silica flour, borax, soda ash are relatively inert, used in small quantities, are of low or no toxicity and are easily cleaned up if spilled.

6.3 Reagent Deliveries

B.Y.G. Natural Resources Ltd. will assist with clean-up of spills of substances destined for the mine within reasonable proximity of the minesite. It will be Company Policy in its contractual arrangements with chemical and fuel suppliers to take possession of the supplies only upon delivery at the mine. It will also be Company policy to purchase chemicals and fuels only from suppliers which have the resources to adequately respond to spills, and have filed Contingency Plans under the Transportation of Dangerous Goods Act for designated substances.

BYG will assist in notifying regulatory agencies of a spill and provide manpower and resources for clean-up; the Company assumes no liability with respect to spills connected with transportation incidents prior to delivery by the consignor.

6.4 Organization and Responsibilities

Spills of chemicals, fuels and other substances may occur as isolated events or they may occur with other emergencies such as fire, explosion, natural causes or accident.

A number of response personnel may be involved to protect mine property and the health and safety of mine personnel and the public.

The key persons involved during a spill occurrence would be as follows:

- The person discovering the spill, and his Supervisor,
- The Mine Manager
- The Environmental Coordinator;
- The Response Team Leader (RTL); and
- The Clean-up crews.

The Spill Contingency Plan will detail the responsibilities of each of these persons in the event of a spill.

6.5 Government Notification Procedure

6.5.1 Minesite Spills

Although several government agencies at the municipal, territorial and federal levels may ultimately be involved, only one government contact is required to be made by the On-Scene Coordinator or his backup for the minesite spills:

Contact: Environment Canada - Yukon

1-403-667-7244

Contact: Environment Canada - Northern B.C.

1-604-387-5966

Environment Canada will notify all concerned agencies, including the following, as appropriate:

- The RCMP
- Environmental Protection
- Department of Health
- Environment Canada
- Any other relevant agencies.

6.5.2 Transportation Spills

In the case of a transport related accident, "dangerous occurrence" (as defined below) must be reported immediately to:

- Environment Canada
- The nearest R.C.M.P. detachment
- The employer
- The owner of the transport trucks.
- The owner or consignor of the dangerous goods.

A "dangerous occurrence" is considered to be:

- Any loss of dangerous goods in excess of specified amounts or which represents a danger;
- Damage to any container of dangerous goods;
- A transportation accident in which radioactive goods are involved;
- An unintentional explosion or fire involving dangerous goods.

While it is the responsibility of the transporter of the goods to report this type of incident, minesite personnel should ensure that it has been carried out properly.

More information on the reporting of a dangerous occurrence is provided in the Transportation of Dangerous Goods Regulations Appendix 4, Section 9 (Transport Canada, 1990, 1991).

6.6 Assessment of Spill Potential

Modern methods of packaging, transport and handling of potentially dangerous substances and an emphasis on proper training make serious spills unlikely.

Nevertheless, the severity of a potential spill is decreased by having a contingency plan in place and a demonstrated state of readiness.

6.6.1 Transportation Spills

The area of greatest vulnerability for spills are transport related accidents resulting from events such as icy roads, washouts, landslides, snow slides, collisions, or mechanical failures. Contingency plans filed by the Shipper with Transport Canada and required to be in the possession of the driver should be capable of addressing most transportation-related accidents.

Because prompt action may be vital in effective containment of a spill, BYG would provide assistance to the transporter in the event of a spill, without assuming any liability. BYG makes every effort to ensure that reagent shipment are scheduled to avoid poor road conditions and that portions of the access road for which it is responsible are properly graded, plowed and otherwise maintained to minimize risk.

6.6.2 Plantsite Spills

A positive feature of the plantsite with respect to spills will be that plantsite drainage will be designed to move downhill towards the collection system. Spilled materials would be reclaimed and the affected areas detoxified accordingly.

6.6.3 Fuels

Fuel unloading is another potential area of vulnerability. Standard procedures will be in effect for the safe unloading of fuels to storage tanks and safety berms will be provided to contain spills at the tanks. In the event of any spill, affected soils would be disposed of in an approved manner.

6.6.4 Cyanide (Solid Form)

Shipping, storage and handling of cyanide using Dupont Flo-bins or Degussa Bag and Crate containers will reduce the potential for spills of straight sodium cyanide. These are robust containers which will withstand considerable mishandling and mechanical abuse without puncture. Clean up of sodium cyanide briquettes would be handled by first recovering as much dry material as possible, followed by excavation of surrounding soils. Contaminated material would be returned to grinding and followed

by conventional effluent treatment. Areas affected by a spill of dry sodium cyanide could be further treated with bleach if required.

6.6.5 Lime

Unloading of granular quicklime from bulk tank trucks can result in spillage but cleanup should be straightforward. Spills of quicklime around the plantsite would be cleaned up with a front end loader and disposed of by recycling material to the crusher.

6.6.6 Explosives

The explosive used at the Mount Nansen Mine will be typical underground explosives and will be handled and stored in the approved manner.

Detonators, detonating delays, prima cord and stick powder will be stored in two separate licensed explosive magazines.

6.6.7 Spills - Internal or External to The Mill

Occasional spills of effluents containing cyanide and other reagents within the mill are anticipated and will be handled by internal sumps. Any other situations will be addressed using a front end loader and portable sump. A temporary catchment sump can be developed quickly, followed by installation of a portable submersible pump which would return spillage to the closest possible point in the circuit.

6.6.8 Sulphur Dioxide (SO₂)

All sulphur dioxide lines and fittings will be back-welded and pressure tested to prevent leaks.

Transfer of sulphur dioxide into the storage tank will be accomplished by padding the tanker truck with recirculated fumes from the storage tank to force the liquid into the storage tank. There will also be no release of fumes to atmosphere.

Small liquid leaks will be detected quickly by smell or application of ammonia gas in the vicinity which produces a white cloud.

Large leaks must be approached using self-contained breathing apparatus and isolated by closing appropriate valving.

Sulphur dioxide is very heavy (2-1/4 times heavier than air) and will seek low areas.

7.0 Prediction of Impacts/Mitigation

The development area is relatively small (13 ha for tailings impoundment, open pits and waste rock disposal), and given that the old mill will be used, effects on terrestrial resources will not be significant. Materials/soils will be removed from the open pits prior to development and can be stockpiled, if suitable, for future reclamation.

There has been hard rock and placer mineral exploration and development in the area since early in the century and mining has been the predominant land use. Mineral claims in the area to be developed are all held by B.Y.G. Natural Resources Inc. Hunting opportunities in the area are marginal and this should not be noticeably affected by the small operation proposed. A "closed area" will have to be posted around the mine area, mill, tailings and other facilities for safety purposes.

No unique or significant vegetation occurs in the area. Effects on wildlife will be negligible. The small amount of upland habitat involved will not affect local populations of moose or caribou and there are not expected to be any significant effects on birds.

Fish populations in Nansen and Victoria creeks would not be affected by the development of the Brown-McDade Zone. Careful management of the tailings system to meet water quality criteria will ensure minimal effects on downstream fisheries values. The small streams draining the deposit and development area (Dome and Pony creeks) do not have any significant fish habitat. The small amount of make-up water (maximum 4.7 L/s) required will be obtained from an aquifer in the Victoria Creek valley and will not affect fish in Victoria Creek. The section of Victoria Creek on the property freezes down to the substrate during the winter so that fish overwintering areas are non-existent.

7.1 Water Quality Impact Scenarios

The selection of tailings dam site #4 will virtually eliminate previous concerns regarding tailings pond seepage and its resultant water quality impacts. The dam will be constructed in permafrost and designed such that following construction, the permafrost will move up into the dam and cause the main body of the dam to become permanently frozen. The dam will be constructed so that the top of the permafrost is above the maximum pond elevation. This design will effectively eliminate seepage potential and result in a dam with high structural strength. In addition, as outlined in Section 3.7, a seepage collection pond will be constructed downstream of the tailings dam to collect and monitor groundwater. Seepage that does not meet criteria specified by Permit will be either pumped to the mill as make-up water or recycled to the tailings pond. The discharge of excess reclaim water from the tailings pond has some potential to impact the water quality of Victoria Creek (Dome Creek is assumed here to be a dilution zone). However as discussed in Section 4.4, the mill tailings will be treated for cyanide using the Inco SO₂-Air process prior to discharge to the tailings

pond. The tailings pond will provide storage and additional attenuation. Decant water will be reclaimed from the pond and pumped back to the mill as make-up water. This closed-circuit will prevent any un-controlled release of excess water that could have a negative impact on Dome Creek and Victoria Creek. If required a secondary treatment system will be installed in the mill to treat excess water prior to release. Based on the tailings characteristics from the recent program conducted by PRA (1994a) (see Section 4.4. and Appendix IV), the reclaim water may contain arsenic above current discharge criteria thereby requiring treatment using the ferric sulfate - HDS process. Proposed discharge criteria for the tailings treatment plant and reclaim water treatment plant and comparisons with Canadian Drinking Water and CCREM Objectives are provided in Table 7-1.

Mass balance calculations were used to estimate the quality of Victoria Creek at V2 (shown on Figure 2-2) during May, June and October, if treated reclaim water is discharged to Dome Creek and flow from there into Victoria Creek. Both a Mean Case and Wet Case have been evaluated. In the Mean Case, which assumes average flows for each of three years, there would be no discharges during the first two years of operation. There would, however, be a requirement for a discharge of 57,567 m³ during Year 3. This volume is equivalent to 4.2 L/sec over a 160 day discharge period. In the Wet Case, which assumes average flows for two years and a 200 year return wet year during the third, there would be no discharge during the first two years, but a requirement for release of 116,367 m³ during Year 3 (equivalent to 8.4 L/sec over a 160 day period).

Tables 7-2 and 7-3 list estimated water quality at V2 resulting from the seasonal release of excess treated reclaim under both Mean and Wet Cases. CCREM water Quality Objectives for aquatic life are included for comparative purposes. Flows are taken from Norecol hydrology data listed in Norecol, (1989a).

Mean water quality in Victoria Creek was calculated from Norecol data from 1985 to 1988 listed in Norecol, (1989a). Parameters that were missing from the Norecol data used Environment Canada data which included cobalt, molybdenum, nickel and antimony. Environment Canada (EPS, 1988) data were from a sampling point near the Dome Creek mouth, while Norecol data were from further downstream on Victoria Creek below its junction with Minnesota Creek. This distance is about 2 km further down Victoria Creek. This difference in sampling point should not significantly influence water quality results.

Tables 7-2 and 7-3 predicts that several parameters would exceed CCREM guidelines at V2 on Victoria Creek following dilution. For copper and iron, this is primarily due to the elevated background levels which exceed the Objectives. The background concentration of cadmium in Victoria Creek is at the objective, therefore providing no dilution capacity. Total cyanide slightly exceeds the 0.005 mg/L objective during low flow periods in both cases but not sufficient to impact water quality since the cyanide

will not be in a form that is toxic, i.e. mainly as iron cyanide. In summary, based on the proposed effluent quality and dilution provided in Victoria Creek, the discharge of treated effluent to Dome Creek should not have a negative impact on Victoria Creek relative to background.

Table 7-1: Proposed Tailings and Discharge Limits and Comparison with CCREM and Canadian Drinking Water Standards

Parameter	Tailings	Discharge Limits ⁽¹⁾	CCREM ⁽²⁾ Objectives Freshwater (Aquatic Life)	Canadian Drinking ⁽²⁾ Standards
pH		6.5 - 8.5	6.5 - 9.0	6.5 - 8.5
Total Suspended Solids		50		
Toxicity (LC ₅₀)		100%		
Total Cyanide	10	0.3	0.005	0.2
Cyanide (WAD)		0.1		
Metals				
Antimony (total)		0.05		
Arsenic (dissolved)		0.05	0.005 - 0.1	0.05
Barium (total)		1.0		
Cadmium (total)		0.02	0.0002 - 0.0018	0.005
Chromium (total)		0.04	0.002 - 0.02	0.05
Copper (total)		0.2	0.002 - 0.004	1
Iron (total)		1.0	0.3	0.3
Lead (total)		0.1	0.001 - 0.007	0.05
Manganese (total)		0.5		0.05
Mercury (µg/L)		5.0	0.1	1
Nickel (total)		0.3	0.025 - 0.15	
Silver		0.10	0.0001	0.05
Zinc (total)		0.30	0.03	

All concentrations in mg/L unless otherwise specified.

⁽¹⁾ Proposed Water License Limits

⁽²⁾ Canadian Water Quality Guidelines, 1987, Task Forces on Water Quality Guidelines of the Canadian Council of Resource and Environmental Ministers (CCREM).

Table 7-2: Predicted water Quality of Victoria Creek at Station V2 for Mean Flow Case

	Initial Concentrations		Calculated Monthly Concentrations				CCREM ^(c)
	Effluent ^(a)	Victoria Creek Average Water Quality (V2) ^(b)	May	June	Sept	Average	
Flow Rate (m ³ /s):	0.00416		0.976	0.221	0.277		
Dilution Ratio ^(d) :			234	53	67	118	
<u>Parameters</u>							
TCN	0.30	0.001	0.0023	0.0065	0.0054	0.0035	0.005
As	0.05	0.001	0.0012	0.0019	0.0017	0.0014	0.005
Cd	0.02	0.0002	0.0003	0.0006	0.0005	0.0004	0.0002
Cu	0.20	0.0155	0.0163	0.0189	0.0182	0.0171	0.002
Fe	1.00	2.230	2.2248	2.2073	2.2118	2.2197	0.3
Mo ^(e)	0.03	0.010	0.0101	0.0104	0.0103	0.0102	
Ni ^(e)	0.30	0.020	0.0212	0.0252	0.0241	0.0224	0.025
Sb ^(e)	0.05	0.050	0.0500	0.0500	0.0500	0.0500	
Zn	0.30	0.006	0.0072	0.0114	0.0104	0.0085	0.03

(a) Proposed Water Licence limits (Table 7-1)

(b) From Norecol water quality data. except as noted.

(c) Canadian Water Quality Guidelines, 1987, Task Forces on Water Quality Guidelines of the Canadian Council of Resource and Environmental Ministers (CCREM).

(d) Days of Flow = 160

(e) From Environmental Protection Data (1988).

Table 7-3: Predicted water Quality of Victoria Creek at Station V2 for Wet Case

	Initial Concentrations		Calculated Monthly Concentrations				CCREM ^(c)
	Effluent ^(a)	Victoria Creek ^(b)	May	June	Sept	Average	
Flow Rate m ³ /s):	0.0084		0.976	0.221	0.277	0.491	
Dilution Ratio ^(d) :			116	26	33	58	
<u>Parameters</u>							
TCN	0.30	0.001	0.0035	0.0112	0.0091	0.0055	0.005
As	0.05	0.001	0.0014	0.0021	0.0018	0.0013	0.005
Cd	0.02	0.0002	0.0004	0.0008	0.0006	0.0004	0.0002
Cu	0.20	0.0155	0.0168	0.0108	0.0102	0.0110	0.002
Fe	1.00	2.230	2.1850	0.5295	0.6472	1.1125	0.3
Mo ^(e)	0.03	0.010	0.0100	0.0033	0.0037	0.0054	
Ni ^(e)	0.30	0.020	0.0221	0.0154	0.0144	0.0149	0.025
Sb ^(e)	0.05	0.050	0.0492	0.0129	0.0153	0.0254	
Zn	0.30	0.006	0.0084	0.0123	0.0105	0.0080	0.03

(a) Proposed Water Licence limits (Table 7-1)

(b) From Norecol water quality data. except as noted.

(c) Canadian Water Quality Guidelines, 1987, Task Forces on Water Quality Guidelines of the Canadian Council of Resource and Environmental Ministers (CCREM).

(d) Days of Flow = 160

(e) From Environmental Protection Data (1988).

7.2 Socio-Economic Impacts

The tailings dam and pond overlays several placer claims. There is no record of any placer activity on the creek, however, BYG will negotiate potential conflicts with the placer claim owners.

Freshwater for the operation will be derived from an aquifer at a depth of 35 to 40 metres below Victoria Creek, and will not effect any water use by others. There could be some impact downstream of the well site due to the extract of water from the aquifer but it is unlikely that it will be substantial since the quantity of water being extracted is low relative to the flow in Victoria Creek.

The project area is not currently effected by first nations land claims. The Company is negotiating with the Little Salmon/Carmacks Band, regarding their participation in the proposed mining operation.

7.3 Surface Disturbance

Surface disturbance will be relatively small. The open pits (2.3 ha), waste rock dump (6.8 ha) and tailings impoundment (4.39 ha) will not result in any significant effects on soils or vegetation of the area. The mill facilities will be removed and the site revegetated once opportunities for future development of the property have been abandoned.

Drainage control will minimize the risk of erosion and site reclamation, where required, will stabilize the waste rock dump. The tailings impoundment will remain partially flooded and controlled by a permanent spillway constructed at closure. The spillway will discharge to a permanent rock lined diversion channel.

8.0 Financial Security

To satisfy the bonding requirements for reclamation, B.Y.G. Natural Resources Inc. will post a bond of \$150,000 plus pledge the new facilities constructed prior to start-up. This will ensure that approximately \$450,000 is available to cover the cost of reclamation should BYG fail to carry out the reclamation work as planned. This is an appropriate level of security given current status of the site and degree of impact expected from mining and milling of the Brown-McDade oxide deposit. A large portion of the reclamation liability (\$231,000) is due to site disturbance related to previous exploration and mining activities outside of the current project area. Reclamation of all disturbances in the project area is beyond the responsibility of BYG. BYG will, however, assume full responsibility for reclamation of the current project area. The company will endeavor to carry out reclamation activities in disturbed areas outside the current project area in agreement with the regulatory agencies. This work will be carried out during active operation and not accrue as a liability at closure.

9.0 Consultation

9.1 Little Salmon/Carmacks First Nations Band

The Mount Nansen site is located in an area considered to be traditional Territory of the Little Salmon/Carmacks Band. This Band is administered from their headquarters and offices in Carmacks.

The Band is currently negotiating land claim settlements with the Federal Government. It is expected that their negotiations will be completed by mid-1995. Although the Bands claims do not currently include the Mount Nansen site, it is acknowledged that following ratification of all land claim issues, First Nations will play a significant role in the management of affairs in the project area.

BYG has met with Band officials to discuss the possible impact that the mining operation would have on Band members, and to discuss ways by which the Band and it's members could participate in the economic benefits. To date (October, 1994), the Band has provided information on their expectations for participation in the venture, and suggestions about the form of agreement to be discussed. BYG has formulated an outline for negotiation with the Band, which was submitted for comment in early October, 1994.

9.2 Local Government

BYG has developed contacts with officials of the Village of Carmacks, and on various occasions have met with the Mayor, the Village Administrator, and the Clerk/Secretary. Discussions have generally revolved around the expected economic effect and impact of the mine on the Village.

9.3 Yukon Territorial Government

BYG has met on occasion with regulatory officials of the YTG concerning items such as heritage concerns, access and transportation, wildlife, and trapping. The Mining Facilitator for the YTG has also been kept apprised of all activities and plans.

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