draft

BYG - MT NANSEN

→ BOB HOA
→ TONY
→ BYG

B.Y.G.
NATURAL RESOURCES INC.

RECEIVED
JAN 15 2:51

ALAND

QZ-94-004

January 6, 1998

RENEWABLE RESOURCES
JAN 14 1998

Yukon Territory Water Board
Suite 106, 200 Range Rd.
Whitehorse, YT
Y1A 3V1

F.Y.I. /action;
as required - thx
PA
98/01/15

Attn. Judi Doering

Re: Water licence QZ94-004, Mt. Nansen Mine, Conceptual Decommissioning and Reclamation Plan

Dear Judi:

Here is a draft copy of our Decommissioning and Reclamation Plan. I still need to include a summary of each water quality station. I thought I had better get the draft in as soon as I could seeing as it is already overdue.

If you have any questions or concerns, please call me at (867)-863-5913 or fax me at (867)-863-6028.

Sincerely,

RECEIVED
JAN 15 1998
WATER RESOURCES
DIVISION

Jillian Chown B.Sc.
Environmental Coordinator

110 Industrial Road, Whitehorse, Yukon Y1A 2T9

BYG NATURAL RESOURCES INC.

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HAND
Q294004

MOUNT NANSEN CONCEPTUAL DECOMMISSIONING AND RECLAMATION PLAN
DRAFT COPY FOR REVIEW

January 1998

Prepared By:

BYG Natural Resources Inc.
110 Industrial Road
Whitehorse, YT

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B.Y.G. NATURAL RESOURCES CONCEPTUAL DECOMMISSIONING PLAN FOR MT. NANSEN PROPERTY

1.0 Introduction

In December 2001, B.Y.G. Natural Resources Inc. Mount Nansen Gold Mining Project is scheduled to cease mining operations. It is at this time that our water licence, QZ94-004, issued by the Yukon Territory Water Board expires. It's our intention to abandon mining operations at Mount Nansen in a manner that will not result in damage to the environment and is acceptable to the Yukon government and public. B.Y.G. Natural Resources Inc. has already initiated other abandonment activities and is seeking approval for the other proposed activities. Further, B.Y.G. has submitted a Temporary Closure Plan (dated January 7, 1997) and will be including some of these measures in the final Decommissioning and Reclamation Plan.

The following plan is intended as a draft Decommissioning and Reclamation Plan that will be finalized once the Yukon Territory Water Board has made recommendations for revision. Some activities, which still need to be conducted, are: consultation with the public, completion of the Arsenic Stability Program (Appendix 4 of Water Use Licence QZ94-004), Thaw Settlement Program (Appendix 9), Liquefaction Program (Appendix 10), and the Tailings Impoundment Seepage Monitoring Program (Appendix 10). Once we have this information, we can begin developing decommissioning strategies for the dam and tailings.

2.0 Project Background

2.1 Location and Access

The Mount Nansen Project is located approximately 60 km west of the Village of Carmacks, which is 180 km north of Whitehorse, on paved Highway 2. The Yukon government highways department maintains a gravel road from Carmacks to the property. 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.

2.2 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 is 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.

A system of veins swarm in a generally NW-SE direction across the property. Surface trenching has been completed on more than 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-sulfide 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 sulfide 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.

Figure 1.1

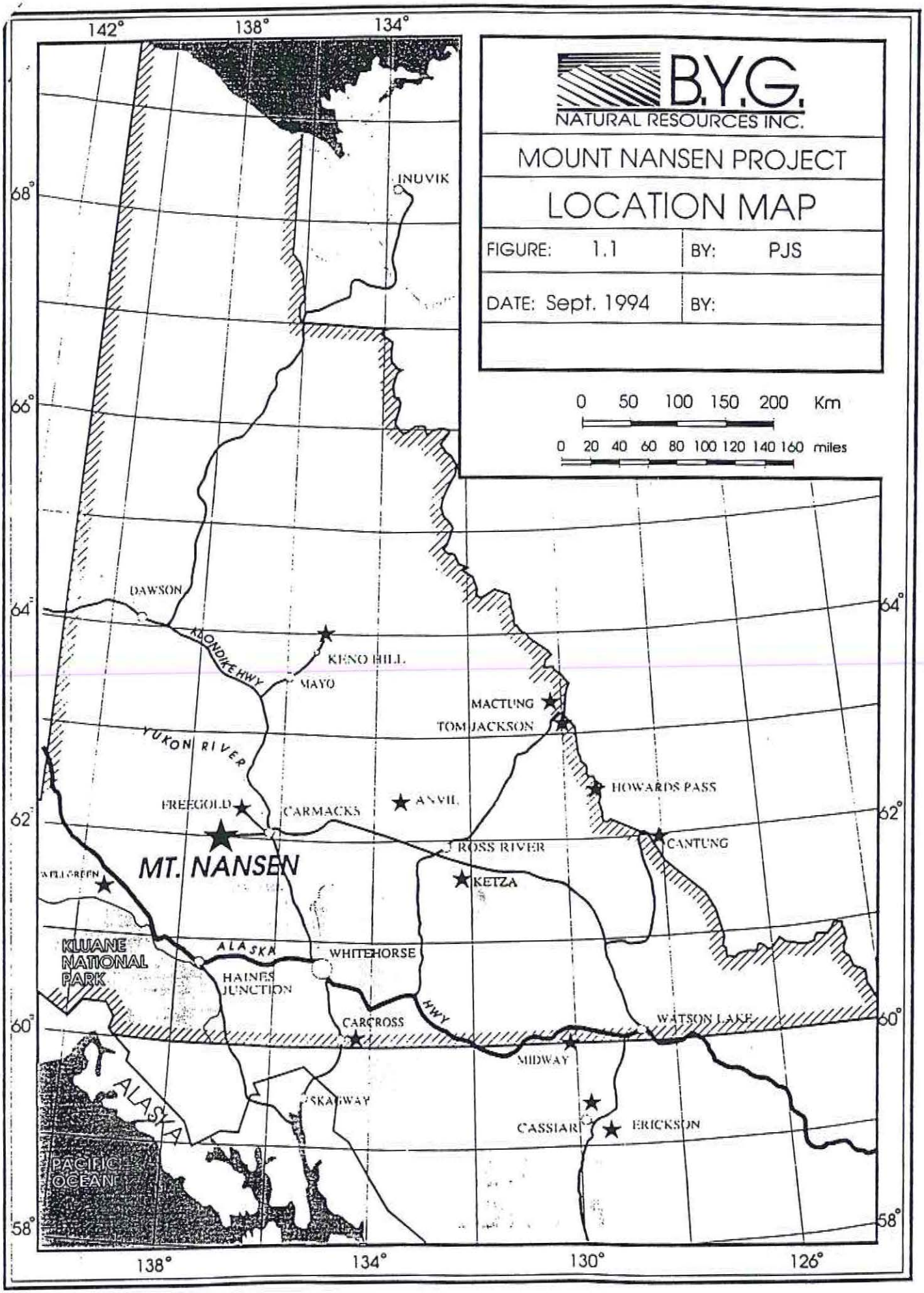

B.Y.G.
NATURAL RESOURCES INC.
MOUNT NANSEN PROJECT
LOCATION MAP
FIGURE: 1.1
BY: PJS
DATE: Sept. 1994
BY:
0 50 100 150 200 Km
0 20 40 60 80 100 120 140 160 miles
142°
138°
134°
130°
126°
68°
66°
64°
62°
60°
58°
INUVIK
DAWSON
KLONDIKE HWY
KENO HILL
MAYO
MACTUNG
TOM JACKSON
YUKON RIVER
HOWARDS PASS
FREEGOLD
CARMACKS
ANVIL
CANTUNG
ROSS RIVER
MT. NANSEN
KETZA
KLUANE NATIONAL PARK
ALASKA
WHITEHORSE
HAINES JUNCTION
HWY
CARCROSS
WATSON LAKE
MIDWAY
SKAGWAY
CASSIAR
ERICKSON
ALASKA
PACIFIC OCEAN

Figure 1.2

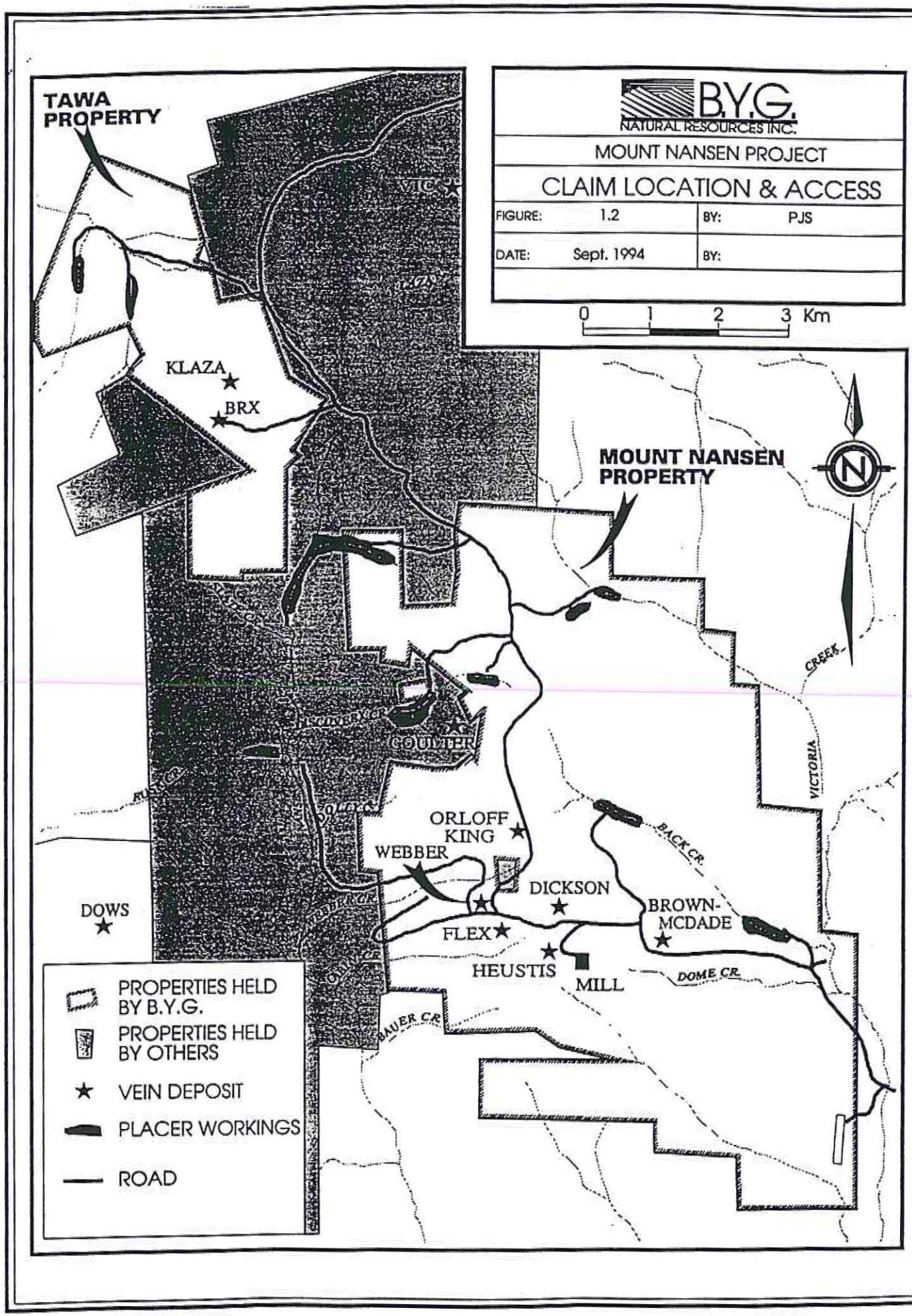

B.Y.G.
NATURAL RESOURCES INC.
MOUNT NANSEN PROJECT
CLAIM LOCATION & ACCESS
FIGURE: 1.2
BY: PJS
DATE: Sept. 1994
BY:
0 1 2 3 Km
TAWA PROPERTY
VIC
KLAZA
BRX
MOUNT NANSEN PROPERTY
N
COULTER
ORLOFF
KING
WEBBER
DICKSON
BROWN-MCDADE
FLEX
HEUSTIS
MILL
DOWS
BACK CR.
DOME CR.
BAUER CR.
VICTORIA
CREEK
PROPERTIES HELD BY B.Y.G.
PROPERTIES HELD BY OTHERS
VEIN DEPOSIT
PLACER WORKINGS
ROAD

Figure 1.3

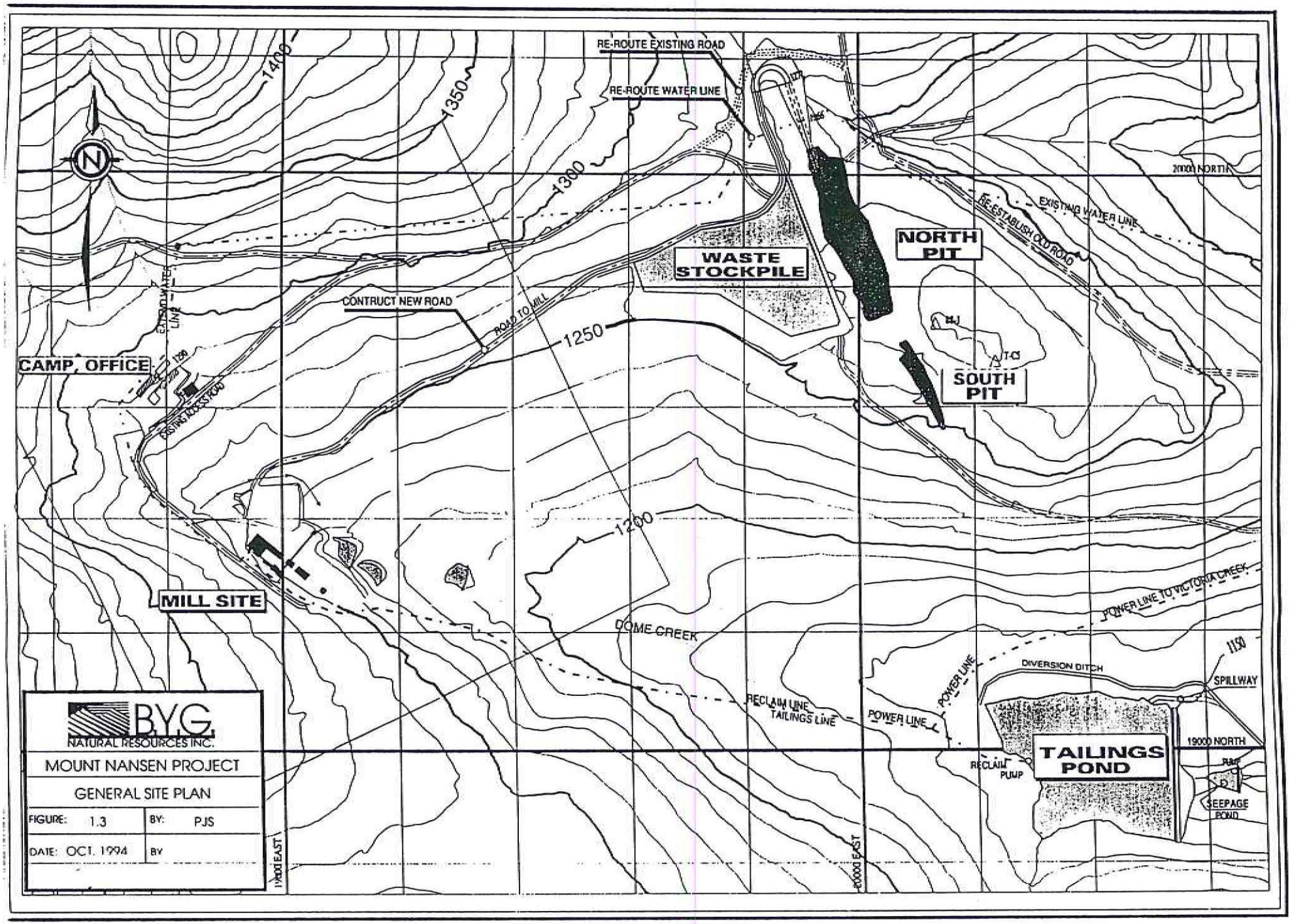

RE-ROUTE EXISTING ROAD
RE-ROUTE WATER LINE
1400
1350
1300
1250
1200
WASTE STOCKPILE
NORTH PIT
SOUTH PIT
RE-ESTABLISH OLD ROAD
EXISTING WATER LINE
20000 NORTH
CONTRUCT NEW ROAD
ROAD TO MILL
EXISTING WATER LINE
CAMP, OFFICE
EXISTING ACCESS ROAD
MILL SITE
DOME CREEK
POWER LINE TO VICTORIA CREEK
DIVERSION DITCH
SPILLWAY
RECLAIM LINE
TAILINGS LINE
POWER LINE
POWER LINE
TAILINGS POND
RECLAIM PUMP
19000 NORTH
SEEPAGE POND
19000 EAST
20000 EAST
BYG
NATURAL RESOURCES INC.
MOUNT NANSEN PROJECT
GENERAL SITE PLAN
FIGURE: 1.3
BY: PJS
DATE: OCT. 1994
BY

Figure 1.4

3.0 Conceptual Reclamation Plan

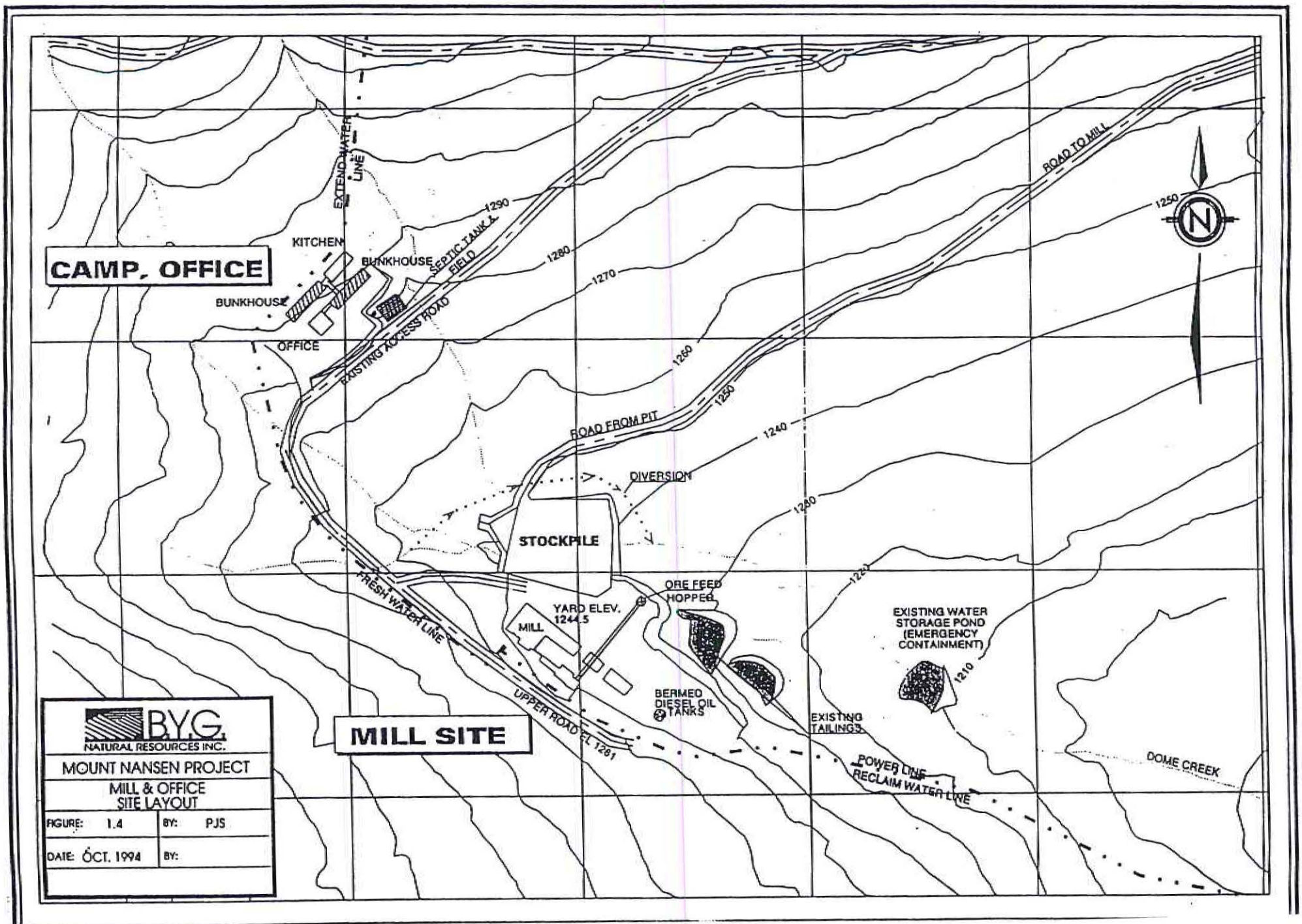
3.1 Reclamation Objectives

The general objective of the Reclamation Plan is to return disturbed lands to their original state and capability. For this mine site, the objective would be to provide wildlife habitat with sufficient undergrowth to serve as available browse. In the case of the Mount Nansen project, there are a number of site disturbances 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 that includes the Brown-McDade open pits and waste dump, the camp/office area, the mill site area, the tailings pond and all other ancillary facilities such site as roads, wells and stockpiles. BYG will 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 plan 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. Some reclamation work has already been started and will be discussed in subsequent sections of this report.


CAMP, OFFICE
KITCHEN
BUNKHOUSE
BUNKHOUSE
OFFICE
EXTEND WATER LINE
SEPTIC TANK & FIELD
EXISTING ACCESS ROAD
ROAD TO MILL
ROAD FROM PIT
DIVERSION
STOCKPILE
FRESH WATER LINE
ORE FEED HOPPER
YARD ELEV. 1244.5
MILL
BERMED DIESEL OIL TANKS
UPPER ROAD EL 1281
MILL SITE
EXISTING TAILINGS
EXISTING WATER STORAGE POND (EMERGENCY CONTAINMENT)
POWER LINE
RECLAIM WATER LINE
DOME CREEK
1290
1280
1270
1260
1250
1240
1230
1220
1210
1250
N
B.Y.G.
NATURAL RESOURCES INC.
MOUNT NANSEN PROJECT
MILL & OFFICE SITE LAYOUT
FIGURE: 1.4
BY: PJS
DATE: OCT. 1994
BY:

3.2 Reclamation Activities During Operations

A program of reclaiming current impacts, such as trenches, old access roads, waste piles from previous underground activities, etc., has been started. This work generally involves backfilling, recontouring, removal of culverts and re-establishing drainages, and test programs for revegetation.
The following activities have been carried out or will be carried out during operation to support and facilitate ultimate closure and reclamation of the site. Some of these activities may overlap other functions.

- Monitor stream water quality, waste dump water quality, tailings dam water elevations and tailings pond seepage. *(currently implemented)*

- Establish priorities and objectives for reclamation activities outside the current project site. *(need to discuss with public and regulatory authorities)*

- Investigate options for reclamation of the exploration trenches.

- Contour overburden slopes around final pit.

- Establish pit waste dump slopes at proper angle during placement of waste.

- Revegetate disturbed areas throughout mine site. *(seeding of disturbed areas has already been started and will continue next spring and upon mine closure)*

3.3 Reclamation Activities 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.*(A fuel-recycling program is currently being established with YTG Waste Management Department. All diesel fuel and Lithium grease on site will be recycled using YTG's program)*

- Complete preparation of waste dumps for revegetation. *(Work on the waste dump has already started. All recyclable items are stored separately, biodegradable items are buried, safe combustibles (paper, wood) are burned, and waste steel is recycled)*

- Scarify plant site, site roads for revegetation. ← removal of mill ?

- 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 buildings will be removed to ground level, trenches and roads will be reclaimed to 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.

3.4 Chemical Stability of Tailings

B.Y.G. Natural Resources Inc. is in the process of completing its Arsenic Stability Program (Appendix 4 of water use licence QZ94-004) to determine the stability of our tails. Results are expected by the end of February, 1998. Once this program is completed, decommission plans regarding tails can be completed.

3.5 Physical Stability of Tailings Impoundment

Due to faulty instrumentation, the Liquefaction Program (Appendix 10 of Licence QZ94-004), Tailings Impoundment Seepage Monitoring Program, and the Thaw Settlement Program (Appendix 9 of Licence QZ94-004) have been delayed. Although there has been some data collected regarding these programs, there is still insufficient data to accurately predict the Physical Stability of the Tailings Impoundment for the long term. B.Y.G.'s engineering consultants are currently implementing the revised instrumentation plan. New piezometers and thermistors as well as data loggers should be installed early in the New Year. DIAND had recorded an increase in the tailings pond water for the month of December. They have measured an increase of 0.5 cm from 03 to 23 December. BYG is aware of the increases in the dam water level and will hopefully have the water treatment plant operating by the end of January. Before BYG begins any milling operations, the water level in the dam will be reduced to a safe level.

3.6 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. Work to revegetate disturbed areas has already begun and will continue in the spring "98" and until mine closure.

3.7 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 grained materials that may be useful for reclamation will be stockpiled at the north end of the waste dump area for future use.

3.8 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 as soon as licence standards for effluent water can be met. 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 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 a 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.

3.9 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.

3.10 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 leveled and backfilled with overburden. Upon completion of the provisions of mine closure of the mill buildings and after it is assured that there is no further need for fresh process water, the pump house at Victoria Creek will be secured. The pump will be removed from well. The will be capped and locked. The pump house building will have all openings sealed and the doors locked. The process water line will be drained and purged with air. A professional engineer will inspect and monitor all structures, at a minimum of once a year, to ensure structural stability.

3.11 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 and revegetation methods. Test-work and research on seed mixtures, fertilization and planting techniques and vegetation has commenced. Randy Lewis, of Decora Landscaping, was consulted to provide technical advice concerning indigenous wild grass seed appropriate for the Mt. Nansen area. Upon his recommendation, an Arctic Alpine Seed Mix was purchased. Re-seeding of the mine site was started in September 1997.

3.12 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. A closure spillway designed for a 200-year return storm event will control the flow out of the tailings pond. 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. This pond will be removed at closure after the dump has been reclaimed.

3.13 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. All equipment will be removed from the open pit. Any temporary structures will be removed. Any remaining fuel oils will be removed from the site or fully consumed. Any temporary fuel containers will be removed from the site. Monitoring of the stations P1 and P2 will continue. A concrete bulkhead will be placed in the Brown McDade portal to prevent any drainage from the existing pit. Design plan will be submitted to the Yukon Territory Water Board before bulkhead construction begins.

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

3.15 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 the 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.

3.16 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 sulfide 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 a priority since it is currently a source of contamination to Pony Creek.

3.17 Prevention and Control of Acid Mine Drainage

Acid Rock Drainage (ARD) Characteristics of Tailings

The tailings from the Brown-McDade oxide ore contain approximately 0.6% sulfide and have slight negative Net Neutralization Potential (Net NP) of around -6 kg $CaCO_3$/tonne. Despite its negative Net NP, acid generation from the tailings 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.

ARD of Waste Rock

The waste rock from Brown-McDade is generally low in sulfide 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 sulfide sulphur above 1% that were 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. The Upper Altered Granodiorite has low sulphur content and sufficient alkalinity that it can be safely used for construction purposes. In addition Upper Feldspar Porphyry is also suitable for construction. Monitoring of seepage and run-off during operation will be conducted to verify the ARD prediction from testwork.
July, 1997 Waste Rock and Pitwall Acid Rock Drainage Study (See Appendix A)

3.18 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. 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
- a 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

A Spill Contingency Plan is included in Appendix B. Mill design will accommodate containment for internal spills.

3.19 Refuse, Sewage, Chemical Waste

All metal, glass, paper and wood products are being separated at source and stored for recycling. 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. All fossil fuels will be sent off-site to be recycled. B.Y.G. is currently working with YTG Waste Management Department (Brian Levia) to implement a waste fuel-recycling program.
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

- a 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.

Upon mine abandonment, process chemicals in circuit can only be removed by continuing the process until they are consumed. Process chemicals in circuit are:

Lime in the lime silo. Sufficient lime will be required to maintain protective alkalinity for the removal of cyanide in circuit. Should the quantity of lime in the silo be insufficient, bagged lime will be used to maintain protective alkalinity. No bagged lime will be used until the entire silo is empty including the screw conveyor feeding the primary ball mill.

Cyanide mixed and in solution. Once the mine operations cease, no further cyanide will be mixed. The processing of ore will continue until all of the cyanide, which has been mixed, has been consumed. Should an increase in cyanide addition be indicated in order to assure that the mixed cyanide is totally used, this will be done. Operation of the cyanide destruction circuit will occur in such a manner as to assure that this increase concentration does not report to the tailings facility. Strips on carbon performed subsequent to the removal of all in circuit cyanide will be performed without cyanide. Once the cyanide in circuit has been eliminated, the cyanide addition system will be flushed with fresh water. This will be done by:

1. Completely emptying the cyanide mix tank.
2. Refilling the cyanide mix tank with fresh water (not reclaim water).
3. Emptying the cyanide mix tank using all the cyanide addition points.
4. Refilling the cyanide mix tank a second time.
5. Emptying the cyanide mix tank using all of the cyanide addition points.

This will purge all of the cyanide in the cyanide mixing system and addition systems. There will still be cyanide in the circuit. Should the lime silo go empty during this procedure, bagged lime will be used until all cyanide in the mixing and distribution systems are purged. Should the cyanide destruction circuit S02 tanker run empty prior to the elimination of cyanide from the circuit, bagged sodium metabisulphite will be used until cyanide in the leaching circuit will used.

Caustic Soda (NaOH) in open barrels. Upon mine closure, any partially open barrels of caustic soda will be dumped into the #1 CIL tank. The caustic mix tank will be flushed as per the procedure for the cyanide system.

Liquid Sulfur Dioxide (SO2). Will be removed by running the cyanide destruction circuit until the tank is empty. Should the tank have residual SO2 after all other materials have been eliminated, the circuit will be run using fresh water. The SO2 placed in solution will report to the tails facility and provide residual cyanide destruction. Once all liquid SO2 is eliminated, the tanker will be flushed with dry compressed air for a period of 24 hours. The flow of air will be directed to the cyanide destruction circuit to stabilize any remnant SO2 and prevent the emission of SO2 to the atmosphere.

Ore in bins. Will be processed as per normal operations. Upon the completion of processing ore in the bins, all the bins shall be emptied into the circuit. Cemented ores from previous operations still in circuit will remain in the bins. Any spilled ore will be cleaned into the circuit. Material in the crusher house will be moved to the fine ore bins via the conveyor system. Ore in the fine ore bins will be directed to the grinding circuit. Upon completion of this, any spills of ore will be hosed to the appropriate sumps.

Once the bins have been emptied, further feeding of rock to the circuit will stop. At this time, the purging of cyanide, lime, caustic soda and SO2 will proceed to completion. Upon the complete depletion of all process chemicals, sufficient bags of sodium metabisulphite will be added to each leach tank to destroy any cyanide in circuit.

Loaded carbon. Will be removed from the circuit by the following method:

1. During the following procedure, once a tank is emptied, the drain at the bottom of the tank will be opened and the cap replaced with a ball valve.
2. Upon completion of the removal of ore products from the crushing and grinding circuit, the normal movement of carbon will stop.
3. The #2 CIL tank will be bypassed, with the discharge of #1 CIL directed to the cyanide destruction circuit. The material in #6 CIL will be pumped to #1 CIL using a sump pump. This will continue until tank is empty. **DO NOT PURGE THIS TANK YET.** During this time, the carbon will be moved to the stripping circuit in the usual manner.
4. When all of the material has been removed from #6 CIL, proceed to #5 CIL and pump all the material in this tank to #1 CIL. During this time, the carbon will be moved to the stripping circuit in the usual manner.

5. When all of the material has been removed from #5 CIL, proceed to #4 CIL and pump all the material in this tank to #1 CIL. During this time, the carbon will be moved to the stripping circuit in the usual manner.
6. When all of the material has been removed from #4 CIL, proceed to #3 and pump all the material in this tank to #1 CIL. During this period, the movement of carbon to the stripping circuit will be suspended.
7. When all of the material has been removed from #3 CIL, proceed to #2 and pump all the material in this tank to #1 CIL. During this period, the movement of carbon to the stripping circuit will be suspended.
8. When #2 CIL is emptied of material, the sump pump will be used to empty #1 CIL to #3 CIL via the loaded carbon screen.
9. When #1 CIL is emptied, each tank will be refilled with fresh water. (This filling can begin once a particular tank is emptied and the ball valve installed on the drain.)
10. Each tank except #3 CIL will be emptied via the bottom drain using a portable pump with the discharge directed to the carbon screen.
11. Once all of the tanks have been emptied, except #3 CIL, #3 CIL will be drained to the cyanide destruction circuit via the carbon safety screen using the bottom drain valve. Any carbon recovered will be directed from here to the stripping circuit.
12. Once all of the leach tanks are completely emptied, the cyanide destruction tank will be emptied using the sump pump with the discharge directed to the tailings box. This tank will be filled once using fresh water and emptied a second time.
13. Once the cyanide destruction tank is emptied, fresh water will be directed to the tails line for a period of 24 hours.
14. Once the tailings line is completely flushed, compressed air will be used to purge the line of any remnant liquids.

The stripping circuit will be emptied next. Carbon stripping will proceed as normal, except that stripped carbon will be directed to appropriate containers located on the grinding floor. These will be used to contain the carbon until the mill is restarted or a decision to permanently shut down is made.

Process Chemicals in Original Containers

Any remaining bagged lime, bagged sodium metabisulphite, barrels of caustic soda, barrels of acid, boxed of sodium cyanide and any refinery fluxes will be moved to the warehouse building (building directly adjacent to the diesel storage facility.) This building will be locked.

Corrosion Protection

All motors, agitators, gear reducers etc. will be greased according to manufacturers specifications for mine shut down. Tanks and process piping will be completely emptied of water. All water flows are to be directed to the final tails box. The tails line will be flushed with water from the Victoria Creek wells and then compressed air.

3.20 Reclamation Costs

A summary of Reclamation Costs –Incurred and Expended is included in Appendix C. The cost to reclaim areas disturbed by previous operators has been estimated at $504,420, while the estimated cost to reclaim areas distributed by the current project is $193,538. This is the total liability over the project life accrued due to a number of items including the open pit, waste dump, tailings pond, diversions and monitoring requirements. The incurred liabilities at the end of Year 1, 2, 3 and 4 have been estimated at $86,425, 41,500, $45,599 and $20,0140 with offsetting expenditures of $40,000, $127,925, $60,000 and $470,458.

Financial Security

To satisfy the bonding requirements for reclamation, B.Y.G. Natural Resources Inc. will post a bond of $150,000 at start-up with an increase to $200,000 after Year 3. This will ensure that sufficient funds are available to cover the cost of reclamation of disturbances caused by the current project should BYG fail to carry out the reclamation work as planned. This is an appropriate level of security given the 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 ($504,420) is due to site disturbance related to previous exploration and mining activities that are not the direct responsibility of BYG . However, BYG will assume full responsibility for reclamation of the current project area. The company will carry out reclamation activities in disturbed areas outside the current project area in agreement and consultation with the regulatory agencies. Some of this work will be carried out during active operation and not accrue as a liability at closure. The BYG's position regarding Financial Security is that it should not be required to post a security bond for reclamation of the previously disturbed areas as long as it commits to carry out the work required.

In the event that additional oxide reserves are delineated on other deposits in the claim group or milling of sulfide proves feasible, the reclamation costs and related bonding requirements will be revised to ensure that sufficient funds are set aside for reclamation.

4.0 Water Management

4.1 Objectives

The key objectives of the water management system are 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 disturbed areas
- Maintain acceptable flows in streams impacted by mining to minimize environmental impact.

4.2 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 designated as the Polishing Pond/Water Storage Pond on Figure 1.4. This pond will overflow to Dome Creek. Detailed design will occur prior to construction and will follow general guidelines required for such structures. 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 current mine plan does not involve excavation to sufficient depth in the North Pit to intercept the existing Brown McDade adit. However there is potential that water retained in the pit could travel through fractures in the bottom of the pit and drain out through the adit. However it should be noted that the adit is currently in permafrost and seepage would freeze prior to reaching the adit. In the event that water stored in the pit, actually leaks into the adit, the adit will be sealed with a reinforced concrete plug to ensure that seepage out of the adit does not occur. Once mining is complete, permafrost will likely intrude the base of the pit and eliminate seepage concerns.

The water management system consists 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 Figures 1.3 and 1.4.

4.3 Current Water Quality

Since operations began in December, 1996, surface water quality has been monitored weekly at 10 monitoring stations as required under the Water Use Licence QZ94-004. Locations of the the water quality stations are as follows:

E1- Reclaim Water Intake
E2- Tailings Pond Seepage
E7- Polishing Pond
D1- Dome Creek Upstream Control Point
D2- Dome Creek .4km from mouth
D3- Dome Creek 100 m down from Tailings Pond
P1- Pony Creek 600 m from mouth
P2- Brown-McDade Adit Entrance
V1- Victoria Creek Pump House
V2- Victoria Creek Downstream of Dome Creek.

A copy of Water Use Licence QZ94-004- Appendix 1, B.Y.G. Natural Resources Inc. Mt. Nansen Project Surface Water Sampling Sites is included in Appendix D.

A six month summary of all water quality parameters for each station is included in Appendix D. The water quality data covers a period beginning in May 1997 and ending in September 1997. This data will provide a current perspective of the surface water quality to date. Please refer to Appendix E for a summary of each station regarding its water quality and compliance with effluent standards. After mine closure, B.Y.G. will continue to obtain and analyse the licence required water quality samples and to ensure that all effluent continues to meet the licence standards.

4.4 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. However, an emergency spillway will be required during operation to prevent dam overtopping during an extreme inflow flood event. With the proposed diversion channel, the pond catchment area will be approximately 0.5 km^2. The estimated peak flood inflow resulting from a 200-year return period rainfall event is 2.9 m^3/s. A 3 m wide emergency spillway would 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

km^2 (including the pond area of 0.04 km^2), resulted in a peak PMF inflow of 34 m^3/sec. This is an approximate value for prefeasibility. 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 G), 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.

4.5 Water Balance

See Appendix E.

4.6 Seepage Collection

There is some seepage through the dam. A small seepage recovery pond was constructed to catch any seepage that by-passes the dam. Water collected in this pond is being pumped back into the tailings pond.

5.0 Future Considerations

The current design assumes a three-year mine operation after which no further tailings will be deposited. Based on this operation plan, the thermal analyses indicate limited thawing under the upstream portion of the dam with eventual freezeback of the tailings after mine operations are ceased. Should the mine life be extended it is anticipated that thaw penetration will continue which must be accounted for in future assessments of the settlement, stability and seepage. Incorporation of a downstream berm has been considered as a future solution to several of the technical concerns. The need for a downstream berm should be determined based on the observations of the performance monitoring program.

Raising of the dam will require new diversion and emergency spillway facilities at a higher elevation. Excavations at higher elevations will be more difficult due to steeper slopes further up the valley slope. In addition, the existing diversion channel design does not include an impervious liner. If seepage losses are excessive, a liner may be required in the future.

Raising of the dam must also consider the method of future embankment construction. Raising of the dam on the existing centerline will require embankment construction of the upstream slope of dam overtop of the tailings beach which may have technical concerns. Shifting the dam crest centreline downstream will allow all construction to occur above the existing compacted embankment, however quantities of new fill will be greater and the downstream toe of dam may encroach on the seepage recovery dam.

The winter tailings deposition method will also affect the tailings density and beach slope. Subaqueous deposition is assumed, however, if beach spigotting occurs during the winter significant ice may build up, thereby reducing available storage densities and potential reclaim water.

A closure spillway is eventually required on the south abutment where bedrock can be exposed at the channel invert for long term protection. The downstream outlet channel of the spillway may, however, be constructed on overburden soils which will require erosion protection. It is anticipated that the riprap protection will be much larger than the riprap installed at the temporary emergency spillway. Waste rock, which is large in size and may be suitable, as riprap should therefore be salvaged from the mine operation over the next three years. The alignment of the closure spillway will be dependent on the eventual dam crest elevation. The invert of this channel should be situated in bedrock at least as far as the downstream toe of dam before descending the slope in the outlet channel. In order to finalize the alignment of the closure spillway, it will be necessary to eventually obtain additional rock depth information in the area downstream of the dam centreline on this abutment.

6.0 Schedule of Reclamation Studies

Thaw Settlement Program	begin installing new thermistors and piezometers in early February. EBA Engineering is waiting for approval for DIAND's approval of the Proposed Instrumentation Plan.
Liquefaction Monitoring Program	to begin in early February.
Tailings Arsenic Stability and	Tailings Arsenic Stability Program is nearing completion. The Multi-element ICP Analysis on treated and untreated tails is complete. (Appendix F)
Effluent Quality Program	Continuous monitoring of effluent water has occurred inside the plant. Reclaim water quality results are included in Appendix D. LC 50 Trout Bioassay has not been passed to date. We are still conducting regular water quality test work on the Effluent water. A summary of these results is available upon request.

7.0 Seepage from the Pit Floor to the Old Underground Adit

B.Y.G. proposes to eliminate all concern regarding seepage from the pit by sealing the adit prior to final abandonment.
Detailed designs will be submitted to YTWB prior to installation of the adit plug.
It is agreed that monitoring and sampling of any flow from the adit will be a condition of the licence.

8.0 Closure Spillway

For mine closure, a permanent spillway should be constructed in rock on the south abutment. For long-term abandonment, the design flood discharge is assumed to be 100% of the Probable Maximum Flood (PMF). Assuming a spillway invert width of 5 m, channel sideslopes in rock of 0.5H:1V, an invert elevation of 1149.2 m (final tailings level) and PMF conditions, a routed maximum pond level of 1151.3 m was calculated. Including freeboard for waves and wind set-up a dam crest of up to 1151.8 m may be required. This exceeds the current planned dam crest elevation of 1150.9 m by 0.9 m indicating that the dam would require raising at closure. Depending on the final level of the tailings it may be acceptable to reduce the invert of the spillway thereby reducing the requirement to raise the dam crest at closure. Alternatively a 10 m wide spillway could be constructed which results in a PMF pond level of 1150.8 m requiring a final dam crest of 1151.3 m, reducing the amount of the dam raise at closure to 0.4 m. The final design of the closure spillway should be determined when the final orientation of the tailings and the settled dam height is known. The analysis should include provisions for wave protection and overtopping.

Average Year Water Balance

The average year water balance results indicate that, with the diversion in place, there will be 237 300 m^3 of excess water over the 3 year mine life. The water level reaches 1149.7 m based on storing a minimum two-month mill water circulation volume of 30 000 m^3/month. During the winter there is a net loss of pond water due to minimal inflow and losses to tailings voids. In an average year, winter losses are estimated to be 2000 m^3/month.

200 Year Water Balance

If a 200 year wet year is added in year 2, with the remaining years being average, results indicate that, with the diversion in place, there will be 298 360 m^3 of excess water over the 3 year mine life. The maximum water level of 1149.7 m is unchanged since it is based on the tailings level plus 2 months volume of mill water circulation.

9.0 Public Consultation

B.Y.G. would like the public to review this conceptual decommissioning and reclamation plan. Our goal is to receive outside viewpoints and ideas concerning open pit mine decommissioning and reclamation. We would like to meet with interested public groups in early February so we can evaluate their opinions and concerns. Once we can hear the public's voice, we can begin finalizing the plan.

APPENDIX A

WASTE ROCK
AND
PIT WALL
ACID ROCK DRAINAGE ("ARD") STUDY

Brown McDade Pit
Mount Nansen Mine
BYG Natural Resources Inc.

July, 1997

William D. Mann, M.Sc.
Geologist

Environmental Coordinator Copy

WASTE ROCK AND PIT WALL ACID ROCK DRAINAGE ("ARD") STUDY FOR BYG's BROWN McDADE MINE AT Mt. NANSEN

Executive Summary

The Mount Nansen Mine began production from the Brown McDade pit in November, 1996. This ARD study is a requirement of the mine's Water Use Licence. ARD testing of 13 samples from the Brown McDade pit walls, and 14 samples from the pit waste dumps in 1997 have confirmed that there is no significant potential for acid generation. These samples are thought to be representative of the currently exposed pit walls, and the current waste dump as of June, 1997. All samples were very low in sulphides (less than 1%), and commonly have a positive net Neutralization Potential. A few samples have slightly negative net Neutralization Potential, but low sulphide content. Most of the rocks exposed in the pit walls and present in the waste dumps are moderately to highly oxidized. Calcite is a common accessory mineral in unoxidized rocks here.

ARD tests for this area were conducted in 1985, 1989 and 1994, and were compiled in the Mount Nansen Initial Environmental Evaluation report. A total of 51 samples thought to be representative of the pit were analyzed, and indicated low sulphide levels and mostly positive net Neutralization Potentials. This work has been verified by the 1997 work.

13 of 14 waste rock samples have positive net Neutralization Potential and do not pose a risk of ARD, and could be used for construction purposes. However, most of the waste rock is highly oxidized, clay-altered, and quite incompetent and therefore not suited for construction.

Additional ARD sampling of pit walls and floor is required upon completion of the pit. Additional waste rock sampling should be conducted as mining continues.

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WASTE ROCK AND PIT WALL ACID ROCK DRAINAGE ("ARD") STUDY FOR BYG's BROWN McDADE MINE AT Mt. NANSEN

OBJECTIVES:

1. To verify the ARD assessment work completed as part of the IEE program, which indicated no significant potential for ARD.
2. To aid in reclamation planning.
3. To fulfill requirements of Water Use License QZ94-004 Appendices 5 and 6.

STUDY METHODOLOGY:

Waste Rock Pile: 14 samples representative of the waste pile were collected at 25m intervals along the base of the waste dump by a qualified geologist.

Pit Walls: 13 samples were collected from the pit walls along the currently exposed portion of the pit. At this stage there are no walls exposed at the southern end of the pit, and the exposed walls may not be the final pit limits. Only 3 samples were collected from the Hangingwall, as there was very little exposed at the time of sampling. Additional sampling will be required when the pit reaches its final depth.

Analysis: Samples were sent to Process Research Associates Ltd. (PRA) of Vancouver. All samples were analyzed by the most recent version of **Acid Base Accounting using the Modified Procedure**. A detailed description of the methods used are available in Appendix 1.

BROWN MCDADE MINE

Pit Geology

Approximately 300,000 Tonnes of waste rock has been stripped at Brown McDade out of a planned total of about 600,000 Tonnes. The waste to date has consisted almost entirely of hangingwall material, as the footwall has only been ripped with a dozer and not blasted. The hangingwall rock is dominantly clay-altered granodiorite, with some felsic porphyry dykes. The dykes are narrow, and therefore the different rock types are mixed together. The waste rock encountered to date has been strongly to moderately oxidized, and very little pyrite has been encountered. The material is generally coated by mud and rusty oxides on fractures, and lithological identification is often very difficult. It has therefore not been possible to segregate the two types of waste rock. Calcite is a common accessory mineral in weakly oxidized rock.
The locations of the samples collected are presented in Figure 1. The descriptions of the samples collected for ARD analysis are summarized in Table 1.

Rock Use in Construction

The rock used for construction purposes on site has been almost entirely surficial material. A small amount of waste rock from the pit was used on the haul road from the pit to the mill, after examination to ensure that no sulphides were present. Most of the

waste rock encountered to date has not been suitable for construction because of poor competency related to strong clay alteration.

ANALYTICAL RESULTS

The ARD samples were sent to Process Research Associates of Vancouver. The samples were analyzed by the **Modified Acid Base Accounting Procedure** detailed in Appendix 1. In addition to the sulfur species analyzed in the above procedure ICP analysis was performed for 31 metals, plus mercury.

PRA's complete report of analytical results is presented in Appendix 2. Graphical presentation of the results is in Appendix 3. All previous ARD studies are summarized in the Initial Environmental Review, section 4.6, which is reprinted in Appendix 5.

The 1997 ARD analyses returned results very similar to previous studies. Most samples have positive net Neutralization Potential, with a few weakly negative samples. Total sulphur and sulphide sulphur values are low, rarely over 1% and generally less than 0.4%. Therefore there is no significant potential for acid generation.

Metal values are locally anomalous, notably for Iron, Manganese, Arsenic, Lead, Zinc and Cadmium. These high values are expected in this area. Metal analyses are presented in Appendix 4. The rocks and soil in the Mt. Nansen area are commonly enriched in these elements.

Table 1.

June 1997 Brown McDade Pit Wall ARD Samples

Sample Number	Location: Section	Elevation	Rock Description
6301	5+29	1261	FW: alt. GD w/ Mn, Hem.
6302	4+96	1261	FW: alt. GD w/ strong Mn
6303	4+63	1255	FW: less alt. GD
6304	4+30	1255	FW: alt. GD w/ Mn staining
6305	3+97	1261	FW: alt. GD w/ Mn staining
6306	3+64	1261	FW: alt. GD w/ Mn staining
6307	3+31	1261	FW: alt. GD w/ Mn staining
6308	2+98	1265	FW: alt. GD w/ Mn staining
6309	2+65	1265	FW: alt. GD w/ Mn staining
6310	2+32	1265	FW: less alt. GD
6316	2+98	1262	HW: clay alt. GD, soft, Mn & Lim. staining
6317	3+31	1262	HW: Porphyry, fresh-mod oxidation, <.5% Py.
6318	3+64	1262	HW: clay alt. GD, Mn & Lim. staining, tr. Py., QV

Brown McDade Waste Dump ARD Samples

Sample Number		Rock Description
6319		GD, Ppy, minor QV, Mn, Lim.
6320		GD, soft, Lim.
6321		GD, clay alt., minor Ppy, bleached GD w/ QV
6322		GD, variably alt., weak Ox., tr. Py
6323		GD, mod. alt., Lim, strong Mn
6324		GD, variable alt., weak Lim, Mn
6325		50% GD, 50%Ppy, clay alt, Mn, Lim, low grade?
6326		75% GD. 25% Ppy, strong Ox., clay alt., Lim., Mn
6327		GD, mod. alt., Ox., Ppy w/ Py <.5%
6328		GD, variable alt., weak Lim, Mn, low grade, mud
6329		GD, strong clay, Ox., minor Ppy, low grade, tr. Py.
6330		GD, strong clay, Ox., minor Ppy, low grade
6331		GD, strong clay, Ox., Hem., Lim., Mn
6332		GD, strong clay, Ox., Hem., Lim., Mn

abbreviations: GD = granodiorite
Ppy = porphyry
Py = pyrite
QV = quartz vein
Ox = oxidation
Mn = Manganese Oxide
Lim = Limonite (iron oxide)
Alt. = Alteration
Hem = Hematite
tr. = trace
FW = footwall
HW = hangingwall

FIGURE 1 SAMPLE LOCATIONS

APPENDIX 1

Modified Acid Base Accounting Procedure

APPENDIX I

The Modified Acid Base Accounting Procedure for neutralization potential used in this study was as follows:

1. Add a few drops of 25% HCl to 1 to 2 g of pulverized sample on a watch glass or piece of aluminum foil. Observe the degree of reaction and assign a fizz rating as "none, slight, moderate, or strong fizz".
2. Weigh approximately 2.00 g of pulverized sample into a 250 mL conical flask and add approximately 90 mL of distilled water.
3. At the beginning of the test (time = 0), add a volume of certified or standardized 1.0 N HCl according to the fizz rating as follows:

Fizz Rating	Volume of 1.0 N HCl (mL) at time = 0 h	at time = 2 h
None	1.0	1.0
Slight	2.0	1.0
Moderate	2.0	2.0
Strong	3.0	2.0

3. Place the flask on a shaking apparatus such a reciprocating shaker, maintained at room temperature. After approximately 2 hours, add the second acid quantity as indicated in the above table.
4. After approximately 22 hours, check the pH of the pulp. If it is greater than 2.5, add a measured volume of 1.0 N HCl to bring the pH into the range 2.0 to 2.5. If the pH is less than 2.0, too much acid was added in steps 2 and 3. In this case, repeat the test adding a reduced volume of HCl.
5. After 24 hours, terminate the test and add distilled water to the flask to bring volume to approximately 125 mL. Measure and record the pH, making sure it is in the required range of 2.0 to 2.5.
6. Titrate the contents of the flask to a pH of 8.3 using certified or standardized 0.5 N or 0.1 N NaOH.
7. Calculate the NP of the sample as follows:

$$\text{Modified NP (kg } CaCO_3/t) = \frac{(N \times \text{vol (mL) of HCl}) - (N \times \text{vol (mL) NaOH})}{\text{weight of sample (g)}} \times 50$$

The acid generating potential of the sample should be calculated on the basis of the sulfide-sulfur content (AP = S$^{=}$ x 31.25). Sulfide-sulfur is typically determined as the difference between total sulfur and sulfate-sulfur, although analysis of other sulfur species such as elemental sulfur and barite-sulfur is sometimes justified. Caution should be exercised for certain samples in interpreting sulfate-sulfur analyses as this form can be either inert (eg. gypsum) or essentially stored products of acid drainage that could become mobilized if conditions within a waste change. Reference to the MEND Report 1.16.1c is suggested (Norecol Environmental Consultants, 1991) for a discussion of sulfur species.

APPENDIX 2

1997 ACID BASE ACCOUNTING TEST REPORTS

Process Research Associates Ltd.

ACID BASE ACCOUNTING TEST REPORT

Modified Method

To: B.Y.G. Industrial Resources Inc.
110 Industrial Road
White Horse, Yukon
Y1A 2T9

Attention: Mr. Bill Mann

Project: 97-066

Date Reported: 22-Jul-97

Sample: 13

Brown McDade Pit

Sample I.D.	% Total Sulfur	% Sulfate Sulfur	Paste pH	Acid Potential	Neutralization Potential (NP)		
					Actual	Ratio	Net
6301	1.82	0.82	7.1	31.25	46.69	1.49	15.44
6302	0.32	0.03	6.3	9.06	7.99	0.88	- 1.07
6303	0.09	0.01	6.5	2.50	- 1.89	- 0.76	- 4.39
6304	0.37	0.04	6.7	10.31	16.01	1.55	5.70
6305	0.21	0.01	6.1	6.41	- 3.12	- 0.49	- 9.53
6306	0.17	0.01	7.7	5.16	13.54	2.63	8.38
6307	0.09	0.01	5.9	2.66	- 1.89	- 0.71	- 4.55
6308	0.12	0.01	7.1	3.59	3.05	0.85	- 0.54
6309	0.11	0.01	6.5	3.28	- 4.36	- 1.33	- 7.64
6310	0.63	0.01	7.7	19.53	23.09	1.18	3.56
6316	0.32	0.01	7.6	9.84	50.54	5.13	40.70
6317	0.81	0.01	7.9	25.16	76.51	3.04	51.35
6318	0.14	0.02	7.0	3.75	5.52	1.47	1.77

Peter Tse, AScT.
Laboratory Manager

Notes:

1. Analytical procedures from "Field and Laboratory Methods Applicable to Overburden and Minesoils". EPA 600/2-78-054, 1978. pp. 45-55 and "Acid Rock Drainage Manual, A manual of chemical evaluation procedures for the prediction of acid generation from mine wastes". Prepared by R.W. Lawrence and P.B. Marchant under CanMet Contract 23440-9-9149/01-SQ. 1990.
2. Actual NP = Neutralization potential as determined by modified method, Acid Rock Drainage Manual.
3. Acid potential = (% total sulfur - % sulfate sulfur) X 31.25.
4. NP Ratio = Actual NP / Acid potential
5. Net NP = Actual NP - Acid potential
6. The acid potential and the neutralization potentials are expressed in Kg $CaCO_3$ equivalent per tonne of sample.
7. Samples with negative Net NP are potential acid producers

ACID BASE ACCOUNTING TEST REPORT

Modified Method

To: B.Y.G. Industrial Resources Inc.
110 Industrial Road
White Horse, Yukon
Y1A 2T9

Attention: Mr. Bill Mann

Project: 97-066

Date Reported: 22-Jul-97

Sample: 14

Waste Pile

Sample I.D.	% Total Sulfur	% Sulfate Sulfur	Paste pH	Acid Potential	Neutralization Potential (NP)		
					Actual	Ratio	Net
6319	0.66	0.02	5.2	20.00	- 8.06	- 0.40	-28.06
6320	0.21	0.01	7.9	6.41	34.82	5.44	28.41
6321	0.21	0.01	7.7	6.41	15.07	2.35	8.66
6322	0.25	0.01	8.0	7.50	27.41	3.65	19.91
6323	0.47	0.01	7.7	14.53	27.41	1.89	12.88
6324	0.26	0.01	7.6	7.97	26.79	3.36	18.82
6325	0.28	0.06	7.8	6.88	20.62	3.00	13.75
6326	0.26	0.03	7.4	7.19	9.51	1.32	2.32
6327	0.25	0.01	7.9	7.66	44.08	5.76	36.42
6328	0.55	0.22	7.6	10.31	13.22	1.28	2.91
6329	0.55	0.38	7.0	5.31	23.71	4.46	18.40
6330	0.45	0.16	7.7	9.06	14.45	1.59	5.39
6331	0.01	0.01	7.9	0.16	8.89	56.90	8.73
6332	0.23	0.10	7.9	4.06	18.15	4.47	14.09

Peter Tse, AScT.
Laboratory Manager

Notes:

1. Analytical procedures from "Field and Laboratory Methods Applicable to Overburden and Minesoils". EPA 600/2-78-054, 1978. pp. 45-55 and "Acid Rock Drainage Manual, A manual of chemical evaluation procedures for the prediction of acid generation from mine wastes". Prepared by R.W. Lawrence and P.B. Marchant under CanMet Contract 23440-9-9149/01-SQ. 1990.
2. Actual NP = Neutralization potential as determined by modified method, Acid Rock Drainage Manual.
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4. NP Ratio = Actual NP / Acid potential
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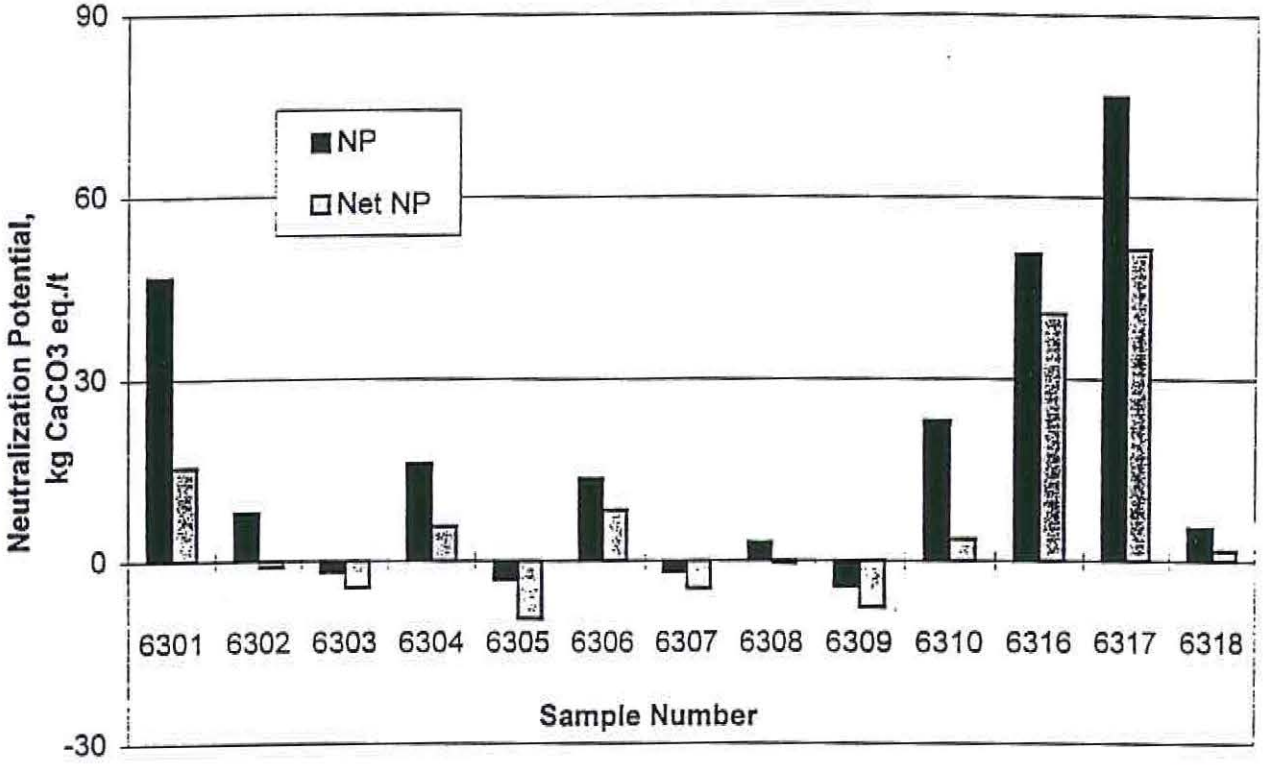
6. The acid potential and the neutralization potentials are expressed in Kg $CaCO_3$ equivalent per tonne of sample.
7. Samples with negative Net NP are potential acid producers

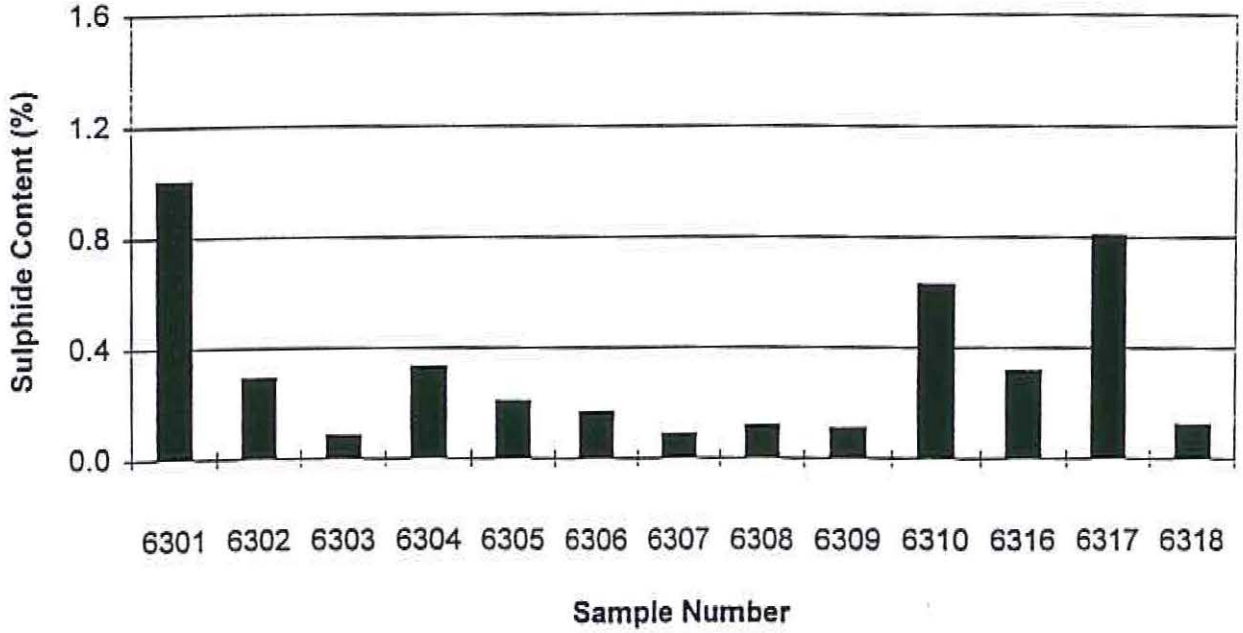
APPENDIX 3

GRAPHS

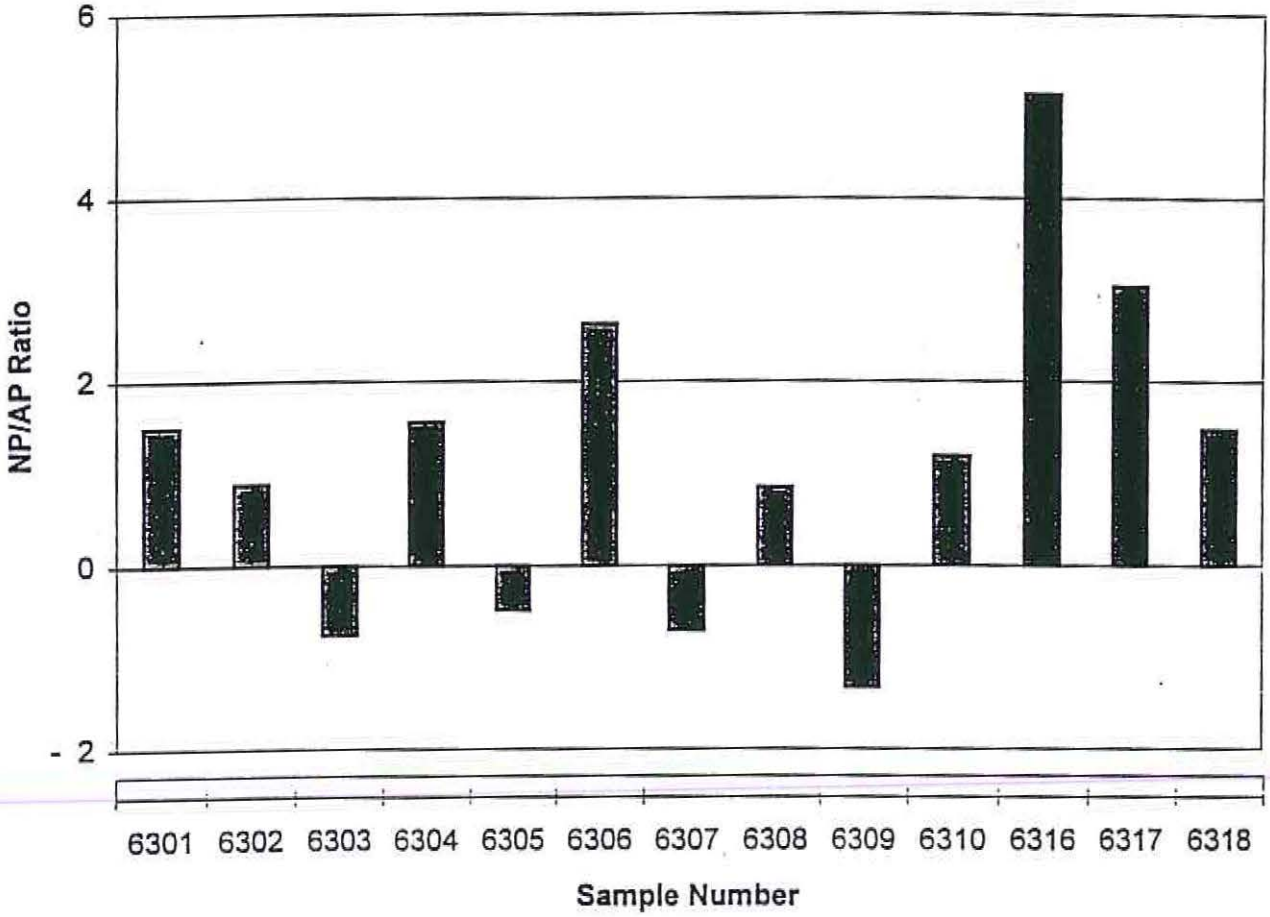
Neutralization Potential of the Brown McDade Pit Sample



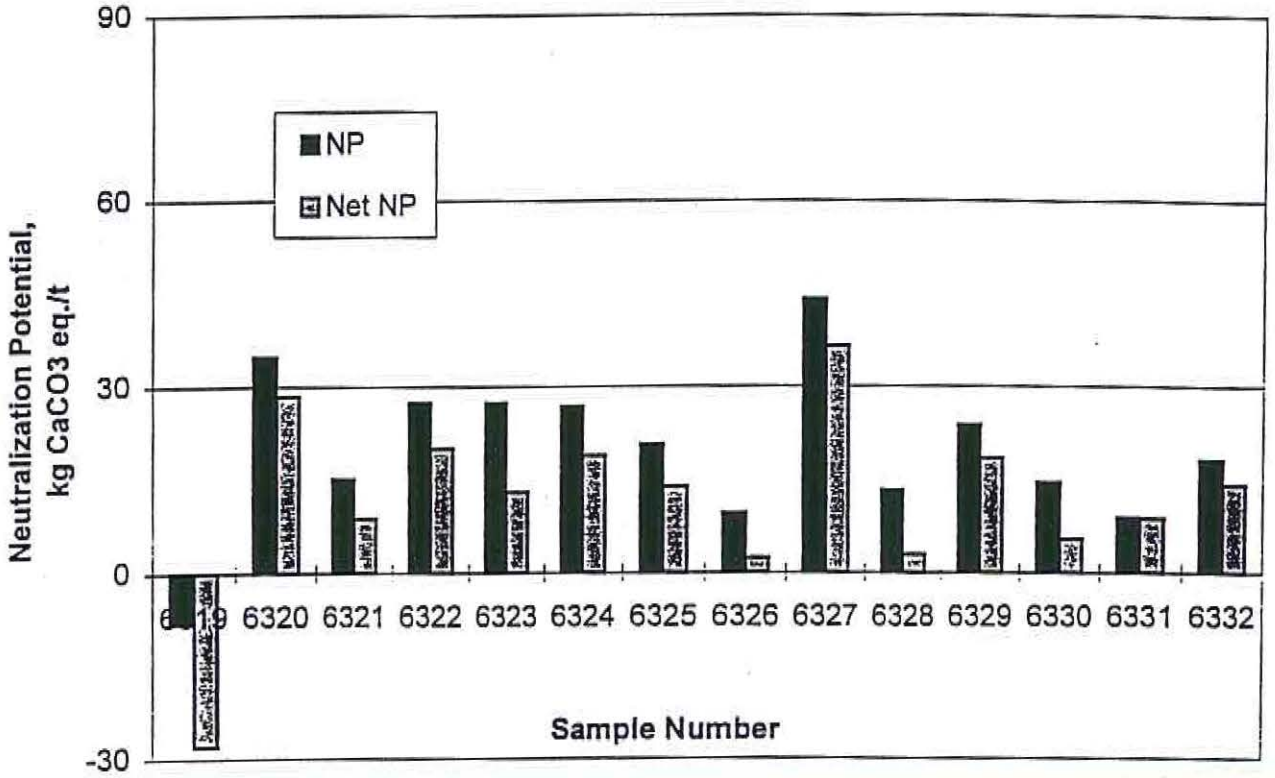
Sulphide Content



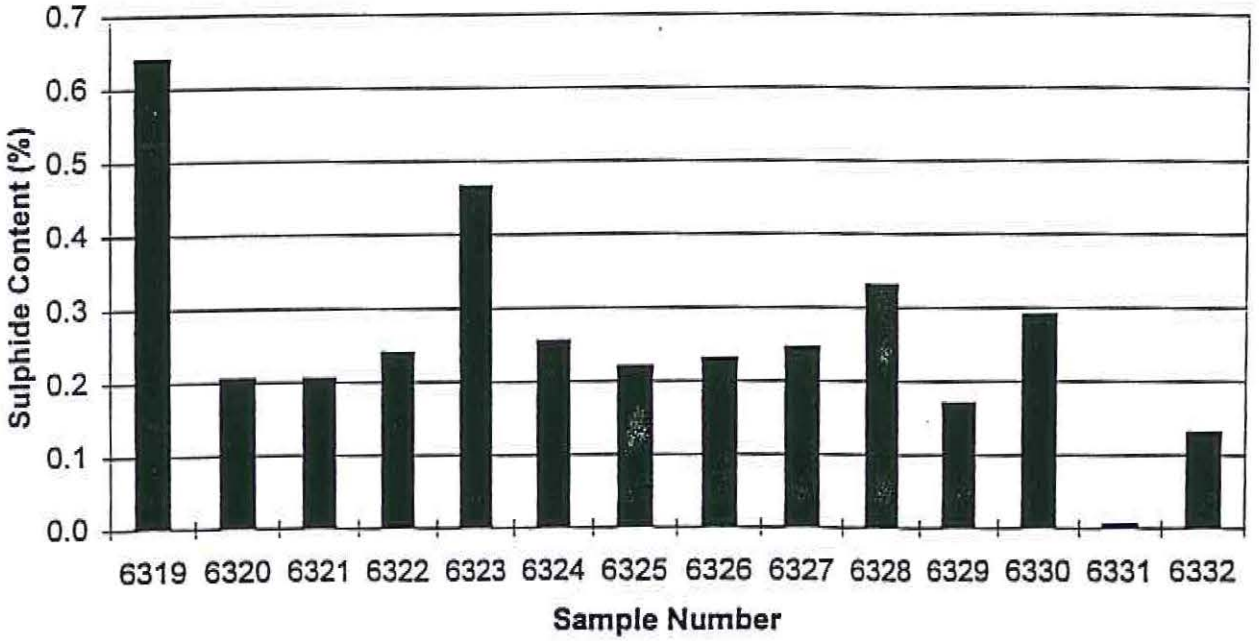
NP/AP Ratio of the Brown McDade Pit Sample

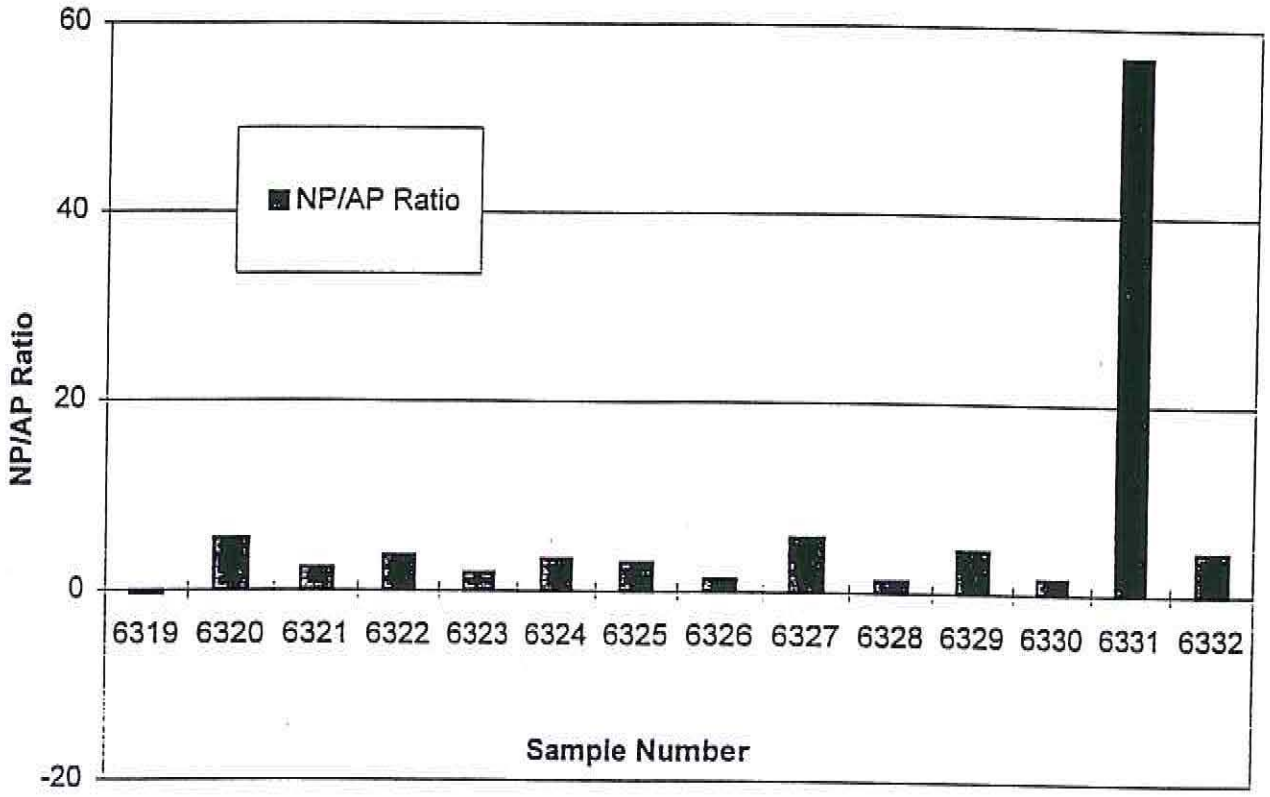


Neutralization Potential of the Waste Pile Sample



Sulphide Content




NP/AP Ratio of the Waste Pile Sample
60
40
20
0
-20
NP/AP Ratio
NP/AP Ratio
6319 6320 6321 6322 6323 6324 6325 6326 6327 6328 6329 6330 6331 6332
Sample Number

APPENDIX B

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- ACTION STEPS G.2

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- MILL/ASSAY H.3
- GENERAL H.3

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- WATER LICENCES I.2
- GRAZING I.3
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APPENDIX 4

ANALYSES

APPENDIX 5

Mt. Nansen Initial Environmental Evaluation
Section 4.6
Waste Rock, Ore and Tailings ARD Assessment

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 $CaCO_3$/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 Grandiorite														
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 CO_2
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

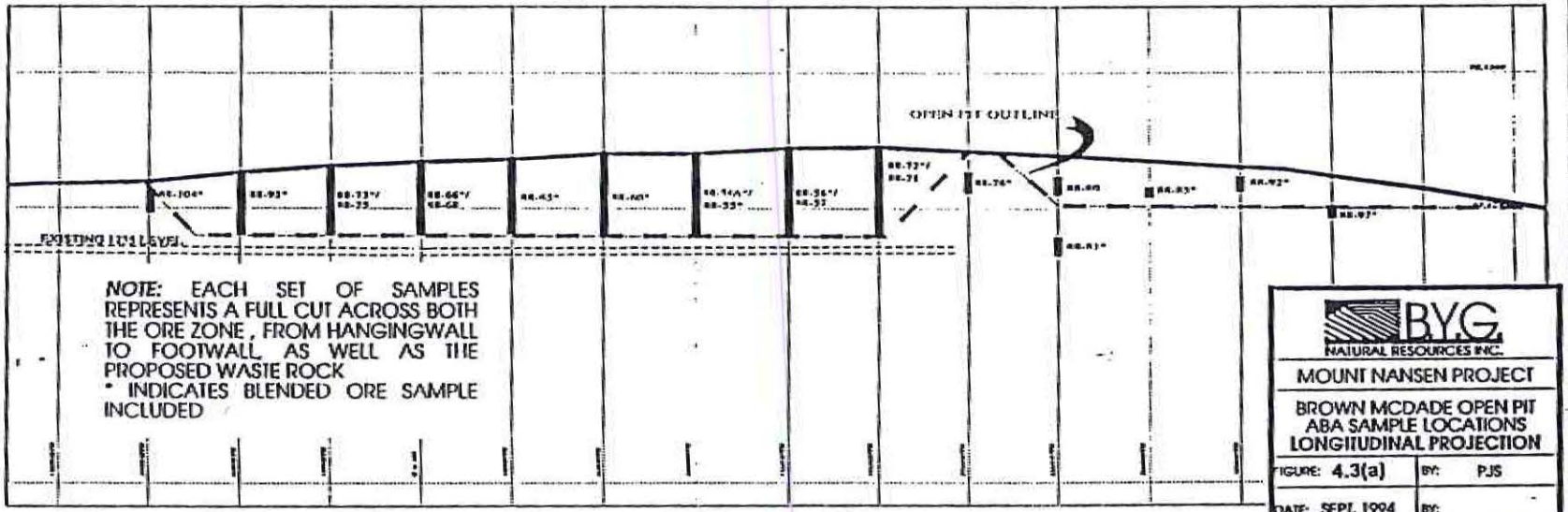
Section	Sample ID		Comments
	DDH#	Depth	
1+00 S	88-55	0-15 m	HW: 70% GD, 30% FP
	88-55	15-24 m	HW: 50% GD, 50% FP
	88-55	50-54 m	FW: 100% Fresh GD
1+33 S	88-56	0-7 m	HW: 35% GD, 65% FP
1+33 S	88-57	0-15 m	HW: 100% GD
	88-57	15-30 m	HW: 100% GD
	88-57	47.4-48.6 m	FW: 90% Fresh GD, 10% Altered
0+67 S	88-60	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

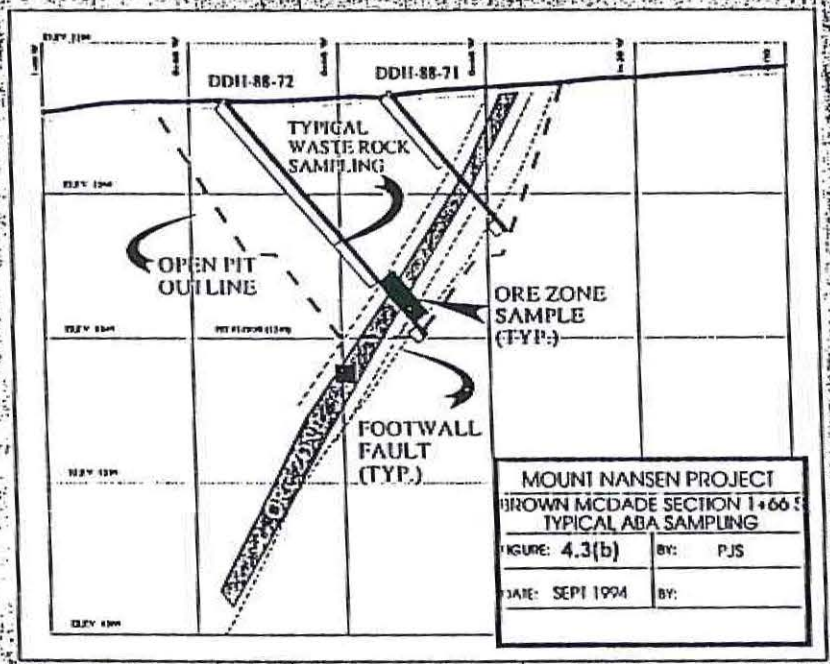
Table 4-4: Waste Rock Characterization - (PRA, 1994)

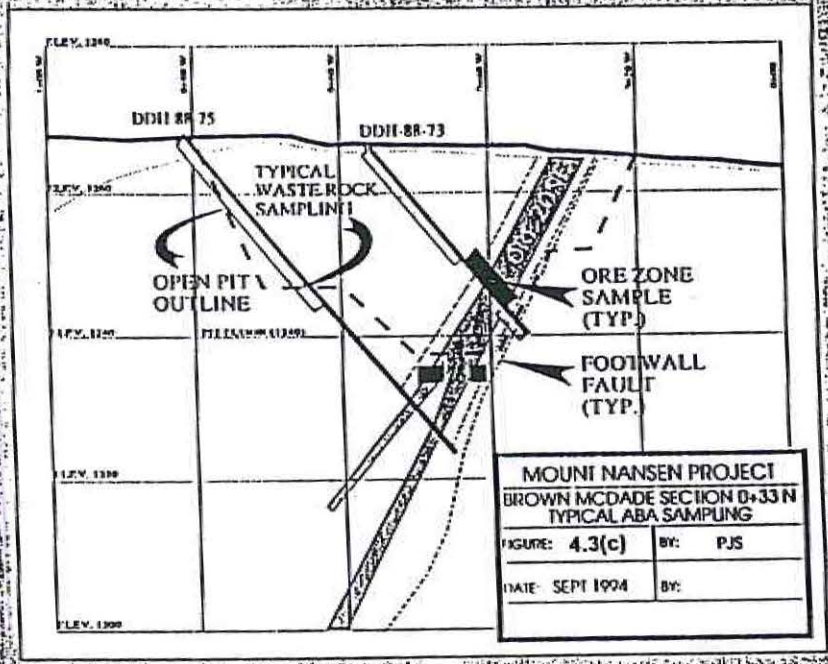
Rock Type	Sample I.D.	S (tot) %	S (SO_4) %	S (S^{2-}) %	Paste pH	NP	MPA	Net NP	NPR
Upper Altered Granodiorite									
	88-57 0-15 m	0.37	0.12	0.25	7.9	33.2	7.8	25.4	4.3
	88-63 0-15 m	0.34	0.01	0.33	8.0	56.4	10.3	46.1	5.5
	88-67 0-15 m	0.14	0.03	0.11	8.2	31.6	3.4	28.2	9.2
	88-68 0-15 m	0.06	0.03	0.03	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	

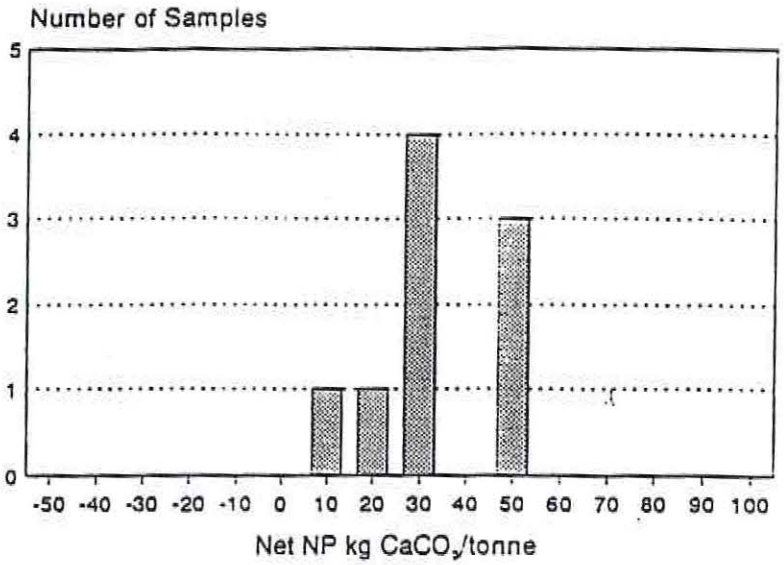
Notes :

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 (%S^{2-} × 31.25) except where $S_{(tot)} < SO_4^{2-}$
   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


OPEN PIT OUTLINE
NOTE: EACH SET OF SAMPLES REPRESENTS A FULL CUT ACROSS BOTH THE ORE ZONE, FROM HANGINGWALL TO FOOTWALL, AS WELL AS THE PROPOSED WASTE ROCK
* INDICATES BLENDED ORE SAMPLE INCLUDED
B.Y.G.
NATURAL RESOURCES INC.
MOUNT NANSEN PROJECT
BROWN MCDADE OPEN PIT
ABA SAMPLE LOCATIONS
LONGITUDINAL PROJECTION
FIGURE: 4.3(a) BY: PJS
DATE: SEPT. 1994 BY:

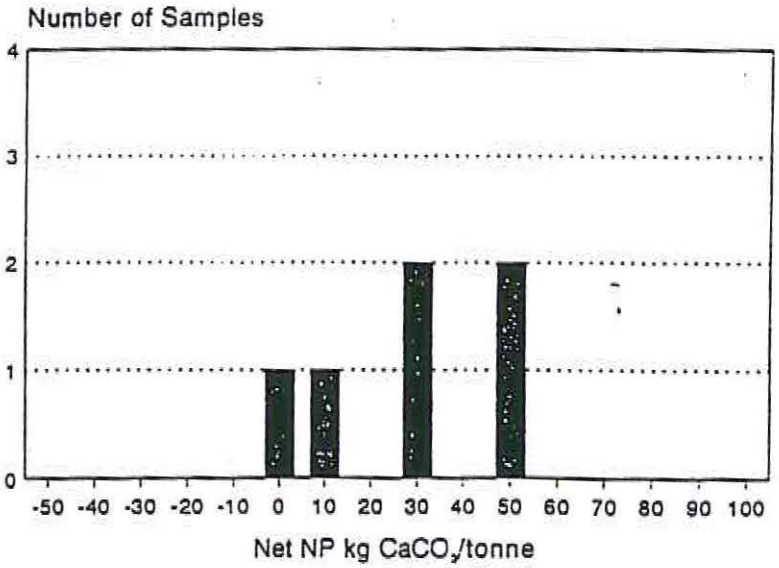

DDH-88-72
DDH-88-71
TYPICAL WASTE ROCK SAMPLING
OPEN PIT OUTLINE
ORE ZONE SAMPLE (TYP.)
FOOTWALL FAULT (TYP.)
MOUNT NANSEN PROJECT
BROWN MCDADE SECTION 1+66 S
TYPICAL ABA SAMPLING
FIGURE: 4.3(b) BY: PJS
DATE: SEPT 1994 BY:


DDH-88-75
DDH-88-73
TYPICAL WASTE ROCK SAMPLING
OPEN PIT OUTLINE
ORE ZONE SAMPLE (TYP.)
FOOTWALL FAULT (TYP.)
MOUNT NANSEN PROJECT
BROWN MCDADE SECTION 0+33 N
TYPICAL ABA SAMPLING
FIGURE: 4.3(c) BY: PJS
DATE: SEPT 1994 BY:



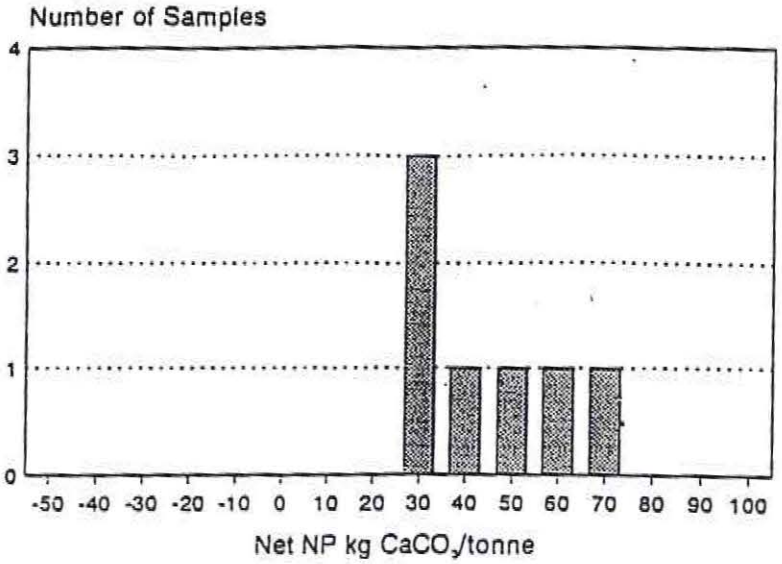
Upper Altered Granodiorite
Mean Net NP = +26.9 kg $CaCO_3$/tonne
Total Samples = 9

Figure 4.4
Distribution of Net NP Values for Upper Altered Granodiorite



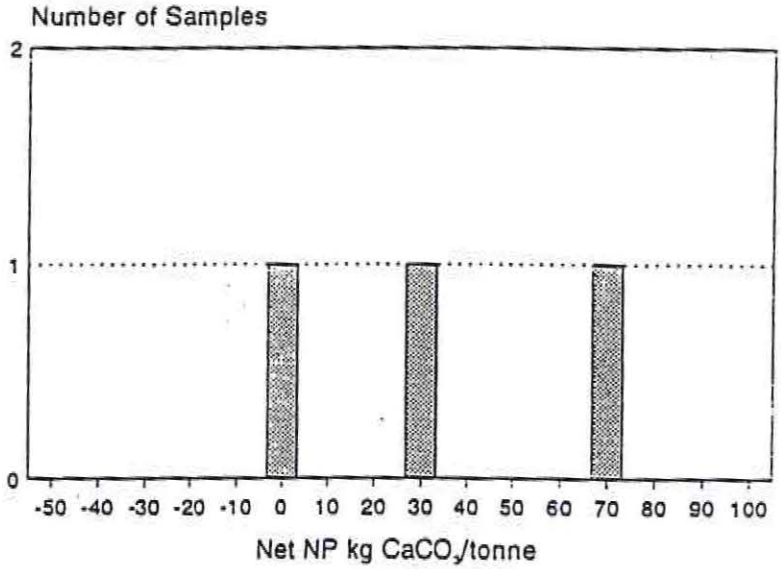
Lower Altered Granodiorite
Mean Net NP = +24.5 kg $CaCO_3$/tonne
Total Samples = 6

Figure 4.5
Distribution of Net NP Values for Lower Altered Granodiorite



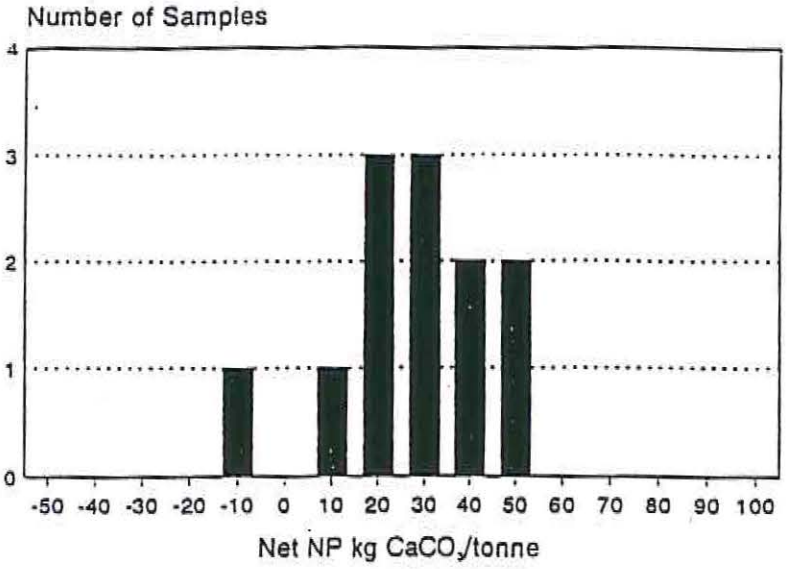
Upper Feldspar Porphyry
Mean Net NP = +38.1 kg $CaCO_3$/tonne
Total Samples = 7

Figure 4.6
Distribution of Net NP Values for Upper Feldspar Porphyry



Lower Feldspar Porphyry
Mean Net NP = +27.6 kg $CaCO_3$/tonne
Total Samples = 3

Figure 4.7
Distribution of Net NP Values for Lower Feldspar Porphyry



Footwall Granodiorite
Mean Net NP = +22.3 kg $CaCO_3$/tonne
Total Samples = 12

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	48	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	0.26	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	0.08	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	0.78	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	98	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	0.28	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	0.68	6	61	21	1	28.5	177	0.33	49	1	84
Mean	0.5	4.17	78		1	0.11	1	2.77	7	8	116	57	1.66	1.09	15	0.61	0.13	2	1.08	4	82	53	5	28.0	358	0.26	39	2	1001

Waste Rock Leaching Characteristics

A secondary concern with the waste rock is the potential for leaching of metals once the 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 metals 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, 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

Composite Samples	Ag µg/g	Al %	As 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	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	0.38	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	16	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	0.08	<.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	36.8	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

SECTION C

GOVERNMENT NOTIFICATION PROCEDURE

C.1 MINESITE SPILLS

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

Contact:

1. TERRITORIAL 24 HOUR EMERGENCY RESPONSE NUMBER

1-403-667-7244

This is a 24 hour number the Department of the Environment will notify all concerned agencies, including the following, as appropriate:

a. The RCMP.

b. Environmental Protection

c. Any other relevant agencies.

2. WATER RESOURCES INSPECTOR

1-403-667-3145

3. DOWNSTREAM WATER USERS

as required, and listed in Section I of this plan.

C.2 TRANSPORTATION SPILLS

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

a. 24 Hour Emergency response number.

b. The nearest R.C.M.P. detachment.

b. The employer.

c. The owner of the transport trucks.

d. The owner or consignor of the dangerous goods.

A "dangerous occurrence" is considered to be:

a. Any loss of dangerous goods in excess of specified amounts or which represents a danger;

b. Damage to any container of dangerous goods;

c. A transportation accident in which radioactive goods are involved;

d. 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 Appendix 4, Section 9 of the Transportation of Dangerous Goods Regulations.

SECTION G

SPILL RESPONSE

G.1 RESPONSIBILITY CHART

Person Discovering Spill
⇓
Supervisor
⇓
General Manager
⇓
On-Scene Co-ordinator
⇓ ⇓ ⇓
Response Team Leader | Lab Supervisor | Equipment Co-Ordinator
⇓
Safety and Environmental Co-ordinator
⇓
Mine Rescue Team

G.2 ACTION STEPS

a) Report spill to 24 hour spill line, water resources inspector and downstream users if any.

b) Stop source if possible

c) Contain spill materials

d) Protect area

e) Remove material

f) Reclaim area

g) Complete spill report

SECTION I

SENSITIVE AREAS AND RESOURCES

I.1 WATERCOURSES

The Mount Nansen Mine property is drained on the north, east, south and west sides by Pony Creek, Back Creek, Dome Creek, Discovery Creek, Dolly Creek, Webber Creek, Cabin Creek and South Fork. All these creeks drain into either Nansen Creek, running north-south on the west of the property, or Victoria Creek running North-south on the east of the property. However the only creeks impacted by the present mine are Pony Creek, Back Creek and Dome Creek. These creeks drain into Victoria Creek which flows into Nansen Creek then into the Nordenskiold River which joins the Yukon River just north of Carmacks. (see location map and site plan).

Site access is via the Mt. Nansen Road which joins the Mt. Freegold Road just north of Carmacks.. There are two significant stream crossings on this road beside the initial crossing of the Nordenskiold River at Carmacks. One crossing is by bailey bridge at 32 km along the road at the crossing of Rowlinson Creek. The other is the crossing of Victoria Creek at 6 km from the mine site. This crossing a ford at the moment will be upgraded to a causeway with culverting. There are several small drainage ditches that cross the road where there may be some concern in regard to spills.

I.2 WATER LICENCES

Following is a list of Water Licenses on the Quesnel River, near or downstream of the Mine:

None

I.3 GRAZING

None

I.4 INDIAN RESERVATIONS

None

I.5 DOWNSTREAM COMMUNITIES

None

SECTION J

OIL SPILL RECOVERY TECHNIQUES FOR STREAMS

The techniques used for recovery of an oil spill depend on the quantity spilled and its location, and whether or not the oil has reached a stream. The applicability of the techniques to the specific incident should be evaluated by the OSC and applied as appropriate.

Because of the location of, and protection provided by the oil storage facilities at the minesite, an oil spill reaching a watercourse is extremely unlikely from this source. Measures such as dyking and absorption of minor spills with sand, soils, or commercial sorbents are considered to be the most likely responses to such incidents.

The main type of incident which must be planned for is an oil transport incident at or near a watercourse. Spill contingency plan developed by the transporter and/or fuel supplier will be the first line of defence for this event.

Some techniques commonly practised to contain oil spills are listed below. Additional information on spill containment procedures are included in Section 1.

J.1 EARTH DAM

A dam made of earth or other available fill can be quickly constructed to contain and prevent a spill from spreading. If the ground is permeable, it may be necessary to excavate a shallow depression and line it with plastic to prevent the oil from seeping away. Where the spill is being contained in a channel containing flowing water, a section of pipe can be buried beneath the berm created, allowing water to escape while retaining floating oil behind the berm. Floating oil can then be absorbed by straw or commercial absorbents.

J.2 PLANK OR LOG DAM

A barrier may be constructed across a small flowing stream or ditch using a wooden plank or log embedded in opposite banks. With this arrangement, water can flow beneath and floating oil collected behind the plank. Floating oil could then be absorbed.

J.3 NET OR WIRE MESH BARRIER

A technique which lends itself to the collection of thin films of oil on fast flowing water is a net or wire mesh barrier. This consists of netting or wire mesh held in place by stakes, behind which sorbent materials are allowed to float.

J.4 BOOM

Booms are an effective way of limiting the downstream movement of any spilled oil, thereby providing the time required to remove the oil from the stream surface. This is more fully discussed in Section 1 - Diesel Fuel.

J.5 SORBENT PADS

Smaller spills that have the potential to migrate to water courses, but are not mobile can be immediately absorbed using commercially available sorbent pads and materials.

12/17/97 WED 11:07 FAX 403 863 6028 BYG MT.NANSEN CARMACKS 008

SECTION L

NOTIFICATION PROCEDURE FOR DOWNSTREAM WATER USERS

Down stream Users as listed below will be telephoned immediately and notified of the time of the spill, the nature of the spilled material and any possible hazardous consequences.

None at present:

APPENDIX C

B.Y.G. NATURAL RESOURCES INC.
MT. NANSEN PROJECT

RECLAMATION COSTS – INCURRED AND EXPENDED

EXISTING IMPACTS ON MT.NANSEN SITE

TYPE OF IMPACT	UNITS HECTARES OR NO.	UNIT COST TYPE	COST PER UNIT	COST EXISTING IMPACT	*SCHEDULE OF RECLAMATION WORK COMPLETED*				
					END OF YEAR 1	*END OF YEAR 2*	*END OF YEAR 3*	*END OF YEAR 4*	*TOTAL*
(1) Existing construction areas	11.3	(1)	$5,250	$59,325		*$15,000*	*$15,000*	*$29,325*	*$59,325*
(2) Existing roads	5.7	(2)	$2,350	$13,395			*$5,000*	*$8,395*	*$13,395*
(3) Existing trenches	11.4	(3)	$4,000	$45,600		*$15,000*	*$15,000*	*$15,600*	*$45,600*
(4) Existing mine portals	5	(4)	$10,200	$51,000				*$51,000*	*$51,000*
(5a) Existing frame buildings and trailers	14	(5a)	$2,500	$35,000	*$10,000*	*$10,000*		*$15,000*	*$35,000*
(5b) Existing steel and concrete buildings	1	(5b)	$105,000	$105,000				*$105,000*	*$105,000*
(6) Existing dams	3	(6)	$3,700	$11,100		*$7,500*		*$3,600*	*$11,100*
(7) Existing ore dumps	72,500	(7)	$2.15	$155,875	*$25,000*	*$75,000*	*$25,000*	*$30,875*	*$155,875*
(8) Existing waste dumps	22,500	(8)	$1.25	$28,125	*$5,000*	*$5,000*		*$18,125*	*$28,125*
TOTAL EXISTING IMPACTS				**$504,420**					
SCHEDULE OF RECLAMATION WORK					*$40,000*	*$127,500*	*$60,000*	*$276,920*	*$504,420*

Table B-2

APPENDIX D

Water Quality Data
Station E1

Parameter	97 06 30	97 07 08	97 07 16	97 07 30	97 08 06	97 08 14	97 08 21	97 08 27	97 09 04	97 09 10	97 09 17	97 09 24
Total Suspend Solid									3			
Conductivity		2040										
pH												
sulphate SO4		1030		1040				1030				828
Ammonia Nitrogen	12.8	1.64	1.5	1.64		1.4		1.42	0.266	1.31	1.43	1.69
Nitrate Nitrogen		0.313		0.362				0.391				0.735
Nitrite Nitrogen		0.028		0.04				0.055				0.075
Total Cyanide		67.2	56.5	66	68	68.5	68.5	67	67.5	59	58.5	60
Cyanate		53.1		72.7	60		67	72.1				60
Thiocyanate		26.9		29.1				28.6				
WAD Cyanide		61.9		52.7				65				
TOTAL METALS												
Antimony	0.0387	0.216		0.28				0.14				0.172
Arsenic		1.83	2.15	1.37	0.13	1.58	1.25	1.33	1.33	1.27	0.982	0.973
Barium		0.02		0.02				0.02				0.02
Cadmium		0.291		0.284				0.0082				0.26
Chromium		<0.001		<0.001				<0.001				<0.001
Copper		5.7		10.4				11.7				14.5
Iron		0.35		0.74				0.11				0.47
Lead		0.007		<0.002				0.004				0.003
Manganese		0.055		0.032				0.019				0.056
Mercury		0.0126		0.0144				0.00746				0.0047
Nickel		0.04		0.07				0.06				0.08
Silver		0.02		0.1				0.04				0.2
Zinc		17.6		20.4				21				21.4
DISSOLVED METALS												
Antimony		0.234		0.262				0.147				0.139
Arsenic	0.0117	1.78		1.3		1.43		1.16	1.35	1.22	0.988	0.939
Barium		0.01		0.02				0.02				0.02
Cadmium		0.292		0.281				0.0085				0.257
Chromium		<0.001		<0.001				<0.001				<0.001
Copper		5.23		9.62				12				11.5
Iron		<0.03		0.45				0.32				0.22
Lead		<0.002		<0.002				<0.001				<0.001
Manganese		0.016		0.014				0.006				0.042
Mercury		0.0141		0.00859				0.00665				0.00358
Nickel		0.04		0.07				0.07				0.08
Silver		0.02		0.29				0.43				0.41
Zinc		16.9		20.6				20.1				21.3

Water Quality Data
Station E1

Parameter	97 05 01	97 05 07	97 05 18	97 09 24	97 05 30	97 06 07	97 06 12	97 06 21
Total Suspend Solid								
Conductivity			1510	2340	1520	1590	1600	1730
pH			9.9	8.5	9.86			
sulphate SO4	342	352	625	660	563	696		
Ammonia Nitrogen	0.22	0.53	1.33	3.24	1.2	1.25	1.37	1.28
Nitrate Nitrogen	0.097	0.137	0.239	0.389	0.29	0.27		
Nitrile Nitrogen	0.033	0.023	0.024	0.033	0.024	0.026		
Total Cyanide	20.7	31.6	62.3	0.437	63	57	59.5	63.8
Cyanate	8.9	12.9	40.5		31.8	37.2		
Thiocyanate	6.5	8.2	12.3		15.2	16.5		
WAD Cyanide	19.8	28.3	54.2	0.33	59	50.4		
TOTAL METALS								
Antimony	0.0503	0.0498	0.0869	0.0123	0.066	0.0911	1.37	0.989
Arsenic	0.508	0.58	0.7	0.0026	0.803	1.17		
Barium	0.03	0.04	0.03	0.04	0.03	0.04		
Cadmium	0.0764	0.115	0.238	0.0134	0.222	0.251		
Chromium	0.002	<0.001	0.001	<0.001	0.001	0.001		
Copper	1.3	1.8	1.82	0.234	1.97	4.16		
Iron	0.57	0.62	0.11	0.11	0.17	1.08		
Lead	0.298	0.167	0.022	<0.001	0.009	0.008		
Manganese	0.15	0.107	0.037	0.11	0.034	0.069		
Mercury	0.00542	0.00932	0.019	0.00078	0.0184	0.0193		
Nickel	<0.02	<0.02	0.02	0.02	0.03	0.03		
Silver	0.03	0.05	0.06	0.05	0.07	0.06		
Zinc	4.45.	6.57	12.7	0.344	12	14.7		
DISSOLVED METALS								
Antimony	0.047	0.0456	0.0826	0.0127	0.0497	0.0729		
Arsenic	0.438	0.0231	0.655	0.0021	0.79	1.13		
Barium	0.02	0.03	0.03	0.04	0.03	0.03		
Cadmium	0.0853	0.116	0.256	0.0075	0.232	0.242		
Chromium	<0.001	<0.001	0.001	<0.001	<0.001	0.001		
Copper	2.47	2.87	5.43	0.155	3.43	3.67		
Iron	0.69	0.82	1.62	<0.03	0.73	0.75		
Lead	0.012	0.008	0.005	<0.001	<0.001	<0.001		
Manganese	0.029	0.034	0.023	0.089	0.021	0.015		
Mercury	0.00622	<0.00005	0.0192	0.00044	0.0162	0.0187		
Nickel	<0.02	<0.02	0.05	0.02	0.03	0.03		
Silver	0.08	0.09	0.06	0.06	0.03	0.03		
Zinc	4.89	6.5	13.8	0.122	13.2	15.2		

Water Quality Data
Effluent Water

Parameter	1/5/97	18/5/97	30/5/97	24/9/97	17/9/97	30/9/97	2/10/97	7/10/97
Conductivity		547	2060	2340	370	4200		
pH		7.5	8.13	8.5	7.9	8.1		
sulphate SO4	96	185	998	660	53	2600	1890	497
Ammonia Nitrogen	0.23	0.07	0.208	3.24		8.86	6.8	1.5
Nitrate Nitrogen	0.308	0.08	0.239	0.389	0.07	0.73	0.692	0.245
Nitrite Nitrogen	0.031	0.017	0.025	0.033	0.003	0.05	0.072	0.018
Total Cyanide	0.057	0.048	0.016	0.437	0.025	0.1	0.24	
Cyanate	<0.5	0.7	<0.5					32.3
Thiocyanate	0.9	<0.5	0.8					5.9
WAD Cyanide	0.019	0.007	0.006	0.33	0.017	0.011		0.054
TOTAL METALS								
Antimony	0.0075	0.0038	0.233	0.0123	0.02	0.03	0.103	0.0137
Arsenic	0.0392	0.103	0.0998	0.0026	0.02	0.02	0.0035	0.0011
Barium	0.06	0.43	0.03	0.04	0.0631	0.024	0.02	0.07
Cadmium	0.0014	0.0014	0.0521	0.0134	0.0005	0.0563	0.118	0.032
Chromium	0.001	0.029	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Copper	0.021	0.052	0.013	0.234	0.031	0.419	1.39	0.272
Iron	1.68	31.2	0.23	0.11	0.063	0.151	0.18	0.1
Lead	0.074	0.027	0.029	<0.001	0.005	0.02	<0.001	<0.001
Manganese	0.572	1.83	0.927	0.11	0.0165	0.212	0.291	0.069
Mercury	0.00006	0.0016	<0.00005	0.00078		0.0015	0.00236	0.00064
Nickel	<0.02	0.03	<0.02	0.02	<0.0002	0.033	0.05	<0.02
Silver	<0.01	<0.01	<0.01	0.05	0.008	0.023	0.01	<0.01
Zinc	0.162	0.201	6.65	0.344	0.035	4.28	9.34	2.38
DISSOLVED METALS								
Antimony	0.042	0.0045	0.225	0.0127	D	D	0.0607	0.013
Arsenic	0.0115	0.0061	0.0447	0.0021	I	I	0.0006	0.0004
Barium	0.03	0.08	0.02	0.04	A	A	0.03	0.07
Cadmium	0.0007	<0.0002	0.0486	0.0075	N	N	0.124	0.031
Chromium	<0.001	<0.0001	<0.001	<0.001	D	D	<0.001	<0.001
Copper	0.014	0.004	0.009	0.155			1.37	0.23
Iron	0.43	0.22	<0.01	<0.03			<0.03	<0.03
Lead	0.006	<0.001	0.009	<0.001			<0.001	<0.001
Manganese	0.481	0.582	0.913	0.089			0.313	0.086
Mercury	<0.00005	<0.000005	<0.00005	0.00044			0.00179	0.00028
Nickel	<0.02	<0.02	<0.02	0.02			0.04	<0.02
Silver	<0.01	<0.01	<0.01	0.06			0.04	<0.01
Zinc	0.06	0.015	6.23	0.122			9.86	2.28

Water Quality Data
Station E2

Parameter	97 05 01	97 05 07	97 05 18	97 05 30	97 06 07	97 06 12	97 06 21	97 06 30	97 07 08	97 07 16
Total Suspend Solid										
Conductivity			387	53	258	279	546			
pH			7.12	6.48						
sulphate SO4	77	87	70	1	19				122	
Ammonia Nitrogen	0.605	0.73	1.15	0.092	0.43	1.63	4.61	1.6	3.9	3.35
Nitrate Nitrogen	0.126	0.126	0.139	0.034	0.059				0.4	
Nitrite Nitrogen	0.007	0.006	0.029	0.005	0.006				0.012	
Total Cyanide	1.86	2.19	2.8	0.16	0.173			63	7.02	3.37
Cyanate	1.9	3.5	6.9	<.5	1.5		4.5		8.7	
Thiocyanate	4.1	5.1	2.7	2	1.3		4.8		6.1	
WAD Cyanide	1.65	1.86	2.67	0.137	0.087		6.98		6.83	
TOTAL METALS										
Antimony	0.0007	0.0006	0.0004	0.0002	0.0003					
Arsenic	0.0236	0.396	0.0151	0.0033	0.0319	0.0239		1.53	0.0008	
Barium	0.21	0.21	0.17	0.04	0.17				0.078	
Cadmium	0.0002	<.0002	0.0006	<.0002	0.0002				0.37	
Chromium	0.002	<.001	0.002	0.001	0.003				0.001	
Copper	0.127	0.277	0.724	0.036	0.144				0.01	
Iron	5.75	7.09	3.32	1.11	5.67				1.3	
Lead	0.006	<.001	0.003	0.001	0.003				15.8	
Manganese	2.2	2.65	1.7	0.252	1.68				0.012	
Mercury	0.00052	0.00192	0.00097	0.00005	0.00012				4.12	
Nickel	0.14	0.18	0.11	<.02	0.02				0.00098	
Silver	0.05	0.05	<.01	<0.01	<0.01				0.13	
Zinc	0.006	0.007	0.015	<.005	0.011				<.01	
DISSOLVED METALS										
Antimony	0.0005	0.0005	0.0004	0.0001	0.0003				0.0005	
Arsenic	0.0162	0.0264	0.0107	0.0022	0.0248		0.0232	1.36	0.0254	0.0702
Barium	0.2	0.2	0.13	0.04	0.12				0.21	
Cadmium	<.0002	<.0002	0.0004	<.0002	<0.0002				0.0002	
Chromium	0.001	<.001	<.001	<.001	<0.001				0.001	
Copper	0.131	0.269	0.739	0.038	0.107				1.26	
Iron	3.43	3.79	1.09	0.63	2.33				4.09	
Lead	<.001	<.001	<.001	<.001	<0.001				<.001	
Manganese	2.23	2.57	1.64	0.262	1.59				4.25	
Mercury	0.00057	0.00072	0.00026	<.00005	<0.00005				0.00009	
Nickel	0.14	0.17	0.1	<.02	<0.02				0.15	
Silver	0.04	0.05	0.03	<0.01	<0.01				<.01	
Zinc	0.0006	0.006	0.006	<.005	<.005				0.007	

Water Quality Data
Station E2

Parameter	97 07 30	97 08 06	97 08 14	97 08 27	97 09 04	97 09 10	97 09 17	97 09 24
Total Suspend Solid					87			
Conductivity								
pH								
sulphate SO4	66	46		254				356
Ammonia Nitrogen	2.06		3.36	4.54	3.29	2.69	4.04	3.68
Nitrate Nitrogen	0.454	0.36		0.471				1.1
Nitrile Nitrogen	0.014	0.021		0.016				0.014
Total Cyanide	2.78			8.4				6.1
Cyanate	1.7		4.5	3.6				
Thiocyanate	4		8.2	9.5				
WAD Cyanide	2.46		6.62	8.12		7.1		5.45
TOTAL METALS								
Antimony	0.0005			0.0031				0.0016
Arsenic	0.0249	0.002	0.055	0.0347	0.0298	0.0467	0.0294	0.0477
Barium	0.12			0.24				0.019
Cadmium	0.0005			0.0012				0.0016
Chromium	0.001			<.002				<.001
Copper	0.0671			2.74				2.67
Iron	3.23			4.56				4.65
Lead	0.003			0.005				0.002
Manganese	1.48			4.84				4.96
Mercury	0.00051			0.00088				0.00012
Nickel	0.07			0.21				0.19
Silver	0.02			0.05				0.06
Zinc	0.009			0.029				0.046
DISSOLVED METALS								
Antimony	0.0004			0.0008				0.0007
Arsenic	0.0222		0.03	0.0137	0.0123	0.0271	0.0223	0.0187
Barium	0.12			0.21				0.19
Cadmium	0.0004			0.0009				0.0014
Chromium	<.001			<.002				<.001
Copper	0.678			2.73				2.73
Iron	2.61			0.34				0.1
Lead	<.001			<.002				<.001
Manganese	1.49			4.77				5.07
Mercury	0.00025			0.00026				<.00005
Nickel	0.06			0.21				0.18
Silver	0.02			0.07				0.06
Zinc	0.007			0.014				0.033

Water Quality Data
Station D1

Parameter	97 05 01	97 05 07	97 05 18	97 05 30	97 06 07	97 06 21	97 07 30	97 08 14	97 08 27	97 09 10
Total Suspend Solid										9
Conductivity			89	81	121	129				
pH			6.91	6.92						
sulphate SO4	22	23	18	11	24	24	36	65	168	32
Ammonia Nitrogen	0.04	0.009	<0.005	<0.005	0.005	<0.005	0.0034	0.03	0.12	0.02
Nitrate Nitrogen	0.008	<0.005	<0.005	<0.005	<0.005	0.006	0.01	<0.005	0.207	<0.005
Nitrite Nitrogen	0.002	0.004	0.002	0.002	0.001	0.002	<0.001	<0.001	0.012	0.001
Total Cyanide	0.043	0.023	0.026	0.026	0.019	0.012	<0.005	0.009	0.078	0.011
Cyanate	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5	
Thiocyanate	1.2	1.4	1	1.2	<0.5				0.7	
WAD Cyanide	<0.005	<.005	<0.005	<0.005	<0.005				0.008	
TOTAL METALS										
Antimony	0.0011	0.001	0.001	0.0013	0.0016	0.0014	0.0011	0.0009	0.0016	0.0013
Arsenic	0.0136	0.0018	0.0021	0.0027	0.0022	0.0024	0.0038		0.126	0.0041
Barium	0.04	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.3	0.03
Cadmium	0.003	0.0011	0.0005	0.0005	0.0005	0.0005	0.004	0.004	0.0012	0.004
Chromium	0.001	<.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.001
Copper	0.007	0.005	0.004	0.005	0.004	0.003	0.002	0.001	0.032	0.003
Iron	1.29	0.18	0.1	0.11	0.06	0.1	0.19	<0.03	14.6	0.08
Lead	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	0.003
Manganese	0.128	0.006	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	2.04	0.02
Mercury	<0.00005	<0.00005	<0.00005	<0.00005	<0.0005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.578	0.277	0.125	0.111	0.108	0.107	0.077	0.077	0.093	0.079
DISSOLVED METALS										
Antimony	0.0012	0.0009	8	0.0013	0.0013	0.0014	0.001	0.0009	0.0026	0.0012
Arsenic	0.007	0.0012	0.02	0.0025	0.0025	0.0021	0.002		0.0204	0.0022
Barium	0.02	0.02	0.0005	0.01	0.01	0.02	0.02	0.03	0.09	0.03
Cadmium	0.0026	0.001	<0.001	0.0005	0.0005	0.0004	0.004	0.0004	<0.0002	0.0003
Chromium	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	0.006	0.004	0.08	0.005	0.005	0.003	0.002	0.001	0.003	0.003
Iron	0.61	0.1	<0.001	0.1	0.1	0.07	<0.03	<0.03	0.21	<0.03
Lead	0.002	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.033	<0.005	<0.00005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005
Mercury	<0.00005	<0.00005	<0.02	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver	<0.01	<0.01	0.121	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.547	0.271	13.8	0.112	0.112	0.102	0.074	0.075	0.07	0.07

Water Quality Data
Station D2

Parameter	97 05 01	97 05 07	97 05 18	97 05 30	97 06 07	97 06 21	97 07 08	97 07 30	97 08 14	97 08 27
Total Suspend Solid										9
Conductivity			89	81	343	347				
pH			6.91	6.92						
sulphate SO4	30	82	18	11	98	101	146	119	164	168
Ammonia Nitrogen	0.073	0.08	<0.005	<0.005	0.22	0.091	0.083	0.053	0.12	0.12
Nitrate Nitrogen	0.018	0.013	<0.005	<0.005	0.032	0.04	0.067	0.089	0.098	0.207
Nitrite Nitrogen	0.022	0.008	0.002	0.002	0.007	0.021	0.013	0.009	0.017	0.012
Total Cyanide	0.17	0.265	0.026	0.026	0.046	0.042	0.036	0.078	0.38	0.078
Cyanate	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	<0.5
Thiocyanate	1.1	2.4	1	1.2	1.8	0.8	1.1	3.5	0.8	0.7
WAD Cyanide	0.127	0.251	<0.005	<0.005	0.005	0.005	<0.005	<0.005	0.006	0.008
TOTAL METALS										
Antimony	0.0036	0.0045	0.001	0.0013	0.0033	0.0054	0.0033	0.004	0.0021	0.0016
Arsenic	0.0373	0.0206	0.0021	0.0027	0.0404	0.0753	0.101	0.12	0.125	0.126
Barium	0.07	0.05	0.02	0.01	0.11	0.17	0.14	0.28	0.59	0.3
Cadmium	0.0007	0.0003	0.0005	0.0005	0.007	0.0008	0.001	0.0014	0.0016	0.0012
Chromium	0.001	<0.001	<0.001	<0.001	0.003	0.01	0.005	0.021	0.032	0.01
Copper	0.032	0.095	0.004	0.005	0.014	0.023	0.019	0.031	0.06	0.032
Iron	2.33	0.75	0.1	0.11	3.22	9.81	4.23	11.6	12.3	14.6
Lead	0.012	0.005	<0.001	<0.001	0.01	0.021	0.011	0.037	0.021	0.016
Manganese	1.2	1.36	<0.005	<0.005	0.572	0.764	1.29	1.38	2.46	2.04
Mercury	0.00011	0.00007	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	0.00005	0.00018	<0.00005
Nickel	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.088	0.031	0.125	0.111	0.038	0.056	0.035	0.079	0.188	0.093
DISSOLVED METALS										
Antimony	0.0029	0.004	8	0.0013	0.0032	0.0037	0.0032	0.003	0.0034	0.0026
Arsenic	0.0136	0.0134	0.02	0.0025	0.0121	0.0154	0.018	0.014	0.017	0.0204
Barium	0.05	0.05	0.0005	0.01	0.05	0.06	0.07	0.08	0.1	0.09
Cadmium	0.0004	0.0002	<0.001	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	0.032	0.109	0.08	0.005	0.005	0.004	0.003	0.003	0.002	0.003
Iron	0.59	0.41	<0.001	0.1	0.49	0.66	0.19	0.22	0.08	0.21
Lead	0.002	<0.001	<0.005	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	1.19	<0.005	<0.00005	<0.005	0.331	0.457	0.781	0.256	0.623	1.97
Mercury	<0.00005	<0.00005	<0.02	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver	<0.01	<0.01	0.121	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.057	0.029	13.8	0.112	0.011	0.007	0.007	<0.005	<0.005	<0.005

Water Quality Data
Station D2

Parameter	97 09 10	97 09 24
Total Suspend Solid	1710	
Conductivity		
pH		
sulphate SO4	167	295
Ammonia Nitrogen	0.11	0.955
Nitrate Nitrogen	0.148	0.287
Nitrite Nitrogen	0.011	0.078
Total Cyanide	0.007	0.021
Cyanate		0.015
Thiocyanate		
WAD Cyanide		0.015
TOTAL METALS		
Antimony	0.0042	0.0039
Arsenic	0.166	0.135
Barium	0.51	0.2
Cadmium	0.002	0.0011
Chromium	0.035	0.013
Copper	0.066	0.026
Iron	35.3	8.7
Lead	0.05	0.023
Manganese	2.5	1.29
Mercury	<0.00005	<0.00005
Nickel	0.03	<0.02
Silver	<0.01	<0.01
Zinc	0.174	0.005
DISSOLVED METALS		
Antimony	0.0024	0.0032
Arsenic	0.0183	0.021
Barium	0.1	0.08
Cadmium	<0.0002	<0.0002
Chromium	<0.001	<0.001
Copper	0.003	0.007
Iron	0.19	0.03
Lead	<0.001	<0.001
Manganese	0.362	0.783
Mercury	<0.00005	<0.00005
Nickel	<0.02	<0.02
Silver	<0.01	<0.01
Zinc	<0.005	<0.005

Water Quality Data
Station P1

Parameter	97 09 17	97 09 24
Total Suspend Solid		
Conductivity		
pH		
sulphate SO4		166
Ammonia Nitrogen	4.04	0.026
Nitrate Nitrogen		0.096
Nitrite Nitrogen		0.002
Total Cyanide		0.011
Cyanate		
Thiocyanate		
WAD Cyanide		<.005
TOTAL METALS		
Antimony		0.0026
Arsenic	0.0294	0.0044
Barium		0.05
Cadmium		0.0089
Chromium		<.001
Copper		0.046
Iron		0.39
Lead		0.002
Manganese		1.67
Mercury		<.00005
Nickel		0.02
Silver		<.01
Zinc		0.674
DISSOLVED METALS		
Antimony		0.0025
Arsenic	0.0223	0.0025
Barium		0.05
Cadmium		0.0084
Chromium		<.001
Copper		0.036
Iron		0.08
Lead		<.001
Manganese		1.62
Mercury		<.00005
Nickel		0.02
Silver		<.01
Zinc		0.64

Water Quality Data
Station P2

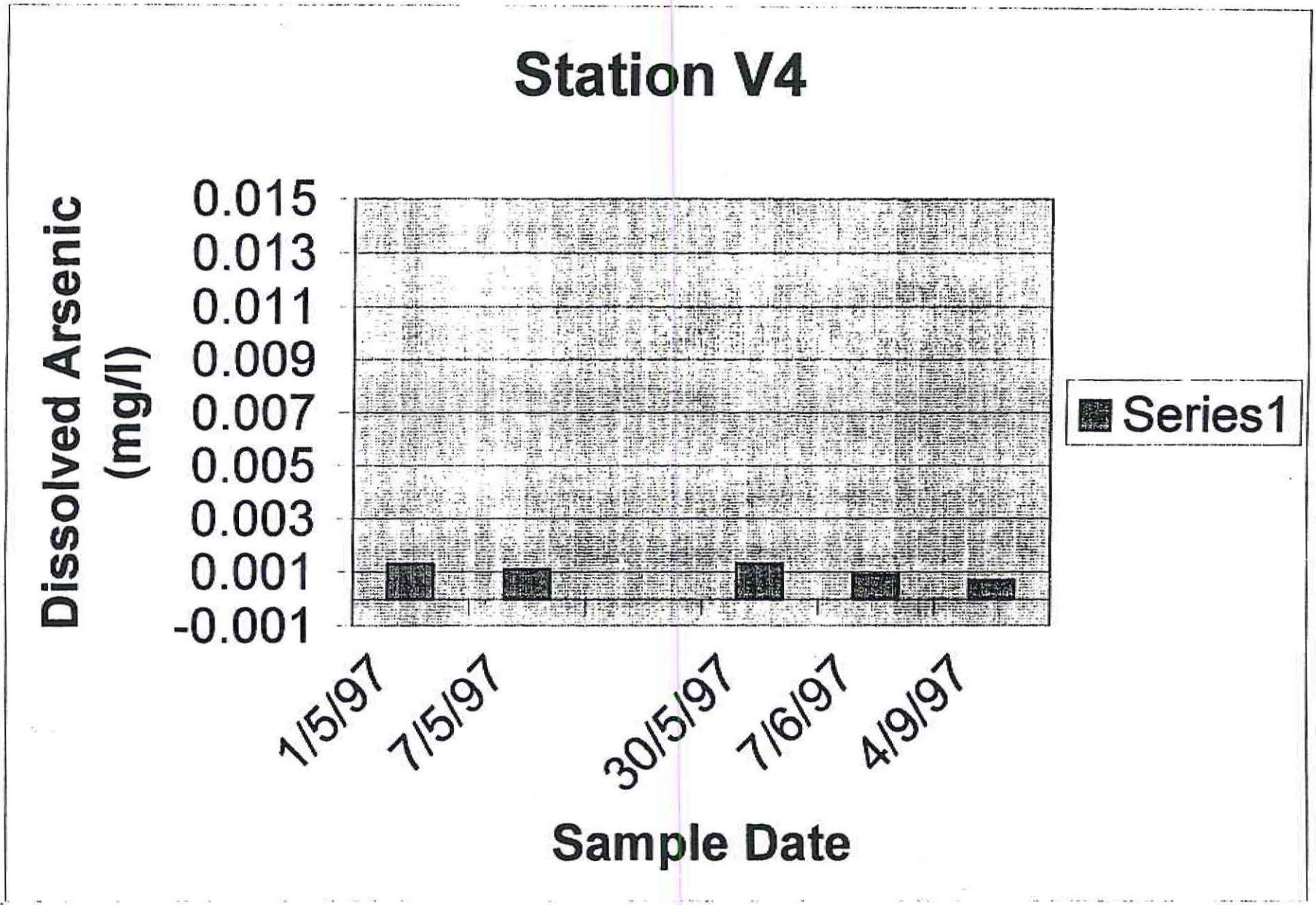
Parameter	97 05 01	97 05 07	97 05 30	97 06 07	97 07 08	97 07 30	97 08 27	97 09 24
Total Suspend Solid								
Conductivity			58	108				
pH			6.43					
sulphate SO4	5	3	8	24	5	94	71	79
Ammonia Nitrogen	<.02	0.016	0.022	0.051	0.045	0.077	0.09	0.034
Nitrate Nitrogen	0.012	<.005	0.013	0.056	0.057	0.273	0.127	0.169
Nitrite Nitrogen	0.001	0.005	0.007	0.004	0.003	0.005	0.004	0.003
Total Cyanide	0.058	0.049	0.039	0.015	0.018	0.023	0.011	0.008
Cyanate	<.5	<.05	<.05	<.5	<.5	<.5	<.5	
Thiocyanate	1.4	2.5	1.4	<.5	0.9	0.6	<.5	
WAD Cyanide	0.028	<.005	<.005	<.005	<.005	<.005	<.005	<.005
TOTAL METALS								
Antimony	0.0006	0.0006	0.0008	0.0011	0.001	0.0016	0.0009	0.0019
Arsenic	0.0045	0.0061	0.0078	0.0054	0.0071	..0242	0.0069	0.0064
Barium	0.04	0.05	0.06	0.05	0.06	0.07	0.07	0.06
Cadmium	0.0003	0.0004	0.002	<.0002	<.0002	0.0371	0.0035	0.0046
Chromium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Copper	0.004	0.005	0.0045	0.003	0.002	0.633	0.034	0.045
Iron	0.69	0.89	0.9	0.064	0.75	8.23	1.27	0.72
Lead	0.002	0.003	0.004	0.002	<.001	0.004	0.001	<.001
Manganese	0.209	0.169	0.06	0.079	0.241	4.51	0.569	0.558
Mercury	<.00005	<.00005	<.00005	<.00005	<.00005	<.00005	<.00005	<.00005
Nickel	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Silver	<.01	<.01	<0.01	<.01	<.01	<.01	<.01	<.01
Zinc	0.022	0.028	0.015	0.009	0.01	2.88	0.227	0.313
DISSOLVED METALS								
Antimony	0.004	0.0004	0.0007	0.0011	0.001	0.0005	0.0008	0.0017
Arsenic	0.0026	0.0023	..29	0.0042	0.0053	0.0008	0.004	..031
Barium	0.04	0.05	0.04	0.05	0.06	0.06	0.07	0.06
Cadmium	0.0002	0.0002	<.0002	<.0002	<.0002	0.0352	0.0027	0.004
Chromium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Copper	0.004	0.005	0.004	0.003	0.002	0.421	0.025	0.025
Iron	0.037	0.33	0.32	0.41	0.45	0.39	0.45	0.15
Lead	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Manganese	0.127	0.01	0.01	0.033	0.214	4.33	0.545	0.517
Mercury	<.00005	<.00005	<.02	<.00005	<.00005	<.00005	<.00005	<.00005
Nickel	<.02	<.02	<.01	<.02	<.02	<.02	<.02	<.02
Silver	<.01	<.01	<.005	<.01	<.01	<.01	<.01	<.01
Zinc	0.022	0.023	<.005	0.005	0.007	2.73	0.167	0.25

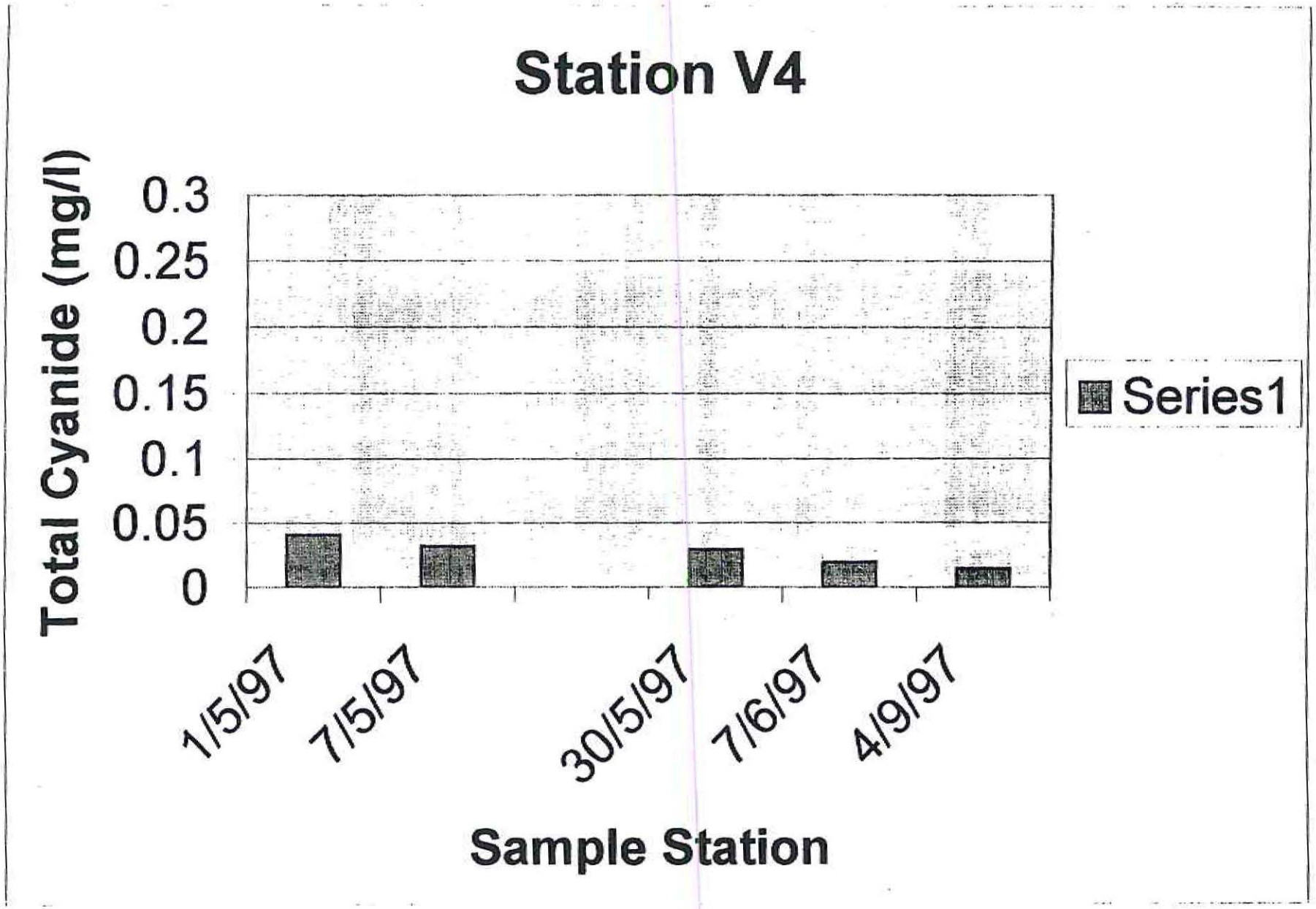
Water Quality Data
Station D3

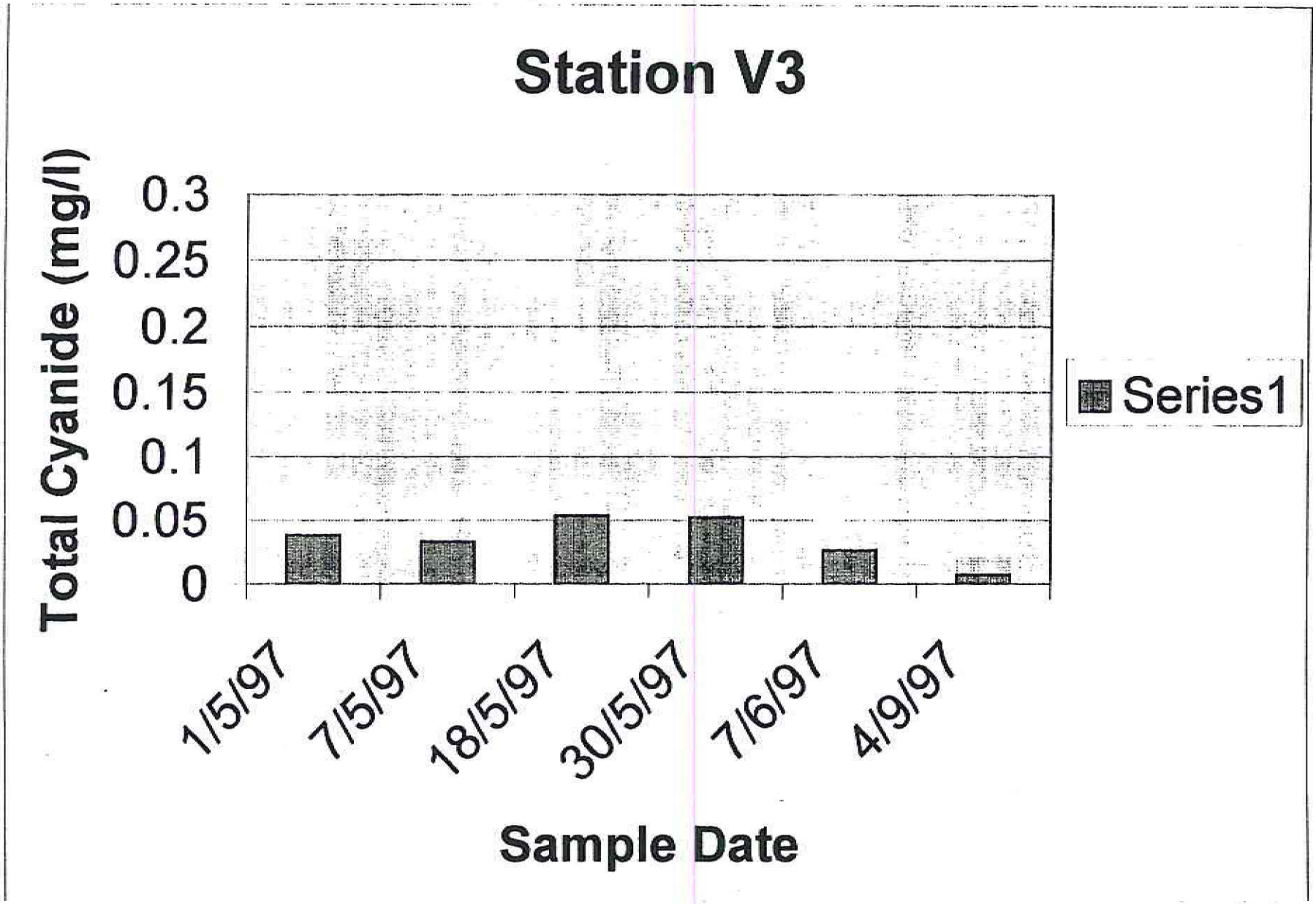
Parameter	97 05 01	97 05 07	97 05 18	97 05 30	97 06 07	97 07 08	97 08 27	97 09 24
Total Suspend Solid								
Conductivity			204	138	278			
pH			7.05	6.83				
sulphate SO4	30	26	24	5	10	<1	8	52
Ammonia Nitrogen	160	0.26	0.028	0.026	0.019	0.02	0.75	1.65
Nitrate Nitrogen	0.07	0.057	0.022	0.009	<.005	<.005	0.067	0.116
Nitrite Nitrogen	0.017	0.015	0.008	0.005	0.004	0.003	0.006	0.005
Total Cyanide	0.418	0.477	0.177	0.089	0.084	0.056	0.297	0.466
Cyanate	<.5	1.2	0.8	<.5	<.5	<.5	0.6	
Thiocyanate	1.4	2.5	0.5	2	0.9	26.9	0.8	
WAD Cyanide	0.418	0.418	0.116	0.035	0.02	0.013	0.231	0.415
TOTAL METALS						6.83		
Antimony	0.0004	0.0006	0.0003	0.0003	0.0006	0.0008	0.0006	0.0004
Arsenic	0.0087	0.0167	0.0084	0.0347	0.0712	0.313	0.688	0.424
Barium	0.14	0.19	0.1	0.07	0.13	0.12	0.16	0.15
Cadmium	0.0003	0.0006	<.0002	<.0002	0.0002	<.0002	<.0002	<.0002
Chromium	0.001	0.008	<.001	<.001	0.001	0.001	<.001	<.001
Copper	0.037	0.067	0.006	0.004	0.004	0.002	0.015	0.164
Iron	2.25	5.74	1.11	2.93	6.68	13.4	18.5	7.24
Lead	0.005	0.016	<.001	<.001	0.001	0.001	<.001	<.001
Manganese	0.785	0.974	1.4	1.63	5.27	1.22	4.43	3.95
Mercury	0.00102	0.0009	0.00005	<.00005	<.00005	<.00005	<.00005	<.00005
Nickel	0.05	0.05	0.03	<.02	0.02	<.02	0.03	0.04
Silver	0.01	0.01	<.01	<0.01	<0.01	<.01	<.01	<.01
Zinc	0.016	0.032	0.009	0.011	0.016	0.01	0.006	0.005
DISSOLVED METALS								
Antimony	0.0003	0.0003	0.0003	0.0003	0.0005	0.0006	0.0005	0.0004
Arsenic	0.0048	0.0037	0.0073	0.017	0.0365	1.08	0.271	0.197
Barium	0.12	0.11	0.1	0.07	0.1	0.11	0.12	0.13
Cadmium	<.0002	<.0002	<.0002	<.0002	<0.0002	<.0002	<.0002	<.0002
Chromium	<.001	<.001	<.001	<.001	<0.001	<.001	<.0001	<.001
Copper	0.038	0.064	0.005	0.003	0.003	0.002	0.013	0.152
Iron	0.69	0.8	0.82	1.5	2.59	4.53	7.07	1.97
Lead	<.001	<.001	<.001	<.001	<0.001	<.001	<.001	<.001
Manganese	0.769	0.809	1.42	1.69	4.02	3.89	3.7	3.38
Mercury	0.00044	0.00031	<.00005	<.00005	<0.00005	<.00005	<.00005	<.00005
Nickel	0.05	0.04	0.02	<.02	<0.02	<.02	0.04	0.03
Silver	0.01	0.01	<.01	<0.01	<0.01	<.01	<.01	<.01
Zinc	0.011	0.005	0.009	0.007	0.009	<.005	0.005	<.005

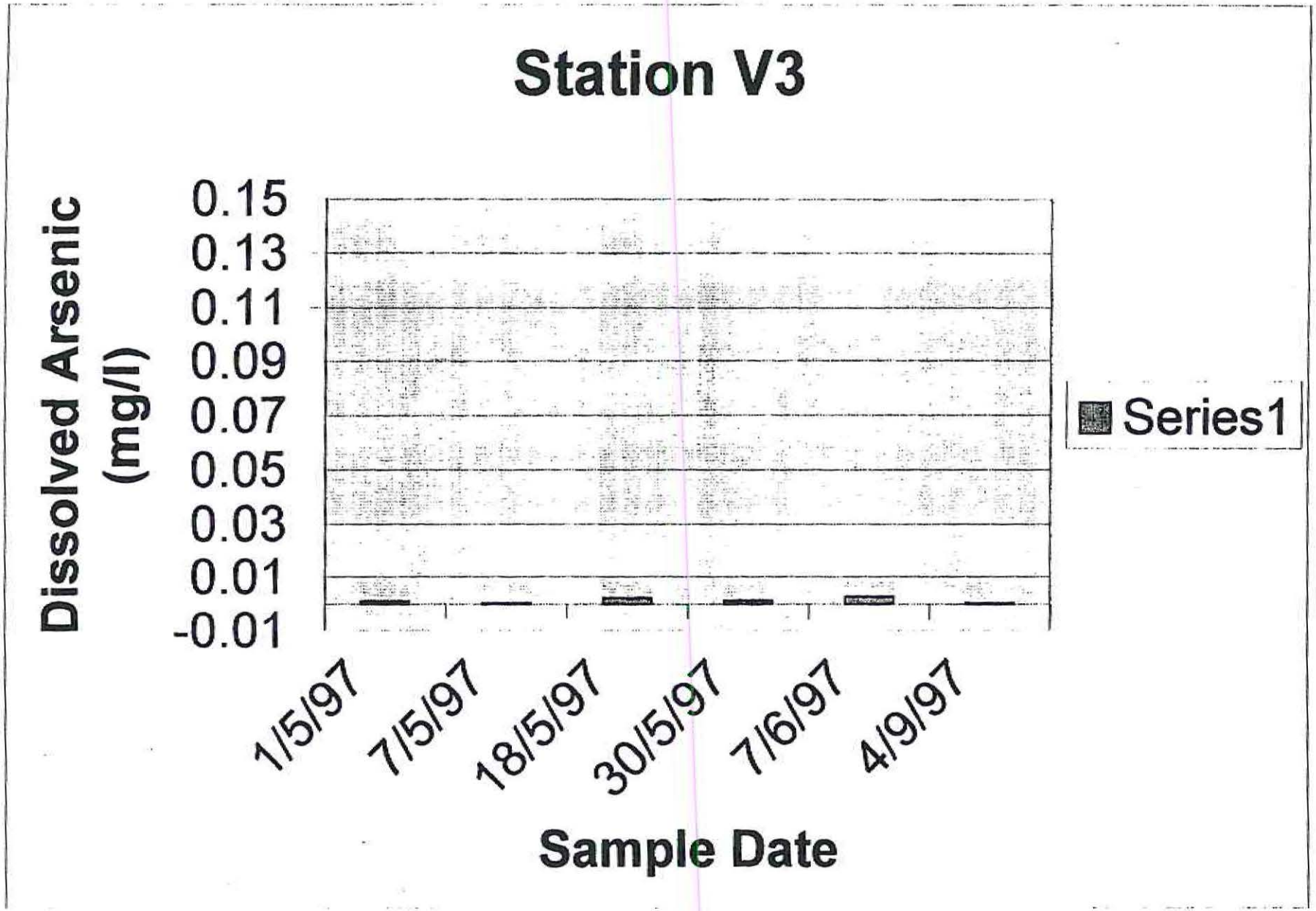
Water Quality Data
Station P1

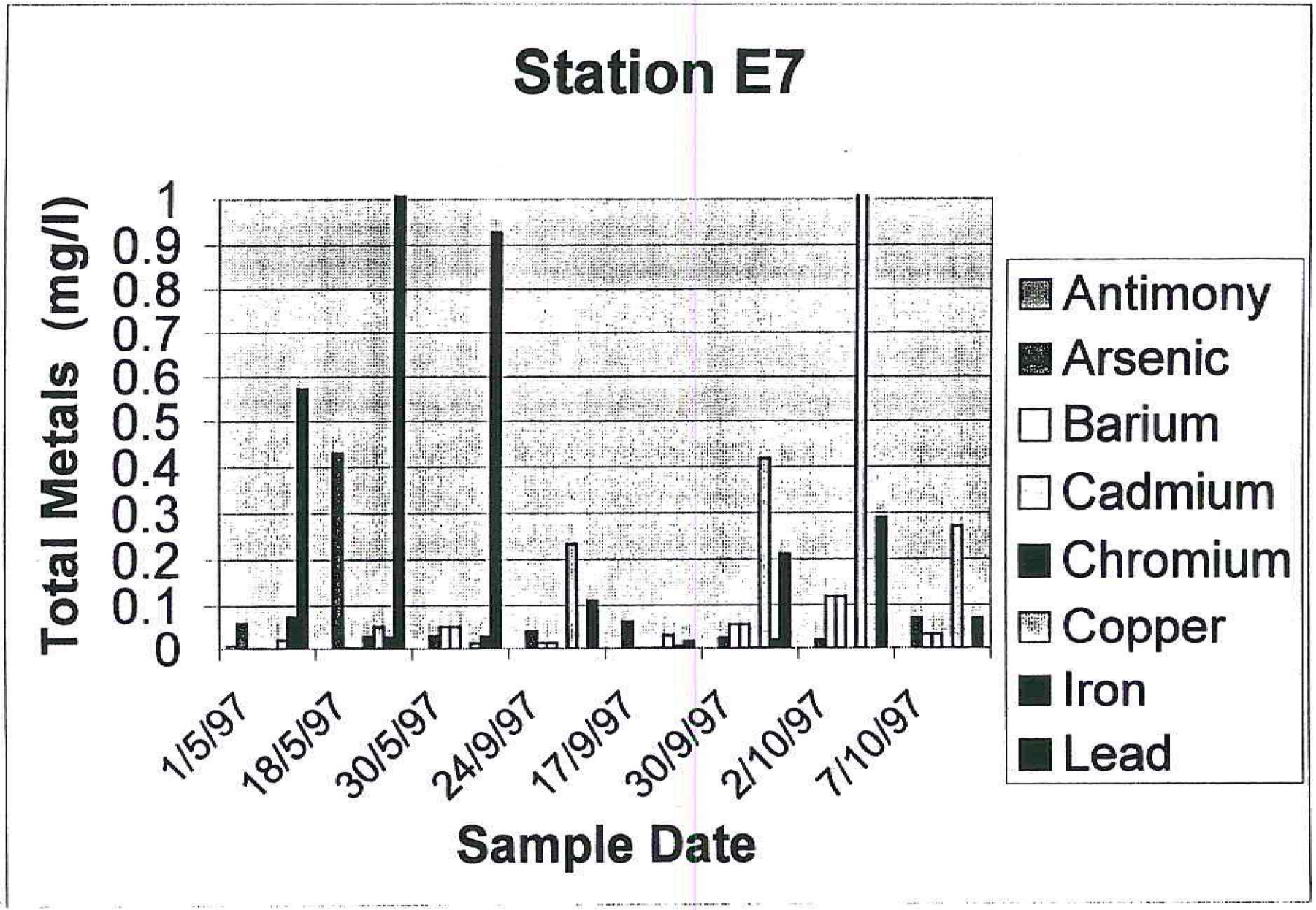
Parameter	97 05 01	97 05 07	97 05 30	97 06 07	97 06 21	97 07 08	97 07 30	97 08 14	97 08 27	97 09 10
Total Suspend Solid										9
Conductivity			66	154	89					
pH			6.34							
sulphate SO4	10	10	9	35		52	233	58	134	147
Ammonia Nitrogen	<.02	0.03	0.015	0.12	0.023	0.028	0.1	0.12	0.11	0.08
Nitrate Nitrogen	0.008	<.005	0.015	0.057		0.059	0.575	0.092	0.216	0.176
Nitrite Nitrogen	<.001	0.004	0.007	0.003		0.003	0.005	0.007	0.004	0.002
Total Cyanide	0.055	0.053	0.028	0.025	0.017	0.018	0.028	0.014	0.013	<.005
Cyanate	<.5	<.5	<.5	<.5		<.5				
Thiocyanate	1.4	2.2	1.5	<.5		<.5			0.3	
WAD Cyanide	<.005	0.01	<.005	<.005		<.0005				
TOTAL METALS										
Antimony	0.001	0.0017	0.0025	0.0028		0.0048	0.0023	0.0009	0.0025	..0019
Arsenic	0.0081	0.0093	0.0182	0.0068		0.0136	0.24		0.0088	0.0043
Barium	0.04	0.04	0.06	0.05		0.04	0.06	0.07	0.06	0.06
Cadmium	0.0024	0.0018	0.0009	0.0011		0.0042	0.865	0.0003	0.0159	0.0207
Chromium	<.001	<.001	<.0001	<.001		<.001	<.001	<.001	<.001	<.001
Copper	0.029	0.045	0.013	0.014		0.049	1.37	0.003	0.123	0.164
Iron	0.81	0.89	1.27	0.57		0.85	15.3	0.97	1.32	0.98
Lead	0.003	0.005	0.009	0.002		0.005	0.01	0 001	0.002	0.002
Manganese	0.327	0.245	0.09	0.14		0.469	11.1	0.273	1.82	2.2
Mercury	<.00005	<.00005	<.00005	<.00005		<.00005	<.00005	<.00005	<.00005	<.00005
Nickel	<.02	<.02	<.02	<.02		<.02	<.02	<.02	<.02	0.02
Silver	<.01	<.01	<0.01	<0.01		<.01	<.01	<.01	<.01	<.01
Zinc	0.173	0.129	0.045	0.093		2.9	7.01	0.017	1.08	1.28
DISSOLVED METALS										
Antimony	0.0007	0.0011	0.0013	0.0027		0.0041	0.0007	0.0007	0.0024	0.0018
Arsenic	0.0047	0.0042	0.0042	0.0051	0.0033	0.0089	0.001		0.0035	0.0013
Barium	0.04	0.04	0.04	0.04		0.04	0.06	0.06	0.06	0.06
Cadmium	0.0024	0.0015	0.0002	0.0009		0.0039	0.0856	<.0002	0.013	0.019
Chromium	<.001	<.001	<.001	<0.001		<.001	<.001	<.001	<.001	<.001
Copper	0.032	0.038	0.009	0.013		0.044	1.29	0.002	0.057	0.062
Iron	0.54	0.43	0.34	0.38		0.58	8.98	0.46	0.03	<.03
Lead	0.002	0.001	0.001	<0.001		0.002	0.001	<.001	<.001	<.001
Manganese	0.304	0.088	0.02	0.115		0.456	11.1	0.247	1.76	2.14
Mercury	<.00005	<.00005	<.00005	<0.00005		<.00005	<.00005	<.00005	<.00005	<.00005
Nickel	<.02	<.02	<.02	<0.02		<.02	<.02	<.02	<.02	<.02
Silver	<.01	<.01	<0.01	<0.01		<.01	<.01	<.01	<.01	<.01
Zinc	0.178	0.117	0.025	0.079		0.273	7.01	0.012	0.825	1.14

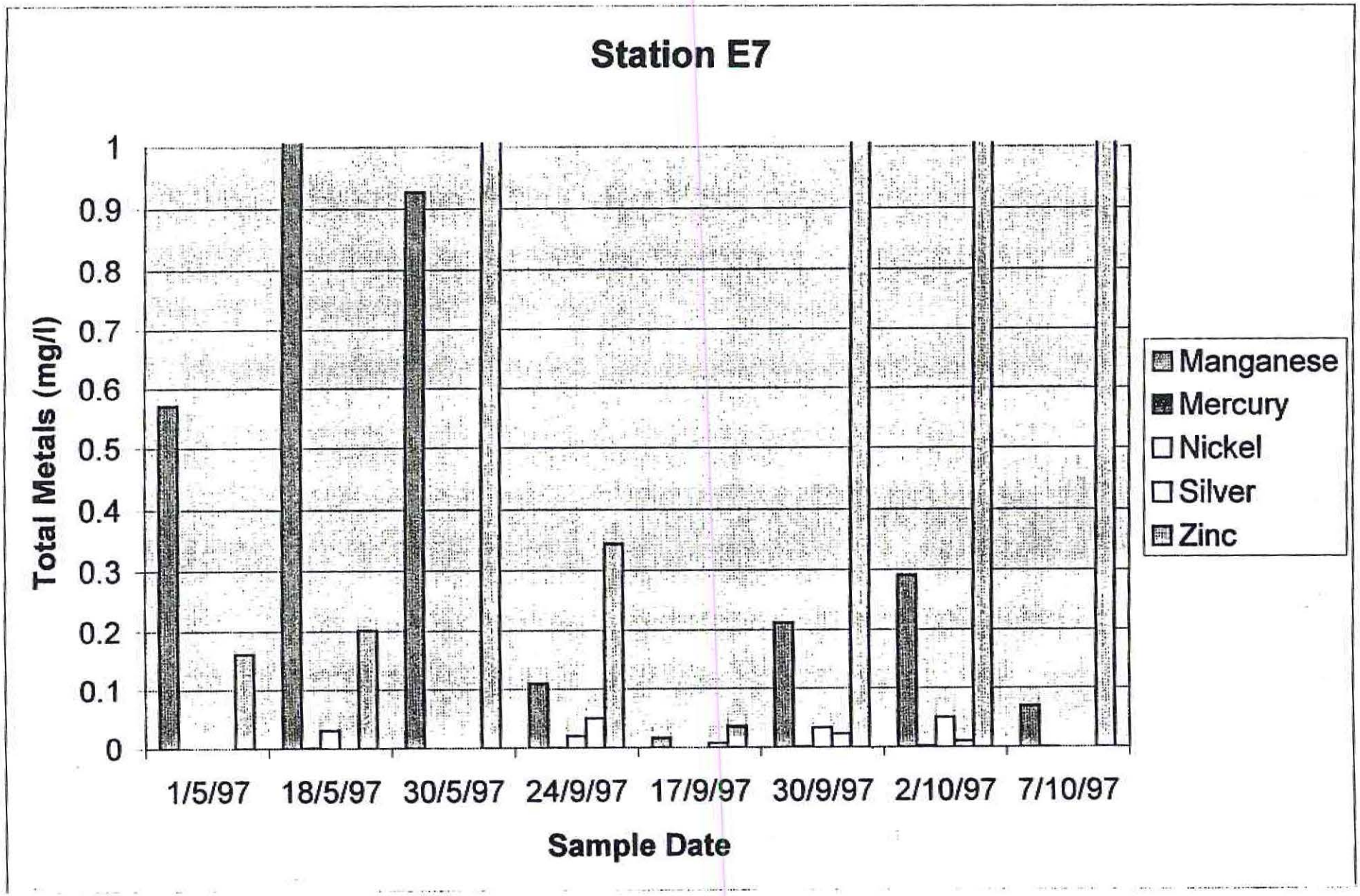

Station V4
Dissolved Arsenic (mg/l)
0.015
0.013
0.011
0.009
0.007
0.005
0.003
0.001
-0.001
1/5/97
7/5/97
30/5/97
7/6/97
4/9/97
Sample Date
Series1

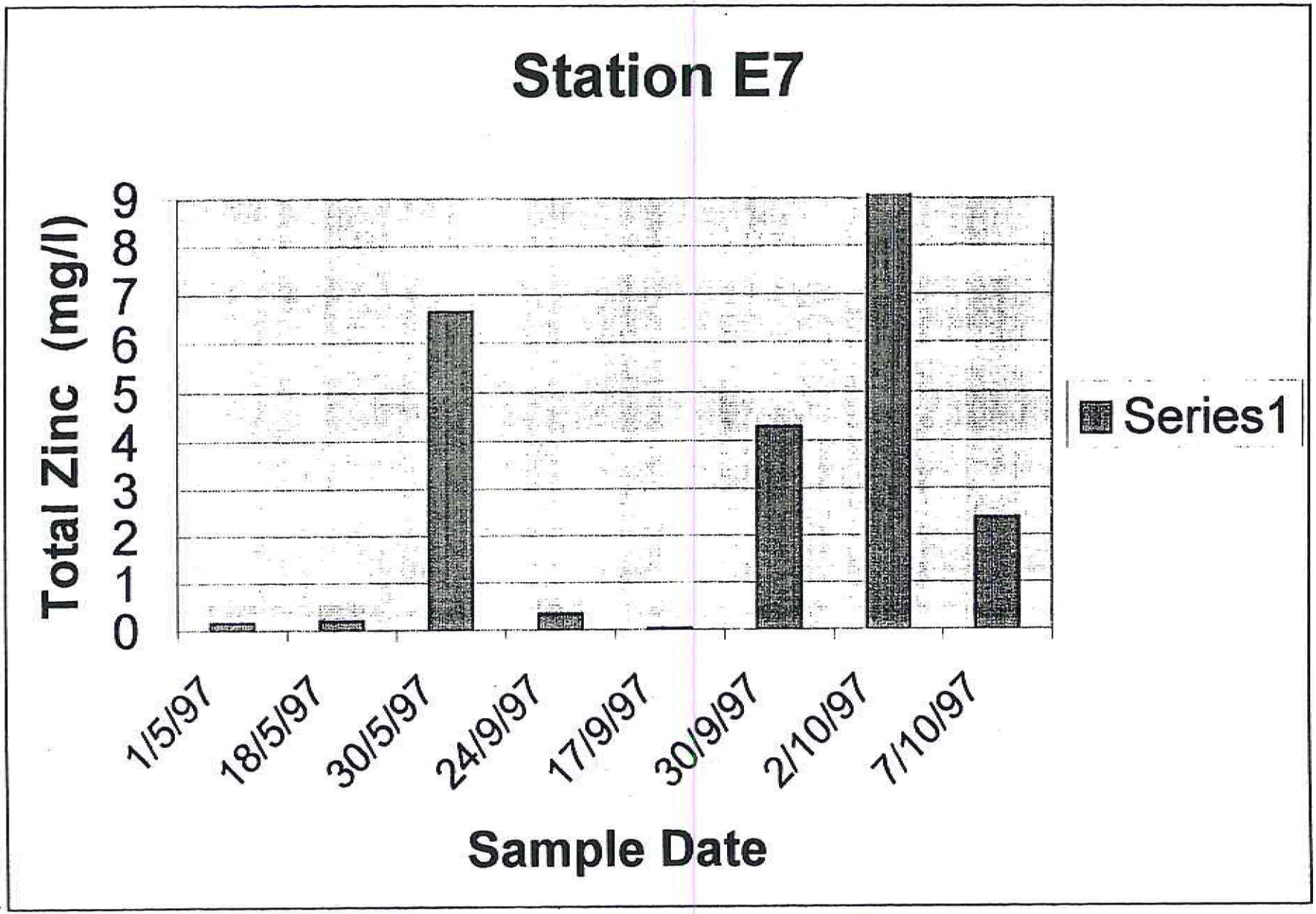

Station V4
Total Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
1/5/97
7/5/97
30/5/97
7/6/97
4/9/97
Sample Station
Series1

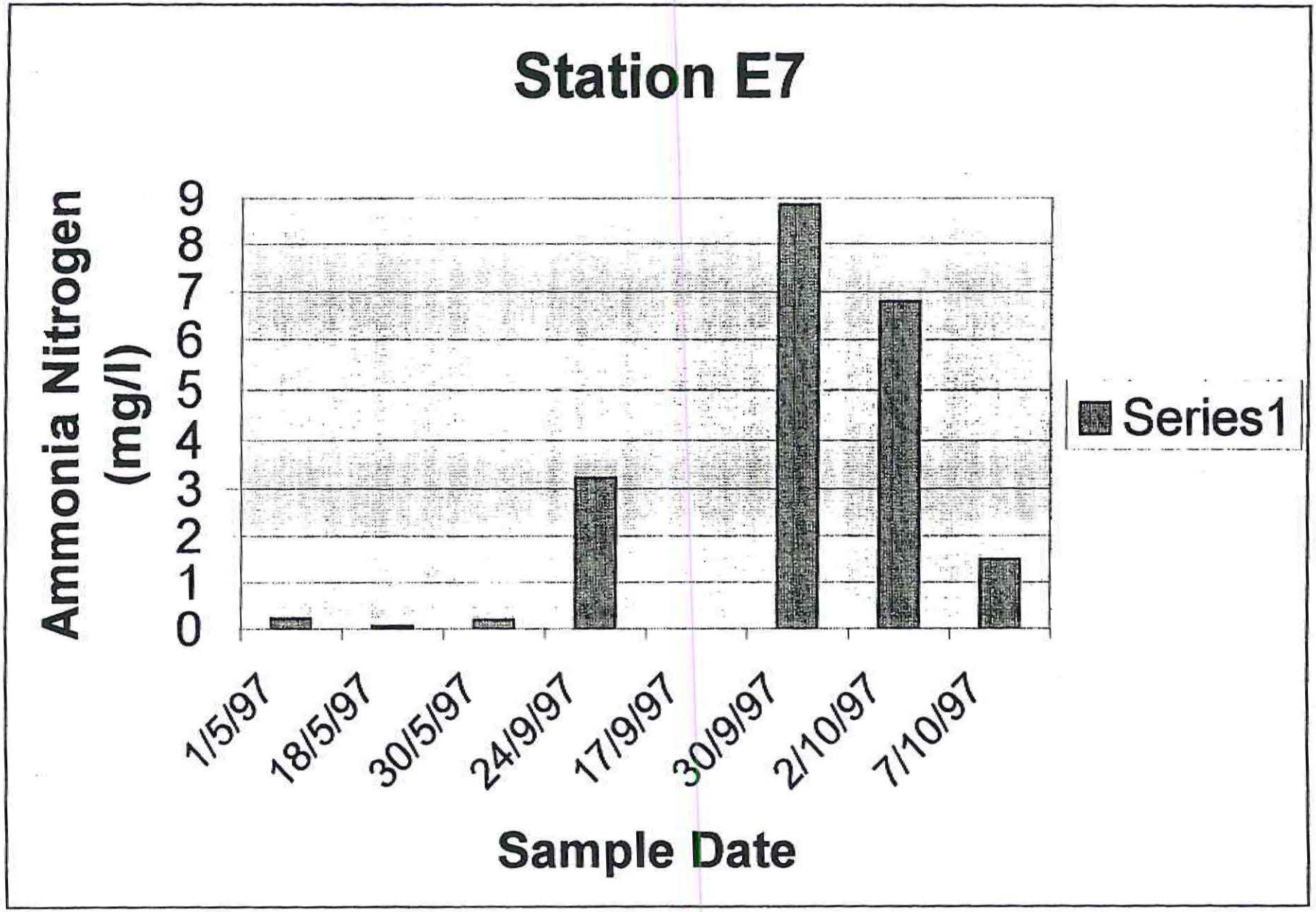

Station V3
Total Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
1/5/97
7/5/97
18/5/97
30/5/97
7/6/97
4/9/97
Sample Date
Series1

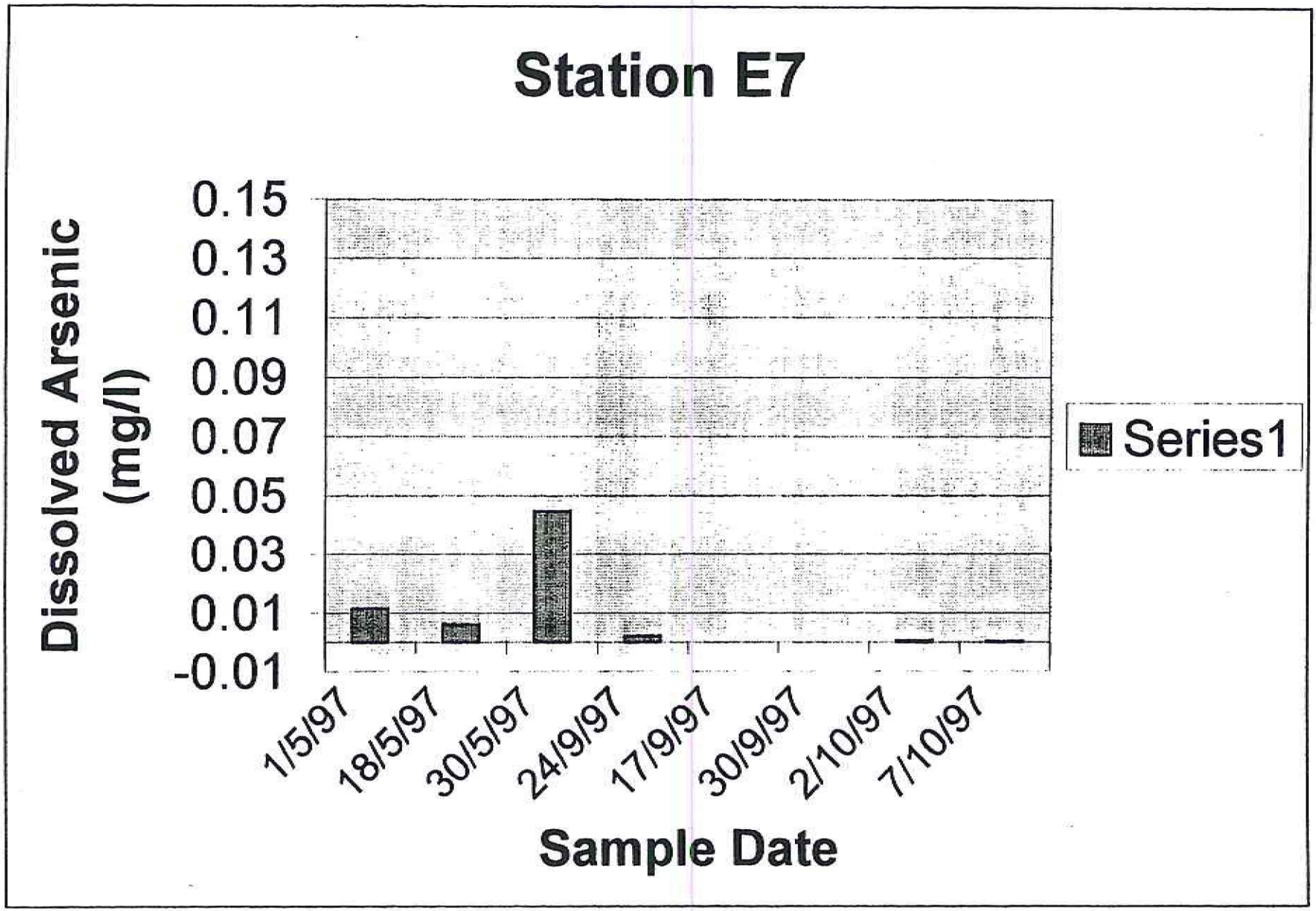

Station V3
Dissolved Arsenic (mg/l)
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
1/5/97
7/5/97
18/5/97
30/5/97
7/6/97
4/9/97
Sample Date
Series1

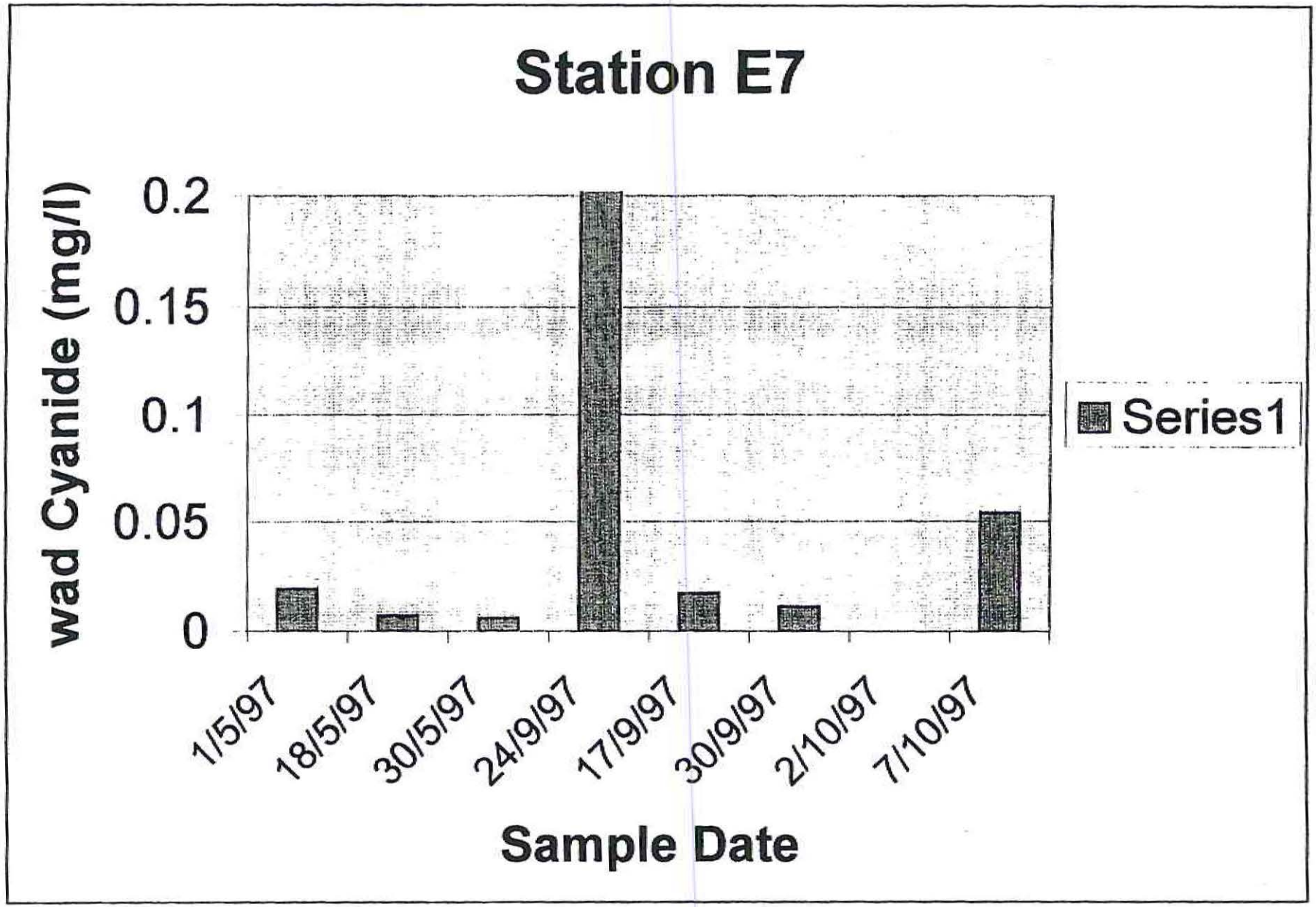

Station E7
Total Metals (mg/l)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Antimony
Arsenic
Barium
Cadmium
Chromium
Copper
Iron
Lead

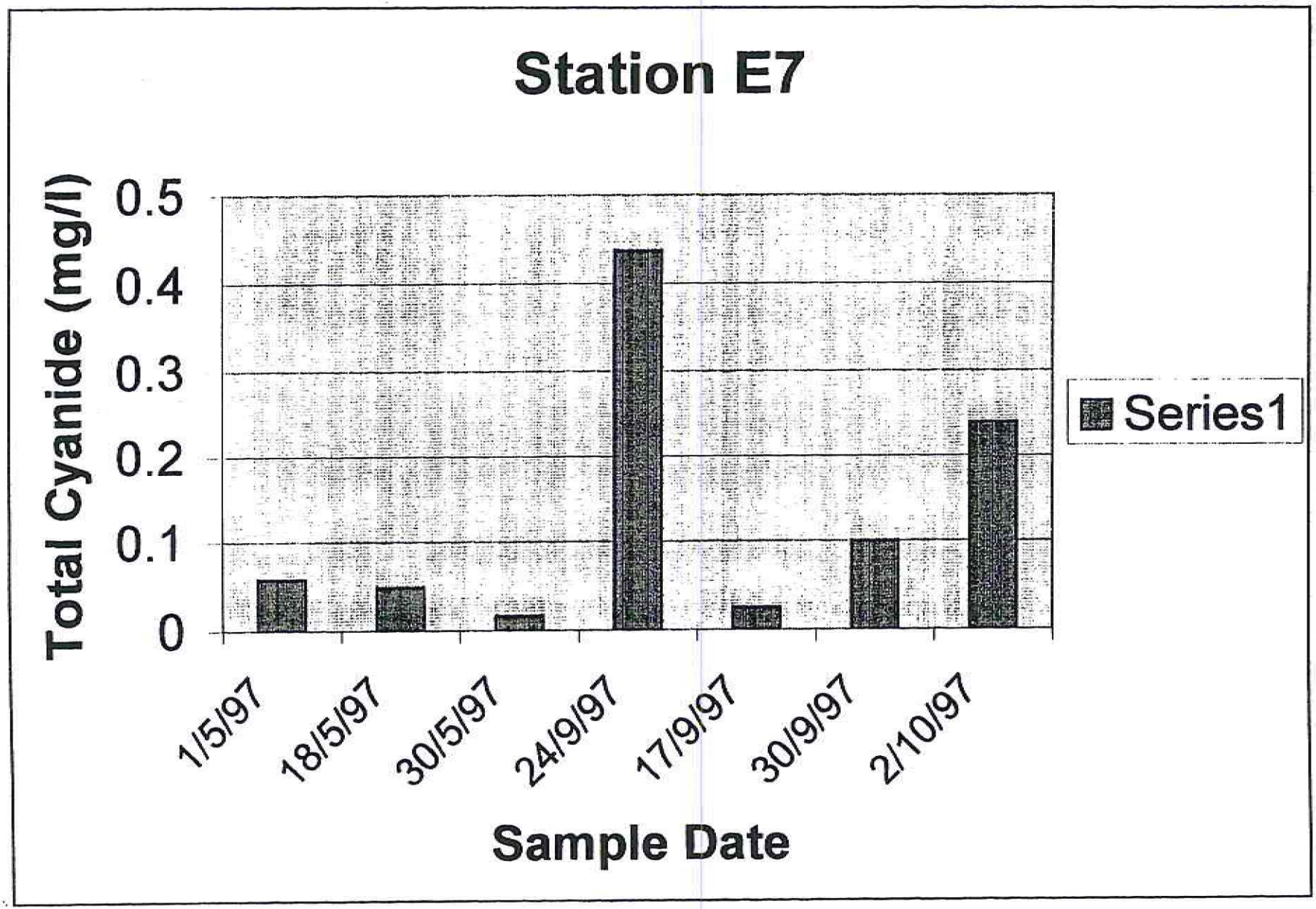

Station E7
Total Metals (mg/l)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Manganese
Mercury
Nickel
Silver
Zinc

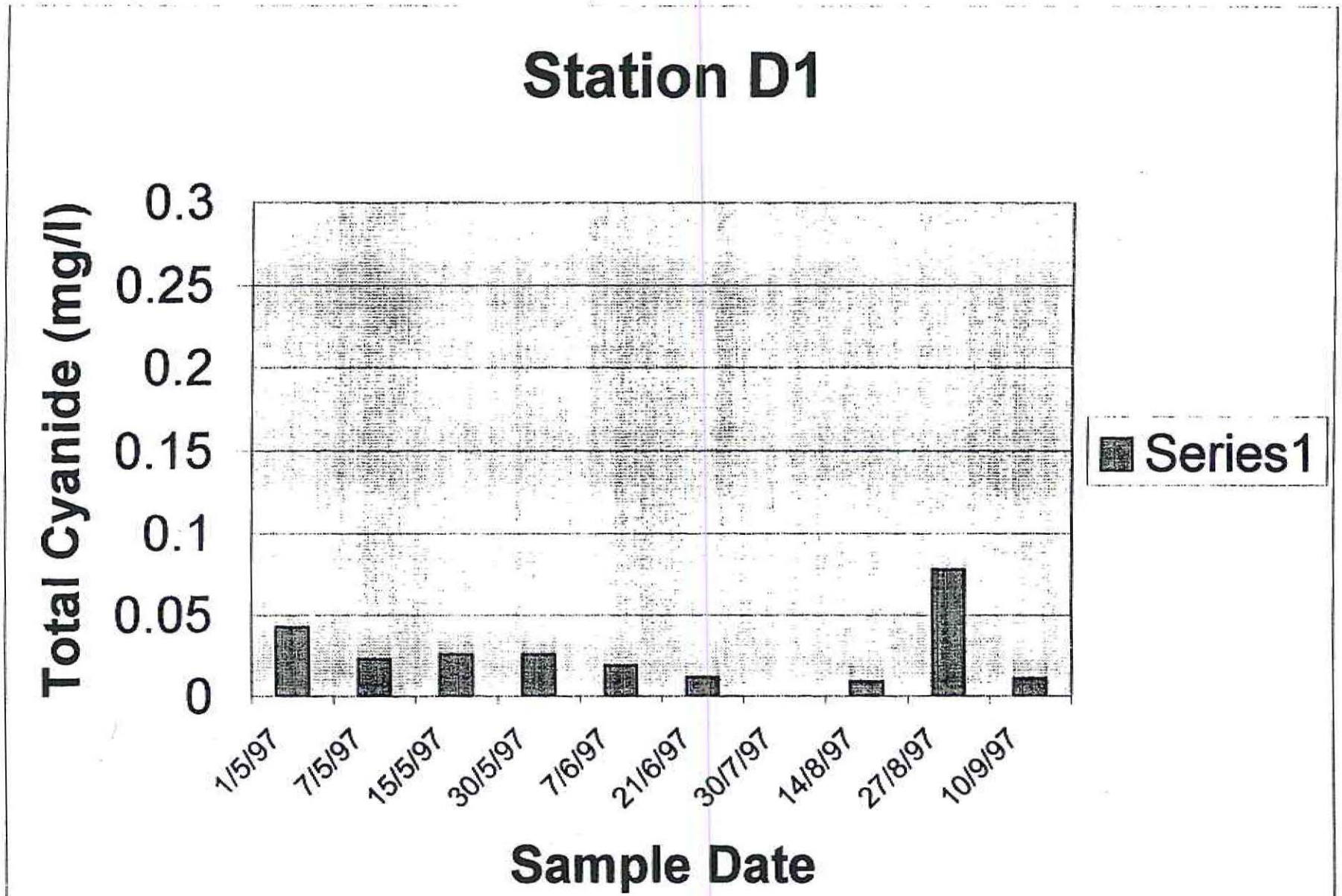

Station E7
Total Zinc (mg/l)
0
1
2
3
4
5
6
7
8
9
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Series1

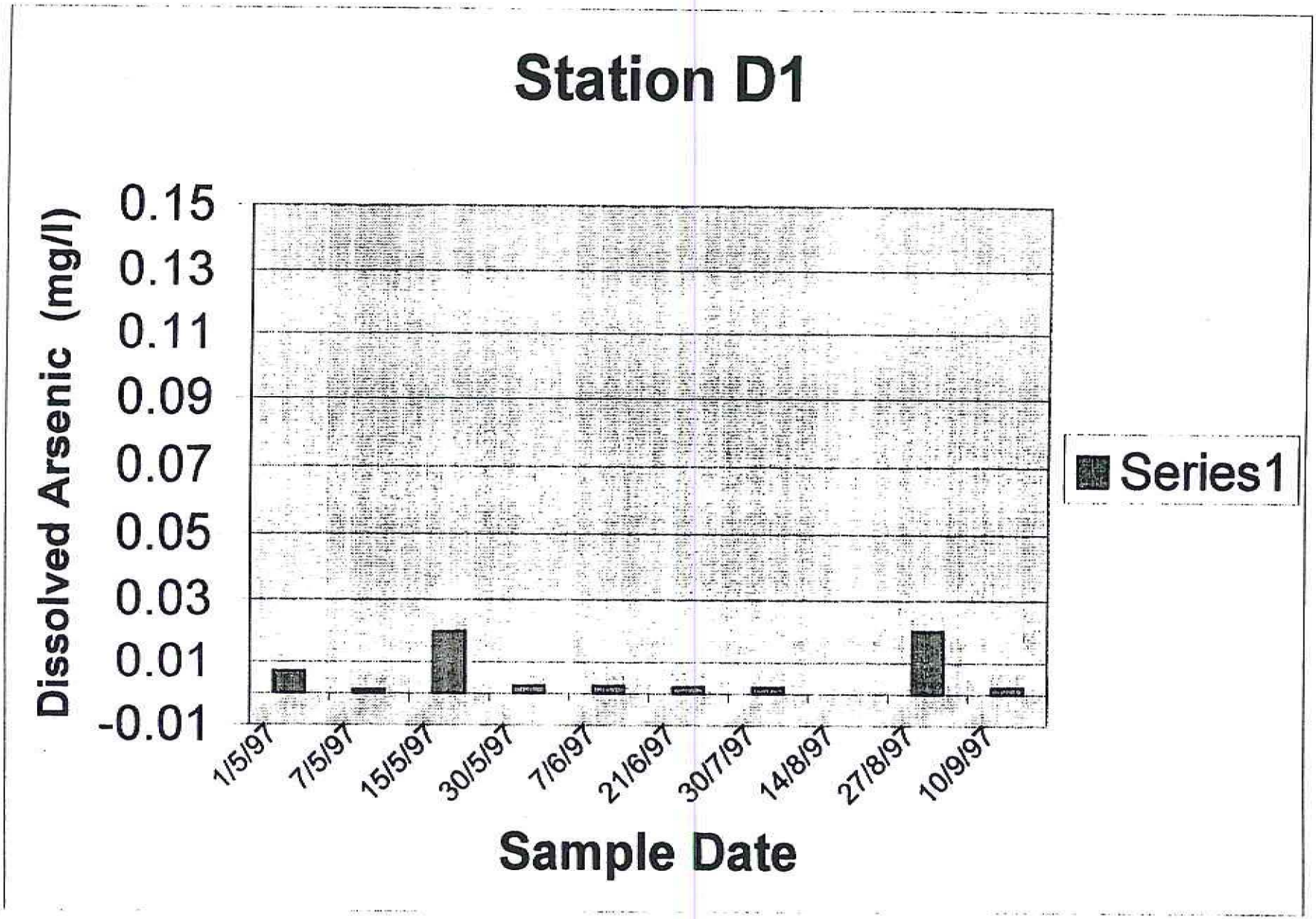

Station E7
Ammonia Nitrogen (mg/l)
0
1
2
3
4
5
6
7
8
9
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Series1

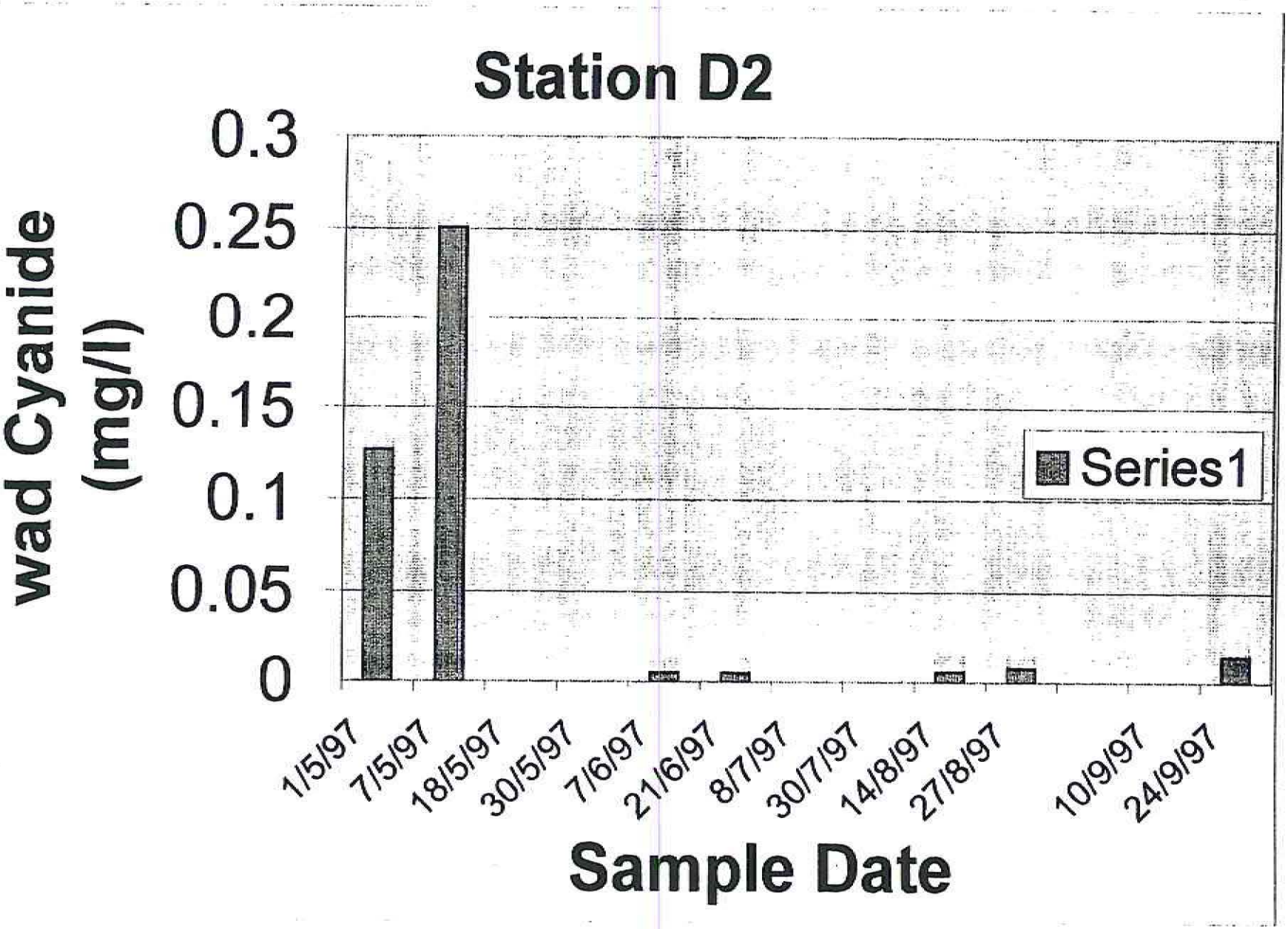

Station E7
Dissolved Arsenic (mg/l)
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Series1

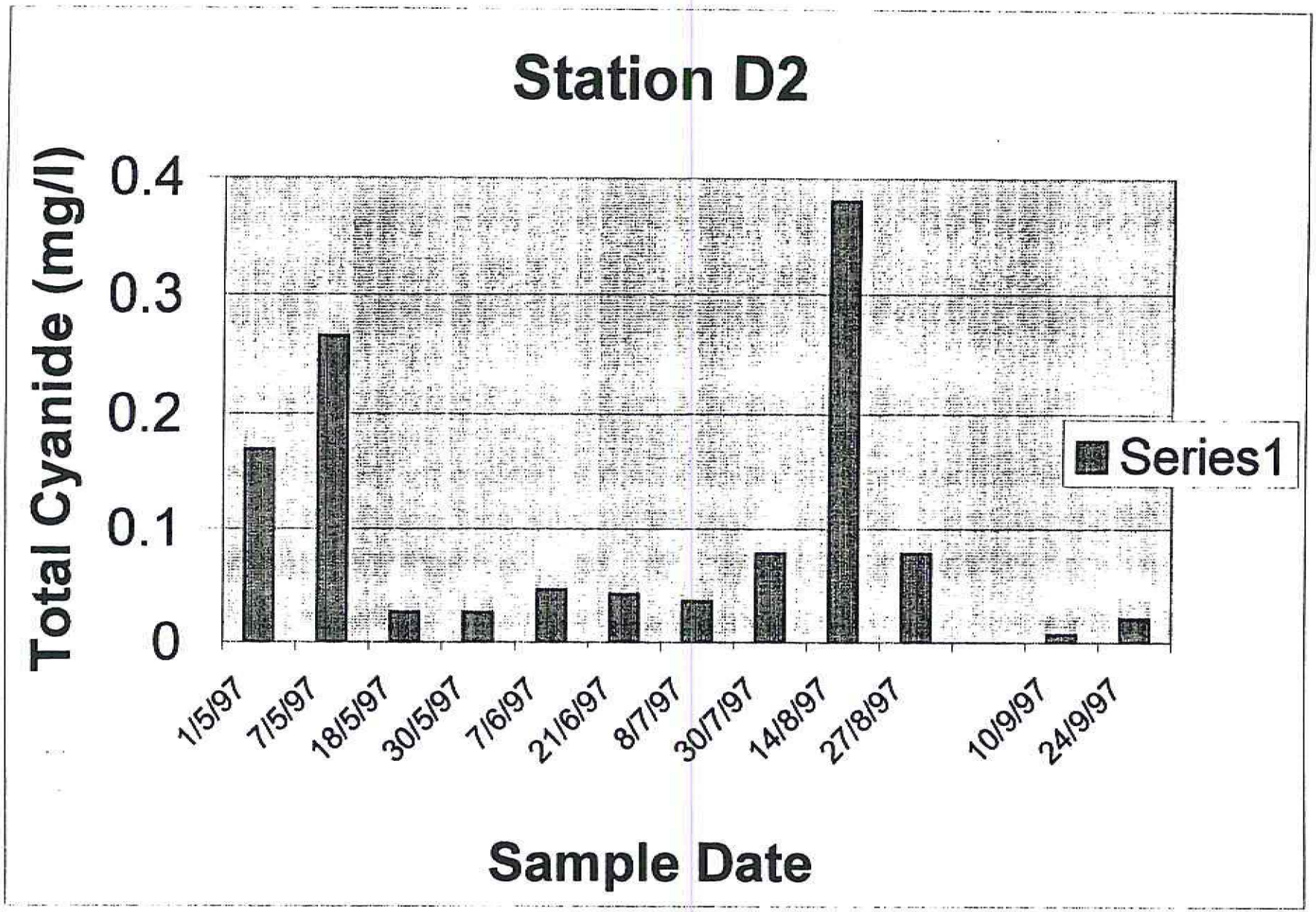

Station E7
wad Cyanide (mg/l)
0.2
0.15
0.1
0.05
0
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
7/10/97
Sample Date
Series1

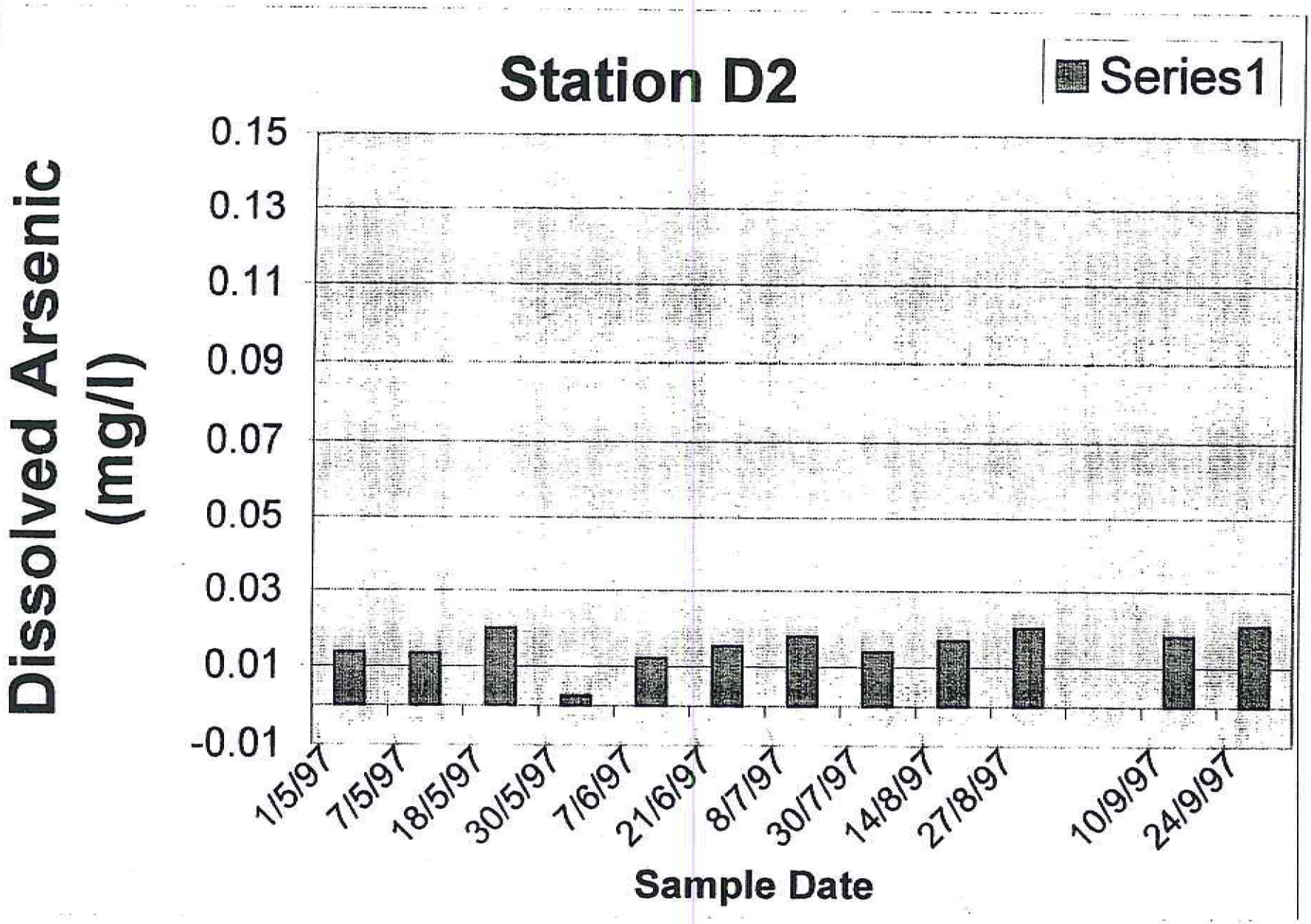

Station E7
Total Cyanide (mg/l)
0.5
0.4
0.3
0.2
0.1
0
1/5/97
18/5/97
30/5/97
24/9/97
17/9/97
30/9/97
2/10/97
Sample Date
Series1

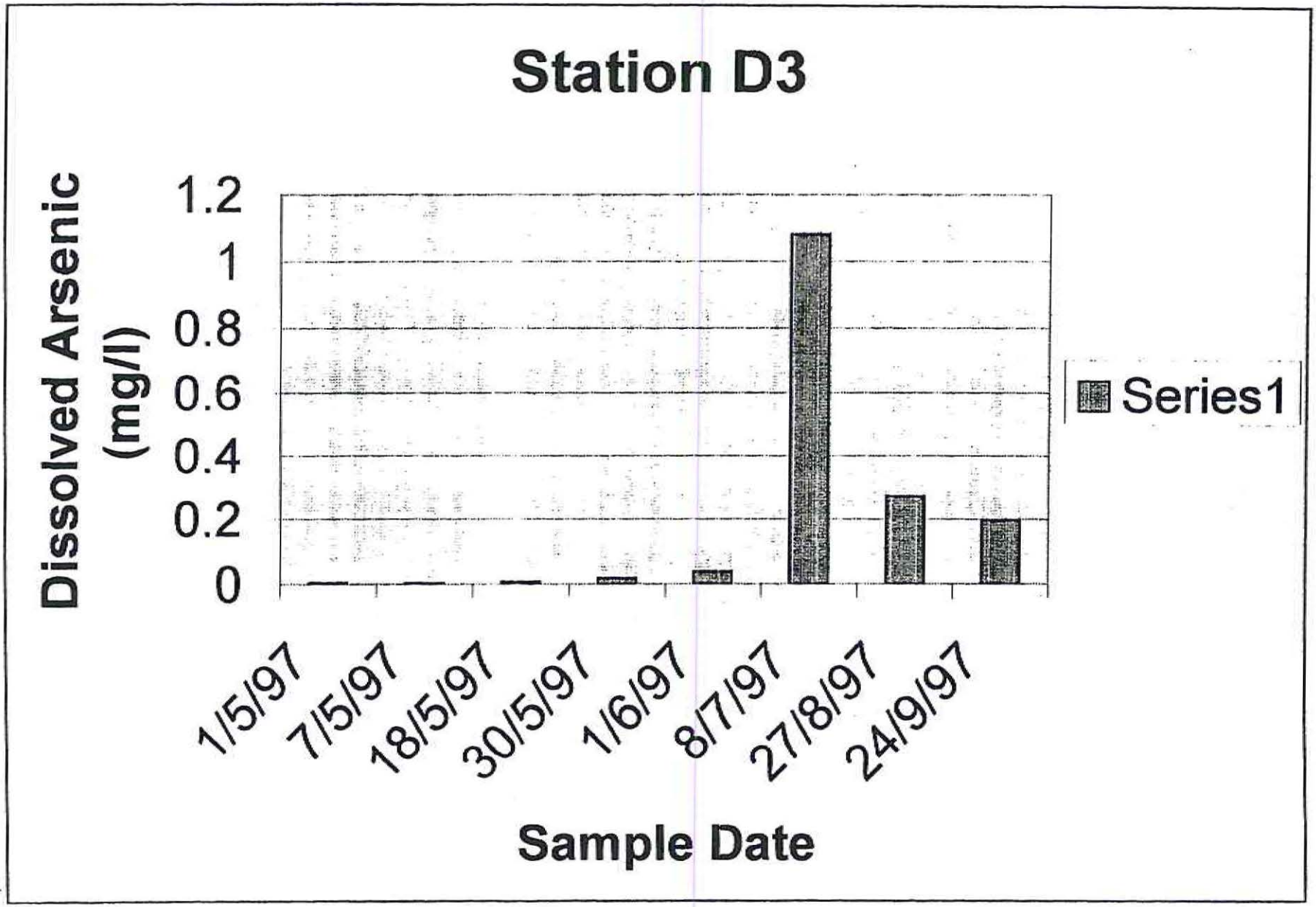

Station D1
Total Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
1/5/97
7/5/97
15/5/97
30/5/97
7/6/97
21/6/97
30/7/97
14/8/97
27/8/97
10/9/97
Sample Date
Series1

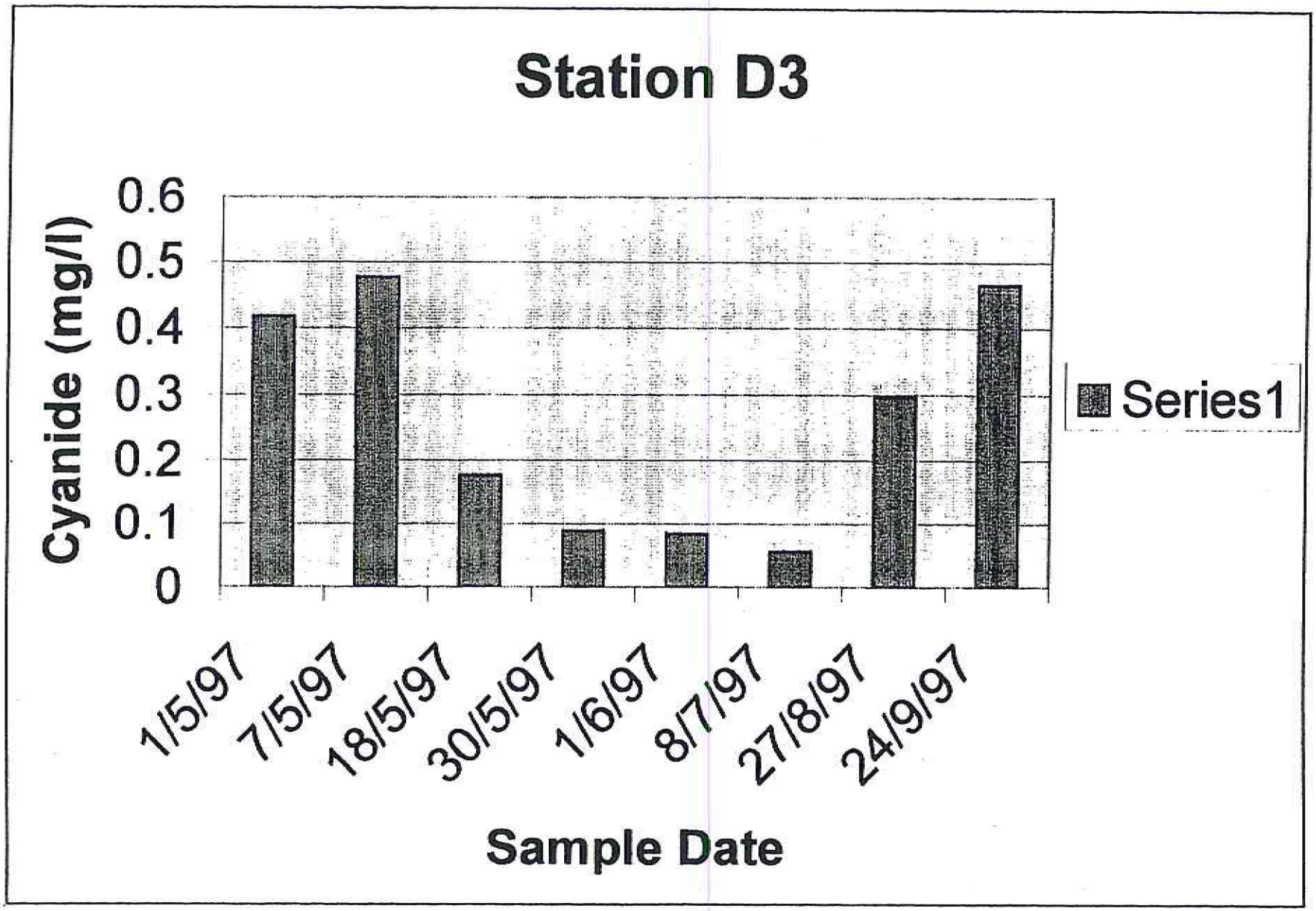

Station D1
Dissolved Arsenic (mg/l)
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
1/5/97
7/5/97
15/5/97
30/5/97
7/6/97
21/6/97
30/7/97
14/8/97
27/8/97
10/9/97
Sample Date
Series1

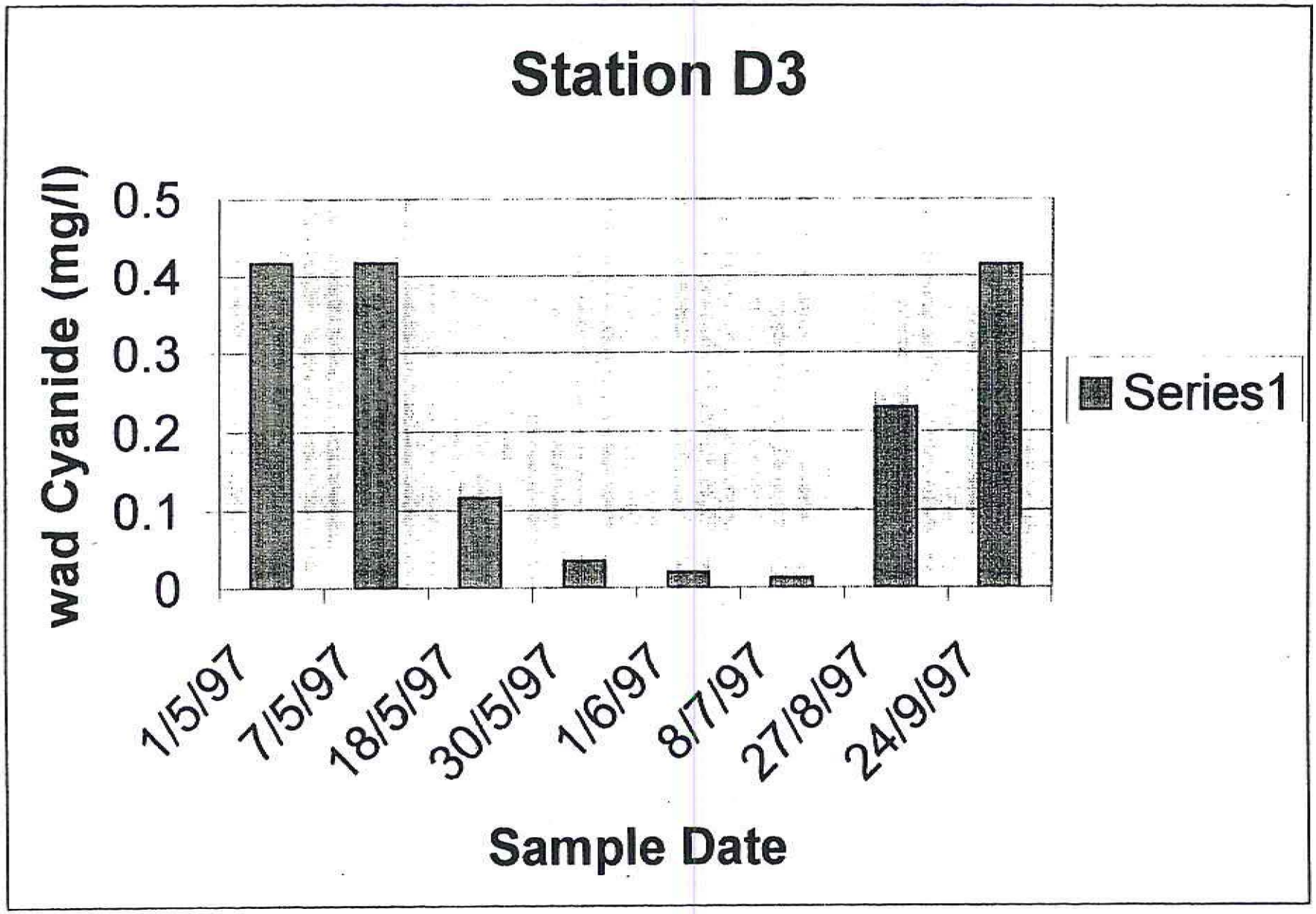

Station D2
wad Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
Series1
1/5/97
7/5/97
18/5/97
30/5/97
7/6/97
21/6/97
8/7/97
30/7/97
14/8/97
27/8/97
10/9/97
24/9/97
Sample Date

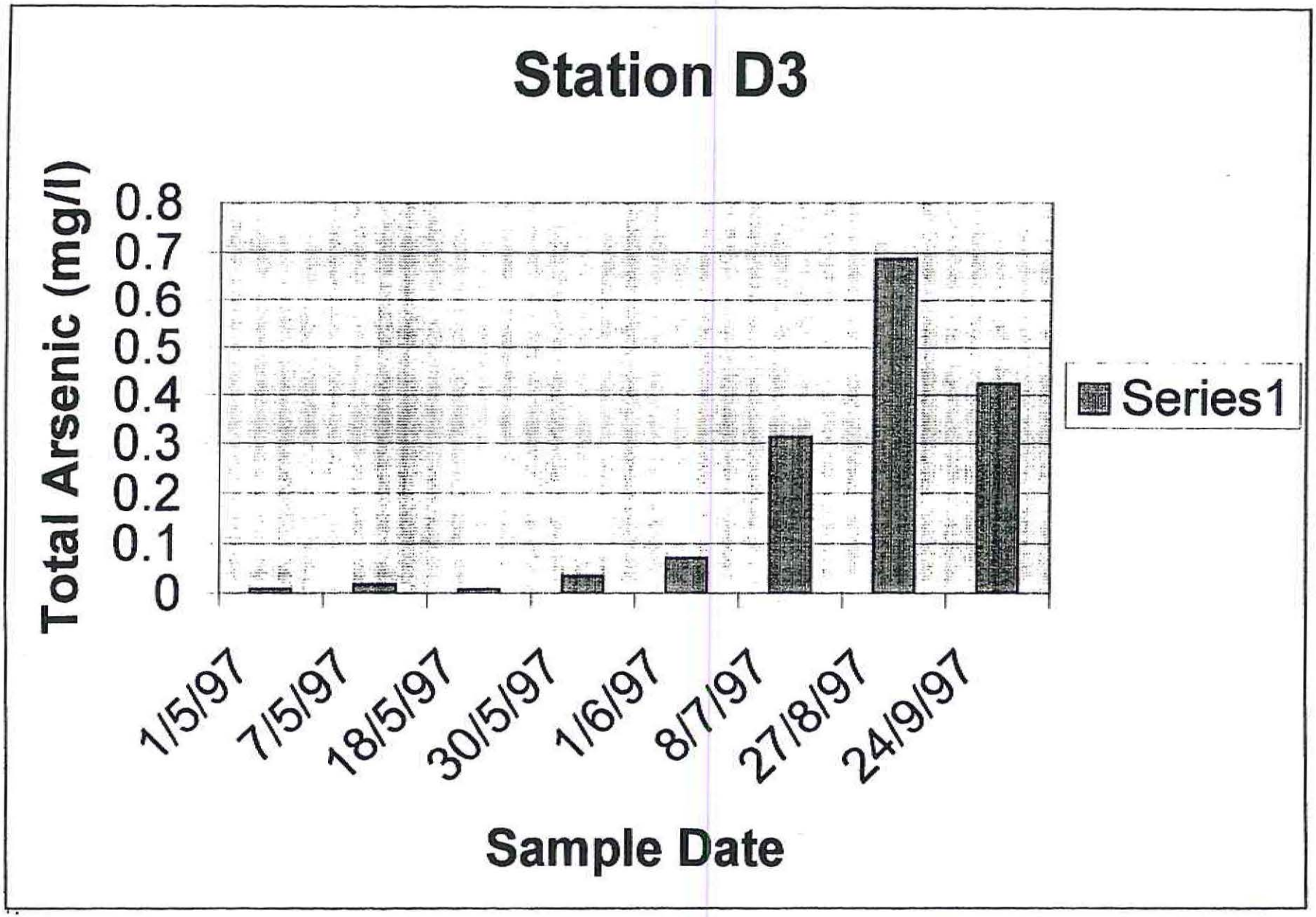

Station D2
Total Cyanide (mg/l)
0.4
0.3
0.2
0.1
0
1/5/97
7/5/97
18/5/97
30/5/97
7/6/97
21/6/97
8/7/97
30/7/97
14/8/97
27/8/97
10/9/97
24/9/97
Series1
Sample Date

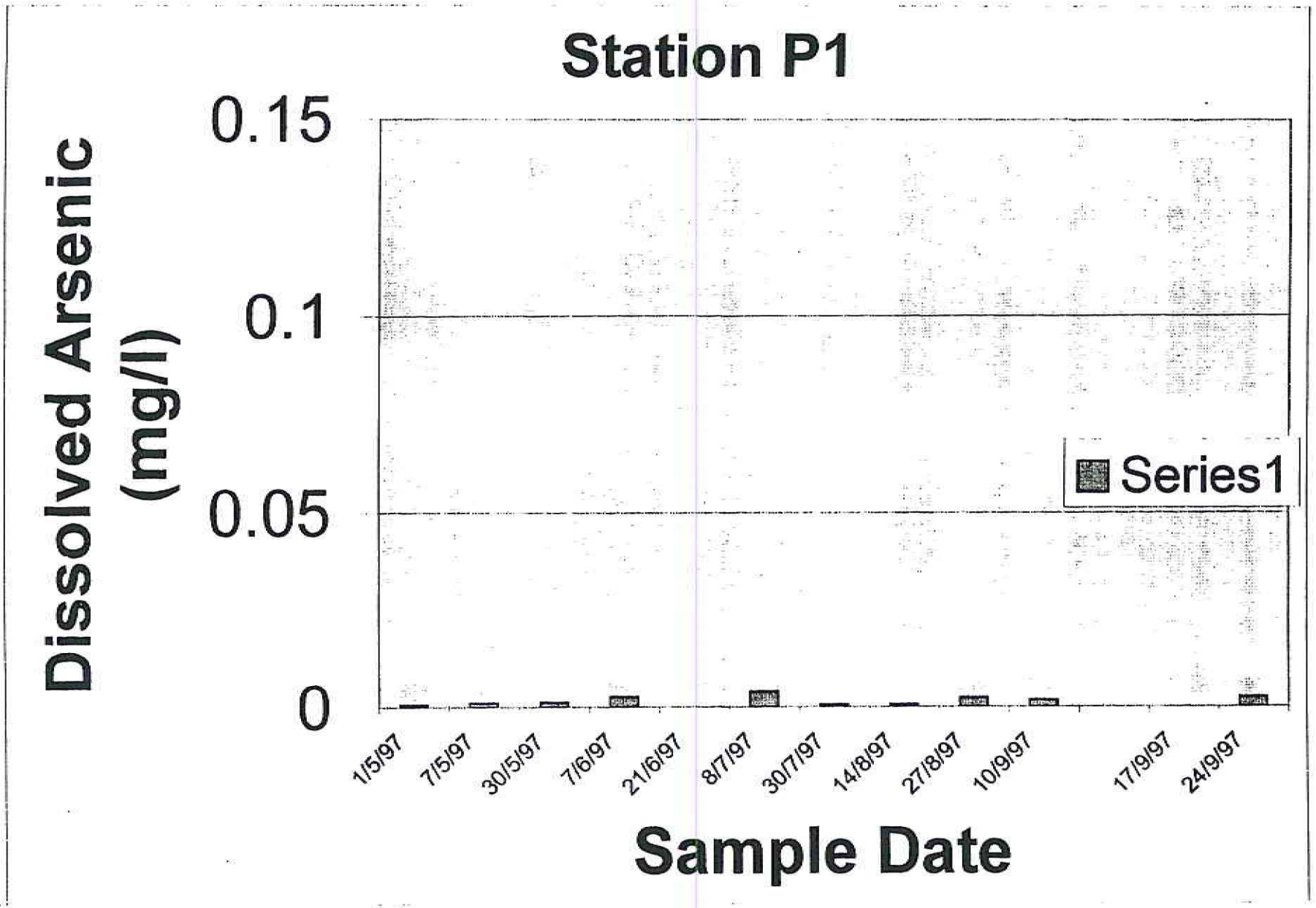

Station D2
Series1
Dissolved Arsenic (mg/l)
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
1/5/97
7/5/97
18/5/97
30/5/97
7/6/97
21/6/97
8/7/97
30/7/97
14/8/97
27/8/97
10/9/97
24/9/97
Sample Date

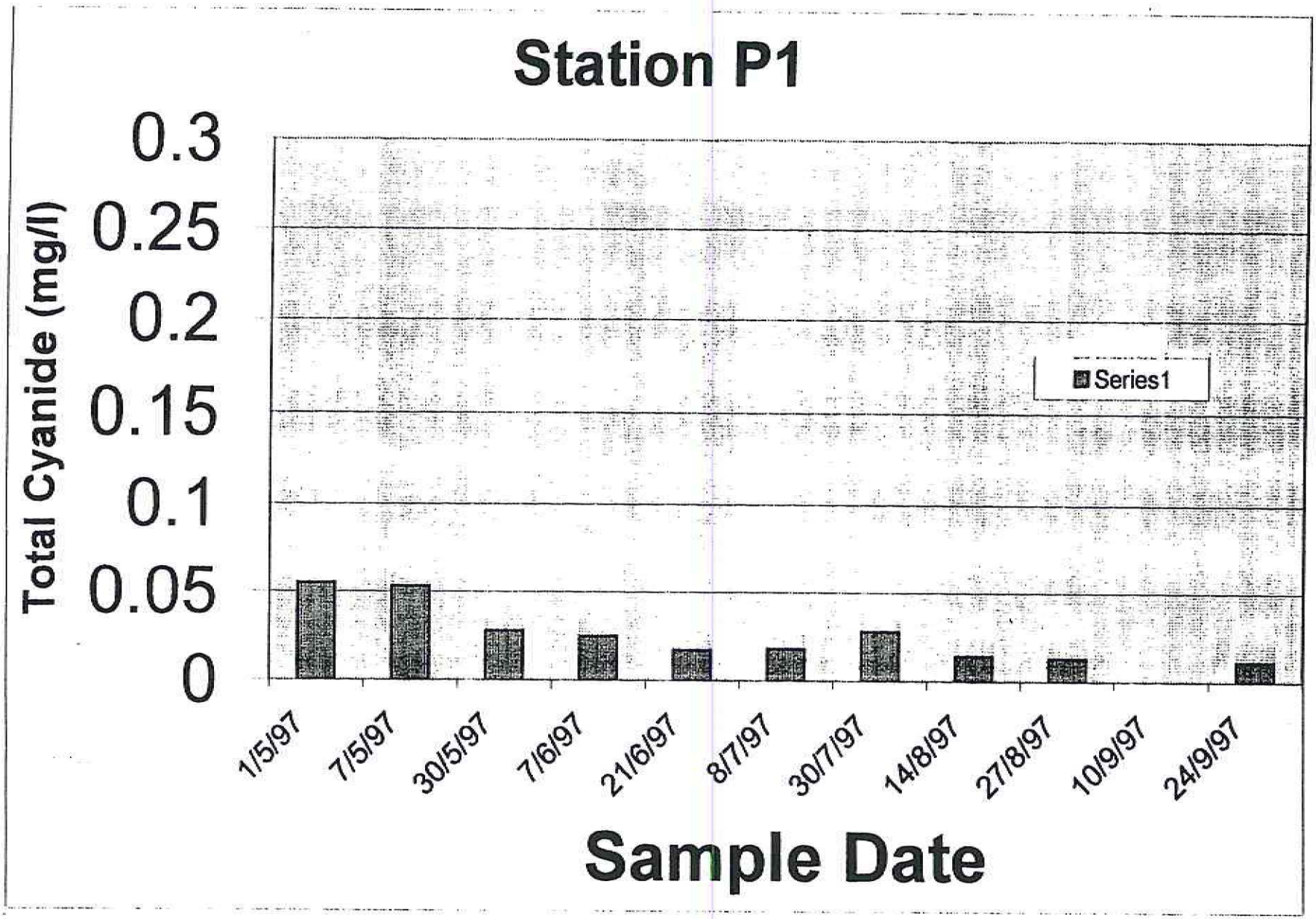

Station D3
Dissolved Arsenic (mg/l)
1.2
1
0.8
0.6
0.4
0.2
0
1/5/97
7/5/97
18/5/97
30/5/97
1/6/97
8/7/97
27/8/97
24/9/97
Sample Date
Series1

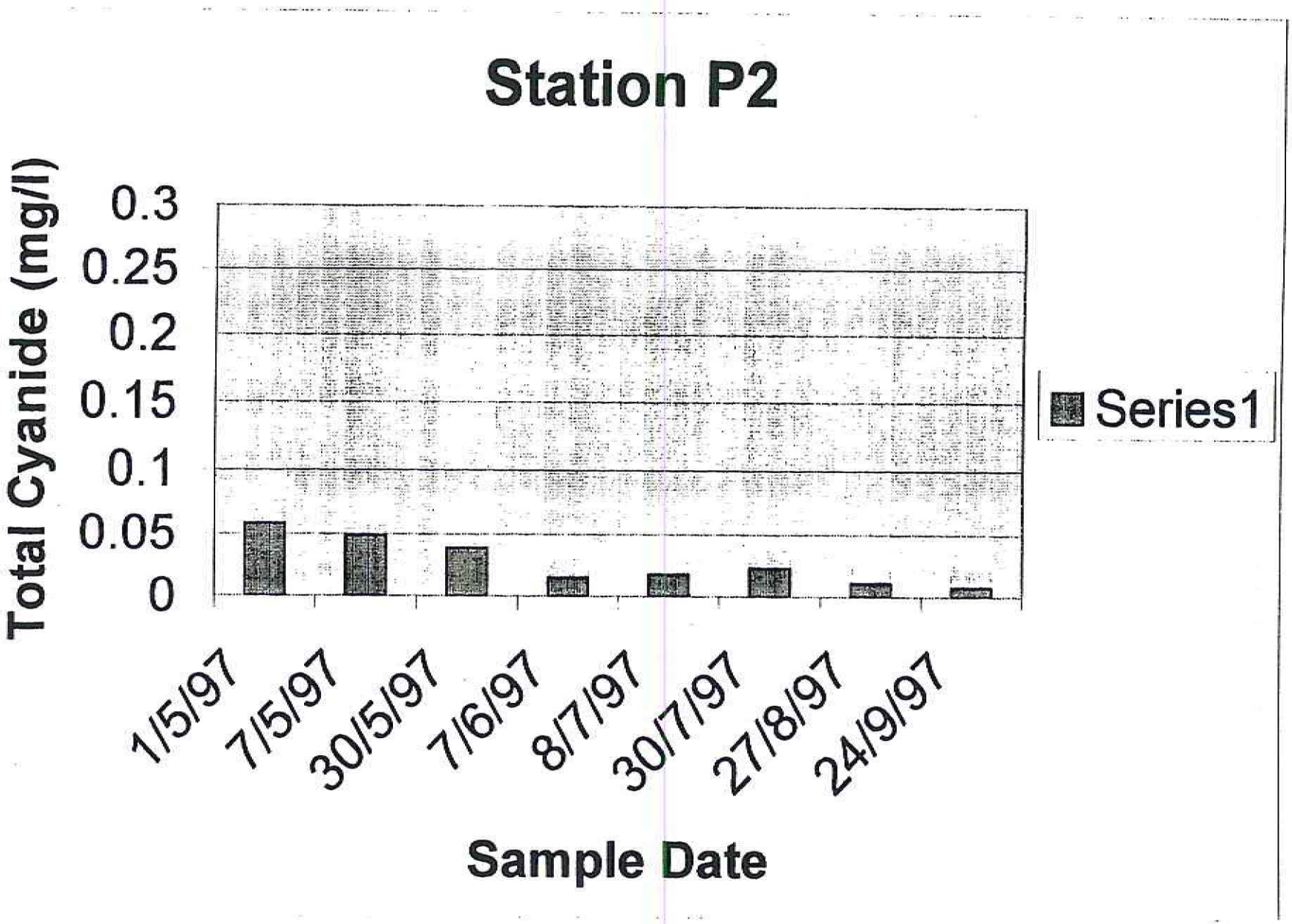

Station D3
Cyanide (mg/l)
0.6
0.5
0.4
0.3
0.2
0.1
0
1/5/97
7/5/97
18/5/97
30/5/97
1/6/97
8/7/97
27/8/97
24/9/97
Sample Date
Series1

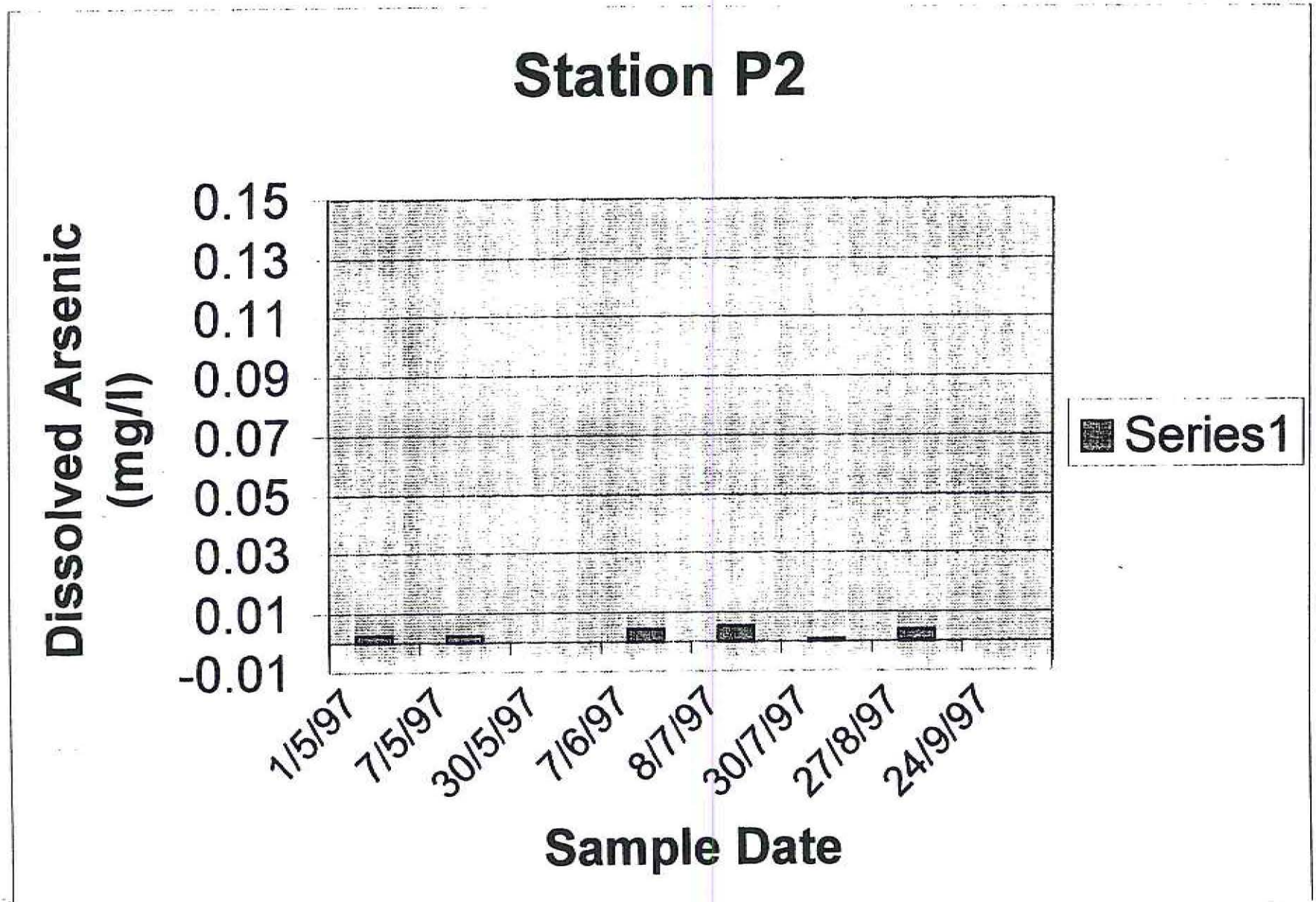

Station D3
wad Cyanide (mg/l)
0.5
0.4
0.3
0.2
0.1
0
1/5/97
7/5/97
18/5/97
30/5/97
1/6/97
8/7/97
27/8/97
24/9/97
Sample Date
Series1


Station D3
Total Arsenic (mg/l)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/5/97
7/5/97
18/5/97
30/5/97
1/6/97
8/7/97
27/8/97
24/9/97
Sample Date
Series1


Station P1
Dissolved Arsenic (mg/l)
0.15
0.1
0.05
0
Series1
1/5/97
7/5/97
30/5/97
7/6/97
21/6/97
8/7/97
30/7/97
14/8/97
27/8/97
10/9/97
17/9/97
24/9/97
Sample Date


Station P1
Total Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
Series1
1/5/97
7/5/97
30/5/97
7/6/97
21/6/97
8/7/97
30/7/97
14/8/97
27/8/97
10/9/97
24/9/97
Sample Date


Station P2
Total Cyanide (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
1/5/97
7/5/97
30/5/97
7/6/97
8/7/97
30/7/97
27/8/97
24/9/97
Sample Date
Series1


Station P2
Dissolved Arsenic (mg/l)
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
1/5/97
7/5/97
30/5/97
7/6/97
8/7/97
30/7/97
27/8/97
24/9/97
Sample Date
Series1

APPENDIX E

B.Y.G.
NATURAL RESOURCES INC.

VISTA
ENGINEERING

MT. NANSEN GOLD MINE

WATER BALANCE MODEL UPDATE
DRAFT REPORT

Prepared By:
Vista Engineering
502 Olgilvie St.
Whitehorse, YT
Y1A 2S7

Prepared For:
B.Y.G. Natural Resources Inc.
110 Industrial Road
Whitehorse, YT
Y1A 2T9

290-03
December 15, 1997

Our File: 290-03

December 15, 1997

Davis and Company
200 304 Jarvis St.
Whitehorse, YT
Y1A 2H2
667-2669 fax

CONFIDENTIAL

Attention: Mr. Rodney Snow

Re: Water Balance Update – Draft Report

Please find enclosed the above noted report.

Four scenarios have been forecast. The water balance has been modeled with the water treatment plant operating at 40 and 50 cubic meters per hour. The effect on tailings pond water level has been modeled assuming 1997 precipitation as well as a two hundred year return wet year precipitation.

Based on the results from the calibrated water balance model, the water level will not exceed the spillway invert under any of these conditions during spring freshet. It is also forecast that the tailings pond will be full by the beginning of November, based on the water licence requirement that tailings are to remain one meter below the spillway invert.

We look forward to receiving your comments, which will be incorporated into the final version of this report.

If you should have any comments or require additional information on the above, please contact us at 393-3458.

Yours truly,

Vista Engineering,

Victor Menkal, P.Eng.

502 Olgilvie St. Whitehorse YT Y1A 2S7 (403) 393-3458 (403) 393-3456 fax www.vistaeng.nt.ca

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2.0 Background	2
3.0 Environmental Data	3
3.1 Precipitation	3
3.2 Evaporation	5
4.0 Surface Runoff	5
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8.0 Conclusions	10
Diversion Ditch Flow Measurement	appendix A
Numeric Water Balance Forecast Data	appendix B

1.0 INTRODUCTION

This report summarizes the calibration of the current water balance model for the tailings facility at the Mount Nansen gold mine. The calibrated model along with current production data is used to forecast water and tailings levels for 1998. Additional background data for the water balance is presented in B.Y.G. Natural Resources Inc. water licence submissions and engineering reports.

2.0 BACKGROUND

A 270,000 cubic meter capacity impoundment facility provides storage of tailings and process water for the Mt. Nansen Mine mill. The impoundment facility was created by constructing a lined earth fill dam approximately 240m long with a crest approximately 20m above original ground level at its maximum height.

Since commissioning, the tailings impoundment has received approximately 90,000 cubic of tailings. The tailings impoundment has also received considerable runoff water which has resulted in an accumulation in excess of 200,000 cubic meters of water in addition to the tailings.

Original forecasts predicted that the pond would have sufficient volume to contain tailings production as well as surface water runoff for two to three years. Water levels were observed to be considerably in excess of that predicted after spring runoff in 1998. Based on these observations, B.Y.G. Natural Resources Inc. made the decision to construct and operate a water treatment plant in an attempt to reduce water levels. It was originally planned to construct the water treatment plant during the third or at the earliest, second year of operation.

The water treatment plant was constructed during the spring and summer of 1998. The plant was able to produce effluent compliant with all licence requirements except for the fish bio-assay test and discharge was not permitted by the Water Resources Division of

DIAND. Extensive upgrades and modifications have been completed to the plant in an effort to produce compliant effluent on a consistent basis.
It is expected that the water treatment plant will be commissioned by mid-December, 1997.

Due to high water levels, B.Y.G. Natural Resources Inc. made the decision to stop milling operations in November, 1997. It is intended that milling will not resume until the water treatment plant is operating satisfactorily and drawing water levels down in the tailings pond.

The water treatment plant has a design capacity of 70 cubic meters per hour. Due to requirements for high treatment efficiency as well as down time for maintenance, it is expected that the actual continuous treatment rate will be approximately 50 cubic meters per hour.

A milling rate of approximately 700 tonnes per day is expected once milling operations resume.

3.0 ENVIRONMENTAL DATA

3.1 PRECIPITATION

The original water balance model utilized rainfall data from Carmacks as the closest available data source. A Davis Instruments weather station was installed at the mine site in August of 1997 at the mine site to provide more accurate climatic data. The weather station includes rainfall, temperature, humidity, wind speed and wind direction sensors.

Table 3.1 summarizes precipitation data from Carmacks and the on-site weather station.

Mt. Nansen Precipitation Data

Month (96 – 97)	Carmacks Precip (mm)	Carmacks Snowfall (cm)	On-site Precip (mm)
July	87.3		
August	55.7		
September	14.1		
October		41	
November		5.7	
December		17	
January		n/a	
February		13	
March		11.5	
April	11.8		
May	32.2		
June	31.7		
July	43.6		
August	15.6		
September	18.1		32.5
October	N/A		20

Table 3.1

If snow fall for 96-97 is averaged to estimate missing data for January, the total water equivalent of snow fall for the winter was 102.9 mm. This corresponds well with the estimate on the original water balance of 100 mm.

It was noted by on-site personnel that there is a significant difference between weather conditions at Carmacks and at the mine site. Rainfall data collected on site for the month of September was approximately double that recorded at Carmacks. Although there is insufficient data to make conclusions on the variability of rainfall data between the two stations, the data collected thus far

indicates that there may be enough difference to have an impact on water balance calculations.

The availability of on-site weather data should improve the accuracy of water balance predictions through next year. Snow pack should be measured in the spring to provide an estimate of the expected run-off from snowfall precipitation during spring runoff.

3.2 Evaporation

Additional evaporation data is not available beyond that compiled for the original water balance. It should be noted that evaporation data collected by conventional means can display considerable variability from actual evaporation from a pond or lake.

4.0 SURFACE RUNOFF

The original water balance model assumed that approximately 40% of water conveyed by the diversion ditch would seep into the tailings pond. This assumption was checked by metering the flow in the diversion ditch in September 1997 (appendix a).

Metering indicated that an inflow rate of 0.025 cubic meters per second, seepage losses were approximately 48%. It is expected that at higher flow rates the seepage losses could be higher due to increase head and a value of 50% is used for seepage losses in the updated water balance.

The amount of seepage losses is expressed as a percentage of the total catchment area. For example, when the diversion ditch is frozen, it is assumed that 100% of the surface flows intercepted by the ditch are conveyed past the tailings impoundment. Thus the catchment area which contributes runoff to the tailings impoundment is reduced to 47 ha.

The assumption that diversion works are 100% impermeable prior to spring melt has not been verified. There is the potential that there is some seepage from these structures event at the end of winter.

A second diversion ditch was constructed across the West End of the tailings facility during to the spring of 1996 to reduce the amount of runoff entering the tailings facility. The water balance presented herein is conservative as it does not account for the reduction in runoff entering the tailings pond due to this structure. The effect of this structure is not included due to concerns that the diversion ditches are not 100% impermeable in the spring.

Seepage rates should be measured in the diversion works during spring melt in 1998 by metering flows in these channels and the model recalibrated based on these data.

5.0 WATER BALANCE MODEL CALIBRATION

The water balance model was calibrated based on precipitation data for 1996, measured seepage in the diversion works, actual water levels in the pond and actual production rates.

On-site evaporation data used was from Pelly Ranch, which is located approximately 80km North of the mine site at an elevation of 454m. Evaporation losses from the pond are estimated by the pond area multiplied by estimated evaporation losses from Pelly Ranch.

Spring runoff was assumed to occur in May, with the amount of snowmelt equal to a water equivalent of 10% of recorded snowfall. As in the initial model, it was assumed that ground was frozen and catchment area was 47 hectares. The water equivalent includes snowpack losses during winter.

For summer months, the model initially assumed that runoff would be 60% which accounts for presence of permafrost at a shallow depth, minimal ponding and relatively

permeable soils. The runoff factor includes evaporation and transpiration from the watershed. A better correlation between predicted and actual water levels was observed when this value was increased to 65% and this value was used for the final model.

Accurate production values are recorded and the slurry concentration is maintained at a constant value of 37% by weight. From these data, accurate estimates of tailings and water deposited to the pond can be made.

As process water is reclaimed from the tailings pond, the net increase in pond levels is limited to the volume of tailings deposited.

Water is retained in the pore spaces of the tailings and can be calculated using the following formula which assumes completely saturated tailings:

$$\omega = e/G_s \times 100$$

Where ω is the saturated water content in percent e is the void ratio and G_s is the specific gravity of the tailings. The tailings have an average specific gravity of 2.7. A typical void ratio of most tailings within this range of specific gravity and deposited underwater is close to 1.0. For these conditions, the in place density is 1.36 t/m^3 and the amount of water to fill the void space is 37% of the dry weight of the tailings.

These constants are used to estimate the volume of tails and water in the tailings pond.

The elevations are based on the calculated volume of the pond and assumes that tails deposition is level. It should be noted that the elevation estimates lose accuracy when the water level is above 1147.9m as elevations were extrapolated from the volume vs. elevation data.

The water balance model is presented in table 5.1 including actual water levels measured in the pond. Correlation between predicted and actual water levels is high and indicates that the accuracy of the model is sufficient for forecasting purposes.

MT NANSEN WATER BALANCE MODEL
MODEL CALIBRATION

Description		*Initial*	*May*	*June*	*July*	*August*	*Sept*
INFLOWS							
Precipitation	mm		132.3	31.7	43.6	15.6	32.5
Pond Area	ha		5.1	5.2	5.6	5.7	6
Pond Precip Inflow	m^3		6,747	1,648	2,442	889	1,950
Catchment Area	ha		47	72	72	72	72
Runoff Coefficent	m^2		0.65	0.65	0.65	0.65	0.65
Catchment Precip Inflow	m^3		40,418	14,836	20,405	7,301	15,210
Mill Production	tonnes		8,800	11,000	11,561	7,681	8,169
Specific Gravity tailings			2.7	2.7	2.7	2.7	2.7
Dry tails produced	m^3		3,259	4,074	4,282	2,845	3,026
Slurry Concentration	%		37	37	37	37	37
Total slurry (solids & water)	m^3		8,809	11,011	11,573	7,689	8,177
Slurry Water Volume	m^3		5,550	6,937	7,291	4,844	5,152
Total Inflow	m^3		55,974	27,495	34,419	15,879	25,337
OUTFLOWS							
Evaporation	mm		107.8	120.5	107.8	79.7	37.1
Pond Area	ha		5.1	5.2	5.6	5.7	6
Evaporation Volume	m^3		5,498	6,266	6,037	4,543	2,226
Reclaim Volume	m^3		5,550	6,937	7,291	4,844	5,152
WTP Effluent Volume	m^3		0	0	0	0	0
Total Outflow	m^3		11,047	13,203	13,328	9,387	7,378
WATER LEVELS							
End Month Vol	m^3	185,365	230,291	244,583	265,675	272,167	290,126
End Month WL	m	**1148.0**	**1148.9**	**1149.2**	**1149.5**	**1149.6**	**1149.7**
Actual WL		**1148.0**	**1148.9**	**1149.3**	**1149.6**	**1149.7**	**n/a**
TAILINGS LEVEL							
Tails Inflow	m^3		6,423	8,029	8,439	5,607	5,963
End Month Tails Vol	m^3	32,200	38,623	46,653	55,091	60,698	66,661
End Month Tails Elev	m	1142.6	1143.0	1143.5	1143.9	1144.2	1144.5

6.0 WATER BALANCE FORCASTS

The water balance model calibrated in section 5.0 is used to forecast water and tailings elevations for 1998. The following assumptions are used:

- The water treatment plant will begin discharging at a rate of 50 m^3/hour in January 1, 1998.
- Milling will resume February 1, 1998 at a rate of 700 t/day,
- Total volume tails deposited to date is 90,000 tonnes and
- The water level in tailings pond will not increase for remainder of December.

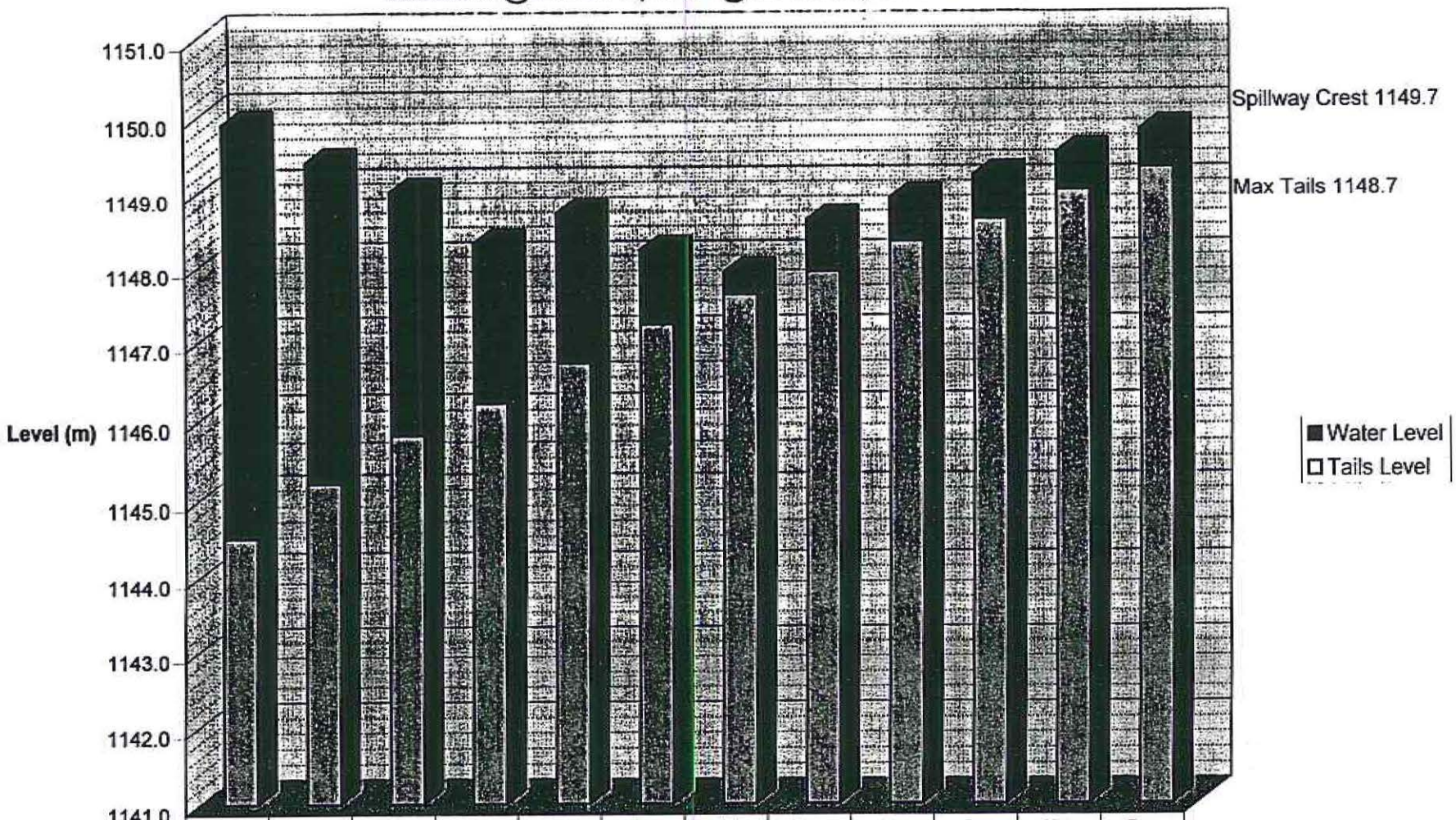
Forecasts are presented in figures 6.1 to 6.4. with numeric data included in appendix B.

Forecasts were made using precipitation data for 1997 as well as a 200 year return wet year. As well, additional forecasts were made with the water treatment plant operating at 40 m^3/hr to evaluate the impact on water levels if plant efficiencies are lower than expected.

From these data, it is predicted that the water level in the pond will remain below the spillway invert even if the water treatment plant operates at lower than expected efficiencies and a 200 year wet year occur simultaneously.

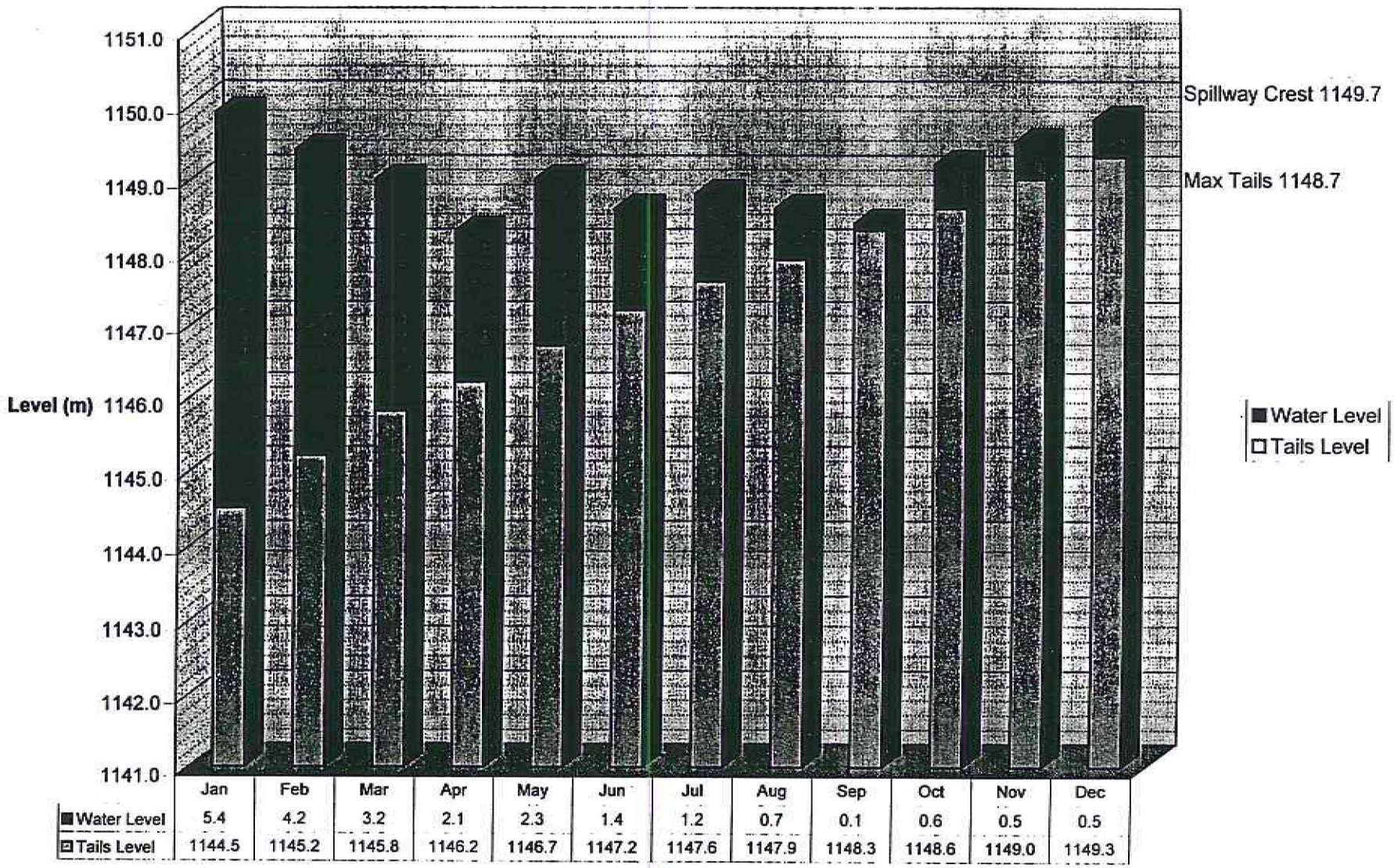
The model also forecasts that the tailings level will reach the limit of 1148.7 imposed by the water licence by the end of October 1998.

MT NANSEN TAILINGS FACILITY
1997 WATER BALANCE FORECAST
MILLING @ 700 TPD, WTP @ 50 m3/hr, 1997 PRECIP



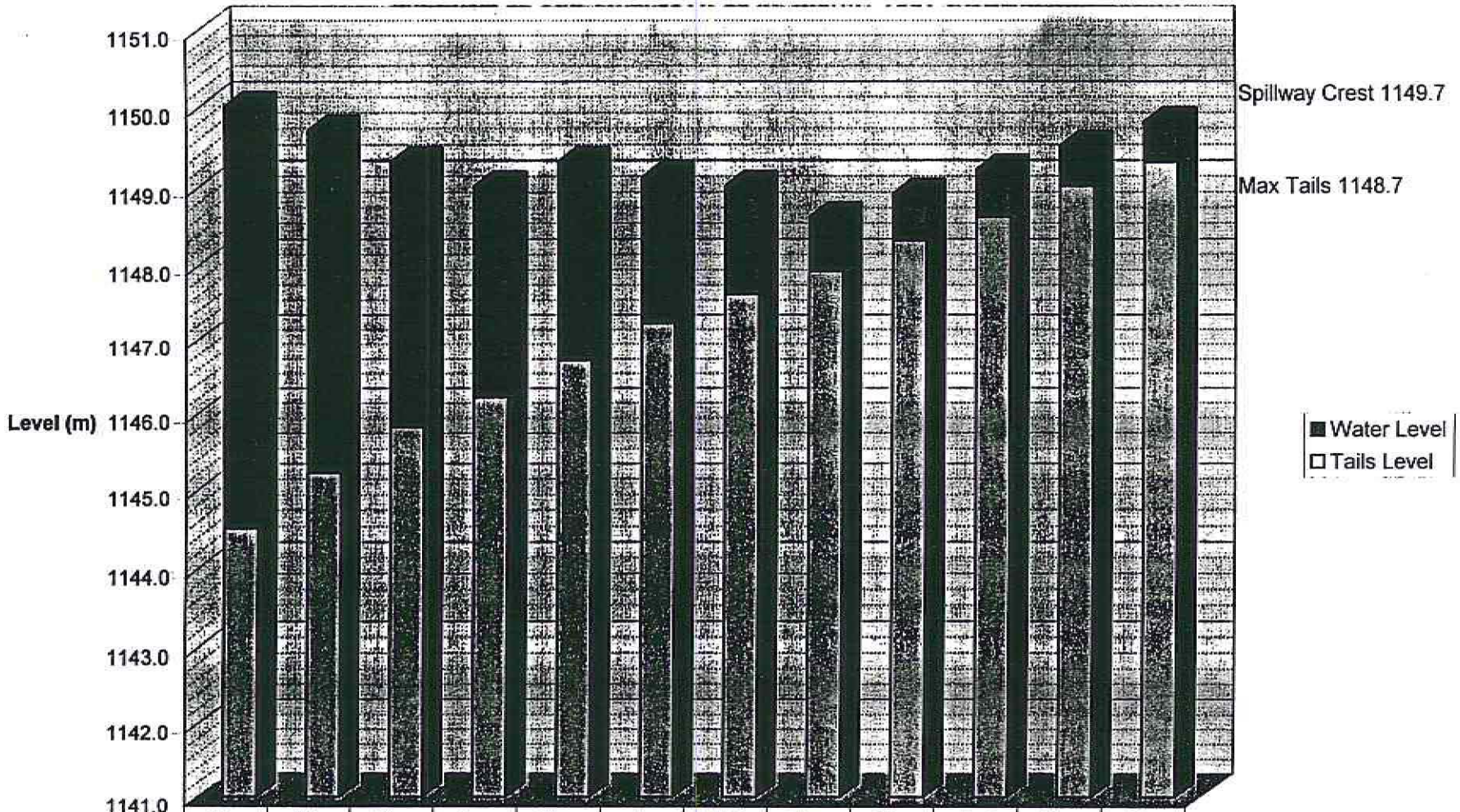
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Level	5.4	4.2	3.2	2.1	2.0	1.0	0.3	0.7	0.6	0.6	0.5	0.5
Tails Level	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3

MT NANSEN TAILINGS FACILITY
1997 WATER BALANCE FORECAST
MILLING @ 700 TPD, WTP @ 50 m3/hr, 200 YEAR PRECIP



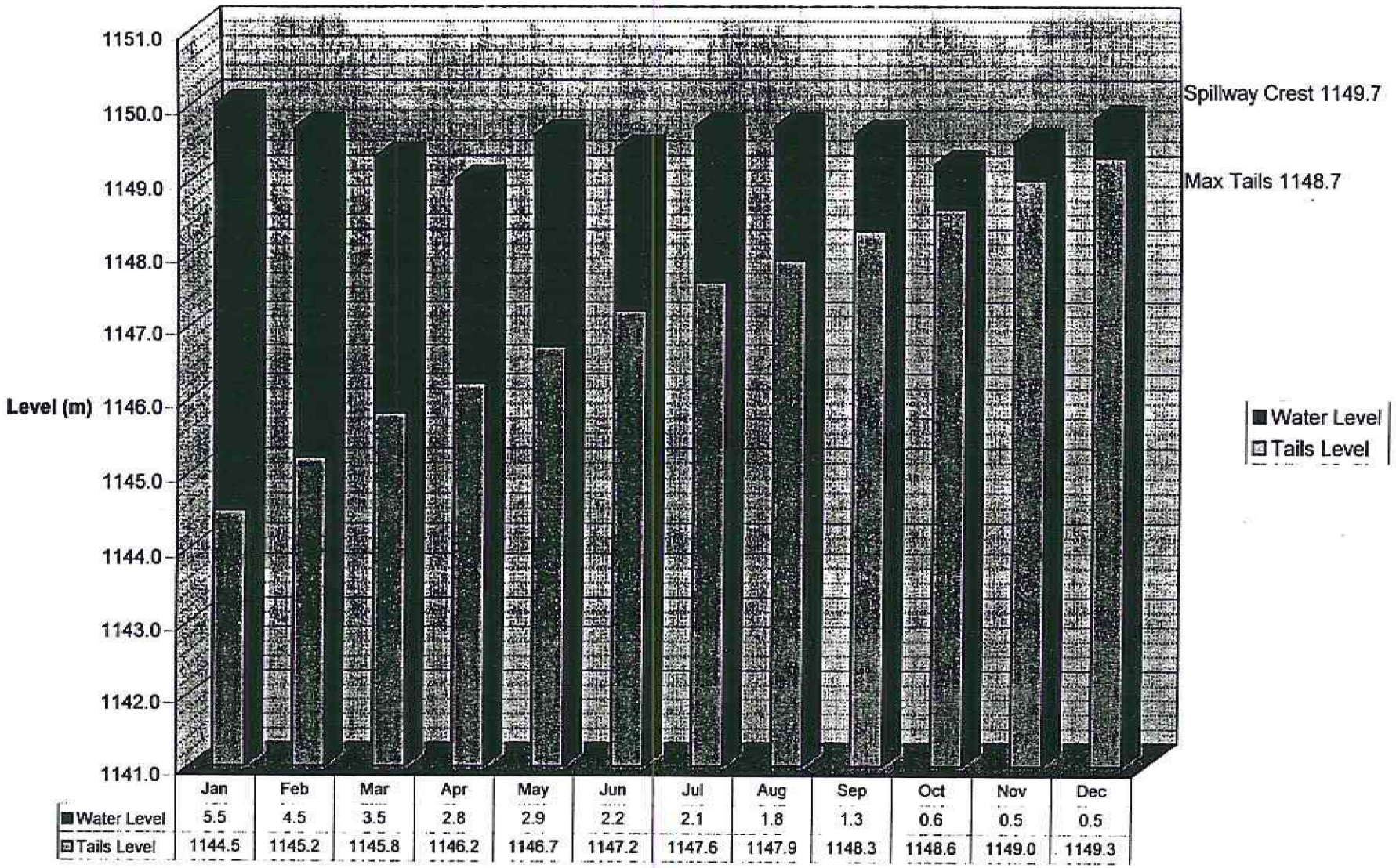
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Level	5.4	4.2	3.2	2.1	2.3	1.4	1.2	0.7	0.1	0.6	0.5	0.5
Tails Level	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3

MT NANSEN TAILINGS FACILITY
1997 WATER BALANCE FORECAST
MILLING @ 700 TPD, WTP @ 40 m3/hr, 1997 PRECIP



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Level	5.5	4.5	3.5	2.8	2.6	1.9	1.4	0.7	0.6	0.6	0.5	0.5
Tails Level	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3

MT NANSEN TAILINGS FACILITY
1997 WATER BALANCE FORECAST
MILLING @ 700 TPD, WTP @ 40 m3/hr, 200 YEAR PRECIP



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Level	5.5	4.5	3.5	2.8	2.9	2.2	2.1	1.8	1.3	0.6	0.5	0.5
Tails Level	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3

FIGURE 6.4

7.0 LIMITATIONS

It must be noted that the water balance is a forecasting tool only and requires the input of accurate data in order that reasonable water and tailings levels predictions can be made.

The model should be updated on a monthly basis with data for mill production, water treatment plant effluent and precipitation entered.

As well, additional field measurements will be required in the spring including snow pack measurements and flow measurements in diversion works.

8.0 CONCLUSIONS

8.1 Calibration of the water balance model indicates satisfactory correlation between predicted and actual water levels in the tailings pond.

8.2 Based on the water balance model presented in this report, it is forecast that the water level in tailings pond will be sufficiently reduced by spring freshet to accommodate surface runoff from snow melt.

8.3 There is sufficient room in the tailings pond to accommodate mill production at a rate of 700 tonnes per day until the end of October 1998.

8.4 It is forecast that the pond will have sufficient capacity to accommodate spring melt even if the water treatment plant operates at a lower than expected capacity and a 200 year wet year precipitation event occurs simultaneously.

8.5 The model should be updated monthly with production, water treatment plant and precipitation data.

8.6 Snow pack and diversion ditch flow data will need to be collected in the spring in order to provide accurate forecasts.

Appendix A

DISCHARGE MEASUREMENT

DATE: 30/09/97
BY: Menkal
METER: SWOFFER 2100
METHOD: wading
LOCATION: lower diversion
AIR TEMP: 5
WATER TEMP: 1
FIRST READING:
LAST READING:
STAGE READING:

DATE-TIME OF METERING: *14:30*
STAGE MEASUREMENT:
DISCHARGE: *0.025*
CHANNEL WIDTH *-0.35*
AVERAGE VELOCITY *0.410*
MAXIMINM DEPTH
AREA *0.201*

DISTANCE FROM INITIAL POINT	WIDTH	DEPTH	DEPTH OF READING	VELOCITY AT POINT (m/s)	MEAN VERTICAL VELOCITY (m/s)	AREA (m^2)	ANGLE COEFFICIENT	DISCHARGE (m^3/s)
0.35	0.125							
0.6	0.175	0.8	0.6			0.14		
0.7	0.1	0.1	0.6	0.1200		0.01		0.0012
0.8	0.1	0.11	0.6	0.3800		0.011		0.0042
0.9	0.1	0.11	0.6	0.5900		0.011		0.0065
1	0.1	0.09	0.6	0.6600		0.009		0.0059
1.1	0.1	0.08	0.6	0.3500		0.008		0.0028
1.2	0.15	0.08	0.6	0.3600		0.012		0.0043
1.4								

DISCHARGE MEASUREMENT

DATE: 30/09/97
BY: Menkal
METER: SWOFFER 2100
METHOD:
LOCATION: Lower diversion
AIR TEMP: 5
WATER TEMP: 1
FIRST READING:
LAST READING:
STAGE READING:

DATE-TIME OF METERING: 13:30
STAGE MEASUREMENT:
DISCHARGE: *0.013*
CHANNEL WIDTH *0.1*
AVERAGE VELOCITY *0.065*
MAXIMINM DEPTH
AREA *0.199*

DISTANCE FROM INITIAL POINT	WIDTH	DEPTH	DEPTH OF READING	VELOCITY AT POINT (m/s)	MEAN VERTICAL VELOCITY (m/s)	AREA (m^2)	ANGLE COEFFICIENT	DISCHARGE (m^3/s)
-0.1	0.2							
0.3	0.25	0.1	0.6			0.025		
0.4	0.1	0.1	0.6			0.01		
0.5	0.1	0.1	0.6			0.01		
0.6	0.1	0.13	0.6	0.0500	0.05	0.013		0.0007
0.7	0.1	0.14	0.6	0.0800		0.014		0.0011
0.8	0.1	0.13	0.6	0.0100		0.013		0.0001
0.9	0.1	0.17	0.6	0.1100		0.017		0.0019
1	0.1	0.2	0.6	0.0900		0.02		0.0018
1.1	0.1	0.21	0.6	0.0900		0.021		0.0019
1.2	0.1	0.18	0.6	0.0900		0.018		0.0016
1.3	0.1	0.16	0.6	0.1200		0.016		0.0019
1.4	0.1	0.12	0.6	0.1200		0.012		0.0014
1.5	0.1	0.1	0.6	0.0800		0.01		0.0008
1.6	0.125							
1.75								

TOTALS **0.199** **0.0132**

NOTES:

Appendix B

MT NANSEN WATER BALANCE MODEL
DECEMBER 1997 FORCAST
700 TPD MILLING, 50 m3/hr WTP, 1997 PRECIP

						wet year	173.4	51.3	81.6	58.4	45.3			
		Initial	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
INFLOWS														
Precipitation	mm		0	0	0	0	132	31.7	43.6	15.6	18.1	20	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Pond Precip Inflow	m^3		0	0	0	0	7,920	1,902	2,616	936	1,086	1,200	0	0
Catchment Area	ha		47	47	47	47	47	47	72	72	72	72		
Runoff Coefficent	m^2		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Catchment Precip Inflow	m^3		0	0	0	0	37,224	8,939	18,835	6,739	7,819	8,640	0	0
Mill Production	tonnes		0	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Specific Gravity tailings			2.7	2.7	2.7	2.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7
Dry tails produced	m^3		0	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778
Slurry Concentration	%		37	37	37	37	37	38	39	40	41	42	43	44
Total slurry (solids & water)	m^3		0	56,757	56,757	56,757	56,757	55,263	53,846	52,500	51,220	50,000	48,837	47,727
Slurry Water Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
Total Inflow	m^3		0	56,757	56,757	56,757	101,901	66,105	75,297	60,175	60,125	59,840	48,837	47,727
OUTFLOWS														
Evaporation	mm		0	0	0	0	0	107.8	120.5	107.8	79.7	37.1	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Evaporation Volume	m^3		0	0	0	0	0	6,468	7,230	6,468	4,782	2,226	0	0
Reclaim Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
WTP Effluent Volume	m^3	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Total Outflow	m^3		36,000	84,979	84,979	84,979	84,979	89,953	89,298	87,190	84,224	80,448	77,059	75,949
WATER LEVELS														
End Month Vol	m^3	326000	290,000	261,778	233,556	205,333	222,255	198,406	184,405	213,600	230,400	247,200	264,000	280,800
End Month WL	m	1150.4	1149.9	1149.4	1149.0	1148.3	1148.7	1148.2	1147.9	1148.6	1148.9	1149.2	1149.5	1149.8
Actual WL	m													
TAILINGS LEVEL														
Tails Inflow	m^3		0	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
End Month Tails Vol	m^3	66,000	66,000	82,800	99,600	116,400	133,200	150,000	166,800	183,600	200,400	217,200	234,000	250,800
End Month Tails Elev	m	1144.5	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3
End Month WL above tails		5.9	5.4	4.2	3.2	2.1	2.0	1.0	0.3	0.7	0.6	0.6	0.5	0.5

MT NANSEN WATER BALANCE MODEL
DECEMBER 1997 FORCAST
700 TPD MILLING, 50 m3/hr WTP, 200 YEAR PRECIP

						wet year	173.4	51.3	81.6	58.4	45.3			
		Initial	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
INFLOWS														
Precipitation	mm		0	0	0	0	173.4	51.3	81.6	58.4	45.3	0	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Pond Precip Inflow	m^3		0	0	0	0	10,404	3,078	4,896	3,504	2,718	0	0	0
Catchment Area	ha		47	47	47	47	47	47	72	72	72	72		
Runoff Coefficent	m^2		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Catchment Precip Inflow	m^3		0	0	0	0	48,899	14,467	35,251	25,229	19,570	0	0	0
Mill Production	tonnes		0	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Specific Gravity tailings			2.7	2.7	2.7	2.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7
Dry tails produced	m^3		0	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778
Slurry Concentration	%		37	37	37	37	37	38	39	40	41	42	43	44
Total slurry (solids & water)	m^3		0	56,757	56,757	56,757	56,757	55,263	53,846	52,500	51,220	50,000	48,837	47,727
Slurry Water Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
Total Inflow	m^3		0	56,757	56,757	56,757	116,060	72,808	93,993	81,233	73,507	50,000	48,837	47,727
OUTFLOWS														
Evaporation	mm		0	0	0	0	0	107.8	120.5	107.8	79.7	37.1	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Evaporation Volume	m^3		0	0	0	0	0	6,468	7,230	6,468	4,782	2,226	0	0
Reclaim Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
WTP Effluent Volume	m^3	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Total Outflow	m^3		36,000	84,979	84,979	84,979	84,979	89,953	89,298	87,190	84,224	80,448	77,059	75,949
WATER LEVELS														
End Month Vol	m^3	326000	290,000	261,778	233,556	205,333	236,414	219,268	223,963	218,006	207,289	247,200	264,000	280,800
End Month WL	m	1150.4	1149.9	1149.4	1149.0	1148.3	1149.0	1148.6	1148.8	1148.6	1148.4	1149.2	1149.5	1149.8
Actual WL	m													
TAILINGS LEVEL														
Tails Inflow	m^3		0	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
End Month Tails Vol	m^3	66,000	66,000	82,800	99,600	116,400	133,200	150,000	166,800	183,600	200,400	217,200	234,000	250,800
End Month Tails Elev	m	1144.5	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3
End Month WL above tails		5.9	5.4	4.2	3.2	2.1	2.3	1.4	1.2	0.7	0.1	0.6	0.5	0.5

MT NANSEN WATER BALANCE MODEL
DECEMBER 1997 FORCAST
700 TPD MILLING, 40 m3/hr WTP, 1996 PRECIP

		Initial	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
INFLOWS														
Precipitation	mm		0	0	0	0	132	31.7	43.6	15.6	18.1	20	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Pond Precip Inflow	m^3		0	0	0	0	7,920	1,902	2,616	936	1,086	1,200	0	0
Catchment Area	ha		47	47	47	47	47	47	72	72	72	72		
Runoff Coefficent	m^2		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Catchment Precip Inflow	m^3		0	0	0	0	37,224	8,939	18,835	6,739	7,819	8,640	0	0
Mill Production	tonnes		0	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Specific Gravity tailings			2.7	2.7	2.7	2.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7
Dry tails produced	m^3		0	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778
Slurry Concentration	%		37	37	37	37	37	38	39	40	41	42	43	44
Total slurry (solids & water)	m^3		0	56,757	56,757	56,757	56,757	55,263	53,846	52,500	51,220	50,000	48,837	47,727
Slurry Water Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
Total Inflow	m^3		0	56,757	56,757	56,757	101,901	66,105	75,297	60,175	60,125	59,840	48,837	47,727
OUTFLOWS														
Evaporation	mm		0	0	0	0	0	107.8	120.5	107.8	79.7	37.1	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Evaporation Volume	m^3		0	0	0	0	0	6,468	7,230	6,468	4,782	2,226	0	0
Reclaim Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
WTP Effluent Volume	m^3	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800
Total Outflow	m^3		28,800	77,779	77,779	77,779	77,779	82,753	82,098	79,990	77,024	73,248	69,859	68,749
WATER LEVELS														
End Month Vol	m^3	326000	297,200	276,178	255,156	234,133	258,255	241,606	234,805	214,990	230,400	247,200	264,000	280,800
End Month WL	m	1150.4	1150.0	1149.7	1149.3	1149.0	1149.3	1149.1	1149.0	1148.6	1148.9	1149.2	1149.5	1149.8
Actual WL	m													
TAILINGS LEVEL														
Tails Inflow	m^3		0	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
End Month Tails Vol	m^3	66,000	66,000	82,800	99,600	116,400	133,200	150,000	166,800	183,600	200,400	217,200	234,000	250,800
End Month Tails Elev	m	1144.5	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3
End Month WL above tails		5.9	5.5	4.5	3.5	2.8	2.6	1.9	1.4	0.7	0.6	0.6	0.5	0.5

MT NANSEN WATER BALANCE MODEL
DECEMBER 1997 FORCAST
700 TPD MILLING, 40 m3/hr WTP, 200 YEAR PRECIP

						wet year	173.4	51.3	81.6	58.4	45.3			
		Initial	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
INFLOWS														
Precipitation	mm		0	0	0	0	173.4	51.3	81.6	58.4	45.3	20	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Pond Precip Inflow	m^3		0	0	0	0	10,404	3,078	4,896	3,504	2,718	1,200	0	0
Catchment Area	ha		47	47	47	47	47	47	72	72	72	72		
Runoff Coefficent	m^2		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Catchment Precip Inflow	m^3		0	0	0	0	48,899	14,467	35,251	25,229	19,570	8,640	0	0
Mill Production	tonnes		0	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Specific Gravity tailings			2.7	2.7	2.7	2.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7
Dry tails produced	m^3		0	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778	7,778
Slurry Concentration	%		37	37	37	37	37	38	39	40	41	42	43	44
Total slurry (solids & water)	m^3		0	56,757	56,757	56,757	56,757	55,263	53,846	52,500	51,220	50,000	48,837	47,727
Slurry Water Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
Total Inflow	m^3		0	56,757	56,757	56,757	116,060	72,808	93,993	81,233	73,507	59,840	48,837	47,727
OUTFLOWS														
Evaporation	mm		0	0	0	0	0	107.8	120.5	107.8	79.7	37.1	0	0
Pond Area	ha		6	6	6	6	6	6	6	6	6	6	6	6
Evaporation Volume	m^3		0	0	0	0	0	6,468	7,230	6,468	4,782	2,226	0	0
Reclaim Volume	m^3		0	48,979	48,979	48,979	48,979	47,485	46,068	44,722	43,442	42,222	41,059	39,949
WTP Effluent Volume	m^3	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800
Total Outflow	m^3		28,800	77,779	77,779	77,779	77,779	82,753	82,098	79,990	77,024	73,248	69,859	68,749
WATER LEVELS														
End Month Vol	m^3	326000	297,200	276,178	255,156	234,133	272,414	262,468	274,363	275,606	272,089	258,681	237,659	280,800
End Month WL	m	1150.4	1150.0	1149.7	1149.3	1149.0	1149.6	1149.4	1149.7	1149.7	1149.6	1149.3	1149.0	1149.8
Actual WL	m													
TAILINGS LEVEL														
Tails Inflow	m^3		0	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800	16,800
End Month Tails Vol	m^3	66,000	66,000	82,800	99,600	116,400	133,200	150,000	166,800	183,600	200,400	217,200	234,000	250,800
End Month Tails Elev	m	1144.5	1144.5	1145.2	1145.8	1146.2	1146.7	1147.2	1147.6	1147.9	1148.3	1148.6	1149.0	1149.3
End Month WL above tails		5.9	5.5	4.5	3.5	2.8	2.9	2.2	2.1	1.8	1.3	0.7	0.0	0.5

APPENDIX F

Multi-element ICP Analysis Results

Test: WL-M1
Sample: Untreated Tail

Date: December 18, 1997
Project: 97-066

Element	Unit	Day 1	Day 3	Day 10	Day 30
Al	mg/L	0.61	0.73	0.84	0.87
Sb	mg/L	0.25	0.30	0.74	1.02
As	**mg/L**	**1.01**	**1.88**	**3.18**	**3.89**
Ba	mg/L	0.008	<0.005	<0.005	<0.005
Be	mg/L	<0.001	<0.001	<0.001	<0.001
Bi	mg/L	<0.1	<0.1	<0.1	<0.1
B	mg/L	0.25	0.03	0.26	0.19
Cd	mg/L	0.028	<0.005	<0.005	<0.005
Ca	mg/L	321.56	490.94	612.48	599.77
Cr	mg/L	<0.01	<0.01	<0.01	<0.01
Co	mg/L	0.31	0.08	0.06	0.08
Cu	mg/L	18.07	20.45	18.96	19.38
Fe	mg/L	2.79	6.69	10.04	7.95
Pb	mg/L	<0.05	<0.05	<0.05	0.09
Li	mg/L	<0.02	<0.02	<0.02	0.03
Mg	mg/L	1.0	1.4	1.8	3.2
Mn	mg/L	0.179	0.063	0.005	0.016
Hg	mg/L	<0.02	<0.02	<0.02	<0.02
Mo	mg/L	<0.01	0.02	0.03	0.06
Ni	mg/L	2.24	0.17	0.04	0.09
P	mg/L	0.2	<0.1	0.1	0.2
K	mg/L	26	35	39.	41.
Se	mg/L	<0.05	<0.05	<0.05	<0.05
Si	mg/L	2.76	3.15	3.36	3.24
Ag	mg/L	1.08	1.41	1.48	1.32
Na	mg/L	249.6	283.0	264.9	218.5
Sr	mg/L	0.698	0.792	1.052	0.919
Tl	mg/L	<0.2	<0.2	<0.2	<0.2
Sn	mg/L	<0.1	<0.1	<0.1	<0.1
Ti	mg/L	<0.01	<0.01	0.02	0.05
W	mg/L	<0.1	<0.1	<0.1	<0.1
V	mg/L	<0.01	<0.01	<0.01	<0.01
Zn	mg/L	2.052	6.858	4.783	0.672

Process Research Associates Ltd.

Multi-element ICP Analysis Results

Test: WL-M2
Sample: Treated Tail

Date: December 18, 1997
Project: 97-066

Element	Unit	Day 1	Day 3	Day 10	Day 30
Al	mg/L	0.98	1.03	0.72	0.77
Sb	mg/L	0.11	0.15	<0.05	0.12
As	**mg/L**	**1.08**	**1.37**	**1.62**	**1.74**
Ba	mg/L	<0.005	<0.005	<0.005	<0.005
Be	mg/L	<0.001	<0.001	<0.001	0.001
Bi	mg/L	<0.1	<0.1	<0.1	<0.1
B	mg/L	0.24	0.25	0.14	0.03
Cd	mg/L	1.743	1.839	1.773	1.117
Ca	mg/L	652.13	644.04	638.68	514.92
Cr	mg/L	<0.01	<0.01	<0.01	<0.01
Co	mg/L	0.10	0.09	0.11	0.11
Cu	mg/L	34.53	36.47	37.95	35.98
Fe	mg/L	4.24	4.55	4.33	3.36
Pb	mg/L	<0.05	<0.05	0.06	0.09
Li	mg/L	<0.02	<0.02	<0.02	0.02
Mg	mg/L	1.4	1.5	2.7	5.2
Mn	mg/L	0.007	<0.005	<0.005	0.023
Hg	mg/L	<0.02	<0.02	<0.02	<0.02
Mo	mg/L	0.04	0.05	0.05	0.08
Ni	mg/L	0.17	0.15	0.10	0.12
P	mg/L	0.4	0.6	0.4	0.6
K	mg/L	60	53	53.	50.
Se	mg/L	<0.05	<0.05	<0.05	<0.05
Si	mg/L	<0.05	<0.05	<0.05	0.75
Ag	mg/L	2.16	2.13	2.08	1.69
Na	mg/L	635.8	632.3	623.4	457.6
Sr	mg/L	1.210	1.080	1.036	0.811
Tl	mg/L	<0.2	<0.2	<0.2	<0.2
Sn	mg/L	<0.1	<0.1	<0.1	<0.1
Ti	mg/L	0.01	0.03	0.03	0.05
W	mg/L	<0.1	<0.1	<0.1	<0.1
V	mg/L	<0.01	<0.01	<0.01	<0.01
Zn	mg/L	192.814	189.936	183.285	139.096

Process Research Associates Ltd.

Multi-element ICP Analysis Results

Test: WL-S1
Sample: Untreated Tail

Date: December 18, 1997
Project: 97-066

Element	Unit	Day 1	Day 3	Day 10	Day 30
Al	mg/L	1.02	1.07	0.79	0.97
Sb	mg/L	0.41	0.69	0.76	1.18
As	**mg/L**	**3.23**	**3.55**	**3.43**	**4.77**
Ba	mg/L	<0.005	0.011	0.007	<0.005
Be	mg/L	<0.001	<0.001	<0.001	0.003
Bi	mg/L	<0.1	0.1	<0.1	<0.1
B	mg/L	0.08	0.25	0.30	0.20
Cd	mg/L	0.041	0.030	0.015	<0.005
Ca	mg/L	597.79	586.30	666.47	607.98
Cr	mg/L	<0.01	<0.01	<0.01	<0.01
Co	mg/L	0.07	0.06	0.07	0.13
Cu	mg/L	28.50	27.23	29.28	29.72
Fe	mg/L	13.01	14.89	15.72	14.56
Pb	mg/L	<0.05	0.06	<0.05	0.10
Li	mg/L	<0.02	<0.02	<0.02	0.05
Mg	mg/L	1.6	1.5	1.7	3.5
Mn	mg/L	<0.005	<0.005	0.006	0.014
Hg	mg/L	<0.02	<0.02	<0.02	<0.02
Mo	mg/L	0.06	0.04	0.06	0.09
Ni	mg/L	0.08	0.13	0.15	0.16
P	mg/L	0.4	0.3	0.4	0.7
K	mg/L	56	47	47.	57.
Se	mg/L	<0.05	<0.05	<0.05	<0.05
Si	mg/L	3.82	3.91	3.32	3.81
Ag	mg/L	1.56	1.52	1.58	1.47
Na	mg/L	386.1	374.3	386.2	343.8
Sr	mg/L	1.040	1.267	1.206	1.064
Tl	mg/L	<0.2	<0.2	<0.2	<0.2
Sn	mg/L	<0.1	<0.1	<0.1	<0.1
Ti	mg/L	0.03	0.02	0.01	0.05
W	mg/L	<0.1	<0.1	<0.1	<0.1
V	mg/L	<0.01	<0.01	<0.01	0.02
Zn	mg/L	23.154	20.753	13.325	0.151

Process Research Associates Ltd.

Multi-element ICP Analysis Results

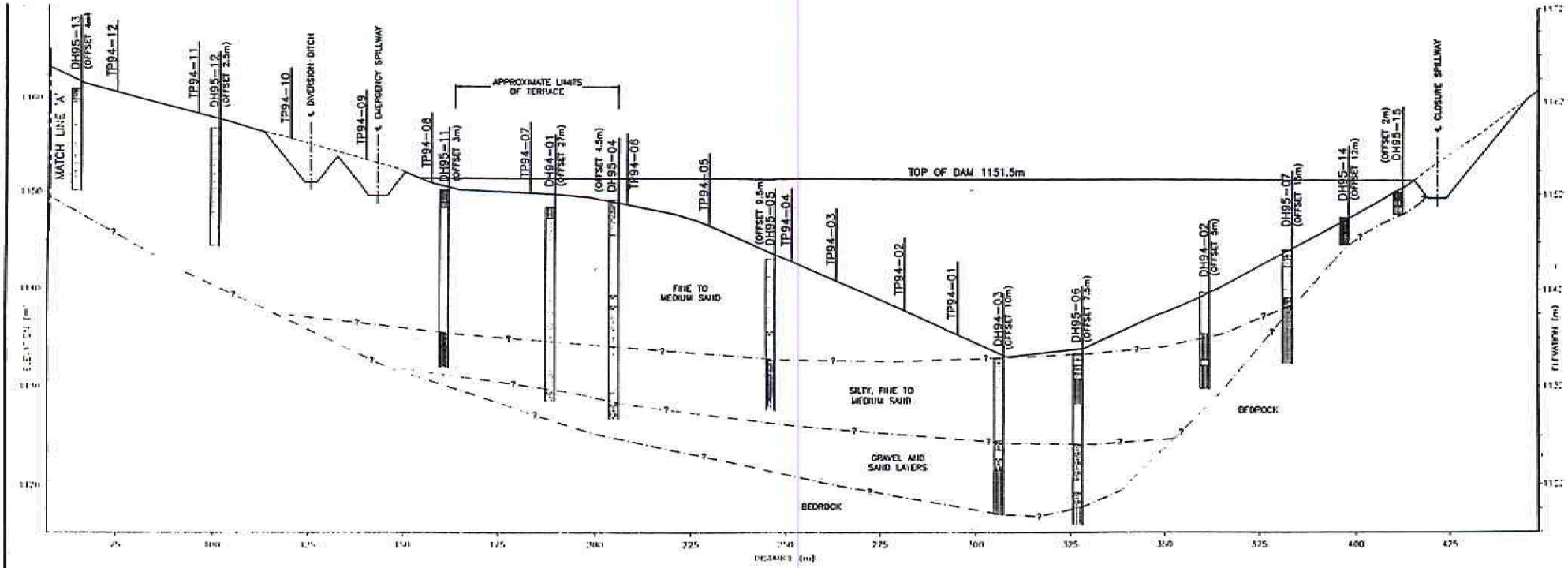
Test: WL-S2
Sample: Treated Tail

Date: December 18, 1997
Project: 97-066

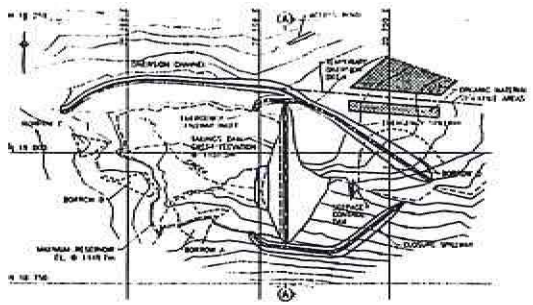
Element	Unit	Day 1	Day 3	Day 10	Day 30
Al	mg/L	0.95	1.02	0.87	0.90
Sb	mg/L	0.06	0.11	0.12	0.20
As	**mg/L**	**1.27**	**1.39**	**1.45**	**1.71**
Ba	mg/L	<0.005	<0.005	<0.005	0.013
Be	mg/L	<0.001	<0.001	<0.001	0.002
Bi	mg/L	<0.1	<0.1	<0.1	0.1
B	mg/L	0.19	0.24	0.20	0.18
Cd	mg/L	2.013	1.881	1.501	1.245
Ca	mg/L	648.06	627.45	642.52	564.26
Cr	mg/L	<0.01	<0.01	<0.01	<0.01
Co	mg/L	0.14	0.11	0.10	0.14
Cu	mg/L	35.67	32.92	37.63	33.06
Fe	mg/L	4.69	4.36	4.19	3.56
Pb	mg/L	0.09	<0.05	<0.05	0.12
Li	mg/L	<0.02	<0.02	<0.02	0.04
Mg	mg/L	1.7	1.4	2.0	4.6
Mn	mg/L	<0.005	<0.005	0.009	0.022
Hg	mg/L	<0.02	<0.02	<0.02	<0.02
Mo	mg/L	0.08	0.06	0.02	0.11
Ni	mg/L	0.13	0.18	0.15	0.29
P	mg/L	0.6	0.7	0.5	0.8
K	mg/L	56	51	55.	59.
Se	mg/L	<0.05	0.10	<0.05	0.38
Si	mg/L	<0.05	<0.05	<0.05	0.72
Ag	mg/L	2.10	2.13	2.10	1.91
Na	mg/L	622.6	614.6	608.8	499.3
Sr	mg/L	1.122	1.057	1.102	0.860
Tl	mg/L	<0.2	<0.2	<0.2	<0.2
Sn	mg/L	<0.1	<0.1	<0.1	<0.1
Ti	mg/L	0.03	0.04	0.01	0.08
W	mg/L	<0.1	<0.1	<0.1	<0.1
V	mg/L	<0.01	<0.01	<0.01	<0.01
Zn	mg/L	189.524	185.873	184.742	136.021

Process Research Associates Ltd.

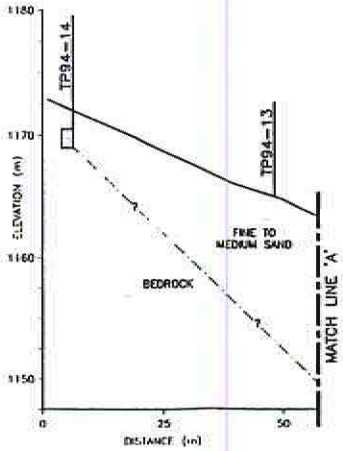
APPENDIX G



SECTION (A) (001)
HOR. SCALE B
VERT. SCALE A



KEY PLAN



LEGEND
- SAND (SP-SM)
- SILTY SAND (SM)
- SILT (ML)
- BEDROCK
- GRAVEL (GP-GM)
- PEAT (Pt)

(1:1000) 0 10 20m (SCALE B)
(1:400) 0 4 8m (SCALE A)
NOTE: FRACTIONAL SCALED FIGURE TO FALL 'B' SIZE DRAWINGS ONLY

AS SHOWN	D.W.R.	L. G. H.	JULY 1995
KLOHN-CRIPPEN	MT. NANSEN GOLD PROJECT		
	CROSS SECTION ON DAM ℄		
B.Y.G. NATURAL RESOURCES INC.	JULY 1995	PM 5314.05	B-5314-004

REPORT ON:

MT. NANSEN MINE
CLOSURE COST ASSESSMENT

Prepared for:
Water Resources Division
Indian Affairs and Northern Development Canada
Whitehorse, Yukon

Prepared by:

Brodie Consulting Ltd.
West Vancouver, B.C.

December 1998

MT. NANSEN MINE
CLOSURE COST ASSESSMENT

1.0 Introduction

As per the instructions from Water Resources, the objectives of the work described in this report are to: estimate and/or update previous estimates of mine abandonment costs and accumulated site liability of the Mt. Nansen gold mine.

Fulfilling the project objectives has included the following steps:

- conduct a site inspection,
- review available information,
- characterize the existing mine condition and expected reclamation measures,
- compile a reclamation cost estimate using the RECLAIM cost estimating model, and,
- prepare this report describing the above steps.

2.0 Site Inspection

A site inspection was conducted on October 29, 1998, with Mr. Bud McAlpine of the Water Resources Division. The site inspection consisted of a brief meeting with Mr. Pascal Renardet, Mine Manager, a self-directed inspection of the pit, waste dump and tailings area. Additional information regarding the operation of the tailings impoundment was provided by Mr. S. Hureau, Environmental Coordinator. An inspection of the mill area was not conducted. However, the layout and condition of the mill area appeared to be substantially as it was during the previous inspection in 1995.

3.0 Information Sources

The following information was reviewed for this project:

- Initial Environmental Evaluation, Mt. Nansen Development, Vol. 1 and 2, Nov. 1994,
- Tailings Impoundment - Final Design Report, Klohn-Crippen, Aug. 1995,
- B.Y.G. Natural Resources, Water Licence Application, Mar. 1995,
- EARP Screening Report, Environmental Directorate, DIAND, Nov. 1995,
- Water Use Licence QZ94-004, and amendments 1, 2, and 3

- Waste Rock & Pit Wall Acid Rock Drainage Study, B.Y.G., July 1997,
- plots of ground temperature and piezometric levels in the tailings dam for the period April to Oct. 1998,
- letter to Water Resources from Geo-Engineering (M.S.T.) Ltd. - Mt. Nansen Mine Tailings Pond Dam Monitoring, Nov. 12, 1998,
- Mt. Nansen Conceptual Decommissioning and Reclamation Plan, January 1998, DRAFT
- Water Quality Reports for June, July and August, 1998,
- Water Resources memorandums on water quality inspections conducted on dates Aug. 19 and Sept. 15, 1998,
- analytical results for acid generation potential on two samples of tailings material collected on Nov. 2, 1998.
- letter to Water Resources Division, comments on arsenic stability test work by S. Hureau, B.Y.G. Environmental Coordinator, Nov. 11, 1998

4.0 Mine Life

This report is based on the assumption that the mine operations will cease within the next few months. At this time the storage capacity of the tailings impoundment has been reached or possibly already exceeded. Furthermore, the reserves of oxide ore (material which is not potentially acid generating) appears to have been exhausted as potentially acid generating tailings are now being deposited in the tailings impoundment. Processing of sulphide ore (interpreted here to mean material which is potentially acid generating) is prohibited under the conditions of the Water Licence.

No plans have been submitted for development of a new tailings impoundment area, and no plans exist for future ore recovery, waste management or water management.

Strict compliance with the terms of the Water Licence would result in immediate termination of mining and milling because of the acid generating ore and the discharge of tailings beyond the capacity of the impoundment.

5.0 Existing Mine Condition

Open Pit

The open pit has been mined down to about the 1230 m elevation, which is about 10 m deeper than proposed in the Nov. 1994, I.E.E. Mining has passed below the exploration adit. Frozen water in the pit bottom indicates that there had not been any ore recovery for possibly several weeks prior to the site inspection. Groundwater was entering the north end of the pit. The water level in the pit had not risen high enough to drain out the adit. A 2 m high berm on the north end of the pit restricts access from the Mt. Nansen access road.

Based on analysis of current tailings discharge, potentially acid generating ore has been recovered from the pit. Consequently, the lower pit walls and floor are also expected to be acid generating.

A study of the waste rock and pit wall rocks was prepared and submitted by B.Y.G. in 1997. This study only examined rocks at elevation 1255 m and above. The transition from oxide to sulphide ore, and thus towards increasing potential for acid generation, was believed to occur towards the bottom of the original pit at about 1240 m elevation (and is confirmed by the analysis of current tailings). Therefore, the waste rock and pit wall study report provides information only on upper pit. Because the more critical material is located at the bottom of the pit, the report is of limited value in addressing concerns relating to the mine condition at the end of operations.

Brown-McDade Adit

This adit is sealed with a temporary closure. It is understood that a portion of the waste rock in the portal dump adjacent to Pony Creek has been removed and processed in the mill.

Waste Dump

A waste dump is located on the south side of the pit. A stockpile of 15,000 to 20,000 tonnes of low grade ore is located on top of the dump. It is understood that the dump is

stable. Stripping of organic soil for revegetation was not conducted as proposed (I.E.E. Fig. 1.12).

Based on the ARD issues for the pit, as described above, it is expected that there may be potentially acid generating rock in the dump and the ore stockpile.

Sampling of the waste dump runoff at Station E4 has not been conducted because no flow has been observed.

Mill & Camp Area

The mill and camp areas were generally clean. Additional structures constructed since 1995 include a tailings thickener, water treatment plant, second crusher, and personnel accommodation.

Tailings Impoundment

Tailings discharge has not been conducted according to the conditions of the Water License or good engineering practice. Concerns regarding the stability of the dam have not been satisfactorily addressed. These and other issues are addressed as follow;

- Potentially acid generating tailings are currently being placed in the impoundment. Two samples of tailings were collected by Water Resources Staff from the tailings disposal area at Mt. Nansen Mine on Nov. 2, 1998. Both samples are potentially acid generating, (N.N.P. values were -72 and -186) although the paste pH indicates that acid generation is currently being buffered by the neutralization potential of the material. These samples are considered to be moderate to strong potential acid generators.
- The above samples were taken from the current discharge and the beach area located at the north end of the tailings impoundment. Deposition of these materials is occurring at or possibly above the maximum permitted elevation in the pond (not higher than 1 m below the spillway invert) and appears to be above the crest of the dam in some areas. During the visual inspection on Oct. 29, 1998, it appeared that the upper-most tailings

may be up to 2 m above the spillway invert. It is not known how much potentially acid generating material is now in the impoundment area.

- It is estimated that approximately 10,000 m^3 of tailings has been deposited in the north-west end of the impoundment above the maximum level and a similar amount on the upstream face of the dam.
- Tailings are being discharged such that the pond is being moved against the dam and reducing the width of the current tailings beach unless water is treated and released at rate equal to the volume of tailings being added to the pond. The design for seepage and stability considerations was based on a 50 m beach on the upstream side of the dam. During the inspection it was on average about 25 m wide and in one place as little as 10 m.
- The seepage return line is discharging onto the upstream face of the dam and eroding the tailings beach at this location.
- It is estimated that the remaining capacity of the impoundment below 1149.7 m elevation could be as little as 28,000 m^3, (assuming 2% aerial beach slopes, 5% submerged beach slopes and a width of 190 m at the point where the pond is deepest).
- Excavation of a ditch on the south abutment downstream of the crest of the dam has resulted in thawing of permafrost and an unstable ditch which is eroding.
- Despite marginal stability of the dam, which required emergency stabilization in 1997, additional material has been placed on the crest of the dam, up to 1 m thick in some locations. The placement of any additional material on the crest of the dam reduces it's stability and should not be conducted. Reviews of the stability of the dam be Geo-Engineering have indicated that the stability of the dam does not meet minimum standards. The stability of the dam could further deteriorate as foundation thawing increases the potential for failure by piping or liquefaction.
- The emergency repairs to the dam were intended to improve stability until analysis of the thermal and seepage monitoring data could permit a final design for improved long-term stability. Currently, the foundation is still thawing and the phreatic surface in the dam is just below the original downstream face of the dam, as described below. The seepage rate is currently at the upper limit of the range predicted by the designers (0.2 to 2 lps) which assumed that the foundation had thawed down to 16 m below original

ground surface for the higher seepage rate. The current extent of thawing is variable, but appears to be in the range of 3 to 5 m. Further thawing towards the 16 m considered by the designers could result in a significant increase in seepage.

- The required analysis of stability and design of stabilization measures has not been conducted. It is believed that additional stabilization measures will be required.
- The seepage return pond has submerged the toe of the dam and is probably contributing to elevated pore pressure in the downstream section of the dam.
- During most of 1998, the WAD cyanide concentration in the tailings pond had an average value of 52 mg/l (Apr. 22 to Sept. 15), which is slightly over twice the 25 mg/l permit level. Only three of the 22 samples were at or below the permit level. Copper, zinc and arsenic are also elevated in the pond water. It is understood that levels were elevated in previous years.
- The WAD cyanide concentration in the seepage water at Station E2 (seepage collection pond) fluctuates in the range of 10 to 20 mg/l.
- Treatment of tailings water has been found to be most effective by raising the water temperature to 25 to 30 degrees Celsius, and then processing in several stages for removal of cyanide, stabilization of arsenic, copper and zinc, and ammonia removal.
- At the monitoring station, D2, in Dome Creek the arsenic concentration has ranged between 0.14 and 0.23 mg/l and the copper concentration is similarly elevated (June 18 to Sept. 15, 1998). This indicates that a there is a significant quantity of seepage water which is passing the seepage return dam.
- Preliminary results from the arsenic stabilization test work have been submitted to Water Resources (B.Y.G., Nov. 11, 1998). The test results should be corrected to reflect water to solid ratios as may occur in the field. For many of the metals, a trend of decreasing concentration followed by a gradual increase was reported. Metals levels could be elevated if the tests had been conducted under mildly acidic conditions. (The majority of the tailings have a marginal potential for acid generation (N.N.P. = -5.6) and the upper most tailings now being discharged have a much higher potential for acid generation {N.N.P. = -129, average of two samples}). Cyanide was not reported in the test results. After five weeks the concentration of antimony, arsenic, and copper was above the Effluent Quality Standards specified in the Water Licence. Other metals are

likely to have exceeded the standards if the tests were conducted under more aggressive (acidic) leaching conditions.

- Seepage out of the tailings impoundment is likely to exceed inflows to the impoundment in dry years when precipitation is low and evaporation is high, and during winter months when there is negligible surface runoff. Consequently, desaturation of the upper layers of tailings is likely to occur. As these materials are potentially acid generating there will be downstream impacts unless the reclamation plan is modified.

Instrumentation has been installed in the dam to monitor pore pressure and thermal conditions. To date, the thermal data indicate little change in the ground temperature in most locations and thawing of 2 to 4 m of soil in three locations. The seepage water temperature is in the range of 2 to 7 degrees Celsius. Further thawing of the foundation is expected due to the migration of this warm water through and under the dam.

Diversion Channel & Spillway

A diversion channel and emergency spillway is located on the north side of the impoundment. At the time of the inspection, erosion of the north side of the diversion channel had partially blocked the channel. Further reduction of the channel cross-section consisted of tailings and return water lines, and the use of culverts to construct a road across the channel. One of these culverts had glaciated. This channel would not likely pass the design flow in its current condition.

The Conceptual Reclamation plan proposes a closure spillway for the tailings impoundment which would be capable of passing the probable maximum flood (PMF). Construction of the closure spillway on the right abutment, as indicated in the decommissioning plan is not recommended as the slope contains frozen soils which are highly erodable once they thaw or are disturbed. Up-grading the existing spillway is preferred.

A previous runoff event resulted in failure of the emergency spillway downstream of the crest of the dam. In this area the channel consists of a geotextile over the native silty sand with an overlying layer of erosion-resistant mine rock. Failure occurred by piping of the

silty sand when the water flowed under the geotextile. Replacement of the failed section was conducted using the same design as that which failed.

Roads & Borrow Areas

No revegetation of the borrow areas has been conducted.

Old Mine Wastes

There were about 41,000 tonnes of sulphide ore from previous operations in the stockpile located south-west of the office. This material was to be processed in the mill. This waste was to be incorporated in the lower portion of the tailings impoundment where saturated conditions would inhibit future acid generation. This work has not been done.

There were about 25,000 tonnes of sulphide tailings from previous operations which were to be processed in the mill or simply relocated to the tailings impoundment. It is understood that this work has been done.

It appears that there is not sufficient capacity remaining in the tailings impoundment for the stockpiled sulphide ore and it would not be kept in a saturated state even if it were relocated to the tailings impoundment.

Programs and Studies

The Water Licence required B.Y.G. to conduct a number of studies to aid in development and decommissioning of the mine.

The initial results of the arsenic stabilization study were to be submitted in a report within 60 days of mill start-up, and the balance within seven months. Two years later the initial phase of this work has been started. It is not certain that the test work which is being conducted is representative of conditions which will exist in the pond at closure (saturated versus unsaturated, pH of rinse water and potential for development of ARD).

An acid rock drainage study was to be conducted to examine the pit walls and floor and the tailings. A pit wall study was conducted in 1997 failed to address the most critical rocks in the floor and wall of the bottom of the pit. No work has been done on the tailings ARD study.

A thaw settlement study was to be conducted to determine the performance of the dam and underlying foundations. The instrumentation was not installed until 1998, two years after construction of the dam, and only then under duress as the stability of the dam was highly questionable. The information obtained to date is not sufficient to definitively characterize thermal trends in the dam. Additional data are needed to complete the design of remedial measures for the dam. However, because of the current state of the mine it is now necessary to consider reclamation measures to deal with conditions which are worse than originally envisioned.

Elements of the Tailings Impoundment Seepage Monitoring and Liquefaction Monitoring programs have not been conducted. SPT date to characterize the dam foundation was not obtained. This data is still necessary.

A detailed decommissioning and reclamation plan was to be submitted by Dec. 31, 1997. A conceptual plan was submitted in Jan. 1998. However, without the complete results from the other studies, this plan is of little value.

Clearly, the management of the Mt. Nansen Mine have not fulfilled their obligations for developing and operating the mine in accordance with their original proposal. Their original proposal for operation using the "observational approach" has proven to be unsatisfactory.

6.0 Reclamation Measures

Open Pit

- Drainage of pit water via the adit is likely to occur in the spring of 1999 unless the water is pumped out. If necessary, the water should be treated and then pumped to the tailings impoundment.
- Construction of a bulkhead in the adit will be required to control drainage and flood the pit bottom to prevent acidic drainage. Construction of a bulkhead for low head conditions at a remote road-access mine in northern B.C. cost approximately $85,000. This work did not include grouting or measures to deal with permafrost. Therefore, the 1995 allowance of $200,000 for a bulkhead appears reasonable.
- The ARD study indicated that the rocks exposed at the 1255 m elevation and above are not potentially acid generating. It is assumed that flooding the bottom 10 m of the pit, up to elevation 1240 m, will submerge most or all of the potentially acid generating rock.

Pit capacity (for waste rock and old ore stockpiles) below the south rim is estimated to be 40,000 m^3 (10 m by 20 m wide by 200 m long).

Brown-McDade Adit

- A permanent closure should be constructed in the adit. The remaining waste rock at the portal should be relocated to the pit.

Waste Dump

- Relocation of some potentially acid generating waste into the pit may be required to prevent ARD. An investigation, consisting of sampling and analysis, should be conducted. At this time allowance for moving low grade ore which cannot be processed due to lack of tailings storage capacity and some waste rock is recommended. In order to compile this estimate, 15,000 m^3 of rock is allowed for.
- The surface of the waste dump should be scarified and revegetated.

Mill & Camp Area

- Hazardous materials and chemical should be shipped off-site for disposal.
- All buildings should be removed. Demolition waste can be disposed of in the open pit after backfilling with potentially acid generating wastes. A cover of waste rock should be placed over the waste.
- Concrete foundations should be cracked and buried in place.
- The camp and offices should be demolished.

Tailings Impoundment

- Construction and operation of the tailings impoundment has been very poorly managed. At closure, measures will be necessary to improve the stability of the dam with respect to slope stability, foundation degradation and potential liquefaction, and piping due to high seepage. In addition, measures will be necessary to prevent potential environmental impact associated with elevated cyanide, arsenic and copper in the pore water, and metal release associated with acid generation from the upper-most tailings.
- Placement of any additional tailings in the impoundment will make some of the following measures very difficult to implement. In addition, because the most recent tailings are potentially acid generating and cannot be flooded at closure in the existing impoundment, it is assumed that the it will be necessary to relocate some tailings to the open pit. This will require construction of a dam in the south end of the pit to contain the material. A provisional volume of tailings to be relocated is 25,000 m^3. This work could be conducted by hydraulic mining of the tailings and pumping the material to the pit. a study of the distribution of potentially acid generating tailings within the impoundment should be conducted.
- After removal of potentially acid generating material, any tailings which have been disposed above the maximum permitted level should be moved into the central pond area. Tailings which are currently located against the upstream face of the dam should remain in place to maintain the pond away from the dam, assuming that these tailings have a low potential for acid generation (N.N.P. = -5.6). Water in the pond must be removed and treated for discharge before this work can commence. The volume of water to be treated is estimated to be 60,000 m^3. After removal of the 25,000 m^3 to the

pit, the remaining tailings should be contoured to increase the width of the beach on the upstream side of the dam. The volume of tailings to be relocated to the middle of the pond is estimated to be 25,000 m^3. This work can also be conducted using hydraulic methods.

- There will be exposed tailings on the beach upstream of the crest of the dam. Measures to prevent wind erosion will be required. Placement of 30 cm of local sand and gravel over the beach will address this problem.
- Water treatment costs during decommissioning will be similar to current costs, which are estimated to be \$1.20/m^3. Post-closure water treatment costs will be higher and are discussed below.
- Additional work will be required for embankment stabilization. This must be preceded by an review of data and design of stabilization measures. Increasing the toe buttress will increase resistance to liquefaction and slope failure. A buttress of 5 m thickness over the existing buttress and 5 m further up the face of the dam may be sufficient. It is estimated that 15,000 m^3 of rockfill could be required. This rock could be taken from the waste rock dump.

Post-closure Water Treatment

- Covering the entire impoundment with an impervious layer appears to be impractical and costly. There is no local source of till or other low permeability material. The area to be covered is in the order of 50,000 m^2. A geosynthetic cover installed with protection for to least in the range of 50 years is likely to cost more than \$25/m^2. Water treatment would still be required because seepage containing cyanide and metals would continue to be released from the pond. The arsenic stabilization work indicates that long-term release of arsenic is likely to occur.
- Post-closure water treatment costs will be higher than during operation due to the higher labour cost per cubic meter processed and the fuel required to heat the water after heat from power generation is reduced. There will be additional costs for maintaining the access road to the site and ongoing water quality monitoring. Perpetual water treatment will justify relocation of the water treatment plant to a location just downstream of the tailings impoundment so that pumping costs are

eliminated. A provisional amount of $250,000 is recommended for construction of a new building. A provisional amount of $50,000 is recommended for design of the treatment process for reduced flows and gradually changing water quality. A provisional amount of $150,000 is recommended for procurement of the plant equipment, installation and commissioning.

- Water treatment will be required for the seepage and incident precipitation. Treatment of 5 pore volumes may be needed to reduce the cyanide concentration to acceptable levels. The pond volume is 240,000 m^3. At a void ratio of 1.0, one half of the pond volume is pore space = 120,000 m^3. Treatment of 5 pore volumes will involve 600,000 m^3. If we assume that further thawing of the foundation results in a 25% increase in the seepage rate to 10 m^3/hr (87,600 m^3/year) then treatment for cyanide and ammonia may be required for 6.9 years. Ongoing treatment will be required after this time for removal of metals. However the treatment cost will decrease with time as reagent consumption decreases.
- Seepage water is by-passing the current collection pond. It is possible that the seepage is passing under the dam in the silty sands and/or the gravels at 9 m depth. It may be possible to collect the seepage in a trench downstream of the dam or by pumping from wells. Ongoing thawing of foundation of the dam may necessitate the use of wells, which has been assumed for this cost estimate.
- It is assumed that the diversion channel will be maintained and continue to route water around the impoundment such that there will be no surface water to treat and all water to be treated will report as seepage. Maintenance of the channel will be required for as long as water treatment is needed.

Diversion Channel & Spillway

- The current construction for the spillway is a rebuild of a design which failed. It is not acceptable for closure. Long-term reliance on a geotextile as the key in meeting performance objectives is not acceptable. The rip rap and geotextile should be removed and replaced. An acceptable design to provide long term resistance to erosion may require two filter layers between the silty sand native soil and the rip rap layer. The spillway length is 390 m and it is currently sized for the 200 year flow. Up-grading for the PMF event should be provided. A hydraulic analysis should be conducted to

design the channel. For the purpose of providing a cost estimate it is assumed that the channel will have a base width of 10 m, each filter layer is 0.5 m thick and the rip rap layer is 0.75 m thick. The volume of material to be removed is 3220 m^3 (8.25 m^3/m x 390 m) of rip rap and the geotextile. The volume to be placed is 3120 m^3 fine filter, 3120 m^3 coarse filter and 4680 m^3 rip rap (8.0 m^3/m fine and coarse filter, 12.0 m^3/m rip rap). Screening of waste rock could be conducted to provide the fine and coarse filter material.

Roads & Borrow Areas

- Roads and borrow areas should be scarified and revegetated.

Old Mine Wastes

- Relocation of the 41,000 tonnes of sulphide ore from previous operations into the tailings impoundment does not appear to be possible. Placement of this material into the pit would mitigate future acid generation. Addition of lime will be necessary to mitigate impacts from oxidation products contained in the waste. Allow two tonnes of lime per 100 tonnes of rock.

6.0 Reclamation Cost Estimate

A cost estimate for reclamation of the Mt. Nansen Mine has been prepared using the RECLAIM model. A complete output from the model is attached as Appendix I. The capital costs at closure are estimated to be $2,160,230 and the cost for post-closure water treatment is estimated to be $5,912,203 (net present value of $170,000 to $190,000 for 100 years), for a total closure cost of $8,038,434.

A supplementary spreadsheet was developed to estimate the cost of post-closure water treatment, and is presented in Appendix II. The cost estimate for water treatment was broken into two parts; the first seven years after closure during which treatment for cyanide, ammonia and metals is required, and years 8 to 100 during which treatment for only metals is required. Estimation of the net present value of the post-closure costs is based on a discount rate (difference between investment returns and inflation) of 2.75 %.

This estimate is presented as "a conservative assessment which has a high degree of confidence of meeting all reclamation requirements". It may be possible to achieve a satisfactory reclamation condition which is less costly. However, at this time the data and analyses to demonstrate a less costly solution are not available. There may be variations to the reclamation solution presented here which are equally effective.

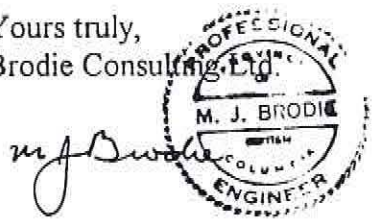
A possible variation which could reduce the reclamation cost may be to dispose of all of the tailings, waste rock and stockpiled ore in the pit with a larger dam. This option is not demonstrable at this time because the capacity of the pit and the hydrogeologic properties of the rock around the pit are not known. If studies can demonstrate that this option is viable then the high cost associated with long-term water treatment could be avoided.

This estimate is higher than the cost estimate of 1995 ($1,438,800). The differences are due to:

- failure of the company to conduct test work and analyses as proposed, resulting in the need for conservative assumptions in this estimate,
- failure of the company to operate the mine as proposed and in the interest of minimizing closure costs (excavation of acid generating materials, deposition of acid generating tailings above the saturation level in the impoundment, old ore stockpiles not processed, failure to stabilize arsenic in the tailings, failure to reduce cyanide levels before discharge of tailings, deposition of tailings such that "minimal efforts" for post-closure water management could be effective), and,
- a requirement for post-closure water treatment for at least 100 years.

I trust that this report addresses your current requirements. Please call if you have any questions.

Yours truly,
Brodie Consulting Ltd.



M.J. Brodie, P.Eng.

RECLAMATION COST SUMMARY

PROJECT NAME: **Mt. Nansen Mine**

BEST ESTIMATE FOR UNIT COSTS 05-Dec-98

CAPITAL COST COMPONENT NAME	COMPONENT TYPE		TOTAL COST
	OPEN PIT		$394,965
	UNDERGROUND MINE		$230
	TAILINGS IMPOUNDMENT		$397,772
	ROCK PILE		$351,671
	BUILDINGS AND EQUIPMENT		$121,130
	CHEMICALS & CONTAM. SOILS		$36,748
	WATER MANAGEMENT		$334,020
	MOBILIZATION/DEMOBILIZATION		$24,581
SUBTOTAL			**$1,661,118**
PROJECT MANAGEMENT	3	% of subtotal	$49,834
ENGINEERING		% of subtotal	$0
CONTINGENCY	25	% of subtotal	$415,279
GRAND TOTAL - CAPITAL COSTS			**$2,126,230**
MONITORING & MAINTENANCE, years 1 - 7	$190,716		
MONITORING & MAINTENANCE, years 8 -100	$170,370		
Discount rate	2.75		
Net present value of perpetual monitoring & Maintenance, for 100 years			**$5,912,203**
TOTAL - CAPITAL & ANNUAL ONGOING COSTS			$8,038,434

PROJECT NAME: **Mt. Nansen Mine** DATE: 05-Dec-98

COMPONENT TYPE: OPEN PIT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: CONTROL ACCESS					
	Fence	m		NA	0	$0
	Signs	each		NA	0	$0
	Ditch, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Berm	m3		NA	0	$0
	Block roads	m3		NA	0	$0
	Other			NA	0	$0
				NA		
B	OBJECTIVE: STABILIZE SLOPES			NA		
	Off-load crest, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	extend dam	m3		NA	0	$0
	, fill mat'l A	m3		NA	0	$0
	, fill mat'l B	m3		NA	0	$0
		m		NA	0	$0
	Pumping, pumps	each		NA	0	$0
	, pipes	m		NA	0	$0
	, power	kWh		NA	0	$0
	Other			NA	0	$0
				NA		
C	OBJECTIVE: COVER/CONTOUR SLOPES			NA		
	Fill over demolition waste in pit	m3	10000	SBSH	5.46	$54,600
	, mat'l B	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Vegetate borrow areas	ha	0.59	VHFL	1100	$649
	Contour & vegetate expl'n trenches	ha	10.1	NA	4100	$41,410
D	OBJECTIVE: SPILLWAY			NA		
	Excavate channel, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Concrete	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Other			NA	0	$0

PROJECT NAME: **Mt. Nansen Mine** DATE: 05-Dec-98

COMPONENT TYPE: OPEN PIT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
				NA		
E	OBJECTIVE: FLOOD PIT			NA		
	Ditch, mat'l A	m3		NA	0	$0
	Grout embankment foundation		1	NA	25000	$25,000
	Embankment, mat'l A, core	m3	1260	SB4H	7.67	$9,664
	, mat'l B, filter zone	m3	490	SB4H	7.67	$3,758
	, mat'l C, rock fill	m3	6160	SBSH	5.46	$33,634
	Pumping,	m3	5000	NA	0.25	$1,250
	, pipes	m		NA	0	$0
	, power	kWh		NA	0	$0
	Other (lime addition)	tonne		NA	0	$0
F	OBJECTIVE: BACKFILL PIT			NA		
	Fill, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Other			NA	0	$0
				NA		
G	OBJECTIVE: DEVELOP WETLAND			NA		
	Earthworks, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
H	Adit Bulkhead	each	1	NA	200000	$200,000
	Engineering of pit embankment	each	1	NA	25000	$25,000
	Subtotal					$394,965

COMMENTS:

PROJECT NAME: **Mt. Nansen Mine** DATE: 05-Dec-98

COMPONENT TYPE: OPEN PIT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: UNDERGROUND MINE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: CONTROL ACCESS					
	Fence	m		NA	0	$0
	Signs	each		NA	0	$0
	Ditch, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Berm	m3		NA	0	$0
	Block adits	m3	30	SB4H	7.67	$230
	Cap shaft	m3		NA	0	$0
	Cap raise #1	m3		NA	0	$0
	Cap raise #2	m3		NA	0	$0
	Backfill adits	m3		NA	0	$0
	Backfill shaft	m3		NA	0	$0
	Backfill raise #1	m3		NA	0	$0
	Backfill raise #2	m3		NA	0	$0
	Backfill open stopes	m3		NA	0	$0
	Specified control			NA	0	$0
				NA		
B	OBJECTIVE: STABILIZE GROUND SURFACE			NA		
	Backfill mine	m3		NA	0	$0
	Collapse mine	m3		NA	0	$0
	Contour, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Maintain dewatering (see "MONITORING/MAINTENANCE			NA		
	Other			NA	0	$0
				NA		
C	OBJECTIVE: FLOOD MINE			NA		
	Plug adits	m3		NA	0	$0
	Plug drillholes to surface	each		NA	0	$0
	Grouting	m3		NA	0	$0
	Other			NA	0	$0
				NA		
D	OBJECTIVE: DEVELOP WETLAND			NA		
	Earthworks, mat'l A	m3		NA	0	$0

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: UNDERGROUND MINE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
	, mat'l B	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
E	SPECIALIZED ITEMS			NA	0	$0
	Subtotal					$230

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: TAILINGS IMPOUNDMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: CONTROL ACCESS					
	Fence	m		NA	0	$0
	Signs	each		NA	0	$0
	Ditch, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Berm	m3		NA	0	$0
	Block roads	m3		NA	0	$0
	Other			NA	0	$0
				NA		
B	OBJECTIVE: STABILIZE EMBANKMENT			NA		
	Toe buttress, drain mat'l	m3		NA	0	$0
	, fill mat'l A	m3	15000	SBSH	5.46	$81,900
	, fill mat'l B	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Raise crest	m3		NA	0	$0
	Flatten slopes	m3		NA	0	$0
	Other			NA	0	$0
				NA		
C	OBJECTIVE: TAILINGS			NA		
	Relocate against dam	m3	25000	NA	2.65	$66,250
	Rip rap	m3	7500	SB2H	5.12	$38,400
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
D	OBJECTIVE: FLOOD TAILINGS			NA		
	Hydraulic mine & pump to pit	m3	25000	NA	3.65	$91,250
	, mat'l B	m3		NA	0	$0
	Raise crest	m3		NA	0	$0
	Other			NA	0	$0
				NA		
E	OBJECTIVE: DEVELOP WETLAND			NA		
	Earthworks, mat'l A	m3		NA	0	$0

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: TAILINGS IMPOUNDMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
	, mat'l B	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
F	OBJECTIVE: UPGRADE SPILLWAY			NA		
	Excavate channel, mat'l A	m3	3220	SC1H	6.54	$21,059
	Place fine filter	m3	3120	SB4H	7.67	$23,930
	Place coarse filter	m3	3120	SB4H	7.67	$23,930
	Rip rap	m3	4680	SBSH	5.46	$25,553
	Other			NA	0	$0
				NA		
G	OBJECTIVE: STABILIZE DECANT SYSTEM			NA		
	Remove	m3		NA	0	$0
	Plug/backfill	m3		NA	0	$0
	Other			NA	0	$0
				NA		
H	OBJECTIVE: REMOVE TAILINGS DISCHARGE			NA		
	Cyclones	m3		NA	0	$0
	Pipe	m	3500	PPLL	1	$3,500
	Other			NA	0	$0
	Design dam stabilization work		15	NA	800	$12,000
I	and spillway design					
	Drill invest. for dam foundation STP		1	NA	10000	$10,000
	Subtotal					$397,772

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: TAILINGS IMPOUNDMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: ROCK PILE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: STABILIZE SLOPES					
	Flatten slopes with dozer	m3		NA	0	$0
	Divert runon, ditch mat'l A	m3		NA	0	$0
	, ditch mat'l B	m3		NA	0	$0
	Toe buttress, drain mat'l	m3		NA	0	$0
	, fill mat'l A	m3		NA	0	$0
	, fill mat'l B	m3		NA	0	$0
	Other			NA	0	$0
B	OBJECTIVE: COVER DUMP			NA		
	Mat'l A	m3		NA	0	$0
	Mat'l B	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Vegetate	ha	6.35	VHFL	1100	$6,985
	Other			NA	0	$0
				NA		
C	OBJECTIVE: UNDERWATER DISPOSAL			NA		
	Move material	m3	15000	SBSH	5.46	$81,900
	Remove rock at portal	m3	4000	SBSH	5.46	$21,840
	Add lime	tonne	361	ILML	136	$49,096
	Add crushed limestone	m3		NA	0	$0
	Other			NA	0	$0
	Move old mine waste to pit	m3	21,500	SBSH	5.46	$117,390
D	Add lime	tonne	410	ILML	136	$55,760
	OBJECTIVE: COLLECT AND TREAT			NA		
	See "ONGOING TREATMENT" costing component					
E	OBJECTIVE: DEVELOP WETLAND			NA		
	Earthworks, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
F	Trenching, geochem. sampling & analysis includes sampling of tailings beach		1	NA	18700	$18,700

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: ROCK PILE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
Subtotal					$351,671

COMMENTS:
ARD sampling based on 6.5 days technician for travel, sampling & reporting @$800/day, 100 samples @ $108 each, $200 shipping, and $2500 travel and accom.

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: BUILDINGS AND EQUIPMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: DISPOSE MOBILE EQUIPMENT					
	Sell equipment 1	each		NA	0	$0
	Sell equipment 2	each		NA	0	$0
	Sell equipment 3	each		NA	0	$0
	Decontaminate and dispose 1	each		NA	0	$0
	Decontaminate and dispose 2	each		NA	0	$0
	Decontaminate and dispose 3	each		NA	0	$0
	Other			NA	0	$0
				NA		
B	OBJECTIVE: DISPOSE STATIONARY EQUIPMENT			NA		
	Sell equipment 1	each		NA	0	$0
	Sell equipment 2	each		NA	0	$0
	Sell equipment 3	each		NA	0	$0
	Decontaminate and dispose 1	each		NA	0	$0
	Decontaminate and dispose 2	each		NA	0	$0
	Decontaminate and dispose 3	each		NA	0	$0
	Other			NA	0	$0
				NA		
C	OBJECTIVE: DISPOSE ORE CONCENTRATION EQUIP			NA		
	Autoclave - sell	each		NA	0	$0
	Decontaminate tanks & plumb.	each		NA	0	$0
	Remove tanks & plumbing	each		NA	0	$0
	Other			NA	0	$0
				NA		
D	OBJECTIVE: DISPOSE WATER TREATMENT EQUIPME			NA		
	Decontaminate tanks & plumb.	each		NA	0	$0
	Remove tanks & plumbing	each		NA	0	$0
	Other			NA	0	$0
				NA		
E	OBJECTIVE: DECONTAMINATE BUILDINGS & TANKS			NA		
	Buildings, all , chemicals	pallet	10	LCRL	1500	$15,000
				NA	0	$0
				NA	0	$0

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: BUILDINGS AND EQUIPMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
	, asbestos	m2		NA	0	$0
	Building 3 , chemicals	m3		NA	0	$0
	, asbestos	m2		NA	0	$0
	Building 4 , chemicals	m3		NA	0	$0
	, asbestos	m2		NA	0	$0
	Building 5 , chemicals	m3		NA	0	$0
	, asbestos	m2		NA	0	$0
	Other			NA	0	$0
				NA		
F	OBJECTIVE: REMOVE/MOTHBALL BUILDINGS			NA		
	Buildings, mill, power, warehouse, conveyors		2520	BRS1H	20	$50,400
	office, camp	m2	1639	BRW2	5	$8,195
	Building, pit shop	m2	225	BRS1H	20	$4,500
	Oil tanks	m2	21	BRS1H	20	$420
	Building 5			NA	0	$0
	Other			NA	0	$0
				NA		
G	OBJECTIVE: BREAK BASEMENT SLABS			NA		
	Buildings, all, break & bury	m2	4384		1	$4,384
	Building 2	m2		NA	0	$0
	Building 3	m2		NA	0	$0
	Building 4	m2		NA	0	$0
	Building 5	m2		NA	0	$0
	Other			NA	0	$0
				NA		
H	OBJECTIVE: REMOVE BURIED TANKS			NA		
	Tank 1, decontaminate	m3		NA	0	$0
	, excavate & dispose	m3		NA	0	$0
	Tank 2, decontaminate	m3		NA	0	$0
	, excavate & dispose	m3		NA	0	$0
	Tank 3, decontaminate	m3		NA	0	$0
	, excavate & dispose	m3		NA	0	$0
	Other			NA	0	$0

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: BUILDINGS AND EQUIPMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
				NA		
I	OBJECTIVE: GRADE AND CONTOUR			NA		
	Grade mill and camp area	m2	3.16	SCFYI	3215	$10,159
	Place soil cover	m3		NA	0	$0
	Rip rap on ditches	m3		NA	0	$0
	Vegetate	ha	3.16	VHFL	1100	$3,476
	Other			NA	0	$0
				NA		
J	OBJECTIVE: RECLAIM ROADS			NA		
	Scarify and install water breaks	ha	5.7	SCFYI	3215	$18,326
	Vegetate	ha	5.7	VHFL	1100	$6,270
				NA		
K	SPECIALIZED ITEMS			NA	200	$0
	Subtotal					$121,130

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: CHEMICALS & CONTAMINATED SOILS

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
	Note: The procedures, equipment and packaging for clean up and removal of chemicals or contaminated soils are highly dependent on the nature of the chemicals and their existing state of containment. Government guidelines should be consulted on an individual chemical basis. Any estimate made here should be considered very rough unless specific evaluations have been conducted.					
A	LABORATORY CHEMICALS	pallet	2	LCRL	1500	$3,000
				NA		
B	PCB	kg		NA	0	$0
				NA		
C	FUEL			NA		
	Type 1	kg		NA	0	$0
	Type 2	kg		NA	0	$0
				NA		
D	OIL			NA		
	Type 1, waste oil	litre	20000	ORL	0.12	$2,400
	Type 2, tank sludge	litre	2100	ORH	0.88	$1,848
				NA		
E	PROCESS OR TREATMENT CHEMICALS			NA		
	Type 1	pallet	8	LCRL	1500	$12,000
	Type 2	kg		NA	0	$0
	Type 3	kg		NA	0	$0
	Type 4	kg		NA	0	$0
				NA		
F	EXPLOSIVES	kg		NA	0	$0
				NA		
G	CONTAMINATED SOILS			NA		
	Type 1, petroleum	m3	500	NA	35	$17,500
	Type 2	m3		NA	0	$0
	Subtotal					$36,748

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: CHEMICALS & CONTAMINATED SOILS

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: WATER MANAGEMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	OBJECTIVE: STABILIZE EMBANKMENT					
	Toe buttress, drain mat'l	m3		NA	1	$0
	, fill mat'l A	m3		NA	0	$0
	, fill mat'l B	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Raise crest	m3		NA	0	$0
	Other			NA	0	$0
				NA		
B	OBJECTIVE: UPGRADE SPILLWAY			NA		
	Excavate channel, mat'l A	m3		NA	0	$0
	, mat'l B	m3		NA	0	$0
	Concrete	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Other			NA	0	$0
				NA		
C	OBJECTIVE: STABILIZE DECANT SYSTEM			NA		
	Remove	m3		NA	0	$0
	Plug/backfill	m3		NA	0	$0
	Other			NA	0	$0
				NA		
D	OBJECTIVE: BREACH EMBANKMENT			NA		
	Remove Fill	m3		NA	0	$0
	Other			NA	0	$0
				NA		
E	OBJECTIVE: STABILIZE DITCHES			NA		
	Flatten side slopes	m3		NA	0	$0
	Rip rap	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
F	OBJECTIVE: BREACH DITCHES			NA		
	Excavate	m3		NA	0	$0

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: WATER MANAGEMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
	Backfill/recontour	m3		NA	0	$0
	Vegetate	ha		NA	0	$0
	Other			NA	0	$0
				NA		
G	OBJECTIVE: REMOVE PIPELINES			NA		
	Remove pipes	m		NA	0	$0
	Concrete plug deep pipes	m3		NA	0	$0
	Other			NA	0	$0
				NA		
H	OBJECTIVE: REMOVE STORAGE TANKS			NA		
	Knock down lump sum			NA	0	$0
	Excavate & backfill	m3		NA	0	$0
	Other			NA	0	$0
				NA		
I	OBJECTIVE: COLLECT DRAINAGE FOR TREATMENT			NA		
	Install groundwater wells	each	4	NA	8600	$34,400
		m3		NA	0	$0
	Pipes	m		NA	0	$0
	Pumps	each		NA	0	$0
	polishing pond, exc. mat'l A	m3	3000	SC1H	6.54	$19,620
	, exc. mat'l B	m3		NA	0	$0
	Collect'n pond, fill mat'l A	m3		NA	0	$0
	, fill mat'l B	m3		NA	0	$0
	polishing pond, liner	m2	2000	NA	15	$30,000
				NA		
J	OBJECTIVE: TREAT DRAINAGE (see "ONGOING TREA			NA		
	Treatment plant building, lump sum		1	NA	250000	$250,000
	Treatment plant , design, control, tanks, pumps		1		200000	
	Subtotal					$334,020

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: WATER MANAGEMENT

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST
Groundwater wells, drilling: mob/demob $2500, 8 days drilling/installation $20,000 casing $2000, pumps $6000, instrumentation $2000, surface piping $2000, total $34, 500					
Treatment plant , design, control, tanks, pumps; cost based on $50,000 engineering and $150,000 equipment, installation and commissioning.					

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: MOBILIZATION/DEMOBILIZATION

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL		UNITS	QUANTIT	COST CODE	UNIT COST	COST
A	MOBILIZE HEAVY EQUIPMENT						
	Machine 1		km	480	MHER	2.4	$1,152
	Machine 2		km	480	MHER	2.4	$1,152
	Machine 3		km	480	MHER	2.4	$1,152
UnderGnd					NA		
B	MOBILIZE CAMP				NA	0	$0
					NA		
C	MOBILIZE WORKERS			10	MM<L	175	$1,750
					NA		
D	MOBILIZE MISC. SUPPLIES				NA	0	$0
					NA		
E	HOUSE WORKERS	person days	days	45	MHWL	75	$3,375
					NA		
F	BONDING	lump sum		1	NA	16000	$16,000
					NA		
G	TAXES	lump sum			NA	0	$0
					NA		
H	INSURANCE	lump sum			NA	0	$0
	Subtotal						$24,581

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: MOBILIZATION/DEMOBILIZATION

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT	COST CODE	UNIT COST	COST

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: MONITORING AND MAINTENANCE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

	ACTIVITY/MATERIAL	UNITS	QUANTIT PER YEA	COST CODE	UNIT COST	COST
A	OBJECTIVE: INSPECTIONS					
	Visual inspection	each		VIL	3000	$0
	Geotech inspection	each	1	VIL	3000	$3,000
	Water sampling	each	4	WSL	4500	$18,000
	Reporting	each		NA	0	$0
	Other			NA	0	$0
				NA		
B	OBJECTIVE: MAINTENANCE			NA		
	Security guard	month		NA	0	$0
	Accomodation	month		NA	0	$0
	Maintain pumping	month		NA	0	$0
	Clear spillway	each	1	NA	2500	$2,500
	Other			NA	0	$0
				NA		
C	OBJECTIVE: ONGOING WATER TREATMENT			NA		
	Note: The cost of water treatment can vary widely depending on the nature of the influent and the effluent objectives. The size of a water treatment plant depends on the peak inflow rate which can be many times greater than the mean. Therefore, an estimate of water treatment costs made here should be considered very rough unless chemical testing and hydraulic modelling has been conducted.					
	Operate treatment plant, post-closure years 1-		1	NA	167216	$167,216
	Operate treatment plant, post-closure years 1- see attached sheet for breakdown		1	NA	146870	$146,870
	Subtotal		Years 1 -7			$190,716
			Years 8 - 100			$170,370

COMMENTS:

PROJECT NAME: Mt. Nansen Mine DATE: 05-Dec-98

COMPONENT TYPE: MONITORING AND MAINTENANCE

COMPONENT NAME:

COMPONENT No.: 1

BEST ESTIMATE FOR UNIT COSTS

ACTIVITY/MATERIAL	UNITS	QUANTIT PER YEA	COST CODE	UNIT COST	COST

PROJECT MT. NANSEN MINE

WATER TREATMENT COSTS **Post-closure years 1 to 7**

ANNUAL VOLUME OF WATER, m3 90000

INFLOW CONCENTRATION

	mg/l = g/m3
CYANIDE	25
AMMONIA	14
ARSENIC	0.5
COPPER	10
ZINC	0.2
pH	7

Reagent addition rates

	mg reagent/mg contam.	cost, $/kg, FOB site
H2O2	1	1.98
lime	0.2 kg/m3	0.15
ferric sulphate	0.05 kg/m3	1.02
copper sulphate	2.5	1.87

Annual reagent cost	H2O2	$	4,455
	lime	$	2,700
	ferric sulp	$	4,590
	copper sulp.	$	5,891

power, fuel for heating and pumping	$	15,000
misc. supplies, hoses, tools	$	2,000
sampling equip.	$	1,000
equip. maintenance and parts	$	3,000

water analysis	$	3,000	samples weekly from pond, effluent & downstream
reporting	$	7,500	samples per month 12
truck	$	5,000	analysis cost, incl shipping 50
road maintenace	$	5,000	

labor $ 35 hourly rate

attendance, men per day for water treatment work 2

on site, days per year 183

spring/fall maintenance, extra 1 week work, 2 men 160 hours

hours worked per year 3088

annual labor cost $ 108,080

Total Cost $ 167,216 per year

PROJECT MT. NANSEN MINE

WATER TREATMENT COSTS **Post-closure years 8 to 100**

ANNUAL VOLUME OF WATER, m3 90000

INFLOW CONCENTRATION

	mg/l = g/m3
CYANIDE	0
AMMONIA	0
ARSENIC	0.5
COPPER	10
ZINC	0.2
pH	7

Reagent addition rates

	mg reagent/mg contam.	cost, $/kg, FOB site
H2O2	1	1.98
lime	0.2 kg/m3	0.15
ferric sulphate	0.05 kg/m3	1.02
copper sulphate	0	1.87

Annual reagent cost

H2O2	$	-
lime	$	2,700
ferric sulp	$	4,590
copper sulp.	$	-

power, fuel for heating and pumping	$	5,000	
misc. supplies, hoses, tools	$	2,000	
sampling equip.	$	1,000	
equip. maintenance and parts	$	3,000	
water analysis	$	3,000	samples weekly from pond, effluent & downstream
reporting	$	7,500	samples per month 12
truck	$	5,000	analysis cost, incl shipping 50
road maintenace	$	5,000	

labor $ 35 hourly rate

attendance, men per day for water treatment work 2

on site, days per year 183

spring/fall maintenance, extra 1 week work, 2 men 160 hours

hours worked per year 3088

annual labor cost $ 108,080

Total Cost $ 146,870 per year

December 15, 1998

Mr. Bud McAlpine
Water Resources Division
Indian Affairs and Northern Development
Whitehorse, Yukon, Y1A 2B5

RE: MT. NANSEN MINE
EVALUATION OF MINE WASTE DISPOSAL IN PIT

Dear Bud,

An assessment of the mine closure issues and an estimate of the cost of mine closure for the Mt. Nansen Mine was presented in the report: Mt. Nansen Mine - Closure Cost Assessment, submitted on Dec. 9, 1998. This report examines an alternative to the closure scenario developed in that report.

In the Dec. 9, 1998 report, the most significant reclamation measure affecting the cost of mine closure has been identified as the potential for metal leaching and acidic drainage from the tailings, a portion of the waste rock and the stockpiled sulphide ore. It was assumed that a small portion of the tailings, all the acid generating waste rock and the stockpiled ore could be relocated to the open pit where they would be submerged to prevent future acid generation. Metal leaching and possibly acidic drainage from the tailings remaining in the tailings pond was to be mitigated by provision of continuous water treatment for a period of at least one hundred years. The cost of this water treatment was estimated to be $167,000 per year for the first 7 years after closure and thereafter $147,000 per year. The net present value of this treatment cost was calculated to be $5.9 million, based on a discount rate of 2.75%.

The following assessment examines the potential for relocation of all of the tailings and stockpiled sulphide ore and a portion of the waste rock into the pit. It is expected that rehandling the tailings into the pit would result in mining of some of the native soils in the impoundment area. An allowance of 5% of the volume of tailings is used here. In addition, the storage volume should include a water cover of at least 1.5 m depth. No allowance for tailings filling the voids in the rock has been made. The estimated quantities of these materials are:

Material	Volume
tailings	250,000 m^3
native soil rehandled with tailings, at 5% of tailings	12,500 m^3
sulphide ore	40,000 m^3
waste rock	15,000 m^3
water cover (1.5 m @ 1260 m elevation)	35,000 m^3
Total	342,500 m^3

B.Y.G. has submitted a current pit plan, dated Nov. 21, 1998. This plan has been used to develop a height-storage volume curve, as shown in Figure 1. The curve assumes that a dam up to 10 m high would be constructed in the south access to the pit. The dam would be located about 50 south of the top of the current ramp to the pit floor.

Based on the above assumptions, the capacity of the pit up to the 1260 contour line is 312,000 m^3. This represents the maximum potential capacity of the pit as the north rim is located between 1260 and 1261 m elevation. Rock conditions in this area may necessitate a slightly lower fill elevation and consequently a small storage capacity. Each metre of storage lost at the 1260 m elevation reduces the storage capacity by 23,500 m^3.

It may be possible to store all of the problem materials in the pit if the some or all of following assumptions can be realized:

- some of the tailings could be pumped into the underground workings,
- some of the tailings are stored in the void space of the waste rock,
- careful mining of the tailings reduces the volume of incorporated native soils, and,
- the water cover could be reduced to 1.0 m.

Even if not all of the materials could be stored in the pit, it is possible the small quantity of material remaining in the tailings pond may not require perpetual water treatment.

A revised assessment of the cost of mine closure has been prepared based on the following assumptions:

- all of the tailings are hydraulically mined and pumped into the pit,
- the tailings will be treated before discharge into the pit to reduce cyanide and ammonia concentrations and stabilize arsenic,
- supernatant from the pit will be returned to the tailings pond for ongoing mining of the tailings,
- processing of the 250,000 m^3 of tailings will require treatment of up to 1,000,000 m^3 of water,
- a dam composed of a compacted till and non-acid generating rock with filter zones will be constructed in the south access to the pit,
- till for the dam will be imported from within 20 km of the mine,
- the dam will be 12 m high and 17.5 m wide,
- foundation preparation and grouting of the rock will be required at the dam location,
- grouting will be required to reduce seepage at the north end of the pit,
- a rock spillway will be constructed to drain overflow from the pit, and,
- following removal of the tailings, the dam and the diversion channel will be breached.

The above assumptions have been used in re-assessing the cost for closure of the Mt. Nansen Mine. The new cost estimate has been made using the RECLAIM model, and the detailed results are attached.

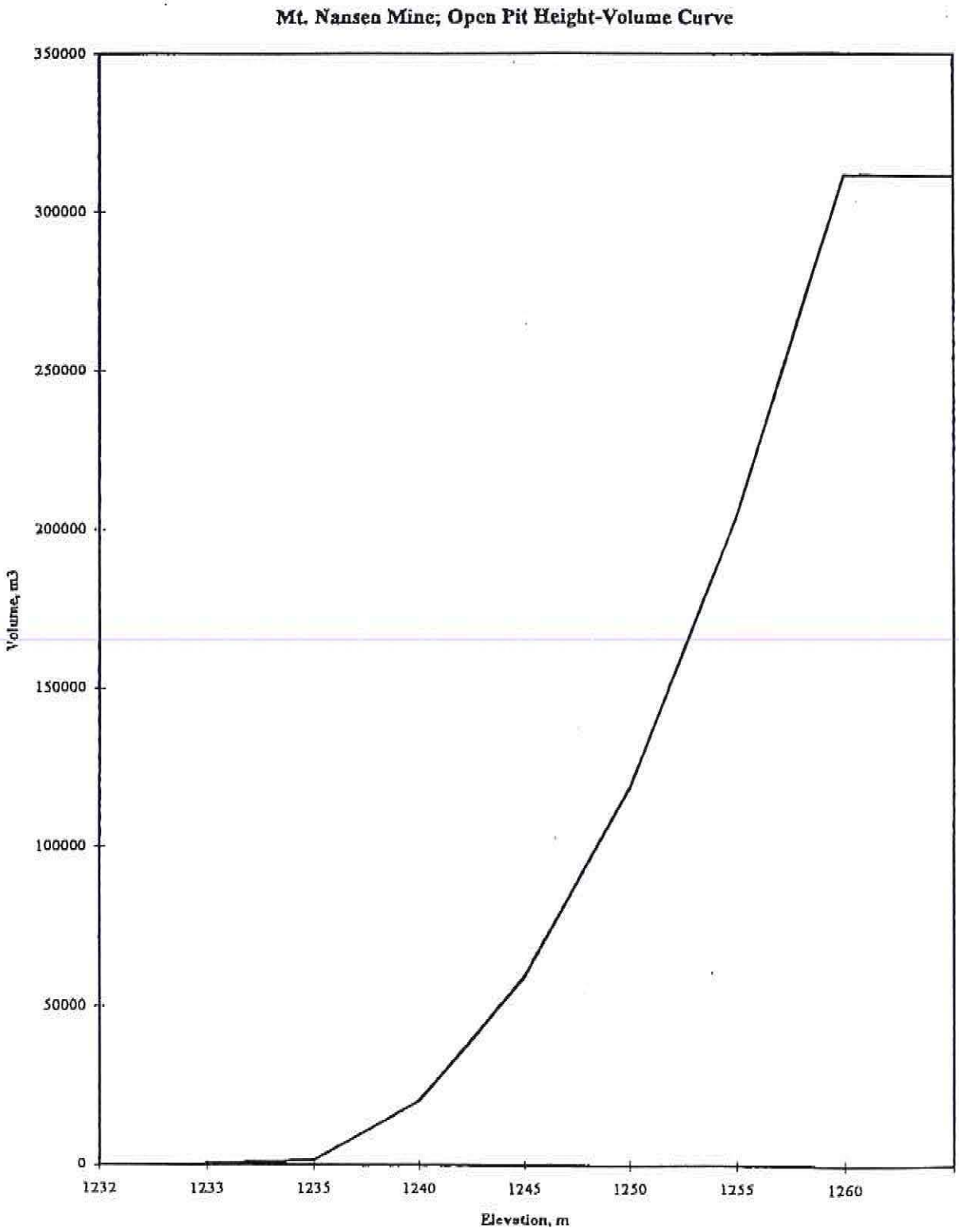
This revised reclamation cost estimate is based on a number of slightly favorable assumptions regarding dam construction and pit storage capacity. In addition, no work has been conducted to substantiate the estimated cost of \$3.65/m^3 for hydraulic mining of the tailings and pumping to the pit. The treatment cost and volume of water involved in

this process is also presented as "order of magnitude" only and should be examined in more detail. The estimated cost for mine closure based on relocation of mine wastes to the pit is $4,213,000. Considering the above assumptions and qualifications, this value should be considered as only indicative of pit disposal being a more cost effective solution to mine closure.

I trust that this letter addresses your current requirements. Please call me if you require additional comments or clarification.

Yours truly,
Brodie Consulting Ltd.

M.J. Brodie, P.Eng.



Pit capacity based on pit plan, Nov. 21, 1998

RECLAMATION COST SUMMARY

PROJECT NAME: **Mt. Nansen Mine**

BEST ESTIMATE FOR UNIT COSTS 15-Dec-98

CAPITAL COST COMPONENT NAME	COMPONENT TYPE		TOTAL COST
	OPEN PIT		$415,401
	UNDERGROUND MINE		$230
	TAILINGS IMPOUNDMENT		$1,056,164
	ROCK PILE		$351,671
	BUILDINGS AND EQUIPMENT		$121,130
	CHEMICALS & CONTAM. SOILS		$36,748
	WATER MANAGEMENT		$1,200,000
	MOBILIZATION/DEMOBILIZATION		$36,756
SUBTOTAL			**$3,218,100**
PROJECT MANAGEMENT	3	% of subtotal	$96,543
ENGINEERING		% of subtotal	$0
CONTINGENCY	25	% of subtotal	$804,525
GRAND TOTAL - CAPITAL COSTS			**$4,119,167**
MONITORING & MAINTENANCE, years 8 -100	$94,000		
			$94,000
TOTAL - CAPITAL & ANNUAL ONGOING COSTS			**$4,213,167**

CHARACTERISTICS OF IMPOUNDED TAILINGS AT MOUNT NANSEN, YUKON TERRITORY – IMPLICATION FOR REMEDIATION

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Natural Resources Canada, Ottawa, Ontario, Canada

ABSTRACT

The Mount Nansen gold property is located in southwestern Yukon, about 180 km north of Whitehorse. Less than two years of recent open-pit mining at the site has left approximately 250,000 tonnes of arsenic- and cyanide-bearing tailings impounded in a facility with questionable long-term physical stability. A recent characterization study has revealed the detailed physical and chemical properties of the impounded tailings and permafrost distribution in the impoundment. The current tailings system appears to be chemically stable with improving water qualities. Only the thiocyanate and ammonia levels in the ponded water and seepage may continue to be of concern in the medium term. However, there is a potential for remobilization of cyanide related or derived species and trace elements like arsenic, antimony and perhaps zinc if the tailings are disturbed. In the light of the newly acquired information, three options for final decommissioning of the tailings are examined. The options include retention in the existing but improved impoundment, relocation to the open pit and surface disposal as a cementitious paste. More detailed information, particularly on the hydrology and hydrogeology of the open pit area and the vicinity of the tailings impoundment, is required to devise an appropriate scheme for final closure of the site.

Key Words: Tailings characteristics, arsenic, cyanide, decommissioning alternatives, Mount Nansen, Yukon.

INTRODUCTION

The Mount Nansen property hosting epithermal gold mineralization is located approximately 60 km west of the Village of Carmacks and 180 km north of the City of Whitehorse in the Yukon Territory, Canada. BYG Natural Resources Inc. operated an open pit mine at the property between November 1997 and February 1999, using cyanidation for gold extraction. The operator went bankrupt in July 1999, leaving significant environmental liabilities, especially in terms of approximately 250,000 tonnes of cyanide- and arsenic-bearing tailings impounded in a management facility with doubtful physical stability. Since mine abandonment, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, has assumed the task of site maintenance to reduce the risks and potential serious environmental impacts of tailings impoundment failure or uncontrolled discharge of potentially deleterious tailings water.

To facilitate developing proper strategies for final closure of the abandoned site, a detailed tailings characterization study has been completed at the CANMET Mining and Mineral Sciences Laboratories (Kwong et al., 2002). The detailed assessment work on the short- and long-term chemical stability of the impounded tailings has been presented and documented elsewhere (Kwong et al., 2003). This paper aims to highlight the relevant physical and chemical properties of the impounded tailings and discuss their implications for long-term safe placement of the tailings.

PHYSICAL CHARACTERISTICS OF THE MOUNT NANSEN TAILINGS

Tailings types and impoundment settings: Tailings generated from the recent mining operation at the Mount Nansen property are impounded in a tailings facility measured about 200 m by 200 m, which was constructed across a broad valley behind an earth dam keyed into the underlying permafrost. For systematic tailings sampling, 19 holes spread over the impoundment and varying from 2.4 to 9.7 m deep were drilled using a sonic device (Vibra-Corer). Based on their apparent contrasts in mineralogy, color and texture observed during field core logging, the impounded tailings are divided into four main types with their relative abundance by volume described as follows:

1. Oxide silt, 35.0%
2. Oxide clayey silt, 29.8%
3. Sulfide-rich silt, 16.5%
4. Sulfide-rich clayey silt, 18.7%

The coarser tailings (oxide and sulfidic silts) typically show a trimodal distribution with a mean particle size ranging from 30 to 119 µm and modes varying at 55-142, 6-7 and 0.4-0.5 µm, respectively. The finer tailings (oxide and sulfidic clayey silts) typically exhibit a bimodal distribution with a mean grain diameter ranging from 4.8 to 13 µm and modes varying at 4-8 µm and 0.3-0.4 µm, respectively. The sulfide-rich tailings are more widespread in the western half of the impoundment, where the most recent tailings were discharged. The finer tailings (silty clay) tend to be more concentrated in the middle portion of the impoundment where ponded conditions usually occur. In the tailings impoundment as a whole, the depth to permafrost appears to be shallower towards the north edge (3-4 m) rather than the south side (~ 7 m). However, the greatest depth to permafrost is apparently near the seepage return to the impoundment, where no frozen ground has been encountered at the drilled depth of 8.8 m. A typical north-south cross section of the impoundment is shown in Figure 1.

Amenability to form cementitious paste: Because of their fine grain size, most of the clayey tailings did not readily bleed water upon retrieval from the cores but exhibited a plastic behaviour. To investigate if they can be converted to a cementitious paste for surface disposal, samples of the oxide clayey tailings were mixed with 8% by weight of Portland cement (Type 10) and sufficient water and the mixtures were cast into paste cylinders for further physical and leach testing. Preliminary results showed that although the paste cylinders readily solidified within a week, it did not appear to develop any cohesive strength. Even after a curing period of seven weeks, subsamples of the paste cylinders became totally disintegrated upon gentle rolling overnight in distilled water during leach testing. Arsenic leaching from the paste material, however, was relatively insignificant compared to that observed in testing with raw tailings.

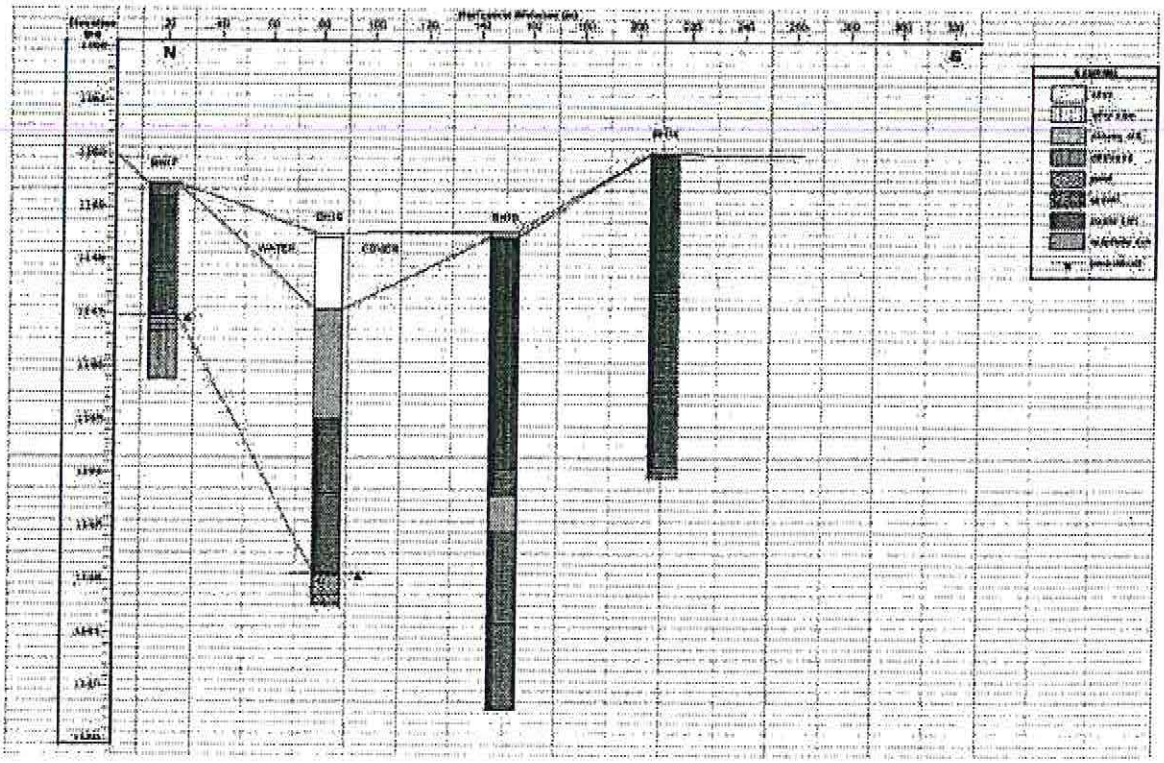

Figure 1. A north-south cross section of the tailings impoundment at Mount Nansen showing the distribution of tailings types and permafrost.

Chemical Characteristics of the Impounded Tailings

Geochemistry: The Mount Nansen tailings are heterogeneous in composition with anomalous contents of arsenic (up to 0.6%), copper (up to 0.06%), lead (up to 0.6%), antimony (up to 0.1%) and zinc (up to 0.3%). The total cyanide (Total CN) content ranges from 5 to 165 µg/g with most of the high values associated with the fine suflidic tails. Furthermore, the clayey tailings are more enriched in arsenic, manganese, lead, zinc and, to a lesser extent, in iron and potassium as well as slightly impoverished in total sulfur (Total S) than the silty varieties. The sulfidic tailings, on the other hand, are only marginally higher in Total S content than the oxide tailings regardless of grain size. The average concentrations of Total CN in the tailings solids and two CN species and selected dissolved metals in the porewaters of the four tailings types are depicted in Figure 2. The relatively high dissolved copper contents (averaging 3.6-6.5 mg/L) apparently correlate with the dissolved cyanide concentrations, indicating the occurrence of copper cyanide complexes in the tailings porewaters. The fact that little copper has been detected in the overlying water in the tailings pond suggests the natural disintegration of the complexes in an active oxidation environment, resulting in the precipitation or sorption of the released copper at the tailings surface.

With regard to the potential for generation of acidic drainage, the impounded tailings can all be classified as moderately acid-generating with a net neutralization potential (NNP) ranging from -12 to -52 kg $CaCO_3$/tonne. The sulfide-sulfur content does not exceed 4 % by weight in any of the 40 samples analyzed. Apparently the oxide tailings, regardless of grain size, are relatively depleted in carbonates while the finer tails, especially the oxide clayey tailings, are relatively impoverished in sulfide-sulfur. The native sediments underlying the impoundment, with a NNP value up to 20 kg $CaCO_3$/tonne, appear to have some inherent acid buffering capacity.

Mineralogy: Mineralogically the tailings are also heterogeneous in their make-up. The coarser tailings generally contain more quartz and less sericite than the finer tailings. Alkali feldspar occurs in subordinate amounts, which tends to be more concentrated in the sulfidic tailings. The most abundant sulfide mineral observed in the tailings is pyrite, which amounts up to 5% by volume. Most of the minor arsenopyrite detected has been altered to scorodite. Because of the common encapsulation of sulfides in coarse quartz particles in all the tailings types, the sulfidic tailings show only marginally more sulfides than the oxide tailings. In addition to iron oxyhydroxide, jarosite occurs as a common secondary mineral in the tailings. Other minor to trace minerals identified include kaolinite, gypsum, calcite, ankerite, manganese oxide, albite, sphalerite, galena, chalcopyrite, covellite, argentite, bournonite, rutile, ilmenite, apatite, epidote, monazite, zircon and a couple of unknown sulfosalts.

Leachability: As detailed in Kwong et al. (2003), the impounded tailings at the Mount Nansen property appear to represent a relatively stable chemical system, the water quality of which is expected to improve with time. Column testing with the coarser tailings simulating four different tailings disposal scenarios has demonstrated a potential for mobilization of thiocyanate, ammonia and arsenic in the tailings porewater and overlying water at undesirable concentrations. Sequential batch leach testing of the clayey tailings using the procedure of Filipek (1999) has shown that arsenic and antimony are susceptible to be released. The results of a partial sequential extraction analysis of the four tailings types using a procedure modified after Hall et al. (1996) indicate that arsenic and zinc are the most readily released trace elements occurring in the tailings. However, as demonstrated by recent site monitoring results, only the thiocyanate and ammonia levels in the tailings pond water and porewater may remain a concern for the medium term if new technology cannot be developed to enhance their removal.

Decommissioning Alternatives

Upon reviewing the remnant economic potential of the Mount Nansen property and the outstanding environmental and reclamation issues, Strathcona Mineral Services Ltd. (2000) suggested two possible options for the long-term disposal of the impounded tailings. These are: (1) retention in the current impoundment with improvement made on the facility; and, (2) transfer and redeposition of the tailings in the nearby open pit. If the tailings can readily be converted to a stable cementitious paste, a third option that should perhaps be considered is surface disposal as a paste. These alternatives are discussed below in the light of the newly acquired information

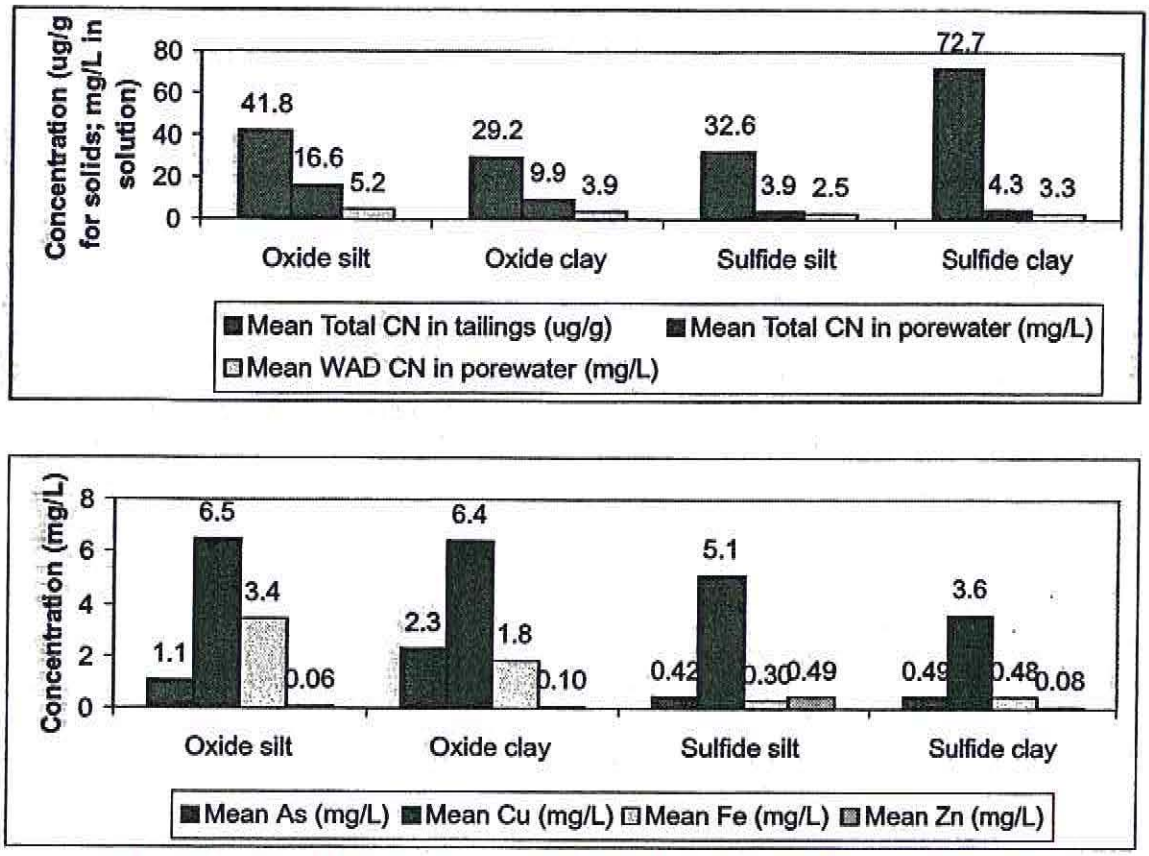

Figure 2. Average Total CN concentration in the tailings solids and selected porewater chemistry in the four types of tailings identified at Mount Nansen.

on the physical and chemical characteristics of the impounded tailings.

Retention in the current impoundment: The most recent tailings sampling campaign has shown that the impoundment is largely contained by permafrost except in the vicinity of portions of the tailings dam (Kwong et al., 2002). As such, the tailings impoundment is apparently isolated from the regional groundwater flow system. Contaminant transport from the impounded tailings is dominated by surface runoff, controlled discharge and limited local seepage. Although anomalous levels of ammonia and thiocyanate in the tailings pond water and seepage currently pose toxicity concerns, historic and on-going site monitoring data as well as the results of various recent laboratory testing suggest that the system is chemically stable and the water quality is improving (Kwong et al., 2002). For the two relatively mobile elements, arsenic and zinc, elevated concentrations of dissolved arsenic are restricted to the tailings porewater and there is no evidence of significant zinc leaching currently occurring in the impoundment. Given the relatively low acid generating potential of the impounded tailings, retaining them in the existing impoundment is a viable long-term solution from a chemical stability viewpoint. This is especially true if means can be devised to reduce ammonia and thiocyanate concentrations to acceptable levels in the tailings pond water and seepage.

The two primary concerns with respect to retaining the tailings in the existing impoundment are (i) the physical stability of the tailings containment dam and (ii) the rapid erosion of the diversion ditches (Water Resources Division, INAC, Whitehorse, personal communication, October, 2001). The tailings dam was designed as a compacted earth dam keyed into permafrost. Its physical integrity, according to the original design, required the initial emplacement of

tailings to press a low-permeability geomembrane against the dam and no water resting directly against the dam structure for 50 m on the upstream side (Klohn Crippen Consultants Ltd., 1995). Both design criteria were apparently ignored when tailings were first placed in the impoundment. This has resulted in partial thawing of permafrost beneath the dam as is evidenced from recent coring and doubts if the dam can survive a relatively serious seismic event. Thus, unless innovative ways can be found to reinforce the tailings dam and to ameliorate erosion of the diversion ditches, the impoundment may not be safely maintained for perpetuity.

Transfer of the impounded tailings to the open pit: Although relocating the impounded tailings and redepositing them in the open pit will eliminate the concern of a potentially unsafe tailings dam, the process will expose the tailings to an entirely new environment. Both column studies with coarse tailings and batch leach tests with fine clayey tails have demonstrated potential mobilization of arsenic, antimony and some weakly sorbed cyanide-related species with disturbance of the tailings. While some free cyanide and weak acid dissociable cyanide may escape during tailings transport, additional loads of thiocyanate and ammonia are likely to be generated at the same time by continual oxidation of the contained cyanide. If the transport medium is eventually contaminated with excessive trace elements and potentially hazardous cyanide-related compounds and their derivatives, the medium has to be impounded and treated before discharge.
In the absence of detailed information on the local hydrology and hydrogeology of the open pit, the post-deposition environmental setting for the transferred tailings is largely unknown. If a relatively deep water cover eventually forms such that reducing conditions start to develop at the tailings/water interface, dissolution of the amorphous iron and manganese oxides and oxyhydroxides may occur, releasing the associated trace elements to the water column. If unsaturated conditions prevail, then oxidation of the remnant sulfides may occur, giving rise to acid generation and metal leaching. In contrast to the tailings impoundment, it is not known if the open pit is isolated from the regional groundwater flow system. If it is not and no measure is taken to prevent the interaction between the tailings porewater and groundwater, contamination of the latter with trace metals like arsenic and antimony as well as various cyanide-related species seems probable following the relocation of the impounded tailings.

Surface disposal as a cementitious paste: Although recent research has demonstrated that cementitious paste with designed cured strength can readily be prepared from cycloned tailings for underground backfill and surface disposal applications (Bloss, 1998; Landriault et al., 1997), paste making using fine tailings remains a challenge. Preliminary testing with clayey tailings from Mount Nansen has shown that while it is possible to cast them into any self-standing forms, the cementitious paste does not possess sufficient cohesive strength to withstand any significant agitation. Consequently, although converting the fine tailings into cementitious paste helps to suppress metal leaching, it is unlikely that the paste can survive mechanical weathering when placed in an unconfined environment. However, since the distribution of coarse and fine tailings in the impoundment has been fairly well delineated during the sampling campaign, the acquired information allows consideration of variations to the themes of maintaining the existing impoundment and in-pit disposal discussed above. For example, if it is technically feasible from an engineering perspective, the coarser tailings concentrated at the eastern and southern portions of the impoundment may be selectively excavated and made into cementitious material for disposal in the open pit or reinforcement of the upstream side of tailings containment dam. Alternatively, low-permeability cementitious paste can perhaps be prepared using the coarser tailings to line the open pit. Afterwards, the remainder of the tailings may be transferred there with or without cementitious amendments. In any case, a thorough understanding of the local hydrology and hydrogeology of the open pit area and the immediate vicinity of the tailings impoundment is required for further evaluation of various applicable options.

SUMMARY AND CONCLUSIONS

In recapitulation, less than two years of open-pit mining at the Mount Nansen has left the property with approximately 250,000 tonnes of arsenic- and cyanide-rich tailings impounded in a facility with questionable physical integrity. Although the existing tailings system appears to be chemically stable with improving water qualities, various chemical

assessments have indicated potential mobilization of cyanide-related species, arsenic, antimony and perhaps also zinc if the tailings are disturbed. Options being considered for tailings management for final mine closure include retention in the existing impoundment with modifications, relocation to the open pit and surface disposal as a cementitious paste. Each option is beset with challenges. More detailed information, especially that on the local hydrology and hydrogeology of the pit area and the vicinity of the tailings impoundment, is required to devise an appropriate scheme for decommissioning the site.

ACKNOWLEDGEMENTS

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REFERENCES

Bloss, M. (Ed.), 1998: Minefill'98, Proceedings of the Sixth International Symposium on Mining with Backfill, Australian Institute of Mining and Metallurgy, Brisbane, Australia.

Filipek, L.H., 1999: Determination of the source and pathway of cyanide-bearing mine water seepage. In: *The Environmental Geochemistry of Mineral Deposits, Part B: Case Studies and Research Topics* (L.H. Filipek and G.S. Plumlee, eds.), Reviews in Economic Geology, Volume 6B, pp.549-565.

Hall, G.E.M., Gauthier, G., Pelchat, J-C, Pelcha and Vaive, J.E. 1996: Application of a sequential extraction scheme to ten geological certified reference materials for the determination of 20 elements. *Journal of Analytical Atomic Spectrometry* **11**: 787-796.

Klohn-Crippen Consultants Ltd., August 1995: Tailings Impoundment – Final Design Report. Prepared for BYG Natural Resources Inc.

Kwong, Y.T.J., Kapoor, A. and Fiset, J-F. 2002: Assessment of chemical stability of impounded tailings at Mount Nansen, Yukon Territory. CANMET mining and Mineral Sciences Laboratories, Report MMSL 02-011(CR), Natural Resources Canada, Ottawa.

Kwong, Y.T.J., Kapoor, A., Fiset, J-F., and McAlpine, B. 2003: Assessment of chemical stability of the impounded tailings at Mount Nansen, Yukon Territory. Proceedings of the 7th International Symposium on Mining in the Arctic, March 30 – April 2, 2003, Iqaluit, Nanuvut, Canada, Canadian Institute of Mining, Metallurgy and Petroleum, Montreal (in print).

Landriault, D., Verburg, R., Cincilla, W. and Wel C., 1997: Paste technology for underground backfill and surface tailings disposal applications, Short Course Notes, CIM Technical Workshop – April 27, 1997, Vancouver, British Columbia, Canada.

Strathcona Mineral Services Limited. 2000: A Review of the Mt. Nansen Property, Yukon Territory. Prepared for Department of Indian Affairs and Northern Development, December 2000.