

CLEAN ENVIRONMENT COMMISSION

REPORT ON

PUFFY LAKE GOLD MINE HEARING

JUNE 3, 1988

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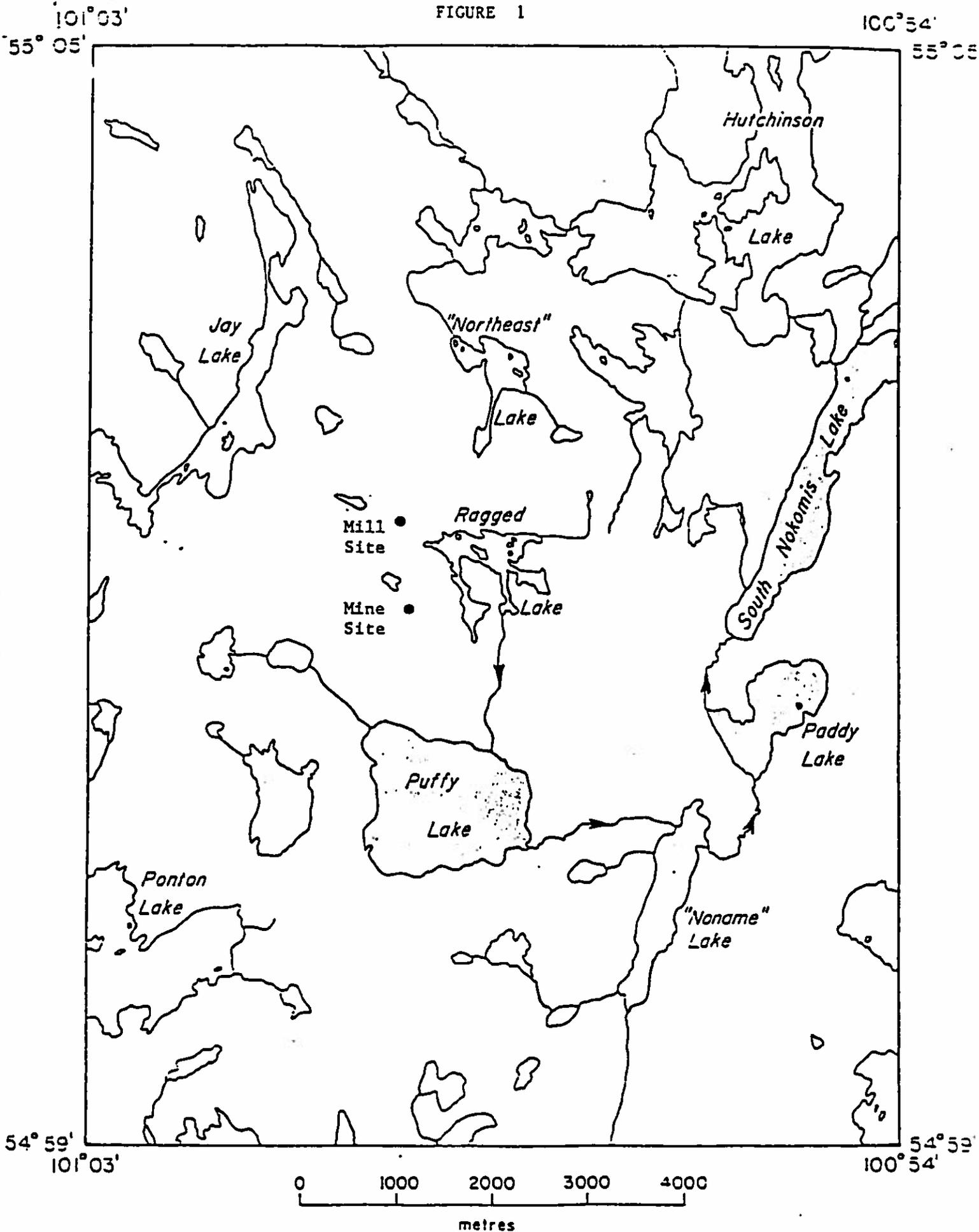
REPORT ON PUFFY LAKE GOLD MINING PROJECT

Background

Pioneer Metals Corporation of Vancouver, B.C., made the decision to bring the Puffy lake ore deposit into production in the fall of 1986. The Puffy Lake project is a gold mining development located 12 kilometres south of Sherridon near Puffy Lake. In addition to an underground mine, there is a 500 ton concentrator which was subsequently upgraded to 1000 tons per day. Production at the operation began in December, 1987 with the first gold being poured in mid December.

Pioneer Metals Corporation registered the Puffy Lake operation with the Environmental Management Division on October 10, 1986 under Section 14(1) of the Clean Environment Act (Chapter C130). Pioneer subsequently submitted a project description and environmental impact assessment to the Environmental Management Division on August 21, 1987. On January 21, 1988, the Environmental Management Division filed a report with recommendations for regulation of the said operation with the Clean Environment Commission. The proposal was advertised by the Commission in the February 9, 1988 edition of the Winnipeg Free Press and the February 11, 1988 edition of the Flin Flon Reminder. Concerns respecting the environmental impact from the operation were received from the Sherridon Community Council and a hearing was advertised to take place on March 22, 1988 at 6:00 p.m. at the Sherridon Community Hall.

FIGURE 1



utilizing trackless vehicles to the stoping areas. Ore is to be hauled from underground to a crusher building located separately from the underground mine site. Fine ore will be conveyed to the mill building nearby. The mill has been designed to handle 1000 tons of ore per day. Further grinding will take place in the mill and the feed thereafter will be transported to flotation cells. Concentrate from these cells will be pumped to cyanidation tanks while the tailings will be used to produce back fill material for the worked out mine or pumped directly to the tailings pond.

The tailings pond is nearby Ragged Lake. Ragged Lake was selected as the tailings area because of its proximity to the mine and mill and its location at the head end of the watershed. Its selection was made with the approval of the Environment Department and the Department of Natural Resources (Fisheries Branch). Application has been made to the Canada Department of Fisheries and Oceans to utilize Ragged Lake for this purpose. This approval awaits the outcome of any concerns that might be addressed at the hearing of the Clean Environment Commission.

The liquid from cyanidation (pregnant solution) is treated to precipitate gold from the solution. Following precipitation, the solids are mixed with flux and charged to a reverbatory furnace to form gold bricks. The first gold brick was poured in December, 1987. Part of the barren bleed solution (the liquid following gold extraction) will be recycled to the leaching circuit whereas the balance will be treated with hydrogen peroxide to destroy residual cyanide before discharge to the tailings basin.

A weir has been constructed to facilitate the regulation and control of effluent from the tailings basin area to the receiving water downstream, known as Puffy Lake. Ragged and Puffy Lakes are headwater lakes in the Burntwood River system. There is apparently sufficient capacity in Ragged Lake to contain the tailings over the present projected life of the mining operation, which is 8 years. The Company is satisfied that the capacity of the lake could be increased to handle the mining operation beyond 8 years, if necessary.

Although the mine is relatively dry, there are mine waters resulting from drilling, transport and the back fill operations. At the onset of operations, these wastes were discharged to an excavated basin and thence to a swampy area nearby. These wastes will be incorporated shortly into the tailings residue area. At present all process water is recycled from Ragged Lake. This program will be continued as fully as possible unless and until the characteristics of this water supply interferes with the milling process.

Of considerable significance to any hard rock mining operation is the potential of the mine tailings to form acids. If this potential exists, precautions must be taken to prevent the impact of leachate from the area on nearby receiving waters, particularly at the time of mine closure. Studies have shown that the Puffy Lake mine wastes do not have acid generating potential.

The principal toxic chemical transported to the mine site is sodium cyanide. The chemical is in the form of a briquet which is encased in durable plastic double bags with lifting straps and packaged in plywood crates. The local truck transporter conveys the material to the site. This transportation would be covered under the regulation, "Transportation of Dangerous Goods". Handling and transport of refined petroleum products and propane would also come under this regulation.

Representation by Interveners

The principal spokesmen for the community were the Mayor and a councillor of the Sherridon Community Council. Their concerns were based on the evidence of environmental degradation that persisted adjacent to the community of Sherridon resultant from a base metal mining operation that had left the area about 35 years earlier. Leachate from tailings from this operation continued to discharge heavy metals to the local lake system seriously contaminating water supplies and aquatic life. Although explanations had been offered that the scale of the operation was significantly smaller at Puffy Lake and that the wastes would be regulated to protect the watershed from environmental degradation, there were still fears that a situation similar to that at Sherridon would be created.

In addition to residents from the communities of Sherridon and Cold Lake, letters of concern were received from 2 fishing lodges located near Cranberry Portage who maintain outcamps on South Nokomis Lake. Puffy Lake is linked to No Name Lake and Paddy Lake through a series of small creeks before discharge to South Nokomis Lake (figure 1). Fisheries personnel also substantiated that South Nokomis lake supported a very good trout fishery.

Environment Department Presentation

In their report, the Environmental Management Division identified that the worst case study with respect to the impact of effluent from the tailings residue in Ragged Lake towards Puffy Lake would occur during the winter months. During the winter, run-off and hence dilution of the effluent would be minimal. Ice would occupy part of the volume of the receiving water and natural degradation of cyanide would be inhibited by lower temperatures.

The water quality criteria selected to be met within the mixing zone of Puffy Lake were those published by the Department under title "Manitoba Surface Water Quality Objectives", December 22, 1986. The most restrictive use of Puffy Lake was that of a cool water fishery which is identified as a category 2B in the "Objectives" document. Among the main constituents of concern in the mine and mill effluent are those of the heavy metals copper, zinc, lead and nickel. These metals are part of the ore that is being mined and milled. Arsenic and iron are also present in the ore and cyanide is used in the milling process.

The water quality objectives for the metals, aside from zinc, factor in the hardness of the receiving water. The receiving water hardness is very low (15 mg/l). Lower hardness results in less tolerance of cool water aquatic life to metal contamination.

The water quality objective document also stipulates that in lakes, the volume of a mixing zone should not exceed 10% of the volume of that portion of the receiving water available for mixing. Using this criteria and based on the volume of effluent discharged from the tailings residue basin estimated in the environmental impact assessment produced by Pioneer Metals Corporation and assuming that 50% of the effluent was to be recycled to the mill operation, it was estimated that 0.6 litres of Puffy Lake water would be available to dilute each litre of final effluent from the tailings basin. The outcome of these calculations results in a maximum monthly arithmetic mean concentration of the following substances in the effluent at the final discharge point (a weir in the south-east arm of Ragged Lake).

<u>Contaminant</u>	<u>Maximum Monthly Arithmetic Mean Concentration</u>
Total Arsenic	0.3 mg/l
Total Copper	0.012 mg/l
Total Lead	0.008 mg/l
Total Nickel	0.034 mg/l
Total Zinc	0.07 mg/l
Total Iron	1.4 mg/l
Free Cyanide	0.01 mg/l
Total Cyanide	0.1 mg/l
Total Suspended Matter	25 mg/l

In addition to the limits cited above, the Departmental report presented to the hearings contained a series of clauses recommending limits, terms and conditions governing both the operation of the mining project and its ultimate rehabilitation. These clauses are included in the recommendations section of this report.

Mines Branch Presentation

Mines Branch personnel were present at the hearing. Their written presentation was made following the hearing and circulated to all parties involved at the hearing. The main thrust of the presentation was that Mines Branch policy was to manage and administer mines and minerals development to the benefit of all Manitobans. The other gold mines in Manitoba established in recent times have not made a profit due to ore grade, recovery problems and gold market price fluctuations.

Restrictions in the form of unrealistic and impracticable limits for toxic substances in mining effluents would discourage new mining developments. When limits are recommended that are much below federal guidelines and below any other limits prescribed for a mining operation in Manitoba, the rationale for the limits should be well supported.

Pioneer Metals Corporation Response to Departmental Recommendations

Near the conclusion of the hearing, after the presentation of the recommendations of the Environment Department, Pioneer Metals Corporation agreed to forward information to the Commission as quickly as possible supporting effluent limits that they could meet, utilizing the mining and treatment processes that are in place at their operation. A submission was received a week following the hearing and forwarded to the Environment Department, the community of Sherridon, the Mines Branch, and the Fisheries Branch for comments. No further comment was received from the Environment Department, the Sherridon Council, or the Mines Branch prior to the Commission's final consideration and adoption of this report.

Of particular importance in this submission were a number of factors noted to be at variance with the assumptions made in the Departmental assessment arriving at the dilution factor. The dilution factor governs the recommended allowable level of substances in the effluent. It was noted that the Department had estimated the volume of Puffy lake at 1.6 million cubic metres whereas in the Companies view the actual volume based on bathymetric studies conducted for the Company was closer to 4 million cubic metres. The Company, in its calculations of lake volume, assumed that the maximum depth of 2 metres was the average depth. The Commission in its recalculation of lake volume has compromised this difference and assumed an average depth of 1.5 metres which results in a lake volume of 3.2 million cubic metres. Also, the Department's report, in the absence of other information, based the

recirculation of tailings effluent on a rate of 50% whereas the Company is currently recycling 100% and will continue to do so as long as practicable. This factor together with an assumed Puffy lake volume of 3.2 million cubic metres results in a mixing zone dilution availability of 3.1 to 1 in place of the Environment Department's 0.56 to 1. The lower dilution was employed in the Department's calculation of the ultimate concentration of contaminants in the Puffy Lake mixing zone.

The following table provides a comparison of constituent levels in the effluent at the final discharge point based on the various approaches.

<u>Contaminant</u>	<u>Column I</u> Departmental Recommended Limits Based on Dilution of 0.56:1	<u>Column II</u> Level Based on Dilution of 3.1:1	<u>Column III</u> Pioneer Metals Proposal in Their Submission of March 28
Total Arsenic	0.3 mg/1	1.5 mg/1	0.5 mg/1
Total Copper	0.012 mg/1	0.07 mg/1	0.2 mg/1
Total Lead	0.008 mg/1	0.04 mg/1	0.1 mg/1
Total Nickel	0.034 mg/1	0.2 mg/1	0.1 mg/1
Total Zinc	0.07 mg/1	0.4 mg/1	0.1 mg/1
Total Iron	1.4 mg/1	8.0 mg/1	2.5 mg/1
Free Cyanide	0.01 mg/1	0.06 mg/1	0.15 mg/1
Total Cyanide	0.1 mg/1	0.6 mg/1	0.2 mg/1
Total Suspended Matter	25 mg/1	25 mg/1	25 mg/1

The Commission's recommendation for the maximum monthly arithmetic mean concentration of contaminants in the tailings pond effluent (Recommendations 2(a) Column I) is a combination of the lower of the two values for contaminants listed in Columns II and III above.

In addition to the increased dilution available based on the higher estimated volume of Puffy Lake and the higher rate of effluent recycle, the Company pointed out that the effluent travels through an extensive area of swamp after leaving the final discharge point of Ragged Lake before reaching Puffy Lake (figure 2). Work by Sparling (1) of the University of Manitoba and others have shown that the metals zinc, copper, cadmium and nickel are absorbed to a significant extent by at least one test species of algae. Leland and others (2) described studies where rooted macrophytes accumulated lead. Based on these and many other similar studies, it would not seem unreasonable to consider an increase of the allowable limit for the concentration of metals in the effluent at the discharge point as requested by the company in their March 28 proposal; or, alternatively the lower effluent contaminant values as tabled in Recommendation 2(a) would provide an added safety factor in meeting the water quality objectives in the mixing zone of Puffy Lake. Also, it is likely that further degradation of cyanide would occur in the swamp due to volatilization of cyanide and transformation to non-toxic forms at least during the warm weather periods. The amount that these contaminant values could be increased as a function of the swamp to absorb these contaminants would have to be a judgement based on information available from scientific studies undertaken in either a laboratory or field setting.

Recommendations

The following are recommendations of the Clean Environment Commission based upon evidence submitted to a hearing and presentations received thereafter.

1. (a) The applicant should ensure that at all times all mine and mill process wastewaters discharged into the environment are discharged directly into Ragged Lake, the tailings disposal area.

 (b) The applicant should ensure that any liquid effluent released as overflow from the tailings disposal area into the environment is discharged only through the designated final discharge point.

2. The applicant should ensure that the liquid effluent discharged at the final discharge point is of such quality that:

 (a) the concentrations of the following substances in the effluent are not in excess of the corresponding maximum allowable concentrations shown for those categories listed under Columns I, II, and III of the following table:

<u>Contaminant</u>	<u>Column I</u>	<u>Column II</u>	<u>Column III</u>
	Maximum Monthly Arithmetic Mean Concentration	Maximum Concentration In a Composite Sample	Maximum Concentration In a Grab Sample
Total Arsenic	0.5 mg/1	0.75 mg/1	1.0 mg/1
Total Copper	0.07 mg/1	0.10 mg/1	0.15 mg/1
Total Lead	0.04 mg/1	0.08 mg/1	0.12 mg/1
Total Nickel	0.1 mg/1	0.15 mg/1	0.2 mg/1
Total Zinc	0.1 mg/1	0.15 mg/1	0.2 mg/1
Total Iron	2.5 mg/1	3.75 mg/1	5.0 mg/1
Free Cyanide	0.06 mg/1	0.1 mg/1	0.15 mg/1
Total Cyanide	0.2 mg/1	0.3 mg/1	0.4 mg/1
Total Suspended Matter	25.0 mg/1	37.5 mg/1	50.0 mg/1

and that,

- (b) the pH of the effluent is not below the minimum allowable values shown for those categories listed under Columns I, II, and III of the following table:

<u>Parameter</u>	<u>Column I</u>	<u>Column II</u>	<u>Column III</u>
	Minimum Monthly Arithmetic Mean pH	Minimum pH in a Composite Sample	Minimum pH in a Grab Sample
pH	6.0	5.5	5.0

- (c) the pH of the effluent is not over the maximum allowable values shown for those categories listed under Columns I, II, and III of the following table:

	<u>Column I</u>	<u>Column II</u>	<u>Column III</u>
	Maximum Monthly Arithmetic Mean pH	Maximum pH in a Composite Sample	Maximum pH in a Grab Sample
<u>Parameter</u>			
pH	9.5	10.0	10.5

3. Subject to recommendation # 5, the applicant should ensure that:

- (a) The effluent discharged at the final discharge point is sampled and analyzed for the following substances at no less a frequency than as specified in the table below whereby the applicability of Columns I, II, III, and IV for each listed substance shall be determined on the basis of the arithmetic mean concentration of that substance in the samples of effluent collected and reported in those preceding six months during which discharge occurred:

<u>Contaminant</u>	<u>Column I</u>	<u>Column II</u>	<u>Column III</u>	<u>Column IV</u>
	At Least Weekly If Concentration Is Equal To Or Greater Than	At Least Every Two Weeks If Concentration Is Equal To Or Greater Than	At Least Monthly If Concentration Is Equal to Or Greater Than	At Least Every Six Months If Concentration Is Less Than
Total Arsenic	0.5 mg/l	0.2 mg/l	0.10 mg/l	0.10 mg/l
Total Copper	0.07 mg/l	0.04 mg/l	0.02 mg/l	0.02 mg/l
Total Lead	0.04 mg/l	0.02 mg/l	0.01 mg/l	0.01 mg/l
Total Nickel	0.1 mg/l	0.05 mg/l	0.02 mg/l	0.02 mg/l
Total Zinc	0.1 mg/l	0.05 mg/l	0.02 mg/l	0.02 mg/l
Total Iron	2.5 mg/l	1.0 mg/l	0.5 mg/l	0.5 mg/l
Free Cyanide	0.06 mg/l	0.03 mg/l	0.01 mg/l	0.01 mg/l
Total Cyanide	0.2 mg/l	0.1 mg/l	0.05 mg/l	0.05 mg/l
Total Suspended Matter	25.0 mg/l	20.0 mg/l	15.0 mg/l	15.0 mg/l

and that,

(b) the effluent discharged at the final discharge point is sampled and analyzed for pH at no less a frequency than as specified in the following criteria:

(i) once a week, where the pH of the effluent was less than 5.0 or greater than 10.5 at any time in those preceding six months during which discharge occurred;

(ii) once every two weeks, where the pH of the effluent was between 5.0 and 5.5 or between 9.5 and 10.5 at any time in those preceding six months during which discharge occurred; or

(iii) once a month if (i) and (ii) do not apply.

4. The applicant should ensure that, unless otherwise specified in writing by the Environment Department, the liquid effluent is monitored at the final discharge point once every six months for the following additional parameters:

Total Cadmium	Total Silver
Total Mercury	Total Chromium
Total Ammonia (as N)	Field Temperature and pH

5. The applicant should ensure that the effluent discharged at the final discharge point is sampled and analyzed in such a manner and/or analyzed for such additional parameters and characteristics and/or sampled and analyzed at such frequencies and for such duration of time as may be specified in writing by the Department.

6. The applicant should ensure that the total volume of effluent discharged at the final discharge point is determined monthly by a method of measurement or estimation which has been filed with and received the approval of the Environment Department.

7. The applicant should ensure that within 30 days after the month during which the data required by clauses 3, 4, 5 and 6 is collected, the said data is submitted to the Environment Department in such form as is satisfactory to the said Department.

8. To ensure that appropriate long range planning is identified with respect to adequately increasing the tailings holding capacity of the tailings area, while at the same time allowing for an adequate ponding area for clarification and retention of the decanted wastewater, the applicant should submit a report to the Environment Department on or before December 31, 1991, which said report should detail the measures and implementation schedule proposed to address the tailings area management strategy for the next 5 years of mining activity.

9. So that the Environment Department may monitor the degree of wastewater recycling actually being attained, the applicant should submit to the said Department, by the 1st day of May during each year of operation, an annual water balance study covering the preceding year of operation, and detailed to the satisfaction of the said Department.

10. The applicant should ensure to carry out a water quality monitoring program on the receiving waters of the final effluent within such lakes, at such frequency and having such scope as is satisfactory to the Environment Department.

11. Upon the request of an Environmental Officer, the applicant should ensure to provide transportation for an Environmental Officer from the mine/mill site to the final discharge point.

12. The Environment Department may at any time request such additional information as is reasonable from the applicant, but not including information of a confidential or proprietary nature, in order to determine the ongoing effectiveness of any segment of the established waste water treatment system, and where so indicated, may request that the applicant carry out such remedial measures as may be required to restore the effectiveness of the treatment system to the level required by the effect of this Licence.

13. The applicant should dispose of bulky metallic waste or other solid wastes (exclusive of waste rock and tailings solids) only in waste disposal grounds designated and approved for that purpose pursuant to Manitoba Regulation 208/76 respecting waste disposal grounds.

14. (a) The applicant should, within one year of the date of the issuance of the Licence, file with the Environment Department a preliminary rehabilitation plan with respect to the eventual closure of the operation, in regards to:

(i) the eventual orderly removal and disposal of all structures, their contents and all other accumulated material (except waste rock and tailings solids) on the site of the said operation, and

(ii) the steps to be taken to rehabilitate the said site at the termination of the said operation in line with safety, aesthetic considerations and the protection of the environment;

(b) In the event of an imminent cessation of the said operation, the application should forthwith file with the Department a final rehabilitation plan, to replace the preliminary rehabilitation plan, for the consideration, possible amendment, and approval, or otherwise.

(c) Upon the termination of the said operation, the applicant should take all steps necessary to carry out the approved final rehabilitation plan within such time frame as specified by the Department.

15. The applicant shall assure that the transportation of dangerous and hazardous goods that are shipped to the site and utilized in the process is in accordance with the requirements of the Transportation of Dangerous Goods Regulation.

Definitions

In these recommendations,

(a) "final discharge point" means the control structure located along the discharge route between Ragged Lake and Puffy Lake unless otherwise designated in writing by the Environment Department;

(b) "monthly arithmetic mean" means the average value of the concentrations determined for each substance in all the composite and grab samples collected and reported during that month, with the exception that, if the applicant collects only one composite or grab sample during a month, the single set of analysis results shall be construed as being representative of the effluent quality for that month and hence shall be treated as the monthly arithmetic mean;

(c) "composite sample" means a quantity of effluent consisting of a minimum of three equal volumes of effluent collected at approximately equal time intervals over a sampling period of not less than 7 hours and not more than 24 hours, or, alternatively, consisting of effluent collected continuously at an equal rate over a sampling period of not less than 7 hours and not more than 24 hours.

References

- (1) Sparling, A. B., Interactions between blue - green algae and heavy metals. DSc Dissertation. (1968).

- (2) Leland, H.V., Shukla, S.S., and Shimp, N.F. Factors affecting distribution of lead and other trace elements in sediments of southern Lake Michigan. In Trace Metal and Metal-organic Interactions in Natural Waters, P.C. Singer, ed. Ann Arbor Science Publishers Inc., Ann Arbor Mich. (1974).