

ENVIRONMENTAL PROTECTION BRANCH
ENVIRONMENTAL PROTECTION SERVICE
PACIFIC REGION

COMPLIANCE EVALUATION
OF NORTHAIR MINES LTD. (N.P.L.),
BRANDYWINE, BRITISH COLUMBIA

78-15

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ABSTRACT

During the period from August 15-17, 1977 the Environmental Protection Service carried out a monitoring study of the effluent discharges from Northair Mines Ltd. (N.P.L.). The purpose of this study was to determine the state of compliance of the mine effluent discharges with respect to the requirements of the Federal Metal Mining Liquid Effluent Guidelines.

The activities involved in this study included the following:

- 1) collecting composite samples of the effluent discharges over a period of three consecutive days.
- 2) analyzing the effluent samples for a number of chemical parameters.
- 3) carrying out bioassay analyses on the collected samples.
- 4) collecting other information as necessary to assist in evaluating the state of compliance of the mine.

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LIST OF ABBREVIATIONS AND DEFINITIONS

D	Dissolved
I.G.P.D.	Imperial Gallons per Day
L	Less Than
ml	Millilitres
mg/l	Milligrams per Litre
T	Total
t.p.d	Tons per Day
Reference Mine Production Rate -	The greater of the design rated capacity and the maximum average annual production rate ever achieved during the operating life of the mine prior to February 25, 1977.

CONCLUSIONS

Based on the data collected at Northair Mines Ltd.(N.P.L.) from August 15 to 17, 1977 the following conclusions are presented:

1. The tailings pond supernatant was in compliance with all parameters of the federal guidelines on all three days.
2. Effluent from the settling pond for the 3250 foot adit minewater (which was augmented by treated minewater from the 3500 foot adit) was out of compliance with the federal guideline requirements for:
 - a) lead on Days 1 and 3,
 - b) zinc on Day 1, and
 - c) total suspended solids (NFR) on Days 1 and 3.
3. Effluent from the second of the two settling ponds for the 3500 foot adit minewater was out of compliance with the federal guideline requirements for lead on Day 1.
4. Minewater from the 3700 foot adit was out of compliance with the federal guideline requirements for:
 - a) toxicity on Day 2,
 - b) lead on Days 2 and 3,
 - c) zinc on Day 3, and
 - d) NFR on Days 2 and 3.

1 INTRODUCTION

On February 25, 1977 the Federal Metal Mining Liquid Effluent Regulations and Guidelines were promulgated (1). These documents were developed pursuant to Section 33 and 34 of the Fisheries Act. The requirements defined in these documents are based on best practicable technology and apply uniformly as national baseline requirements. The Regulations apply to every new, expanded and reopened base metal, uranium and iron ore mine, while the Guidelines apply to existing base metal, uranium and iron ore mines (1). These control requirements were developed by a Task Force consisting of representatives of the mining industry, and provincial and federal government regulatory agencies. The Environmental Protection Service was responsible for the overall co-ordination of all the necessary inputs required to develop the national effluent controls.

Following promulgation of these guidelines, EPS Pacific Region undertook a review of all operating metal mines in the Region (B.C. and Yukon), to determine the state of compliance of each operation. The review indicated that 14 mines operated tailings impoundment systems such that there was no positive discharge of effluent to a receiving body of water and therefore were in compliance with federal guidelines. Four mines discharged unconfined tailings and were obviously out of compliance with federal requirements. The remaining seven mines operated a tailings impoundment system and discharged supernatant into a receiving body of water, and could thus be in or out of compliance depending upon the quality of the effluent being discharged.

In order to complete the assessment of the status of compliance for all mining operations in the Pacific Region, EPS carried out effluent surveillance studies for compliance verification at all 7 mines (five in B.C., and two in the Yukon), which discharged tailings pond supernatant to a receiving body of water. This report is an account of the effluent surveillance study conducted on August 15, 16 and 17, 1977 at Northair Mines Ltd. (N.P.L.) north of Squamish, British Columbia.

The following report includes a description of the mine, the procedures and methods in the study, the results obtained and a determination of the state of compliance of this mine with the federal guidelines.

2 MINE DESCRIPTION

2.1 General Information

Northair Mines Ltd. (N.P.L.) is located 35 miles north of Squamish, B.C. (Figure 1). The mine consists of three zones - the Warman, Manifold, and more recently, Discovery Veins. These have been developed from adits at the 3500, 3700, and 3250 foot levels respectively. Known ore reserves for the mine total 330 637 tons averaging .369 oz gold/ton, 4.56 ozs silver/ton, 2.72% lead and 4.06% zinc. The ores, in order of abundance, are pyrite, sphalerite, galena, chalcopyrite, native gold, and electrum. At a milling rate of 300 t.p.d. the mine's anticipated life is 4-1/2 to 5 years.

The reference mine production rate, based on the design rated capacity, is 124 100 dry tons of ore per year.

2.2 Concentrator Operation

The mill, located near Anomaly Creek on the eastern slope of Callaghan Creek valley, began production of lead-copper, zinc, silver, and gold concentrates in May, 1976, from ore from the Warman and Manifold zones.

Ore is transported to the mill and ground to 60-70% minus 200 mesh. Differential flotation is employed to produce lead-copper and zinc concentrates. A jig concentrator is used to remove gold and silver. Flotation reagents used include zinc sulphate, sodium carbonate, copper sulphate, calcium hydroxide, potassium cyanide (used where necessary for zinc sulphide suppression), Polyglycol Frother, Z-200, and Ethyl Zanthate.

As of February 28, 1977, 67 000 tons of ore were milled, producing 26 565 ounces of gold, 186 055 ounces of silver, 926 294 pounds

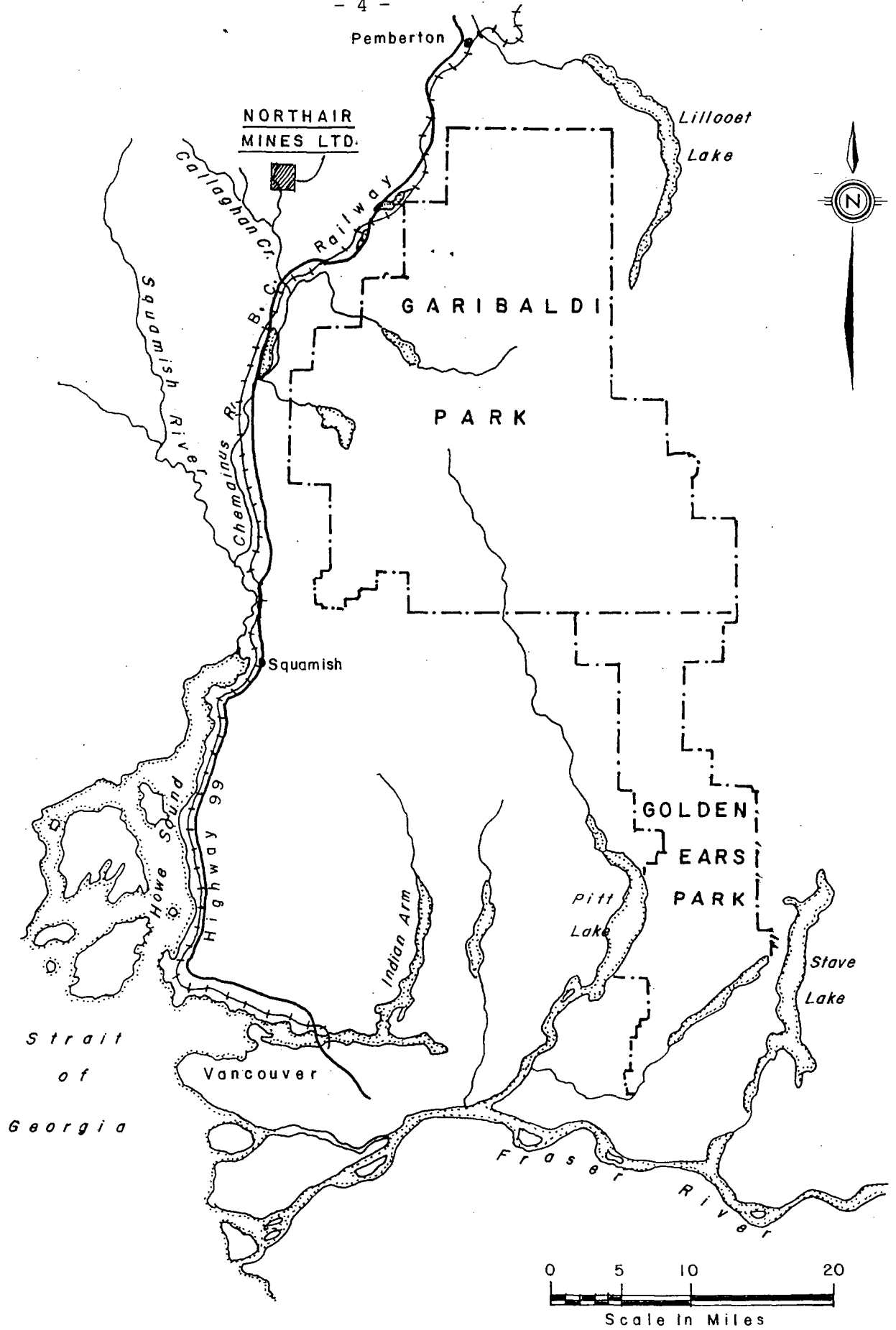


FIGURE 1 LOCATION OF NORTHAIR MINES LTD. (N.P.L.)

of lead, 1 260 306 pounds of zinc, and 1228 pounds of cadmium. No figure are available for copper prior to April, 1978.

The concentrates are trucked to the Cominco Smelter at Trail,
B.C.

3 WASTEWATER SOURCES

At the time of the survey, mine water and surface drainage were the only discharges to Anomaly Creek from the Northair Mines property. The mill recycles its effluent after treatment in a tailings pond and cycloning to remove some of the suspended solids.

It had been planned that a second holding pond would be used to store effluent from the mill and then, after aging, the effluent would be discharged to the Callaghan Creek system. Those plans were dropped, and at the time of the survey, Northair Mines was applying to the Pollution Control Branch to discharge tailings supernatant to nearby Bellamy Lake, and from there to Water Licence Creek at an average rate of 180 000 IGPD. The tailings pond also receives chlorinated sewage effluent from a secondary treatment plant.

The mill uses approximately 180 000 IGPD of water, primarily in the grinding operation and the flotation circuits. In the grinding circuit, water is used to facilitate grinding and classification. In the flotation circuit, water is used for adjustment of the solids level in the flotation feed and for the reagent solutions.

Mine water consists of groundwater and drilling water and discharges from the Discovery, 3250, 3500, and 3700 adits of 1 425 000 IGPD to Anomaly Creek. At the time of the survey, mine water from 3250 and 3500 adits was being treated by settling ponds, but discharges from the Discovery and 3700 adits were not being treated.

4 SAMPLING AND ANALYTICAL METHODS

4.1 Sampling Program

Time proportional 10 hour composite samples were collected at the following points:

1. Tailings pond decant;
2. 3250 adit settling pond outlet;
3. 3500 adit second settling pond outlet; and
4. 3700 adit

The Discovery adit was not sampled. The sampling point locations are illustrated in Figure 2.

Ten hour composite samples were collected once per day for three consecutive days. Aliquots were collected hourly and stored in 30 gallon polyethylene containers.

The effluent stored in the polyethylene container was well mixed prior to sample division. Composite samples for chemical analyses were collected on all three days whereas composite samples for bioassay were collected on the first and second day only. The samples for chemical analysis were preserved according to the Environmental Protection Service, Sampling Handbook as illustrated in Table 1. All samples were received by the Environmental Protection Service Laboratory facilities in North and West Vancouver within 48 hours of collection of the last sample.

4.2 Analytical Methods

Further to the methods outlined in the Environment Canada Laboratory Manual (2), the following notes are added.

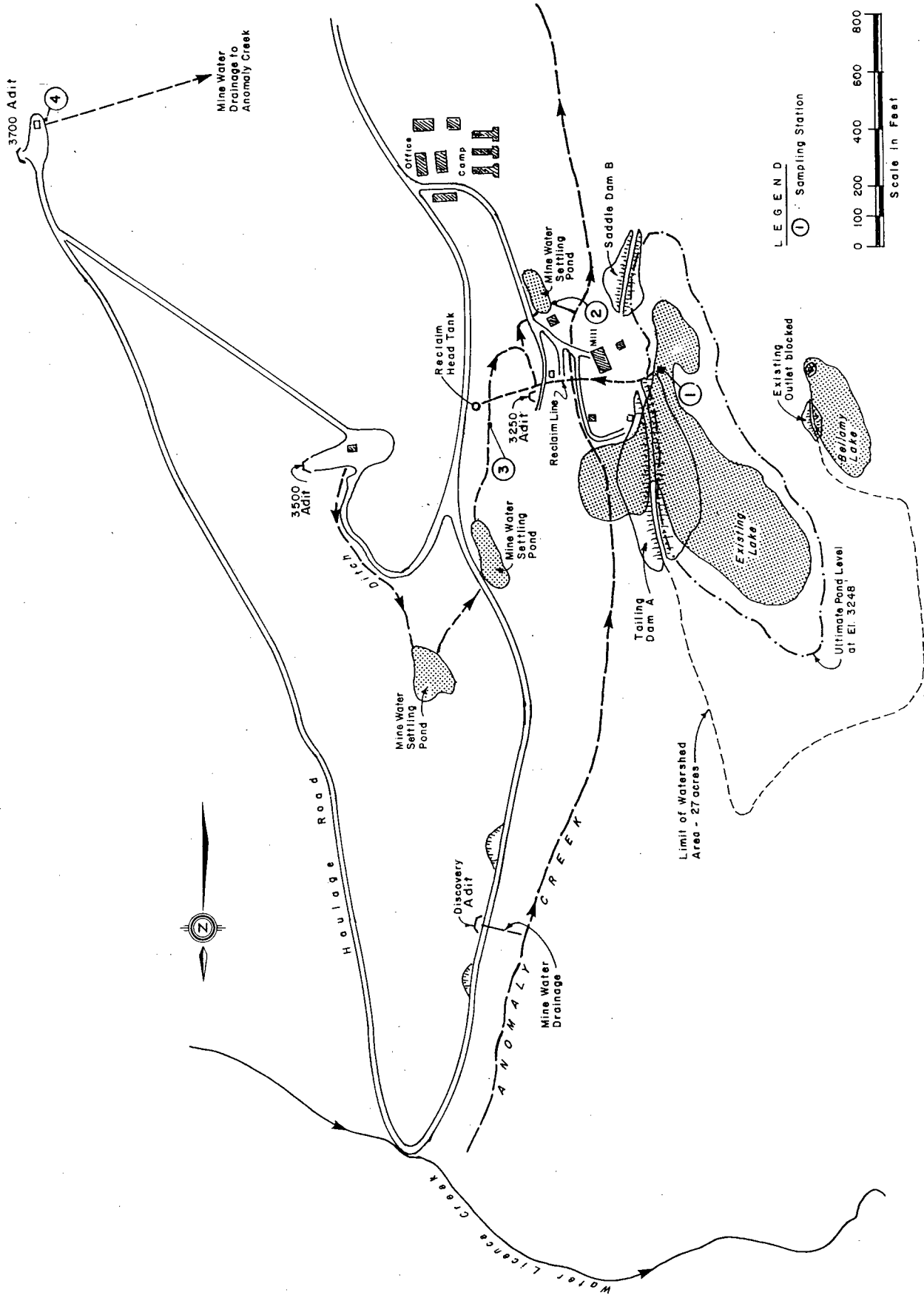


FIGURE 2 NORTHAIR MINE SITE AND SAMPLING LOCATIONS

TABLE 1 SAMPLE CONTAINERS AND PRESERVATION METHODS

Parameter	Type of Container	Preservation
LC ₅₀ (96 hour)	5 gallon Polyethylene jerry cans	none
Total Arsenic	500 ml wide mouth Polyethylene bottle	none
Total Metals (Cu, Cd, Fe, Ni, Pb, and Zn)	100 ml wide mouth Polyethylene bottle	acidified with HNO ₃ to pH 1.5
Total Mercury	100 ml wide mouth Polyethylene bottle	acidified with HNO ₃ to pH 1.5
Dissolved Metals (Cu, Cd, Fe, Ni, Pb, and Zn)	100 ml wide mouth Polyethylene bottle	filtered and acidified with HNO ₃ to pH 1.5
Residues (NFR, TR)	1000 ml wide mouth Polyethylene bottle	none

4.2.1 Bioassay Determination (96 hour LC₅₀). The static fish bioassay gives an approximate value of the biological toxicity of an effluent. It is defined as the concentration or level of a measurable lethal agent required to kill the 50th percentile in a group of test organisms over a period of 96 hours.

The static bioassay test consisted of a series of 30 litre, all-glass test vessels containing different sample dilutions. The test vessels were placed into a controlled environment room where the temperature was maintained at 13 degrees \pm 1°C and the photo period was limited to 16 hours per 24 hours. The samples were continuously aerated throughout the 96 hour test period with oil-free compressed air. Eight to 10 underyearling Rainbow Trout (Salmo gairdneri) were placed in each test vessel. The fish - loading density in each test vessel did not exceed 0.60 grams of fish per litre of test water. The fish mortality versus sample dilution for each test vessel was plotted on a graph and a 96 hour LC₅₀ was established.

4.2.2 Total Metals (Cd, Cu, Fe, Ni, Pb and Zn). The total volume of the sample (approximately 100 ml) was transferred to a beaker. The sample bottle was rinsed with 6 ml hydrochloric acid and 2 ml concentrated nitric acid (aqua regia). This rinse plus deionized water rinses, were added to the sample in the beaker. This solution was evaporated to 50 ml on a hot plate then made up to the original volume with deionized water in the original sample bottle. The samples were then analyzed by direct aspiration on the Jarrell - Ash 810 Atomic Absorption Spectrophotometer with background correction used for Pb, Ni, Cd and Zn. The detection limits are Cd - 0.01 mg/l, Cu - 0.01 mg/l, Fe - 0.03 mg/l, Ni - 0.05 mg/l, Pb - 0.1 mg/l and Zn - 0.01 mg/l.

4.2.3 Dissolved Metals (Cd, Cu, Fe, Ni, Pb and Zn). The samples were filtered through a 45 micron filter and the pH was adjusted in the field to 1.5 with concentrated nitric acid. The samples were analyzed by direct aspiration on the Jarrell - Ash 810 Atomic Absorption

Spectrophotometer for Ni, Cu, Zn, Cd, and Fe. Pb was extracted into methylisobutylketone (MIBK) using ammonium pyrrolidinedithiocarbamate (APDC) and sodium dithiodiethylcarbamate (DDC) complexing agents buffered with sodium acetate. The MIBK extract was analyzed by aspiration on the Jarrell - Ash 810 Atomic Absorption Spectrophotometer. The detection limits are Cd - 0.01 mg/l, Cu - 0.01 mg/l, Fe - 0.03 mg/l, Ni - 0.05 mg/l, Pb - 0.1 mg/l and Zn - 0.01 mg/l.

4.2.4 Total Arsenic (As). A 100 ml aliquot was removed from the sample, 2 ml of concentrated nitric acid was added and the acidified aliquot was then boiled for 10 minutes. Distilled water was added to bring the volume back to the original 100 ml and nickel nitrate was added to fix the arsenic. The arsenic concentration was determined using the Graphite Furnace technique employing a Perkin Elmer Model 306 Atomic Absorption Spectrophotometer equipped with an HGA graphite furnace. The detection limit is 0.001 mg/l.

4.2.5 Total Mercury (Hg). A 60 ml portion of the above aqua regia leached sample was digested with a 1:2 nitric:sulfuric acid mixture. The mercury was then reduced to elemental mercury with a solution of hydrazine sulfate and stannous chloride. The volatilized mercury vapour was passed through an absorption cell and measured on a Jarrell Ash Atomic Absorption Spectrophotometer. The detection limit is 0.0002 mg/l.

4.2.6 Non-Filterable Residues (N.F.R.). Non-filterable residue is that portion of the total residue retained by a GF/C filter. NFR is also referred to as suspended matter or suspended solids.

The sample was filtered through a pre-weighed Gooch crucible containing GF/C filter paper. The crucible was dried at 103°C, cooled, and brought to constant weight, then re-weighed. The increased weight was used to calculate the NFR and the results are reported as mg/l. The minimum amount detectable is 10 mg in a 1 litre sample.

4.2.7 Total Residue (T.R.). Total residue refers to the material left in an evaporating dish after evaporation of the sample.

One hundred ml of the sample was placed in a dried pre-weighed evaporating dish and evaporated at 90°C. The residue was then heated to 103°C for one hour. The dish was cooled, brought to constant weight and then re-weighed. The increase in weight was used to calculate the TR concentration in the sample and reported as mg/l. The minimum amount detectable is 10 mg in a 1 litre sample.

4.2.8 pH Determination. pH is a measure of the H^+ ion concentration.

Numbers above seven indicate basic condition with increasing numerical value. Numbers below seven indicate increasing acidic conditions with decreasing numerical value. pH 7 is neutral.

All pH values quoted in this report are the results of on-site measurements using a Fisher Accumet 107. The Accumet 107 has a precision of ± 0.03 pH units.

5 RESULTS

The results for analyses of the composite samples are presented alongside Federal Guideline requirements in Tables 2 to 5. Sample stations for the tailings pond supernatant, and the mine water discharges from the 3250, 3500 and 3700 adits have been depicted as stations 1 and 4 respectively, in Figure 2.

TABLE 2 NORTHAIR MINES TAILINGS POND SUPERNATANT -
COMPOSITE SAMPLE RESULTS

A. Chemical Analyses

Parameter	Day 1	Day 2	Day 3
As (T) mg/l	L0.001	L0.001	L0.001
Cd (T) mg/l	L0.01	L0.01	L0.01
Cd (D) mg/l	L0.01	L0.01	L0.01
Cu (T) mg/l	0.05	0.04	0.05
Cu (D) mg/l	0.03	0.04	0.04
Fe (T) mg/l	0.52	0.42	0.31
Fe (D) mg/l	L0.03	L0.03	0.03
Hg (T) mg/l	0.0002	0.0005	0.00034
Ni (T) mg/l	L0.05	L0.05	L0.05
Ni (D) mg/l	L0.05	L0.05	L0.05
Pb (T) mg/l	0.15	L0.1	L0.1
Pb (D) mg/l	0.03	0.05	0.07
Zn (T) mg/l	0.23	0.16	0.16
Zn (D) mg/l	0.15	0.10	0.10
N.F.R. mg/l	23	8	L5
T.R. mg/l	450	430	450
pH	8.0	8.0	-

B. Toxicity Determination

	<u>Day 1</u>	<u>Day 2</u>
LC ₅₀ (96 hour)	non-toxic	non-toxic

TABLE 3 NORTHAIR MINES 3250 ADIT - COMPOSITE SAMPLE RESULTS

A. Chemical Analyses

Parameter	Day 1	Day 2	Day 3
As (T) mg/l	0.001	L0.001	L0.001
Cd (T) mg/l	L0.01	L0.01	L0.01
Cd (D) mg/l	L0.01	L0.01	L0.01
Cu (T) mg/l	0.09	0.02	0.06
Cu (D) mg/l	0.05	L0.01	L0.01
Fe (T) mg/l	5.4	1.9	2.9
Fe (D) mg/l	0.07	0.09	0.06
Hg (T) mg/l	0.0004	0.0003	0.0003
Ni (T) mg/l	L0.05	L0.05	L0.05
Ni (D) mg/l	L0.05	L0.05	L0.05
Pb (T) mg/l	0.51	0.20	0.40
Pb (D) mg/l	0.06	0.05	0.07
Zn (T) mg/l	0.77	0.26	0.49
Zn (D) mg/l	1.4*	0.07	0.08
N.F.R. mg/l	77	17	55
T.R. mg/l	500	430	460
pH	8.0	8.0	-

B. Toxicity Determination

	<u>Day 1</u>	<u>Day 2</u>
LC ₅₀ (96 hour)	non-toxic	non-toxic

*The dissolved result is higher than the total result, most likely due to sample contamination.

TABLE 4 NORTHAIR MINES 3500 ADIT - COMPOSITE SAMPLE RESULTS

A. Chemical Analyses

Parameter	Day 1	Day 2	Day 3
As (T) mg/l	L0.001	L0.001	L0.001
Cd (T) mg/l	L0.01	L0.01	L0.01
Cd (D) mg/l	L0.01	L0.01	L0.01
Cu (T) mg/l	0.04	0.03	0.04
Cu (D) mg/l	L0.01	0.01	L0.01
Fe (T) mg/l	2.1	2.0	1.9
Fe (D) mg/l	0.08	0.09	0.04
Hg (T) mg/l	0.0002	0.0004	0.0003
Ni (T) mg/l	L0.05	L0.05	L0.05
Ni (D) mg/l	L0.05	L0.05	L0.05
Pb (T) mg/l	0.31	0.20	0.30
Pb (D) mg/l	0.05	0.08	L0.02
Zn (T) mg/l	0.40	0.29	0.34
Zn (D) mg/l	0.11	0.16	0.10
N.F.R. mg/l	29	17	28
T.R. mg/l	350	310	290
pH	7.9	8.0	-

B. Toxicity Determination

	<u>Day 1</u>	<u>Day 2</u>
LC ₅₀ (96 hour)	non-toxic	non-toxic

TABLE 5 NORTHAIR MINES 3700 ADIT - COMPOSITE SAMPLE RESULTS

A. Chemical Analyses

Parameter	Day 1	Day 2	Day 3
As (T) mg/l	L0.001	L0.001	0.005
Cd (T) mg/l	L0.01	L0.01	L0.01
Cd (D) mg/l	L0.01	L0.01	L0.01
Cu (T) mg/l	0.02	0.14	0.03
Cu (D) mg/l	L0.01	L0.01	0.02
Fe (T) mg/l	1.9	25	42
Fe (D) mg/l	0.03	0.13	0.29
Hg (T) mg/l	0.0003	0.0004	0.0004
Ni (T) mg/l	L0.05	L0.05	L0.05
Ni (D) mg/l	L0.05	L0.05	L0.05
Pb (T) mg/l	0.20	0.63	1.6
Pb (D) mg/l	0.05	L0.02	0.13
Zn (T) mg/l	0.21	0.67	1.8
Zn (D) mg/l	0.08	0.05	0.07
N.F.R. mg/l	26	440	790
T.R. mg/l	230	700	970
pH	8.0	8.0	-

B. Toxicity Determination

	<u>Day 1</u>	<u>Day 2</u>
LC ₅₀ (96 hour)	non-toxic	36%

6 DISCUSSION

A comparison between the effluent monitoring results and the federal guideline requirements is presented in Table 6 to 9.

The tailings pond supernatant met all requirements of the federal guidelines. However, mine water discharges from each of the three adits sampled exceeded at least one of the guideline requirements.

Mine water from the 3250 adit exceeded the federal guideline requirement for lead, zinc, and NFR on Day 1 (0.51 mg/l, 0.77 mg/l, and 77 mg/l respectively) and it exceeded the requirements for lead and NFR on Day 3 (0.40 mg/l and 55 mg/l respectively).

Mine water from the 3500 adit exceeded the federal guideline limit for lead on Day 1, with a total lead concentration of 0.31 mg/l.

Mine water from the 3700 adit met all federal guideline requirements on Day 1, but on Days 2 and 3, work was being done on the drift and the mine water exceeded six parameters of the guidelines. On Day 2, the mine water exceeded the total lead and NFR limits with concentrations of 0.63 mg/l and 440 mg/l respectively. The effluent was also acutely toxic, exhibiting a 96 hour LC_{50} of 36%. The total zinc concentration, at 0.67 mg/l, approached the guideline limit of 0.75 mg/l on the same day, and the dissolved zinc concentration was 0.05 mg/l.

It is not clear what caused the effluent's toxicity, although the NFR may have been directly or indirectly responsible. Elevated NFR levels in the presence of even low concentrations of toxic substances may be lethal.

Although the water from the 3700 adit was not tested for toxicity on the third day of sampling, it did continue to exceed the guideline limits for total lead (1.6 mg/l), total Zinc (1.8 mg/l), and NFR (790 mg/l). It is quite likely that this discharge would have been toxic on the third day as well.

TABLE 6 COMPARISON OF THE TAILINGS POND SUPERNATANT RESULTS WITH FEDERAL GUIDELINES

Parameter	Guideline Requirement	Day 1	Day 2	Day 3
As (T) mg/l	0.75	L0.001	L0.001	L0.001
Cu (T) mg/l	0.45	0.05	0.04	0.05
Pb (T) mg/l	0.30	0.15	L0.1	L0.1
Ni (T) mg/l	0.75	L0.05	L0.05	L0.05
Zn (T) mg/l	0.75	0.23	0.16	0.16
N.F.R. mg/l	37.5	23	8	L5
pH	5.5 minimum	8.0	8.0	-
LC ₅₀ (%)	100	non-toxic	non-toxic	-

TABLE 7 COMPARISON OF 3250 ADIT RESULTS WITH FEDERAL GUIDELINES

Parameter	Guideline Requirement	Day	Day 2	Day 3
As (T) mg/l	0.75	0.001	L0.001	L0.001
Cu (T) mg/l	0.45	0.09	0.02	0.06
Pb (T) mg/l	0.30	0.51	0.20	0.40
Ni (T) mg/l	0.75	L0.05	L0.05	L0.05
Zn (T) mg/l	0.75	0.77	0.26	0.49
N.F.R. mg/l	37.5	77	17	55
pH	5.5 minimum	8.0	8.0	-
LC ₅₀ (%)	100	non-toxic	non-toxic	-

TABLE 8 COMPARISON OF 3500 ADIT RESULTS WITH FEDERAL GUIDELINES

Parameter	Guideline Requirement	Day 1	Day 2	Day 3
As (T) mg/l	0.75	LO.001	LO.001	LO.001
Cu (T) mg/l	0.45	0.04	0.03	0.04
Pb (T) mg/l	0.30	0.31	0.20	0.30
Ni (T) mg/l	0.75	LO.05	LO.05	LO.05
Zn (T) mg/l	0.75	0.40	0.29	0.34
N.F.R. mg/l	37.5	29	17	28
pH	5.5 minimum	7.9	8.0	-
LC ₅₀ (%)	100	non-toxic	non-toxic	-

TABLE 9 COMPARISON OF 3700 ADIT RESULTS WITH FEDERAL GUIDELINES

Parameter	Guideline Requirement	Day	Day 2	Day 3
As (T) mg/l	0.75	LO.001	LO.001	0.005
Cu (T) mg/l	0.45	0.02	0.14	0.03
Pb (T) mg/l	0.30	0.20	0.63	1.6
Ni (T) mg/l	0.75	LO.05	LO.05	LO.05
Zn (T) mg/l	0.75	0.21	0.67	1.8
N.F.R. mg/l	37.5	26	440	790
pH	5.5 minimum	8.0	8.0	-
LC ₅₀ (%)	100	non-toxic	36%	-

REFERENCES

1. Metal Mining Liquid Effluent Regulations and Guidelines, Department of Fisheries and the Environment (1977).
2. Laboratory Procedures, Environmental Protection Service, Pacific Region (1974).