PROPERTY FILE

BOSS MOUNTAIN PROJECT

March 1975

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Resources
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I. SUMMARY

A. Conclusions

1) The economic feasibility of the Boss Mountain Open-Pit Project depends on three factors:

(i) technical feasibility of beneficiating the ore by screening or autogenous grinding prior to milling

(ii) size and grade of potential orebody

(iii) capital cost and operating cost of the project

2) Method of beneficiation and the size of the potential orebody has to be known before a new feasibility study can be done.

3) Noranda's cost estimates in the feasibility studies are very optimistic. No cost contingencies have been incorporated.

4) It is not expected that there will be a real price increase in the price of molybdenum and from 1978 to 1982 there could be oversupply in molybdenum.

5) The profitability of the project is not high enough as to warrant investing in it.

6) The present underground operation faces possible closure due to the environmental problems with respect to tailings disposal. Although not precisely measured, the social cost of discontinuation may be greater than the cost to the environment.

B. Alternatives

1) Do nothing.
2) Participate in exploration and testing in form of a subsidy.
3) Buy the property from Noranda.
4) Participate in form of an equity investment.
5) Provide them with support to reduce cost of tailings disposal.

1. Analysis of Alternatives

The open-pit project is presently very speculative and the probability of getting a return is low. The existing legislation does not allow for the royalty to be waived, however, if it were possible, it would not increase the return sufficiently so as to make the project viable. To give them relief from pollution control requirements is beyond the power of the Department and for a long-term project not advisable, although it is a worthwhile consideration for the short-term to prevent closure of the mine on short notice.

2. Recommendation

In consideration of all the factors influencing the project, it would not be advisable for the Government to take active participation in the project.

C. Object

The situation at the Boss Mountain mine has been examined regarding geological, technical, environmental and social aspects. The object of the exercise was to analyse the present and future viability of the operation as outlined in various feasability studies recently presented to the Department of Mines by Noranda. These studies have suggested that in order to extend the life of the mine and community the B. C. government should:

(1) waive royalties in order to allow Boss to fund exploration and metallurgical testing

(2) consider purchasing Noranda Mines investment in Boss Mountain

(3) consider a deep hole exploration project

D. Scope of the Study

On the basis of investigating an open pit feasibility study presented by Noranda an evaluation team including Mr. D. Tidsbury P. Eng., Inspection Branch; Mr. G. Klein P. Eng., Resident Geologist, Mr. J. Rohwedder, Research Officer, Operations Branch; and E. W. Grove Ph.D., P. Eng., Senior Geologist, Mineral Resources Branch, travelled to the Boss Mountain mine pit February 24, 1975. The members of the team met with the mine staff during February 25 and 26 who cordially answered all questions and supplied all the material requested. Although snow covered the open pit area it was viewed, and both the underground and mill operation were visited for purpose of orientation.

On arrival at the mine it was found that the terms of reference, the feasibility reports of January 30 and February 17, had been updated. As a result the submission which outlined costs, equipment and material requirements became a frame of reference from which to discuss the current direction of mine planning.

Summary

1. The Boss proposals of January 30 and February 17, 1975 have become a frame of reference only because of increased tonnage estimates.

2. Benificiation of the stringer zone mineralization by crushing and screening which was the main thrust of the feasibility studies has been augmented by autogenous grinding studies.

3. In order to delineate the tonnage and grade of the proposed larger pit proposal core drilling footage on a 100 foot grid is required and will exceed the early estimates by a factor of at least two.

4. The tailing disposal problem currently facing Boss Mountain mine has not been solved to the Pollution Control Board's satisfaction.

5. The current tailing disposal area is adequate for the life of the underground operation only - a new area capable of handling open pit production and agreed on by the various government agencies concerned and Boss Mountain has not been negotiated.

6. Generally the planning and cost estimates first proposed are redundant in view of the new larger tonnage proposals.

7. The Boss concentrator is inadequate at present in view of the larger tonnage proposal.

8. A large expenditure on housing is required if the open pit operation is undertaken.

9. The total feasibility study will have to be repeated in more detail when the results of the metallurgical testing and the exploration drilling are completed - if these tests and drilling appear favourable.

10. The present underground mine has a projected life of less than two years - unless the tailings effluent problem is solved before the heavy Spring runoff the mine operation will be suspended in 1975.

Boss Mountain Mine

Location & Physical Features

The Boss Mountain mine, mill and townsite are located 57 miles by road northeast of 100 Mile House in the Prince George management district (Fig. 1). The main adit, mill, and office are at the 5,045 foot elevation on the east slope of Takomkane (Boss) Mountain. Underground mining has been active above this level to the surface at about 5,600 feet. The mine lies within a narrow cirque with walls rising steeply on the west to ridges and peaks at 7,000 foot elevation. The cirque is drained by Molybdenite Creek which flows easterly, then into the Horsefly River, a tributary of the Quesnel River. Boss Creek and Hendrix Creek which drain the surface camp area flow southerly into the Clearwater-North Thompson drainage. Both the Quesnel and Thompson are major tributaries of the Fraser River.

Rock outcrops are sparse in the cirque below 6,000 feet except in the small canyons along Molybdenite Creek. The geology and mineralization at the mine are best known from the underground workings and from core drilling.

General Geology

The mine area lies on the eastern margin of the composite Takomkane batholith which has intruded Triassic volcanic and sedimentary rocks correlated to the Nicola Group. The batholithic complex has been cut by numerous younger dikes, breccias, and the Boss Mountain stock. Takomkane Mountain partly comprises basalts of probable Pleistocene age that form the prominent peaks.

Local Geology

In the vicinity of the Boss Mountain mine the massive Takomkane granodiorite exhibits a number of elongate to irregular breccia zones, known as the Boss breccias, which are composed mainly of granodiorite

but include various dike and other rock types as well (Fig. 2). About 1,200 feet northeast of the breccia zones the Takomkane granodiorite has been intruded by the younger (80 m.y.) Boss Mountain stock. The breccia zones appear to lie within an inner, apparently annular, biotite alteration zone presumed to be related to the Boss Mountain stock. Underground and surface drilling information has suggested that the stock extends or dips southwesterly under the breccia zones at about 20 degrees. The exact relationship between these breccias and the stock is not known but it has generally been assumed in the past that the stock has also transected the breccias at depth. This point of contention is significant when molybdenite mineralization is confined to the quartz breccia zones.

History

Mineral claims were first staked on Takomkane Mountain in 1914. In 1917 the molybdenite showings along Molybdenite Creek were located and a bulk sample shipped to Lac La Hache. No further activity ensued until 1930 when the Consolidated Mining Smelting and Refining Company of Canada Ltd. explored the creek stringer zone as well as a breccia zone.

In 1942 Dr. John S. Stevenson of the B. C. Department of Mines mapped the area and supervised the drilling of a total of 1323 feet of x-ray core. He recommended further exploration of the breccia zones but the project was terminated.

In 1955 the Climax Molybdenum Company optioned the claims from H. H. Heustis and associates. Between 1957 and 1960 this company and associates completed 37,000 feet of drilling as well as other surface work. Noranda optioned the property in 1961 from Heustis and the property was re-examined. In 1962-63 Noranda drove the main adit at the 5045 level elevation, initiated underground development and decided in late 1963 to bring the property into production. The camp and mill was constructed in 1964 and production commenced in March 1965 at 1000 tons per day.

Production

During 1966, the first full year of production, the concentrator treated an average of 1190 tons per day at a 95.8% recovery rate to

produce 3,069 tons of concentrate containing 3,576,000 pounds of Mo. The operation was suspended December 3, 1971 after producing during the year a total of 534,500 tons averaging 0.203% Mo and concentrates containing 2,010,000 pounds of Mo.

The mine reopened in late 1973. During 1974 the mine produced 493,904 tons averaging 0.20% Mo. Mine production to the end of 1974 totals 3,792,505 tons with an average grade of 0.27% Mo. (Fig. 3).

Mineral Deposits

The bulk of the molybdenite ore mined at Boss Mountain has been produced from the crudely elliptical Main Breccia Zone and the smaller South Breccia Zone. These are nearly vertical pipe-like diatremes that are known to extend to a depth of at least 1100 feet below the surface. In these breccias the molybdenite occurs as segregations outlining the rock fragments, as discrete segregations within the breccia matrix, and as ribbons or streaks in brecciated quartz veins. The breccia zone ore has been veined by younger quartz veins which are typically barren.

Molybdenite mineralization also occurs in quartz veins which permeate the granodiorite surrounding the breccia zones. These veins comprise what has been termed the stringer zones in part mined underground and which now form the mineralized zone having the greatest potential for open pit mien production.

The potential for open pit mining of the stringer mineralization at Boss Mountain was recognized some time ago, and Noranda has made a number of feasibility studies in this regard since August 1973.

Open Pit Mining Proposals

General

Surface as well as some undergound drilling has indicated the widespread occurrence of near surface molybdenite bearing quartz veins surrounding the Main and South breccia zones. This rock mass includes at least three or four of the stringer zones outlined underground. Early work at the mine suggested these quartz veins represented fracture filling and comprised

an umbrella-shaped halo surrounding the two main breccia bodies. More recently a northwest trending linear zone of breccia pipes has been indicated along which quartz-molybdenite veins are concentrated in east and west dipping sub-parallel fractures or stringer zones. Exploration diamond drilling along this zone has been mainly limited to the vicinity of the glory hole (mine area) and has not delimited the full extent of the stringer zone mineralization.

Development and Exploration

Pit Proposal

The initial 12 million ton proposal indicated that in order to complete the geological evaluation of the tonnage and grade of the pit stringer mineralization that 22 core drill holes totalling 4500 feet at 200 foot centres would be required. In view of the proposed increase in pit extent, both in area and depth, more holes on a 100 grid are required. The number, length, core size, and location of these drill holes was not completed at the time of the interview.

Because of timing the decision on drilling in the pit area will have to be made fairly soon. Costs of this drilling can be estimated crudely but would be meaningless at this point.

Deep Hole Proposal

Geological studies of the Boss Mountain mineralization and apparent controls have suggested to the Noranda geologists that a similarity to Henderson-Climax ore exists. Because of these assumed similarities Noranda geologists suggest that at least one deep (2500 feet) core hole be drilled to test their concept. The various pros and cons of the geological concept were discussed in some detail with the mine geologist Mr. Arnie Pollmer and Noranda exploration geologist Dr. D. Carson.

As indicated in this report the zone of stringer mineralization is much more extensive than previously considered and is still known in only a cursory manner. In general surface exploration of the mine area has been very limited because the costs are directly borne by the mine, and because of the more immediate requirement of maintaining underground reserves.

Because of the topographic restrictions (the cirque) imposed upon any pit depth in the mine area the occurrence of ore grade mineralization at depth becomes both academic and a problem for underground mining.

If, and when the mine can afford deep drilling the program should be instituted to test at depth along the length of the breccia zone. Prerequisites for the near surface pit mineralization are more important at this stage and should be completed first.

Tonnage and Grade

Underground

The Boss Mountain ore reserves at start of production were estimated at 1,200,000 tons averaging 0.42% Mo. In 1967 the ore reserves above the 5045 adit level were maintained at 2,475,000 tons with an average grade of 0.28% Mo. At shutdown in December 31, 1971 the reserves were estimated at 1,900,000 tons averaging 0.24% Mo. Ore reserves at the end of 1974 are now estimated at 1,674,000 with an average grade of 0.20% Mo. At the present rate of production of 624,000 tons per year the underground reserves will be exhausted in mid 1977, that is, assuming no significant discoveries before that date (Fig. 3).

Open Pit

Noranda's estimates of surface mineralization have increased significantly between the presentation of the January 30, 1975 report and the present time. In the first report to the B. C. Department of Mines the company indicated the presence of 12,000,000 tons of drill-indicated (and possible) mineralization with an estimated grade of about 0.088% Mo. In the February 17, 1975 report the estimate was increased to 14,560,000 tons at 0.088% Mo. More recent calculations by the mine geologist suggests a possible 30 million tons with an estimated grade of from 0.07 to 0.08% Mo between the 5200 level elevation and surface. If the zone between the 5045 level adit 5200 is included the possible tonnage is increased to at least 40 million at an estimated similar grade. Of the 30 million plus potential tonnage approximately one half can be classified as drill-indicated (Noranda) tonnage with the remainder classified as possible (inferred).

In view of the very irregular spacing of the exploration drilling only the block immediately adjacent to the east side of the glory hole can be said to have been sufficently drilled to give a reasonable estimate of grade and tonnage. This block is estimated to contain about 7.0 million tons at an estimated average grade of 0.09% Mo and would on the basis of the available incomplete information constitute the highest grade portion of the proposed open pit (Fig 4).

The available results do not indicate the presence of any significant tonnage of underground ore grade mineralization (0.20% Mo) within the limits of the pit proposal.

Benificiation

A. The Boss mine proposal to upgrade stringer zone mineralization to mill-head feed grade by screening has been outlined in detail in the report submitted January 30, 1975 (Brand, April, 1974). The proposal suggests that because of the nature of the stringer mineralization about half the tonnage containing less than 10% of the available MoS_2 could be discarded by crushing and screening prior to primary mill treatment. The feasibility of this concept remains to be proven by testing at least 25,000 tons of stringer mineralization from a surface test pit.

B. A second method of benificiation has now been proposed by the mine staff. This involves autogenous, or semi-autogenous grinding of the mill feed after crushing as part of the primary mill circuit. A four ton sample of stringer zone ore from the underground mine has been shipped to the Ontario Research Council for autogenous grinding tests. The results of this test are expected to be completed and available to the mine staff by the end of March.

C. The results of the autogenous grinding and the proposed crushing/screening tests will determine the feasibility of benificiation of stringer zone mineralization and will in part determine the future of the open pit proposal.

Waste Removal

The removal of at least 2 million tons of overburden was indicated in the first pit proposal. With the recent increase of the proposed pit size from the original 4.5 acres to at least 5.4 acres the estimate

of overburden has approximately doubled to about 4 million tons.

With the increase in tonnage from 12 to 30 (+) million tons the amount of waste rock has increased to at least 5 million tons or more depending on the ultimate pit depth.

Most of the proposed pit limit has already been logged but the fringe areas would require further work again depending upon the pit limits.

The problem of overburden and waste rock storage has been considered but has not been solved. It is possible that part of the waste could be used to raise the height of the present tailings disposal dams. But there is no reasonable flat area near at hand and ready for dump use as yet.

Tailings Disposal

The present tailing disposal system has adequate storage for the remaining life of the underground mine. But the method has been termed inadequate by Pollution Control. The mine has been warned that unless the tailings effluent is not brought up to Pollution Control Board standards (Mo, Cu, Fe content, with 20:1 dilution rate the guideline) the mine will be closed.

Several ways of upgrading the mill effluent have been examined. These include complete or partial recycling of mill effluent as well as perimeter drainage to reduce runoff movement and resultant overflow, and the raising of the two storage dams to impound the overflow. Dam raising would involve engineering studies of the site and a considerable capital expense.

It is thought highly unlikely that the present tailings disposal area could be used to impound the volume of mill waste anticipated by an open pit operation. A new site will have to be found which will meet the approval of the government agencies concerned. Tailings disposal is a serious problem because of the unique location of the mine at the headwaters of two major streams.

Mr. Tidsbury has indicated that even under the present B. C. Department of Mines reclamation regulations abandonment of the mine will involve considerable expenditure for spillways and collection canals for groundwater. In view of the many agencies and requirements now involved tailings disposal poses a major impediment to extended and increased mine production.

Pit Mining Considerations

Equipment

The initial equipment and other related proposals are inadequate in view of the possible expansion of tonnage from 12 to 30 (to 50) million tons. Groundwater diversion in the pit has not been considered and would be a major problem as well as an added cost.

Labour

In view of recent contract settlements the suggested $72.00 per man shift is probably optimistic.

Costs

These are only a preliminary estimate and would require detailing when the exploration drilling, mill testing, mill design, pit design, production and other factors are more realistic. Market forecasts are difficult in the best times but must be considered in view of the rapidly changing world conditions.

Roads & Hydro

As indicated in the Boss feasibility studies the pit planning was in a very preliminary stage. Items not considered such as roads for waste removal, road relocation, ramps, runaway lanes, stockpiling, sorting if required, all have to be considered on the basis of the tonnage to be handled and with strict regard to safety and environmental standards.

With a larger tonnage factor and the resultant increased hydro demand the question of availability, line costs, and unknown costs become important. For example the sub-station at 100 Mile House may not be capable of delivering the required or proposed mine load.

Concentrator Expansion

The results from the autogenous grind tests, proposed screening

tests and the tailings problems are significant factors in determining mill design and capacity. In the reports submitted only design changes with respect to the present plant were considered. Again the results of the testing, and the pit output will determine the suitability of the present mill (if at all) and the operating costs.

Townsite

The suitability of the present townsites was discussed in some detail by Mr. Tidsbury and the property manager Mr. Cromie. It is apparent that the present facilities which in large part date to 1964 require upgrading. A major undertaking is implicit in this regard and would include expanded sewage disposal, and replacement of 35 company owned trailers. The costs of this project would probably exceed the initial proposal.

The Community

The Boss Mountain mine directly employs about 150 at the site. At present there are about 250 people living at the Hendrix Lake camp and 85 at the mine site in single trailer accommodation. There are 31 houses, 50 trailers, a recreation hall, curling rink, other recreational facilities, library, and lunch counter owned and maintained by the mine in Hendrix Lake. The service station is owned and operated by Gulf Oil (with a mine subsidy) and the local store is family owned and operated. The school, housed in a school board owned trailer unit, handles 40 pupils through grade 8. About 8 to 10 of the mine employees reside at Eagle Creek which has a 50/50 logging-mining employment base. Two employees commute from Williams Lake, 6 from Forest Grove, and one from Lac La Hache.

Virtually all the mine purchases are through Vancouver with the exception of minor available local items. Fuel and gasoline are mainly handled by the subsidized Gulf station. Family food stuffs are purchased at the local store or in bulk in the larger centers.

There is some potential for recreational development such as skiing but apart from the local residents this use is light.

A. Mine Closure

On the basis of a very cursory study of the mine community it

appear that the main effect of mine closure would be the displacement of, or the transfer of, the employees and their families. Transfer from one mine to another on short notice is an expected part of mining. The turnover rate of labour at the mine has stabilized in recent months but this is typical of the industry in B. C. in general.

It would appear that only a small number of the mine employees own property in the area. Closure would effect the garage and store but it is likely that the local logging and resort concerns would take over the Hendrix Lake camp for their own use.

B. Open Pit Operation

Should the mine convert from underground to open pit operation contractors would be required for pit development, tailings disposal preparation, possible mill construction, townsite reparation, and other ancillary projects. Equipment purchases for the pit operation would require a significant capital outlay. Pit operation would probably mean only a small increase in personnel.

III. ECONOMIC STUDY

A. Background

The Boss Mountain molybdenite property of Noranda was brought into production in 1965. The mine is located in the Central Cariboo region, 57 miles northeast of 100 Mile House at an elevation of 5,000 feet on the side of Takomkane (or Big Timothy) Mountain. In December of 1971, the mine was closed down to reduce the high concentrate inventory caused by the reduction in demand during the economic slowdown in 1970 - 71. Increasing molybdenum demand during 1972 and 1973 enabled Noranda to decrease inventory to normal levels. In the fall of 1973, Noranda decided to reopen Boss Mountain and $300,000 were expended for this purpose in 1973. Present ore reserves of 1.6 million tons, grading 0.20% molybdenum, are sufficient to operate the mine until mid-1977. In the event that operating cost should accelerate faster than expected, Noranda could try to mine only the remaining high grade breccia ore of the main orebody which is presently mixed with lower grade breccia and stringer ore of the west and southwest stringer ore zones.

B. Analysis

1. Boss Mountain

(a) Operation

Boss Mountain was brought into production at a cost of $14.9 million. The mill was built to handle 1,500 tons of ore per day. Molybdenum production has decreased since the first year of operation due to the decline in grade of the ore.

Operating Statistics of the Boss Mountain Division of Noranda Mines

	Production						
	Value in $000's	in '000 lbs Mo	in tons of ore	Net Grade	Employees	Man Hours	Tons/Hour
1965	2,481	1,615				279,903	
1966	5,832	3,535	433,832	.407	163	375,944	1.15
1967	5,493	3,130	469,444	.333	168	380,064	1.24
1968	4,206	2,404	497,836	.2410	172	356,222	1.40
1969	4,241	2,342	547,500	.2138	176	389,834	1.40
1970	4,348	2,457	591,168	.208	186	412,208	1.43
1971	3,517	2,010	534,522	.188	157	315,733	1.69
1972			-				
1973			-				
1974	3,974	1,821	493,904	.184	-	-	
1975							

	Cost per Ton of Ore Milled					
	Mining	Milling	General	Cash Expenses	Depreciation	Total
1965	3,934	1,580	2,334	6,848	-	6,848
1966	1,517	1,333	3,162	6,012	3,099	9,111
1967	2,491	1,181	2,084	5,756	3,017	8,773
1968	2,412	1,147	2,104	5,663	2,971	8,634
1969	2,614	1,164	2,081	5,859	2,767	8,626
1970	2,655	1,247	2,135	6,037	2,637	8,674
1971	3,059	1,124	2,093	6,276	3,364	9,640
1972						
1973						
1974	3,857	1,757	2,420	8,034	1,638	9,672

Operation seems to be efficient and it is doubtful that the operating cost could be lowered without any large investment.

(b) Labour

The company presently employs 186 employees. Of these, 66 are employed underground. Labour turnover was high at the startup of operation and reached 25% in a few months. With the build-up of married men who live in the townsite and the decrease of labour mobility due to the tight employee labour market, turnover has decreased to 8% per month. This is still high and represents a turnover of nearly 100% per year. The high turnover can be attributed to two factors:

(i) Low wages. The average pay is $6.64, this is low compared with Cominco's pay of around $8.00 per hour.

(ii) It takes a few years to build up a stable work force who will stay at the mine because they like the work and the environment.

(c) Financial

Noranda over estimated the stability of the molybdenum market when it decided to bring Boss Mountain into production. As can be seen from the following table, the mine has not been profitable. The data for 1975 - 77 are estimated by Noranda.

Period			Price per Pound of Molybdenum (in constant 1974 $'s)
Preproduction		Net Cash Flow	
- Preproduction costs	($4,260,182)		
- Bldg & Equipment at cost	($9,264,766)		
- Project costs	($1,397,034)		
1964			2.90
1965		$ 970,000	2.85
1966		3,355,000	2.74
1967		2,772,346	2.70
1968		1,378,145	2.64
1969		1,007,796	2.80
1970		814,965	2.77
1971		(27,352)	2.73
1972	no production	(239,022)	2.55
1973	no production	(544,000)	2.10
1974		(114,983)	2.05
1975		349,000	2.19
1976		(360,000)	
1977		259,000	
	($14,921,982)	$9,620,895	
		($5,301,087)	

Cost estimates by Boss Mountain's management seem to be optimistic. In 1974, operating costs were 13% higher than planned. In spite of these higher operating costs, production was 10% less than planned. Labour turnover, which was the main cause for the negative variances, has declined significantly and management expects that this year's performances will be closer to plan.

1976 and 1977 estimates are based on the assumption that labour cost will increase by only 10% per year. The present labour contract expires at the end of this year and unless unemployment is at a level above 10%, it is doubtful that a contract of less than 15% increase would be accepted by the work force. Hence, production cost estimates could be low for 1976 and 1977. If wages increase by 15% in 1976 and 10% in 1977, operating cost increases by $139,000 in 1976 and $75,000 in 1977 over the estimated cost. Instead of obtaining a net cash flow of $248,000, the net cash flow for the two and one half remaining years will be only $34,000.

2. Noranda

(a) Company

Noranda Mines Ltd. is a fully integrated industrial mining company. It is the second largest Canadian mining company and the largest Canadian copper producer. It is also engaged in copper fabricating, aluminium smelting, the forest industry, zinc and fertilizer production (see table next page). Noranda is presently engaged in a phase of consolidation and restructuring.

1) Capital spending has been reduced by 45% or $100 million from planned expenditure. Projects affected are:

(i) Participation in a 100,000 metric ton-per-year copper refinery complex in South Korea (Metals Week, January 27, 1975, p 3).

(ii) $25 million Canadian copper smelter expansion (Metals Week, January 13, 1975, p 1).

(iii) $8 million Central Canada Potash Co. expansion.

2) Expenditures have gone into zinc production and zinc properties. Purchases in the last three months of 1974 have been:

(i) $2,595,000 for Magusi copper-zinc property from Iso Mines and Copperfield Mining Corp.

(ii) $4,455,000 for 330,000 Mattagami Lake Mines shares.

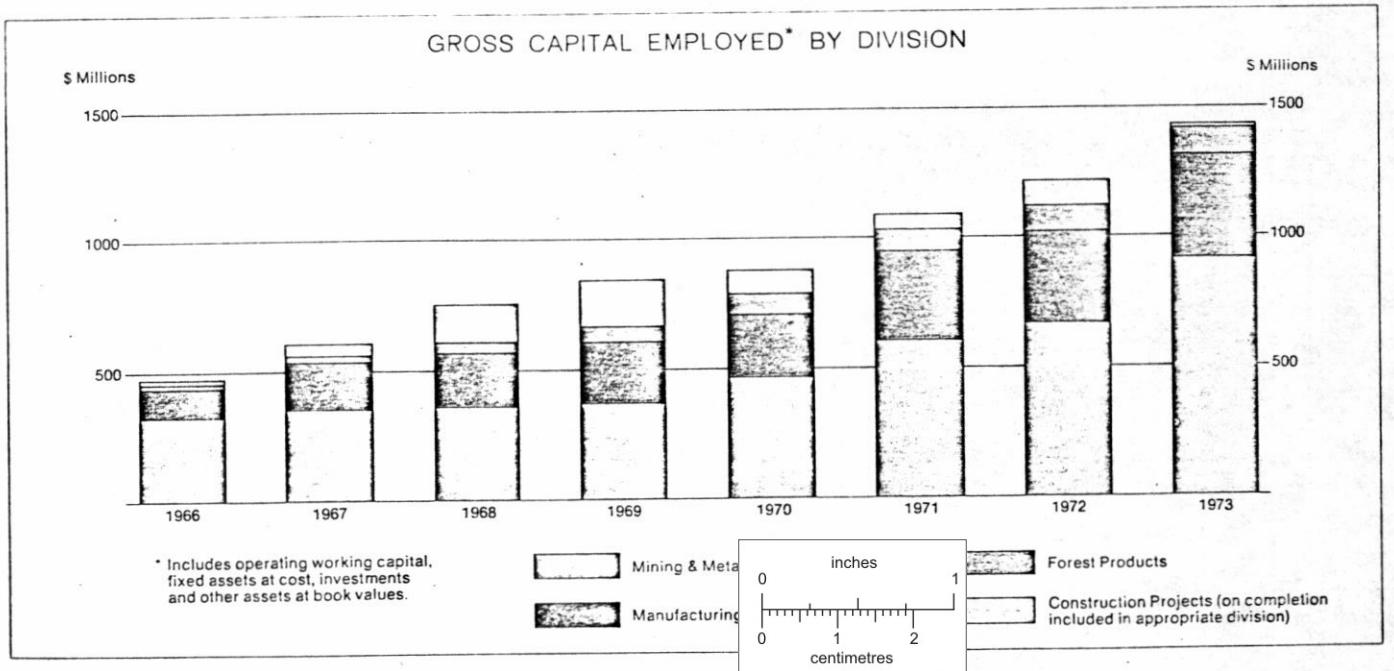
(iii) Option to acquire Barvue zinc property (Barraute Quebec for $500,000 from Manitou Barvue Mines Ltd.

CONSOLIDATED DIVISIONAL RESULTS

	1973	1972
	(in thousands)	
Revenue from metals, products and custom tolls		
Copper mining, smelting and refining operations *	$ 327,890	$ 214,186
Other mining and metallurgical operations **	229,638	141,209
Total mining and metallurgical operations	557,528	355,395
Manufacturing operations	438,798	339,685
Forest products operations **	253,889	167,974
Gross revenue	1,250,215	863,054
Less: sales between divisions	102,709	72,137
sales by associated companies **	298,961	209,865
Revenue as reported	$ 848,545	$ 581,052
Earnings		
Copper mining, smelting and refining operations *	$ 46,259	$ 44,719
Other mining and metallurgical operations **	67,403	27,023
Earnings from mining investments	1,117	909
Gross mining and metallurgical earnings	114,779	72,651
Less exploration written off net of applicable tax reductions	7,673	6,433
Net mining and metallurgical earnings	107,106	66,218
Manufacturing operations and investments	23,233	11,364
Forest products operations **	15,005	10,696
Earnings before common costs	145,344	88,278
Less common costs	23,950	19,111
Earnings as reported	$ 121,394	$ 69,167
Breakdown of common costs		
Corporate office costs	$ 7,512	$ 6,251
Interest expense net of revenue	23,599	19,147
Unallocated research costs	982	638
Less applicable tax reductions	(8,143)	(6,925)
Total	$ 23,950	$ 19,111

* Consists of operations of the Horne, Geco and Bell Copper mines, Gaspé Copper Mines and Canadian Copper Refiners.

** Gross revenues and earnings include Noranda's share of the revenues and earnings of associated companies accounted for on an equity basis. These gross revenues include $122,377,000 from mining and metallurgical operations, $126,336,000 from forest operations, and $50,248,000 from manufacturing operations in 1973. ($65,677,000, $108,601,000 and $35,587,000 respectively in 1972.)



Source: Noranda 1973 Annual Report

Noranda also bought a potash property in New Mexico and a bauxite interest in Guinea.

These changes can be partly explained with the good prospects of the zinc industry and the presently depressed copper market requiring changes in the investment exposure by diversifying. The purchase of 51% interest in the Fraser companies for $35 million in April 1974 is an example of the diversification move.

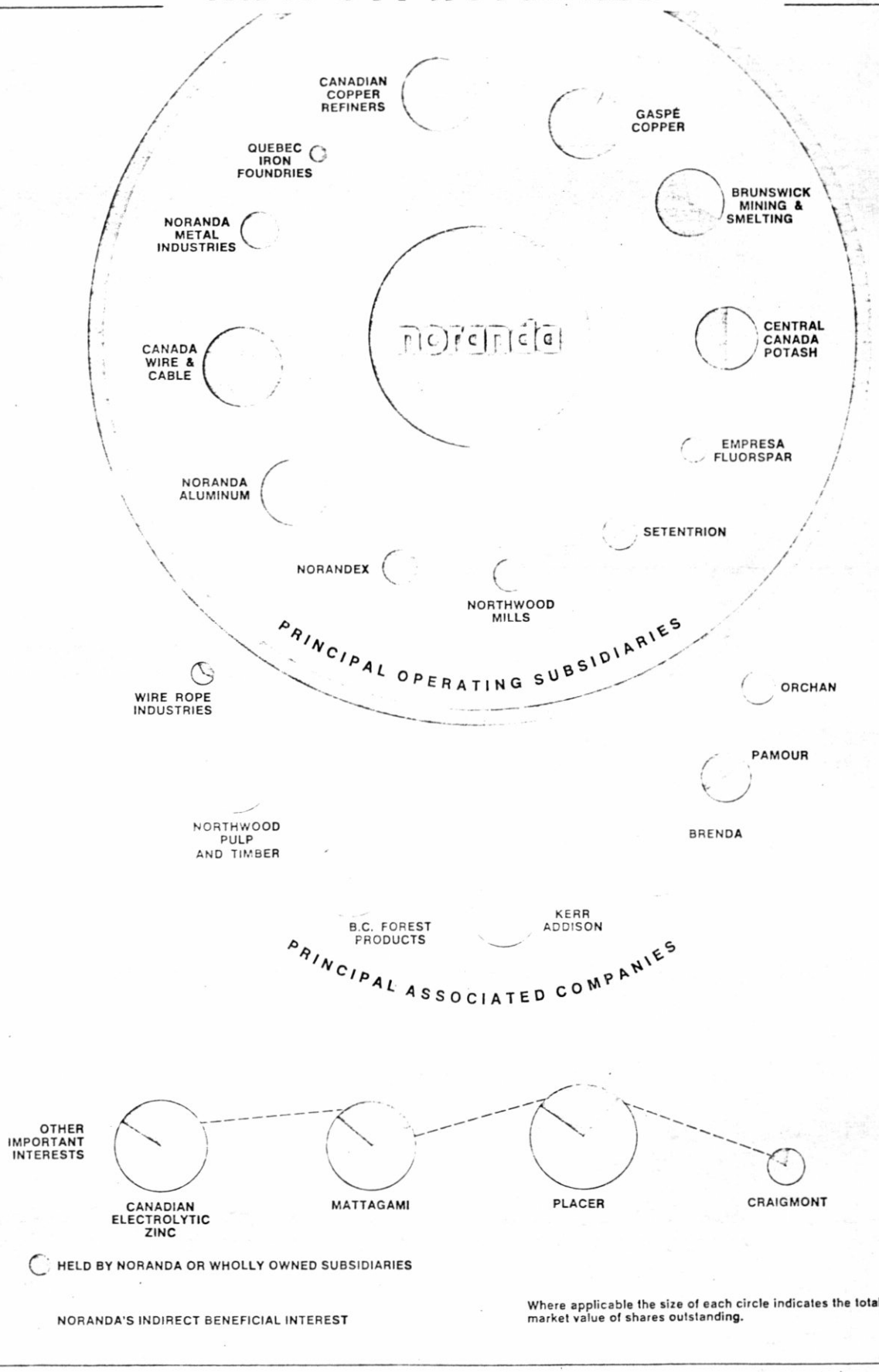
(b) Organization of Noranda

Noranda is not one centrally ruled corporation. Each division and subsidiary is operated as a profit centre and not as a cost centre (see chart). Division management has to justify investment. The deciding criterion used is the discounted cash flow method or rate of return. If new investment does not yield a sufficient return on invested capital, no funds are provided.

(c) Boss Mountain, A Division of Noranda

Boss Mountain would not have reopened if Noranda had anticipated the higher than budgeted production cost. Total operating profit was $806,836 below plan. Original budgeted cost for 1975, 1976 and 1977 have been increased by 10%. Had the operation performed as planned, operating profits would have been $2.1 million higher than presently anticipated. Currently, Boss Mountain requires financing from Noranda to keep operating. As Boss Mountain is not profitable, expenses have to be approved by Noranda. It is very doubtful that approval will be given to the pit project as substantially more drilling has to be done to prove the presently inferred ore reserves and verify the grade. If the Pollution Control Board requires major expenditures on the tailings pond, the mine may close down this summer.

MAJOR INTERESTS



Source: Noranda 1973 Annual Report

C. Molybdenum

1. Consumption

Molybdenum is an important alloying element in steel. Eighty-five percent of total consumption is used by the steel industry and, of this, 68% in alloy steels. Its properties lie between the characteristics of chromium and tungsten and it can be substituted by these metals and also by nickel and manganese. Graphite can replace molybdenum in lubricant application. Price dictates which material is being used. Molybdenum increases hardening ability, tensile and creep strengths, and corrosion resistance.

The correlation between world steel shipments and molybdenum consumption is .98. Over the last 16 years steel consumption has increased by 5.2% per year and molybdenum consumption by 6% per year. The higher increase in molybdenum consumption than in steel is the result of research done by American Metal Climax. Climax controlled the molybdenum market until the mid-Sixties. At that time, other mining companies began molybdenum production and the price deteriorated. Consumption remained nearly constant from 1969 to 1972 with demand increasing only in the later period of the 1970 to 1974 business cycle when consumption increased by 22% in 1973 (see graph).

World consumption will be affected by the present business downturn; but, till the present, consumption has remained firm with the exception of Japan, where steel production has been declining. Molybdenum has been protected so far from the downturn because it is used to a large extent by the capital goods sector.

Molybdenum Material Forms in End Use (1968)

('000 pounds of contained molybdenum)

End Use	Molybdic Oxides	Ferro-Molybdenum	Ammonium and Sodium Molybdate	Other Molybdenum Materials	Total	%
Transportation	12,250	3,550	-	700	16,500	29
Industrial machinery and equipment, machine tools	10,000	2,810	-	590	13,400	24
Pipes, tubing, and tubular products	7,800	1,930	-	270	10,000	18
Chemicals, catalysts, pigments, and lubricants	2,400	-	1,100	1,000	4,500	8
Electrical and electronic equipment	-	-	-	1,400	1,400	3
Other	5,850	2,710	-	1,440	10,000	18
Total	38,300	11,000	1,100	5,400	55,800	100

Source: U.S. Department of the Interior, Mineral Facts and Problems, 1970 edition.

Although a large proportion is used in the transportation sector, the recession in the automobile industry has had minor effects, since much of the molybdenum used is in the heavy equipment sector and in trucks. Demand has remained high for these products to date.

(a) Consumption Outlook

The use of a new high strength steel containing .25% molybdenum and 0.06%[1] columbium in the manufacture of gas pipelines should keep molybdenum demand up in the expected steel downturn as many pipeline projects are presently under construction or in the process of being planned. A new drill steel for deep wells containing sour gas or high saline water, containing 75% molybdenum[1], has been successfully tested. The U.S. Bureau of Mines forecasts that consumption will increase by 3.25% to 4.25% in the U.S. and 4% to 5% in the rest of the world[2].

(see table next page)

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[1] Mining Annual Review, 1974, Mining Journal, London p 85.

[2] U.S. Department of the Interior, Mineral Facts and Problems, p 333.

FREE WORLD MOLYBDENUM CONSUMPTION, PRODUCTION AND PRICE

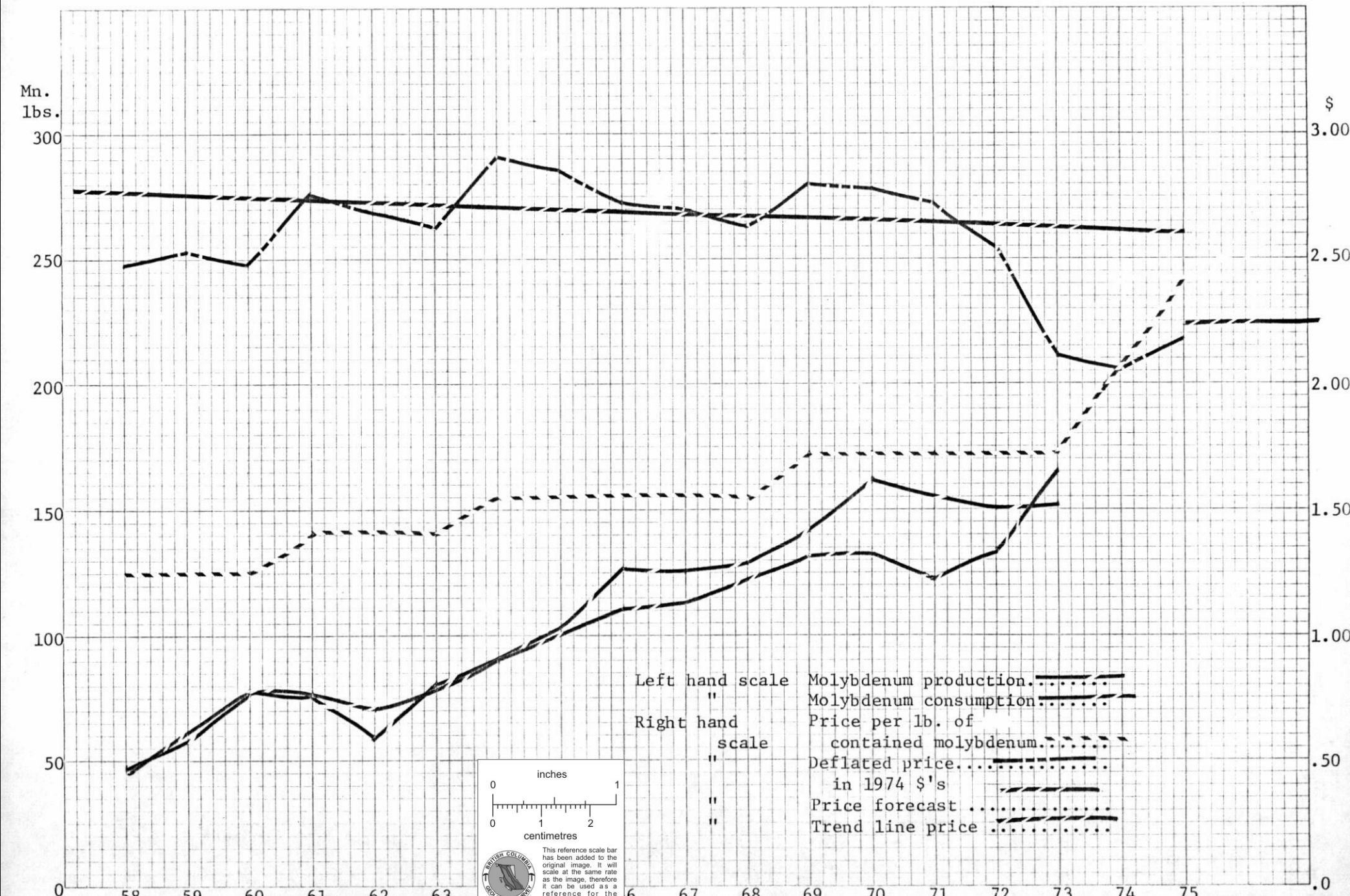
(in million pounds of molybdenum in concentrate)

	Molybdenum Production	Total World Steel Shipments (in million short tons)	Molybdenum Consumption	Mo Consumption Production	Price	Price Multiplier Canadian Wholesale Price Index (1974 = 100)	Deflated Price (in 1974 $'s)
1958	46	299	45	.98	125	202	248
1959	57	336	61	1.07	125	199	253
1960	76	382	75	.99	125	199	249
1961	75	387	76	1.01	140	197	276
1962	60	396	70	1.17	140	192	269
1963	81	425	79	.98	140	188	263
1964	90	482	90	1.00	155	187	290
1965	103	506	100	.97	155	184	285
1966	126	524	111	.88	155	177	274
1967	125	543	112	.90	155	174	270
1968	129	584	123	.95	155	170	264
1969	144	633	132	.92	172	163	280
1970	162	655	133	.82	172	161	277
1971	155	640	123	.79	172	159	273
1972	150	692	135	.90	172	148	255
1973	151	763	165	1.09	172	122	210
1974[1]	165	710	165	1.00	205	100	205
1975	157	740	155	.99	243	90[2]	219
1976	170	795	175	1.03	274	82	225
1977	190	820	190	1.00	288	78	225
1978	210	845	208	.99	304	74	225
1979	230	870	220	.96	316	71	225
1980	240	895	230	.96	336	67	225

[1]1974 to 1980 are very rough estimates.

[2]Inflation rate equals 10% in 1975 and 1976 and 1976-1980.

FREE WORLD MOLYBDENUM CONSUMPTION, PRODUCTION AND PRICE
IN MN. LBS. OF MO. IN CONCENTRATE



2. Production

Production is a function of the price and long-term price outlook. Present known ore reserves are sufficient for the remainder of this century.

Estimated Molybdenum Reserves

Country	Million Pounds of Contained Molybdenum
U.S.	6,300
U.S.S.R.	2,000
Chile	1,750
Canada	500
Peru	250
Others	27
Total	10,827

Source: U.S. Department of the Interior, Mineral Facts and Problems (1970 edition)

At the 1973 consumption rate of 165 million pounds of molybdenum, this would be sufficient for 66 years of consumption. Reserve life of most other metals is not as favourable as that of molybdenum.

Metal	Reserves[1]	1973 Production[2]	Reserves / 1973 Production
Copper	280.0 million metric tons	7.514 million metric tons	37
Zinc	82.0 million metric tons	5.835 million metric tons	14
Tin	4.3 million metric tons	.221 million metric tons	19
Nickel	66.0 million metric tons	.666 million metric tons	99
Lead	48.0 million metric tons	3.564 million metric tons	13

[1] Source: U.S. Department of the Interior, Mineral Facts and Problems (1970 edition)

[2] Source: World Bureau of Metal Statistics (November 1974)

Molybdenum is produced from predominantly molybdenum deposits and from porphyry copper deposits where molybdenum is a by-product or co-product. Minor quantities are recovered from tungsten and uranium ores. By-product molybdenum production has increased in recent years. In 1968, 74%[3] of U.S. production came from molybdenum ores. This had decreased to 52%[4] in 1973. Two large new

[3] U.S. Department of the Interior, Mineral Facts and Problems (1970 edition) p 338

[4] Energy, Mines and Resources, March 1974, p 120

molybdenum mines are expected to start producing in the near future, Henderson, U.S., in 1976 - 77, and a 40,000 ton-per-day ore capacity open-pit mine in Mongolia in 1978 - 80.

British Columbia molybdenum producers are:

Company	1973 Production ('000 pounds)
Endako	14,134
Brenda	11,106
Lornex	3,385
Island Copper	970
Gibraltar	494
Mount Copperland (ceased production October, 1973)	301
	1974 Production
Boss Mountain	1,821

high 8.3

3. Prices

Over the last 10 years the real price of molybdenum has been declining slightly. The most recent decline in price was caused by stagnation in molybdenum consumption from 1969 to 1972 and excess production over consumption since 1965 (see graph). The real price of molybdenum declined over the period 1964 to 1974 from $2.90 to $2.05 in 1974 constant dollars. This is a decline of 29% or an average annual rate of -3.4%. The trend line price of the last 16 years has been declining by .2%.

Prior to 1965, Amax was the major producer and enjoyed a quasi-monopoly position. In the mid-Sixties a number of other producers were attracted into the market and the monopolistic market structure broke down. It is not expected that the cost of recovery will decrease in constant dollars as the largest of the molybdenum mines (Climax at 60 million pounds/year and Henderson at 50 million pounds/year) are underground mines where the scope of cost reduction by mechanization and use of larger equipment is limited.

The economics of the Henderson project result in a price of $3.07 per pound, the calculation follows. The Henderson project will cost around $400 million[(1)] when it goes into production between 1976 and 1978. Its final

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(1) Amax Inc., Prospectus, $75,000,000 7 3/8% Sinking Fund Debentures (New York, January 14, 1975) p 16

capacity will be 50 million pounds of molybdenum per year. This production rate is expected to be reached in 1980. This means capital cost of molybdenum is $8.00 per pound of annual production.

The orebody contains 303 million tons grading .29% molybdenum. At 95% recovery the reserves of 1,670 million pounds are sufficient for 33 years. If one assumes that the mining and milling costs per ton of ore for the Henderson project are equal to the current operating cost of $8.59 per ton of ore incurred by Boss Mountain, then operating cost will be $1.53 per pound of molybdenum at Henderson. Depreciation would amount to 40¢ per pound, assuming a life of 20 years, and the remaining capital cost of $1.14 per pound will be interest, taxes and profit.

Assuming that $250 million is financed by debt capital at an interest rate of 10%, interest charges would amount to 50¢ per pound of molybdenum. If the remaining $150 million are financed by owners' equity at the assumed cost of capital for Amax of 13%, a pretax profit of 64¢ per pound of molybdenum is required under a 50% tax rate and a 22% depletion allowance. The total cost of producing 1 pound of molybdenum is therefore:

Current Operating Cost	$1.53 per pound of molybdenum
Capital Cost	1.54 per pound of molybdenum
Total Cost	$3.07 per pound of molybdenum

If this operating cost is inflated by 10% for 1975 and 10% for 1976, operating cost in 1977 would be $1.85 per pound and the price required to make the mine profitable, $3.39 per pound. Since 50% of these costs are fixed costs, Amax could adapt the policy of raising the price only slowly to squeeze out mines operating at a marginal level, like Boss Mountain. When Henderson comes into production, molybdenum supplies will probably exceed consumption for the period 1978 to 1982. Amax alone will have a production capacity of 110 million pounds per year.

(a) Price Outlook

Because of ample supplies it is anticipated that the price of molybdenum will remain around $2.50 in constant 1975 dollars. The present decline in consumption will be partly offset by production cutbacks in by-product molybdenum production which will probably reduce molybdenum by-product production by 10% and total molybdenum production by 5% in 1975 from 1974 production levels. The

production cutback should be enough to allow producers to raise prices at the end of 1975 to compensate for rising costs. A price increase in real prices is not expected before 1985.

D. Pit Project

1. Financial

Noranda's feasibility study (J. B. Smith, February 17, 1975) is based on very optimistic cost assumptions. Capital cost requirements are minimum requirements and do not even take environmental regulations into account. Nearly all the costs have been raised for this rough feasibility study. The probability that Noranda is able to come up with an ore deposit of 40 million tons as speculated by Boss Mountain's management team is thought to be .8 by Dr. E. W. Grove. To prove that these reserves are present and that the technology of beneficiating the ore pior to milling and flotation is feasible, roughly $500,000 will have to be expended. As the rate of return of the project is only 5% (see cash flow analysis next page), it is not advisable to spend these funds on the project. Even if royalties were waived the project would have only a return of 9.6%. Assuming that Noranda's cost estimates are not too low, Noranda would require ore reserves of 26 million tons to get a 13% rate of return. At 40 million tons their rate of return would be 16%. Hence, if Noranda believes that their cost estimates are correct, they will be able to do the project by themselves. If these cost estimates are too low and the real cost approximates the higher cost estimate of this study the project is not feasible at all at the present ore grade of .088% molybdenum and size of 40 million tons.

Different methods of beneficiation screening versus autogenous grinding would have a significant effect on the cost estimates. The rate at which stripping is done would influence the rate of return also.

From the data supplied in the study by Noranda and modifications of the cost assumption, it can be concluded that the project is not feasible, unless no environmental protection is required. No protection requirements would reduce capital cost by $2 million and operating cost by probably 20¢ per pound.

2. Socio-economical

In case of mine closure, the presently employed 185 people would lose their jobs or would be relocated. It can be estimated that most of management personnel would remain with Noranda, not necessarily in their present positions. Half of the employees who presently live in bunkhouses (roughly 45 men) would probably leave the Province. Many of these came from the East. Another 45 of the employees would probably find employment in other mines or in the lumber industry without too much disruption. This would leave around 70 men without

employment. At the presently depressed state of the mining and lumber industry, it may be worthwhile to keep the mine operating through this summer even at a certain environmental cost. In case the mine closes down, the unemployment cost of 70 people for six months could be estimated at $168,000. It is doubtful that the damage to the environment is that high. By the time the effluent reaches major water streams important for the salmon industry, the heavy metal and chemical content will be diluted and no longer detrimental to the fish, wildlife and human life.

If the pit project should go ahead, around 155 employees would find permanent employment in the mine. This employment would not only benefit Hendrix Lake but also 100 Mile House which provides Hendrix Lake with the service of banking, medical care, hotels and around 20% of their consumer goods purchases. The Government would not be required to make any additional investments. The Hendrix Lake community could in future expand and provide living quarters for loggers. The area has many assets to attract tourists, but without a stable base industry the asset cannot be exploited fully. Road maintenance is done mainly by the mining and the logging industry.

The capital investment of $10 million would provide downstream benefits. Roughly half of the investment will be for purchases within the Province and, hence, would benefit the general British Columbia economy during the next two years. Price-Waterhouse estimates that for every employee in the mining industry there are 2.9 workers employed in support of the mining industry in British Columbia. The multiplier for the capital cost is probably very similar and, hence, the total effect by Boss Mountain on the British Columbia economy is probably around three times as large as expressed in the cash flow analysis. But, in spite of the downstream benefit, if the project is uneconomical (low grade), the potential benefit is zero or even negative if other projects, which should have been undertaken, are deferred because of the Boss Mountain Open-Pit Project.

ESTIMATED OPERATING STATISTICS AND NET CASH FLOW FOR THE BOSS MOUNTAIN PIT PROJECT*

(in '000 $'s)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Production (1)			4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872	4,410,872
Revenue (2)			10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520	10,520
Operating Cost (3)			7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723	7,723
Operating Profit			2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797
Preproduction Cost (4)	500	5,000														
Capital Cost (5)		10,000	2,000	200	200	200	200	200	200	200	200	200	200	200	200	200
Tax Calculation																
30% Depreciation (6)		4,500	3,750	2,685	1,939	1,418	1,052	797	617	492	405	343	300	270	250	0
Write-off (7)	500															
Production Income (8)	(500)	(4,500)	(953)	112	858	1,379	1,745	2,000	2,180	2,305	2,392	2,454	2,497	2,527	2,547	2,797
Depletion (9)	(125)	(1,125)	(238)	28	214	345	436	500	545	576	598	613	624	632	637	699
Federal Taxable Income (10)	(375)	(3,375)	(715)	84	644	1,034	1,309	1,500	1,635	1,729	1,794	1,841	1,873	1,895	1,910	2,098
25% Federal Tax	(94)	(844)	(179)	21	161	258	327	375	408	432	448	460	468	474	478	524
Royalty (11)			526	526	526	526	526	526	526	526	526	526	526	526	526	526
Mining Tax Taxable Income (12)	(500)	(4,500)	(1,479)	(414)	332	853	1,219	1,474	1,654	1,779	1,886	1,928	1,971	2,001	2,021	2,271
12.75% Mining Tax	(64)	(574)	(188)	(53)	42	109	155	188	211	227	238	246	251	255	258	290
Provincial Corporate Tax Taxable Income (13)	(327)	(2,944)	(968)	(271)	218	558	798	964	1,082	1,164	1,221	1,262	1,290	1,310	1,322	1,486
13% Corporate Tax	(43)	(383)	(126)	(35)	28	73	104	125	141	151	159	164	168	170	172	193
Net Cash Flow to Noranda (14)	(299)	(13,199)	864	2,075	1,840	1,631	1,485	1,383	1,311	1,261	1,226	1,201	1,184	1,172	1,163	1,064
British Columbia	(107)	(957)	212	438	596	708	785	839	878	904	923	936	945	951	956	1,009

Discounted rate of return equals 5%

*For explanation see notes

NOTES ON CASH FLOW

1. Production is assumed to equal production as estimated by Noranda Mines, 8,000 tons per day or 2,797,000 tons per year, grading .088% molybdenum. Recovery equals 86%. Ore reserves of 40 million tons would provide mill feed for 14 years.

2. The price of $2.42 per pound of molybdenum, as assumed by Noranda is reasonable and represents the 1975 price. Marketing expenses of 1.5% are deducted to arrive at revenue.

3. Operating cost at $2.65 per ton as estimated by Noranda.

4. Preproduction cost: $250,000 for 10,000 feet of drilling
   $250,000 for testing of screening or autogenous grinding
   $5,000,000 for stripping ($1 per ton)

5. Capital Cost:

		Noranda's Estimate
Townsite improvement	$1.0 million	$ .75 million
Tailing pond and water recirculation	2.0 million	.75 million
Hydroline	.4 million	.38 million
Expansion of milling facilities	1.5 million	.75 million
Crushing and screening plant or grinding	2.0 million	1.675 million
Open-pit equipment and transportation	5.0 million	3.68 million
Total	$9.9 million	~ $10 million

20% of total capital cost is estimated for possible major modification

6. Depreciation is calculated at 30% capital cost allowance.

7. The preproduction cost of further exploration drilling and the test are written off as incurred.

8. Production income equals operating profit less depreciation (financing cost is not deducted).

9. Depletion equals 25% of production income. As the project will reduce Noranda's total production income in the first three years, depletion is negative. This reduces the tax deferral to a certain degree.

10. Federal taxable income equals production income less depletion.

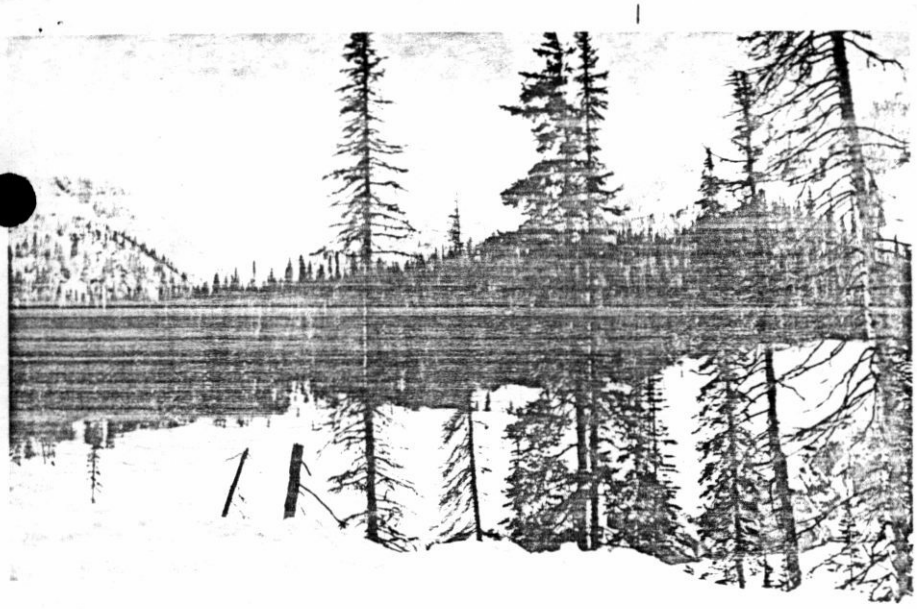
11. Only the 5% royalty is deducted: At the price of $2.42 no incremental royalties are payable.

12. Mining tax taxable income equals production income less royalties.

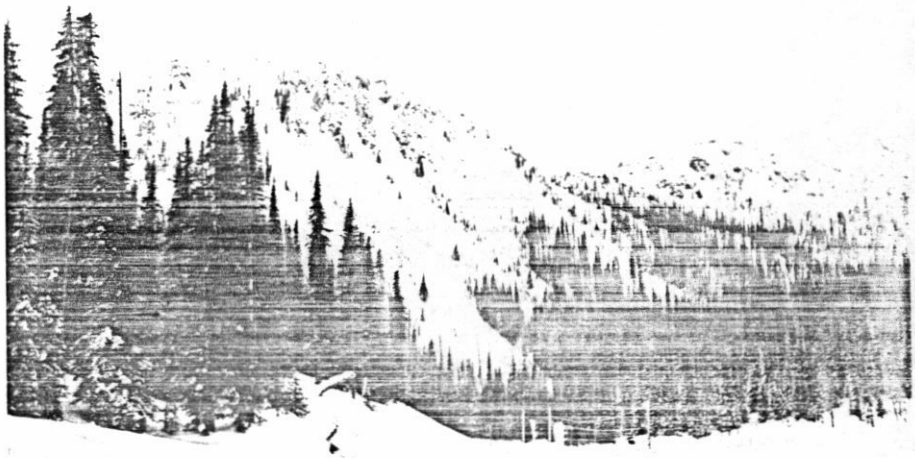
13. Provincial corporate tax taxable income equals mining tax taxable income less mining taxes, less a 25% depletion allowance on the remainder.

14. Net cash flow equals cash inflow minus cash outflow. Noranda's cash flow equals operating profit less capital cost, royalty and taxes. British Columbia's cash flow equals the Provincial corporate income tax, mining tax and royalty.

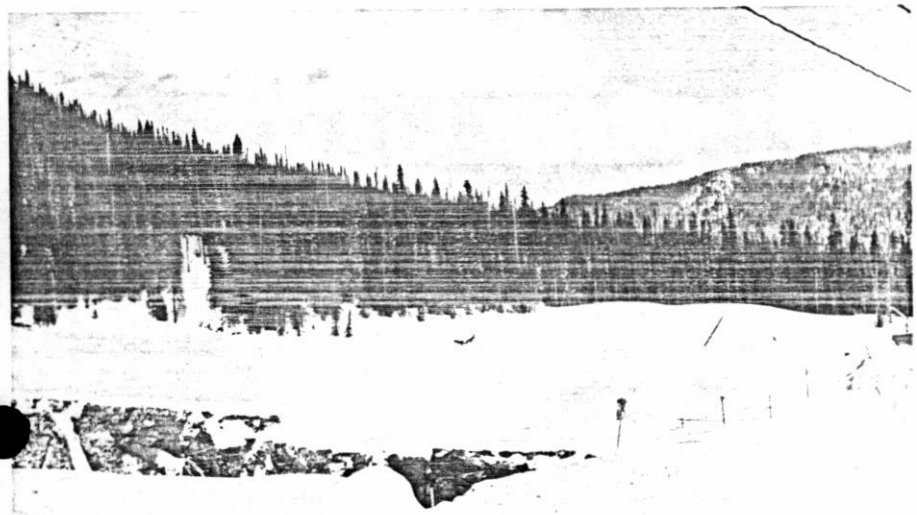
PHOTOGRAPHS



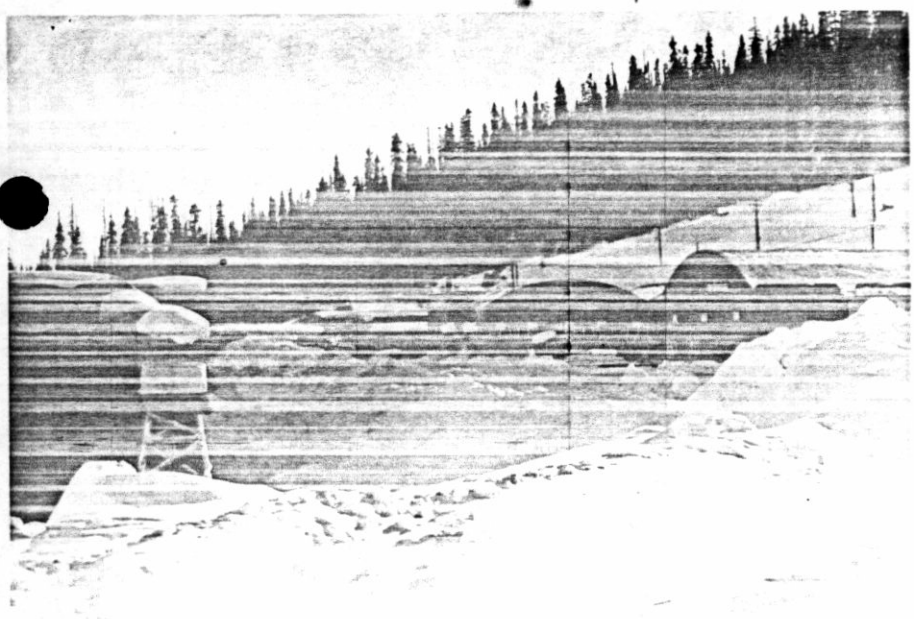
Northwest side of pit area with glory hole in foreground.



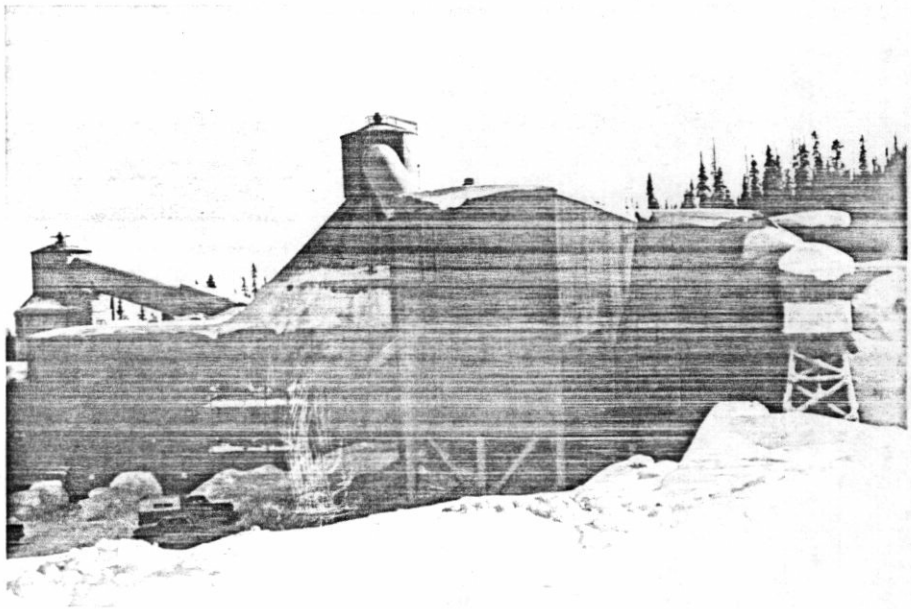
outhwest side of pit area.



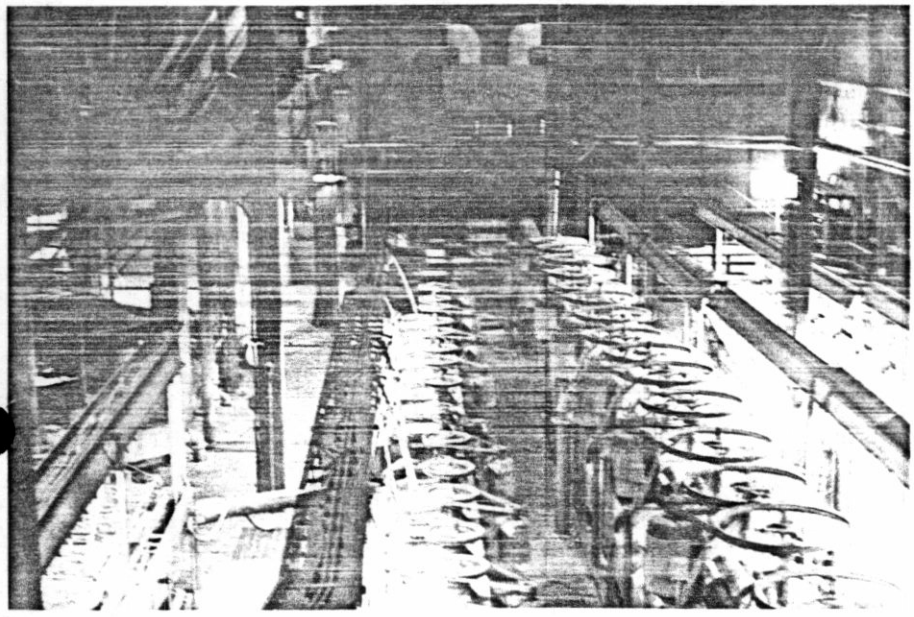
Glory hole and northeast area of future pit. Future pit area is cleared of trees. Overburden and waste would have to be dumped further east in the valley.



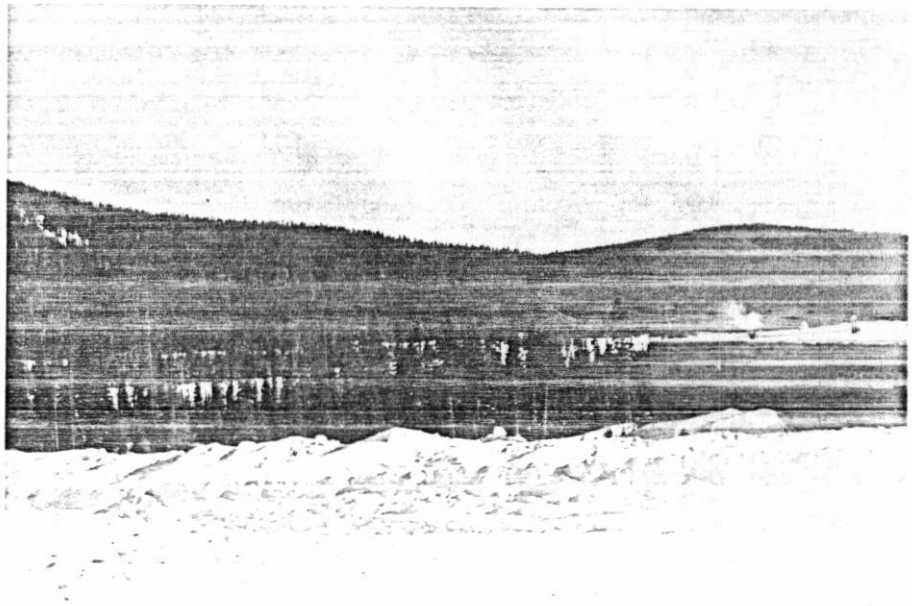
Crusher house and shops with adit in the background.



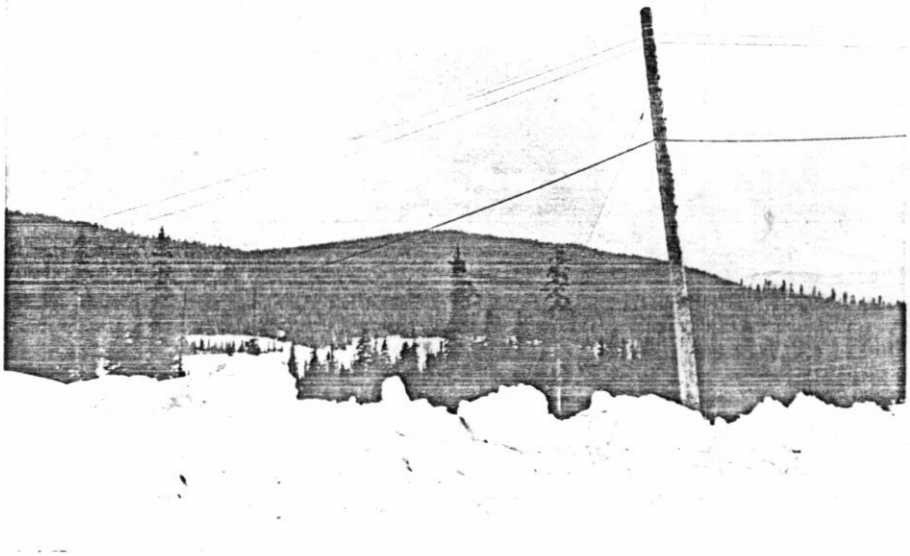
Concentrator and crusher of Boss Mountain. The large bin in the foreground is the fine ore bin. A second fine ore bin would be required for the pit project. The bin in the background is the coarse ore bin.



Flotation cells with drier and filter in upper lefthand corner. One more row of cells would be required for the pit project. This would require an extention of the mill.



Concentrator with tailings area in background.



Tailings area. The tailings area is situated on a saddle and requires a dam on each side.

PROPOSED TEST WORK, ENGINEERING
AND EXPLORATION FOR THE BOSS
MOUNTAIN PIT PROJECT

1)	Diamond Drilling HQ-2 3/8" 14,000 feet @ $10/ft.	$140,000
2)	Open pit and ore reserve computer program	100,000
3)	Mine, crush & screen 250,000 tons from trial pit @ $2.50/ton	625,000
4)	Rental of Processing Equipment & mobilization cost	500,000
5)	Purchase Mining Equipment	580,000
6)	Technical Labour & Supplies	30,000
7)	Haul and mill ore fraction	188,000
8)	Stripping for test pit 40,000 tons @ $1.00	40,000
9)	Contingency	132,000
total required including working capital		2,335,000
Less revenue from ore processed		783,000
Less salvage of mining equipment		290,000
Net cost of test program		$1,262,000