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J. SEFEL & ASSOCIATES

FALCON IRON ORE DEPOSIT

PINE PASS
MACKENZIE

OMINECA MINING DIVISION
BRITISH COLUMBIA

PRELIMINARY EVALUATION REPORT

BY

Robert L. Kemeny, B.Sc., A.R.S.M., P.Eng.
Consulting Mining Engineer

MAY 1979

STOKES EXPLORATION MANAGEMENT CO. LTD.
#713 - 744 W. Hastings Street
Vancouver, B.C. V6C 1A5

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FALCON IRON ORE DEPOSIT .

INTRODUCTION:

This report was prepared at the request of J. Sefel & Associates Ltd. of Calgary, Alberta. Its purpose is to:

a) review the information on the Falcon Iron Prospect, compiled by W.M. Sharp, M.A.Sc., P.Eng., in his report dated April 26th, 1976.

b) report on the subsequent helicopter-borne magnetic survey, carried out in October 1978.

c) review the preliminary feasibility study compiled by R. Glanville, B. App.Sc., P.Eng., M.B.A., on the economics of producing pre-reduced iron pellets via the Midrex Process, dated May 6th, 1976.

d) comment on the preliminary metallurgical results reported by H.E. Neal & Associates, mineral consultants.

e) summarize the current available technologies for producing marketable products from the property.

f) examine the underlying conditions and governing policies for a successful mining venture for short and long term.

g) assess the economic importance of the property, presenting a preliminary evaluation.

h) to recommend an exploration program and estimate the funds and time required for it.

The writer, R.L. Kemeny, B.Sc., A.R.S.M., M.I.M.M., M.A.I.M.E., P.Eng., has not visited the property as it has been under heavy snow cover since October 1978 when J. Sefel & Associates optioned it.

This report is prepared on the available information and its conclusions are based on the research and experience of the writer in evaluating iron ore deposits for private placement of exploration and development funds.

It is not for public financing at which time a detailed report would be necessary.

Continued . . .

CONCLUSIONS & RECOMMENDATIONS:

1. A field examination utilizing a magnetometer was carried out in April 1976 on the Falcon claim blocks situated 40 kilometers N.N.W. of MacKenzie, B.C. Samples from the strata-bound magnetite/hematite orebody assayed 30.4% - 57.0% iron.

2. Over the iron ore showings mapped in April 1976 by W.M. Sharp, P.Eng., a helicopter-borne magnetic survey was carried out in October 1978. The survey area was extended to beyond the claim boundaries and covered 57.6 square kilometers.

3. The magnetic survey delineated a deposit containing significant quantities of magnetic rocks over an aggregate strike length of 5,500 meters.

4. The tonnage potential of the magnetometer indicated geologically-inferred reserve amounts to 134.7 million tons per 100 meters of depth. The deposit is situated 30 kilometers from the Carbon Creek billion ton coal deposit, which is ready for development and owned by Utah Mines Ltd.

5. During the metallurgical test work done on material from the deposit, magnetic concentrates assaying 71.6% iron content and low impurities were obtained on a laboratory scale.

6. The concentrate is suitable for producing pellets, which could be marketed directly or used for the production of metallized pellets by direct-reduction technology.

7. The size and location of the deposit warrant home markets. Alberta, the Seattle area, Vancouver and Regina are potential markets.

8. These markets could absorb 400,000 tons of Direct-Reduced pellets annually in the early 1980's, and probably 600,000 tons annually by 1988.

9. Assuming 30 million tons of mineable resources and an average grade of 36% iron content, we estimate that the cost of bringing the property into production at a rate of 400,000 metric tons of direct-reduced pellets yearly, would range from 90 - 110 million U.S. dollars. A work program to final feasibility would require a minimum of two years and the expenditure of $3-5 million U.S.

10. Sufficient revenue (before tax) could be generated to pay back the investment within 5 years.

Continued . . .

CONCLUSIONS & RECOMMENDATIONS (continued)

11. At present pre-reduced pellet prices, the net present value of the project is 10.7 million dollars. Assuming price forecasts for the mid 1980's, the net present value of the project can reach 56.5 million dollars.

12. The project has sufficient potential and merits to warrant further exploration.

13. We recommend a multi-stage exploration program contingent on the results obtained at each stage. For the 1979 work program, $100,000 should be budgeted.

14. If the deposit proves to be sufficient in size and grade to support a profitable operation, we believe the principle problem to be solved will involve transportation, taxes, and establishing infrastructure.

    These items should be negotiated on provincial levels in British Columbia and Alberta, and also on a federal level.

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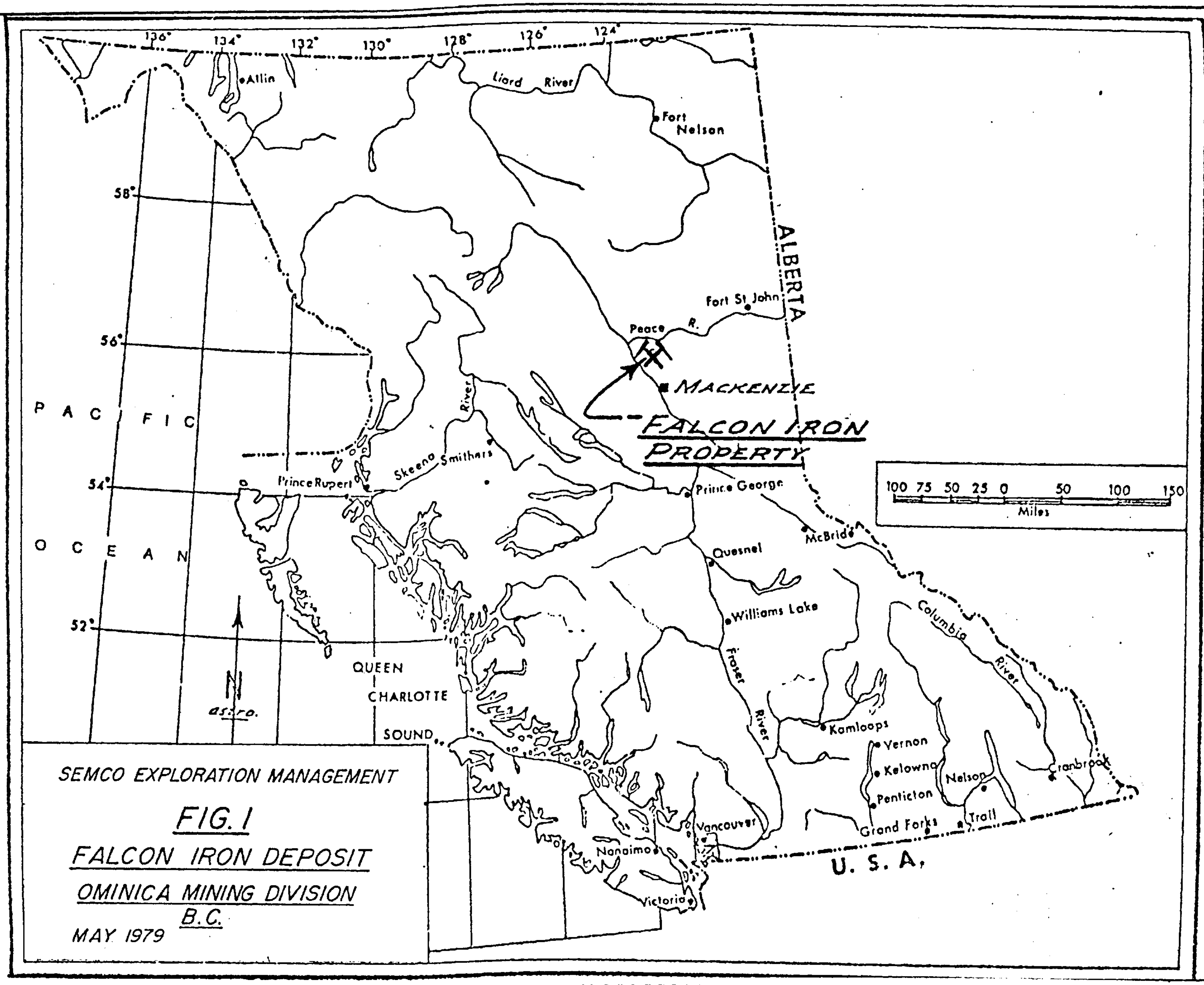

SEMCO EXPLORATION MANAGEMENT

FIG. I

FALCON IRON DEPOSIT

OMINICA MINING DIVISION

B.C.

MAY 1979

LOCATION & ACCESS:

General Descriptions

The Patsuk and Kimta Creek area east of Williston Lake's Parsnip Reach, which contains the iron ore deposit described in this report is situated about 40 Km north of the town of Mackenzie in British Columbia. The claims are located within the Misinchinka Range at longitude 123° 20' W, latitude 55° 42' N on map area NTS 930/11W. The claim block is located between 5,200 and 5,800 feet above sea level. (Fig. 1 & 2).

There are no roads leading to the property at the present time and access is by helicopter. The Williston Lake Road which extends along the Parsnip Reach of the Lake is about 6 Km distance from the property and could be reached by a 12 Km road to be built.

Mackenzie lies 25 Km from the railroad line which extends from Prince George to Dawson Creek, approximately 792 Km from Vancouver and 490 Km from Edmonton by rail.

HISTORY:

The iron ore mineralization was discovered in August 1975 by the prospector, A.R.C. Potter.

The claim blocks of Falcon #1 consisting of 20 units and Falcon #2 of 16 units, were staked between 3rd - 7th of April 1976, by A.R.C. Potter, and recorded in Vancouver. (Fig. 3)

Welcome North Mines Limited and Ventures West Capital Ltd., both of Vancouver, B. C., obtained the exclusive rights on the property from A.R.C. Potter by an option agreement, dated on 3rd July, 1976.

J. Sefel & Associates optioned the property from Welcome North and Ventures West on 11th October, 1978.

PHYSICAL FEATURES AND CLIMATE:

(Quoted directly from the report of Mr. W.M. Sharp)

"The topography within the general locality ranges from moderately rugged, to rugged, to locally precipitous.

The climate at the general elevation of the showings may be described as typically central-interior alpine. The relatively dry summer seasons probably extends from early June through September, with temperatures generally ranging between cool and warm. Over the remainder of the year, temperatures would be expected to range from cold to extremely cold. The moderate amount of precipitation during the winter accumulates as snow, with normal depths probably reaching a maximum 8 - 10 feet at the general elevation of the showings."

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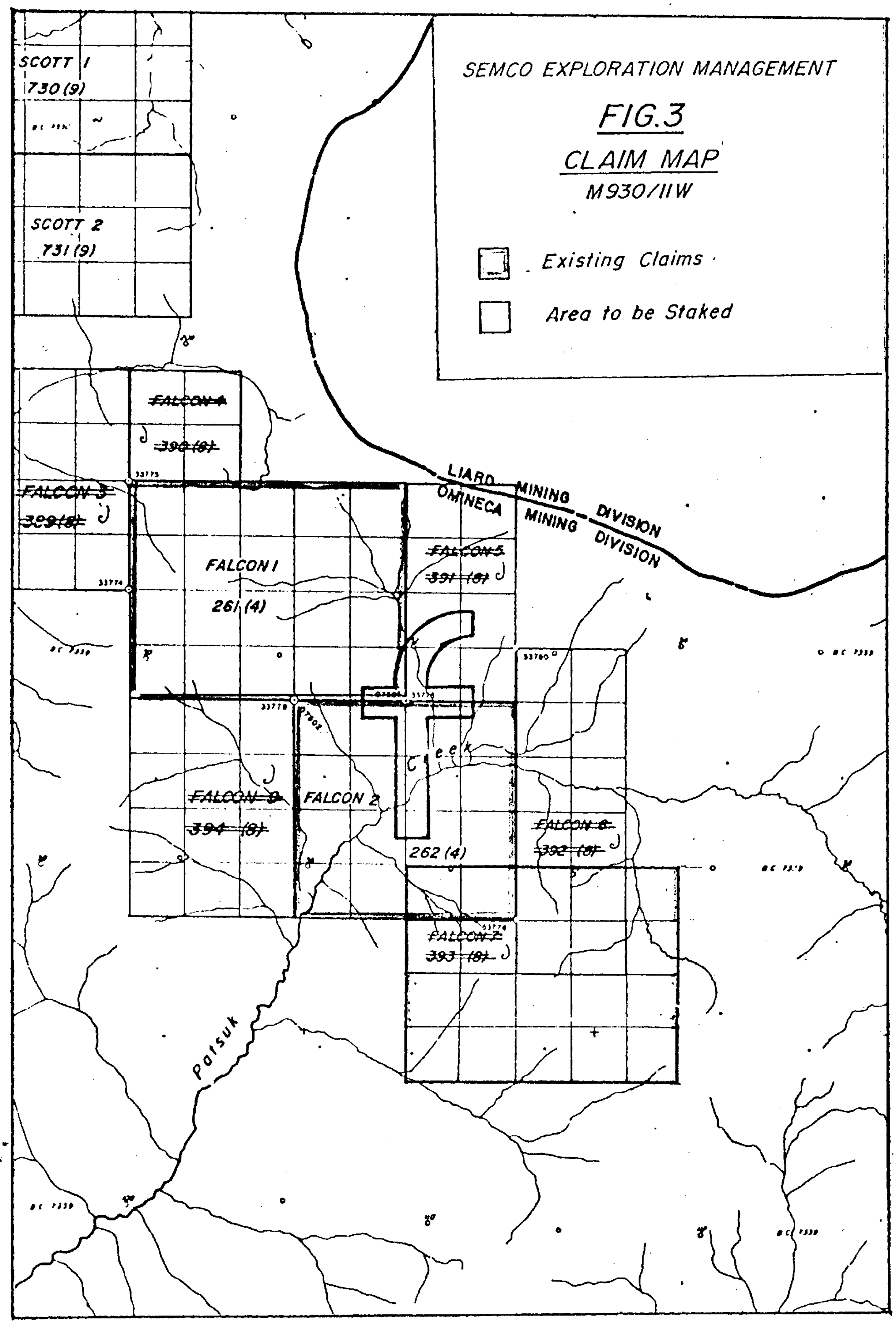
SEMCO EXPLORATION MANAGEMENT
FIG.3
CLAIM MAP
M930/11W
Existing Claims
Area to be Staked
SCOTT 1
730 (9)
SCOTT 2
731 (9)
FALCON 4
390 (8)
FALCON 3
389 (8)
FALCON 1
261 (4)
FALCON 5
391 (8)
LIARD MINING DIVISION
OMINECA MINING DIVISION
FALCON 9
394 (8)
FALCON 2
262 (4)
Creek
FALCON 6
392 (8)
FALCON 7
393 (8)
Patsuk

REGIONAL GEOLOGY:

"The Falcon Iron showings situate within the Eastern Marginal Tectonic Belt of the Canadian Cordillera near its west edge, (Fig. 4) and within the westerly-flanking ranges of the Rocky Mountains. Rocks within this belt rather uniformly strike northwestward or parallel to the general Cordilleran trend. They also display regional continuity, in that series and formations of similar age and lithology extend from southeastern B. C. into and through the Yukon. Within much of the belt the rocks are predominantly fine to coarse-grained metasediments and clastic sediments with a high proportion of carbonates, and are of Upper Proterozoic to Lower and Middle Paleozoic age. To a lesser extent, strips of similar rock occur within the Omineca Belt to the west across the dividing Rocky Mountain Trench.

The style of structural deformation within the Rocky Mountain section of the East Marginal Belt is one in which the gross section of rocks have been displaced and stacked by several roughly parallel, generally low-angle, eastward-directed thrusts. Within British Columbia there is some evidence of the existence of at least three major deep-seated, probably high-angle faults cutting the gross Cordilleran Belt. These probably reflect the occurrence of persistent displacements on basement structures initiated in early Precambrian time. The middle one of these is shown cutting the general section on a line positioned some 30 miles northwest of the Falcon Iron property. The possible association of clusters of mineral deposits within broad belts centered on these structural features has often been mentioned in the geological literature.

At the Falcon Iron property the chert-magnetitite/hematite mineralization occurs within soft schistose argillites, greywackes and related sediments which are included in a broad formational unit of Hadrynian argillite, phyllite, sandstone, limestone, and grit. The mineralization comprises a stratiform desposit - possibly of the "Shuswap" type. The local host rocks and mineralization reflect a typical structural incompetence and appear to have been closely and frequently complexly folded. Also, the type and lithologic setting of the mineralization are, on the basis of the writer's understanding, similar to that existing at the 2-billion ton-plus Crest chert-hematitie (taconite) deposit of the north Yukon section of the East Marginal Belt. The Crest deposit, however, has not yet been developed, by reason of its remote location in respect of major supply, service, and transportation facilities.

The regional strike length of the particular Precambrian formational unit hosting the Falcon Iron mineralization exceeds 30 miles. Consequently, there are no apparent lateral restrictions that might influence decisions relative to prospecting and exploration on a broader, or regional scale."

Continued . . .

PROPERTY GEOLOGY & MINERALIZATION:

(a) Lithology and Apparent Structure

"Bedrock, where exposed within a few very local snow-free areas, was tentatively identified as strongly schistose black argillite and slaty-to-schistose grey to brown argillite and greywacke. Some massive, apparently-sedimentary rocks also occur within the local formation: however, most of these comprised ridge and upper-ridge exposures which were inaccessible at the time of the examination.

There were no obvious bedding structures within the rock exposures examined by the writer. Cleavage and schistosity, however, are well developed - with strikes and dips, respectively, ranging between N30° - 70°W and 25° - 80°SW. The observed structures are indicative of a highly deformed assemblage of relatively incompetent rocks. Cross-sectional features of the gross formational unit are not known.

(b) Mineralization

The snow cover at the time of the examination precluded inspections of the mineralization across most of its apparent (magnetometer-indicated) width at any of the mapped exposures. What was seen consisted of mixed, hard, fine-grained magnetite, with apparently, generally subordinate hematite. This was generally substantiated by streak-tests, which ranged from dark brown to black. No other metallic minerals were observed in the material examined. Some degree of colour-banding (banded Feoxides or interbedded oxides and waste rock) was evident on most occurrences. This feature is, reportedly, quite pronounced within some relatively lower-grade mineralization occurring in the central saddle area, where part of the material exposed consists of thin bands of magnetite/hematite and grey, white, buff, and red-brown (jaspilite) chert. This occurrence could be considered to be at least one variety of 'taconite' - the characteristic low-grade ore of the Lake Superior (and Crest) sedimentary iron formations.

Mineralization within the strike interval of the zone which was examined by the writer occurs in two parallel bands. On the basis of the interpreted magnetometer data both have apparent horizontal widths which range between 100 and 300 feet. Locally, two outcrops provide actual evidence of good grade iron mineralization across widths of at least 40 feet. Coincidentally, each band was traceable over a N.W.-S.E. length of about 3840 ft. (1170 m.) The structural and magnetometer evidence indicate that both bands dip steeply to the southwest. Currently, two possibilities exist: the first being that they comprise separate mineralized units within the section, and the second that they comprise the (truncated) upper and lower limbs of a partly over-turned, anticlinal or synclinal fold. On the west band, continuity to the northwest appears to have been at least locally interrupted by a fault, or by buckling or pinching of the mineralized band itself.

Continued . . .

Mineralization on both bands is open to the southeast. From current indications of its general trend, it would appear to extend at least an additional 8300 ft. southeasterly, with more or less local interruption or complication, to the separate exposure found by Mr. Potter in the S.E. corner of Falcon #2 claim.

The general depth continuity of the mineralization is assured by reason its sedimentary origin or relationships. However, as it occurs within an obviously deformed panel of relatively incompetent rocks, its width and character at deeper horizons may well be affected by local structural complications - with either adverse or beneficial results. A moderate amount of additional geological and magnetometer exploration to the southeast and down-slope of sta 10-1 (Dwg. 76-1) should provide at least local information on 'cross-sectional' features of the mineralization. (Fig. 5)

(c) Sample/Assay Details

Systematic sampling was not attempted or even seriously considered during the recent examination, in view of the very limited area of bedrock exposed. Consequently, the writer took only two "character samples" of material that appeared to be geologically representative of the local mineralization. These were later submitted for analysis by Chemex Labs of North Vancouver - primarily for a determination of impurities accompanying the iron mineralization. The results are as follows:

Sample No.	% 'Equiv. Fe_2O_3'/Fe	% TiO_2/Ti	% P_2O_5/P	% S
40273	45.29/31.7	0.62/0.37	0.10/0.44	0.01
40274	43.40/30.4	0.65/0.39	0.17/0.074	under 0.01

Continued . . .

EXPLORATION:

In July 1976 A.B. Mawer, Geologist of Cominco, examined and sampled the outcrops on the property. His geological interpretation of, at that time available data, is shown in Figure 6. Although no report has been obtained from Cominco on his evaluation of the deposit, we understand that Cominco abstained from acquiring the property for:

(a) the owners' terms of acquisition were unacceptable for the company.

(b) Cominco has been searching for iron deposits of several hundred million tons of potential for export markets and Mr. Mawer's cursory examination indicated that the deposit seen within the Falcon #1 claim block didn't have that potential. They estimated a 40 - 50 million tonnage potential carrying acceptable ore grade for pelletization.

Subsequent to optioning the property by J. Sefel & Associates, Stokes Exploration Management Company Ltd. (SEMCO) was retained to manage an exploration program. SEMCO suggested an airborne magnetic survey to be carried out over the claim block and its vicinity. A work program was started by a helicopter-borne magnetic survey flown on October 26th, 1979 by Aerodat Limited.

The attached total field magnetic map - Misinchinka Range Area - (see Aerodats Report), shows the five magnetic anomalies discovered. One of the anomalies (1A) corresponds to the known orebody surveyed by W.M. Sharp and B. Mawer. A smaller orebody southeast of it is within the claim block and the anomalies 3A, 3B, and 3C lie outside the Falcon #1 and #2 claims.

The ground on which these anomalies were located, is being staked currently for J. Sefel & Associates.

The magnetic survey indicates that the extention of the magnetic rocks is considerable, approximately 5,500 mt along strike. It appears to be a steeply, dipping orebody of 40 - 150 mt wide. Faulting broke the continuity and three distinctive ore zones can be identified. The following is quoted directly from the report of R.F. Sheldrake, B.Sc., Appendix VI.

Geophysicist: -

"The survey consisted of 61 traverse lines and one tie line, for a total of 315 linear kilometers. The survey block is 4.8 km wide x 12 km long and is located 7.5 kilometers northeast of the confluence of Kitma Creek and Six Mile Creek. The greater dimension of the survey block is oriented parallel to the Misinchinka Range. Some of the survey traverses penetrate the Liard Mining Division, whose boundary protrudes into the survey block.

Continued . . .

"The terrain within the survey area varied from 1,156 meters to above 1,795 meters with the steepest topographic gradients range between 40% - 50%.

"The airborne magnetic survey has delimited three zones of magnetic rocks over an aggregate strike length of 5,500 meters."

MINERAL INVENTORY:

At the present stage of exploration when no drilling has been done on the property which would permit to demonstrate proven or probable reserves, our preliminary assumptions as to the minimum tonnages and average grade probably present for the purpose of determining the value of the deposit, can be based only on the magnetic and limited geological data.

Interpreting Anomaly #1A, W.M. Sharp states:-

"the writer has tentatively interpreted the two parallel NW-trending bands of mineralization. However, due to the fact that magnetometer readings were taken at heights of from 2½ feet to probably over 30 feet above bedrock, the resulting gamma values are bound to contain inconsistencies which would not be present to the same degree if the survey had been made over bare ground. Also, actual boundaries of mineralized zones are much less clearly indicated by magnetometer survey methods than they would be under bare-ground conditions. For current estimating purposes, mineralized widths are interpreted as being less than the magnetometer-indicated widths - whether or not this is actually the case."

Figures 5a, and 5d illustrate the magnetic and geologic data and magnetometer survey profiles, compiled by W.M. Sharp.

Continued . . .

ORE RESERVE POTENTIAL:

W.M. Sharp calculated the tonnage potential of the deposit based on "mineralization grading 50% (magnetite and hematite) and 50% gangue minerals. On this basis the tonnage factor amounts to 9 1/3 cu. ft. per long ton. The current estimates are restricted to the magnetometer-indicated strike-intervals shown on Dwg. No. 76-1." (ANOMALY #1A).

"West Band"			"East Band"		
Length	1170 m. =	3,840'	Length	1170 m. =	3,840'
Average Width	78.94 m. =	259'	Average Width	56.08 m. =	184'
(A) Cut-Width @ 75%		194'	(A) Cut-Width @ 80%	=	147'
Horizontal Area = 744,960 sq. ft.			Horizontal Area = 564,480 sq. ft.		
Long tons per vert. ft. =		79,846	Long tons per vert. ft. =		60,502
LT/ 100 vertical ft.		= 7,984,600	LT/ 100 vertical ft.		= 6,050,200

Total, East and West Bands per 100 vert. ft. = 6,050,200
7,984,600

14,034,800 long tons

More Conservative Calculations:

(B) Cut Width @50%	92'	(B) Cut Width @50%	129.5'
Long tons per vert. ft. =	37,865	Long tons per vert. ft. =	53,299
LT/ 100 vertical ft.	= 3,786,500	LT/ 100 vertical ft.	=5,329,900

Total, East and West Bands per 100 vert. ft. = 3,786,500
5,329,900

9,116,400 long tons

Continued . . .

PRODUCTION OF MARKETABLE PRODUCTS:

The ore samples taken from the outcrops of the orebody 1A assayed:

SAMPLE	Fe TOTAL %	P%	S%	Ti%	As%
#1	31.7	0.044	0.01	0.37	0.1
#2	30.4	0.074	0.01	0.39	N/A
#3	42.0	N/A	N/A	N/A	N/A
#4	56.0	N/A	N/A	N/A	N/A

All impurities are well within the acceptable limits for this type of ore.

The preliminary metallurgical tests carried out in May 1976 by H.E. Neal & Associates Ltd. of Toronto, and by the Lakefield Research of Canada Ltd. of Lakefield, indicated that using conventional beneficiation processes:

a) Magnetic concentrates with over 71% Soluble Iron were produced from the two samples. This grade of concentrate is suitable for direct reduction production of metallized pellets.

b) Magnetic Iron Content - by Davis Tube Test

Sample	Magnetic Concentrate			Grind
	% Wt	% SolFe	% FeRecovery	% -400 M
1	45.8	71.8	77.7	100.
2	73.1	71.4	92.2	56.2
	72.1	71.8	91.5	91.3

Sample 2 had a higher proportion of iron present as Magnetite than Sample 1 showing a 92% Fe Recovery versus 78% Fe Recovery for sample 1 by magnetic separation.

c) Concentrate Analyses

The concentrates from Sample 2 were analysed for elements which might be undesirable for iron concentrate. The level of trace elements is within normal acceptable limits.

Continued . . .

Soluble Fe	71.6%
Titania (TiO_2)	0.11%
Silica (SiO_2)	0.70%
Sulphur (S)	0.006%
Phosphorus (P_2O_5)	0.05%
P	0.011%

The alternatives for beneficiation and agglomeration are described in detail in Appendix II. H.E. Neal & Associates' report is attached as Appendix III.

Nevertheless, before any recommendations could be made as to what technology should be applied, laboratory tests should be conducted in search of ways to take advantage of the ore's competency. Once a representative sample is obtained, much should be learned about the relationships between crude ore, size structure and amenability for concentration, pelletization and direct reduction.

After concentrating and/or agglomerating, the ore can be processed into iron by three methods:

1) Smelted in a blast furnace to produce pig iron.

2) Partially reduced and then fed to a blast furnace.

3) Reduced and then fed to an electric furnace for use directly in steel-making.

The blast furnace is still the most efficient for reducing large tonnages. However, capital requirements, transportation costs of suitable reductant and fuel make other methods more desirable.

The use of high grade feed such as pellets, which have been "direct reduced", converted without smelting from hematite to metallic iron, substantially increases the efficiency and lowers the overall cost of production.

For an operation at a remote area - such as the Falcon Deposit - direct reduction is an attractive possibility since it permits the iron ore and low-cost-readily-available-energy - coal - to be combined into a single product.

Transportation costs are substantially reduced since the iron moves as an element instead of an oxide and the energy reductant works at the plant site.

Continued . . .

Direct-reduction (DR) producing sponge iron as a prime product for alternative steel-making has in recent years achieved final commercial breakthrough in steel-making.

DR iron can be used to replace all or part of the pig iron or scrap in cold-melt steel-making and foundry operations.

DR iron is especially valuable for feed to electric arc furnaces making high-grade steel because it is much lower in the trace elements normally found in most scrap.

Direct iron processes can be classified according to the reductant used. These can be:

a) Gaseous reductants like hydrogen and carbon monoxide.

b) Solid reductants like coal and coke.

A number of proven processes are available for the two alternative routes.

A short summary on different processes and technologies currently used in the industry, is given in Appendix II.

Continued . . .

THE STEEL MARKET IN WESTERN CANADA:

The most important steel-using industries in Canada over the last two decades have been the construction, metal stamping and pressing, automotive, and steel pipe and tube industries. Growth in the automotive sector has been the most rapid of these four by far.

However, the importance of pipe and tube mills as a steel-using industry, especially in the Prairie Provinces is growing rapidly.

Further increases in steel consumption of these industries is expected in view of the demand for more pipelines in the gas and oil industries.

Total demand for rolled steel products in British Columbia is projected to reach approximately 1.785 million tons by 1995, at a growth rate of 4.9 percent from 1973. This rate of growth exceeds the historical rate of 3.7 percent (1956-74) in British Columbia, and also expectations for growth in steel demand for Canada of about 4.0 percent.

R. Glanville in his study (Appendix IV) stated "The market for pre-reduced pellets in Western Canada and Washington by the late 1980's might be a total of 1,300,000 ton/year."

We agree with the concept of a 1.3 million ton of market potential in the 1980's, but believe that substantial proportion of the demand will be met from the U.S. (especially for the consumers in Seattle and Regina).

We feel confident, however, that 400,000 t/yr of direct-reduced sponge iron 92% - 95% Fe, or up to 600,000 t/yr of 65-67% Fe could be absorbed by the market without difficulty.

THE FALCON IRON DEPOSIT IN PERSPECTIVE OF THE STEEL MARKET:

In terms of quantities, steel is the single most important metal used in our industrial society.

An analysis of future supply and demand for steel in Canada and more particularly in Western Canada is a prerequisite to forecasting the need of establishing any new iron-producing facilities in the country.

According to studies carried out by the Department of Energy, Mines and Resources, Ottawa, "raw steel consumption nationally is forecast at 20.5 million tons in 1980, 25.4 million tons in 1985 and 35.2 million tons in 2000. This compares with forecasts of producer shipments of 19.1 million tons in 1980, 23.2 million tons in 1985, and 33.0 million tons in 2000.

Continued . . .

Canada's trade position with respect to steel is expected to worsen, shown in Appendix V. Steel Supply & Demand. Although this trend is predicated on past and current developments, the factors causing the trade imbalance in general promise to itensify. "Among the most significant factors on the import side are: the possibility of lower Canadian tariffs, the selling of foreign steel at distressed prices in the Canadian market, the logistics and cost of shipping Canadian steel to east and west-coast markets, and the availability of capital. On the other side of the coin, growth in Canadian exports is expected to remain moderate because of competitive factors, tariffs, non-tariff barriers or protectionism, (higher fuel and freight rates), possible energy constraints and steel self-sufficiency in many developing nations that traditionally have imported Canadian steel.

The growing trade imbalance will have tremendous repercussions for the Canadian economy. A production shortfall by 1985 of 2.2. million tons of crude steel translates into a loss of investment of $2 billion in terms of current dollars and a loss of about 10,000 jobs for Canadians in the primary iron and steel sector and in the production of raw materials. Closing this gap is indeed an opportunity Canada should not miss."

THE ROLE OF STEEL SCRAP IN THE INDUSTRY:

Regarding supplies or iron and steel scrap, in a study made in 1976 it was stated: "The demand for purchased scrap in the steel and castings industry is expected to increase by 13% to 1980 and 23% to 1985. If it were not for reduced iron coming onto the market, the requirements for scrap would be substantially higher.

This scenario depicts a potential worsening situation with respect to purchased scrap supply. Meeting of growth requirements will depend largely on the availability of imported scrap, which already accounts for 25% of Canadian purchased scrap needs. "This dependency on imports, mainly from the U.S., was exposed in 1973 and 1974 when a shortage in the U.S. resulted in restrictions being placed on exports to all countries, including Canada."

These restrictions emphasized Canada's vulnerability, and the need to improve the security of supply by finding alternatives like substituting scrap by direct-reduced iron.

Scrap prices, in recent years, have been fluctuating from $45/t up to $170/t. Presently the price is $91/t - $94/t F.O.B. Chicago.

Continued . . .

The price of pre-reduced pellets follow closely the scrap market. Usually as the pre-reduced pellets are free from tramp elements, the price is $10 - $15/t higher than scrap.

SIDBEC is selling DR pellets (Midrex Products) at U.S.$104.00 - $106.00/LT F.O.B. East Coast. Market analysis and price forecasts made by Midrex indicate a steep increase in price of their products in the 1980's, some figures released, indicate an expected U.S.$160/t F.O.B. price for the year 1985.

The study pointed out "scrap is costly to ship by rail, and in scrap-deficient areas such as Regina or Edmonton, expansion of electric steelmaking will depend on the availability of reasonably priced imports or reduced iron," and wisely concluded "there is a clear indication that the demand for steel-making raw materials by the Canadian steel industry will remain strong throughout the remainder of this century. Canada, with its large resource base of coal and iron ore, should be in a position to fill the bulk of these future demands. However, this fulfillment will not be realized unless the competitiveness of Canadian raw materials is enhanced. The solutions are complex in that they require close communication and cooperation between industry and Governments at all levels."

The growth forecast for the Canadian steel industry does not include the potential development of large iron and steel-making facilities on the east and west coast, which could use Canadian resources of coal, iron ore and labour for making semi-steel or even finished steel products.

Both Federal and Provincial Governments will be interested in the Falcon Project as it fulfills one of the major objectives of current Federal Government policy for the upgrading of raw materials prior to export. The project might also provide a means of rationalizing Alberta's iron ore (steel) requirements. Federal Government support will enhance the viability of the project, because of the need for Government investment in infrastructure, provisions that will satisfy FIRA, and Government negotiations in the matter of safeguards, tariffs and non-tariff barriers.

Continued . . .

For a proper profitability analysis of the reserve information, assumptions on technical operating data and the expected tax structure should be combined to provide the potential investor with an overall measure of the attractiveness of the Falcon project.

However, even a preliminary examination of the combinations of technology, taxation and marketing presents so many possibilities that a computer program should be written to calculate rates of return for any given set of circumstances.

This work should be undertaken contingent on positive results of the second stage of the exploration program outlined in the respective chapter.

Unless the market and other estimates are unduly optimistic, the feasibility of an iron ore operation for producing pellets or direct reduced iron from the Falcon deposit will depend upon proving sufficient reserves and locating a potential investor who has some special advantage.

For example, an investor who had one or more of the following:

- a captive market, which is now being supplied with iron ore feed from elsewhere.

- the ability and willingness to finance the project.

A decision to invest capital in developing a new mining operation reflects both the economic projections (referred to above) and an evolution of intangible factors (political and geographic) affecting the operation to the extent that there cannot be reflected in the cost estimates.

In general, adverse intangible factors tend to increase the grade of ore required to make the venture attractive, and favourable intangible factors may make the sales value-cost spread more attractive.

A new iron ore industry simply could not at present depressed prices and existing taxation risk the capital to develop a mine. The industry should receive from both Federal and Provincial Governments, that an operation based on opening up the Falcon Deposit,will support a tax burden permitting:

a) a capital recovery system that would permit the write-off of all investment costs within five years.
b) reduction in corporate income taxes. This would increase the amount of cash flow industry can retain and invest.

Continued . . .

R. Glanville, B.App.Sc., P.Eng., M.B.A., in May 1976, prepared a"Preliminary Feasibility Study - Economics of Producing Pre-reduced Iron Pellets Via the Midrex Process."

These calculations (attached in Appendix IV) are based on the assumptions of available:

a) 50,000,000 T mineable reserves.
b) 45% Fe average grade of iron ore.
c) 1,300,000 Tons of yearly output of Direct-Reduced pellets.
d) Available markets for the products in Western Canada and the U.S.

Under these premises and a 200 million dollar investment, the Internal Rate of Return on 100% equity would be 16.25% and 27.0% if 50% equity/50% debt financing is arranged.

Our preliminary evaluation of the project is based on a ore grade of 36% Fe and our forecast for available markets is in the range of 400,000 - 500,000 T/yr. for Direct-Reduced Pellets.

There also might be a possibility that taconite-type (not reduced) pellets could also be marketed.

Continued . . .

ECONOMIC POTENTIAL:

From an overview of the aero-magnetic survey results, and geology, it doesn't appear plausible to draw comparisons between the Falcon deposit and the huge Snake River (Crest) taconite deposit on the northern edge of the MacKenzie Mountains of the Yukon/ Northwest Territories boundary, neither for its extension nor for its tonnage potential.

At Snake River, the thick Jasper-hematite formation is near the base of shaley conglomerates.

The deposit extends over an area of 30 miles by 10 miles on the gently, dipping limb of the MacKenzie Mountain. There are several billion tons of iron-bearing rocks in the area.

However, within the relative limitations of the extension of the magnetic anomaly at Falcon, it is still reasonable to assume that the mineralizations is continuous in depth down to - or over 100 mt. in view of:

a) outcrops appear on 5,100 ft. and also on 5,500 ft. elevation. The difference being 400 ft. or 120 mt.

b) mineralization along strike can be followed for 1,170 mt. on magnetic anomaly 1A.

It is unlikely that such a lateral extension of mineralization should not extend in depth to at least 10 - 30% of strike length.

PRELIMINARY ECONOMIC ASSESSMENT:

Production target:

a) 400,000 t/yr. Direct Reduced Pellets, or alternatively

b) 550,000 t/yr. Pellets

ASSIGNED PARAMETERS:

The following parameters are assigned to this economic assessment:
T=metric ton $=U.S.$ M$=million U.S.$

a) In respect of mineralized reserves and grade:

Theoretical Reserves:

-Length of Orebody:	5,500 mt
-Mineralized width:	70 mt
-Assumed depth:	100 mt
-Ore grade, average minimum:	36-38% Fe
-Total iron:	36%

-Inferred reserves: 5500 x 70 x 100 x 3.5 = 134,750,000 T
-Mineable reserve: 33% of inferred reserves = 44,000,000 T

Continued . . .

PRELIMINARY ECONOMIC ASSESSMENT (continued)

b) In respect of mine production:

-Mining Method:	Open pit
-Strip ratio:	1.5 waste to 1.0 ore
-Yearly production:	1,200,000T ore
-Yearly stripping:	1,800,000T waste
-Total Material Handled:	3,000,000T/yr
-Operating days/year:	300
-Life of Mine:	44,000,000: 1,200,000 = 36 years

c) In respect of beneficiation and pelletization:

-Concentrator capacity:	4,000 T/day
-Metallurgical recovery:	85%
-Grade of concentrate:	67% Fe
-Pelletization:	670 Kg Fe
-	360 Kg Fe x 0.85 = 2.2. T ore/T Pellet
-Pelletizer:	600,000 T/yr
-@ 92% availability	550,000 T/yr

d) In respect of Direct Reduction:

-Production target:	400,000 T/yr
-Metallization:	92% Fe
-Operating Losses:	4% in weight
-Plant capacity:	920 Kg Fe
-	670 Kg Fe = 1.373 T pellet/T Direct Reduced Iron
-Pellet Plant Capacity:	(1.373 + 4%)/T DR pellet x 400,000=571,000 T/yr

CAPITAL OUTLAY:	US$1000
-Mining Equipment, Concentrator	$40,000
-Pelletizing Plant	15,000
-Direct Reduction Plant	40,000
	$95,000

OPERATING COSTS:	YEARLY EXPENSES US. US X $1000
-Mining 0.70/T x 3,000,000	$ 2,100
-Beneficiation $2.5/T x 1,200,000	3,000
-Pelletization $4.0/T x 571,000	2,300
-General expenses $1.0/T x 1,200,000	1,200
-Direct Reduction costs $40/T x 400,000	16,000
-Refurbishment expenses	600
-Transport to market $17/T x 400,000	6,800
	$32,000

Continued . . .

PRELIMINARY ECONOMIC ASSESSMENT (continued)

e) In respect of Depreciation and Taxes:

Accelerated depreciation scheme and taxation system to be agreed upon with Federal and Provincial Governments.

f) In respect of Royalties:

Property owners receive: 2% of gross sales revenue.

g) In respect of sales revenues:

Direct-Reduced Pellets	
Today's price:	
-FOB Atlantic Port	104.00 $/T
-FOB Edmonton (approx)	144.00 $/T
Future Price Forecast:	
-FOB Edmonton (approx)	174.00 $/T
Scrap Iron	
Today's price:	
-FOB Chicago	90-93 $/T
-FOB Edmonton (approx)	127.00 $/T
Future Price Forecast:	
-FOB Edmonton (approx)	160.00 $/T

-Present yearly sales revenue, (assuming similar prices will be attained): 400,000 x 144 = $56,600,000/yr.

-Future yearly sales revenue:
400,000 x 174 = $69,600,000/yrd.

INVESTMENT & CASH FLOW ANALYSIS:

	AT PRESENT DR. PELLET PRICES $x1000	WITH FUTURE DR. PELLET PRICES $x1000
Sales Revenue	57,600	69,600
-Operating Costs	32,000	32,000
GROSS PROFIT:	25,600	37,600
-Royalties	1,200	1,400
YEARLY INCOME BEFORE DEPRECIATION & TAX:	24,400	36,200
PAYBACK PERIOD:	<4 years	<3 years

If tax holiday could be negotiated until the entire investment can be recovered, the Payback Period is less than 4 years.

Continued . . .

INVESTMENT & CASH FLOW ANALYSIS (continued)

Under this assumption, the Net Present Value (NPV) of the Future Cash Flows will be:

NPV ANALYSIS:	AT PRESENT DR. PELLET PRICE $x1000	WITH FUTURE DR. PELLET PRICE $x1000
Gross Profit	25,600	37,600
-Royalties	1,200	1,400
TAXABLE INCOME:	24,400	36,200
Tax 50%	- 12,200	- 18,100
CASH FLOW:	12,200	18,100

ASSUMPTIONS:

-Life of Operation:	25 years (only)
-Discount Rate:	15%/yr
-Investment Period:	3 years
-Year 0:	3 M$
- 1:	20 M$
- 2:	30 M$
- 3:	67 M$
-TOTAL INVESTMENT:	100 Million $
-Tax Holiday:	4 years
-Tax, from 5th year of operation:	50%

F = Discount Factors from Tables

NPV = Present Value of Future Cash Flows - Present Value of Investment

A. At present DR Pellet Prices:

4 yrs. Payback Period (no tax) Years 4 - 7	21 yrs. Operation 50% tax Years 8-29	Period of Investments &Consumption Years 0-3
NPV=24.4 x P/A +	12.2 x P/A x P/F =	3 + 20 x P/F_1 + 30 x P/F_2 + 67 x P/
NPV =10.7 M$		

B. At future DR Pellet Prices:

NPV=36.2 x P/A +	18.1 x P/A x P/F =	3 + 20 x P/F + 30 x P/F + 67 x P/F
NPV = 56.5 M$		

Continued . . .

TACONITE PELLET PRODUCTION:

If marketing possibilities for taconite-type 67% Fe pellets (not reduced) would exist in the Edmonton/Seattle area, the profit margin would be higher.

As the freight from the East or from Duluth to Edmonton is in the range of 34-38 $/T and from the Falcon Deposit it is assumed to be $17/T, there is an important saving in using pellets from the Falcon Project.

Cash Flow Projection for Pellet Production:

	$ x 000's
- Mining 0.70/T x 3,000,000	$2,100
- Beneficiation $2.5/T x 1,200,000	3,000
- Pelletization $4.0/T x 571,000	2,300
- General expenses $1.0/T x 1,200,000	1,200
- Refurbishment expenses	600
- Transport to market $17/T x 550,000	9,400
	$18,600

Sales Revenue:

For Taconite Pellets

-Today's price - Lower Lake Port, FOB:	65¢/unit
67% Fe x 0.65$/% Fe =	43.5$/T FOB Lower Lake
-(approximate price) FOB Edmonton:	78.0$/T

- Present yearly sales revenue (assuming similar prices will be attained): 550,000/T x 78.0 = $42,900,000/yr

	$x1000
Sales Revenue:	$42,900
-Operating costs	18,600
Gross Profit:	24,300
-Royalty	900
YEARLY INCOME BEFORE DEPRECIATION & TAX	$23,400

If a Direct Reduction Plant is built in Edmonton or on the Pacific Coast in the Seattle or Vancouver area, the investment to bring Falcon into production is substantially reduced - to approximately 60 M$. In view of the large cash flow, the project could generate, this alternative should be investigated with the possible consumers.

Continued . . .

FREIGHT RATES FROM MACKENZIE:

The distance from MacKenzie to Vancouver by rail is 592 miles, and to Edmonton approximately 625 miles.

British Columbia Railway indicated the rate (for a preliminary feasibility study only) of $15.00 per ton, plus additional switching charges on traffic for furtherance via CN or CP Railways.

On this basis, the rate to Edmonton should be $15.83 per ton. For this study, we used a rate of $17.00 per ton.

CNR would be the main carrier of the ore to Edmonton and their rate structure is such that if the product goes to the Canadian market, there is a "normal rate" of $27.93 per ton from MacKenzie to Edmonton.

It seems to us that this rate is subject to negotiation and for a project which creates jobs and substitutes the import scrap - to be paid in foreign currency - one would get at least the same rates - $15.83 or say $17.00 per ton - which applies for iron ore, if its destination is for export.

Continued . . .

EXPLORATION PROGRAM:

SEMCO in August 1978 recommended a five-stage work program.

The first stage of the program is already finished; consisted of the following items:

STAGE I

Work Items	EXPENDITURES
- Preparation of an air-mosaic map, covering 18 sq. miles.	$ 800.00
- Limited field exploration and surveying to establish a base line to permit sampling and exploration survey control.	1,200.00*
- Helicopter-borne magnetometer survey. Survey lines spaced 1/8 mile. An area of 3 miles x 6 miles will be surveyed, flying approximately 150 line-miles.	10,000.00
- Field supervision, sampling	1,000.00 *
- Engineering, assaying, office work	3,000.00
- Mobilization and contingencies.	1,000.00
TOTAL:	$17,000.00

* Pending due to bad weather conditions on the property.

The airborne magnetic survey results are encouraging enough to recommend the following multi-stage exploration program.

STAGE II

Work Items	EXPENDITURES
A.	
- Staking additional ground.	$ 3,000.00
- Topographic base maps.	1,000.00
- Reconnaisance geology mapping and systematic sampling. On picket line grid of 100 meter line spacing and 25 meter station intervals covering the 6 known magnetic anomalies.	12,000.00
- Detailed ground magnetic survey.	10,000.00
- Preliminary metallurgical testing.	3,000.00
- Helicopter support.	12,000.00
- Travel expenses.	3,000.00
- Supervision & consulting work.	10,000.00
- Office & drafting work.	2,000.00
	$56,000.00
B. Diamond Drill Testing	
- Open, contingent on the evaluation of the results of Stage II A.	$40,000.00
- Helicopter support.	12,000.00
- Consulting work & geologic.	8,000.00
- Contingency and supplies	4,000.00
	$64,000.00
	$120,000

Continued . . .

EXPLORATION PROGRAM (continued)

STAGE III
Work Items

(Open, contingent on results of Stage II)

- Preliminary investigation of infrastructure, logistics, capital and operating costs to assess economic feasibility and relating technical and financial controls.	13,000.00
TOTAL:	$150,000.00

STAGE IV

(Open, contingent on results of Stage III)

- Detailed geologic mapping.
- Preliminary drilling program.
- Preliminary feasibility study.

STAGE V

(Open, contingent on results of Stage IV)

- Detailed drilling program.
- Bulk sampling.
- Metallurgical testing.
- Feasibility study.

Continued . . .

SUMMARY:

From the above review of the Falcon Iron Deposit on one hand, and the supply demand pattern of the Canadian iron/steel industry on the other, it appears evident that the Falcon Project has enough merits to warrant:

a) further exploration and work programs to outline its real potential, - and contingent to the results -.

b) opening negotiations with Federal and Provincial Governments proposing the revision of the tax structure to encourage the eventual development of a mine.

The iron formation on the Falcon Claims appear to be amenable for open pit mining. With a strip ratio of 1.5 waste to 1 ore, there are several ten million tons of material.

The logical market for the Falcon ore is Alberta, British Columbia, and the west coast U.S.A. As the trend of demand indicates these markets in the next 5 - 10 years could not absorb more than 500,000 tons/yr. of pellets, or 400,000 tons/yr. of direct reduced pellets. The deposit appears to have its limitations to support a multi-million ton yearly operation anyway, but even if large reserves exist, the grade and location of the mine couldn't compete with Australian iron ore deposits for the Japanese export market.

Thus at this stage, when planning of an operation is narrowed down to home markets, as long as ore reserves for 20 - 25 years of operation can be foreseen proven out, the exact amount of potential ore is only of academic interest.

The principle advantages of the Falcon Iron Deposit is its relative proximity to the market in the Prairie Provinces and:

a) low impurity content

b) amenability for high grade 67-70% Fe concentrate

c) proximity to a billion ton coal deposit

d) proximity to existing railroad.

A significant problem, however, is the high investments required for infrastructure and high unit costs to produce ore concentrates on a small scale.

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H.E. Neal & Associates Ltd., Preliminary Metallurgical Results - British Columbia Iron Samples. June 1, 1976.

D.A. Bold and N.T. Evans, Direct Reduction Down Under: The New Zealand Story. Iron and Steel International, June 1977.

M.L. Shrikant, Economics: Financial and Technical Consideration In The Choice of Mini-Steel Plant Technology by Developing Nations. Iron-making and Steel-making 1974, No. 2.

A Summary View of Canadian Reserves and Additional Resources of Iron Ore, MR 170, Energy, Mines and Resources Canada, 1977.

G.S. Crawford and J.E. Roberts, Addendum Report, Preliminary Feasibility Study of a Steel Manufacturing Plant in British Columbia for Department of Industrial Development, Trade and Commerce, Victoria, B.C. May 1972.

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V.J. Svesson, Grangcold Pellet Process. Steel Times, May 1969.

Testing of Experimental Grangcold-Bonded Pellets in the Blast Furnace. TMS - AIME Iron-making Proceedings (1970).

Use of Direct Reduced Iron and Balanced Integrated Iron and Steel Operations. Ironmaking and Steelmaking 1977 No. 5.

VERBAL COMMUNICATION AND CORRESPONDENCE WITH:

- Lurgi Canada Ltd., Toronto.
- Allis Chalmers, Reduction Systems Division, Milwaukee, Wisconsin.
- Midrex Corporation, Charlotte, North Carolina.
- Mineral Services Inc., Cleveland, Ohio.
- British Columbia Railway, Vancouver, B.C.
- D.F. Gunning, P.Eng., Vancouver, B.C.
- T.R. Metalcraft, Griffith Mine, Stelco, Ontario.
- Utah Mines Ltd., Vancouver and San Francisco offices.
- Sala Machines Works Ltd., Mississauqa, Ontario.

APPENDIXES

APPENDIX I

BENEFICIATION & AGGLOMERATION

APPENDIX II

DIRECT REDUCTION PROCESSES & TECHNOLOGIES

APPENDIX III

PRELIMINARY METALLURGICAL RESULTS - BRITISH COLUMBIA IRON SAMPLES by H.E. Neal & Associates, June 1st, 1976.

APPENDIX IV

PRELIMINARY FEASIBILITY STUDY - ECONOMICS OF PRODUCING PRE-REDUCED IRON PELLETS VIA THE MIDREX PROCESS by R. Glanville, B.App.Sc., P.Eng., M.B.A.

APPENDIX V

STEEL SUPPLY & DEMAND

APPENDIX VI

REPORT ON HELICOPTER MAGNETIC SURVEY MISINCHINKA RANGE AREA, B.C. OMINECA MINING DIVISION by Aerodat Limited, Ronald F. Sheldrake, B.Sc., December 15th, 1978.

APPENDIX I

BENEFICIATION & AGGLOMERATION:

The Falcon iron ore requires both beneficiation and agglomeration to obtain a marketable product.

The beneficiation and agglomeration have the greatest influence on the economics of iron and steel production. The object of iron ore preparation is to improve the condition of the raw material put into the smelting furance, so that the efficiency of the smelting process is increased and the cost of the final metal is reduced.

BACKGROUND:

In order to meet the requirements of low cost iron and steel production, iron ore as mined has to undergo some form of preparation determined by the physical condition and chemical composition of the ore. Minerals used as source for iron in the industry are magnetite Fe_3O_4, hematite Fe_2O_3, geothite FeO (OH), limonite $Fe_2(OH)_6$ Fe_2O_3, ilmenite FeT_1O_3, siderite $FeCO_3$. The preparation in most cases consist of: crushing, sizing, concentration and agglomeration.

An iron ore concentrate is the end product of an industrial process which can be complex or simple according to the physical and chemical composition of the ore to be treated. The basic goal in all concentration processes is to liberate the pure iron ore grains, eg. magnetite, hematite, etc., from the gangue minerals and form a product suitable for smelting. Usually the preceeding steps of the concentration proper, are those of crushing, grinding, screening and blending.

Crushing and fine grinding is demanded to liberate the ore grains from the wate gangue. The final size an ore has to be ground depends on the grain size of the iron ore particles, which vary from one ore to the other. In case of the North American taconite type, low grade iron ore (22-38% Fe), the concentrates must be ground to 80-85% - 325 mesh (0.045 mm).

The product of the beneficiation of the low grade iron ores is a concentrate which is made up of loose, small size grains of iron ore. As the efficiency of the blast furnace is greatly impaired by a burden containing mixed lumps and fines, methods of agglomeration are widely used in the industry.

Continued . . .

The term "agglomeration" is used to describe any process by which fine, small grained material is formed into larger shapes. Today the most important agglomeration methods are: sintering, pelletizing and briquetting. Sintering is used to fuse together by heat, fine ore of minus ½". However, sintering cannot be used efficiently to agglomerate iron ore with a high proportion of -100 mesh 149 micron particles. As the size range of the ore grains are well below 100 mesh in the case of concentrates of low grade iron ores, a new technology had to be found, which is called pelletization.

The word pellet or ball describes the product of the pelletizing plant. The pellets are spherical in shape and usually +3/8" - ½" in diameter. Their composition varies according to the iron content of the concentrates fluctuating 60-66% Fe. Normally, pelletizing is a two-stage process. It comprises first a balling stage in which the moist loose grains of concentrates are balled into green pellets and then a burning stage during which the pellets are dried and indurated."

BENEFICIATION:

The objective of beneficiating the 36% Fe content Falcon ore is primarily to raise the iron content by concentration of iron minerals and elimination of gangue.

The ore will require extensive beneficiation owing to the need to liberate ore minerals from gangue and to eliminate large quantities of waste.

The preliminary metallurgical tests (detailed in Appendix II) show that a very high grade concentrate, 71.6% Fe was obtained at a grind -400 mesh.

Although the liberation size has not been determined, it is assumed that a coarser grind (325 - 350 mesh) will be sufficient.

Beneficiation will be accomplished by crushing, screening, grinding and probably by gravity separation and magnetic concentration.

The presence of hematite in the ore calls for a more complex flow-sheet in the concentration process, but not enough is known about the ore at this stage to assess the impact in the increase in cost of beneficiating the ore. The iron ore concentrates consisting of particles less than 150 mesh, to be charged to blast furnace or electric furnace for iron/steel-making, must be agglomerated.

Continued . . .

AGGLOMERATION:

"Agglomeration of fine particles has a long history in the iron/steel industry. The requirement and choice of technology may be dictated by a number of factors, including those related to economical, operational and environmental conditions."

Iron ore pellets production (formation of spherical masses of concentrates) has started in 1940 on a commercial basis. The process was known in Europe since the beginning of this century.
"Pellets are made by mixing a small quantity of binder (usually bentonite, sometimes hydrated lime) with finely ground concentrate and balling the mixture in rotating drums or saucer-like disks. The moisture content of the mix must be closely controlled and is usually between 9% and 10%. The "green pellets", usually 3/8 inch to 1/2 inch in diameter, are then hardened in gas or oil-fired furnaces or kilns at about 2,400°F. Most pelletizing systems in use today are of the "straight grate" or "grate-kiln" type. Finished pellets usually contain 62% to 67% iron, have relatively high compressive strength (400 lb/sq.inch or more), and withstand the abrasion of handling and transport better than sinter. General requirements for good quality pellets include complete reductibility in iron and steel furnaces without degradation or excessive swelling.

At the present time, the major portion of pellets is produced in the conventional high temperature processes such as the shaft furnace, rotary kiln, grate, grate-kiln, etc., where the high temperatures require large amounts of energy. Furthermore, a large capital investment is usually required and this necessitates large annual production requirements (over 2 million t/yr) for a profitable operation. The oxidizing conditions transform all of the magnetite in the pellets to the more highly oxidized hematite. These drawbacks have forced the iron/steel industry to look for other less energy-consuming types of agglomeration processes."

Due to the rising price of fuel, oils and natural gas, induration operations requiring less energy than the conventional hot technologies are gaining importance.

COLD BOND PROCESSES:

There are numerous processes available in different stages of development around the world.

Continued . . .

Most of the processes involved are applied at ambient temperatures with or without heat requirements.

The following is a brief description of the most important technologies:

1. THE GRANGCOLD PROCESS

This process was developed by Dr. J. Svesson for Grangesberg Company, Sweden. Iron ore concentrate is mixed with about 10% portland cement or clinker fines, and pellets are formed in a pelletizer and screened to the proper gradation. The green pellets are, however, relatively weak resulting in degradation during storage in the large bins required for hardening. Furthermore, the green pellets have a tendency to stick to one another. To eliminate these problems, the pellets are mixed with an amount of fresh iron ore concentrate equivalent to 1/3rd the weight of pellets. This iron ore is used as a packing material and is fed together with the pellets into the large bins. Early hardening requires a minimum of from 3 to 6 days. During this time, the strengths of the pellets reach about 70% of the final values. The pellets are then screened to remove the iron ore fines and are stored in outside stockpiles to complete a 30 day setting time. The Grangcold pellets have been used mostly in blast furnace and hasn't had encouraging results in any direct reduction system.

2. HYDROTHERMAL PROCESSES

The binding mechanisms in these processes are entirely different than those in the previous process. Lime and silica which are used as binders, dissolve to some degree under hydrothermal conditions and react with one another to form a new product consisting of calcium hydro silicates, which binds particles together in a manner similar to hydrothermal rock formation in nature.

3. MTU COLD BOND PROCESSES

Research on the cold bond agglomeration process for pelletizing and briquetting of mineral fines such as chromite, manganese and iron was started in 1960 at Michigan Technological University.

The process was developed primarily for iron ore agglomeration.

The fine materials to be agglomerated are mixed intensively with a binding agent such as lime and silica and reducing agents (such as coke or coal fines) may be added when desired. Green pellets are formed, then screened, dried and finally hardened

Continued . . .

in an autoclave. The autoclaving time is from 1 to 2 hours at 300 psig (21 atm.) or longer at lower temperatures.

During autoclave hardening, the reactants (hydrated lime and siliceous materials) partially solubilize under hydrothermal conditions, react chemically and form a new substance which bonds the particles together. The bonding action remains firm under reducing, oxidizing and neutral conditions.

As the test results indicate, MTU Cold Bond process pellets are equivalent to or better than conventional iron ore pellets. The pellets were found to be resistant to outside storage or climatic conditions and some pellets were stored outside immediately after production for more than one year at Houghton, Michigan.

As visualized, MTU Cold Bond process pellets would be applied in a manner quite similar to hot indurated pellets in the SL/RN Direct Reduction process. The main differences would be in the characteristics of the pellets. The MTU pellets would contain the carbon internally which has been found to result in internal solid-solid reduction as follows:

$$Fe_2O_3 + 3C \rightarrow 2Fe^{O} + 3CO \qquad (1)$$

The carbon monoxide diffuses from the interior of the pellets to the shell and burns in the furnace with excessive air. In the SL/RN process, CO is formed on the surface and the pellets are reduced by solid-gas reduction as follows:

$$Fe_2O_3 + 3CO \rightarrow 2Fe^{O} + 3CO_2 \qquad (2)$$

whereby the much slower rate of diffusion of CO from the shell to the interior of the pellets has a very important effect on the rate and percentage completion of reduction. This obviously results in longer retention times and the requirement for relatively larger equipment. Metallization of MTU process pellets would also have important advantages over the gas-reducing processes, primarily since relatively inexpensive reducing reagents can be applied. These include coke breeze, bituminous coal fines, and lignite or char; a gaseous reductant is not required. This substitution of cheaper reductants is not only economical, but as pre-reduction gains in importance, it will result in tremendous savings in the limited reserves of natural gas or other gaseous petroleum derivatives worldwide.

Continued . . .

Researchers of the MTU process report:

"Reduction with internal carbon in the MTU process can be accomplished at higher than conventional temperatures. The resultant metallized pellets are dense, hard iron masses which are usually more or less pryrophoric. Laboratory experiments with iron ore super concentrates have indicated that application of the MTU Cold Bond process results in pellets of either similar or superior quality to SL/RN process pellets. Tests show that this pellet can be metallized to 98.5% with a resultant iron content of 88.5% and carbon of 0.70%."

Presently the MTU process appears to be the most promising for an industrial scale operation.

Kaiser Steel is building a plant in the U.S.

For the Falcon project, this technology should be investigated in depth as excellent use could be made of the nearby coal deposit.

DIRECT REDUCTION PROCESSES AND TECHNOLOGIES:

The numerous processes used today can be categorized as follows:

1. Retort processes: nearly isothermal reduction in a fixed ore bed.

2. Shaft furnace process: gas reduction of a descending ore charge.

3. Fluidized bed processes: isothermal gas reduction of a fluidized, fine-grained ore bed, usually in several successive steps.

4. Rotary kiln processes: reduction in a kiln rotated about its longitudinal axis (30 revs/h), usually using solid reducing agents.

1. RETORT PROCESSES

The best known retort process is the HyL (Hojalata y Lamina), Developed in Mexico, it has been applied on a large industrial scale in Monterrey since 1957. The process operates discontinuously; the charge (lump ore or pellets) is pre-reduced, finish-reduced, cooled and discharged in separate stages.

2. SHAFT FURNACE PROCESS

Of the shaft furnace processes, which like HyL operate on a lump charge, mention should be made of the Midrex (Korf Group, Purofer (Thyssen) and Armco processes. An important operating condition for shaft furnace processes is uniform gas penetration of the burden. The processes differ mainly in the means of gas production, gas circulation (Midrex and Purofer involve gas recycling, Armco does not) and the shape of the shaft. Furthermore, in the Purofer process, the sponge iron is not cooled at the end of the shaft, but either hot-charged directly to the furnaces or hot-briquetted.

The Midrex process is the most widely used Direct Reduction technology used today. For iron deposits situated in areas where gas is readily and cheaply available, this process proved to be the most economical.

3. FLUIDIZED BED PROCESSES

In the fluidized bed processes, fine-grained ore is whirled up by the gas to form a quasi-homogeneous medium and then reduced. However, the gas velocity has to be correlated to grain diameter (in a narrow size range). A further problem, sticking of the fine-grained ore during reduction, makes it necessary to operate at low temperatures. In this group are US Steel's HIB process (High Iron Briquette) and the FIOR process (Fluid Iron Ore Reduction) developed by Esso Research.

Continued . . .

DIRECT REDUCTION PROCESSES & TECHNOLOGIES (continued)

4. ROTARY KILN PROCESSES

The main process using solid reductants is the rotary kiln. In rotary kiln reduction, the various operations take place both in parallel and successively (transport, mixing, grain separation, heating, gas production, reduction).

The rotary kiln systems used on an industrial scale are the Krupp Sponge Iron and the SL/RN process developed by Lurgi in cooperation with Stelco, Republic Steel, and National Lead processes.

Direct reduction in the rotary kiln according to the SL/RN process meets all technological requirements for the use of low-grade coals in the production of sponge iron, which in turn can be utilized directly as a primary material in the steel mill. For this purpose, a rotary kiln is charged at a controlled rate with ore in the form of pellets, lump ore or fine ore and with coal, while the successive processes of drying, heating and reduction are controlled by means of air which is blown in directly along the length of the kiln and indirectly by submerged air-injection. To avoid reoxidation, to control carbon level in the kiln discharge material, fuel oil or gas is submerged injected in the last part of the kiln. This is also required for direct hot charging of kiln product. After the product has been cooled in a drum, the ashes and any re-cyclable fuel which may be left over are screened off or magnetically separated from the sponge iron.

Today, SL/RN plants are built for capacities ranging from 300,000 to 400,000 t/yr. of sponge iron.

This system has a special advantage in that it permits small units, the so-called mini-steel plants, to be operated economically by using large variety, locally available solid reductants - lignite, low rank coal.

Another important Direct Reduction technology is "ACCAR" - Allis Chalmers' Direct Reduction System.

In the ACCAR process, iron ore is thermo-chemically reduced into a highly metallized product. The ported rotary reactor - kiln - was developed by Allis Chalmers.

It operates on a mixture of sprayed-in oils and natural gas, which is converted into reducing gas within the charge; alternate or simultaneous addition of solid reducing agents is also possible.

Continued . . .

DIRECT REDUCTION PROCESSES & TECHNOLOGIES (continued)

A process involving solid reduction in an external heated shaft furnace has been developed by Kinglor Meteor S.A., a company jointly owned by Danieli (Italy) and Monteforno (Switzerland). The Kinglor Meteor process is used only for low production rates; each reduction module comprises a furnace containing a number of vertical retorts. The first commercial plant at Cremona in Italy, has a capacity of 40,000 t/y.

H. E. NEAL & ASSOCIATES LTD.
Mineral Consultants
Geology - Mineral Dressing - Mining
124 Roxborough Drive, Toronto, Canada. Telephone 925-1534

APPENDIX III

MEMORANDUM

TO: Welcome North Mines - Ventures West Capital

FROM: H.E. Neal P.Eng.

DATE: June 1, 1976

SUBJECT: Preliminary Metallurgical Results - British Columbia Iron Samples

1. GENERAL STATEMENT

The attached report by Lakefield Research of Canada contains preliminary results of metallurgical testwork on two small shipments of iron ore specimens forwarded by Mr. John Brock of Welcome North Mines Ltd.

Sample	Weight	Crude Grade	
		% SolFe	% Magnetic Iron
1	10 pounds	42.4	32.4
2	30 pounds	56.6	52.2

The specimens consisted of a medium to fine-grind crystalline magnetite with minor hematite, limotitic stain, chlorite and quartz. Sample 2 material showed a faint banding or schistosity of magnetite crystals which appears to be a metamorphic product rather than the very fine-grained primary taconite type of sediment.

2. SUMMARY OF RESULTS

a) Magnetic concentrates with over 71% Soluble Iron were produced from the two samples. This grade of concentrate is suitable for direct reduction production of metallized pellets.

b) The specimens tested showed an above average crude iron and magnetic iron content.

c) Both samples showed excellent liberation at minus 400 mesh (37 microns) with Sample 2 showing magnetite liberation at 56% minus 400 mesh.

d) Magnetic Iron Content - By Davis Tube Test

Sample	Magnetic Concentrate			Grind
	% Wt	% SolFe	% FeRecovery	% -400 M
1	45.8	71.8	77.7	100.
2	73.1	71.4	92.2	56.2
	72.1	71.8	91.5	91.3

Sample 2 had a higher proportion of iron present as Magnetite than Sample 1 showing a 92% Fe Recovery versus 78% Fe Recovery for Sample 1 by magnetic separation.

e) Concentrate Analyses

The concentrates from Sample 2 were analysed for elements which might be undesirable for iron concentrate. The level of trace elements is within normal acceptable limits.

2. e) (continued)

Soluble Fe:	71.6%
Titania (TiO_2)	0.11%
Silica (SiO_2)	0.70%
Sulphur (S)	0.006%
Phosphorus (P_2O_5)	0.05%
P	0.011%

The semi-quantitative Spectrographic Analysis showed no harmful elements present except for Arsenic at 0.1%. This analysis is not considered to be reliable by spectrographic analysis and it is being checked by normal distillation quantitative analysis. This result will be reported as soon as it is available.

H.E. Neal P.Eng.
Consulting Engineer

An Investigation of

THE RECOVERY OF IRON

from samples

submitted by

M.R. NEAL AND ASSOCIATES LIMITED

Progress Report No. 1

Project No. L.R. 1927

NOTE:

This report refers to the samples as received.

The practice of this Company in issuing reports of this nature is to require the recipient not to publish the report or any part thereof without the written consent of Lakefield Research of Canada Limited.

LAKEFIELD RESEARCH OF CANADA LIMITED
Lakefield, Ontario
May 31, 1976

I N D E X

I N T R O D U C T I O N

Two samples of iron ore from British Columbia, marked Welcome North, were received from Mr. H.E. Neal on April 28th, 1976 and May 6th, 1976, respectively.

It was requested that David Tube Tests should be conducted on both samples. On the first sample a reducing roast was to be followed by David Tube concentration, as well as a mineralogical examination was to be carried out.

LAKEFIELD RESEARCH OF CANADA LIMITED

A.G. Scobie, P. Eng.,
Manager

D.M. Wyslouzil, P. Eng.,
Chief Metallurgist

Investigation by: O.F.C. Cook
R.W. Deane

S U M M A R Y

1. Sample No. 1

The sample contained medium-grained magnetite and minor fine-grained hematite in a gangue matrix, which consisted of quartz, chlorite and mica. The head analysis of this ore was 42.4 % soluble iron and 32.4 % magnetic iron. After magnetic roasting the amounts of soluble and magnetic iron were equal.

1.1. Davis Tube Results

Sample No.	Head Assay %		Concentrate			Tailing	% Minus
	Sol. Fe	Mag. Fe	Weight %	% Sol. Fe	% Fe Rec'y	% Sol. Fe	400 mesh
As is	42.4	32.4	45.8	71.8	77.7	17.5	100
Roasted	43.7	43.6	61.9	66.2	93.7	7.1	100

Conditions:

Davis Tube : Pulverized to 100 % -400 mesh.Standard Davis Tube parameters.

Roasting : 25 % CO, 75 % CO_2 mixture
700° for 1 hour.

2. Sample No. 2

This sample was higher in iron and contained little hematite. Soluble iron was determined to be 56.6 %, whereas the magnetic iron content was 52.2 %.

2.1. Davis Tube Results

Grinding Time per 100 grams	% Minus 400 Mesh	Head Analysis		Concentrate			Tailing
		% Sol. Fe	% Mag. Fe	Weight %	% Sol. Fe	% Fe Rec'y	% Sol. Fe
8 Minutes	56.2	56.6	52.2	73.1	71.4	92.2	16.4
24 Minutes	91.3	56.6	52.2	72.1	71.8	91.5	17.3

Summary - Continued

2.2. Concentrate Analysis

Soluble Iron (Fe)	71.6 %
Titania (TiO_2)	0.11 %
Silica (SiO_2)	0.70 %
Sulphur (S)	0.006 %

A semi-quantitative spectrographic analysis is shown with the test results.

NOTE TO ACCOMPANY PAGE 3

The Soluble Iron in the Combined Concentrate of Sample 2 should be 71.6% rather than 72.6%. This typing error was noted after the report was issued and it was revised as a result of a telephone discussion with Mr. Wyslouzil of Lakefield Research Of Canada. The 71.6% Fe is confirmed by the average of the Davis Tube Concentrates from the 8 minute and 24 minute grinds.

H.E. Neal P.Eng.

June 1, 1976

SAMPLE PREPARATION

Both samples were crushed to minus 20 mesh. From Sample No. 1 a head sample was prepared and assayed for soluble iron, magnetic iron and loss on ignition at 1100°C. Samples were also removed for the reducing roast and the mineralogical examination.

From Lot 2 several 100 gram samples were prepared for grinding in the pebble mill.

DETAILS OF TESTS

Sample No. 1

A. Davis Tube Tests

Samples of the pulverized head and roast product were hand-mortared to all minus 400 mesh. A ten gram charge of each was passed through the Davis tube under the following conditions:

Waterflow	1 liter per minute
Tube Oscillations	100 strokes per minute
Current to Poles	2.0 amperes
Retention Time	5 minutes

The magnetic fractions were filtered, dried, weighed and assayed for soluble iron. The non-magnetic fractions were recovered but not assayed.

Davis Tube Results

Head Sample

Head			Concentrate			Tailing	
Assay % Sol. Fe	Assay % Mag. Fe (Satmagan)	Assay % Mag. Fe (Calc.)	Weight %	Assay % Sol. Fe	% Rec'y Sol. Fe	Assay % Sol. Fe	% Minus 400 Mesh
42.4	32.4	32.9	45.8	71.8	77.7	17.5	100

Roasted Product

43.7	43.6	41.0	61.9	66.2	93.7	7.1	100

Details of Tests - Continued

B. Reducing Roast Test

Test No. R-1

Purpose: To convert hematite to magnetite.

Feed: 500 grams of Lot 1 sample was stage-pulverized to minus 65 mesh.

Procedure: The ground sample was roasted for one hour at 700°C in a Vycor glass rotary tube furnace. The flow of gas was 500 ml. per minute and consisted of 25 percent CO and 75 percent CO_2.

Observations: The roast product was black in colour. Some dust loss was observed.

Results: Weight of roaster product 46.4 grams

Sample No. 2

Davis Tube Tests

100 gram charges of the Lot 2 sample at minus 20 mesh were ground in an Abbe Pebble Mill for 8 minutes and for 24 minutes. Ten gram charges of each were then passed through the Davis Tube.

8 Minute Grind

Head Assay % Sol. Fe	Head Assay % Mag. Fe (Satmagan)	Head Assay % Mag. Fe (Calc.)	Concentrate Weight %	Concentrate Assay % Sol. Fe	Concentrate % Rec'y Sol. Fe	Tailing Assay % Sol. Fe	% Minus 400 Mesh
56.6	52.2	52.2	73.1	71.4	92.2	16.4	56.2

24 Minute Grind

Head Assay % Sol. Fe	Head Assay % Mag. Fe (Satmagan)	Head Assay % Mag. Fe (Calc.)	Concentrate Weight %	Concentrate Assay % Sol. Fe	Concentrate % Rec'y Sol. Fe	Tailing Assay % Sol. Fe	% Minus 400 Mesh
56.6	52.2	51.8	72.1	71.8	91.5	17.3	91.3

Details of Tests - Continued

Screen Analyses

Lot 2

Pebble Mill Grind (8 Minutes)

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 150 mesh	1.1	1.1	98.9
200 mesh	8.0	9.1	90.9
270 mesh	14.5	23.6	76.4
400 mesh	20.2	43.8	56.2
- 400 mesh	56.2	100.0	-
Total	100.0	-	-

Pebble Mill Grind (24 Minutes)

+ 200 mesh	0.3	0.3	99.7
270 mesh	1.0	1.3	98.7
400 mesh	7.4	8.7	91.3
- 400 mesh	91.3	100.0	-
Total	100.0	-	-

Additional Analyses

Head Sample - Lot 1

Loss on Ignition

Sample treatment - heated from 500°C in increments of 200°C to 1100°C where heat maintained for one hour.

Sample gained 0.32 % by weight on ignition.

Details of Tests - Continued

Additional Analyses

Combined Davis Tube Concentrates Lot 2

The David tube concentrates from the 8 minute and 24 minute grinds were combined and assayed for:

P_2O_5	0.05 %
SiO_2	0.70 %
TiO_2	0.11 %
S	0.006 %

A portion of this concentrate was also prepared for 30 element semi-quantitative spectrographic analysis.

Details of Tests - Continued

30 Element Semi-Quantitative Spectrographic Analysis

Concentrate

Element	Lot 2	Element	Lot 2
Aluminum (Al_2O_3)	<.01 %	Manganese	<.005 %
Antimony	-	Magnesium (MgO)	<.01 %
Arsenic	.1 %	Molybdenum	<.002 %
Barium	-	Neodymium (Nd_2O_3)	-
Beryllium (BeO)	-	Nickel	.002 %
Bismuth	-	Phosphorus	-
Boron	-	Silver	-
Calcium (CaO)	<.05 %	Silicon (SiO_2)	.5 %
Cadmium	-	Sodium (Na_2O)	-
Cerium (CeO_2)	-	Strontium	-
Chromium	.01 %	Tantalum (Ta_2O_5)	-
Cobalt	.01 %	Thorium (ThO_2)	-
Columbium (Cb_2O_5)	-	Tin	-
Copper	<.002 %	Titanium	<.01 %
Gallium	-	Tungsten	-
Germanium	-	Uranium (U_3O_8)	-
Iron (Fe)	H	Vanadium	<.005 %
Lanthanum (La_2O_3)	-	Yttrium (Y_2O_3)	<.002 %
Lead	<.002 %	Zinc	<.01 %
Lithium (Li_2O)	-	Zirconium (ZrO_2)	.01 %

CODE:

H - High 10 - 100 % approx.
- - Not Detected - Elements looked for but not found
< - Less Than

APPENDIX

Microscopic Examination

of a "Welcome North Project" sample

submitted by

H.E. Neal and Associates Limited

I N T R O D U C T I O N

A minus 10 mesh "Welcome North Project" head sample (Sample No. 1) was received in the Mineralogical laboratory from H.E. Neal and Associates Limited on May 4, 1976.

The sample was submitted for identification of the iron-bearing minerals.

S U M M A R Y

The sample contained medium-grained magnetite plus minor fine-graine hematite in a gangue matrix, which consisted of quartz, chlorited and mica.

PREPARATION AND PROCEDURE

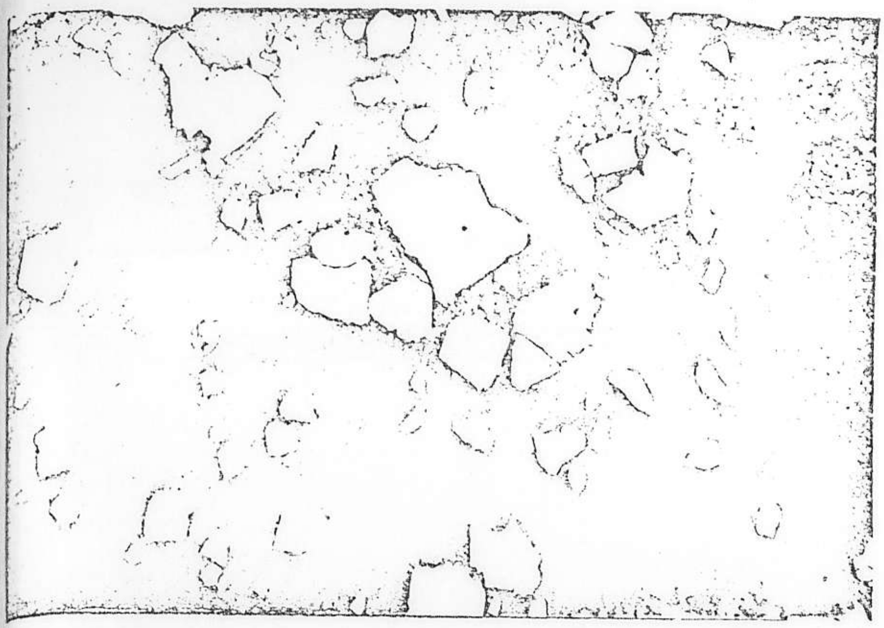
A portion of the sample was briquetted and polished for microscopic examination in reflected light.

RESULTS

The sample contained magnetite and minor hematite as the major iron-bearing minerals, and quartz plus chlorite and biotite as the gangue minerals. The magnetite was relatively medium-grain sized and the hematite fine-grained, as is shown in the accompanying illustrations.

Some hematite occurred as partial rims or as attachments on magnetite, but most of it was associated with gangue. This material appeared to represent a metasedimentary rock.

LAKEFIELD RESEARCH OF CANADA LIMITED
Lakefield, Ontario
May 31, 1976 , dmm, sem

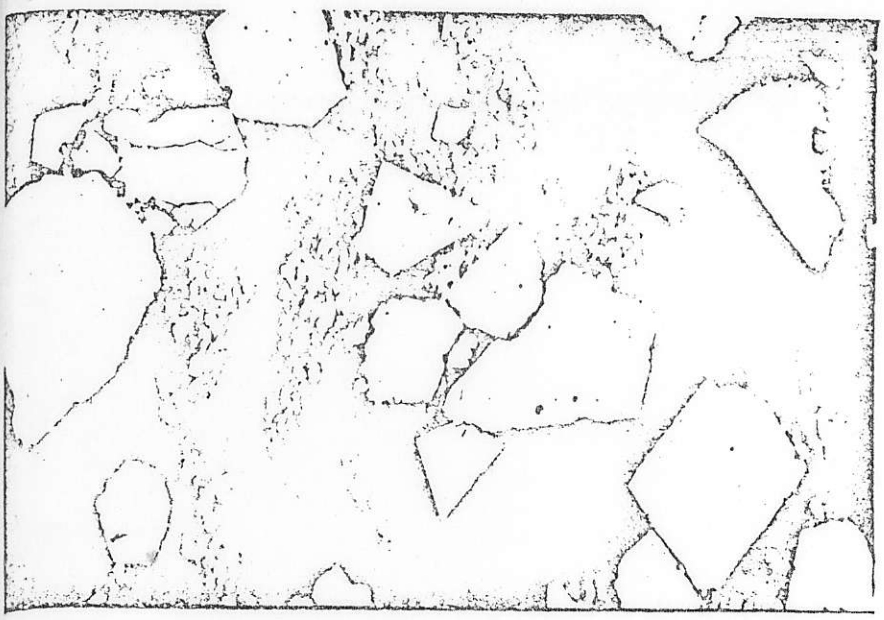


74 µm
(200 mesh)

Illustration 1

Magnetite (coarse-grained gray grains) with hematite present as fine-grained white coloured inclusions in gangue.

Magnification 250 X



74 µm
(200 mesh)

Illustration 2

As for Illustration 1. Note the hematite on the magnetite grains.

Magnification 250 X

THE FOLLOWING INFORMATION IS A DIRECT QUOTATION FROM: PRELIMINARY FEASIBILITY STUDY - ECONOMICS OF PRODUCING PRE-REDUCED IRON PELLETS VIA THE MIDREX PROCESS (BY R. GLANVILLE, B.App.Sc., P.ENG., M.B.A.)

MARKET FOR PRE-REDUCED PELLETS

QUANTITY

The market for pre-reduced pellets in Western Canada and Washington by the late 1970's might be as follows:

Ipsco, Regina	400,000 tpy
Manitoba Rolling Mills, Selkirk	75,000 "
Western Canada Steel (Calgary & Vancouver)	200,000 "
Stelco, Edmonton (now supplied by Griffith Mine)	200,000 "
Anthies, Calgary	25,000 "
Seattle area	400,000 "
	1,300,000 tpy

PRICE

The average delivered price we might expect to receive would be between \$100 and \$110/short ton delivered.

Although there is a demand for pellets in many other locations throughout the world, our market is probably limited to an area to which material can be delivered at transportation costs of less than \$25/SDT.

COSTS

The following approximate costs are based on those of the Midrex Process:

CAPITAL COSTS

Midrex plant	\$ 85/ST of pre-reduced pellets
Mine/mill/pellitizer	\$ 55/ST " " "
	140/ST " annual capacity

Assume production level of 1,300,000 tpy
therefore capital cost = \$182,000,000

Allowing for interest during two year construction period raises this cost to about \$200,000,000.

OPERATING COSTS

a) Mine/mill

Assume strip ratio:	3:1
" ore grade:	45% Fe
" recovery:	85%
" pellet feed grade:	65% Fe

Mill throughput: 1,300,000 x 100/65 x 65/45 x 1/0.85 = 3,400,000 tpy

Mill cost at \$2/ton milled \$6,800,000

Continued . . .

Amount mined at 3:1 strip ratio = 4 x 3,400,000 = 13,600,000 tpy
Mine cost at 60¢/ton $8,160,000/year
Total mine mill costs $14,960,000
Cost of mine/mill per ton of pre-reduced pellets is:
$14,960,000/1,300,000 = $11.50

b) Oxide pellitizing operating cost is approximately $5.00/Short Ton of pre-reduced pellets.

c) Midrex process

Natural gas (11,000,000 BTU) at $2.00/MCF	$22.00
Electricity 125 KHW/ST x 1.2 cents	1.50
Manpower (230 men at $20,000/year)	3.50
Total conversion cost	$30.50

Summary of operating costs:

Total conversion costs	$30.50
Mine/mill operating costs	11.50
Pellitizing operating costs	5.00
Transportation (average)	20.00
Total operating	$67.00

AMORTIZATION OF CAPITAL

Assume average delivered price	$105.00
Total operating costs	67.00
Revenue per ton	$ 38.00

Revenue/year = $38.00 x 1,300,000 tpy = $49,400,000
Assumption:
a) depreciation at 20% declining balance
b) tax rate of 45%

CONCLUSION

This preliminary economic analysis indicates a project rate of return of over 16 percent after taxes. With the use of $100,000,000 of debt (i.e. debt/equity ratic = 1.0) at 12% interest rate the rate of return on equity is increased to 27 percent.

The above rates of return indicate that we should attempt to delineate the magnetite ore body. Minimum tonnage for a plant capable of producing 1,300,000 tpy of pre-reduced pellets would be about 50,000,000 tons grading 45% iron. However, at production levels of 2/3 and 1/3 of the above, the required tonnage would be reduced accordingly.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenue Minus Operating Costs	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400
Depreciation (20%)	40,000	32,000	25,600	20,480	16,384	13,107	10,486	8,389	6,711	5,369	4,295	3,436	2,749	2,199	1,760
Taxable Income	9,400	17,400	23,800	28,920	33,016	36,293	38,914	41,011	42,689	44,031	45,105	45,964	46,651	47,201	47,640
Tax at 45%	4,230	7,830	10,710	13,014	14,857	16,332	17,511	18,455	19,210	19,814	20,297	20,684	20,993	21,240	21,357
Cash Flow	45,170	41,570	38,690	36,386	34,543	33,068	31,889	30,945	30,190	29,586	29,103	28,716	28,407	28,160	28,043
Discount at 15%	39,278	31,433	25,439	20,804	17,174	14,296	11,988	10,116	8,582	7,312	6,255	5,367	4,617	3,980	3,446
Discount at 18%	38,280	29,855	23,548	18,768	15,099	12,249	10,011	8,233	6,807	5,653	4,712	3,940	3,303	2,775	2,342

Cumulative at 15% = $210,087,000

Cumulative at 18% = $185,575,000

IRR = 16¼% = Project Rate of Return

50% Debt = $100,000,000
50% Equity = $100,000,000
Loan amortized over 15 years at 12% interest
Annuity payment = $14,682,347/year

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenue - Operating	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400	49,400
Interest Cost	12,000	11,678	11,318	10,914	10,462	9,955	9,388	8,753	8,041	7,244	6,351	5,351	4,232	2,978	1,573
Capital Cost Allowances	37,400	34,590	25,600	20,480	16,284	13,107	10,486	8,389	6,711	5,369	4,295	3,436	2,749	2,199	1,760
Interest plus CCA	49,400	46,268	36,918	31,394	26,846	23,062	19,874	17,142	14,752	12,613	10,646	8,787	6,981	5,177	3,333
Taxable Income	0	3,132	12,482	18,006	22,554	26,338	29,526	32,258	34,648	36,787	38,754	40,613	42,419	44,223	46,067
Tax at 45%	0	1,409	5,617	8,103	10,149	11,852	13,287	14,516	15,592	16,554	17,439	18,276	19,089	19,900	20,730
Principal payback	2,682	3,004	3,365	3,769	4,221	4,727	5,294	5,930	6,642	7,439	8,331	9,331	10,451	11,705	13,109
Interest Cost	12,000	11,678	11,318	10,914	10,462	9,955	9,388	8,753	8,041	7,244	6,351	5,351	4,232	2,978	1,573
TOTAL Deductions	14,682	16,091	20,300	22,786	24,832	26,534	27,969	29,199	30,275	31,237	32,121	32,958	33,772	34,583	35,412
Cash Flow	34,718	33,309	29,100	26,614	24,568	22,866	21,431	20,201	19,125	18,163	17,279	16,442	15,628	14,817	13,988
Discount at 15%	30,190	25,186	19,134	15,217	12,215	9,886	8,057	6,604	5,436	4,490	3,714	3,073	2,540	2,094	1,719

Cumulative at 15% = $149,555,000
therefore net present value = $149,555,000 - $100,000,000 = $49,555,000

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discount at 25%	27,774	21,318	14,899	10,901	8,050	5,994	4,495	3,389	2,567	1,950	1,484	1,130	859	652	492

Cumulative at 25% = $105,954,000

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discount at 28%	27,123	20,330	13,876	9,915	7,150	5,199	3,807	2,803	2,074	1,538	1,143	850	631	467	345

Cumulative at 28% = $97,351,000

Therefore IRR = 27%

STEEL SUPPLY & DEMAND APPENDIX V

Forecast of rolled and crude steel supply and demand 1980, 1985, and 2000 (000 net tons).

	1980	1985	2000 Low	2000 High
A. ROLLED STEEL, AND SEMIS AND INGOTS				
Total producer shipments	14,632	17,784	25,300	28,671
Apparent consumption	15,934	19,678	27,200	32,968
B. RAW STEEL EQUIVALENTS [1]				
Total producer shipments	18,867	22,961	32,722	37,100
Apparent consumption	20,543	25,406	35,175	42,665
C. STEEL CASTINGS				
Total producer shipments	228	252	322	322
Apparent consumption	216	240	310	310
D. TOTAL RAW STEEL (B + C)				
Total producer shipments	19,095	23,213	33,044	37,422
Apparent consumption	20,756	25,646	35,485	42,975
NET INCREASE IN IMPORTS [2]	1,661	2,433	2,441	5,553

---

[1] (Rolled steel + semis and ingots) less (total semis and ingots) - 0.77 (i.e. one ton of raw steel is equivalent to 0.77 ton of rolled steel) plus (total semis and ingots).

[2] Imports currently in excess of exports promise to increase because of higher growth for consumption compared with production.